NESTE PARK

NATURE CENTER DESIGN PROJECT

Gutowski & Guys

Matthew Allender, Sarah Gutowski, Nicholas Herkert, Brock Kamrath, Jaccob O'Connor, Kyle Rodriquez, Alex Zeppieri

Submitted:
May 1st, 2015 to
The University of Iowa
Department of Civil and Environmental Engineering

The University of Iowa
IOWA INITIATIVE
FOR SUSTAINABLE COMMUNITIES

Executive Summary

Outside of Decorah, Iowa, the Winneshiek County Conservation Board has designated a retired farmstead as the site for a project that will benefit the area in a multitude of ways- the Neste Park Recreational Facility and Nature Center. A multi-functional facility in coordination with a brand new trail system will produce an ideal setting for activities of all types during all seasons.

Gutowski & Guys received the opportunity to design the recreational facility and nature center in the early months of 2015. Seven skilled members account for the team responsible for completing the requested 30% design, bringing experience from all fields of civil engineering and architectural design. Project details and desires were provided by the Winneshiek County Conservation Board through online and in person communication. The scope of the project provided to Gutowski & Guys consisted of designing a multi-functional nature center, an access road, green technology, and a parking lot. Although no budget was defined, the designed building, roadway, and parking lot can be built for an estimated ***$2,505,761.04***.

Following client requests, a two story facility was designed for the retired farm land. Requests included but were not limited to a barn theme, high visibility from the neighboring highway, an interactive exhibit area, spacious office areas, and an auditorium or community center area capable of housing large scale events. Using two design alternatives, the client and design team produced two varying yet quality possibilities. Following the client's request, an off set two story design with areas capable of carrying out more than one role was designed, including solar panels on southern facing roofs, extensive outdoor decking and patios, and exposed wooden materials.

Inside the multi-story building will be several main areas. As the visitor approaches the site from the neighboring highway, a state of the art facility will be clearly visible from both directions. Upon entrance to the facility, a 3000 square foot interactive exhibit area will be visible, along with five offices and a conference room totaling roughly 2000 square feet. Along the east, west, and south sides of the building runs a wooden deck for outdoor gatherings or simply viewing the park. As for the lower level, a multi-function conference center complete with stage totaling over 5,000 square feet will dominate the area. In addition, the lower level will feature a kitchen/catering area, and an accommodating storage room, complete with a storm shelter capable of protecting over 50 people. Outside the lower level, a concrete patio allows for easy enjoyment of the landscape and a potential rest area for visitors coming off the new trail.

An asphalt road following appropriate design standards was designed to connect a country road with the new facility. Just to the west of the building and access road lies a parking lot with the capacity to function for varying event sizes, including multiple bus parking stalls and a bioretention cell to manage stormwater runoff. Handicap accessibility was emphasized both in the parking lot and building design, with five handicapped spaces and an elevator/walkway design both aligning with ADA standards. In addition, all appropriate turning radiuses and lane sizes present in the parking lot/access road are large enough to accommodate RV travel during popular camping seasons.

1.0 Introduction

Here at the University of Iowa, the capstone course for senior level engineering students is Project Design and Management. The goal of this course is to unite students from various Civil Engineering focus areas to function as a team to handle a real world project. Throughout this real world project, the students gain insights into the work load, design process, and constraints of practicing engineers. Along with insights into the world of practicing engineers, students get the opportunity to show the skills they've gathered on an actual design, all while developing new skills to successfully navigate unexpected design challenges. For Gutowski & Guys, this real world project was the development of a nature center design and subsequent site work. The following report presents a thorough annotation of the steps taken throughout the span of the project.

2.0 Problem Statement

2.1 Design Objective

Gutowski & Guys was tasked with developing an environmentally friendly and aesthetically appealing design of a Nature Center for the Neste Park recreational area. The current nature center within Winneshiek County was built in the 1970s in is severely outdated. The proposed designs seek to develop the park and create a center that encourages people to interact with, learn about, and connect to natural resources. The center will cater to school groups, tourist, campers, bicyclists from the trail system, and other organized groups, such as naturalist-led programs. As specified prior to project proposal, the designs presented in this report are taken to roughly 30% completion.

2.2 Approaches

The designs were developed in a manner to accentuate the existing features of the site, all the while being as environmental friendly as fiscally possible. In regards to aesthetic appeal, the design incorporates a prairie themed building, utilizes wood building materials for its structural components, an open floor plan, and large windows to accentuate the surrounding scenery. In regards to environmentally friendly design components, the design was built into a hill to minimize heating and cooling cost due to natural ground insulation, and incorporates a solar energy system, a rainwater collection system, daylighting techniques, and a bio retention cell for parking lot rain runoff.

The structural design was done in accordance with the codes and stipulations laid out by the three distinct entities of the Winneshiek County Planning and Zoning function; the Zoning Administrator, the Planning and Zoning Commission, and the Board of Adjustments. The structural components were designed following guidelines laid out by organizations such as ACI, ASCE, APA, and various others referenced later in the report.

The transportation infrastructure will be designed with the Iowa Department of Transportation Office of Design's Design Manual as the primary source and the water management plan will be designed with the Iowa Storm Water Management Manual as the primary source. Both these systems were developed with the Civil 3D software.

2.3 Constraints

In the course of the design process, several constraints were prevalent, such as cost, space, aesthetics, design requirements, and environmental considerations.

The allowable cost of the project was not explicitly given to the design team. The design team strived to produce a design that was as cost effect as possible, while still possessing all the necessary functions specified by the client.

The client provided the design team with a location that the structure is to be built, as well as what the structure should contain. The client specified the nature center should contain a general open area for temporary displays and presentations, accommodations for permanent displays (specifically a cold water aquarium with 3 species of live trout), educational facilities in the form of one or more classrooms, approximately 5 offices, board room, reception desk, conference room with 200-250 person capacity, kitchen attached to conference room, large outdoor patio for receptions, and a basement level to house all mechanical equipment.

The client requested that the design be aesthetically incorporated into the landscape and appear as natural as possible. This constraint guided the design alternative developments to focus on barn and/or prairie themed buildings.

The environmental considerations are one of the most important considerations for the Nature Center and were a constant point of emphasis throughout the design process. The design team sought to employ several sustainable technologies, such as solar, rainwater management, and energy efficient measures to ensure the building will have as small an ecological footprint as possible.

2.4 Challenges

In the course of the design process, there were several challenges in developing the design alternatives, such as topography, inexperience with sustainable technologies, time, and distance from the site location.

The first challenge for the design team was the predetermined site location. The predetermined site location is resting in a steep hillside and posed challenges to developing alternatives that utilizes the topography efficiently. Having the site location for the building already predetermined challenged the design team to orient the building in a manner to incorporate easy access from the parking lot, southern facing roof surfaces for a solar energy installation, and a large topographically flat area for a patio reception area.

Another challenge for the design team was the relative newness of the sustainable technologies that the site will involve. No member of the design team had a substantial history in the design of sustainable technologies. Many of the design processes for these alternatives (such as a solar energy system), lack any official manual, and thereby lack any clear cut procedures.

The relatively short amount of time (13 weeks) to design such a large and complex structure made it very difficult to incorporate and design all requested components. The design team worked as fast as possible to keep on schedule for the on-time completion of the project. The distance from the client made it difficult at times to keep on track due to the need to meet and discuss options with the client. The design team acknowledges that certain aspects of the project services outlined in the proposal did not get completed due to the time restraints.

2.5 Societal Impacts

The implementation of a nature center to the Neste Park Recreational Area will impact the surrounding communities economically, environmentally, and academically.

The first economic impact of the nature center will be the temporary jobs created for the construction of the building. The nature center will also attract new people to the area, which will lead to additional customers for local businesses causing growth in the local economy. The nature center will also promote local business by hosting conferences and weddings, which will also contribute to a growth in the local economy. Also, the clean energy sources implemented into the nature center may be capable at times of sending power back into the grid, if the solar energy system exceeds the demand of the nature center.

Environmentally, the total scope of the project will restore farmland back to its original form as a prairie. This restoration will positively impact the ecosystem by reducing polluted runoff to Dry Run Creek, creating natural habitats to animals of the area, and reducing the erosion of the area's top soil. The nature center itself will enhance the environment through the use of an onsite wastewater treatment system, which will add natural fertilizers to the nearby ground. The use of solar panels will also help the environment by reducing the need for coal generated energy and giving clean energy back to the grid.

Academically, the nature center will provide children and adults a great way to learn about their surrounding environment. This will be done through nature exhibits and classrooms activities, as well as interactive outdoor activities. The nature center will promote healthy outdoor habits, all while teaching adults and children alike about the local environment. It can also serve as a model from teaching households about the benefits of implementing green technologies, with the hope that these households will then choose to implement green technologies in their own houses.

3.0 Preliminary Development of Alternative Solutions

Based upon initial requests from the client, follow-up questions, and a site visit discussion with the client, two preliminary design alternatives were developed for the client. Design alternative one incorporates larger areas that are sectioned to promote singular functionality spaces, with clear divisions between the areas. Design alternative two incorporates a more compacted design alternative than design alternative one, utilizing dual purpose spaces. Both design alternatives are elaborated on in subsequent sections.

The preliminary designs alternative were solely designed for the functionality of the building. However, the designs were developed with the intentions of incorporating green technologies, such as daylighting, solar, geothermal, etc. The design of the green technology systems, parking lot, septic system, access road, and water management features were done after the selection of a final building design (outlined in section 4.0 of this report) and not presented in this section.

Renders of each of the preliminary design alternative was done using the Autodesk Revit software. These render can be found in Appendices A and B .

3.1 Design Alternative 1

Design alternative one is a 3-section building with two large wings. Each wing serves a different purpose. It is situated on the east side of the road and follows the curve towards the back of the property. This provides views from the highway and entrance road. Large glass windows promote daylighting techniques and present scenic views of the grassland and wetland features on the site. An exposed timber facade gives the structure an old barn theme, while still utilizing and showcasing green/modern building technologies. Restrooms are located in each wing for ease of access of every member utilizing the building.

The main entrance to the nature center is through the small centralized welcome building. This small structure will incorporate, a reception desk, one administration office, small seating areas, and several small exhibits. This central building will be used to create a welcoming atmosphere and direct people to the appropriate areas of the building they are there to use.

The southernmost wing of the building will function as the educational wing. It will incorporate a large exhibit area for interactive display pieces on the top floor, such as a large aquarium for trout species. The bottom level of the southernmost wing will function as a large class room for educational programs. This space is designed in a longitudinal manner to allow for easier subdivision of the area into smaller classrooms for instances when two or more educational programs need to occur simultaneously. The bottom level will also have storage space for display pieces not in current use, or to house mechanical systems.

The northernmost wing of the building will function as the business wing. The top level will incorporate a large conference area with a stage for events and receptions. The floorplan is designed to be open with no permanent structures to allow alterations to accommodate different functions. The bottom level of the northernmost wing will house several offices, a small kitchen, break room, and a smaller conference room for use by the members who will permanently work in then nature center. This area will also incorporate storage space to be utilized for mechanical components or general storage.

Along the exterior of the building, deck and patio areas were created for activity and meeting spaces. These exterior features will provide view of the surrounding scenery, incorporate educational plaques for teaching the public, and provide a general assembly area for hosting small events. This area will also be readily accessible to the people utilizing the trail system, providing a place to meet, relax, and rest with access to restrooms and drinking water fountains.

3.2 Design Alternative 2

Design Alternative two is a two-story singular building designed with spaces having multiple functions. The main level contains nature exhibits, office space, and a large upper deck. The lower level contains a large multi-purpose space, storage space, a kitchen, and a large walk-out deck.

The main entrance of the building will face the west adjacent to the proposed parking lot location. Immediately within the main entrance there will be a reception desk, a bathroom, a small administration office space, and a stairwell to the bottom level. To the left of the main entrance, behind the reception desk, is a space dedicated to several small offices and a small conference room for the residential personal. To the right of the main entrance, behind the reception desk, is the exhibit area. The exhibit area was designed as a large open area that can be divided into several smaller exhibits at the discretion of the administrative personal. A minimal amount of windows were implemented in this area of the building to preserve the integrity of the exhibits. The nature center exhibits can be secured behind a locked door to allow people to enter the conference area during non-business hours without a security guard on duty.

The upper level also contains a large deck area to allow guest to enjoy the scenery of the surrounding area. The deck was design to be large enough so it can be utilized for congregation and outdoor educational programs.

The lower level of the building features an approximately 3500 sq. foot multipurpose room to be utilized as a conference center or educational classroom. The design was left open with no permeant structures to allow for the space to be changed to accommodate different functions. This space is designed in a longitudinal manner to allow for easier subdivision of the area into smaller classrooms for instances when two or more educational programs need to occur simultaneously. The space also contains space for a commercial-sized kitchen and storage area for any mechanical needs of the building.

The lower level also contains a large walk-out patio that connects to the upper deck. The space was designed to be large enough to accommodate outdoor receptions or educational programs.

4.0 Selection Process

The selection of a final design was made by qualitatively assessing the pros and cons (outlined in Table 1) of each alternative with the client. The pros and cons were initially developed by the design team and amended to reflect the opinions of the staff and board members overseeing the design process. The pros and cons expressed in Table 1 reflect these amendments and additions.

Table 1: Pros and Cons of the preliminary design alternatives.

	Design Alternative 1	Design Alternative 2
Pros	- Large square footage - More opportunity for community use - Singular purpose spaces - Modular design allows for easy construction phasing - Completely handicap accessible - Plenty of storage space to conceal mechanical equipment and green technologies - Large viewing windows of surrounding area - Barn like attributes such as roofline, exposed framing and materials - Larger lower level patio for receptions	- Frank Lloyd Wright Prairie School Architectural style - Small footprint - Large multi-purpose room that can be closed off or opened up for different activities - Large upper and lower deck - Clerestory windows provide natural daylight and ventilation to main level - Plenty of southern facing roof (for solar panel installation) - Barn-like attributes such as roofline and exposed wood
Cons	- Large Footprint, big cut and fill requirements and parking lot - Expensive - Stand-alone conference center would need research, political support, marketing, etc. - Too much deck space for maintenance capabilities - Possess several “dead” spaces - Small amount of southern facing roof for solar panel installation - No multi-use of spaces	- Potential noise issues in the conference area (below the main level) - Gently sloping roof may require extra maintenance - Dual function spaces prevent simultaneous events - Rear view of the building lack aesthetic appeal - Commercial size kitchen may be larger than required - Minimal amount of office and storage space

After assessing the pros and cons with the client, the final design alternative selection was left to the discretion of the design team. At this point in time, the client expressed interest in retaining each preliminary design alternative, due to uncertainty in future plans. The client felt that both alternatives satisfied the intended purposes, while showcasing two very different design styles.

Therefore the design team revisited the pros and cons internally, and selected to further develop design alternative two into a final design. This selection was made because it is a more environmental friendly design, with a smaller footprint, greater ability to implement green technologies, and hypothesized cheaper cost.

5.0 Final Design Details

The components of the final design are elaborated on in subsequent section. These components include revised building floorplan/functionality, structural loading calculations, site plan, parking lot, solar energy system, septic system, and a roof rainwater system which are all located in their respective appendices at the end of the report.

5.1 Revised Building Floorplan and Functionality

Upon selecting design alternative two as the preferred final design, modifications were made to the original design based upon comments and concerns from the Winneshiek County staff and board members. The changes made to the floorplan and functionality are outlined in subsequent paragraphs, and can be viewed in detail in Appendix C.

One major concern of the board members was the flatness of the southernmost roof. Concerns were expressed for the difficulty in maintaining a flat roof. With this concern in mind the southernmost roof was raised from a 0% slope to a 10% slope. The slope was chosen to only be 10% to try and maintain the aesthetic look of the structure.

Another concern was the number of windows. In an attempt to be as environmentally friendly as possible, many windows were removed from the preliminary design. A large number of windows drastically increases the heating/cooling cost of any building. The number of windows was also lessened in the exhibit area, because too much light on display pieces has been shown to decrease their lifespan.

In response to the concern of too much deck space for maintenance capabilities and too little office space for proper personnel, the deck space was decreased and the offices space was expanded out in the northeast corner of the building, where the deck used to be. The office space was expanded to include two more offices for a total of five offices and a meeting room, for resident workers.

The stairwell leading to the basement was revised and repositioned. The preliminary design had a spiral staircase design, located near the reception desk. The final design now incorporates a traditional stairway, to the right of the reception desk, immediately upon entering the building.

In the basement area, the storage/kitchen space was modified. The board members informed the design team that a commercial size kitchen was not needed and a much smaller kitchen space would suffice. They also expressed concern over the lack of storage space and lack of a proper storm shelter. With all these concerns in mind, the basement kitchen was shrunk, replacing the former kitchen space with storage space. Within the storage space a section was portioned off to act as a storm shelter with a 60 adult person capacity.

5.2 Structural Design

Three primary means of structural support considered for the design nature center consisted of joists, beams, and columns. The joist used for the nature center are considered wooden open joists. The open joist are constructed by Allegheny Structural Components. For the floor trusses, an open-web design was used. The open-web floor joist are constructed using a process of finger joining and waterproof structural adhesive. The open joist system is preferable to other wooden systems due to its ability to span long distances. The long distance span allows for a more open room design by removing the need for excessive support beams or columns, as well an increased factor of safety and lower cost. The savings involved in using the open joist over steel plating are typically seen around 20% to 30%, as the steel plate joist system can have sharp edges, contrary to the open joist. The open joist system has the highest strength-to-cost ratio when compared to the rest of the engineered floor joist, which was a major reason for their use in the nature center.

Similar to the joists, the beam material selected for the nature center are also wooden. The wooden beams to be used in the nature center are in the Parallam Plus PSL series of beams manufactured by Weyerhaeuser. The actual beams will be 2.0 Grade E Parallam PSL beams. The beams use a patented process to bond long, thin strands of wood together, creating a very strong and consistent beam when compared to other alternatives. The engineering construction process to build these beams creates a product resistant to shrinking, twisting, and bowing, as well as an insect rand decay resistant beam ideal for this project. Another appealing aspect of the Parallam Plus beams is their ability to support heavy loads over long spans. As stated in the joints section, the ability to carry loads over long distances is essential to the open exhibit design. These beams can also be sealed and stained on-site, which is perfect for the nature centers exposed timber look. For the columns of the structure, a Parallam PSL engineered wood product was used, but at a 1.8 Grade instead of a 2.0 Grade. This is because the columns will be used more on the exterior of the building for the deck structure. In order to view the process applied to design the timber member, all processes can be viewed in Appendix D.1.

In order to design a structurally sound slab, various calculations were utilized. In accordance with the revised Design 2, the concrete slab would need a thickness of five inches with #3 rebar reinforcements spaced at 12 inches on center. The applied design process can be viewed in Appendix D.2.

Another structural element considered, the basement bearing walls, required various calculations. The walls were all designed in accordance with the westernmost wall, as it carried the heaviest load. By applying this design to the other walls, the basement is ultimately over designed, but ensures safety. The bearing ball was calculated to require a thickness of 14 inches with #4 vertical rebar reinforcements at 10 inches, and #3 horizontal rebar reinforcements at 12 inches for each face. Detailed calculations can be referenced in Appendix D.3.

Similar to the basement walls, the strip foundation was also designed based on the western most wall. To ensure safety and in compliance with a 30% design, this feature was applied to the other walls as well. Following detailed equations in Appendix D.4.A The calculations produced foundation parameters of a six foot base at a 1.5 foot thickness, with #5 rebar reinforcements at nine inches, and #3 rebar reinforcements at eight inches.

Lastly, the rectangular spread foundation was designed. Calculations were performed for the largest column load and applied to all other to increase safety and simplicity. The rectangular spread foundation calculated has design parameters of four feet long by three feet wide with four #4 long reinforcement, and six #4 short reinforcement. Detailed calculations are presented is Appendix D.4.B.

5.3 Building Components

5.3.1 Septic System

The wastewater generated from the site will be handled with a traditional septic system with an adsorption field. Spatial requirements for the system were estimated and designated spaces were placed on the site plan.

The wastewater flow from the building was calculated to be approximately 7900 L/day. This flowrate was estimated using the typical wastewater flowrates from different sources such as Metcalf and Eddy (1991) Wastewater Engineering Treatment Disposal Reuse, G. Tchobanoglous and F.L. Burton (Eds.), 1820pp. New York: McGraw-Hill. The Nature Center was evaluated to be a mixed source structure containing a 51% office-like space and 49% visitor center for the flowrates. It was estimated that operating at max capacity the Nature Center would operate with 10 employees and serve approximately 500 people per day. Assuming that each employee produces 49 liters of wastewater flow per day and each visitor produces 19 liters of wastewater flow per day, the 10 employees and 500 visitors would produce a combined daily flowrate of approximately 10,000 liter per day.

The volume required for the septic tank was calculated following procedures outlined in the Onsite Wastewater Treatment System Manual developed by the EPA. In addition to the estimated flow from above, a hydraulic retention time of 24 hours (6-24 hours suggested), and a safety factor of 2, the volume of the septic tank required was estimated to be 5300 gallons.

The absorption field area required was also estimated following procedures outlined in the Onsite Wastewater Treatment System Manual developed by the EPA. The loading rate for the infiltration field was designed to be 0.8 gpd/ft^2 as suggested in the manual referenced above. This loading rate is well below the percolation capacity of the site, which is approximately 15 gpd/ft^2. Based on the loading rate and the estimated flow, the total area required for the infiltration field is approximately 3400 ft^2.

This system consists of many smaller components. As the wastewater exits the building it will be piped into the septic tank where it will be held for at least 24 hours to promote primary sedimentation. After this minimum 24 hour retention period, the outflow will be sent through a filter to the distribution box to be dispersed into the infiltration field. It was estimated that the distribution box would require 7 outlets and 7 dispersion pipes. This system of 7 dispersion pipes will require 5 PVC tee joints and 2 PVC bend joints. Each dispersion pipe is constructed of perforated PVC piping and requires a flow leveler. Each dispersal pipe will run the length of the 60 foot long infiltration field, amounting to a total of 420 feet of perforated PVC piping. The cut for the dispersion field will be 4 feet deep throughout the entire infiltration field. A cubic yard of stone aggregate fill will be installed surrounding the PVC pipes to assist in percolation. The rest of the fill material required will be sourced from the earthwork of the excavation process.

5.3.2 Solar Energy System

In the interest of making the building as energy efficient as possible, the capacity of several different potential photovoltaic solar arrays were assessed. Four different sizes of solar arrays were explored and the capacity of these solar systems are outlined in subsequent paragraphs and summarized in Table 2.

The solar array system will be implemented on the southern facing roofs. The lower (and larger) of the southern facing roofs, is approximately 4100 square feet with a slope of 10% and is pointed due south (0° azimuth.) The higher (and smaller) of the southern facing roofs, is approximately 900 square feet with a 75% slope and is pointed due south (0° azimuth.)

Four different array sizes and placements were explored to assess the potential for solar energy production. The first option consists of a 900 square foot array on the uppermost southern facing roof. The second option consists of a 2000 square foot array on the lower most (and larger) southern facing roof. The third option consists of a 4100 square foot array on the lower most (and larger) southern facing roof. The fourth and final option consists of a 900 square foot array on the uppermost southern facing roof, in addition to a 4100 square foot array on the lower most (and larger) southern facing roof.

To assess the contribution of the solar array alternatives to the total energy requirements of the building were estimated. The energy consumption levels were estimated using Energy Star's U.S. Energy Use Intensity by Property Type Technical Reference. To acquire an estimate from this reference, the Nature Center was designated as a mixed use property, which has a Source EUI of 123.1 kBTU/ft^2. Based upon this EUI values and a total building square footage of approximately 12,000 square feet, the total energy requirements of the building each year was estimated to be approximately 420,000 kWh/yr.

The energy generation capacity of the solar arrays were assessed with two different online tools. The first of the two tools used was the Solar Calculator tool developed by the Iowa Energy Center. The Iowa Energy Center was created by the Iowa General Assembly and signed into law in 1990, and is administrated through Iowa State University. The Solar Calculator tool utilizes solar radiation measurements at five Iowa recording stations and the ASHRAE WYEC2 model to geographically interpolation and extrapolate from the five measurements site to cover the entire state of Iowa. The Solar Calculator simulates photovoltaic power generation from irradiance, temperature, and wind speed data, using a simplified version of the PVFORM software developed by Sandia National laboratories. The Solar Calculator allows the user to specified geometry and whether the system is fixed or a tracking array. The Solar Calculator outputs average power outputs in Watts for the considered time period. The results include yearly and monthly energy production values at a nominal 1-kW size. These outputs must then be prorated to reflect the actual system size.

The second of the two tools used to assess the energy generation capacity of the solar arrays was the PVWatts Calculator developed by the National Renewable Energy Laboratory (NREL). The NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC. The PVWatts Calculator allows the user to specify location of implementation, DC system size in kW, module type, (standard or premium), array type (fixed or tracking), array tilt (horizontal slope), array azimuth (vertical alignment), system losses, and invertor efficiency. The PVWatts Calculator outputs an estimate of energy production per year, as well as a monthly production profile.

Table 2 summarizes the energy generation potential of the four options from the two different models. It also shows a solar array size (in kW) that is calculated from the total square footage of the option, a 1000 w/m2 solar inundation, and a 15% energy conversion efficiency for the photovoltaic cells. The final estimate for energy production from the solar arrays will be taken as the median of the two separate models discussed above. The percent contribution was calculated by dividing the energy production potential of the solar array by the total estimated energy requirement for the building given above (420,000 kWh/yr.)

Table 2: Summary of Solar Array System Options and Energy Potentials

	Option 1	Option 2	Option 3	Option 4
Lower Roof Coverage (sq ft)	0	2000	4100	4100
Upper Roof Coverage (sq ft)	900	0	0	900
Solar Inundation (W/m^2)	1	1	1	1
Efficiency (%)	0.15	0.15	0.15	0.15
Solar System Size (kW)	13	28	57	70
Solar Calculator Estimate (kWh/yr)	15815	41110	84275	100090
PVWatts Calculator Estimate (kWh/yr)	15379	33125	67433	81894
Median of Two Models (kWh/yr)	15597	37117	75854	90992
Percent Contribution (%)	4%	9%	18%	22%

5.3.2 Roof Rainwater Collection Alternatives

To mitigate excess runoff from the impervious surface of the roof two different water management strategies were explored, a rain garden and rainwater collection system. A preliminary design for both these alternative are presented in subsequent paragraphs.

The roof runoff will be divided into two portions, the northern sloping roof and the southern sloping roof. Each of these portions will require a water management structure, placed on the north and south side of the building respectively. The northern roofs cover a total of 2460 square feet, while the southern roofs cover a total of 4620 square feet. The water management structures were designed to capture the water quality volume (WQV), which consists of the first 1.25 inches of rain during a rain events. This WQV will cover 90% of rain events in Iowa. Using the square footage of the roof and the WQV it was found that the northern water management structure would need to capture 1920 gallons of runoff, and the southern water management would capture 3600 gallons.

The first water management strategy employed to mitigate excess roof runoff was a rain garden. Rain gardens are an infiltration-based storm water management system that captures runoff from impervious surfaces and infiltrates it back into the soil, while providing aesthetically pleasing landscaping. The rain gardens for this system were design following procedures outline in the Iowa Rain Garden Design and Installation Manual assembled in cooperation between the Iowa Storm Water Education Program, the Iowa Stormwater Partnership, the Iowa Department of Agriculture, Rainscaping Iowa, the Iowa DNR, the U.S. Department of Agriculture, Iowa Life Changing, Polk Soil & Water Conservation District, and the Living Roadway Trust Fund.

The recommended surface area requirements for the rain gardens were calculated by multiplying a conversion factor of 0.1 for a 6 inch deep rain garden with a 1in/hr percolation rate (as specified in the Iowa Rain Garden Design and Installation Manual), by the surface area of the roof draining to the rain garden. This yielded an area of 246 square feet for the northern rain garden, and 462 square feet for the southern rain garden.

The second water management strategy designed to mitigate excess roof runoff was a water collection system. A water collection system functions to capture the water from the roof in a collection barrel, so that water can then be used for non-potable uses, such as watering plants. Based upon the runoff volumes calculated above, the northern roof portion would require a 2500 gallon collection barrel and the southern roof portion would requires a 5000 gallon collection barrel. Based upon a yearly rainfall average of 26-in per year for Winneshiek County, the water collection system would be able to capture 15,340 cubic feet, or 115,000 gallons, of water every year.

5.4 Site Plan

The site plan was designed and developed for the Neste Park Nature Center using the Autodesk software Civil 3D 2015 Imperial. This software has components to assist in the development of corridors, pressure pipe, networks, gravity flow networks, grading, bridge modelling, geotechnical models, and many other various functions. This software allows the user to import the elevations from a specific site location when developing a site plan for a construction project.

The design team used Civil 3D to layout the site plan. The design team imported the surface area for the Neste Park Nature Center, and laid out the different components of the site, such as the building, the parking lot, the access road, the connecting sidewalks, and the septic system. On top of being utilized to layout the site plan, the Civil 3D software was used to calculate the overall earthwork and excavation and fill for all components of the site (Nature center, access road, parking lot, sidewalks, etc.).

Figure 1 on the next page shows the site plan for the entire nest park development area. The new North/South asphalt access road enters the site for Townline Road, visible at the bottom of the drawing, running east/west. The new parking lot surface is on the west side of the new road and the nature center is visible on the east side of the road. After the parking lot ends the asphalt road will turn back into a gravel road for economic, aesthetic, and safety purposes. On the south side of the nature center, the onsite septic system layout is shown. On the north side of the parking lot the biorentention cell layout is shown. The parking lot is located from station 15-50 to station 18-50. The location was selected for its relatively flat topography. The location for the nature center was not ideal for the walkout basement. However, the nature center location was tethered to the parking lot location in order to maintain a small distance between the handicap parking spaces and the nature centers front door.

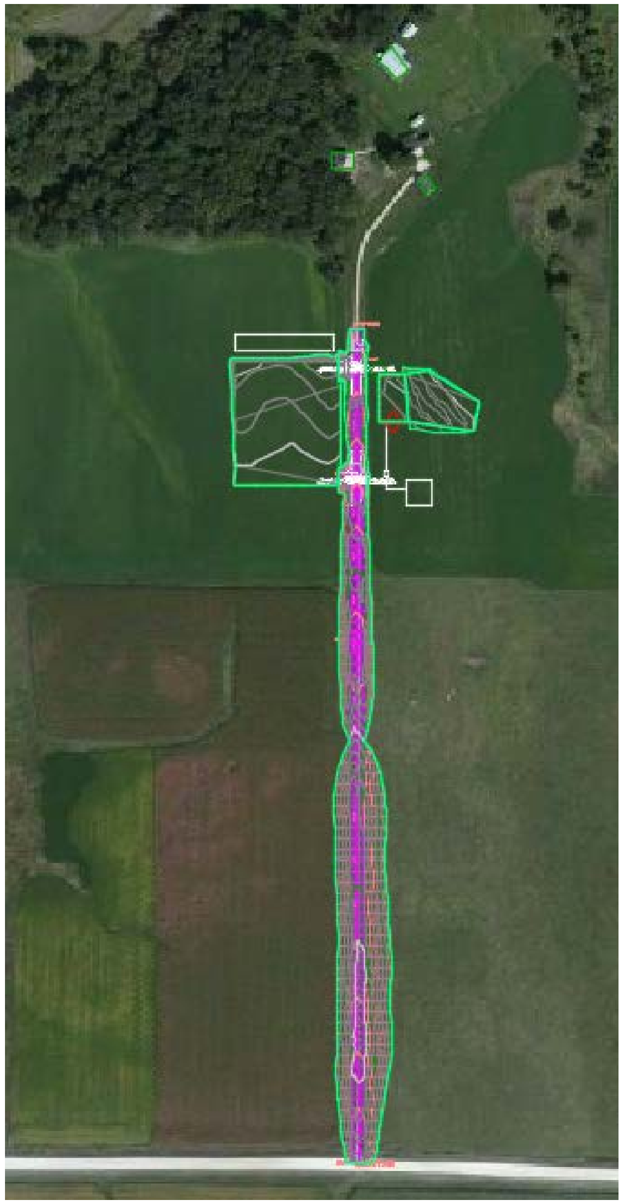


Figure 1: Aerial view of site work created on Civil 3D at Neste Park

On the next page, Figure 2 shows in detail the two intersections leading into the parking lot. The site work surfaces of the parking lot and nature center are shown with gradation lines. The parking lot will drain to the north with excavation needed on the north side and fill needed on the south side. The nature center site work at this point in the design will consist solely of excavation to create the basement patio.

Figure 2: A close aerial view of the site work from station 15-00 to station 19-00 of the new asphalt road

Figure 3, shown on the following page, shows the gradation of the site work as a solid object. The nature center site work is entirely excavation with the grey scale blocks indicating the cut needed for the building and walk out basement conference center. The large amount of excavation needed behind the nature center is necessary for the storm water to flow away from the building.

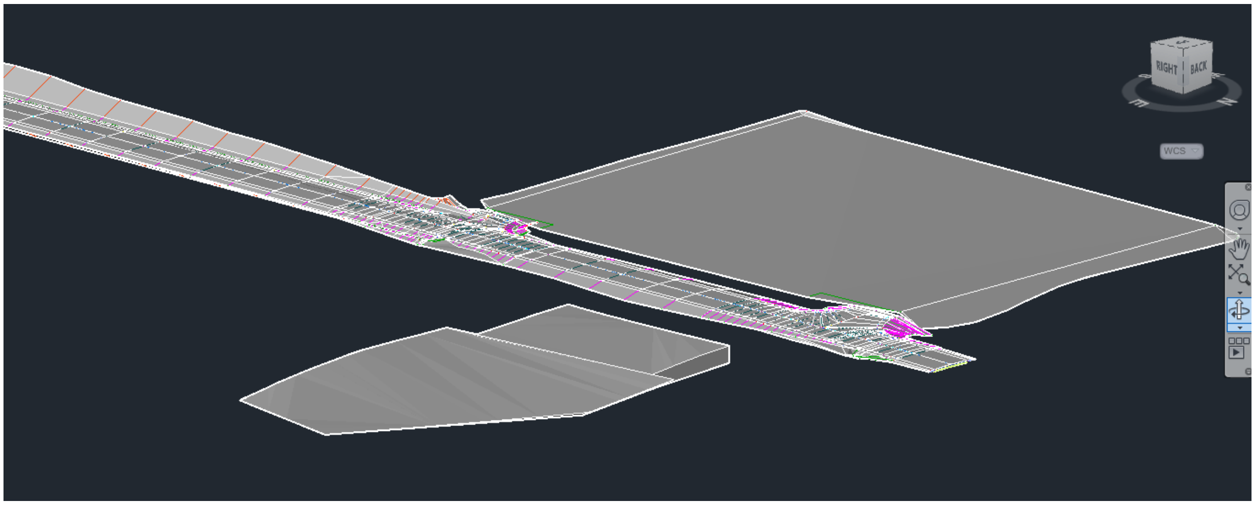


Figure 3: The parking lot and nature center site work shown with depth in greyscale

5.4.1 Access Road

The access road is surfaced with an asphalt concrete pavement. From the APAI (Asphalt Paving Association of Iowa) design standards, the asphalt concrete surface is two inches thick, the asphalt concrete base is two inches thick, and the untreated aggregate base layer is eight inches thick of coarse gravel, as the subgrade (CBR = 6, classified as Moderate) is a loamy dark-grayish sediment. The access road and road surrounding the parking lot are designed at 24 feet wide with each lane twelve feet wide to accommodate APAI design standards.

Displayed on the next page, Figure 4 shows the profile view of the new asphalt access road beginning at station 0-00 and ending at station 19-15. The road was designed using Civil 3D's AASHTO 2011 design criteria. The initial elevation of the profile is 1076 feet with a slope of -1.05% until the road reaches station 7+40, where its elevation is 1068 feet. From station 7+40 the profile rises at a slope of 1.05% for 465 feet until station 12+05. From station 12+05 the slope stays negative all the way until the end of the road. The slope goes from -2.03% to -1.89% to -3.00% with a final elevation of 1058 feet. The new vertical profile largely adequately flattens out the old hilly road. Due to this leveling, the new access road will need a large amount of excavation and fill too due to removal of the large hill for safety reasons.

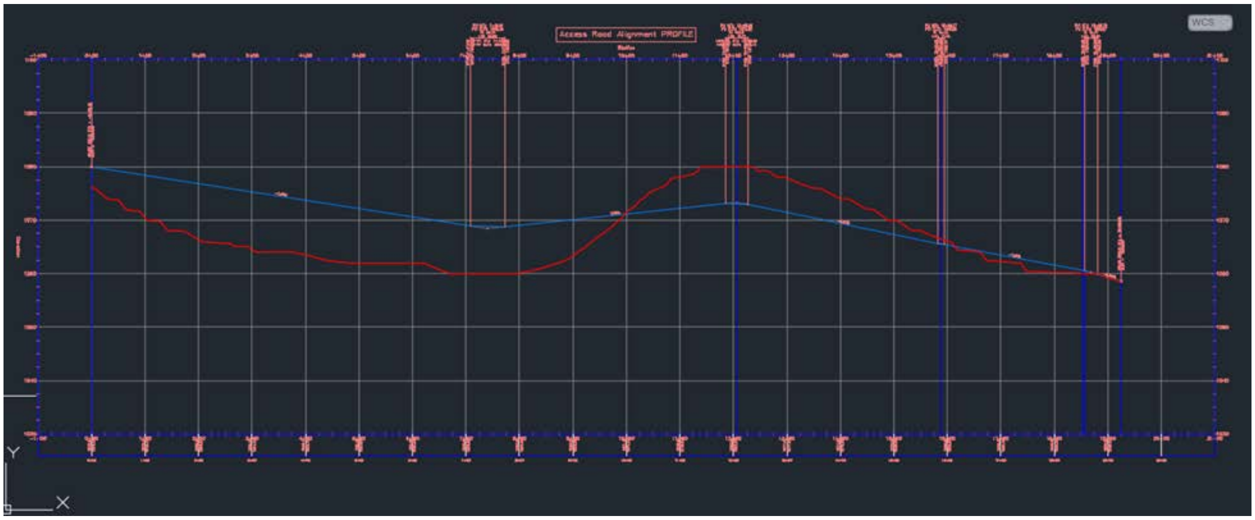


Figure 4: The new asphalt access road's vertical profile from Civil 3D. Red line indicates existing surface elevation. Blue line indicates new roadway surface.

Figure 5 below shows the asphalt access road cross-section created using Civil 3D's basic assembly template as a reference point. The basic assembly of the road and subgrade were adequately represented on the basic assembly so no change was necessary. The roadway's basic assembly in Civil 3D is set to a width of 24 feet, which was the same distance required for the requested access road. An alteration to the basic assembly was the removal of the curb on both sides of the roadway due to preference of a shoulder. The shoulder was considered a better option for the access road due to the possible bus travel that the road need to endure. With buses frequenting the site, the shoulder is a better alternative as it allows for the busses to utilize road side parking.

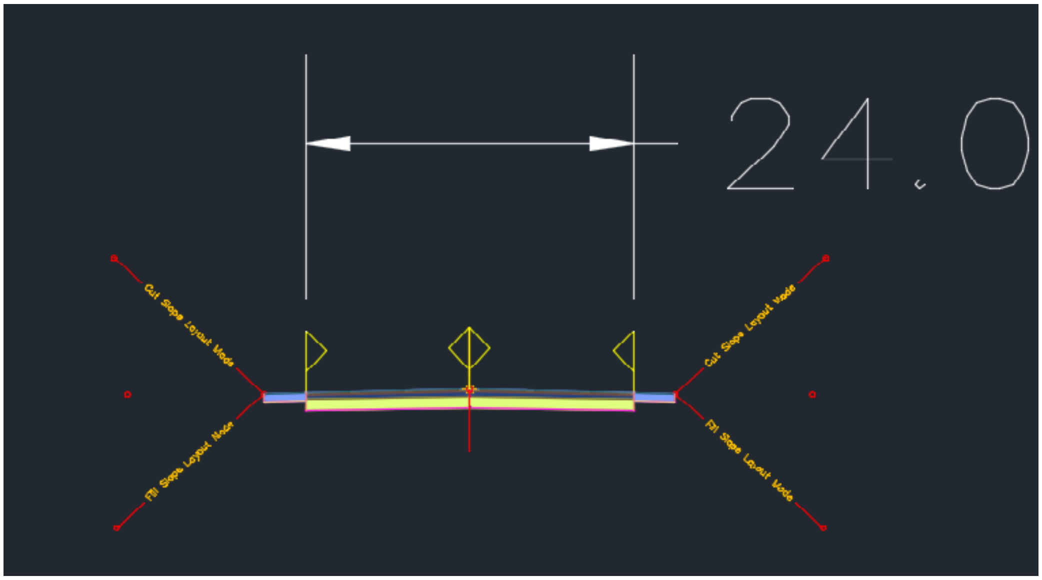


Figure 5: The assembly (cross-section) of the asphalt access road

5.4.2 Parking lot design

The parking lot design was constructed using the Autodesk Revit software. Renders of the parking lot design can be found in Appendix E.

The parking lot is surfaced with an asphalt concrete pavement. From the design standards of the APAI, the asphalt concrete surface is three and a half inches thick, and the untreated aggregate base layer is six inches thick of coarse gravel as the subgrade (CBR = 6, classified as Moderate) is a loamy dark-grayish sediment. A cross sectional area can be seen in Figure 6 on the next page. The curb bordering the road and islands of the parking lot consists of Portland Cement Concrete in accordance with the design requirements of AASHTO M 85 specifications from the Iowa DOT.

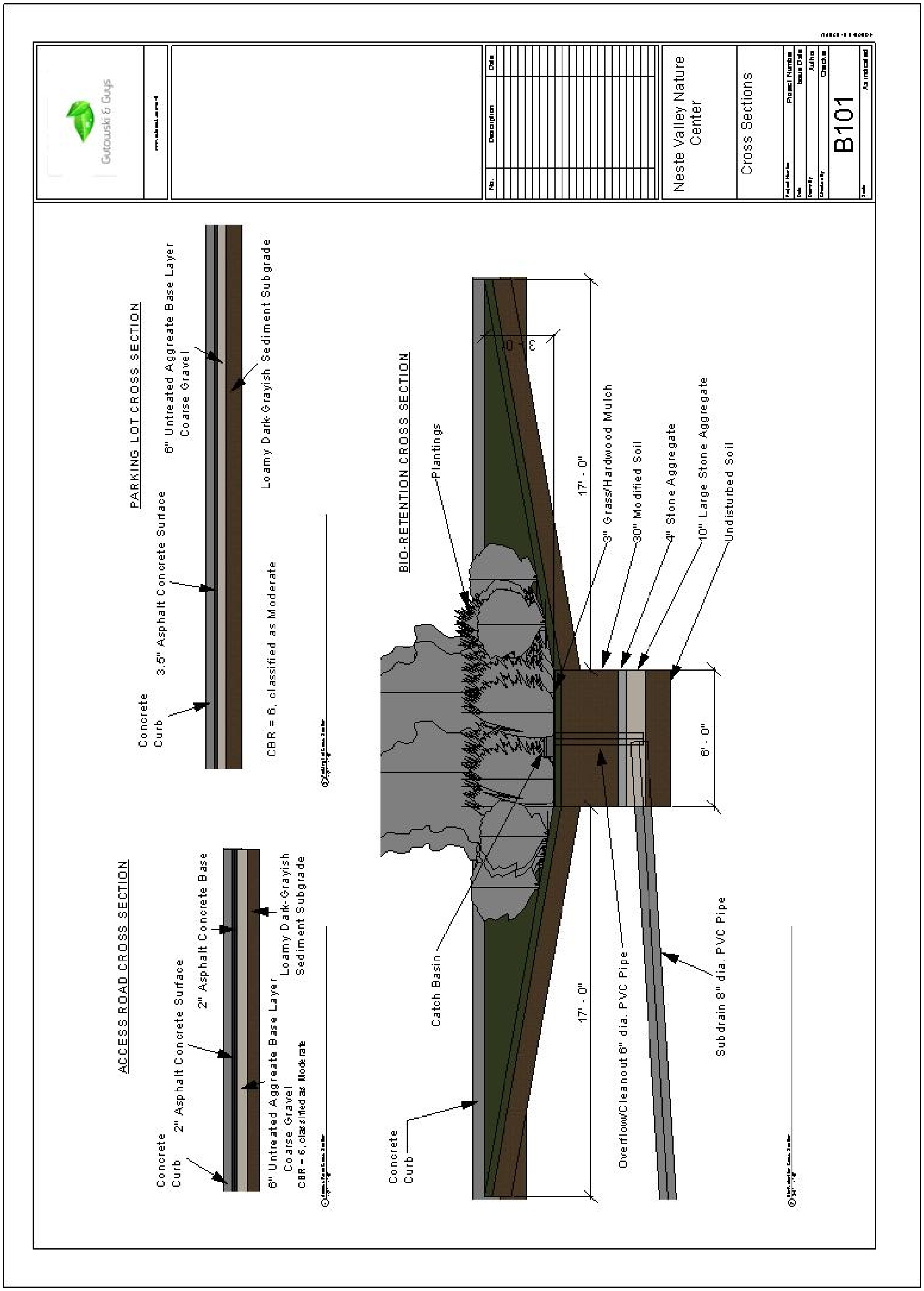


Figure 6: Cross Section of the Parking Lot, Access Road, and BioRetention Basin

The east to west and north to south dimensions of the parking lot are 230 feet and 272 feet (excluding access road), respectively. In accordance with the AASHTO street design standards, the number of stalls varies with the function/max occupancy of the Nature Center. With a max occupancy of about 200 people, the inner parking lot is designed to hold 126 vehicles (1.2 spaces per person, considering 100 person max capacity). From the 126 total inner parking spots, five of those spaces will be designed for handicapped parking (includes two handicapped van parking stalls) to accommodate ADA parking requirements.

The parking stalls are 90 degree stalls that are nine feet wide and 18.5 feet long to accommodate APAI design standards. The space between the east and west section of the parking stalls is 24 feet that will allow easy access/exit of vehicles. The handicapped parking includes two handicapped van parking stalls that are 11 feet wide and 18.5 feet long to accommodate ADA (Americans with Disabilities Act) parking requirements. The handicapped van parking stalls also include an access aisle that is 5’ 10” inches wide. The handicapped parking stalls will be located in the eastern most section of the parking lot (closest to the Nature Center) allowing easy entrance and exit.

Since large busses and RV’s will be traveling to and from the Nature Center, the minimum turn radiuses are designed at 42 feet to accommodate the AASHTO street design standards. This will also allow large buses to easily maneuver from entrance to exit in the Nature Center parking lot. Buses will not be able to enter the inner parking lot, since the inner parking lot will be used by smaller vehicles (e.g. cars, SUVs, etc.) The most western strip of parking lot road will accommodate bus parking for four buses. These four spaces will prove beneficial for the large events such as weddings, school trips, conference meetings, etc. and will contribute to the true maximum occupancy of about 200 people. This western portion of the road will be a one-way road where buses will park on the right side and buses/vehicles will still have access to pass the parked buses, on the east side.

Parking islands that consist of a concrete curb, grass, shrubbery, lights and benches will be placed on the north, south, west and east sides of the inner parking lot to separate the bus parking, car parking, and access road. An east to west concrete sidewalk with a width of 5’10”, will be segmented through the middle of the parking lot, connecting the bus parking, car parking and building entrance all together. The sidewalk will allow easy access from the bus parking to car parking to building entrance and vice versa.

The lighting component of the parking lot was designed following procedures outlined in the Urban Design Standard Manual. Four parking lot lights will be placed on the south side within the islands as well as four on the north side of the parking lot, also within the islands. Three lights will be placed in the middle of the parking lot, bordering the sidewalk and parking stalls. The height of each light will be 25 feet and will have a round light source of two feet. Each light will be 400 watts, halogen, and suited for the exterior conditions.

The signage component of the parking lot was designed following procedures outlined in the Urban Design Standard Manual. Stop-for-pedestrian signs will be placed on each side of the crosswalk (portion of sidewalk crossing the access road) to ensure maximum safety for visitors.

A bus-parking-only sign as well as a one-way sign, will be placed right before the western strip of the parking lot to clarify parking of buses as well as direction. A car-parking-only sign will be placed on the outside (north and south sides) of the inner parking lot within the islands. Cars will be able to enter the inner parking lot through the south and north openings, but will not be able to go north bound on the western one-way (bus parking) road. This will help direct visitors who traveled by car to successfully find the appropriate parking stalls. A do-not-enter sign will be placed at the south-western curve of the lot to ensure vehicles that the most western portion of the lot is a one-way road. Two no-parking signs (40 feet apart) will be placed directly north of the cross walk to provide access for emergency vehicles when appropriate. The access road will consist of a dotted-middle-line to separate incoming and outgoing vehicles. The access road directly in front of the Nature Center will serve as immediate drop off for buses. Handicapped-symbols will be painted on the appropriate handicapped stalls to ensure no parking confusion.

The stormwater management plan subsequently outlined was developed following procedures outlined in the Iowa Stormwater Management Manual. The entire parking lot will consist of a -1% slope directing north which will provide adequate stormwater runoff from the parking lot. Openings in the curb along the northern islands and northern section of the road will allow the stormwater runoff to appropriately channel into the grassy island or bioretention cell north of the parking lot. The islands will be slightly sloped to successfully allow stormwater runoff enter the grassy, shrubbery area. The bioretention section will roughly be about 9,000 square feet and will consist of a downgrade slope (17 feet), middle flat section (6 feet) and upgrade slope (17 feet). The bioretention cells will be designed primarily for storm water quality for the removal of pollutants. At the six foot middle flat section; the top, second, third, fourth (choker layer), fifth (base layer) and bottom layer will consist of plantings, three inch thick hardwood mulch, 30 inches of modified soil, four inches of stone aggregate, ten inches of large stone aggregate and undisturbed soil, respectively. An overflow/cleanout pipe will be placed at the middle of the six foot flat section, within these layers, dropping all the way to the bottom of the base layer and extending six inches above the hardwood mulch. A subdrain will be connected at the bottom of the overflow/cleanout pipe which will allow excess ponding water to adequately drain out of the bioretention cell. There will be a total of four of these catch-drain/pipe systems within the biorentention cell, evenly distributed across the length of the basin. A cross sectional area can be seen in Figure 6.

6.0 Cost and Construction Estimates

In the proceeding sections, details pertaining to estimating costs for different aspects the project are explained. On the following page, in Table 3, a summary of all costs accounted for in the 30% design are displayed, with solely the bolded figures being applied to the total cost. With the lack of a defined budget, Gutowski & Guys wanted to ensure a quality design without producing excessive costs. At an estimate of ***$2,579,324.62***, the previously explained designs and functions can be applied to Neste Park.

Table 3: Total cost summary for 30% design

Total Cost Summary	Feature	**Cost**
Building Materials		
Structure	Nature Center Structure	**$1,794,999.80**
Accessibility	Walkway	
	Painted Wood	$19,475.95
	Treated Wood	**$12,549.60**
	Concrete	$41,983.89
	Elevator	
	Interior Shaft	$158,149.86
	Exterior Shaft	$102,623.69
Deck	Material	
	Pressure Treated Lumber	**$55,552.45**
	Redwood/Cedar	$66,361.13
Patio	Concrete Slab	**$2,140.72**
Building Components		
Septic	Septic System	**$125,155.24**
Solar Array System	Array Sizes	
	Option 1	$31,194.71
	Option 2	$69,321.58
	Option 3	**$142,109.23**
	Option 4	$173,303.94
Roof Rainwater	Method	
	Rain Garden	$3,540.00
	Water Collection	**$7,556.98**
Site Plan		
Building Footprint	Earth Work	**$4,994.14**
Access Road	Materials	**$166,277.39**
	Earth Work	**$39,380.43**
Parking Lot	Materials	**$143,557.00**
	Earth Work	**$11,488.05**
	Total	**$$2,505,761.04**

6.1 Building Materials

A preliminary cost estimate for building materials is presented below. Tables presented represent costs related to the physical nature center, accessibility features, and deck/patio options.

In order to establish a material cost for the Nature Center, RSMeans Square Foot Costs 36th Edition (2015) was referenced. Due to lack of a specific nature center category, separation of the nature center into different categories based on function was necessary. Square footages were calculated from floor plans for both main and lower levels. Costs the manual are linked to a set range of square footages, and to obtain estimates for the community center and auditorium, extensions of the data was necessary. This was done through creating a best fit equation (R^2>=0.98) and entering in appropriate square footages, which can be located in Appendix F.

The square footages of each feature were multiplied by the full cost per square foot to obtain an initial cost figure. Each feature's cost estimate included full enclosure, a roof, and basement. However, not all are applicable in the design. To account for this, subtractions of unnecessary features were performed to produce a cost estimate for each portion of the nature center. This is displayed below in Table 4

Table 4: Nature center material cost estimate by square footage

Nature Center Cost				Unnecessary Features			**Total (Location Factor= 0.83)**
Main Level	Square Footage	Cost per S.F.	Cost	Enclosure Subtraction	Roof Subtraction	Basement Subtraction	
Community Center	2,979.71	$151.47	$546,031.91	$87,365.11		$60,063.51	$398,603.30
Office (1 Story)	2,077.90	$209.65	$435,632.07		$7,841.38	$16,554.02	$411,236.67
Lower Level							
Auditorium	5,565.79	$185.54	$1,032,662.30		$47,502.47		$985,159.83
						Total	**$1,794,999.80**

In order to establish cost estimates for handicap accessible features, Means ADA Compliance Guide 2nd Edition (2004) was referenced. Multiple means and finishes can be seen in Table 5 in order to provide the client multiple options. The costs for the walkways are representative of two straight ramps followed by sub-grade switch back ramp, all designed to ADA standards. Costs displayed include all cut and fill, and are not included in the exaction portion of the report. Elevator costs were pulled directly from the manual, and two options are displayed once again to provide options to the client.

Table 5: Accessibility costs following ADA estimates

Accessibility	Material	**Cost(Location Factor= 0.83)**
Walkway	Painted Wood	$19,475.95
	Treated Wood	$12,549.60
	Concrete	$41,983.89
Elevator	Interior Shaft	$158,149.86
	Exterior Shaft	$102,623.69

Deck estimates were obtained from RSMeans Residential Cost Data 34th Annual Edition (2015). By interpolating square footage costs for different materials, estimates for the main level wrap-around deck can be viewed below in Table 6. A 6” concrete slab was selected for patio material, and the cost per cubic yard was located in the RSMeans Heavy Construction Data 29th Annual Edition (2015).

Table 6: Deck and patio cost estimates by square footage

Deck	Material	Square Footage	Cost per S.F	**Cost (Location Factor= 0.83)**
Main Level	Pressure Treated Lumber	2190.50	$30.56	$55,552.45
	Redwood/Cedar		$36.50	$66,361.13
		Cubic Yards	Cost per C.Y	
Lower Level	Concrete Slab	12.90	$200.00	$2,140.72

6.2 Building Components

6.2.1 Septic System

A cost for the septic system design given in section 5.3.1 of this report was estimated using the RSMeans Facilities Construction Costs 30th Edition (2015). The total cost of the system was estimated to be $125,155.24. A breakdown of the components discussed in detail in section 5.3.1 of this report and their respective cost can be seen in Table 7. The location factor of 0.83 for Winneshiek County was applied to the total prorate the base dollar cost given by the RSMeans standards to the specific site location.

Table 7: Summary of Septic System Components and Cost Breakdown

Item	Quantity	Component Cost ($)	Total Component Cost ($)	Total Component Cost ($) with Location Factor (0.83)
Septic Tank Per 5,000 gallon tank	1	$ 12,000.00	$ 12,000.00	$ 9,960.00
Filter Per 6” diameter filter	1	$ 365.00	$ 365.00	$ 302.95
Distribution Box Per 7 outlet box	1	$ 150.00	$ 150.00	$ 124.50
Flow Leveler per leveler	7	$ 12.35	$ 86.45	$ 71.75
PVC pipe per linear foot	420 ft	$ 8.30	$ 3,486.00	$ 2,893.38
PVC tee each	5	$ 127.00	$ 635.00	$ 527.05
PVC bends each	2	$ 87.50	$ 175.00	$ 145.25
Excavation Cost Per CY	13600 CY	$ 1.81	$ 24,616.00	$ 20,431.28
Stone Aggregate Fill Per CY	3400 CY	$ 25.00	$ 85,000.00	$ 70,550.00
Dirt Fill Per CY	10200 CY	$ 2.38	$ 24,276.00	$ 20,149.08
			Total Cost $	$ 125,155.24

6.2.2 Solar Energy System

A preliminary estimate of cost and payback period for each of the four solar array options were calculated following the procedure outline below. The results are summarized in Table 8.

The estimate of cost of installation of a solar panel array was calculated using historical data. The data of historical Photovoltaic array system installations was acquired from the Open PV Project Database website. The Open PV Project is a database containing data on all PV solar installation projects in the U.S. The database was compiled by the National Renewable Energy Laboratory (NREL), a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC. The database contains data on project size (in kW), cost, and location. The design team utilized this database to find all PV installations in the state of Iowa in the past two years. The data from this two year time in the state of Iowa was utilized to generate a normalized installation cost in dollars per kW size based on project size (in kW) and cost given in the database. This process yielded a resulting normalized installation cost of $3553/kW size.

Table 8 summarizes the installation price, savings, payback period, cost with rebate, and payback period with rebate, for each of the solar array options. The installation prices was determined by using the solar system size (in kW) given in section 5.3.2 of this report and the normalized installation cost ($3553/kW). The savings per year was calculated using the energy production capacity of the solar array options given in section 5.3.2 of this report, and the average energy cost in the state of Iowa at 0.0816 $/kWh. The payback period was determined by dividing the total installation price by the savings per year.

The cost with rebate and payback period with rebate, refer Residential Renewable Energy Tax Credit incentive currently in use in Iowa. This incentive offers up to a 30% rebate on installation cost of solar array systems. The cost with rebate was simply calculated by subtracting 30% of the installation cost from the installation cost. The payback period with rebate was calculated by dividing the discounted installation price by the savings per year.

Table 8: Summary of Solar Array System Cost and Payback Periods

	Option 1	Option 2	Option 3	Option 4
Solar System Size (kW)	13	28	57	70
Solar Energy Generation Capacity (kWh/yr)	15597	37117	75854	90992
Energy Cost ($/kWh)	0.0816	0.0816	0.0816	0.0816
Installation Cost ($/kW)	3553	3553	3553	3553
Savings ($)	1272.73	3028.77	6189.67	7424.95
Installation Price ($)	44563.87	99030.82	203013.19	247577.06
PayBack Period (yr)	35.0	32.7	32.8	33.3
Potential Rebate (%)	30%	30%	30%	30%
Cost with Rebate ($)	31194.71	69321.58	142109.23	173303.94
PayBack Period with Rebate (yr)	24.5	22.9	23.0	23.3

6.2.3 Roof Rainwater Collection Alternatives.

A preliminary cost for the two water management structures given in section 5.3.2 of this report was estimated and summarized in Table 9 on the next page.

The rain garden cost estimates we calculated at $5 per square foot of area required, as recommended by the Iowa Rain Garden Design and Installation Manual. This value amounted to a combined cost for both rain gardens of $3,540.00, with the northern rain garden costing $1,230.00 and the southern rain garden costing $2,310.00.

The rain barrel cost estimate for the 2500 and 5000 gallon tank were acquired from the Tank Depot website. They price a 2500 gallon tank at $2,808.99 and a 5000 gallon tank at $4.747.99. To estimate a payback period for the water collection system a price for the yearly collected water value by the system had to estimate. This estimate was done by dividing the total 15,340 cubic feet of collective water into a quarterly volume of 3,835 cubic feet. With this estimated quarterly volume of water collected and the water rates outlined in section 13.20.020 B of the Decorah Code of Ordinance, a projected value of the water collected would be $365. This amounts to a yearly water collected value of $1,460. This value is the value of savings from the water collection system each year by providing “free” water, to water garden etc. With a yearly savings of $1,460 and a capital cost of $7,556.98 for both tanks, the payback period of this system would be 5 years.

Table 9: Summary of Water Management System Cost and Payback Periods

	Cost of Rain Garden	Cost of Water Collection System
Northern Portion	$ 1,230.00	$ 2,808.99
Southern Portion	$ 2,310.00	$ 4,747.99
Total	$ 3,540.00	$ 7,556.98
Yearly Savings	-	$ 1,458.12
Payback Period (yr)	-	5 years

6.3 Site Plan

In the proceeding sections, cost estimates for earthwork and materials necessary for construction of the access road, parking lot, and building footprint are examined.

6.3.1 Building Footprint

A preliminary cost for creating the building footprint based on cut and fill figures is presented on the following page in Table 10.

In order to account for estimate these costs, approximate figures for excavation and fill were required. Using Civil 3D, the final building design as set into the hillside, and using embedded function in the program cut and fill values were produced. Once those figures were obtained, estimated costs for each process was obtained from RSMeans Heavy Construction Data 29th Annual Edition (2015). For simplicity, the excavation cost is an approximate cost for cubic yards of earth for one front end loader with a 5 C.Y. capacity. In regards to fill, the same manual provided a general fill estimate based on cubic yards of earth which was applied.

Table 10: Building footprint cost estimate by cubic yards

Building Footprint	Process	Cubic Yards	Cost per C.Y.	**Cost (Location Factor =0.83)**
	Excavation	4,392.00	$1.37	$4,994.14
	Fill	0.00	$2.38	$0.00
			Total	**$4,994.14**

6.3.2 Access Road

A preliminary cost for the earth work and construction of the designed access road based on cut and fill along with material costs is presented on the following page in Table 11.

To approximate the earth work cost related to the designed access road, excavation and fill estimated were required. Following completion of designing the roadway profile, cross section, and length in Civil 3D, the embedded cut and fill function was used to determine approximate cubic yardages. In order to produce a cost estimate for these figures, RSMeans Heavy Construction Data 29th Annual Edition (2015) was referenced for costs. For simplicity, the excavation cost is an approximate cost for cubic yards of earth for one front end loader with a 5 C.Y. capacity. In regards to fill, the same manual provided a general fill estimate based on cubic yards of earth which was applied.

A cost estimate for the roadway materials was obtained using the design described in section 5.4.1. Following those standards, cost for each material quantity was calculated using RSMeans Heavy Construction Data 29th Annual Edition (2015). Separate cost estimates were used for binder and wearing asphalt despite identical thickness.

Table 11: Cost estimate for access road including earthwork and materials

Access Road	Process	Cubic Yards	Cost per C.Y.	**Cost (Location Factor = 0.83)**
Earth Work	Excavation	22,605.40	$1.37	$25,704.60
	Fill	6,923.07	$2.38	$13,675.83
Construction	Material	Square Yardage	Cost per S.Y.	
	2" Binder Asphalt	6,154.66	$9.70	$49,551.17
	2" Wearing Asphalt	6,154.66	$10.90	$55,681.21
	8" Crushed 1.5" Stone	6,154.66	$11.95	$61,045.00
			Total	**$205,657.82**

6.3.3 Parking Lot

Estimation of the costs associated with the required materials and earthwork for the designed parking lot are presented in Table 12.

Obtaining cut and fill costs required first determining quantiles for each. Following the design described in section in 5.4.2, the parking lot was laid out in Civil 3D and the embedded cut and fill function produced the displayed quantities. In order to convert that to a cost, RSMeans Heavy Construction Data 29th Annual Edition (2015) was utilized. For simplicity, the excavation cost is an approximate cost for cubic yards of earth for one front end loader with a 5 C.Y. capacity. In regards to fill, the same manual provided a general fill estimate based on cubic yards of earth which was applied.

Material estimates for the design described in 5.4.2 were calculated using the RSMeans Heavy Construction Data 29th Annual Edition (2015) again.

Table 12: Parking lot cost estimate including earth work and materials

Parking Lot	Process	Cubic Yards	Cost per C.Y.	**Cost (Location Factor =0.83)**
Earth Work	Excavation	524.10	$1.37	$595.95
	Fill	5,513.87	$2.38	$10,892.10
Construction	Material	Square Yardage	Cost per S.Y.	
	3.5" Wearing Asphalt	6,960.17	$18.30	$105,718.03
	6" Crushed 0.75" Stone	6,960.17	$6.55	$37,838.97
			Total	**$155,045.06**

7.0 Conclusions

In conclusion, following the requests set out by our client, the Winneshiek County Board of Conservation, a 30% design was fulfilled for a nature center, parking lot. In the preceding report, all appropriate standards and assumptions have been referenced. A two-story nature center with multi-function areas, accompanied with a paved access road and parking lot, produced an estimated cost of $2,505,761.04. With no defined budget, Gutowski & Guys exercised freedom in the design all while limiting unnecessary costs. The potential for this entire project is tremendous, and with Gutowski & Guys' presented designs, the groundwork has been laid for what certainly can be an amazing area for not only Winneshiek County, but the state of Iowa.

8.0 References

American Association of State Highway and Transportation Officials. (2011). *Roadside Design Guide* (4th ed.). Washington D.C.: A.S.H.T.

American Institute of Steel Construction. (2011). *Steel Construction Manual* (14th ed.). Ingram.

APA. (2011). Engineered Wood Construction Guide. *APA, E30V*. Retrieved April 27, 2015, from http://www.apawood.org/

Committee 318. (2011). *Building Code Requirements for Structural Concrete and Commentary*. American Concrete Institu

Das, B. (2010). *Principles of Foundation Engineering* (7th ed.). Stamford, Connecticut: Cengage Learning.

Demos, S. (2004). *Means ADA Compliance Pricing Guide* (2nd ed., pp. 40-53, 128-133). Kingston, Massachusetts: Reed.

Energy Star. (2014). Portfolio Manager Technical Reference: U.S. National Energy Use Intensity. *EPA*. Retrieved April 26, 2015, from http://www.energystar.gov/buildings/tools-and-resources/portfolio-manager-technical-reference-us-national-energy-use-intensity

Fortier, R. (2015). *RSMeans Heavy Construction Cost Data* (29th ed., p. 73, 229, 238, 298, 299, 302, 576). Norwell, Massachusetts: RSMeans

Fortier, R. (2015). *RSMeans Square Foot Costs* (36th ed., p. 86, 87, 112, 113, 174, 175). Norwell,Massachusetts: RSMeans

Iowa Department of Natural Resources. (2009). *Iowa Stormwater Management Manual* (Vol. 3). Iowa: Iowa DN.

Iowa Energy Center. (2015, January 1). Solar Energy: Solar Calculator Tool. Retrieved April 27, 2015, from http://www.iowaenergycenter.org/solar-calculator-tool/

Iowa Stormwater Partnership. (2008). Iowa Rain Garden Design and Installation Manual.*United States Department of Agriculture*. Retrieved April 27, 2015.

Metcalf and Eddy, Inc. (1991). *Wastewater Engineering—Treatment, Disposal, and Reuse.* (3rd ed.) New York, New York: McGraw-Hill Publishing Company

Mewis, B. (Ed.). (2015). *RSMeans Residential Cost Data* (34th ed., p. 244, 245). Norwell, Massachusetts: RSMeans.

Open Joist. (2009). *Where Speed Meets Strength*. Universal Forest Products.

NREL. (n.d.). NREL's PVWatts Calculator. Retrieved April 26, 2015, from http://pvwatts.nrel.gov/Wayland III, R. (2002). Onsite Wastewater Treatment System Manual. *EPA*. Retrieved April 26, 2015.

Ring, S. (n.d.). Asphalt Paving Design Guide. *Asphalt Paving Association of Iowa*.

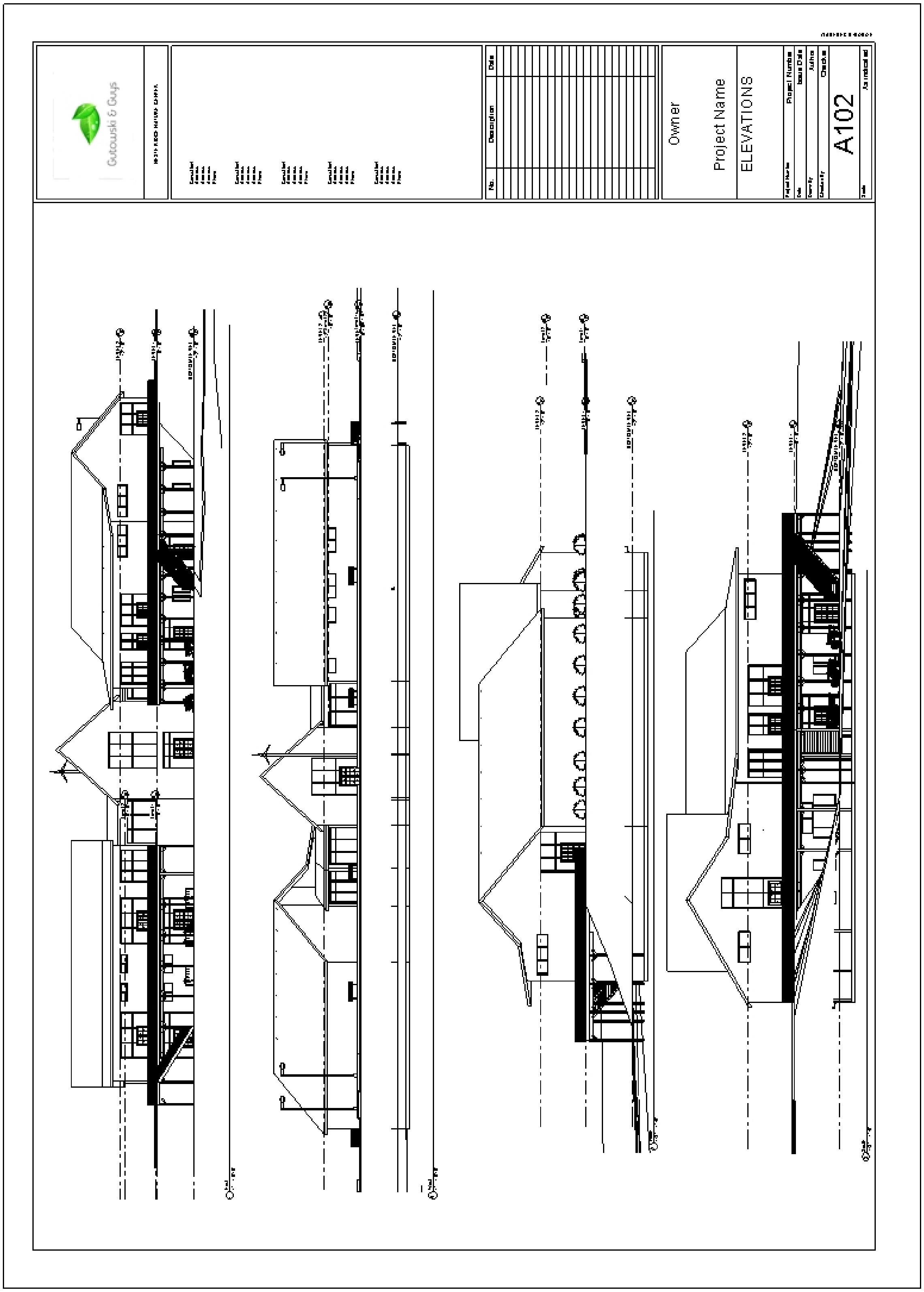
Roadside Design Guide (4th ed.). (2011). Washington D.C.: A.S.H.T.O.

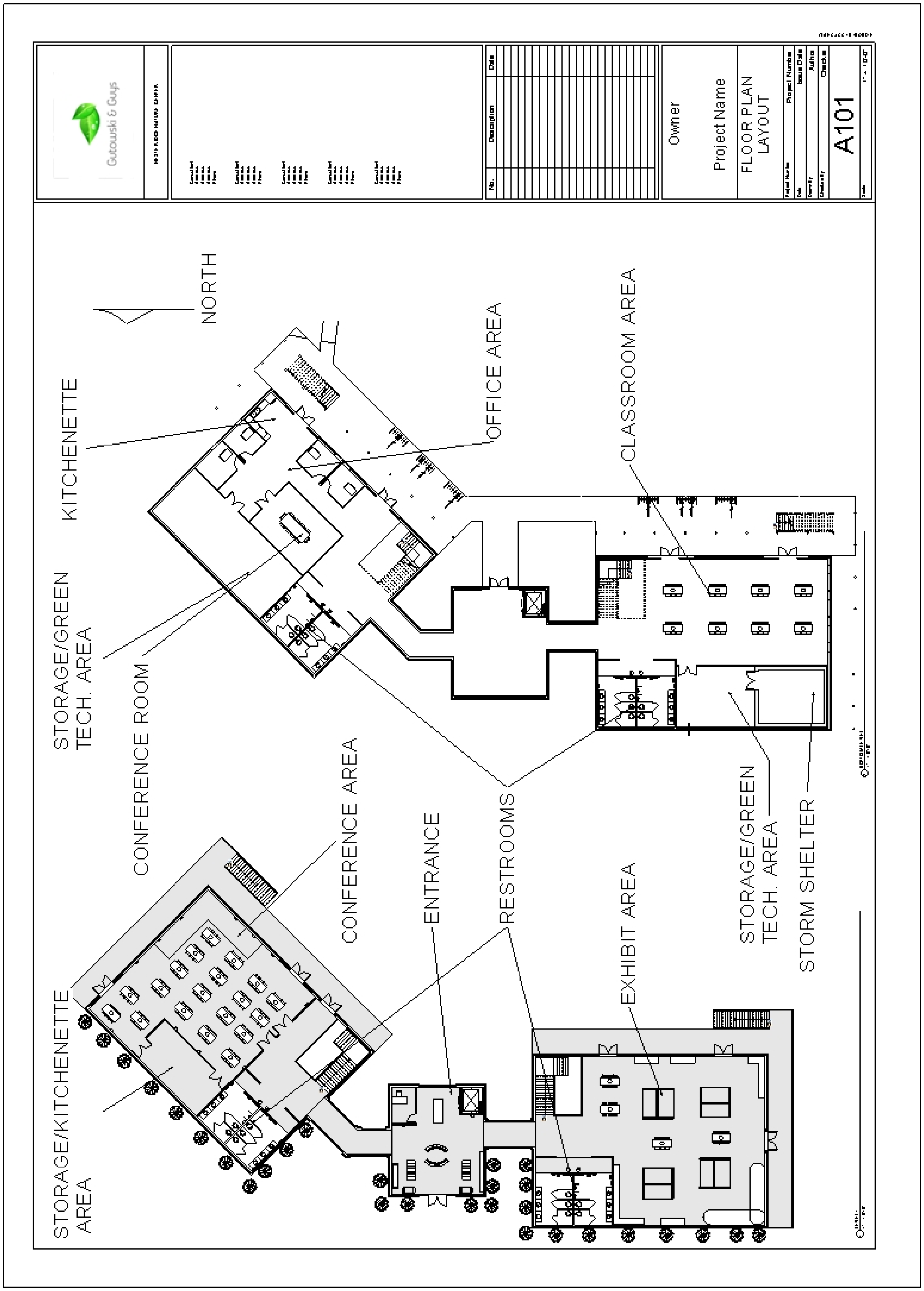
Statewide Urban Design and Specifications. (2014). Urban Design Standards Manual.*S.U.D.A.S, 5*. Retrieved March 3, 2015, from http://www.iowasudas.org/manuals/manual.cfm?manual=design

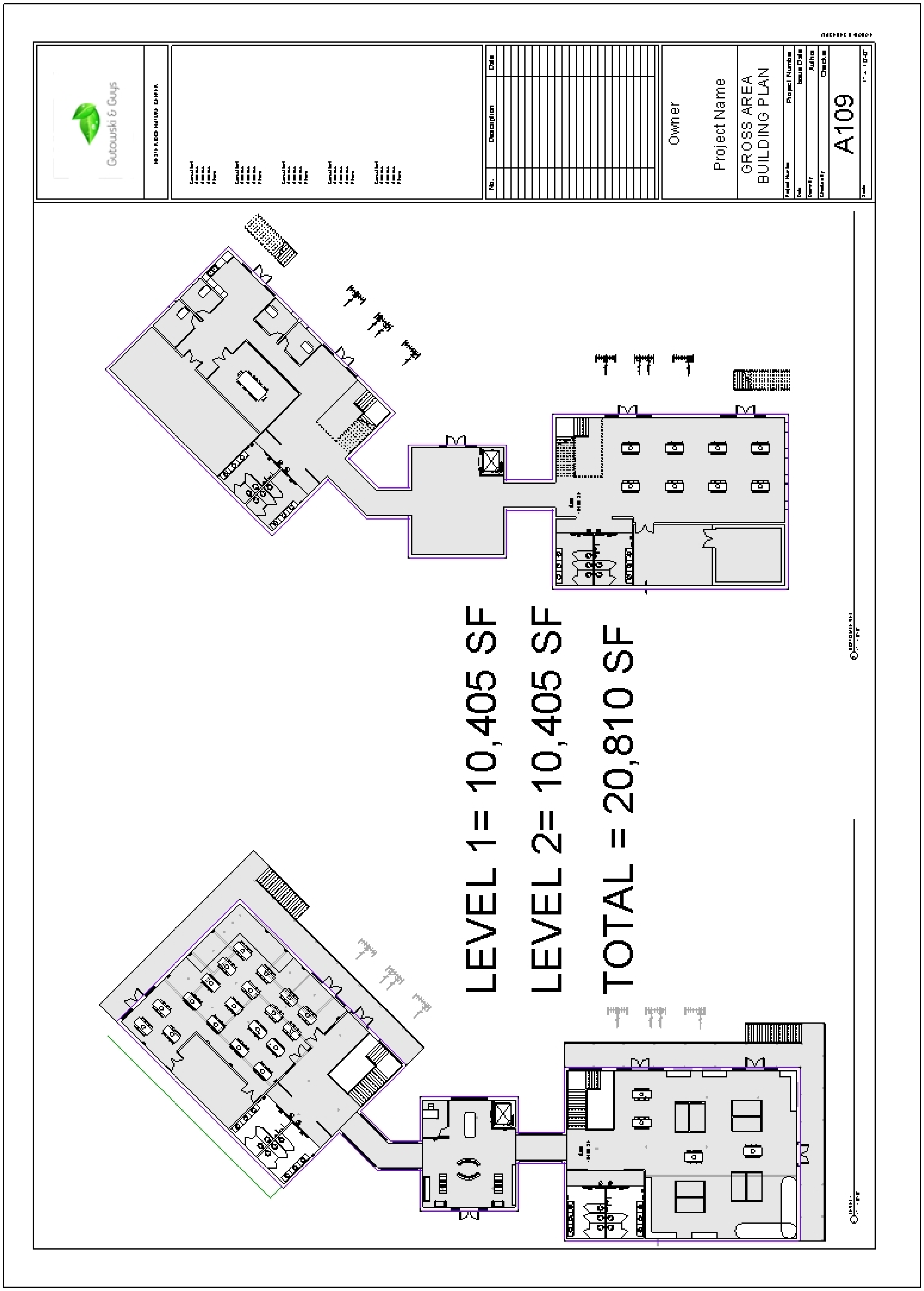
Weyerhaeuser. (2012). *Beams, Headers, and Columns: TJ-9000*.

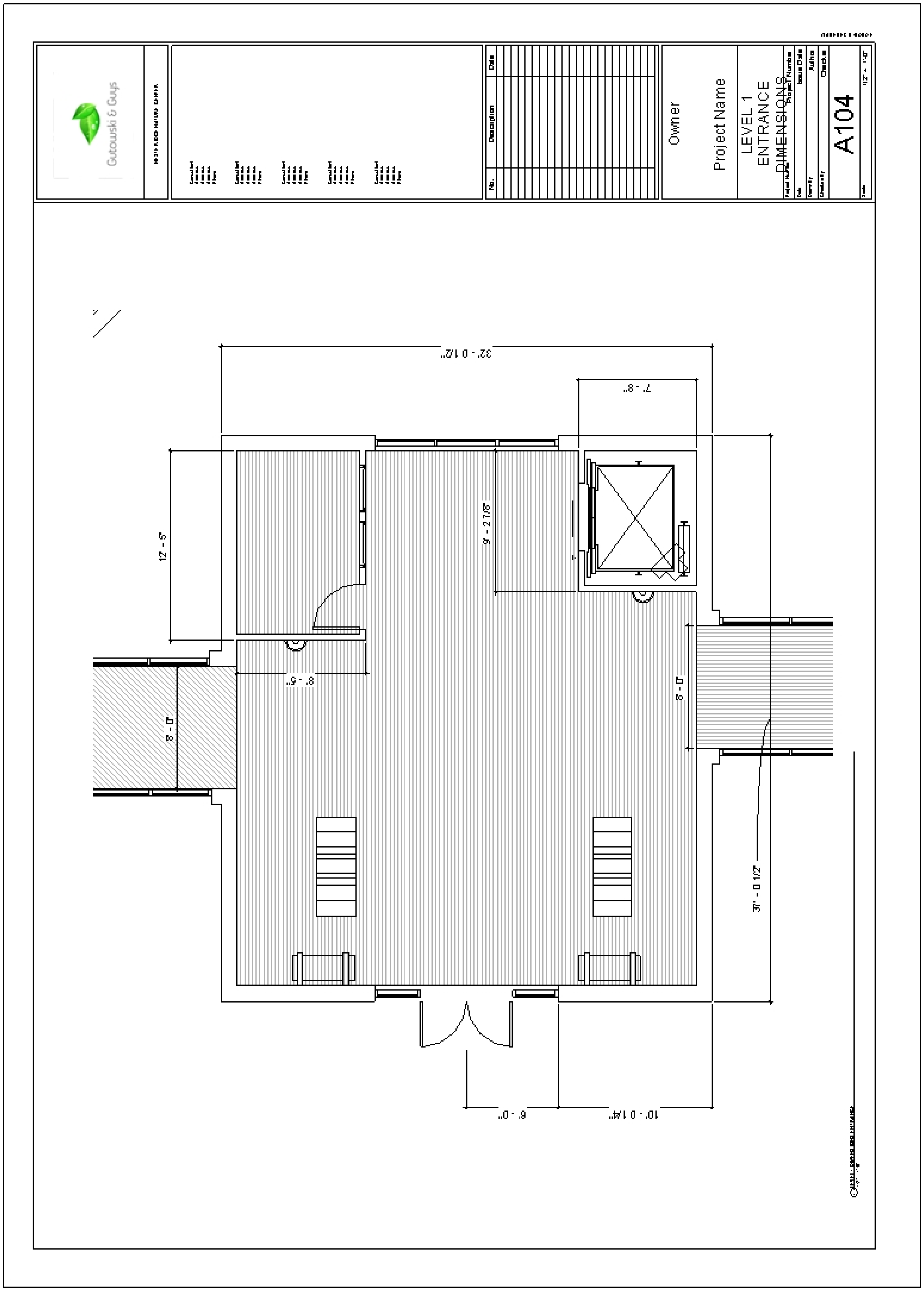
Wright, J., & MacGregor, J. (2012). *Reinforced Concrete Mechanics & Design* (6th ed.). Pearson.

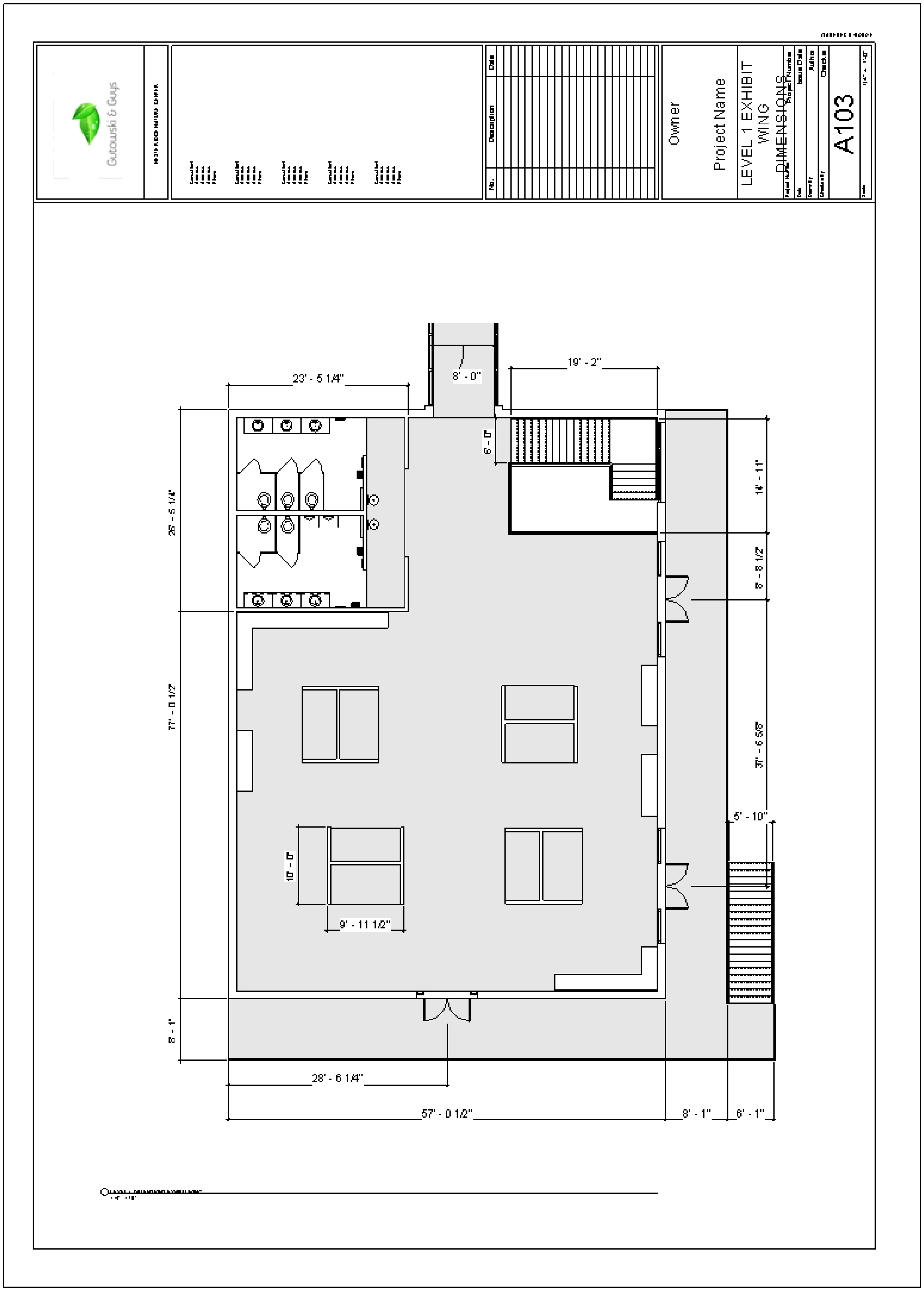
Appendix A.1: Design Alternative 1 Floorplan

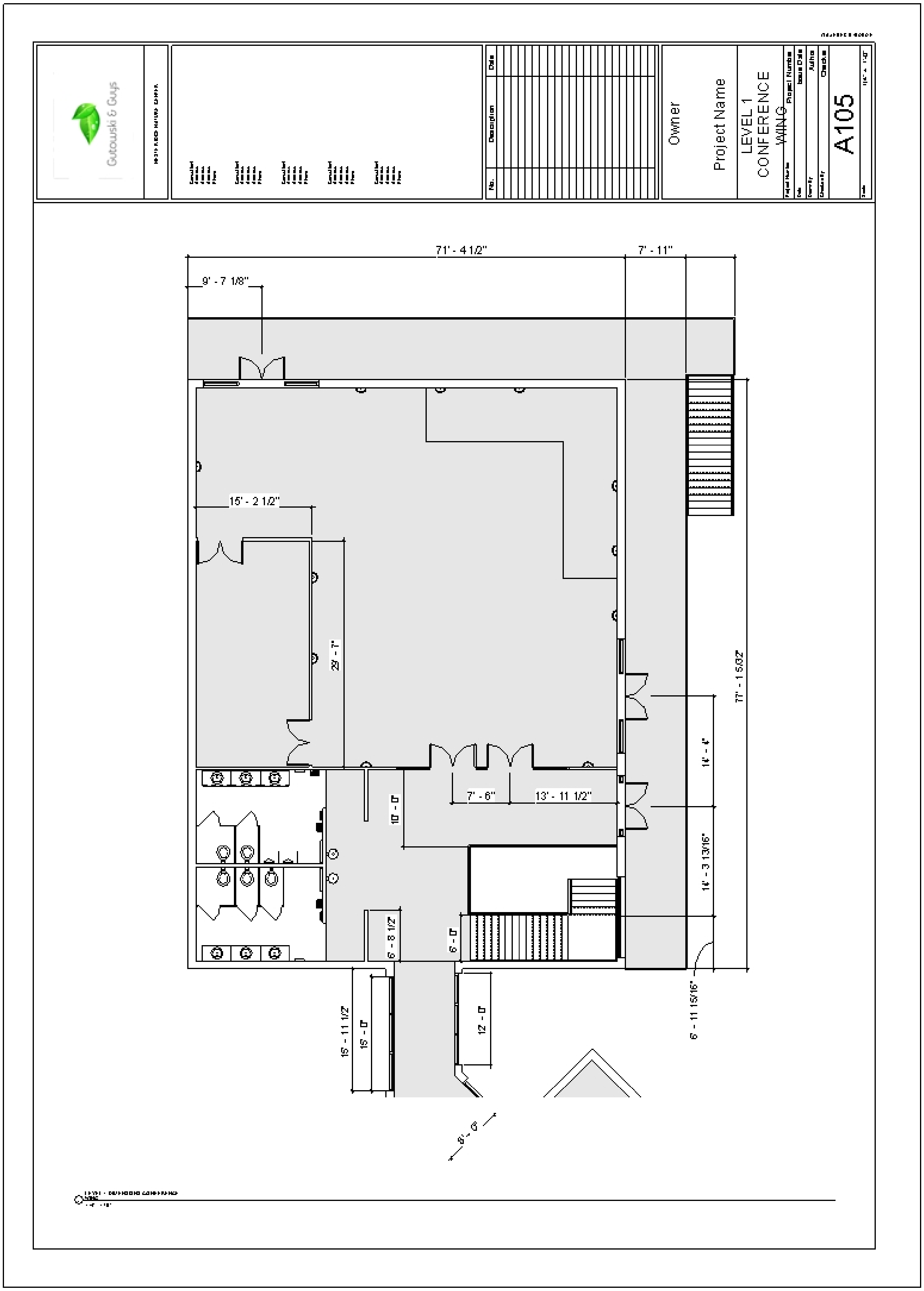


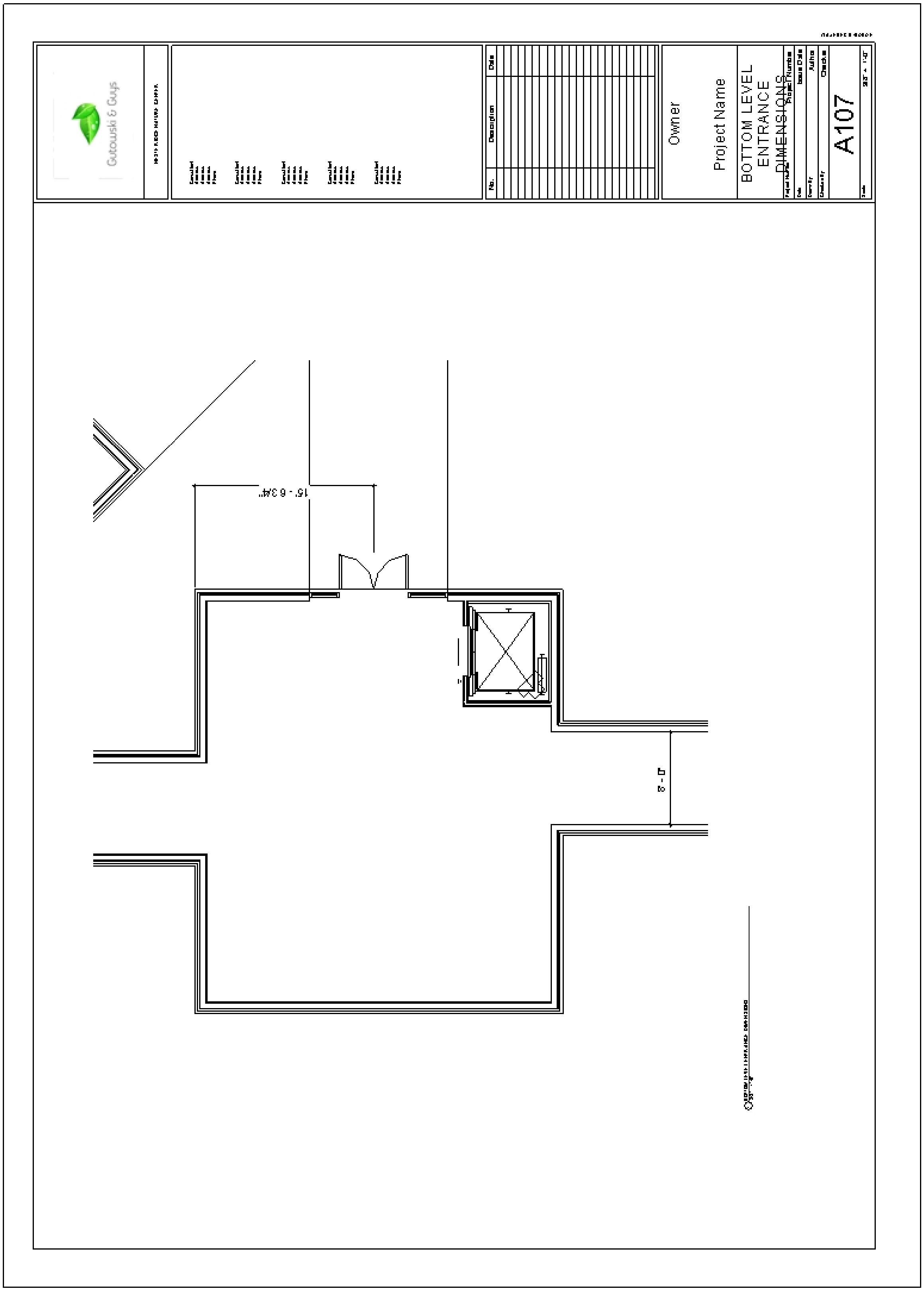

NORTH
KITCHENETTE
OFFICE AREA
CLASSROOM AREA
STORAGE/GREEN TECH. AREA
CONFERENCE ROOM
CONFERENCE AREA
ENTRANCE
RESTROOMS
EXHIBIT AREA
STORAGE/GREEN TECH. AREA
STORM SHELTER
STORAGE/KITCHENETTE AREA
Gutowski & Guys
Owner
Project Name
FLOOR PLAN LAYOUT
A101

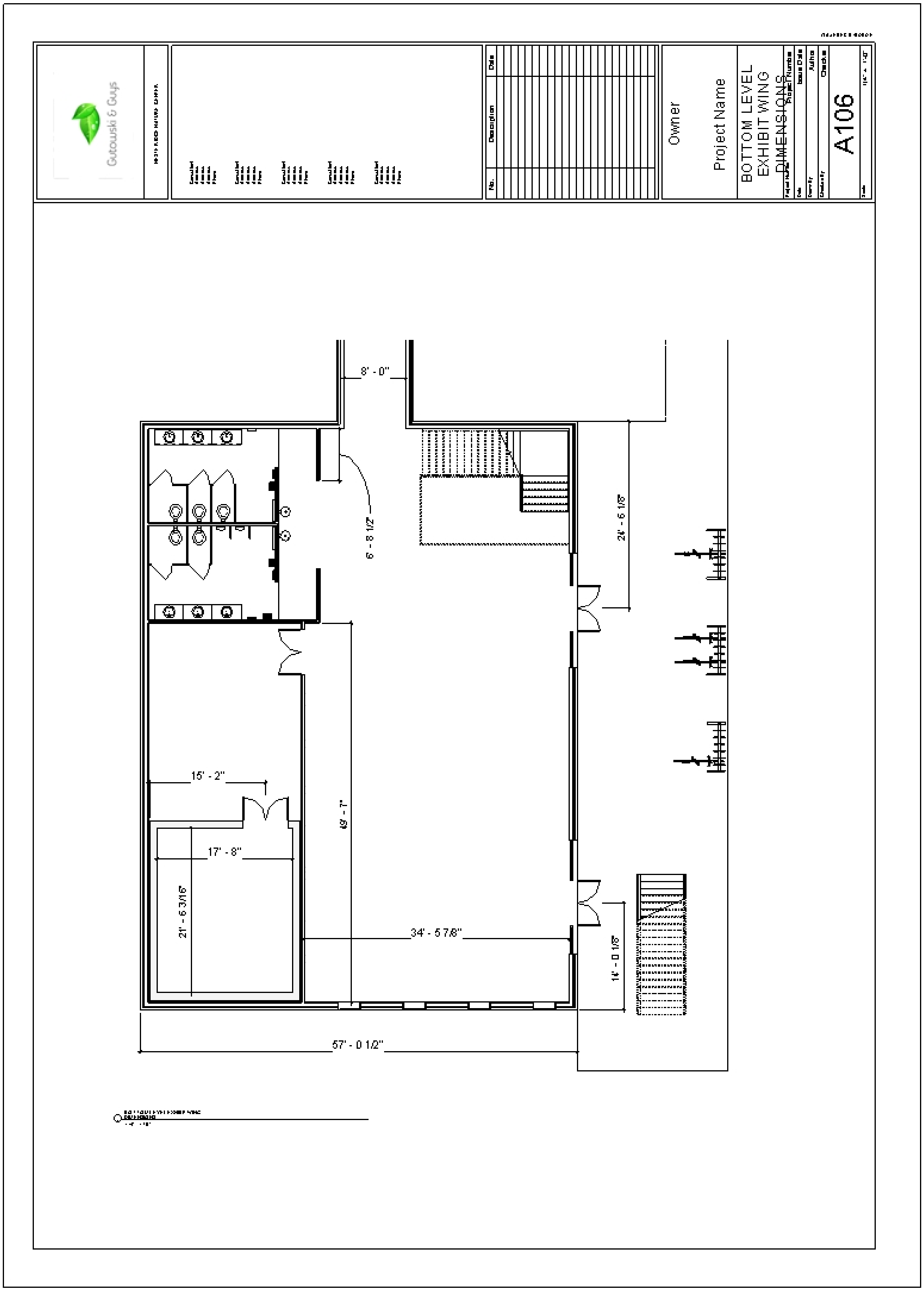

Gutowski & Guys
Owner
Project Name
GROSS AREA
BUILDING PLAN
A109
LEVEL 1= 10,405 SF
LEVEL 2= 10,405 SF
TOTAL = 20,810 SF

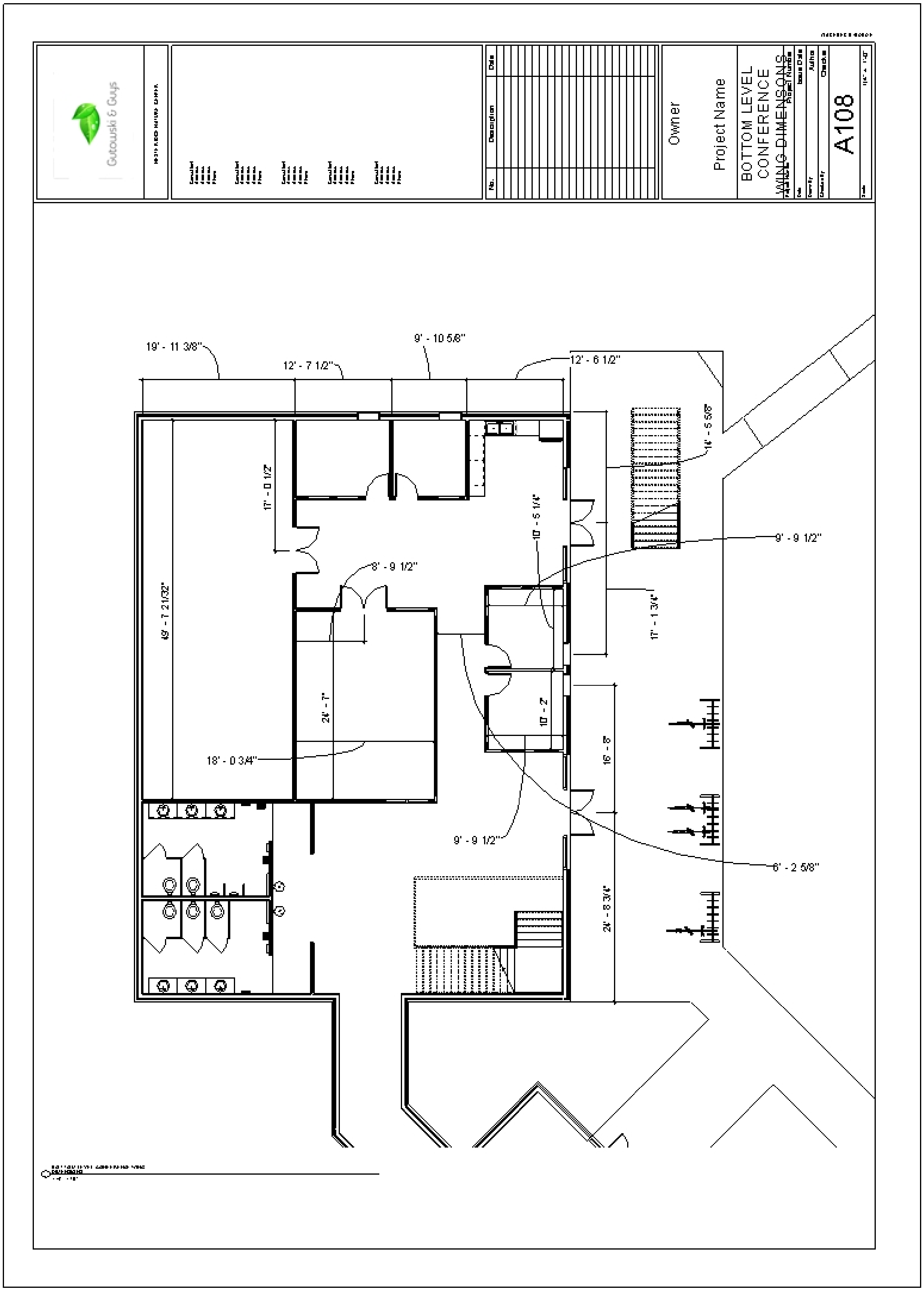

Gutowski & Guys
Owner
Project Name
LEVEL 1
ENTRANCE
DIMENSIONS
A104
32' - 0 1/2"
7' - 8"
12' - 5"
9' - 2 7/8"
8' - 9"
8' - 0"
8' - 0"
31' - 0 1/2"
6' - 0"
10' - 0 1/4"


Gutowski & Guys
Owner
Project Name
LEVEL 1 EXHIBIT WING DIMENSIONS
A103
23' - 5 1/4"
8' - 0"
19' - 2"
6' - 0"
14' - 11"
8' - 8 1/2"
31' - 6 5/8"
5' - 10"
26' - 5 1/4"
77' - 0 1/2"
10' - 0"
9' - 11 1/2"
8' - 1"
28' - 6 1/4"
57' - 0 1/2"
8' - 1"
6' - 1"


Gutowski & Guys
Owner
Project Name
LEVEL 1 CONFERENCE WING
A105
71' - 4 1/2"
7' - 11"
9' - 7 1/8"
15' - 2 1/2"
29' - 7"
7' - 6"
13' - 11 1/2"
10' - 0"
6' - 8 1/2"
6' - 0"
15' - 11 1/2
15' - 0"
12' - 0"
8' - 0"
71' - 1 5/32
14' - 4"
14' - 3 13/16"
6' - 11 15/16"

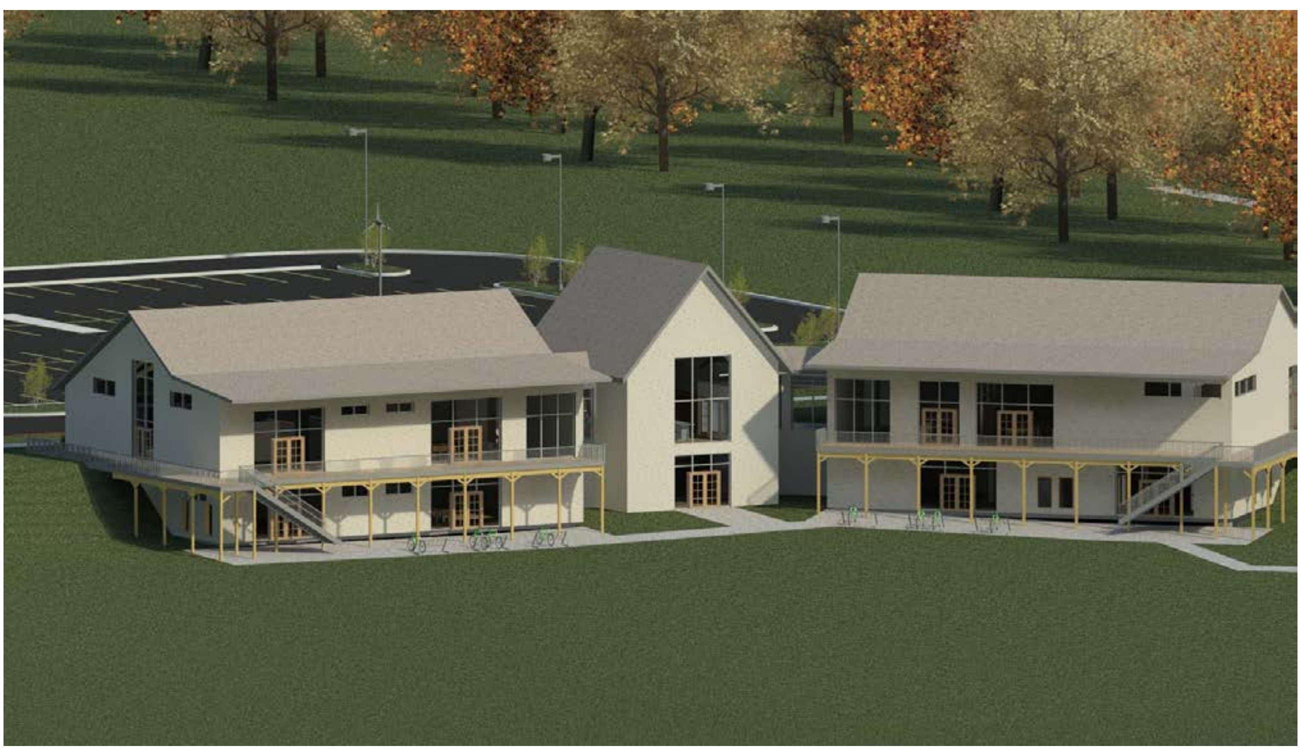

Gutowski & Guys
Owner
Project Name
BOTTOM LEVEL ENTRANCE DIMENSIONS
A107
15' - 6 3/4"
8' - 0"


Gutowski & Guys
Owner
Project Name
BOTTOM LEVEL
EXHIBIT WING
DIMENSIONS
A106
8' - 0"
6' - 8 1/2"
24' - 6 1/8"
15' - 2"
17' - 8"
21' - 6 3/16"
49' - 7"
34' - 5 7/8"
14' - 0 1/8"
57' - 0 1/2"



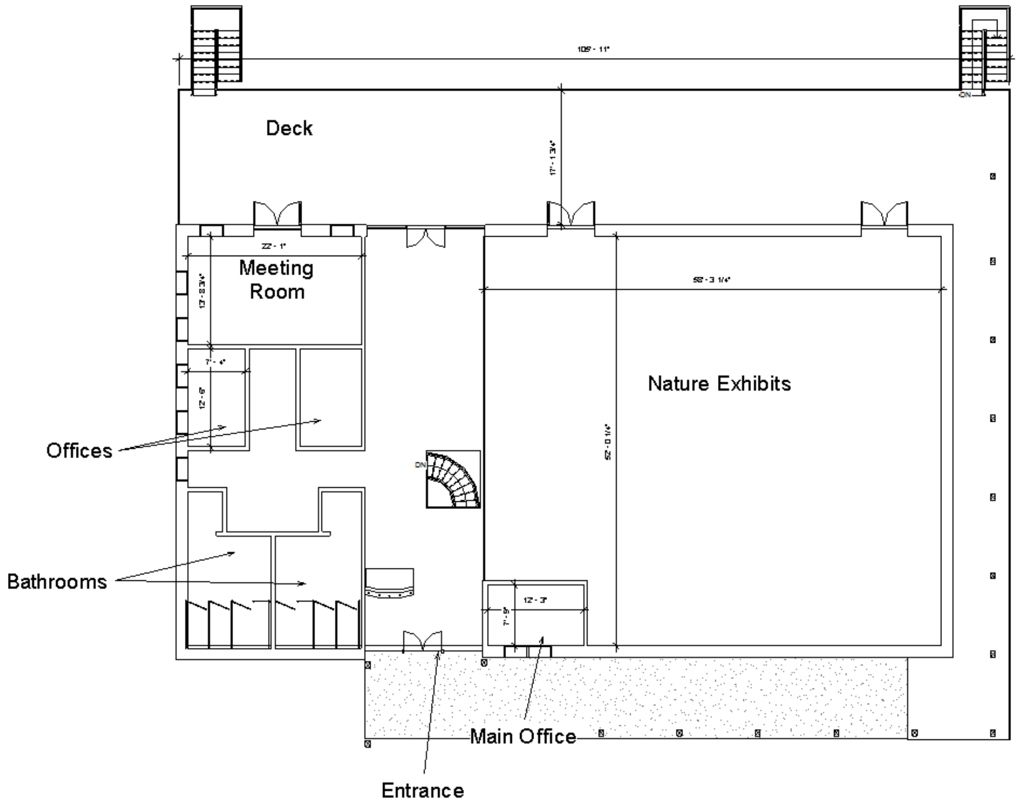
Gutowski & Guys
Owner
Project Name
BOTTOM LEVEL CONFERENCE WING DIMENSONS
A108
19' - 11 3/8"
12' - 7 1/2"
9' - 10 5/8"
12' - 6 1/2"
14' - 5 5/8"
17' - 0 1/2"
10' - 5 1/4"
9' - 9 1/2"
8' - 9 1/2"
49' - 7 21/32"
17' - 1 3/4"
24' - 7"
10' - 2"
16' - 8"
18' - 0 3/4"
9' - 9 1/2"
6' - 2 5/8"
24' - 8 3/4"

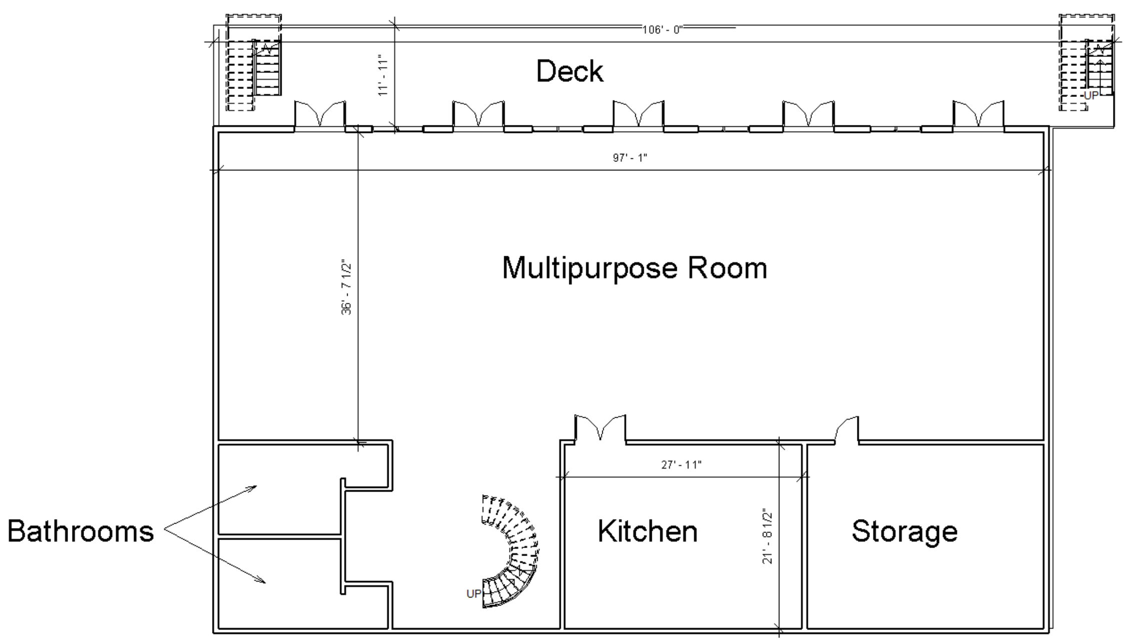
Appendix A.2: Design Alternative 1 Exterior Renders



Appendix A.3: Design Alternative 1 Interior Renders

Appendix B.1 Design Alternative 2 Floorplan





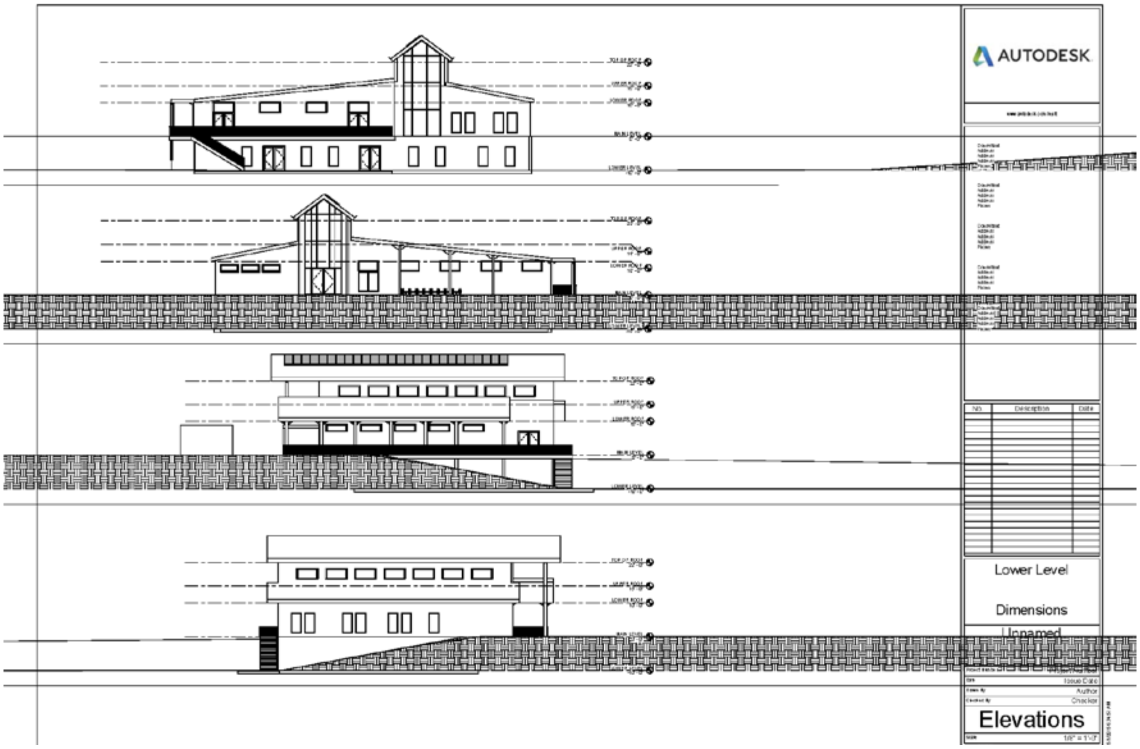
Appendix B.2: Design Alternative 2 Exterior Renders

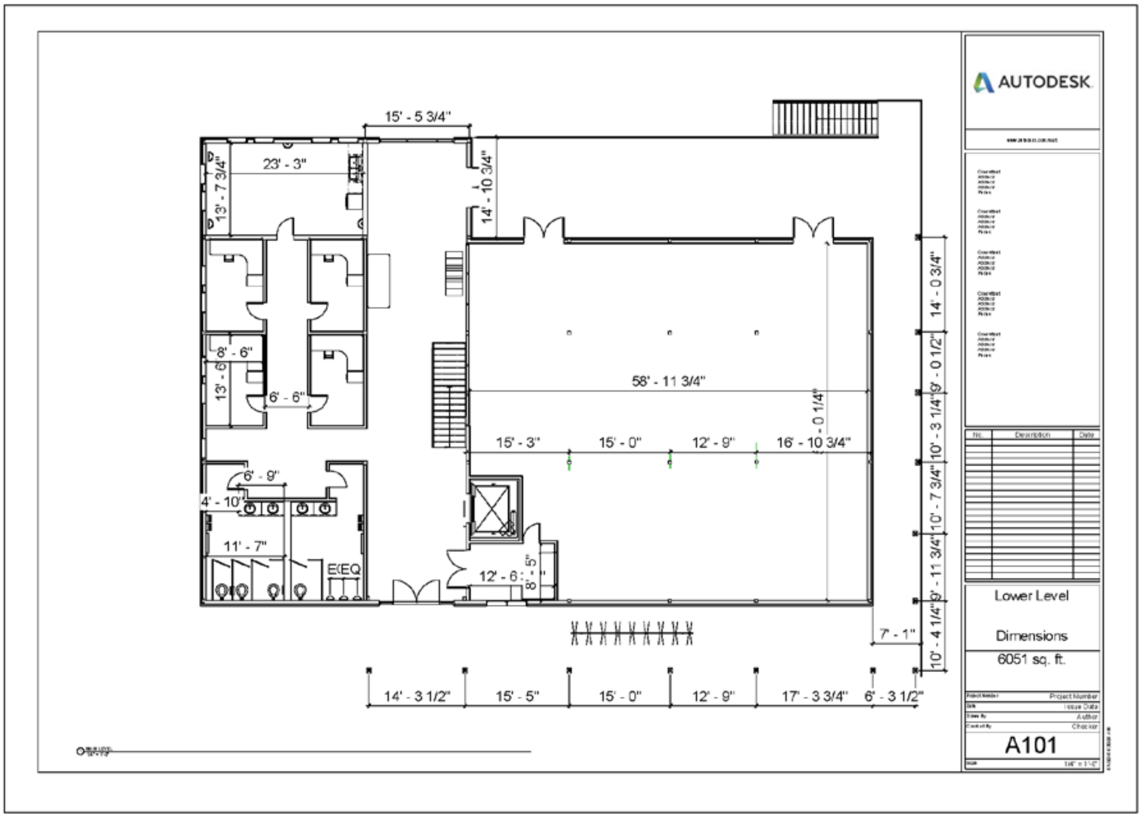
Appendix B.3: Design Alternative 2 Interior Render

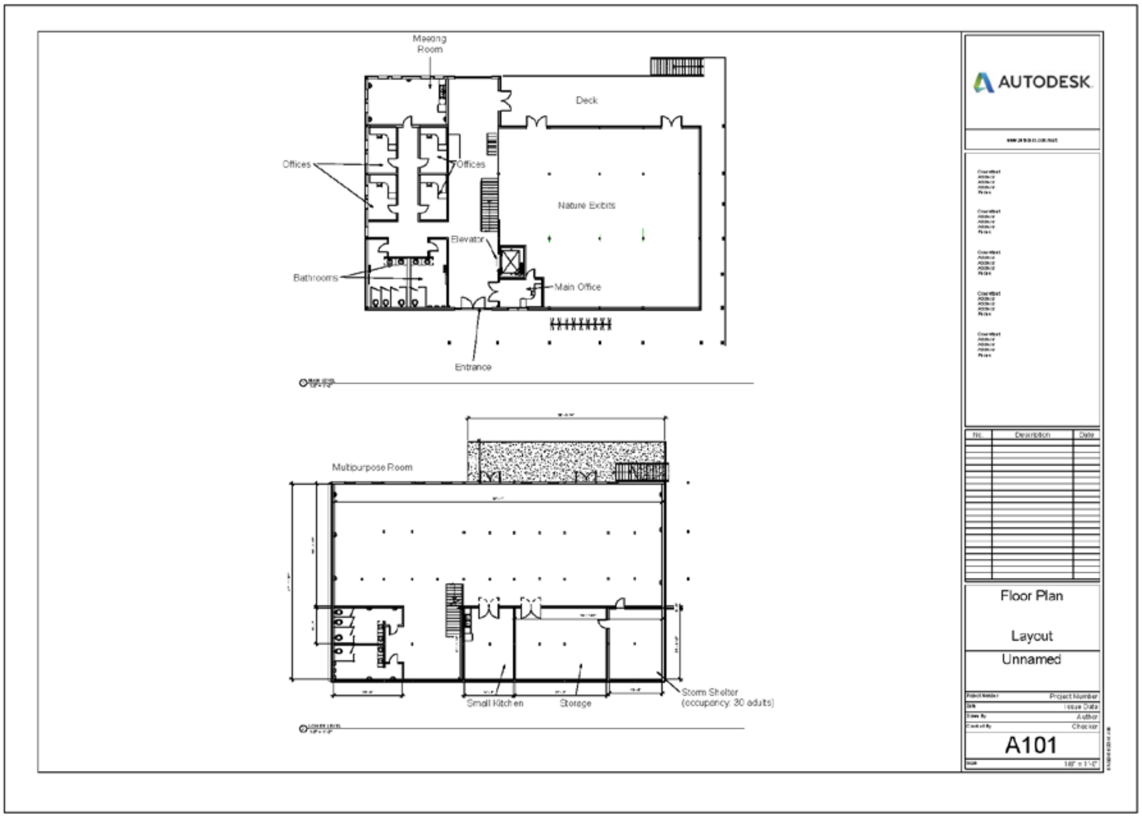
Appendix C.1: Revised Design Alternative 2 Exterior Render

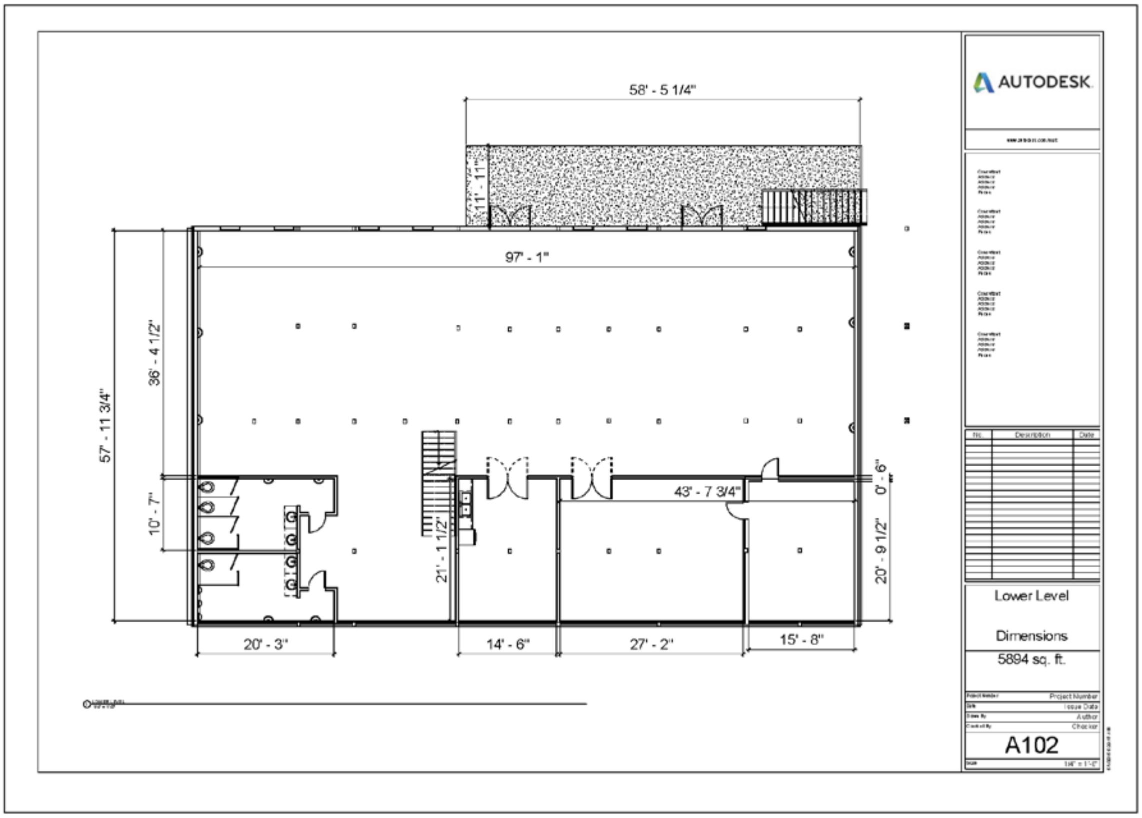

Welcome

Appendix C.2: Revised Design Alternative 2 Interior Renders


AUTODESK
Lower Level
Dimensions
Unnamed
Elevations


AUTODESK
15' - 5 3/4"
23' - 3"
13' - 7 3/4"
14' - 10 3/4"
8' - 6"
13' - 6"
6' - 6"
58' - 11 3/4"
15' - 3"
15' - 0"
12' - 9"
16' - 10 3/4"
6' - 9"
4' - 10"
11' - 7"
EQ
12' - 6"
8' - 5"
7' - 1"
14' - 3 1/2"
15' - 5"
15' - 0"
12' - 9"
17' - 3 3/4"
6' - 3 1/2"
14' - 0 3/4"
9' - 0 1/2"
10' - 3 1/4"
10' - 7 3/4"
9' - 11 3/4"
10' - 4 1/4"
No.
Description
Date
Lower Level
Dimensions
6051 sq. ft.
Project Number
Issue Date
Author
Checker
A101


Meeting Room
Deck
Offices
Offices
Nature Exibits
Elevator
Bathrooms
Main Office
Entrance
Multipurpose Room
Small Kitchen
Storage
Storm Shelter
(occupancy: 30 adults)
AUTODESK
No.
Description
Date
Floor Plan
Layout
Unnamed
Project Number
Issue Date
Author
Checker
A101


AUTODESK
58' - 5 1/4"
11' - 11"
97' - 1"
57' - 11 3/4"
36' - 4 1/2"
10' - 7"
21' - 1 1/2"
43' - 7 3/4"
0' - 6"
20' - 9 1/2"
20' - 3"
14' - 6"
27' - 2"
15' - 8"
No.
Description
Date
Lower Level
Dimensions
5894 sq. ft.
Project Number
Issue Date
Author
Checker
A102

Appendix D.1 Design of Timber Members

1. Layout columns, joists, and beams, for both the roof and floor
2. Calculate roof loads using ASCE Chap. 3, 4, 7.
    a. Dead Loads – ASCE Chapter 3
    b. Live - ASCE Chapter 4
    c. Snow - ASCE Chapter 3
    d. Factored loads - LRFD Approach (ASCE Chap 2) including self-weight.
3. Determine Beams from Truss Joist – Weterhaesur
    a. Allowable Design Properties Tables
    b. Turning Joist reactions into loading thru tributary area
    c. Max Shear =
    d. Max Moment =
    e. Select same size for similar beams
4. Determine necessary column size
    a. Autodesk Robot Structural Analysis Professional 2015 to find reaction forces on each column due to load
    b. Similar column size for columns in same row
    c. Find weight of columns
        i. SG, PCF Density
    d. Column length determined from roof height – joist
5. Determine bearing walls
6. Repeat process from joist, beams, column on main floor and deck
    a. Columns add additional from above columns.

Appendix D.2 Design of Concrete Slab on Grade.

1. Determine fire rating of structure
2. Select 5" thick concrete slab for 2 hour fire rating
3. Determine minimum reinforcement required for shrinkage and temperature of concrete.

Appendix D.3 Design of Bearing Walls

1. Calculate the Rankine active-pressure coefficient
2. Determine the surcharge acting on soil
3. Calculate the pressure from active-earth pressure & surcharge
4. Determine the tributary area
5. Determine the loading on the wall (distributed & axial)
6. Analyze the structure using Robot to find the maximum shear & moment
7. Assume dimension of wall using unit length method
8. Determine shear carried by the concrete & reinforcement in the beam
9. Calculate the reinforcement needed due to torsion
10. Determine the stirrups necessary for shear & torsion

11. Check the minimum stirrup spacing
12. Determine vertical reinforcement (area & slope)
13. Check minimum required reinforcement, minimum & maximum spacing
14. Determine the nominal strength of section
15. Check the wall section is tension controlled
16. Determine the nominal moment strength and compare to design moment
17. Determine the horizontal reinforcement required and spacing or bars

Appendix D.4.A Design of Strip Foundation

1. Assume width of foundation and use unit length approach
2. Determine the allowable load-bearing capacity using Terzaghi's Bearing capacity theory for continuous
3. Calculate the factored net pressure
4. Calculate the nominal shear strength
5. Calculate the nominal moment strength
6. Determine the size and spacing of flexural reinforcement
7. Check the tension controlled limit state
8. Check the development length
9. Determine the minimum temperature reinforcement
10. Calculate the elastic settlement of the structure

Appendix D.4.B Design of Spread Foundation

1. Estimate the footing size and factored net soil pressure
2. Check the thickness for two-way shear
3. Check the one way shear
4. Design the reinforcement in the long direction
5. Design the reinforcement in the short direction

Appendix D.6 Equations for Structural Analysis

Equation Number	Equation	Variables
D.1.1	$1.2D + 1.6L + 0.5S$	D= dead load L= Live load S=Snow load
D.1.2	$1.2D + 1.6S + L$	
D.1.3	$P_f = 0.7C_eC_tIP_g$	P_f= Snow load on flat roof C_e= Exposure factor C_t= Thermal factor I= Importance factor P_g= Ground snow load
D.1.4	$P_s = P_fC_s$	P_s= Sloped roof snow load C_s= Slope factor
D.1.5	$V_u = \frac{w_uL}{2}$	V_u=Maximum shear stress w_u=Factored distributed load L=Length of beam
D.1.6	$M_u = \frac{w_uL^2}{8}$	M_u= Maximum moment
D.1.7	$SG = \frac{\rho}{\rho_w}$	SG=Specific Gravity ρ= Density of material ρ_w=Density of water at 4° C
D.1.8	W= ρbwL	W= Weight b=Base w=Width
D.2.1	$A_g = 12h_f$	*A_g=Cross sectional area of unit length* *h_f=Width of slab*
D.2.2	$A(S\&t) = 0.0018A_g$	A(s&t)= Minimum area of reinforcement for shrinking and temperature

D.2.3	$\frac{A(s\&t)}{s} \leq \frac{A_s}{s}$	A_s=Area of steel reinforcement s=Spacing of reinforcement
D.3.1	$K_a = tan^2(45 - \frac{\varphi'}{2})$	K_a=Rankine active earth pressure ϕ'= Effective angle of friction
D.3.2	$P_z = qK_a + \gamma K_a z$	P_z= Active force q= Surcharge loading γ= Unit weight of soil z= Height
D.3.3	$\phi V_N \geq V_u$	ϕ= 0.75 V_N= Nominal shear strength V_U= Design shear strength
D.3.4	$V_N = V_C + V_s$	V_c= Shear carried by concrete V_s= Shear carried by stirrups
D.3.5	$V_c \leq 2\lambda bd\sqrt{f_c'}$	λ= 1.0 for normal weight concrete b=Base d=Depth from top to reinforcement f_c'= Compressive strength of concrete
D.3.6	$V_s = \frac{A_v F_y d}{s}$	A_v= Area of shear reinforcement F_y= Yielding strength of steel
D.3.7	$\tau_{max} = \frac{VQ}{It}$	τ_{max} =Maximum shear strength Q= Shear modulus I= Moment of inertia t= Thickness
D.3.8	$p_{cp} = 2(h + b)$	P_{cp}= Perimeter of the concrete section
D.3.9	$A_{cp} = bh$	A_{cp}= Area enclosed by the concrete section
D.3.10	$T_{th} = \phi \frac{A_{cp}^2}{p_{cp}} \sqrt{f_c'}$	T_{th}= Threshold torsion
D.3.11	$\phi T_N \geq T_u$	
D.3.12	$A_{OH} = (b - 3 - d_b)(h - 3 - d_b)$	A_{OH}= Area enclosed by the centerline of the stirrups
D.3.13	$p_H = 2(b - 3 - d_b) + 2(h - 3 - d_b)$	p_H= Perimeter of the centerline of the outermost stirrups
D.3.14	$T_N = \phi \sqrt{f_c'} (\frac{A_{OH}^2}{p_H})$	
D.3.15	$T_N = \frac{2A_0 A_t f_{yt}}{s} cot\theta$	

D.3.16	$A_o = 0.85A_{OH}$	
D.3.17	$\frac{A_{v+s}}{s} = \frac{A_v}{s} + \frac{2A_t}{s}$	
D.3.18	$\frac{A_v + 2A_t}{s} \geq 0.75\sqrt{f_c' \frac{b_w}{f_{yt}}}, and \geq \frac{50b_w}{f_{yt}}$	
D.3.19	$\rho_l = \frac{A_s}{bh} > .0015 > .0025$	
D.3.20	$P_n = 0.85f_c'ba - A_sf_y$	P_n= Nominal axial strength of cross section
D.3.21	$\phi P_n \geq P_u$	
D.3.22	$c = \frac{a}{\beta_1}$	B_1=0.85
D.3.23	$\epsilon_t = \frac{0.003}{c}(d - c) > 0.005$	ϵ_t= Stress at tensile
D.3.24	$\phi M_n \geq M_u$	M_n= Nominal moment strength M_u= Design moment strength
D.3.25	$\phi M_n = 0.90[0.85(f_c')(b)(a)\left(\frac{h}{2} - \frac{a}{2}\right) - (A_s)(f_y)(\frac{h}{2} - d)$	
D.3.26	$S_{max} = min\ (3h, 18)$	
D.4.1	$q = \gamma D_f$	D_f= Depth of foundation
D.4.2	$q_u = c'N_c + qN_q + \frac{1}{2}N_\gamma \gamma B$	N_c, N_q, N_γ= Bearing capacity factors q_u=Ultimate bearing capacity
D.4.3	$q_{all} = \frac{q_u}{FS}$	q_{all}=Allowable bearing capacity FS= Factor of safety= 3
D.4.4	$q_n = q_a - (d_c\gamma_c + d_\gamma \gamma)$	q_n=Net pressure d_c= Depth of concrete γ_c= Unit weight of concrete (150pcf) d_γ= Depth of soil
D.4.5	$V_u = q_n(a_t)(w)$	a_t= Tributary area w= Unit length
D.4.6	$V_c \leq 2\lambda bd\sqrt{f_c'}$	
D.4.7	$M_u = q_n\frac{(a_t + d)^2}{2}$	
D.4.8	$M_u \leq \phi M_n = \phi A_sf_yjd$	
D.4.9	$A(S\&t) = 0.0018A_g$	

D.4.10	$S_{max} = \min(2h, 18)$	
D.4.11	$a = \frac{A_s f_y}{.85 f_c' b}$	
D.4.12	$c = \frac{a}{\beta_1}$	
D.4.13	$\epsilon_t = \frac{0.003}{c}(d - c) > 0.005$	
D.4.14	$\phi M_n = 0.90[(A_s)(f_y)(d - \frac{a}{2})$	
D.4.15	$S_e = q_o(\alpha B') \frac{1 - \mu_s^2}{E_s} I_s I_f$	S_e= Elastic settlement q_o= Net applied pressure on foundation μ_s= Poisson's ratio of soil E_s= Modulus of elasticity of soil B'= B/2 for center of foundation =B for corner of foundation α=4 for center, 1 for corner I_f= depth factor I_s= Shape factor
D.4.16	$I_s = F_1 + \frac{1 - 2\mu_s}{1 - \mu_s} F_2$	
D.4.17	$F_1 = \frac{1}{\pi}(A_o + A_1)$	
D.4.18	$F_2 = \frac{n'}{2\pi} tan^{-1}(A_2)$	
D.4.19	$A_o = m' ln \frac{(1 + \sqrt{m'^2 + 1})(\sqrt{m'^2 + n'^2})}{m'(1 + \sqrt{m'^2 + n'^2 + 1})}$	m'= L/B n'=2H/B for center =H/B for corner
D.4.20	$A_1 = ln \frac{(m' + \sqrt{m'^2 + 1})(\sqrt{1 + n'^2})}{m' + \sqrt{m'^2 + n'^2 + 1}}$	
D.4.21	$A_2 = \frac{m'}{n'\sqrt{m'^2 + n'^2 + 1}}$	
D.4.22	$S_{e(rigid)} = 0.93 S_{e((flexible,center)}$	

Appendix D.7 Raw Data

- Roof Loads
  - Snow Loads
    - Figure 7-1: Pg = 35 PSF
    - Table 1-1: Category III → I=1.1
    - Table 7-2: Category C Terrain → Fully Exposed Ce = 0.9
    - Table 7-3: Ct = 1.0
    - Figure 7-2a
      - 10 slope, max value, slippery slope → Cs = 0.95
      - 75 slope, slippery slope, → Cs = 0
      - 20 slope, no solar panels → Cs = 1.0
  - Live Loads
    - 20 PSF for ordinary
  - Dead Loads
    - 3/8 in APA rated 1610 wood sheathing → 3 PSF
    - Solar Panels → 4 PSF
    - Asphalt Singles → 2 PSF
    - Insulation → 1.1 PSF
    - Self-Weight of trusses → 13.5 PLF
    - Open Joist
      - Meeting Room roof: 14” 4x2 MSR2100 16” O.C. → 3.35 PLF
      - Main Hall: 9 ¼” 3x2 #2 16” O.C. → 2.4 PLF
      - Nature Exhibit → 11 7/8” 4x2 #2 16” O.C. → 3.2 PLF
      - Deck → 9 ¼” 3x2 #2 16” O.C. → 2.4 PLF

Live Loads Main		**PSF**
4-1	Meeting Room	100
4-1	Offices	250
C-4-1	Bathrooms	120
4-1	Nature Exhibits	100
4-1	Stairs	100
4-1	Hallways	100
4-1	Deck	100
4-1	Partitions	15

Live Loads Lower		PSF
C4-1	Bathrooms	120
C4-1	Kitchen	60
C4-1	Storage	80
C4-1	Shelter	100
C4-1	Mechanical Room	300
4-1	Multipurpose Room	100
4-1	Ramp	250
C4-1	Elevator	150
4-1	Partitions	15
4-1	Roof	20

Dead Loads All		PSF
C-3-1	Acoustical Fiber Board	1
C-3-1	Wood Furring Suspension System	2.5
C-3-1	Plywood	0.8
C-3-1	Hardwood Floor	4
C-3-1	2x6 @ 16 in, 5/8 gypsum. Insulated	12
C-3-1	Windows	8
C-3-1	Mechanical Duct Hanging	4
C-3-1	Lights	1
C-3-1	Wood Studs, ½ in gypsum board	8

Location	L (ft)	Weight (PLF)	DL (PLF)	LL (PLF)	SL (PLF)	Total (PLF)	Force (Lbs)
Meeting room	23.33	3.35	8.13	20.00	24.26	72.60	846.95
Main Hall	15.48	2.40	13.47	20.00	0.00	51.04	395.03
Nature exhibit 1	15.25	3.20	13.47	20.00	23.04	76.86	586.09
Nature exhibit 2	15.00	3.20	13.47	20.00	23.04	76.86	576.48
Nature exhibit 3	12.75	3.20	13.47	20.00	23.04	76.86	490.01
Nature exhibit 4	16.90	3.20	13.47	20.00	23.04	76.86	649.34
Deck	7.08	2.40	6.67	20.00	24.26	69.70	246.84

							Parallam	PSL 2.0		Design		
Roof beam	Length (ft)	Weight (PLF)	Load left (PLF)	Load right (PLF)	Total (PLF)	Shear (lbs)	M(ft-lbs)	Width (in)	Depth(in)		Weight (P	Total (PLF
Meeting1a	28.54	35.00	0.00	635.21	677.21	9664.52	68961.20	7.00	16.00	7x16	35	677.21
Meeting1b	19.25	24.60	0.00	635.21	664.73	6398.07	30790.69	7.00	11.25	7x16	35	664.73
Meeting1c	20.98	26.00	0.00	635.21	666.41	6990.35	36662.64	7.00	11.88	7x16	35	666.41
Meeting2abottom	28.54	35.00	635.21	0.00	677.21	9664.52	68961.20	7.00	16.00	7x16	35	677.21
Meeting2bbottom	19.25	24.60	635.21	0.00	664.73	6398.07	30790.69	7.00	11.25	7x16	35	664.73
Meeting2cbottom	20.98	26.00	635.21	0.00	666.41	6990.35	36662.64	7.00	11.88	7x16	35	666.41
Meeting2dbottom	10.77	20.20	635.21	0.00	659.45	3551.49	9563.27	7.00	9.25	7x16	35	659.45
Meeting2atop	28.54	24.60	0.00	296.27	325.79	4649.05	33170.97	7.00	11.25	7x11.25	24.6	325.79
Meeting2btop	19.25	20.20	0.00	296.27	320.51	3084.93	14846.21	7.00	9.25	7x11.25	24.6	320.51
Meeting2ctop	20.98	20.20	0.00	296.27	320.51	3362.17	17634.58	7.00	9.25	7x11.25	24.6	320.51
Meeting2dtop	10.77	20.20	0.00	296.27	320.51	1725.96	4647.14	7.00	9.25	7x11.25	24.6	320.51
Main 1top	14.39	15.20	296.27	0.00	314.51	2263.23	8143.09	5.25	9.25	5.25x9.25	15.2	314.51
Main 2top	14.15	15.20	296.27	0.00	314.51	2225.17	7871.54	5.25	9.25	5.25x9.25	15.2	314.51
Main 3top	19.25	15.20	296.27	0.00	314.51	3027.18	14568.29	5.25	9.25	5.25x9.25	15.2	314.51
Main 4top	20.98	15.20	296.27	0.00	314.51	3299.07	17302.81	5.25	9.25	5.25x9.25	15.2	314.51
Main5top	10.77	15.20	296.27	0.00	314.51	1693.80	4560.99	5.25	9.25	5.25x9.25	15.2	314.51
Main1bottom	14.15	15.20	0.00	439.57	457.81	3238.98	11457.88	5.25	9.25	5.25x11.25	18.5	457.81
Main2bottom	19.25	18.50	0.00	439.57	461.77	4444.50	21389.15	5.25	11.25	5.25x11.25	18.5	461.77
Main3bottom	20.98	18.50	0.00	439.57	461.77	4843.93	25406.39	5.25	11.25	5.25x11.25	18.5	461.77
Main4bottom	10.77	15.20	0.00	439.57	457.81	2465.29	6637.78	5.25	9.25	5.25x11.25	18.5	457.81
Nature 1a	14.15	18.50	439.57	432.36	894.13	6325.94	22378.02	5.25	11.25	5.25x16	26.3	894.13
Nature 1b	19.25	26.30	439.57	432.36	903.49	8696.05	41849.75	5.25	16.00	5.25x16	26.3	903.49
Nature 1c	20.98	26.30	439.57	432.36	903.49	9477.57	49709.84	5.25	16.00	5.25x16	26.3	903.49
Nature1d	10.77	15.20	439.57	432.36	890.17	4793.54	12906.62	5.25	9.25	5.25x16	26.3	890.17
Nature 2a	14.15	18.50	432.36	367.51	822.07	5816.12	20574.51	5.25	11.25	5.25x16	26.3	822.07
Nature 2b	19.25	23.00	432.36	367.51	827.47	7964.36	38328.48	5.25	14.00	5.25x16	26.3	827.47
Nature 2c	20.98	26.30	432.36	367.51	831.43	8721.66	45745.10	5.25	16.00	5.25x16	26.3	831.43
Nature2d	10.77	15.20	432.36	367.51	818.11	4405.50	11861.81	5.25	9.25	5.25x16	26.3	818.11
Nature 3a	14.15	18.50	367.51	487.00	876.71	6202.73	21942.15	5.25	11.25	5.25x16	26.3	876.71
Nature 3b	19.25	26.30	367.51	487.00	886.07	8528.43	41043.06	5.25	16.00	5.25x16	26.3	886.07
Nature 3c	20.98	26.30	367.51	487.00	886.07	9294.88	48751.65	5.25	16.00	5.25x16	26.3	886.07
Nature3d	10.77	15.20	367.51	487.00	872.75	4699.76	12654.11	5.25	9.25	5.25x16	26.3	872.75
Nature4a	14.15	15.20	487.00	185.13	690.37	4884.39	17278.54	5.25	9.25	5.25x14	23	690.37
Nature4b	19.25	23.00	487.00	185.13	699.73	6734.94	32411.88	5.25	14.00	5.25x14	23	699.73
Nature4c	20.98	23.00	487.00	185.13	699.73	7340.21	38499.38	5.25	14.00	5.25x14	23	699.73
Nature4d	10.77	15.20	487.00	185.13	690.37	3717.66	10009.81	5.25	9.25	5.25x14	23	690.37
Deck 1	14.15	10.10	185.13	0.00	197.25	1395.54	4936.71	3.25	9.25	3.25x9.25	10.1	197.25
Deck 2	19.25	10.10	185.13	0.00	197.25	1898.52	9136.64	3.25	9.25	3.25x9.25	10.1	197.25
Deck 3	20.98	10.10	185.13	0.00	197.25	2069.14	10852.66	3.25	9.25	3.25x9.25	10.1	197.25
Deck 4	10.77	10.10	185.13	0.00	197.25	1062.19	2859.94	3.25	9.25	3.25x9.25	10.1	197.25

	1.8E Parallam PSL					
Roof column	Required width (in)	Base (in)	Effective Length (ft)	Load (Lbs)	Acutal leng	Weight (lbs)
Meeting 1a	7.00	3.50	6.00	3670.00	8.83	46.90
Meeting 1b	7.00	3.50	6.00	12080.00	8.83	46.90
Meeting1c	7.00	3.50	6.00	10020.00	8.83	46.90
Meeting1d	7.00	3.50	6.00	13480.00	8.83	46.90
Meeting1e	7.00	3.50	6.00	7030.00	8.83	46.90
Meeting2a	7.00	5.25	7.00	5440.00	13.83	110.19
Meeting2b	7.00	5.25	7.00	17890.00	13.83	110.19
Meeting2c	7.00	5.25	7.00	14820.00	13.83	110.19
Meeting2d	7.00	5.25	7.00	19720.00	13.83	110.19
Meeting2e	7.00	5.25	7.00	15520.00	13.83	110.19
Meeting2f	7.00	5.25	12.00	5330.00	21.23	169.15
Main1a	5.25	5.25	8.00	2300.00	15.83	94.60
Main1b	5.25	5.25	8.00	7750.00	15.83	94.60
Main1c	5.25	5.25	8.00	12960.00	15.83	94.60
Main1d	5.25	5.25	8.00	15540.00	15.83	94.60
Main1e	5.25	5.25	8.00	12230.00	15.83	94.60
Main1f	5.25	5.25	12.00	4200.00	21.23	126.86
Nature1a	5.25	**5.25**	8.00	6370.00	14.22	84.97
Nature1b	5.25	**5.25**	8.00	15390.00	14.22	84.97
Nature1c	5.25	**5.25**	8.00	18100.00	14.22	84.97
Nature1d	5.25	**5.25**	8.00	14290.00	14.22	84.97
Nature1e	5.25	5.25	8.00	4850.00	14.22	84.97
Nature2a	5.25	**5.25**	7.00	5870.00	12.46	74.46
Nature2b	5.25	**5.25**	7.00	13860.00	12.46	74.46
Nature2c	5.25	**5.25**	7.00	16700.00	12.46	74.46
Nature2d	5.25	**5.25**	7.00	13180.00	12.46	74.46
Nature2e	5.25	5.25	7.00	4770.00	12.46	74.46
Nature3a	5.25	**5.25**	6.00	6300.00	10.97	65.55
Nature3b	5.25	**5.25**	6.00	14870.00	10.97	65.55
Nature3c	5.25	**5.25**	6.00	17730.00	10.97	65.55
Nature3d	5.25	**5.25**	6.00	13950.00	10.97	65.55
Nature3e	5.25	5.25	6.00	4790.00	10.97	65.55
Nature4a	5.25	3.50	6.00	4950.00	9.22	36.73
Nature4b	5.25	3.50	6.00	11690.00	9.22	36.73
Nature4c	5.25	3.50	6.00	13940.00	9.22	36.73
Nature4d	5.25	3.50	6.00	10970.00	9.22	36.73
Nature4e	5.25	5.25	6.00	3770.00	9.22	55.10
Deck1a	3.50	3.50	6.00	1420.00	9.22	24.49
Deck1b	3.50	3.50	6.00	3350.00	9.22	24.49
Deck 1c	3.50	3.50	6.00	3990.00	9.22	24.49
Deck1d	3.50	3.50	6.00	3140.00	9.22	24.49
Deck1e	3.50	3.50	6.00	1080.00	9.22	24.49

Main Floor Joists											
Room	Length (ft)	DL (PLF)	Weight (PLF)	LL(PLF)	Total (PLF)	Force (lbs)	Depth (in)	Spacing (in)	Chord size	Chord grade	
Meeting Room a	14.39	21.30	3.50	100.00	189.76	1365.32	16.00	12.00	4x2	#2	OJ
Main a	14.39	41.30	3.50	100.00	213.76	1538.00	16.00	12.00	4x2	#2	OJ
Deck a	14.39	15.00	3.50	100.00	182.20	1310.93	16.00	12.00	4x2	#2	OJ
Offices a	14.15	21.30	3.50	100.00	189.76	1342.55	16.00	12.00	4x2	#2	OJ
Main b	14.15	21.30	3.50	100.00	189.76	1342.55	16.00	12.00	4x2	#2	OJ
Nature a	14.15	21.30	3.50	100.00	189.76	1342.55	16.00	12.00	4x2	#2	OJ
Offices b	19.25	21.30	3.50	100.00	189.76	1826.44	16.00	12.00	4x2	#2	OJ
Main c	19.25	21.30	3.50	100.00	189.76	1826.44	16.00	12.00	4x2	#2	OJ
Natureb	19.25	21.30	3.50	100.00	189.76	1826.44	16.00	12.00	4x2	#2	OJ
Bath	10.88	18.30	3.50	60.00	122.16	664.25	16.00	12.00	4x2	#2	OJ
Main c	10.88	21.30	3.50	100.00	189.76	1031.82	16.00	12.00	4x2	#2	OJ
Nature	10.88	25.00	3.50	100.00	194.20	1055.96	16.00	12.00	4x2	#2	OJ
BE Bath	9.77	18.30	3.50	60.00	122.16	596.75	16.00	12.00	4x2	#2	OJ
BE Main	9.77	21.30	3.50	100.00	189.76	926.98	16.00	12.00	4x2	#2	OJ
BE Office	9.77	24.47	3.50	50.00	113.57	554.77	16.00	12.00	4x2	#2	OJ
BE Nature	9.77	21.30	3.50	100.00	189.76	926.98	16.00	12.00	4x2	#2	OJ

								Parallam	PSL 2.0	Design		
Roof beam	Length (ft)	Weight (PLF)	Load left (PLF)	Load right (PLF)	Total (PLF)	Shear (lbs)	M(ft-lbs)	Width (in)	Depth(in)		Weight (PLF)	Total (PLF)
Multi1a	15.54	30.60	0.00	1379.72	1416.44	11005.76	42757.39	7.00	14.00	7x14	30.60	1416.44
Multi1b	8.34	20.20	0.00	1379.72	1403.96	5854.53	12206.69	7.00	9.25	7x14	30.60	1416.44
Multi1c	15.40	30.60	0.00	1552.40	1589.12	12236.25	47109.56	7.00	14.00	7x14	30.60	1589.12
Multi1d	15.00	26.00	0.00	1310.93	1342.13	10065.97	37747.38	7.00	11.88	7x14	30.60	1347.65
Multi1e	14.92	26.00	0.00	1310.93	1342.13	10010.27	37330.80	7.00	11.88	7x14	30.60	1347.65
Multi1f	12.90	24.60	0.00	1310.93	1340.45	8643.22	27865.73	7.00	11.25	7x14	30.60	1347.65
Multi1g	16.81	30.60	0.00	1310.93	1347.65	11329.01	47618.67	7.00	14.00	7x14	30.60	1347.65
Multi2a	15.54	39.40	1379.72	1342.55	2769.56	21519.44	83603.04	7.00	18.00	7x18	39.40	2769.56
Multi2b	8.34	20.20	1379.72	1342.55	2746.52	11452.97	23879.44	7.00	9.25	7x18	39.40	2769.56
Multi2c	15.40	39.40	1552.40	1342.55	2942.24	22649.33	87177.26	7.00	18.00	7x18	39.40	2942.24
Multi2d	7.50	39.40	1310.93	1342.55	2700.76	10127.85	18989.73	7.00	18.00	7x18	39.40	2700.76
Multi2e	7.50	20.20	1310.93	1342.55	2677.72	10041.45	18827.73	7.00	9.25	7x18	39.40	2700.76
Multi2f	7.46	39.40	1310.93	1342.55	2700.76	10073.84	18787.71	7.00	18.00	7x18	39.40	2700.76
Multi2g	4.46	20.20	1310.93	1342.55	2677.72	5971.32	6658.02	7.00	9.25	7x18	39.40	2700.76
Multi2h	8.41	20.20	1310.93	1342.55	2677.72	11253.12	23645.62	7.00	9.25	7x18	39.40	2700.76
Multi2i	12.90	35.00	1310.93	1342.55	2695.48	17380.46	56034.61	7.00	16.00	7x18	39.40	2700.76
Multi2j	8.41	20.20	1310.93	1342.55	2677.72	11253.12	23645.62	7.00	9.25	7x18	39.40	2700.76
Multi2k	8.41	20.20	1310.93	1342.55	2677.72	11259.82	23673.76	7.00	9.25	7x18	39.40	2700.76
Multi3a	7.77	20.20	1342.55	1826.44	3193.23	12405.71	24098.08	7.00	9.25	7x11.25	24.60	3198.51
Multi3b	7.77	20.20	1342.55	1826.44	3193.23	12405.71	24098.08	7.00	9.25	7x11.25	24.60	3198.51
Multi3c	8.34	24.60	1342.55	1826.44	3198.51	13337.80	27809.30	7.00	11.25	7x11.25	24.60	3198.51
Multi3d	7.70	20.20	1342.55	1826.44	3193.23	12293.94	23665.84	7.00	9.25	7x11.25	24.60	3198.51
Multi3e	7.70	20.20	1342.55	1826.44	3193.23	12293.94	23665.84	7.00	9.25	7x11.25	24.60	3198.51
Multi3f	7.50	20.20	1342.55	1826.44	3193.23	11974.62	22452.41	7.00	9.25	7x11.25	24.60	3198.51
Multi3g	7.50	20.20	1342.55	1826.44	3193.23	11974.62	22452.41	7.00	9.25	7x11.25	24.60	3198.51
Multi3h	8.41	24.60	1342.55	1826.44	3198.51	13449.74	28278.08	7.00	11.25	7x11.25	24.60	3198.51
Multi3i	7.46	20.20	1342.55	1826.44	3193.23	11910.76	22213.56	7.00	9.25	7x11.25	24.60	3198.51
Multi3j	7.46	20.20	1342.55	1826.44	3193.23	11910.76	22213.56	7.00	9.25	7x11.25	24.60	3198.51
Multi3k	8.41	20.20	1342.55	1826.44	3193.23	13427.54	28231.40	7.00	9.25	7x11.25	24.60	3198.51
Multi3l	8.41	20.20	1342.55	1826.44	3193.23	13427.54	28231.40	7.00	9.25	7x11.25	24.60	3198.51
Bath4a	15.54	39.40	1826.44	664.25	2537.97	19719.99	76612.15	7.00	18.00	7x18	39.40	2537.97
Bath4b	8.34	20.20	1826.44	664.25	2514.93	10487.24	21865.89	7.00	9.25	7x18	39.40	2537.97
Hall4c	15.40	39.40	1826.44	1031.82	2905.54	22366.85	86089.99	7.00	18.00	7x18	39.40	2905.54
Kitchen4d	7.50	20.20	1826.44	1055.96	2906.64	10899.91	20437.33	7.00	9.25	7x18	39.40	2929.68
Kitchen4e	7.50	20.20	1826.44	1055.96	2906.64	10899.91	20437.33	7.00	9.25	7x18	39.40	2929.68
Storage4f	7.46	20.20	1826.44	1055.96	2906.64	10841.78	20219.91	7.00	9.25	7x18	39.40	2929.68
Storage4g	7.46	20.20	1826.44	1055.96	2906.64	10841.78	20219.91	7.00	9.25	7x18	39.40	2929.68
Storage4h	12.90	35.00	1826.44	1055.96	2924.40	18862.40	60831.23	7.00	16.00	7x18	39.40	2929.68
Shelter4i	8.41	20.20	1826.44	1055.96	2906.64	12222.43	25697.66	7.00	9.25	7x18	39.40	2929.68
Shelter4j	8.41	20.20	1826.44	1055.96	2906.64	12222.43	25697.66	7.00	9.25	7x18	39.40	2929.68

Roof column	Required width (in)	Base (in)	Effective Length (ft)	Actual length (ft)	Weight above (lbs)	Beam R Load(lbs)	Total Load (lbs)	Weight new (lbs)
Multi1a	7.00	5.25	6.00	8.67	46.90	12430.00	12476.90	69.05
Multi1b	7.00	5.25	6.00	8.67	0.00	19100.00	19100.00	69.05
Multi1c	7.00	5.25	6.00	8.67	110.19	18990.00	19100.19	69.05
Multi1d	7.00	5.25	6.00	8.67	94.60	24320.00	24414.60	69.05
Multi1e	7.00	5.25	6.00	8.67	24.49	23940.00	23964.49	69.05
Multi1f	7.00	5.25	6.00	8.67	24.49	22260.00	22284.49	69.05
Multi1g	7.00	5.25	6.00	8.67	24.49	23770.00	23794.49	69.05
Multi1h	7.00	5.25	6.00	8.67	24.49	13450.00	13474.49	69.05
Multi2a	7.00	5.25	6.00	8.67	46.90	22530.00	22576.90	69.05
Multi2b	7.00	5.25	6.00	8.67	0.00	34620.00	34620.00	69.05
Multi2c	7.00	5.25	6.00	8.67	110.19	34420.00	34530.19	69.05
Multi2d	7.00	5.25	6.00	8.67	94.60	33210.00	33304.60	69.05
Multi2e	7.00	5.25	6.00	8.67	0.00	21760.00	21760.00	69.08
Multi2f	7.00	5.25	6.00	8.67	84.97	21700.00	21784.97	69.05
Multi2g	7.00	5.25	6.00	8.67	0.00	21640.00	21640.00	69.08
Multi2h	7.00	5.25	6.00	8.67	74.46	29530.00	29604.46	69.05
Multi2i	7.00	5.25	6.00	8.67	65.55	30900.00	30965.55	69.05
Multi2j	7.00	5.25	6.00	8.67	0.00	24380.00	24380.00	69.05
Multi2k	7.00	5.25	6.00	8.67	36.73	12190.00	12226.73	69.05
Multi3a	7.00	5.25	6.00	8.67	46.90	12430.00	12476.90	69.05
Multi3b	7.00	5.25	6.00	8.67	0.00	24860.00	24860.00	69.05
Multi3c	7.00	5.25	6.00	8.67	0.00	25770.00	25770.00	69.05
Multi3d	7.00	5.25	6.00	8.67	110.19	25660.00	25770.19	69.05
Multi3e	7.00	5.25	6.00	8.67	0.00	24640.00	24640.00	69.05
Multi3f	7.00	5.25	6.00	8.67	94.60	24320.00	24414.60	69.05
Multi3g	7.00	5.25	6.00	8.67	0.00	24000.00	24000.00	69.05
Multi3h	7.00	5.25	6.00	8.67	84.97	25460.00	25544.97	69.05
Multi3i	7.00	5.25	6.00	8.67	0.00	25400.00	25400.00	69.05
Multi3j	7.00	5.25	6.00	8.67	74.46	23880.00	23954.46	69.05
Multi3k	7.00	5.25	6.00	8.67	65.55	25400.00	25465.55	69.05
Multi3l	7.00	5.25	6.00	8.67	0.00	26920.00	26920.00	69.05
Multi3m	7.00	5.25	6.00	8.67	36.73	13460.00	13496.73	69.05
Multi4a	7.00	5.25	6.00	8.67	46.90	19430.00	19476.90	69.05
Multi4b	7.00	5.25	6.00	8.67	0.00	29860.00	29860.00	69.05
Multi4c	7.00	5.25	6.00	8.67	110.19	32760.00	32870.19	69.05
Multi4d	7.00	5.25	6.00	8.67	94.60	33210.00	33304.60	69.05
Multi4e	7.00	5.25	6.00	8.67	84.97	21760.00	21844.97	69.05
Multi4f	7.00	5.25	6.00	8.67	74.46	21700.00	21774.46	69.05
Multi4g	7.00	5.25	6.00	8.67	65.55	21640.00	21705.55	69.05
Multi4h	7.00	5.25	6.00	8.67	0.00	29530.00	29530.00	69.05
Multi4i	7.00	5.25	6.00	8.67	36.73	30900.00	30936.73	69.05
Multi4j	7.00	5.25	6.00	8.67	36.73	24380	24416.73	69.05
Multi4k	7.00	5.25	6.00	8.67	36.73	12190	12226.73	69.05

Side Deck												
Joists	Length (ft)	DL (PLF)	Weight (PLF)	LL(PLF)	Total (PLF)	Force (lbs)	Depth (in)	Spacing (in)				
Deck	7.08	0	10	100	172	608.88	2x12	12				
Deck beam	Length (ft)	Weight (PLF)	Load (PLF)	Total (PLF)	Shear (lbs)	M(ft-lbs)	Width (in)	Depth(in)		Weight (PLF)	Total (PLF)	
Decka	14.40	15.20	608.88	627.12	9030.53	16254.95	5.25	9.25	5.25x14	23.00	636.48	9165.31
Deckb	14.19	15.20	608.88	627.12	8898.83	15784.30	5.25	9.25	5.25x14	23.00	636.48	9031.65
Deckc	19.25	23.00	608.88	636.48	12252.24	29481.95	5.25	14.00	5.25x14	23.00	636.48	12252.24
Deckd	20.63	23.00	608.88	636.48	13130.58	33860.49	5.25	14.00	5.25x14	23.00	636.48	13130.58
Decke	10.77	15.20	608.88	627.12	6754.08	9092.68	5.25	9.25	5.25x14	23.00	636.48	6854.89
Deck lower colum	Required width (in)	Base (in)	Effective Length (ft)	Actual length (ft)	Weight above (lbs)	Beam R Load(lbs)	Total Load (lbs)	Weight new (lbs)				
Deck1	5.25	3.50	6.00	10.00	0.00	4610.00	4610.00	39.84				
Deck2	5.25	3.50	6.00	10.00	24.49	9150.00	9174.49	39.84				
Deck3	5.25	3.50	6.00	10.00	24.49	10700.00	10724.49	39.84				
Deck4	5.25	3.50	6.00	10.00	24.49	12870.00	12894.49	39.84				
Deck5	5.25	3.50	6.00	10.00	24.49	10160.00	10184.49	39.84				
Deck6	5.25	3.50	6.00	10.00	24.49	3450.00	3474.49	39.84				

Design of Bearing Wall			
Variable	Value	Unit	Comment
Unit Weight	15	kN/m3	
Unit Weight	95.415	PCF	
Friction angle	20	deg	
Cohesion	20	kN/m2	
Cohesion	127.22	PSF	
Ka	0.490291		
q	209.56	PSF	
z (top)	0	ft	
P (z=0)	102.7453	PSF	
z (bottom)	10	ft	
P (z=10)	570.5561	PSF	
At	5.385	ft	
W1	3072.444	PLF	
W2	553.2834	PLF	
At2	5.44	ft	
load on wall	1.05596	kip/ft	
axial force	5.744422	kip	
Vu	11.15	kip/ft	
Length of Wall	1	ft	
Vu2	11.15	kips	
Mu	22.92	kip-ft/ft	
Mu2	22.92	kip-ft	
fc'	4000	lb/in2	
b	14	in	
d	9.5	in	
Vc	16.82332	kips	
phi	0.75		
Vs	-1.46749	kip	
Fy	60	kip/in2	
Av/s	-0.00257	in2/in	
I	2016	in4	
t	12	in	
Q	252	in3	
tmax	0.116146	kip/in2	
T	5.533058	kip-ft	
h	12	in	
Acp	168	in2	
Pcp	52	in	
phi2	0.75		

Tth	2.145484	kip-ft	
Tu	5.533058	kip-ft	
Aoh	89.25	in	
Ph	38	in	
	204.314	PSI	<= 474.3416 PSI
			Beam is large enough
phi	0.75		
Vs	-1.95665	kip	
Av/s	-0.00343	in2/in	
Tn	88.52894	kip-in	
Ao	75.8625	in	
At/s	0.009725	in2/in	
(Av+t)/s	0.016017	in2/in	> 0.011068 Check for minmum
			> 0.011667 Check for shear
Ab (stirrup)	0.2	in2	#4
Bar Diameter	0.5	in	
Spacing	12.48696	in	
>	10	in	
As	0.24	in2/ft	
pl	0.002857		> 0.0015
			> 0.0025
Pn	1.173289	kip/ft	
a	1.42539	in	
c	1.676929	in	
et	0.013995		
dt	9	in	
phiMn-new	29.6052	kip-ft/ft	
Max s	36		<
>	18		< Select Smallest
>	10		<
Ab (horiz)	0.31	in2	#5
	19.35479	in	
>	12	in2	
As	0.31	in2/ft	
p2	0.00369		

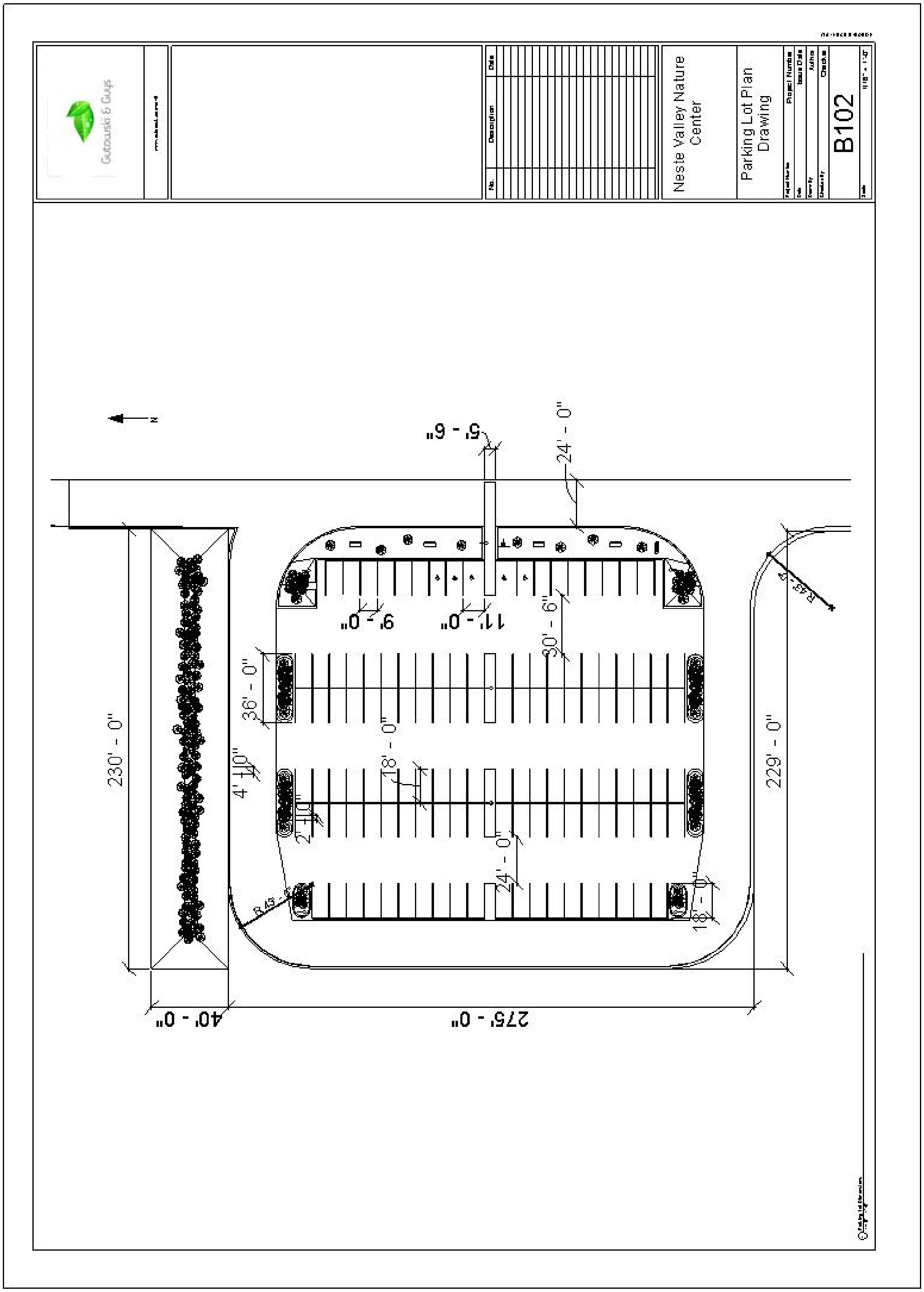
Design of Foundations			
Variable	Value	Unit	Comment
Concrete Slab			
hf	5	in	2 hr fire rating
Ag	60	in2/ft	
As(s&t)	0.108	in2/ft	
Adesgin	0.11	in2	#3
Spacing	12.22222	in	
>	12	in	
Foundation			
Unit Weight	15	kN/m3	
Unit Weight	95.415	PCF	
Friction angle	20	deg	
Cohesion	20	kN/m2	
Cohesion	127.22	PSF	
b	14	in	
bar diameter	1	in	#8
fc'	4000	PSI	
bw	12	in	
Fy	60000	PSI	
Allowable Load			
Thickness	1.5	ft	
H	1	ft	
Df	11.5	ft	
P	1124.96	lb/ft	
Nc	17.69		
q	1097.273	PSF	
Nq	7.44		
gamma	95.415	PCF	
Nr	3.64		
B	6	ft	
qu	11456.16	PSF	
qa	3818.72	PSF	
Actual Load			
Qn	2.496448	KSF	
qnu	0.182879	KSf	
d	10.5	in	
	18.5	in	
Vu	0.281938		
phi	0.75		

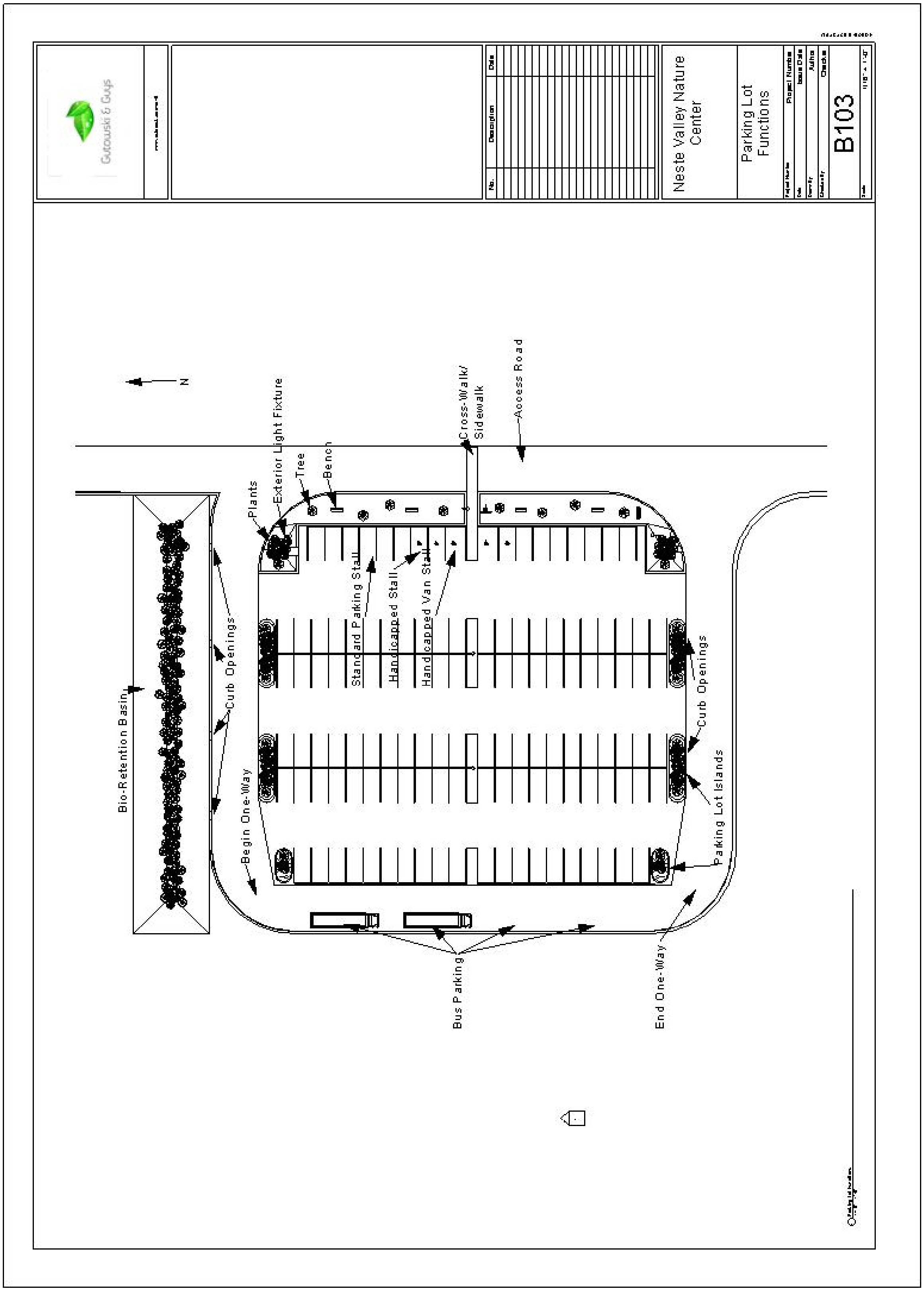
Pvc	11953.41	lbs/ft	
Mu	0.534031		
phi	0.9		
As	0.011897		
Min As	0.3888		
Max S	36		Pick Smaller
or	18		
As	0.31	in2	development tables
s	9.567901		
a	0.455882		
phiMn	14.32952	kip-ft/ft	Check that Mu is less the phiMn
et	0.055732	in	Greater than 0.005
Ld	14.2125		
	26		Greater than ld so good
As-again	2.3328		
Max s	18		
Tot A	2.936709	3 #8	
Settlement			
Corner			
alpha	1		
L	98.7		
B	6		
m'	16.45		
H	5.5		
n'	0.916667		
Ao	0.001546		
A1	0.304185		
a2	1.087218		
F1	0.097317		
F2	0.076618		
mews	0.35		
Is	0.132679		
qo	954.15		
B'	6		
Es	2175.6		
If	0.78		
Se	0.238965		
Middle			
alpha	4		
L	98.7		
B	6		

m'	16.45		
H	5.5		
n'	1.833333		
Ao	0.006142		
A1	0.733281		
a2	0.541112		
F1	0.235366		
F2	0.485545		
mews	0.35		
Is	0.459463		
qo	954.15		
B'	3		
Es	2175.6		
If	0.78		
Se	1.655051		
Column Foundation			
Unit Weight	15	kN/m3	
Unit Weight	95.415	PCF	
Friction angle	20	deg	
Cohesion	20	kN/m2	
Cohesion	127.22	PSF	
fc'	4000	PSI	
Fy	60	Ksi	
wc	7	in	
bc	5.25	in	
Pu	34620	lbs	
wf	4	ft	
bf	3	ft	Assumed
thickness	1	ft	Assumed
bar diameter	1	in	
d	8	in	
qn	2.885	KSF	
bcrit	13.25	in	
wcrit	15	in	
Vu	30.6381	kip	
bo	56.5	in	
beta	1.333333		
	5		
	> 4		EQN. 15.13 NO GOOD
alphas	40		

	7.663717 > 4		EQN 15.14 NO GOOD
Vc	114.348	kip	
phi	0.75		
Pvc	85.76097		> Vu = design accetpable
Tribute	1.041667	ft	
Vu1	9.015625	kip	
Pvc1	27.32208	Kip	> Vu = design accetpable
phi	0.9		
Mul	12.62939	kip-ft	
As	0.36928	in2	
asmin	0.7776	in2	GOVERNS
As	0.8	in^2	4 #4 long
Tributwo	1.28125	ft	
Mus	9.472041	kip-ft	
As	0.27696	in2	
Asmin	1.0368	in2	GOVERNS
As	1.2		6 #4 short

Appendix E: Parking Lot Renders





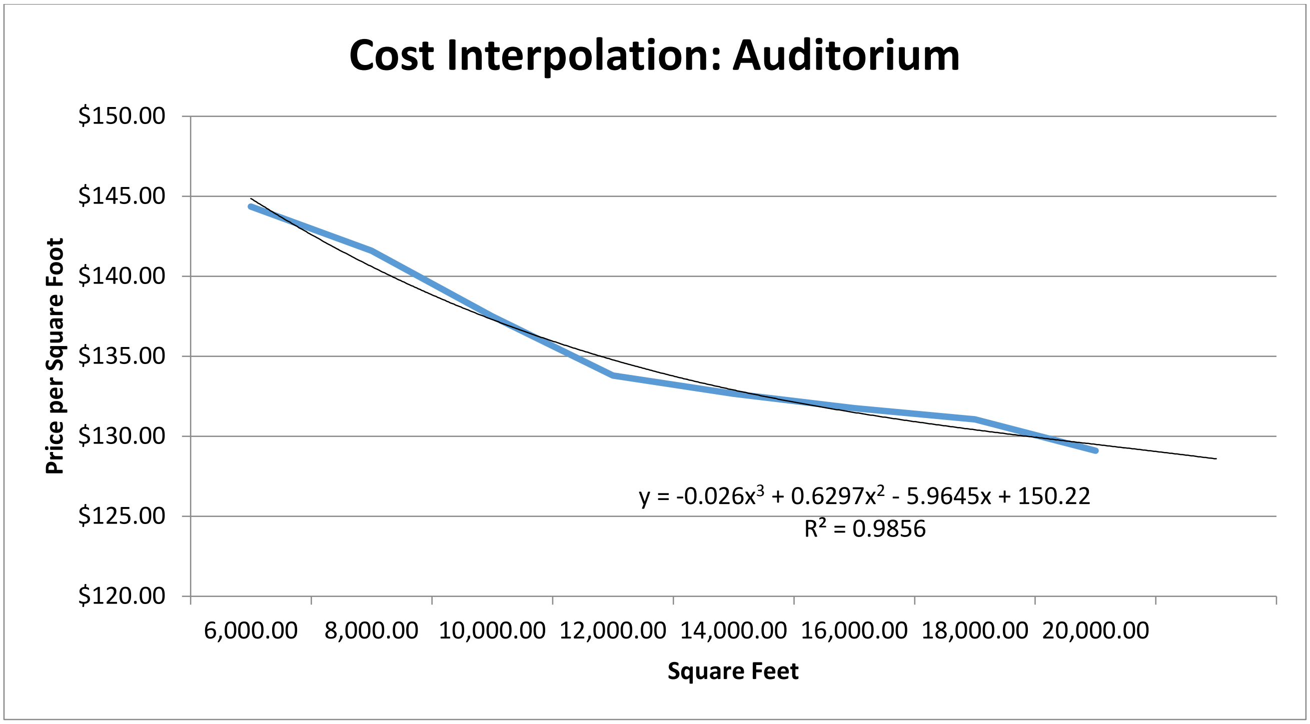
Gutowski & Guys
No.
Description
Date
Neste Valley Nature Center
Parking Lot Functions
B103
N
Access Road
Cross-Walk/ Sidewalk
Exterior Light Fixture
Tree
Bench
Plants
Standard Parking Stall
Handicapped Stall
Handicapped Van Stall
Curb Openings
Curb Openings
Bio-Retention Basin
Begin One-Way
Parking Lot Islands
Bus Parking
End One-Way

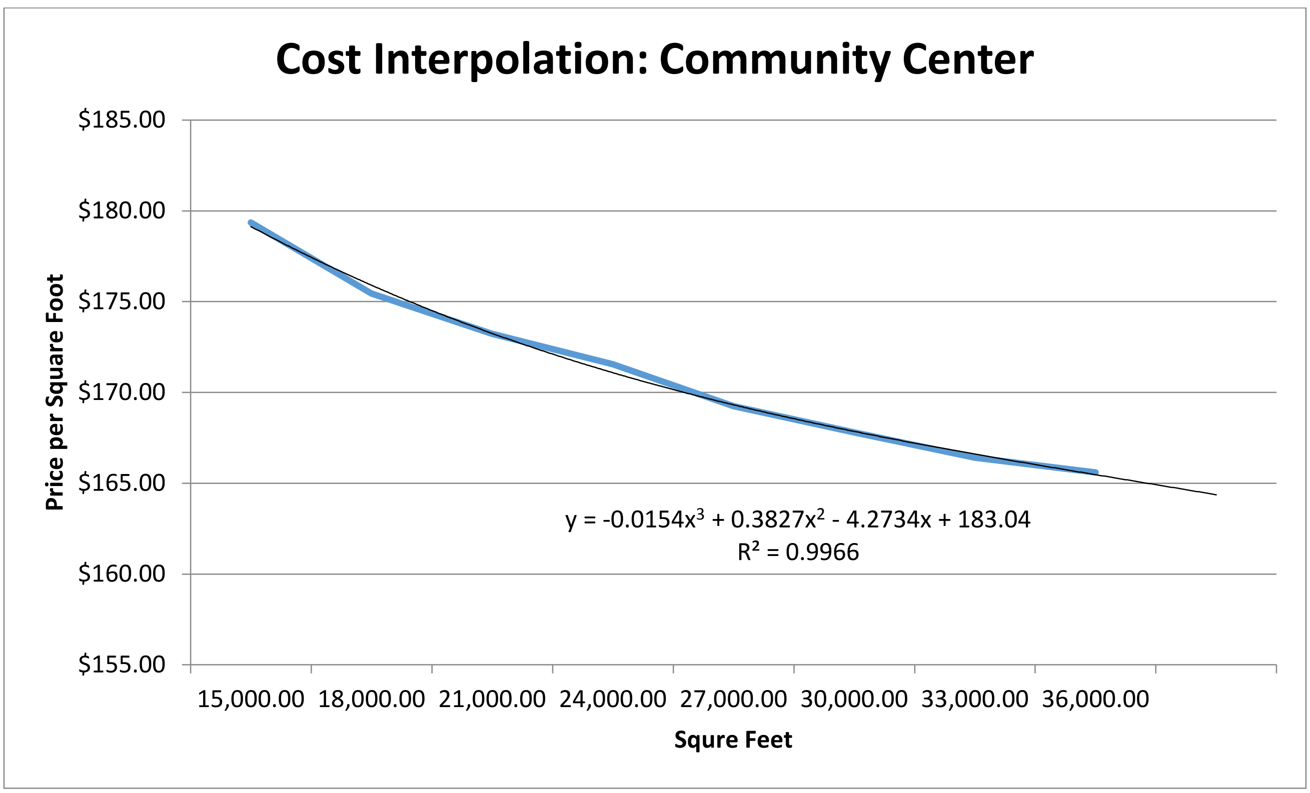
Appendix F: Cost Estimates

Main Level		Square Footage	Percent of Total (%)
	Community		
		2,979.71	28.05
	Office		
		1,982.96	18.67
		94.94	0.89
		2,077.90	19.56
Lower Level			
	Auditorium	**5,565.79**	52.39
Total		**10,623.40**	

Deck		Square Footage
	Main Level	**2190.50**
	Lower Level	**696.38**

Costs	Details	Square Footage	Cost per S.F.	Basement (%)	Roof (%)	Exterior Enclosure (%)
1 Story Office	Wood Siding					
	Wood Truss					
		2000	**$209.65**	**3.80%**	**1.80 %**	**16.00%**
1 Story Communtiy Center	Tilt Up Concrete Wall Panels	4,000.00	$149.95			
	Bearing Walls	6,000.00	$144.35			
		8,000.00	$141.60			
		10,000.00	$137.50			
		12,000.00	$133.80			
		14,000.00	$132.65			
		16,000.00	$131.75			
		18,000.00	$131.05			
		20,000.00	$129.10			
		3,000.00	**$151.47**	**11.00%**	**6.40 %**	**15.90%**
1 Story Auditorium	Decorative Concrete Block	12,000.00	$183.25			
0.5	Bearing Wall	15,000.00	$179.35			
		18,000.00	$175.45			
		21,000.00	$173.23			
		24,000.00	$171.55			
		27,000.00	$169.25			
		30,000.00	$167.80			
		33,000.00	$166.40			
		36,000.00	$165.60			
		5,300.00	**$185.54**	**7.50%**	**4.60 %**	**21.70%**


Cost Interpolation: Auditorium
$150.00
$145.00
$140.00
$135.00
$130.00
$125.00
$120.00
Price per Square Foot
y = -0.026x³ + 0.6297x² - 5.9645x + 150.22
R² = 0.9856
6,000.00
8,000.00
10,000.00
12,000.00
14,000.00
16,000.00
18,000.00
20,000.00
Square Feet


Cost Interpolation: Community Center
$185.00
$180.00
$175.00
$170.00
$165.00
$160.00
$155.00
Price per Square Foot
y = -0.0154x³ + 0.3827x² - 4.2734x + 183.04
R² = 0.9966
15,000.00
18,000.00
21,000.00
24,000.00
27,000.00
30,000.00
33,000.00
36,000.00
Squre Feet