Fall 10-15-2021

Construction of an Apartment Building and Parking Garage

Kirsten Wilson

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Murray State University Honors College
HONORS THESIS
Certificate of Approval

Construction of an Apartment Building and Parking Garage

Kirsten Wilson
December 2021

Approved to fulfill the
requirements of HON 437/438

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Mr. Kevin Perry, PE, AIA, Associate
Professor
Institute of Engineering

Approved to fulfill the
Honors Thesis requirement
of the Murray State Honors
Diploma

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Examination Approval Page

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Mr. Kevin Perry, PE, AIA, Associate Professor	Date
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Construction of an Apartment Building and Parking Garage

Submitted in partial fulfillment
of the requirements
for the Murray State Honors Diploma

Kirsten Wilson

December 2021

Abstract

Construction projects are known far and wide to all people. Buildings we need for daily survival would not exist if it were not for the construction industry. Our homes, healthcare facilities, groceries, and other necessary amenities would be gone if it were not for the structures they are housed in. This project aims to simulate the lifespan of a construction job from the design phase to the preconstruction phase and stops at the final presentation before an agreement to start construction.

To create the simulation for the students, a fake RFP, or request for proposal, was created and given to the assigned groups for the project. In this RFP were the guidelines and requirements of the project. It listed what kind of project this was, what was necessary in the project, and the timeline given to complete it. The project was to be a living area for students on Murray State's campus. Guidelines were given for the number of apartments and parking spaces needed for the building. The building also needed to be ADA compliant and LEED Silver certified or better. Progress meetings were scheduled to create a real environment, as progress meetings are typically held in a real construction project to keep the owner updated and keep communication between all members of the project team. The results of this project gave students a real-world type of work experience before getting into the field for themselves. Students were put in the mind of a worker in the industry, given their time frame and assigned partners, and expected to perform and present a full project at the end of the semester.

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1. Introduction

The process of a construction project is lengthy and taxing. Projects can be split into two main parts which include the design phase and the construction phase. For this project, the component that will be discussed is the design process. Elements from site choices to the design process will be presented in detail from my, the main architect's, point of view. My group received a request for proposal from our professor to start the project. In this proposal, our professor gave us essential outlines of what our project entailed. We were tasked to create an apartment building with a parking garage. Twenty to twenty-five apartments were necessary as well as one hundred parking spaces plus one for each apartment were needed in the parking garage. Additional spaces such as meeting rooms, public restrooms, and computer labs were encouraged but not required. The building had to be ADA compliant, silver LEED certified, and follow Kentucky building codes. Not only must we pay attention to LEED requirements, but we must also pay attention to safety standards and COVID precautions. We were tasked with two phases of our project. Phase one entails the feasibility study where we test out possible sites for our project and we consider basic details of the building such as size and configuration. Phase two embodies the breakdown of the detailed design phase. This phase involves structure design, site design, environmental design, estimates, schedules, construction means, and methods of design (Perry).

II. First Steps

The first step with my group was to allocate the work we had at hand for the semester. Our professor made the groups with at least one person from every discipline. My group includes an environmental engineer, a surveying/civil engineer, two construction majors, and myself, the architect. We also got to create our own company name and logo. My first thought was to go out of the box. I did not want to use a play on our names or our group members' initials. So, me being interested in mythology, I dug in there. The Greek god of carpenters and building is Hephaestus, but that is too long for a name. I decided to go with the Roman equivalent of this god, Vulcan, and from then on, my group would be known as Vulcan Design & Build. The logo design itself came from a basic logo found on a website. The instrument in the center of the design was rotated one hundred and eighty degrees to be shown upside down to symbolize a "V" for our company name, Vulcan. Also, the warm colors of the background were chosen as symbols of colors often thought of with Hephaestus and Vulcan.

Figure i. Company Logo

We were tasked to create a rough project schedule to help us stay on track which included deadlines given to us by our professor and deadlines of specific elements of the project created by our group, like having our design complete and getting our estimate completed. One cohesive schedule was compiled of our set-in-stone deadlines given by Professor Perry, like the different presentation deadlines, and our ballpark deadlines set for ourselves, like when we wanted to have the design mostly finished, when we wanted the LEED elements done by, and when we wanted to be finishing up on the documents we needed.

Our next step was to select a location on Murray State University campus for our build to take place. This step included all members of the group but focused on our environmental and surveying members. Each member posed their suggestions for location ideas and as a group we selected a location that had been previously built on. This decision was made for a few reasons, one being recyclable materials. We can reuse the parking lot material when resurfacing the parking lot itself. Reusing this material also would allow us to earn LEED points for our construction. We also chose to work on developed land because most grading work and earthwork has already been done to make the land relatively flat in the area, and it also means there is already a runoff design built for the land. This choice also cuts back on time for the project because this land has already been deemed suitable for construction meaning we do not have to worry about soil tests or other environmental matters that could restrict or prohibit the construction from moving forward. Our chosen location is the parking lot to the northwest of the Engineering Physics building at the crossroads of Calloway Avenue and Kentucky Avenue.

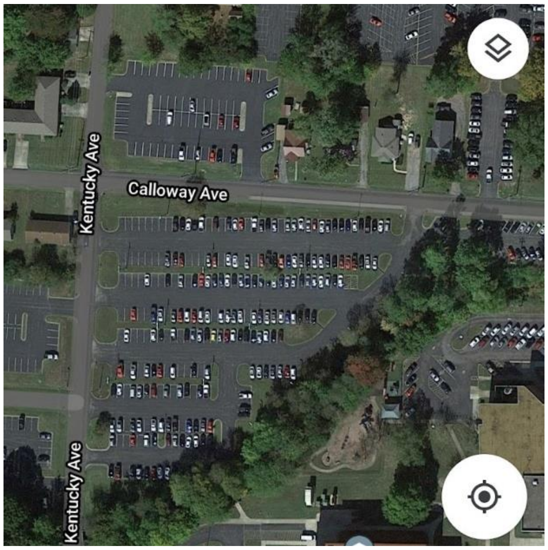

Figure ii. Site Location

This plot has already been developed seeing as it is an existing parking lot. Other positive outlooks to this choice include allowing distance from the rest of campus, the space for design possibilities, and that it is in proximity to off campus residential areas. The distance from campus is a positive in our eyes because this complex is meant to be built for graduate students and students with families. We want to give them a private space that will not be constantly flooded with the buzz of the main area of campus but still allow them to be close enough to campus and other amenities in Murray that will allow them a stress-free living space. Some negative attributes include taking out an existing parking lot and breaking up the asphalt there, being across campus from on campus residency, and the construction period may be a distraction to classes in nearby buildings. Our environmental impact with this location choice would be stormwater runoff, sediment, chemical, and noise pollution, erosion, flooding, and potential wind tunnel effect. Stormwater runoff, erosion and chemical pollution, and flooding will be a possible problem given the location having a creek running on the south side of the site near between the parking lot and Alexander Hall. Also, the noise pollution will not only come from the construction period itself, but also from the site after construction because this will most likely increase traffic flow through this area post-construction. Our potential design solutions are a one-and-a-half-acre rectangular plot that can be used for the building. The building could be five to seven floors depending on the possible layout of the apartments. We are considering LEED elements including a green roof and solar panel windows. I will be using Revit to develop a 3D model of our building with the ability to realistically see what our interior and exterior will look like. Our potential exterior will potentially be red brick and concrete to blend with many of the buildings already situated on campus.

III. Revit

The use of Revit, a Building Information Model, or BIM system, helps us to grasp our idea in a nonphysical form before construction, and it also will allow us to portray the project to clients in a way that they can “see” the building before it is physically built. BIM is advantageous to architects because while drafting designs, they are created as one element. If you edit an aspect on one floor plan, it is changed on all views, whether that be 3D plans, section views, or elevations (Gamayunova & Vatin, 2014). Some advantages of BIM technology include, but are not limited to, fewer amendments in the project meaning less money lost, analysis on the design to increase efficiency, 3D visualization and coordination, and automatic changes saving time on design. Along with these advantages come some disadvantages including, but not limited to, the focus on architecture, labor intensity on creation and possible technical errors, and dependence on software suppliers (Gamayunova & Vatin, 2014). This elevated technology provides a “step-up” to architects, engineers, contractors, and customers because it allows visualization of the overall project. Everyone is kept on the same page with development and changes to the project before construction. It also helps with estimates in cost for the project, gauge the performance of the building and infrastructure before construction, and give insight on restoration and replacement of the building in the future (Gamayunova & Vatin, 2014). The BIM process is simple and clean; building information loss is reduced and design efficiency is skyrocketed. Sustainable design and green technology are also emphasized in the use of this technology. Possibilities in building designs are open to the entire imagination because designing with BIM technology is more open to complex shapes and structures (Zhongbao & Xiangfeng, 2013).

IV. Phase One Revisions

After our presentation, we have decided as a group that it would be best to go with a two-building design with a connection across the road. This connection will be a sky bridge between the parking garage portion and the housing portion. In doing this, we can get a bigger footprint for each building and keep the levels down to blend in with the surrounding buildings. Members of the team who are more suited to do surveying work, like our civil engineer, will go out to the plot to survey the land to make a topographical map of our site. This also allows for Revit design to start with accurate dimensions and scaling of the site. Design inspiration photos were looked at for the one- and two-bedroom apartments required and the sky bridge to help get the creativity flowing and to hopefully spark some ideas for the Revit work to come.

An element to consider during the design process is the fact that while this is not a normal student housing structure like a dormitory, this is still for students at the university who are in a developmental part of their lives. For many this will be their first experience on their own in the real world. It must also be taken into consideration that they are still in fact here for their education. Sean Studzinski, principal of KSQ Architects, has been quoted saying, "students are in a transitional phase in their life and so the facilities have to be conducive to that learning environment…. We try to define each university and each student differently. No residence project is the same, no university is the same and no two students are the same (Scott, 2020)." Later there will be more discussion on the division of the building itself. Including communal spaces was an important element we were tasked to include in our designs. We plan to have a yard type area outside for students to mingle in and each floor will have a lobby-type area, or a meeting area designated. This will be an open space on each floor with tables and chairs or couches that allow students to socialize in a common space. "Research has shown that students who live in communal settings are more likely to continue in their education, more likely to go on to graduate and are more likely to remain involved at an alumni level (Scott, 2020).” Monica Roberts, Director of Communications & Campus Research at KSQ Architects, has also said, “there is a lot of research that shows that the suicide rate can go up when kids move off-campus into their own space and become isolated…. While that sounds really extreme, that is the reality.” A major influence on the project itself will be the environment and personality of Murray State University. Murray State University has a unique personality and the city of Murray takes pride in being known as “the friendliest small town in America.” This is going to be incorporated in our work by focusing on pleasing future residents with the design and ideas implemented in the building. Community space will be a big part of the design on every floor. There will be lounge areas, computer areas, and free space for communal hang outs outside of the apartments themselves. These will not only be inside on each floor, but they will also be in the green space around the building and in the rooftop garden included for the residents. This will sway the design and construction of the building to fit with the rest of the campus as if it were a puzzle piece that had been missing and was found and placed where it belongs. “With so many evolving factors in student housing, it takes a village of architects, developers, investors and owners to continue creating housing that will meet the needs of both today and tomorrow’s students (Scott, 2020).” Many may think that designing a building is just like playing Tetris, all you must do is piece together the rooms and it is done. In reality, there is so much more work under the surface that is done. The building must be aesthetically pleasing yet functional. Architects must work alongside engineers, construction managers, clients, and subcontractors to have the correct draft for everyone to work together seamlessly and efficiently on the project.

V. Integrated Design and Construction

Design phase is the portion of a project where creativity is abundant. During the design phase, the new building for the project blossoms through plans, details, and specifications. Then, the project leads into the next step known as construction planning. In this phase, the resources and materials needed to make this vision a reality are discussed and decided. Then, the construction phase begins. This phase is the physical creation of the building designed by the architects and engineers (Hendrickson & Au, 2008). There are many things that need to be kept in the forefront of everyone's minds while working on a project. These include time, location, patience, and many other things. Time is important to think about because all projects are unique. That statement leads to the point that this project is new to those working on it. It is all together a new beast that must be tackled by those on the project team. Time is needed not only for the architects and engineers to present a design that the owners accept, but time is also necessary for the construction team to turn the thoughts of the architects and engineers from drawings on a paper to a physical building that is safe for occupants to work, live, and exist in. Location is another big key in designing and constructing a new building. Location is important for multiple reasons. One reason is codes that must be followed. Not only are there state codes to be followed, but there are also sometimes specific county, city, or developer requirements that must be followed in the design and construction of a new building also. Location also leads to other conditions like weather, labor and material supply, and site conditions. These elements are not things that can be changed by the individuals on the project team, but they are obstacles that must be looked at and over come by the team with communication and resolution. Patience is necessary throughout a construction process also. There will be things that go awry, and everyone must be ready to fix and adapt to these situations that are thrown in the way. Some of these occurrences may include future requirements, market demands, and design changes during construction. If a project team works together and has a strong communication between owners, architects, engineers, contractors, and construction teams, they will be able to take these issues and solve them quickly before the problem becomes a bigger issue and is harder and more costly to fix or change.

VI. Drafting

Between the feasibility presentation and our midpoint progress review, the group was able to get the surveying complete and form the topographic map of our site, discuss and make choices for a Silver Certification for LEED, and start on a basic design to show. The surveying was done in one afternoon. A few members went out to our chosen site and took plenty of survey points. Some points were chosen specifically, like the corners of our plot and the edges of the road. Other points were taken to get a more specific topographic map. The more data points you have the more accurate the topographic map will be because you have more accurate data on the grade of the land. For us to obtain a Silver Certificate for LEED, we must accumulate fifty points in LEED categories. In the Location and Transportation category we settled on points for a high priority site, access to quality transit, bicycle facility, and green vehicles. Under the Energy and Atmosphere category we took points for optimized energy performance and renewable energy production. The Sustainable Sites category got us points for construction activity pollution prevention, open space, rainwater management, heat island production, and light pollution production. The last category we tallied points in was Water Efficiency. These points were for outdoor and indoor use reduction and building-level energy metering (LEED v4.1). Some of these categories, like the bicycle facility, are self-explanatory; others, however, are not. The green vehicle portion will include charging stations for electric vehicles. The optimized energy performance will be dimming lights and motion sensors, and the renewable energy production will be the photovoltaic cell windows we plan to install in the building. Indoor water use reduction will include grey water toilets and waste type buttons on the water closets. Grey water toilets recycle the water used in sinks, showers, and other household appliances. Also, the type buttons will limit the amount of water used for a flush depending on what is being discarded. At the presentation, we received feedback on the design itself. Questions were posed about the layout of the floors and where the rooms themselves were placed. Our original design was three stories, each story being ten feet tall with ceiling heights of eight feet. The first floor had a basic layout for ten one-bedroom apartments and space left for community space, community laundry, and stairwells/elevators. The second and third floors both had six two-bedroom apartments just laid out differently on the floors. There was also space for community laundry and stairwells/elevators on these two floors.

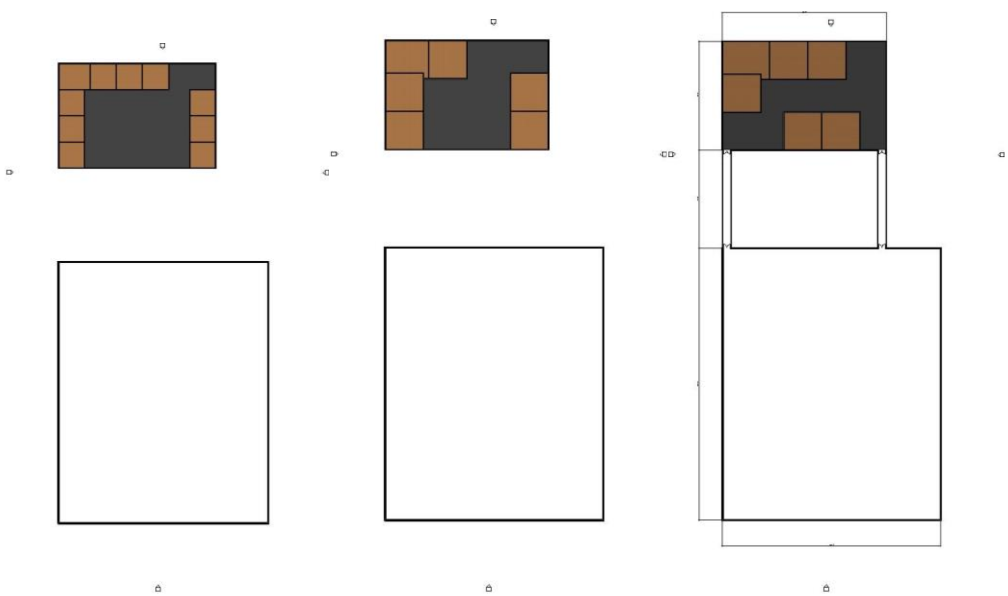

Figure iii. First Draft Floor Plans

The concern with the first design was the use of space. A comment was made that normally apartment buildings have a certain shape with a main hallway throughout the building connecting the apartments to the exit ways. Taking this and other comments into consideration we came up with the new basic structure for the building, mainly changing the second and third floor layouts.

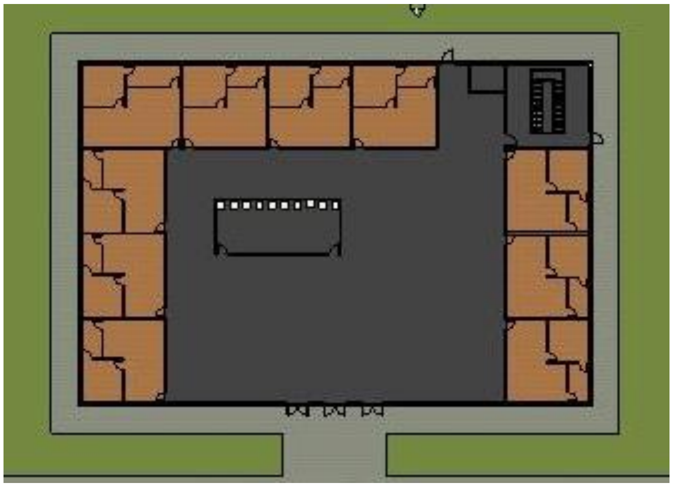

Figure iv. Updated First Floor Plan

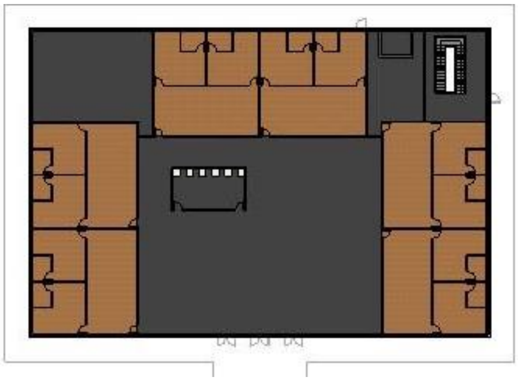

Figure v. Updated Second and Third Floor Plan

Our new floor heights are twelve feet with the ceiling height set to eight feet allowing for four feet between floors for ventilation, electrical wiring, and plumbing needed throughout the building. Calculations have been made for the parking garage also. We found out that if we make the parking garage four stories (including parking on the roof) and one hundred and fifty feet by one hundred and fifty feet, we will have ninety thousand square feet in that building. An estimate for the parking spaces we need, allotting for two hundred spaces in our structure, would be about forty thousand square feet, leaving us fifty thousand square feet for the driveways and support columns.

Work has continued on the design of the apartment building itself, including layouts of both the one- and two-bedroom apartments and the placement of community laundry rooms on each floor. A rough placement has been made of the staircase in the back of the building and the elevator next to the stairs. I am still debating the idea of a second staircase in the middle of the building. If this was to be added it would be a nicer, open concept staircase used as a focal point of the building. I would hopefully investigate a spiral staircase with glass and metal trim to look nice and sleek to people in the building. A rough site plan has been developed for the project also. The apartment building has grass all around it with no driveways on that side of the development. There is a continuous sidewalk around the entire building too. That sidewalk continues from the front doors to the road on which we would add a crosswalk, then the sidewalk continues from the other side of the road up to the main foot traffic entrance of the parking garage. There are five total connections from the street to the parking lot/parking garage. Two are on the street between the apartment building and the parking garage. Three are on the right side of the parking garage if you were looking at the front of the building. We made this choice originally to allow for more entrances/exits to help with traffic flow in and out of the lot. There is also still a large asphalt lot around our parking garage. This is still here because we did not need to demolish the entire parking lot we were taking for the garage portion of our project. Parking will still exist in the original lot; it will just be redesigned around the changes made. We also considered the parking we were eliminating from the lot itself and added that to our overall spots that would be held in the parking garage. Instead of the necessary one hundred spots plus one for every apartment, totaling one hundred and twenty-two spots for our specific project, we have accounted for one hundred and fifty to two hundred spots in our four-story parking garage.

VII. Phase Two Revisions

After the second update, we have been told to get a move on the design itself and to start getting calculations done for the parking garage itself. Our group came up with a basic layout for the parking garage itself.

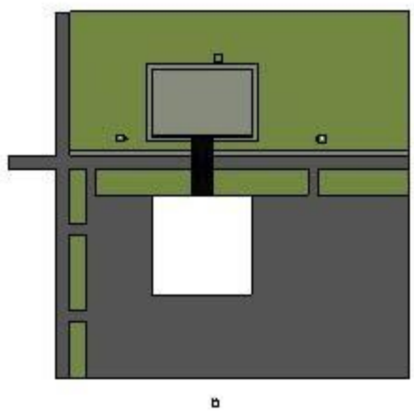

Figure vi. Overall Site Plan

With this, there will be one drive in and one drive out. The outer perimeter of the garage will have parking spaces. The middle of the building will hold the ramps to ascend and descend the structure. Along the sides of the ramps on each floor there will be more parking spots also. Calculations have to be finished for the angles used for the ramps, the columns and beams used for support in the structure, the thickness needed for the concrete slabs, and overall loads that will be exerted throughout the structure. These calculations will also help us to line up the buildings for the sky bridge to line up on the third floor of both buildings. The parking garage will already be offset from the apartment building by approximately four feet after dirt work is completed on both sites. This being said, it will not be easy to line up the floors for the sky bridge but doing a few calculations and determining the angles needed for the ramp will make it possible. The ramps will have two different slopes, the beginning and ending eight feet of each ramp will be a smaller slope to eliminate the chance of bottoming out cars while transitioning from flat ground to ramp or vice versa. In the middle portion of the ramp, the angle will be raised slightly to allow for the ramp to connect the two floors in the given space. Also, touching back to the design of the apartment building, the decision was made to keep a staircase in the back corner of the building as more of an emergency stairwell that had an exit door on the first floor. The elevator was moved to the middle of the building so residents would not have to travel to the back of the building to access it. Also, it was decided that a second staircase was needed, and a glass spiral stairwell was added in the main area of the building as a nice architectural focal point of the interior design. The community aspect of the design would be shown with each floor having their own community lounge area and computer lab.

VIII. Scheduling and Estimating

The average amount of time used for the construction of a multifamily residential building according to the 2014 Survey of Construction from the Census Bureau was 11.7 months (Zhao, 2015). The completion time of multifamily housing obviously depends on how many units are in said structure. Housing plans with twenty or more units took on average 14.9 months, ten to nineteen units took 13.6 months, five to nine units took 11.5 months, and two to four units took 11.4 months according to statistics from the 2014 study above (Zhao, 2015). The time it took to obtain permits for building, however, did not follow the same trend. Surprisingly, structures with ten to nineteen units took 2.0 months to get authorization and was the longest wait time. Buildings with five to nine units on the other hand, took the shortest amount of time at 0.9 months for authorization (Zhao, 2015). The location of construction sites can also influence the schedule of a project. Seasonal variances and weather patterns in different regions have a noticeable influence on the overall construction time for a project. “The Northeast had the longest time from authorization to completion, 14.9 months, followed by the West, 13.5 months, and the South 12.5 months. The shortest permit-to-completion period happened in the Midwest with 11.4 months” (Zhao, 2015). Planning a construction project in Murray, Kentucky will have differing effects depending on when the construction itself takes place. If it is in the spring, there will be rainstorms and possible tornadoes to worry about. In the summer, the blazing sun and heat will be a factor, but not as intense compared to projects in the southern United States. In the winter, there is snow and ice to worry about. That is the negative aspect about working in the Midwest, weather is so unpredictable. When creating a construction schedule, you must have that thought in the back of your mind and remember to incorporate a buffer in your schedule. It is better to allot extra time and finish a project early than to have a tight schedule and possibly have to ask for an extension or rush parts of the construction. According to our scheduler, our planning process will take roughly four months and the physical construction, from demolition to completion, will take roughly seven months. This is also an educated guess given our building dimensions, materials, and other information. An important element when creating construction schedules is also to realize that you can have overflow. In fact, it is encouraged. You do not want to run a project and only have one thing working at a time. That would make construction processes exponentially longer than they need to be. You must have a solid group of workers that can work around each other and other groups.

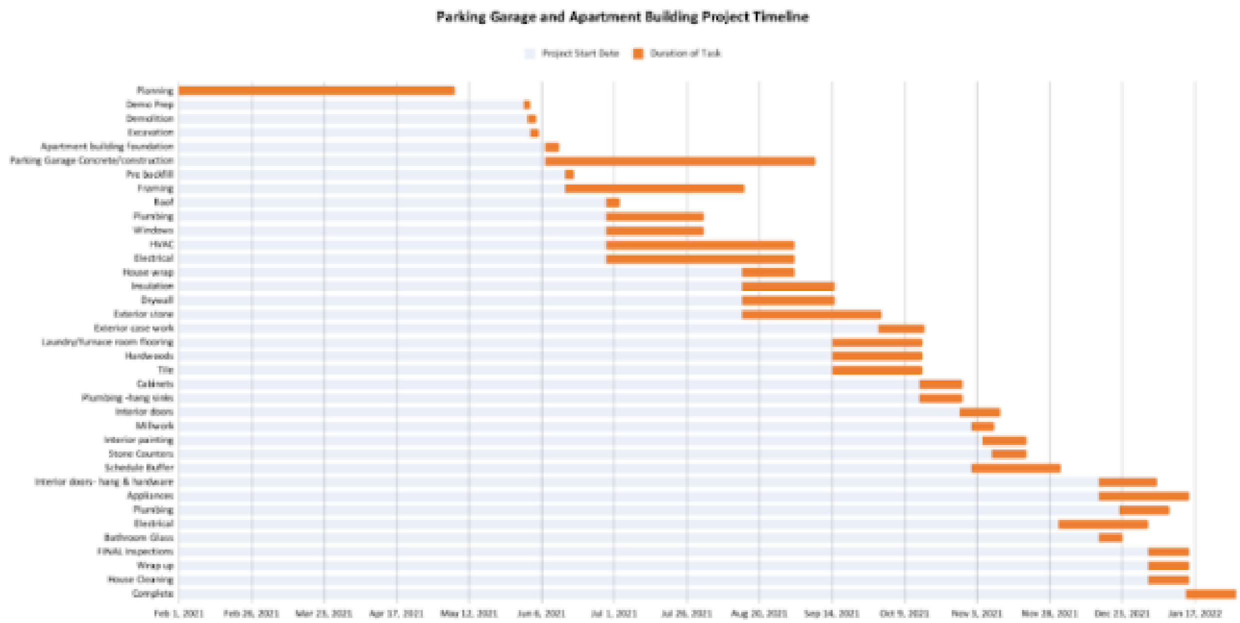

Figure vii. Project Schedule Gantt Chart

For the estimate, our estimator went through with a set of construction documents on Planswift and estimated our entire project, both the parking garage and apartment building. We not only had an overall bid number, but we also went into detail with how that was split into the separate CSI divisions and the separate elements in each division that gave it the total price.

Project: SENIOR							
Estimator:							
						Total	
Description							**Total**
DIV 1							$429,195,00
DIV 2							$189,570,00
DIV 3							$4,240,950,40
DIV 4							$455,036,05
DIV 5							$1,012,086,29
DIV 6							$284,651,20
DIV 7							$83,445,65
DIV 8							$93,354,68
DIV 9							$612,427,25
DIV 10							$115,569,00
DIV 11							$151,580,00
DIV 12							$51,238,00
DIV 13							$0,00
DIV 14							$125,830,00
DIV 15							$382,350,00
DIV 16							$565,422,00
INSURNACE							$1,500,000,00
SUBTOTAL							$10,262,505,52
PROFIT	8,00%						$821,000,44
TAX	7,00%						$718,375,39
Total							$11,801,881,35

Figure viii. Final Estimate

For clarification, division one is general requirements of the project, division two is existing conditions on the site, division three is concrete elements, division four is masonry elements, division five is metal elements, division six is wood, plastic, and composites, division seven is thermal and moisture protection, division eight is openings, division nine is finishes, division ten is specialties, division eleven is equipment, division twelve is furnishings, division fourteen is conveying systems, division fifteen is mechanical and plumbing systems, and division sixteen is electrical.

IX. Final Presentation

As time began to wind down on the project, the group needed to gather all the materials, documents, and information collected and created over the course of the semester. A compiled PDF was created of all the documents that stood at around one hundred and twenty pages of information from construction documents to our estimate and schedule. The last few weeks of the project were spent compiling everything and creating our presentation for the class. The architect's main focus was to make sure the drawings were up to standard, create a set of construction documents with the correct labels on the title blocks, and to create good perspective views of the building's interior and exterior for the presentation itself. The estimator/project superintendent oversaw finishing our estimate and making sure it came out close and accurate numbers for a project of this scale. The project manager/safety manager oversaw collecting all the documents the group kept throughout the project. This included but was not limited to the CSI division clarifications, the owner contracts, and safety documents. The civil engineer had to make sure the topographical map was completed. He also took on the scheduling of the project and the beam and column analysis and design. Lastly, the environmental engineer/LEED expert wrote up our sustainable design document and tallied our LEED points for our certification. He also compiled a document that gave more detail as to what the project did to earn the LEED points it would.

X. Conclusion

There are many ways people may go about the stages in a construction project. As shown, my group did their own process. We experienced a handful of other groups who went about the project requirements in a different way. Everyone had unique elements. That is the beauty of this industry. There will never be two people who have the same original idea when presented with a prospective project. Going with that, there will never be two buildings that are exactly the same. There may be chain companies, like restaurants or hotels for example, that have a basic design style, but no two structures will ever be identical. This is because different people will work to build them as well as different people inhabiting them. The construction industry is one of the biggest industries growing and booming in the world right now. That will not slow down anytime soon due to the fact that the limit is practically endless for what we can do especially with new technologies and materials coming around in future development. This research has shown me as an individual how to work in groups I am assigned to and how to take those group members, analyze their strengths and weaknesses, and divide and conquer the work based on that analysis. This has enlightened me as an individual to challenges I should expect in my future career. Projects rarely, if ever, start with one design that ends up being the final design that is constructed. There are typically many drafts of the architectural design, just like in this project. This project and research go to show the insane amount of work the contractors, architects, engineers, and everyone involved in a project must do to complete their portion of the job at hand. The amount of work can be stressful at times, but in the end, it is rewarding to see what has been created and that the structure will be a permanent mark the team leaves on the world if their structure still stands.

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Appendix A – LEED Score Sheet

LEED v4.1 BD+C
Project Checklist

Project Name: Vulcan Design & Build
Date: 5/3/2021

Y	?	N			
Y			Credit	Integrative Process	1
9	**0**	**22**		**Location and Transportation**	**16**
		16	Credit	LEED for Neighborhood Development Location	16
		1	Credit	Sensitive Land Protection	1
2			Credit	High Priority Site	2
		5	Credit	Surrounding Density and Diverse Uses	5
5			Credit	Access to Quality Transit	5
1			Credit	Bicycle Facilities	1
1			Credit	Reduced Parking Footprint	1
1			Credit	Electriv Vehicles	1
6	**0**	**5**		**Sustainable Sites**	**10**
Y			Prereq	Construction Activity Pollution Prevention	Required
		1	Credit	Site Assessment	1
		2	Credit	Protect or Restore Habitat	2
1			Credit	Open Space	1
3			Credit	Rainwater Management	3
		2	Credit	Heat Island Reduction	2
1			Credit	Light Pollution Reduction	1
8	**0**	**3**		**Water Efficiency**	**11**
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
2			Credit	Outdoor Water Use Reduction	2
6			Credit	Indoor Water Use Reduction	6
		2	Credit	Cooling Tower Water Use	2
		1	Credit	Water Metering	1
23	**0**	**10**		**Energy and Atmosphere**	**33**
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
		6	Credit	Enhanced Commissioning	6
18			Credit	Optimize Energy Performance	18
		1	Credit	Advanced Energy Metering	1
		2	Credit	Grid Harmonization	2
5			Credit	Renewable Energy	5
		1	Credit	Enhanced Refrigerant Management	1
0	**0**	**13**		**Materials and Resources**	**13**
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
		5	Credit	Building Life-Cycle Impact Reduction	5
		2	Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
		2	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
		2	Credit	Building Product Disclosure and Optimization - Material Ingredients	2
		2	Credit	Construction and Demolition Waste Management	2
9	**0**	**7**		**Indoor Environmental Quality**	**16**
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
2			Credit	Enhanced Indoor Air Quality Strategies	2
3			Credit	Low-Emitting Materials	3
		1	Credit	Construction Indoor Air Quality Management Plan	1
2			Credit	Indoor Air Quality Assessment	2
		1	Credit	Thermal Comfort	1
2			Credit	Interior Lighting	2
		3	Credit	Daylight	3
		1	Credit	Quality Views	1
		1	Credit	Acoustic Performance	1
0	**0**	**6**		**Innovation**	**6**
		5	Credit	Innovation	5
		1	Credit	LEED Accredited Professional	1
0	**0**	**4**		**Regional Priority**	**4**
		1	Credit	Regional Priority: Specific Credit	1
		1	Credit	Regional Priority: Specific Credit	1
		1	Credit	Regional Priority: Specific Credit	1
		1	Credit	Regional Priority: Specific Credit	1
55	**0**	**70**		**TOTALS** Possible Points:	**110**

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

Goal: LEED silver certificate (at least 50 points)

LEED v4.1 Building Design + construction - New construction

Prereq:
1 cred - Integrative process (IP) : analyze the following

- Water related systems - preliminary water budget analysis - indoor water demand, outdoor water demand, process water demand, supply sources
- Health & Well Being - establish health goals, prioritize design strategies,anticipate outcomes

<u>(LT) Location and Transportation</u> (16 possible cred)
<u>High Priority Site</u> -
Opt. 2 Equitable development (1pt)
- Path 1 Equity and Community Benefits (develop and implement and equity plan) (1pt) - 2 cred
<u>Access to Quality Transit</u> -
Path 1 - need bus stop within ¼ mile walking distance - theoretically add stop to MCTA - 5 cred
<u>Bicycle Facilities</u>
Case 2. - provide short term bicycle storage for at least 2.5% max capacity/provide long term for 15% occupants,1 per 3 units- 1 cred

- 7 bikes

<u>EV</u> -
Option 1. Provide electric vehicle supply equipment 5% all parking spaces or 2 lots (whichever is greater)/must provide level 2 charging capacity (208-240volts), comply with standards for electrical connectors, meet ENERGY STAR connected functionality criteria - 1 cred

- 8 lots

<u>Sustainable Sites</u> (10 possible)
Req- Construction Activity Pollution Prevention
- create and implement erosion and sedimentation control plan for construction activities
<u>Site Assessment</u> - 1 cred

- Pay contractor for site assessment

<u>Open Space</u> - 1 cred
Provide outdoor space greater than or equal to 30% total site area, at least 25% vegetated - roof garden + rain gardens

- 40% total site outdoor space, 41.66% of that is vegetated

<u>Rainwater Management</u> - 3 cred
Option 2. Calculate difference of proj. Runoff vol. And vol. Under natural land conditions and retain difference using LID (low impact development) and GI (green infsirrastructure) practices

- Rainwater collection cistern, permeable pavement and rain garden plants
- Natural Land runoff = 2629.87gal/yr, proj. Runoff vol. 2642.4 gal/yr (Close enough)

<u>Heat Island Reduction</u> - 2 cred
-Option 1. Non-roof and Roof - 6250 sqft/ 0.75 = 8333.33 < 22,500 + 15,000 = 37,500

- Do not qualify

<u>Light Pollution Reduction</u> - 1 cred
Option 1 BUG rating method- do not exceed uplight ratings for luminaires

<u>Water Eff.</u> (11 possible)
Req. Outdoor Use Management
Req. Indoor water use reduction
Req. Building level water metering
<u>Outdoor water use reduction</u> - 2 cred
Option 1 - no irrigation required
<u>Indoor water use reduction</u> - 6 cred
Reduce fixture and fitting water use - uses table, points by percentage water reduction

- Implement Grey Water Toilets, and Waste type buttons saves 88,400 gpy
- Low flow shower heads, saves 2,543,576.336 gpy
- Estimated water use 4,351,818 gal/yr, saves 60%

Energy and Atmosphere (25 Possible)
Req. Fundamental Commissioning and Verification - complete commissioning (Cx) process activities
Req. Minimum energy performance - Comply with ANSI/ASHRAE/IESNA Standard 90.1-2016
Req. Building level energy metering - install new building level energy meters
Req. Fundamental refrigerant management - do not use CFC or HCFC based refrigerants
<u>Optimize Energy Performance</u> - 18 cred
Option 1 - Performance Cost Index (PCI) % Cost PCI below + % Greenhouse gas emissions below

- Self dimming lights
- Motion sensors to turn lights off/on
- Estimated 160,833.6 kW hr/yr saved, 56%
- PCI = .45
- GHG PCI = 1.07

<u>Renewable Energy</u>- 5
Tier 1 - On-site renewable energy generation. Points for % renewable energy procurement

- Solar panels on parking garage roof
- 145,315.625 kWh/yr system = 55%

<u>Materials and Resources</u> (13 possible) (dont really think we need to do this one)
Req. Storage and Collection and Recyclables
Req. Construction and Demolition Waste Management Planning
Req. Pbt source reduction - mercury

<u>Indoor Environmental Quality</u> (16 possible)
Req. Minimum indoor air quality performance - Option 2. ASHRAE engineered natural ventilation system compliance path
Req. Env. Tobacco Smoke Control - Option 1. No Smoking
<u>Enhanced Indoor air quality -</u> 2 cred
strategy 3 - Filtration of outdoor air - each ventilation system that supplies outdoor air has MERV or 13 or more or ePM 50% or higher
<u>Low emitting materials</u> - use materials on the building interior that are low emitting - points per number of categories met

- Paints and coatings
- Adhesives and sealants

- Flooring
- Wall panels
- Ceilings
- Insulation
- Furniture
- Composite wood

Indoor air quality assessment - 1 point
Option 1. Path 1 - before occupancy - perform building flushout
Interior Lighting - 2 points
1.Glare Control - Unified Glare Rating UGR rating <19
2. Color Rendering - Color rating index CRI at least 90
3. Lighting control - dimming lights

Innovation (6 possible)

Regional Priority (4 possible)

Appendix B – Project RFP

MURRAY STATE UNIVERSITY

School of Engineering

ENT 419
SENIOR PROJECT
CAPSTONE DESIGN
SPRING 2021

I. Project Information

The owner desires to hire an experienced Design-Build firm to deliver the professional services described below for a project with Murray State University

The owner desires to construct a multi-use building containing a multilevel parking garage and graduate/family apartments. The parking area will be for the residents of the apartments as well as general parking for students. The apartments should be a 50-50 mix of one and two bedroom units for graduate students and students with families. Additional spaces such as meeting room, public restrooms, storage, computer lab, etc. are encouraged per the designers' discretion.

There should be 20-25 apartments. The parking garage will hold 100 vehicles plus 1 space per apartment. All will be ADA accessible and have security measures. In addition to usability and function, special attention should be made for LEED requirements, safety and COVID/pandemic design elements.

The project consists of the two phases:

Phase 1 will be a feasibility study of the possible location and general size and configuration of the structure.

Phase 2 will be the preliminary design of the structure, site design, environmental design and presentation of estimate, schedule, construction means and methods of the design.

Design Code:

2018 Kentucky Building Code (KBC) – which is a slightly modified 2015 International Building Code (IBC 2012). For this RFP the 2018 KBC can be viewed here (https://up.codes/codes/kentucky).

LEED Certification:

The design and materials used for this project will need to be such that the project can obtain a *LEED Silver Certificate*.

A. **Master Planning:**
The entire site will need to be master planned to allow for the proposed development.

B. **Design & Preconstruction Phase:**
For this phase of the project, the Construction Manager shall function as professional consultant to the owner and shall provide design and preconstruction services which include, but are not limited to the following:

1. The Construction Manager shall provide a preliminary evaluation of the Owner's program requirements and project budget, each in terms of the other.
2. The Construction Manager shall review all applicable laws, codes, ordinance and standards applicable to design and construction of the project, including but not limited to local building codes and NFPA standards. The Construction Manager shall correlate such requirements with the project program and advise the Owner if any aspect of the program may cause a violation of such requirements.
4. The Construction Manager shall submit to the Owner preliminary design documents, a detailed statement of the Guaranteed Maximum Price (GMP), and a detailed project

schedule determining a Guaranteed Delivery Date (GDD) for the project completion. Preliminary design documents shall consist of drawings, outline specifications and other documents (if required) sufficient to establish the size, quality and character of the project, architectural, structural, mechanical and electrical systems. The proposed building materials and such other elements of the project as may be appropriate to fully describe the project features and the required scope of work.

5. **Tasks to be included for design and construction are as follows:**

a. Site Layout
   a. Must meet all the site development (setbacks, easements, etc.) requirements as established by the City of Murray and Calloway County, Kentucky.
   b. Check zoning requirements
b. Must meet ADA requirements.
c. Specific design requirements per design team handout.
d. Storm water collection system.
e. Erosion and sedimentation control.
f. Development of an opinion of probable cost for the entire project.
g. Develop a detailed schedule for design and for construction (two separate schedules).
h. The Construction Manager will hold and administer all subcontracts and shall be responsible for all project administration including but not limited to; scheduling the work, verifying and approval of all required shop drawings and submittals, ordering and ensuring timely delivery of all required materials, enforcement of all OSHA safety regulations and approval of all material invoices and subcontractor pay requests.
i. The Construction Manager will be responsible for managing the site and coordinating all construction activities.
j. The Construction Manager shall be required to provide a Labor and Material Payment Bond and a Performance Bond. Each bond shall be issued in an amount equal to 100% of the Guaranteed Maximum Price (GMP).
k. The Construction Manager shall be required to provide all insurance coverage required by the Contract.
l. The Construction Manager shall be required to provide Builder's Risk Insurance for the project.
m. The Construction Manager shall employ a competent superintendent who shall remain on-site continuously during construction activities and have authority to act on behalf of the Construction Manager.
n. Prior to commencing construction, the Construction Manager shall be required to submit overall project schedule utilizing MS Project scheduling software, or equal. The schedule shall include all construction activities and shall provide adequate detail to establish an acceptable and realistic construction sequence to achieve the required completion for each project phase. The schedule shall be

updated and submitted to the Owner no less than once a month upon construction commencement.

o. The Construction Manager shall report to the Owner all construction contingency allocations and shall update and submit to the Owner a log of contingency allocations no less than once a month.

II. Evaluation Criteria for Final Submittal

1. **(10%) Project Programming –** Provide a written narrative describing the design problem/issue to be solved. This should include desired outcomes and goals of the design.

2. **(5%) Safety Approach** - Describe your corporate approach to Project Safety and Safety Control and how they will be met in this project.

3. **(5%) Sustainable Approach** - Describe your corporate approach to sustainable design and construction practices and how they will be met in this project.

4. **(5%) Project Approach –** Describe your firm's specific management/ staffing approach for this project.
   A. Provide an organizational chart, indicating hierarchy of responsibility for the proposed project team, (Project Executive, Project Director, Project Superintendent, Safety Manager, and Preconstruction Manager).
   B. Provide a resume of each individual to be assigned to the project.
   C. Provide your firm's approach to the different phases of the project, e.g. Preconstruction, Design, Construction, Safety, Sustainable Construction, Closeout.

5. **(60%) Design/Project Management**
   a. Architectural (10%)
      i. Site Layout
      ii. Final Design
   b. Surveying (10%)
      i. Layout/Site Plan
      ii. Coordination on design
      iii. Development of topographic map
   c. Civil (10%)
      i. Roadway design including pavement design
      ii. Foundation Design
      iii. Geotechnical Report
      iv. Pavement Design
   d. Specifications and Contracts (10%)
      i. Standard AIA, AGC or EJCDC Owner/Contractor Agreements
      ii. 3 major section specifications
   e. Construction (10%)

i. Planning and Scheduling
ii. Estimating
iii. Safety
iv. Project Management

f. Environmental (10%)

i. Storm water Collection
ii. Erosion and sedimentation control iii. Water distribution

6. (15%) Presentation Quality – Proposals will be evaluated on the quality as well as the content of the final documents.

A. Bound proposal containing all documents, contracts, specifications, drawings, notes, design calculations, estimates, schedules and narratives neatly organized and tabbed.

B. Owner presentation summarizing your teams project approach, design, schedule and estimate presented using story boards, PowerPoint, videos, handouts or any method to clearly convey your teams design to the client.

III. <u>Schedule of Events</u>

Schedule of Events – Each team will develop a schedule of events for when specific portions of the project shall be completed. This is the first and one of the most important tasks you will need to complete. Below are two dates that you cannot change or miss.

Feasibility Presentation – Tuesday February 23, 2021

Preliminary Presentation – March 23 and March 25 , 2021

Proposals due to Owner – May 6, 2021

Final Presentations – May 4 and 5, 2021

IV. <u>Submission of Proposals</u>

Proposals will be received until 2:00 p.m. (Central Time), Thursday, May 6, 2021. Late proposals **<u>WILL NOT BE ACCEPTED</u>**. To be accepted, all proposals are to be submitted, in ***PDF documents*** marked “CAPSTONE DESIGN PROJECT SPRING 2021”. Proposals must be hand delivered. No proposals will be accepted via fax or email transmission regardless of time of delivery.

The owner intends to award the contract to the most qualified firm based on the evaluation criteria listed above. Should the owner and the first firm selected fail to negotiate mutually acceptable fees for service, the owner shall abandon negotiations with the first firm and initiate negotiations with other firms in rank order, however the owner reserves the right to reject any or all proposals if deemed to be in the best interest of the owner.

V. Questions

Questions regarding the Request for Proposals shall be submitted through Canvas – Discussions as an RFI. Questions will not be answered after May 1, 2021. Answers provided by the Instructor are considered the correct and only answer to a question.

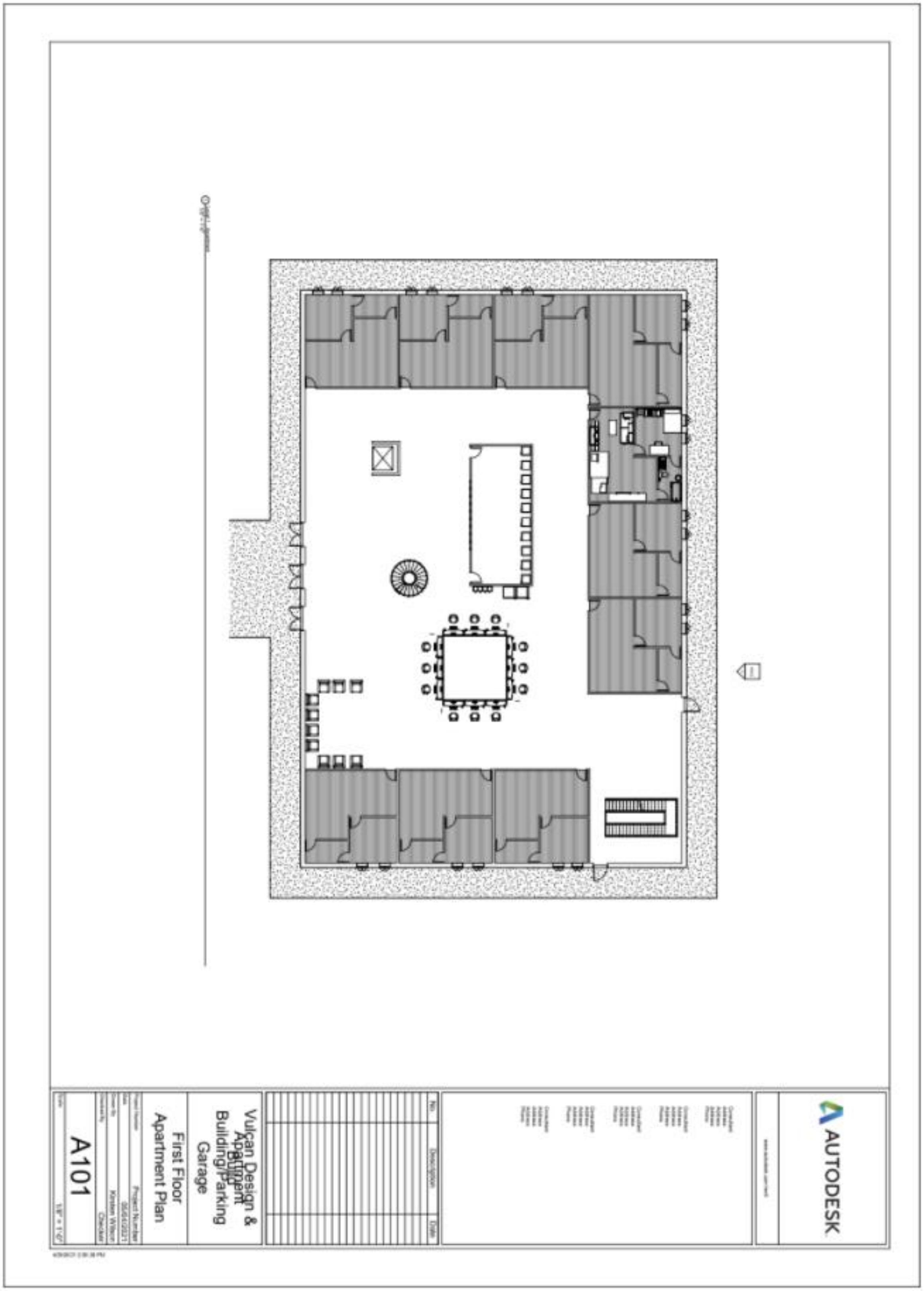
Hints to make this project a success:

A. All resumes in the Final Binder should be in the same format.
B. Must work as a team.
C. This class WILL take more time than any other class you have taken. Schedule your time accordingly.
D. Don’t procrastinate.
E. When you don’t know….ask a teammate, search the internet, ask an instructor.
F. All drawing borders in the Final Binder must match.
G. Instructions will be provided in class both verbally and in writing. Take good notes.

PARKING GARAGE – DESIGN TEAM HANDOUT

- Two story parking garage – 200 vehicles (minimum) - must provide detailed calculations showing how you developed the size and layout of the structure. This is considered off-street parking.
- Must be ADA compliant
- Self-park structure
- May be concrete, structural steel or combination of both. Must design one floor beam and one column.
- Parking lane width 8’-6” (perpendicular spaces – adjust for angled parking)
- Parking lane length 18’-0” (perpendicular spaces)
- Stairs and elevator(s)
- Gate system or other method to control who can enter the structure
- Design an entrance or multiple entrances
- Site grading
- Storm water runoff from the structure and from the site
- Evaluate pedestrian flow from the garage to other areas on campus – sidewalk design
- Establish staging area for construction
- How will the project be constructed? Detailed discussion on how to accomplish this task.
- Lighting
- Security
- Signing

Appendix C – Project Revit Drawings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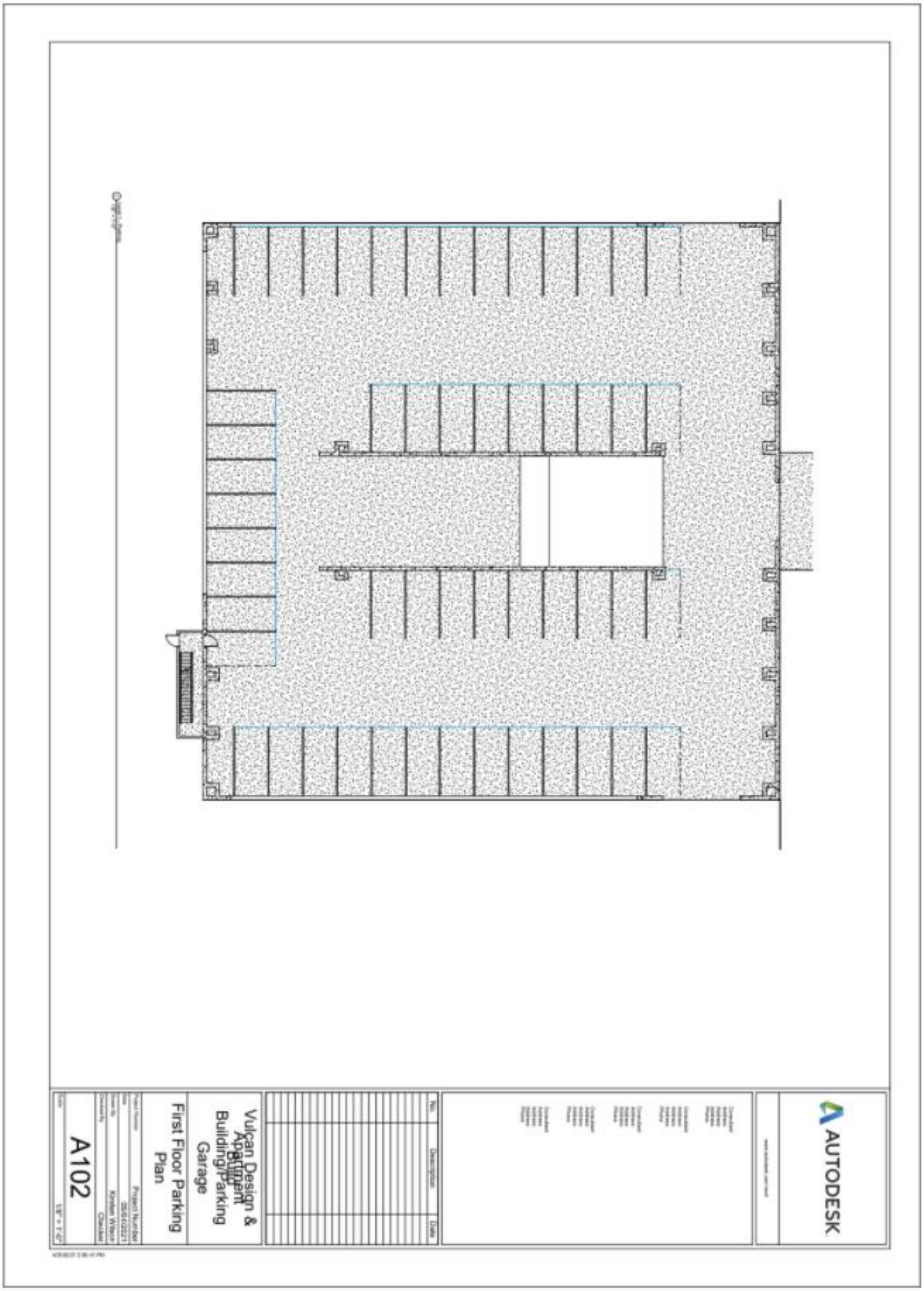
First Floor Apartment Plan
Project Number
Checker
A101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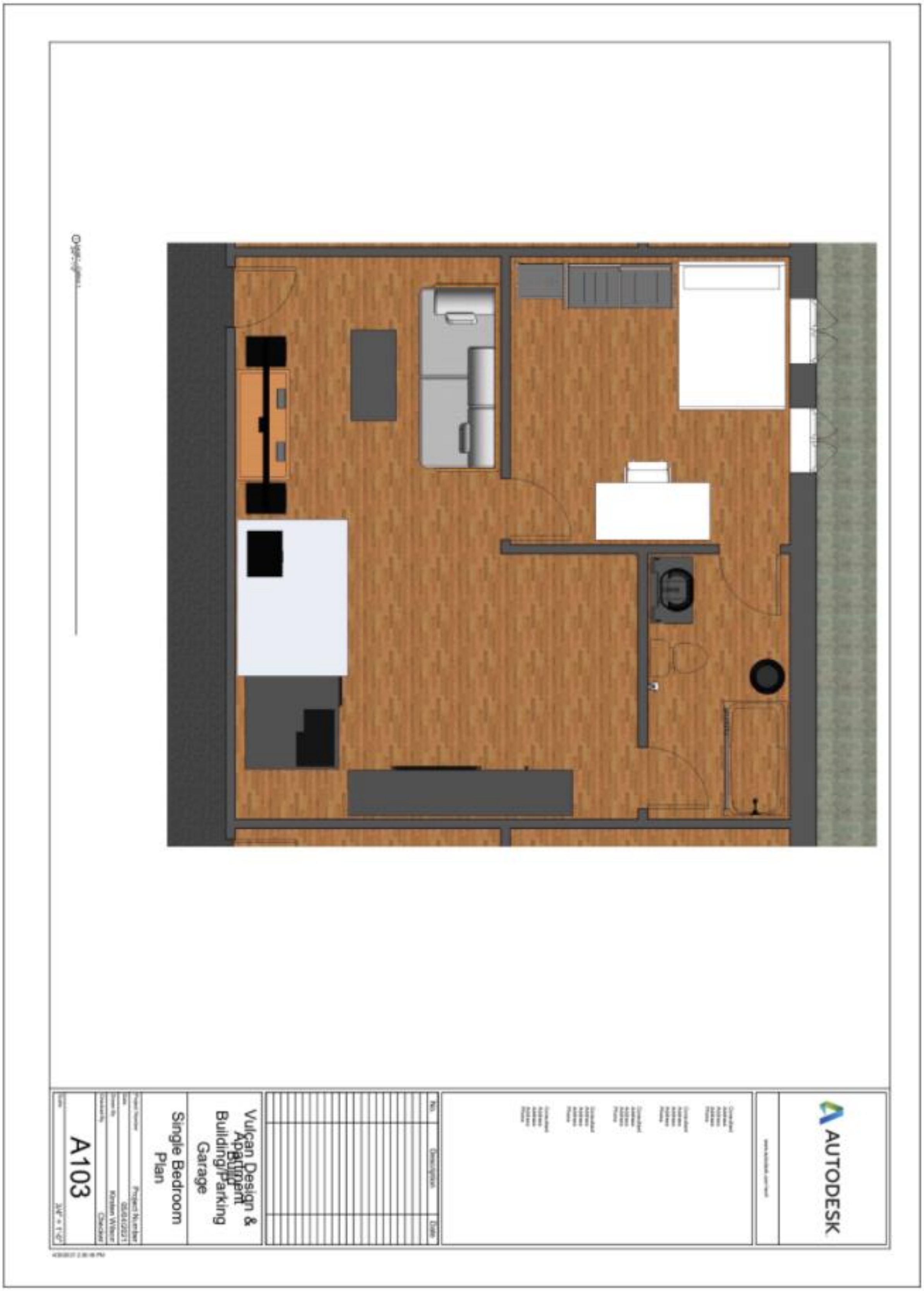
First Floor Parking Plan
Project Number
Kirsten Wilson
Checker
A102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Single Bedroom Plan
Project Number
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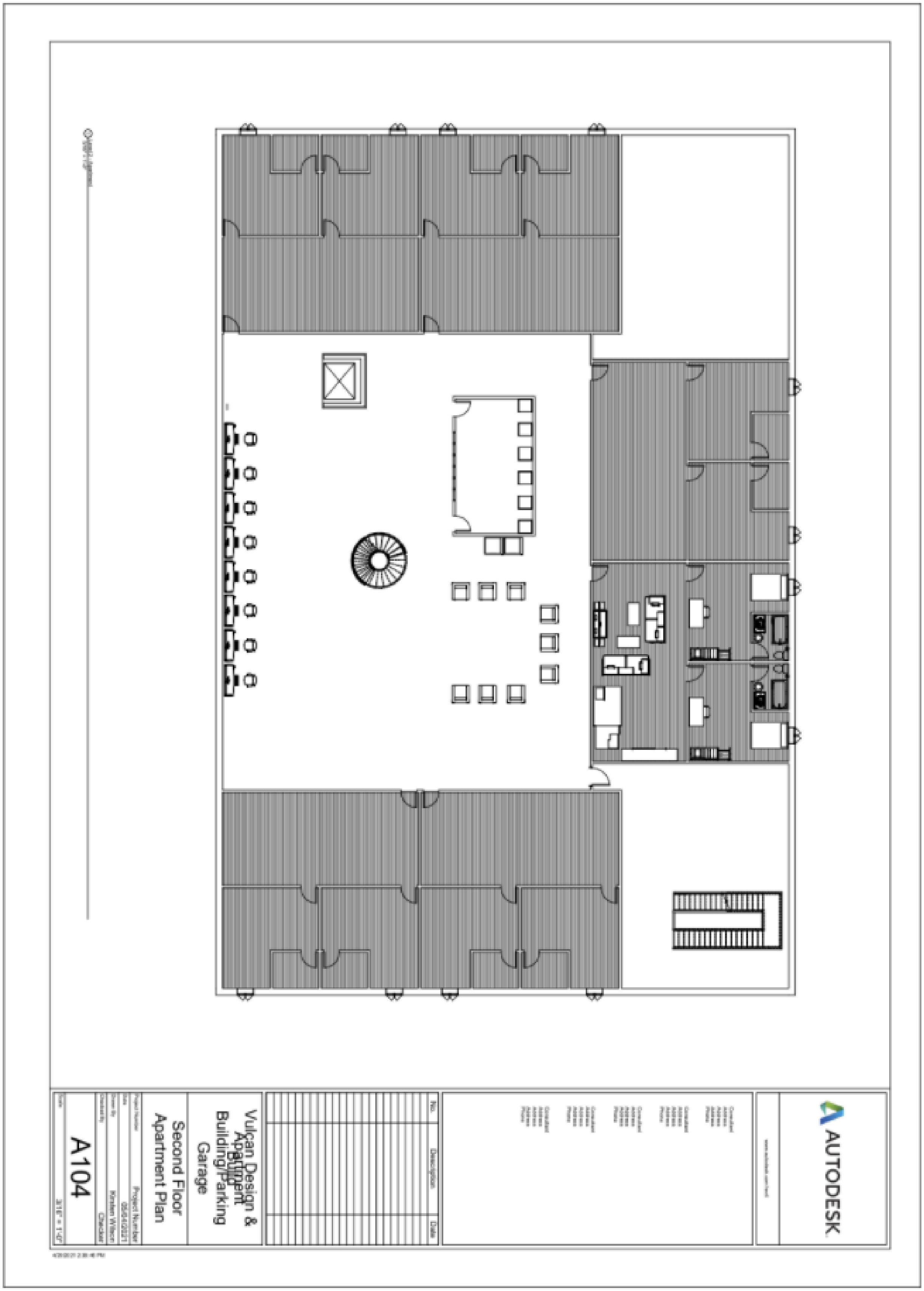
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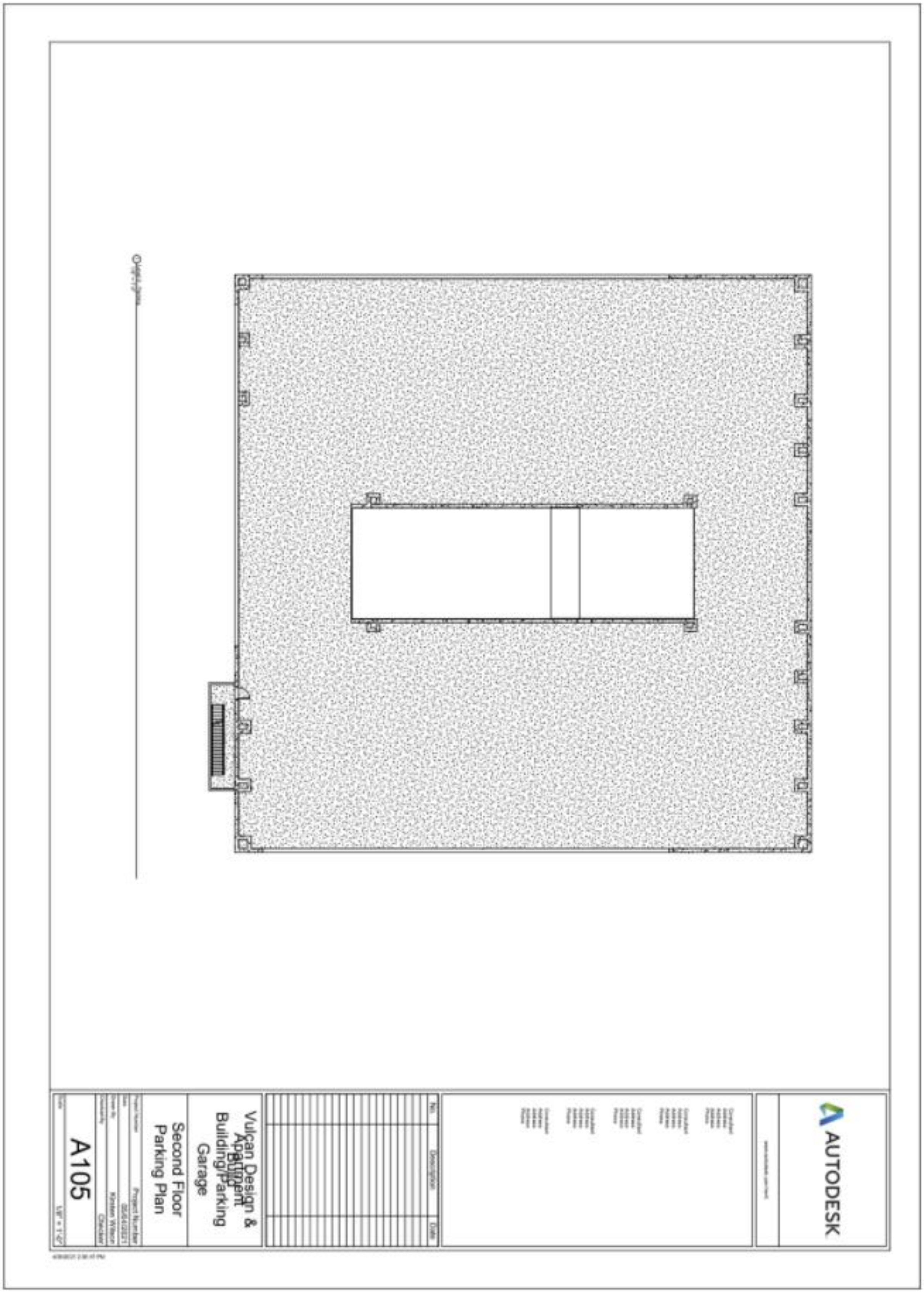
Second Floor Apartment Plan
Project Number
Checker
A104
3/16" = 1'-0"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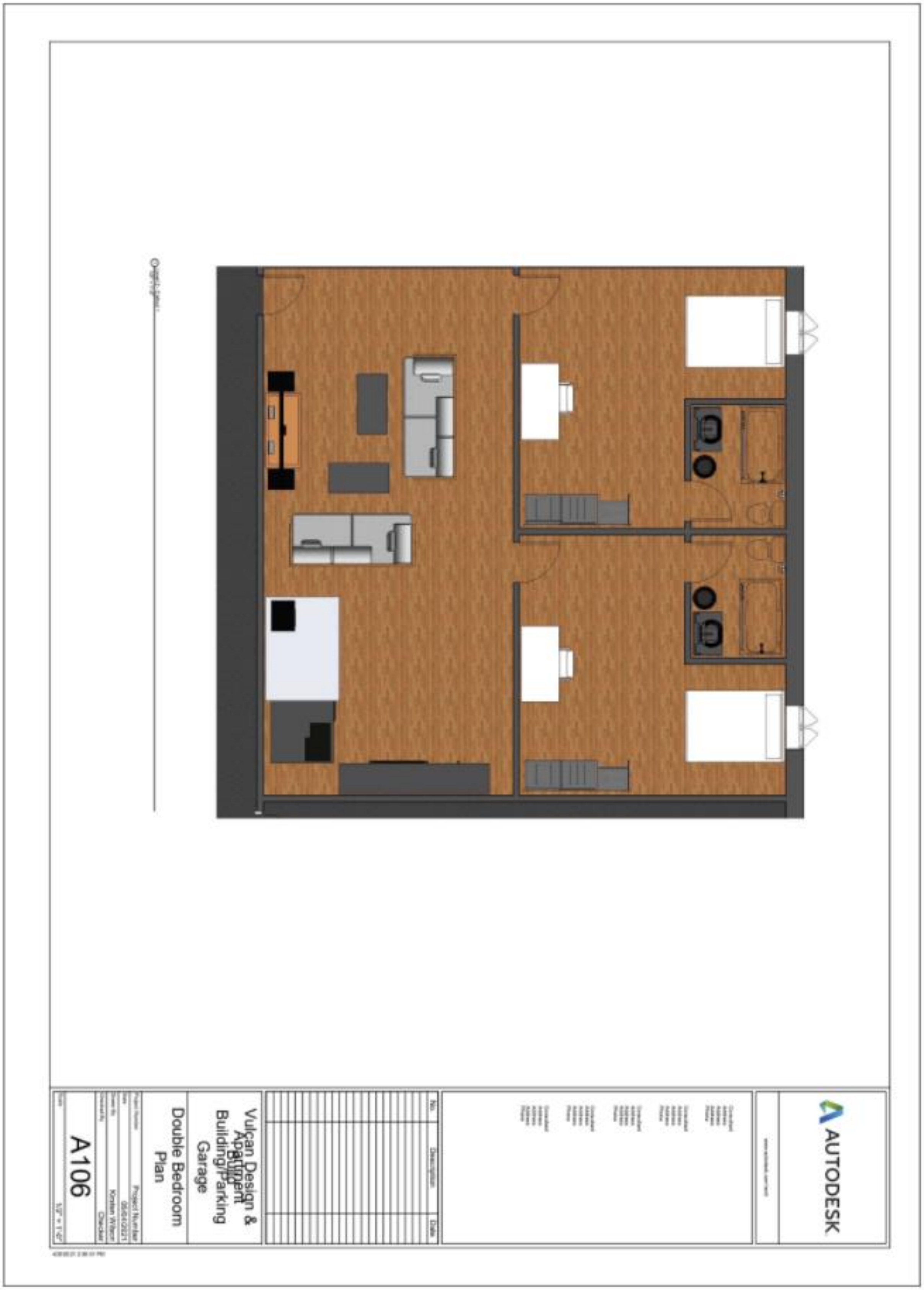
Vulcan Design &
Apartment
Building/Parking
Garage
Second Floor
Parking Plan
A105



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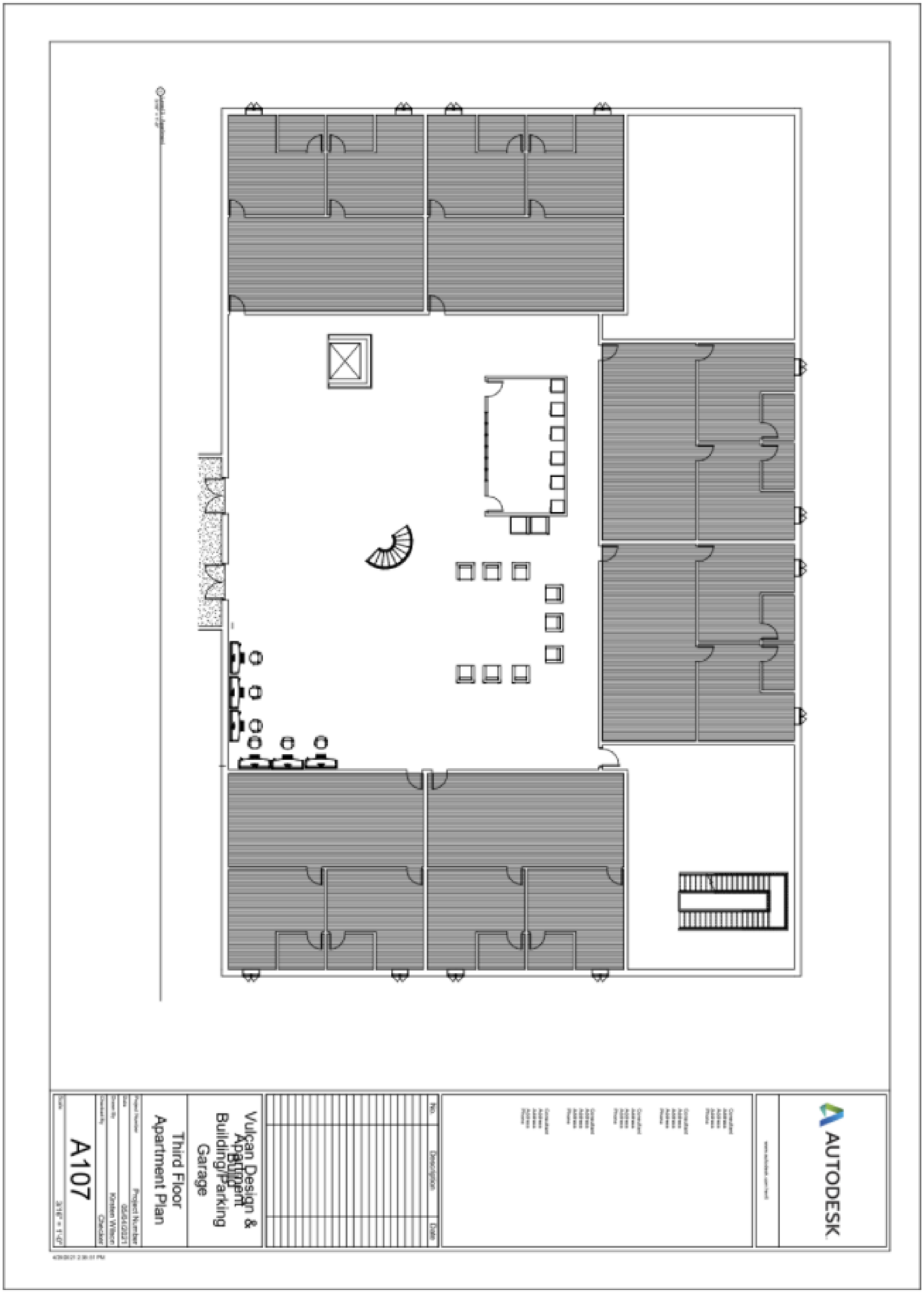
Double Bedroom Plan
Project Number
Checker
A106



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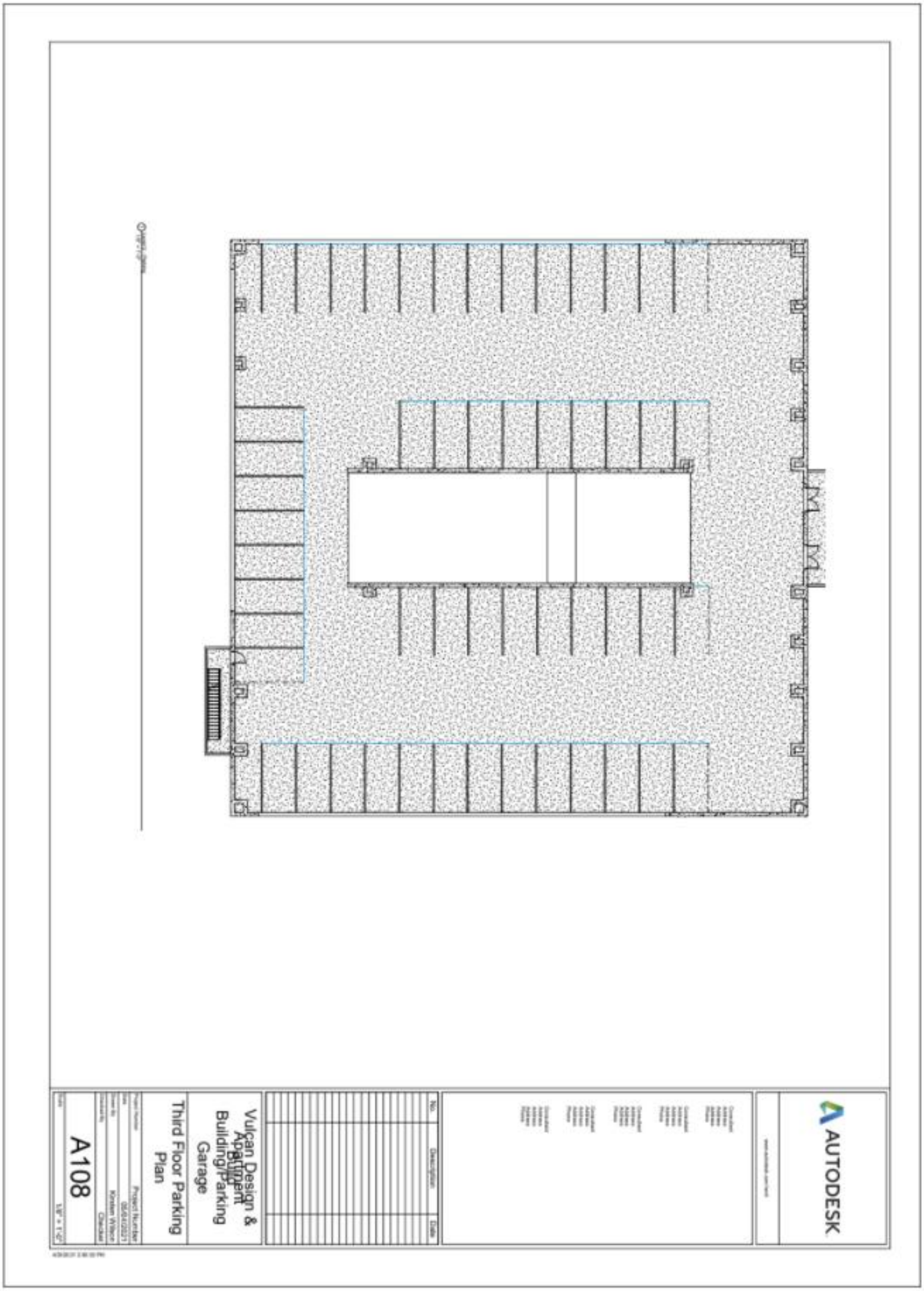
Third Floor Apartment Plan
Project Number
Kirsten Wilson
Checker
A107
3/16" = 1'-0"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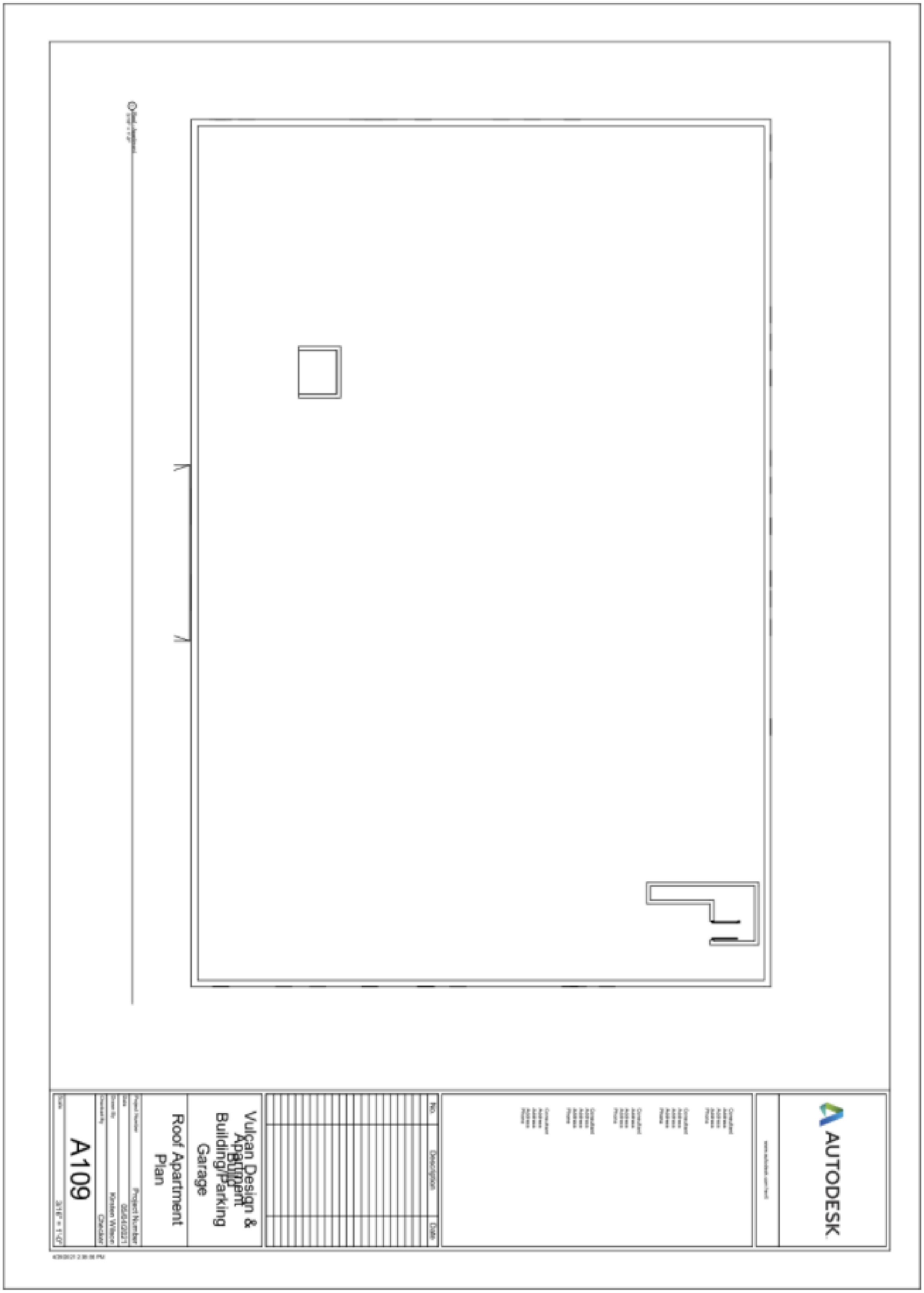
Project Number
Kirsten Wilson
Checker
No.
Description
Date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Roof Apartment Plan
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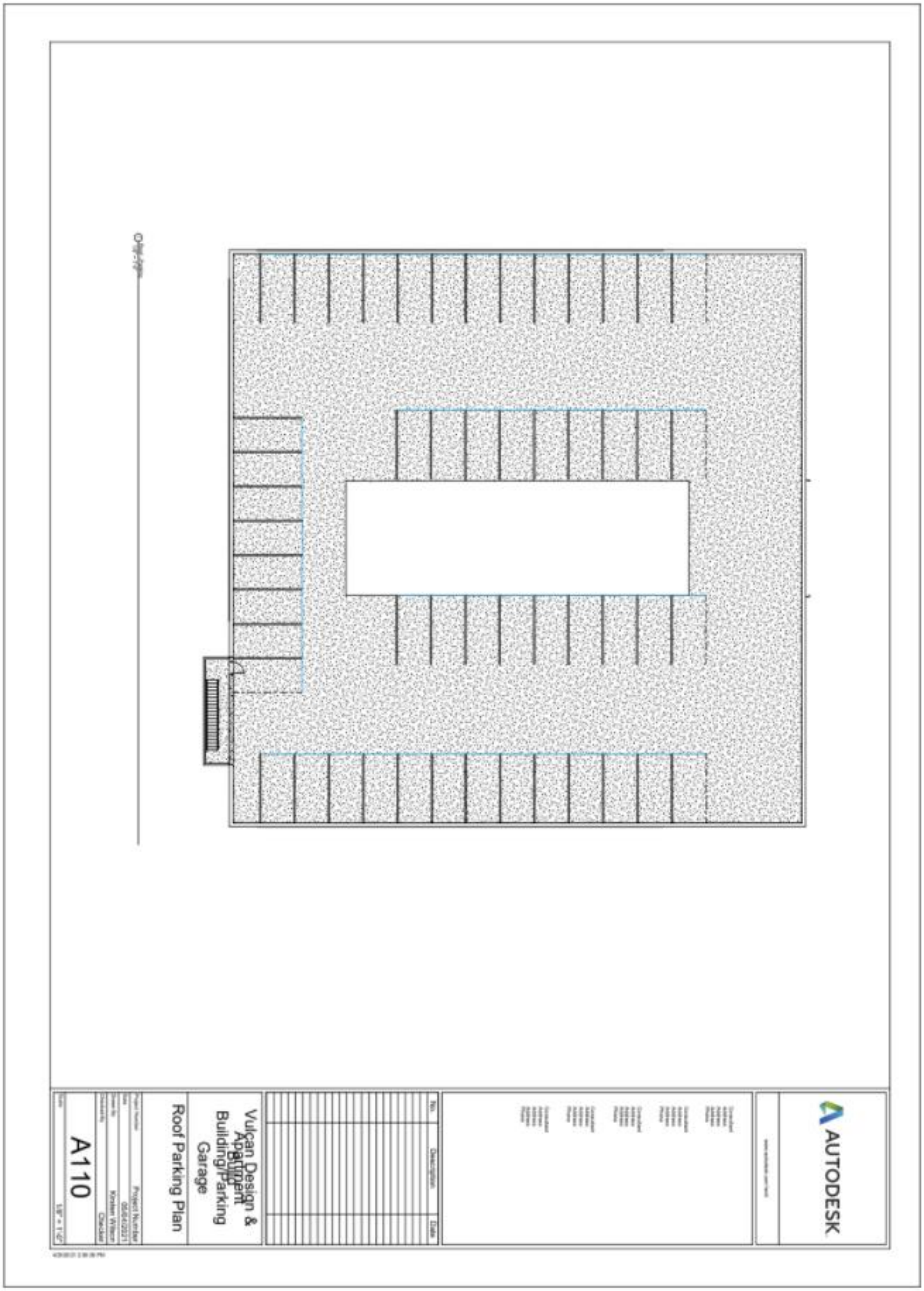
Description
Date



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Roof Parking Plan
Project Number
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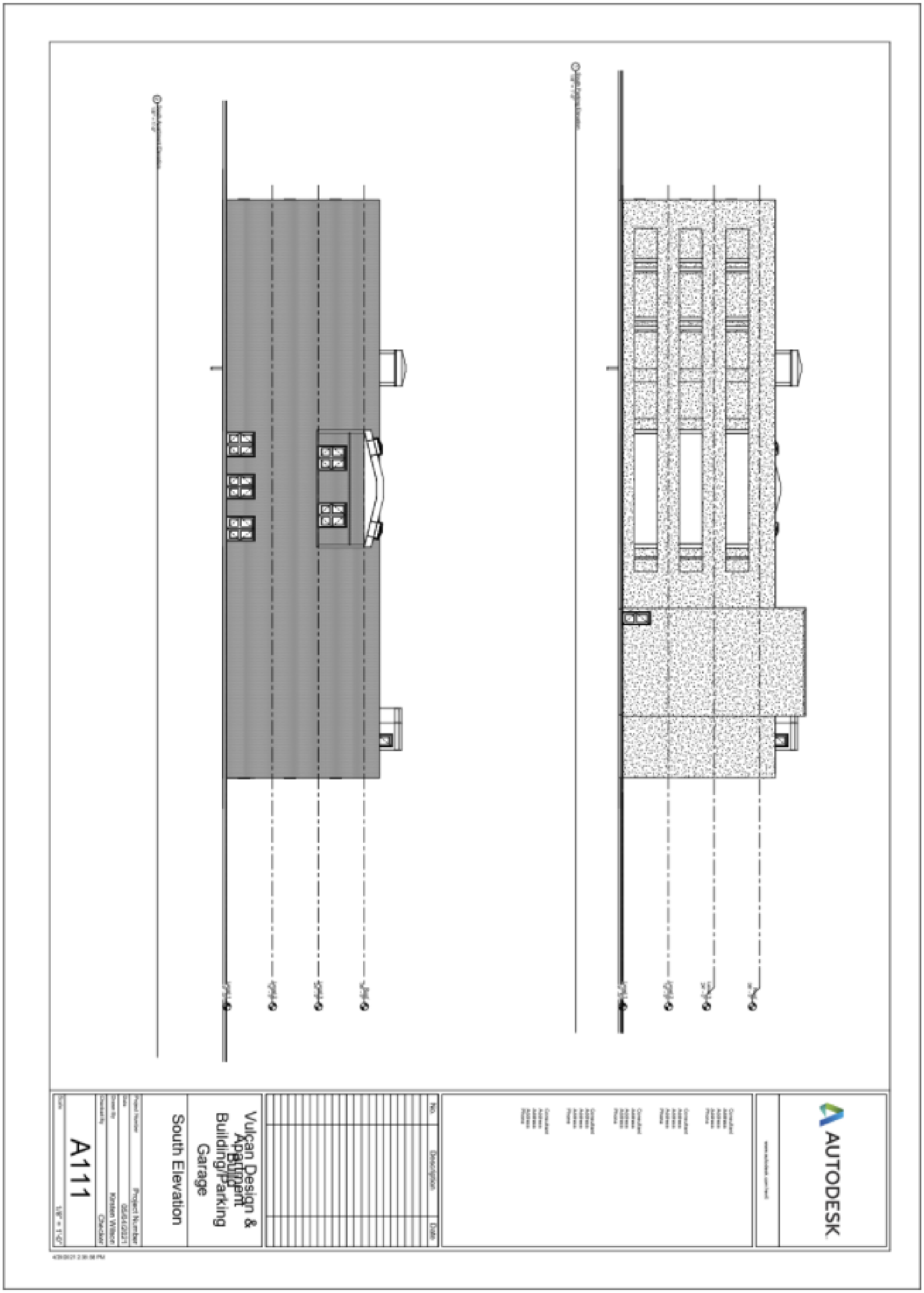

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South Elevation
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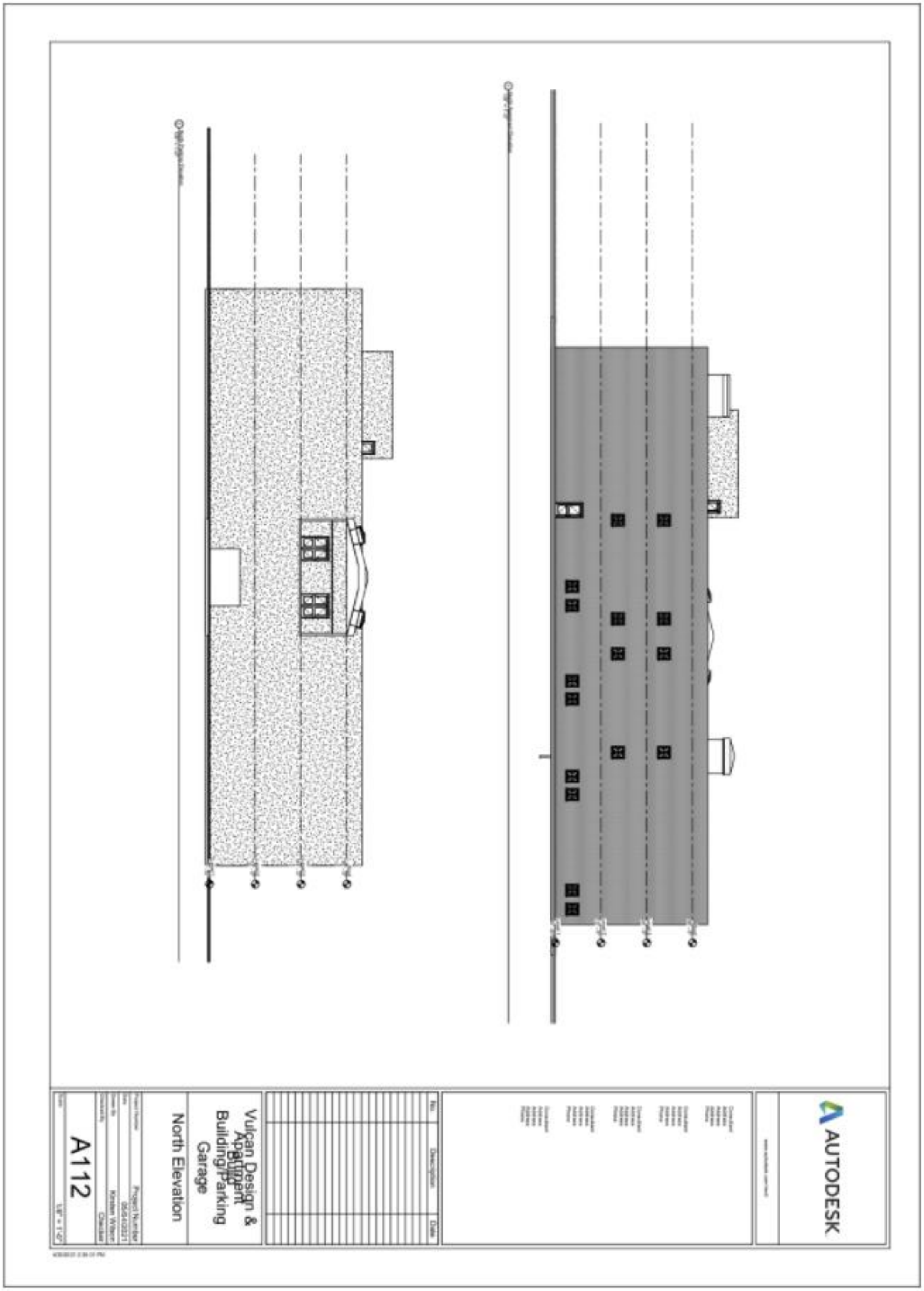
1/8" = 1'-0"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North Elevation
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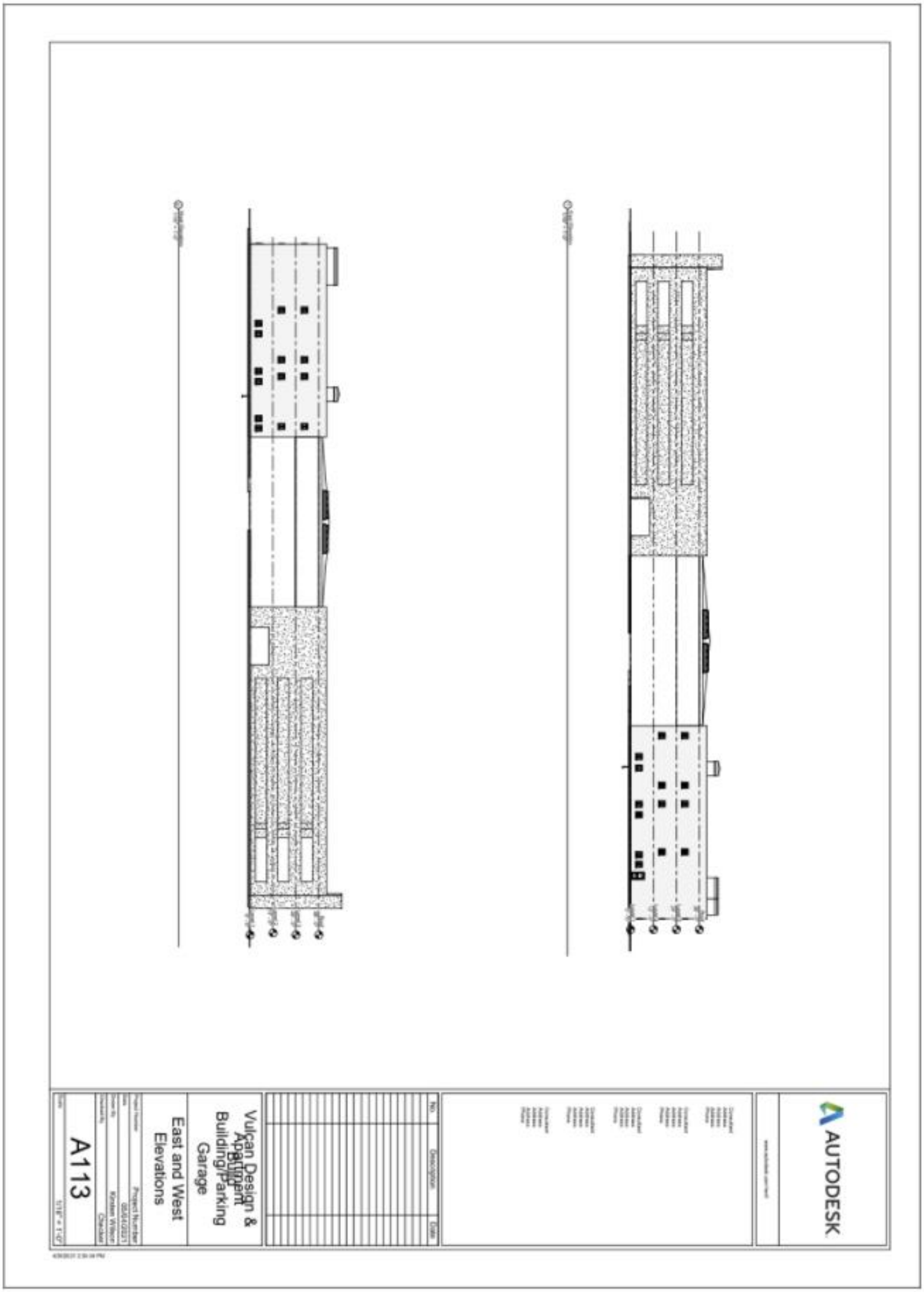
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East and West Elevations
Project Number
A113


AUTODESK
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Perspectives
Project Number
Checker
A114