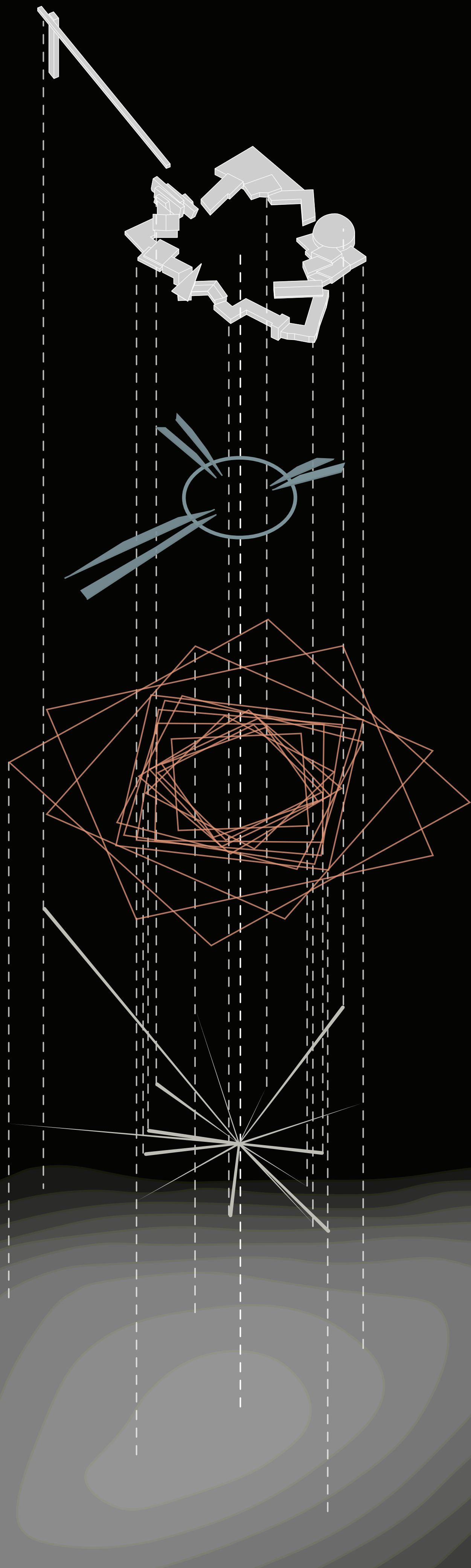


SPACE SKY EARTH

WEATHER LEARNING MUSEUM AND RESEARCH CENTER

Space Sky Earth : Weather Learning Museum and Research Center

A Design thesis submitted to the Department of Architecture
North Dakota State University

By: *Ben Gutowski*
In partial fulfillment of the requirements for the degree of Master of Architecture

Primary Thesis Advisor ______________________________
Dr. Ganapathy Mahalingam

Thesis Committee Chair______________________________
Dr. Ganapathy Mahalingam

May 2021
Fargo, North Dakota

TABLE OF CONTENTS

LIST OF TABLE AND FIGURES

THESIS ABSTRACT

A rainstorm now and again can be a calming experience. With our climate changing and a focus on more sustainable built projects, we can only wonder if it is enough to help offset the carbon footprint that architects create. Through the creation of a research facility to monitor and observe natural phenomena, researchers and the public can learn and study the weather and climate that surround us in our everyday lives. The building itself will be used as a learning tool by integrating sustainable building practices mixed with interactive spaces to learn about green building. The three areas of focus at the facility are the earth, sky, and space. Qualitative, correlated, and case studies will be my primary forms of research. These will provide in-site as to how research is done and how to design for a sustainable building. Designing a multi-disciplinary building that strives for the best sustainable design all while showing the effects of climate change on our planet will be the goal of this project.


FIGURE 1 | Texaco Hill Sunset (Shannon, 2001-2020)

NARRATIVE OF THE THEORETICAL ASPECT OF THE THESIS

With our world increasingly getting more and more hectic, we often forget to stop to take in the world around us. Weather happens around us every day, so why don't we know more about it than what the temperature is going to be a week from now? While some might call it "bad weather", to others, a thunderous storm is just what they need for a calm and pleasant evening. I am one of those people who embrace a good thunderstorm. In the many trips out west have I been on, you could see the thunderstorms approaching from miles away. Viewing beautiful sunsets as they paint the sky in an array of colors every evening can really bring someone inner peace. While we spend our whole lives surrounded by natural phenomena (rain, snow, sunshine, and the sky), how much do we really know about it?

This facility would be for the study and learning of all these different types of natural phenomena. Topics such as climate change and environmental design would also be on display to enrich the knowledge of those who wish to learn more. The premise here is that when people learn about and appreciate the world they live in, they take better care of it.

This so happens to be the unifying idea behind my proposal: That teaching people of all ages about the weather, climate change, and sustainable design will get them to see the world in a new way and take better care of it.

Sergio Altomonte writes about how architects can help reduce effects of negative climate change in the built environment. He writes an article about mitigation and adaptation of design for a more sustainable built environment. Altomonte (2008) writes:

> In summary, it is very likely that the portfolio of technologies and know-how needed to make built environments minimize their impact on the ecosystem and adapt to shifting climatic conditions is already with us, as long as integrated design and behavioral strategies are put in place for their implementation. Making the most of ancient, existing and forthcoming knowledge (also featuring hybridizations between seemingly distant disciplinary fields), the design of buildings has to progress in response to environmental and users demands, re-establishing the fundamental connection between humans and the natural system that has sustained us so far, cradling and nourishing us, making all of our (sometimes insane) actions possible. A sustainable future is possible, but there is still a long way to go. (Pg. 108)

These practices will be pushed as much as they can in this project to attempt to create a building that is a model for sustainable design. This is part of why the research facility is important: to help with the study on the different aspects of our planets weather and new ways on live sustainably. It is also how to reinvigorate how people see the planet, its weather patterns, and what is in the sky through an engaging place for them to entertain their curiosity.
This unifying idea will be explored Through qualitative, correlative, and case study research methods. Professionals and those who work in similar facilities will be interviewed to gather information of how the day to day operations run and how research is being done on climate change and sustainable design. Projects will also be analyzed to see how other designers have integrated sustainable principles and how they perform. These will help with the layout of equipment and labs for the design of the complex and give a glimpse into how data is being collected.
In conclusion, I would hope that my findings lead to a design solution that incorporates all my research done and creates a project that feels like a whole while showcasing sustainable design.

SCIENTIFIC RESEARCH FACILITY

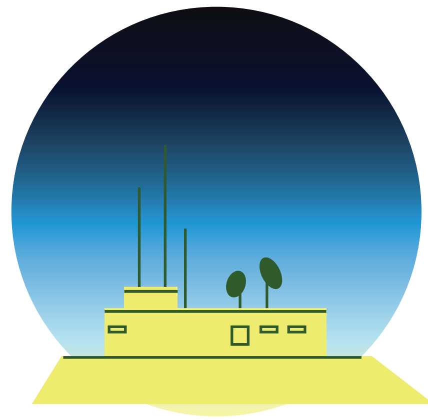
- Professionals work on a variety of projects in labs and field research. With an emphasis in sustainable building techniques and climate change research.

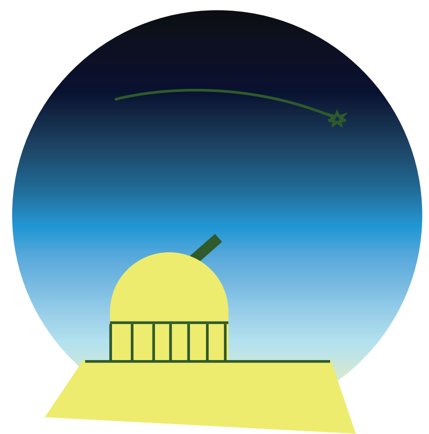
MUSEUM

- Students and the public can visit the complex to learn and see what type of research have been going on and possibly view some experiments or phenomena themselves.

OBSERVATORY

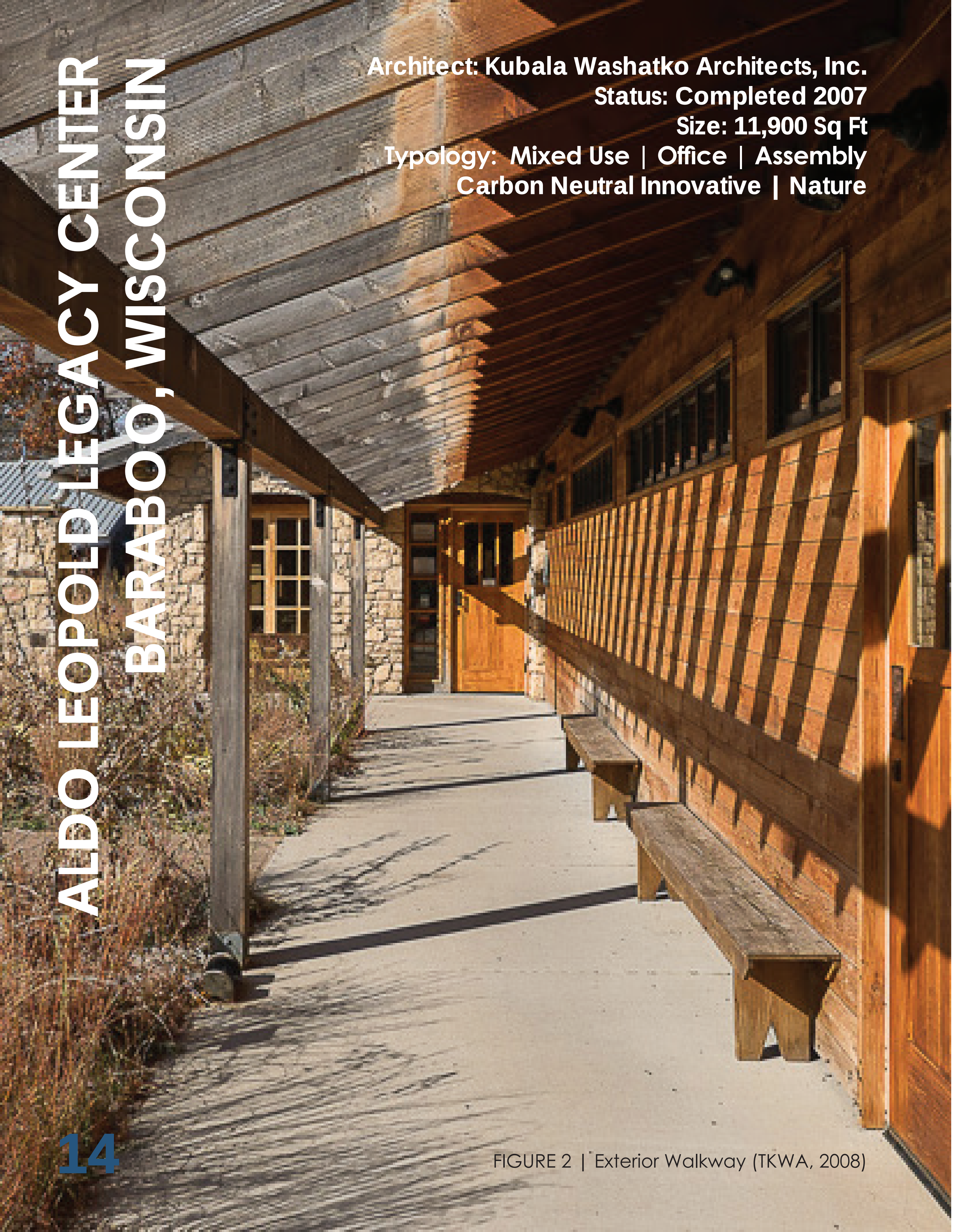
- To be used for both researchers and the public to view the natural phenomena both inside and outside the building. There would be a space observatory to view the reaches of the universe.





These would be blended to create a flowing space of learning and teaching spaces to facilitate knowledge sharing among everyone who visits. Landscaping around the building would also be designed to reinforce studies that are going on there and native plants. The whole building is meant to have a minimal impact on the site around it and not subtract from the surrounding environment.

ALDO LEOPOLD LEGACY CENTER
BARABOO, WISCONSIN



Architect: Kubala Washatko Architects, Inc.
Status: Completed 2007
Size: 11,900 Sq Ft
Typology: Mixed Use | Office | Assembly
Carbon Neutral Innovative | Nature

FIGURE 2 | Exterior Walkway (TKWA, 2008)

"The World's First Carbon Neutral Building" Greets you upon searching for this project on the firm's website. It was the first building that LEED recognized as carbon neutral which was due to the dedicated contribution of the multidisciplinary design team working diligently together. The site was already cleared due to previous fires and environmental reasons, which was part of the environmental restoration that was also in the program. The center is mostly constructed of wood that was from the site originally and was planted by the organization's founder in the 1930s. The design team had to work backwards when designing the building because they could only use as much wood as they had cut down on the exterior and interior of the building. It also includes a large solar array, geothermal heating, earth tube cooling, and many other design choices that increase the building's performance. The building's plan was designed to be largely slim to allow light to pass through the space.

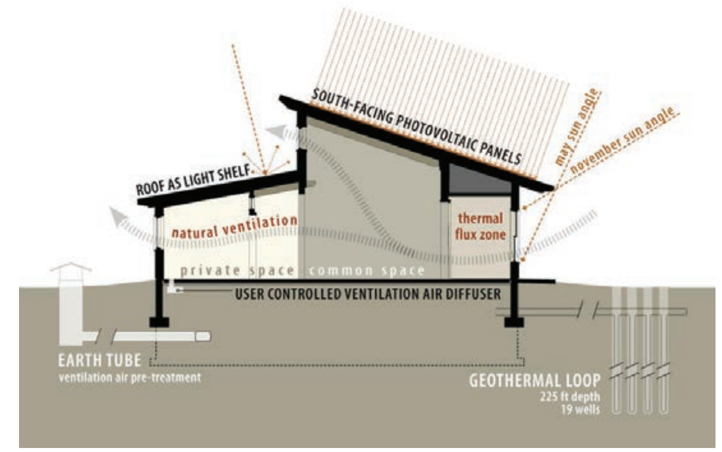


FIGURE 3 | Building Section (TKWA, 2008)

FIGURE 4 | Wood cutting (TKWA, 2008)

Not only does the building teach us about sustainable effort now, but as they were building it tours and workshops where held on the site to show others how their sustainable design was going to work. The current staff of the building use mostly public transportation to reach the site, carpool, or bike to work every day. Both the building and the people working there are dedicated to living in a more sustainable world.

(Kubla Washatko Architects, 2008)

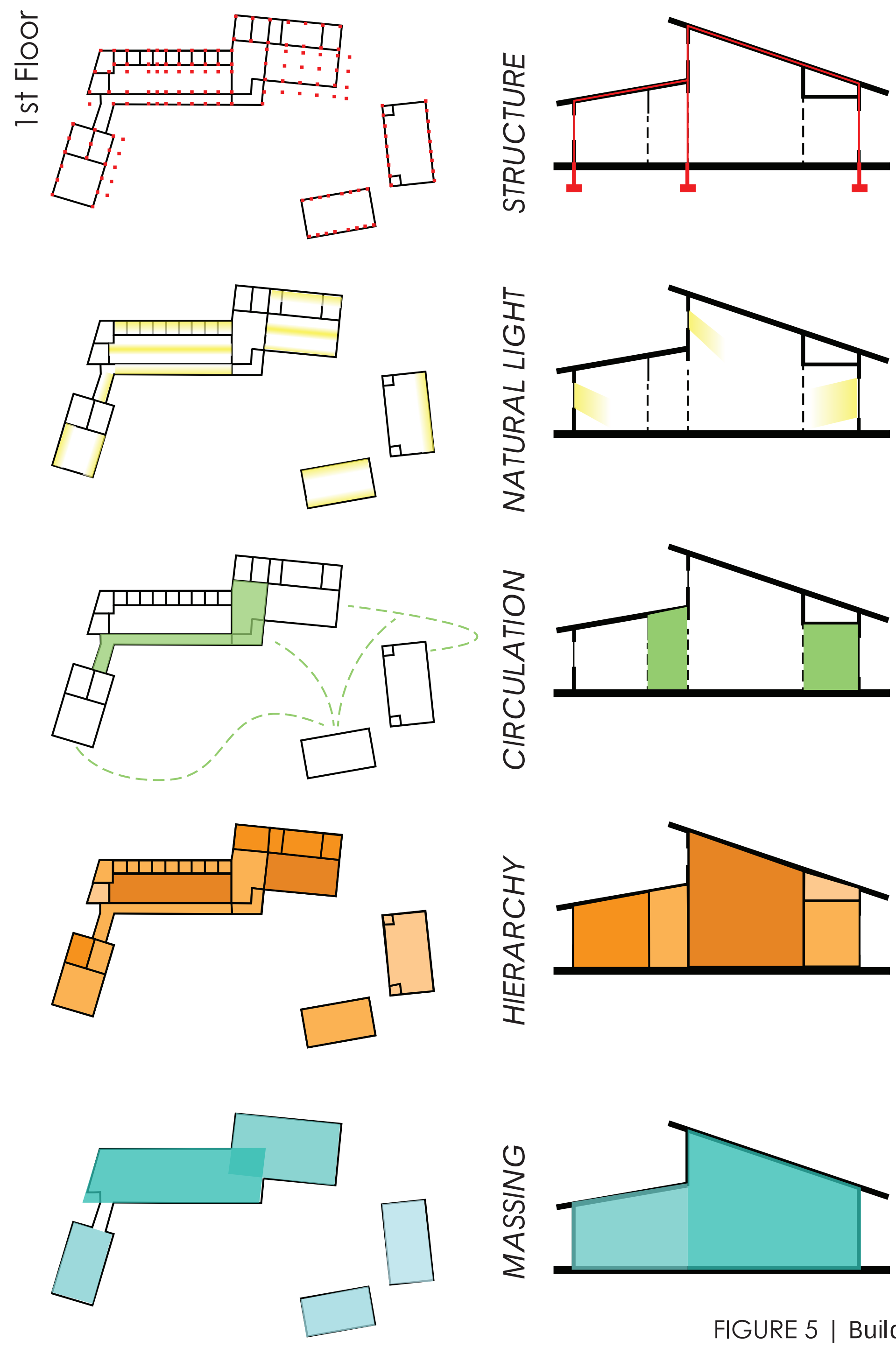


FIGURE 5 | Building Analysis

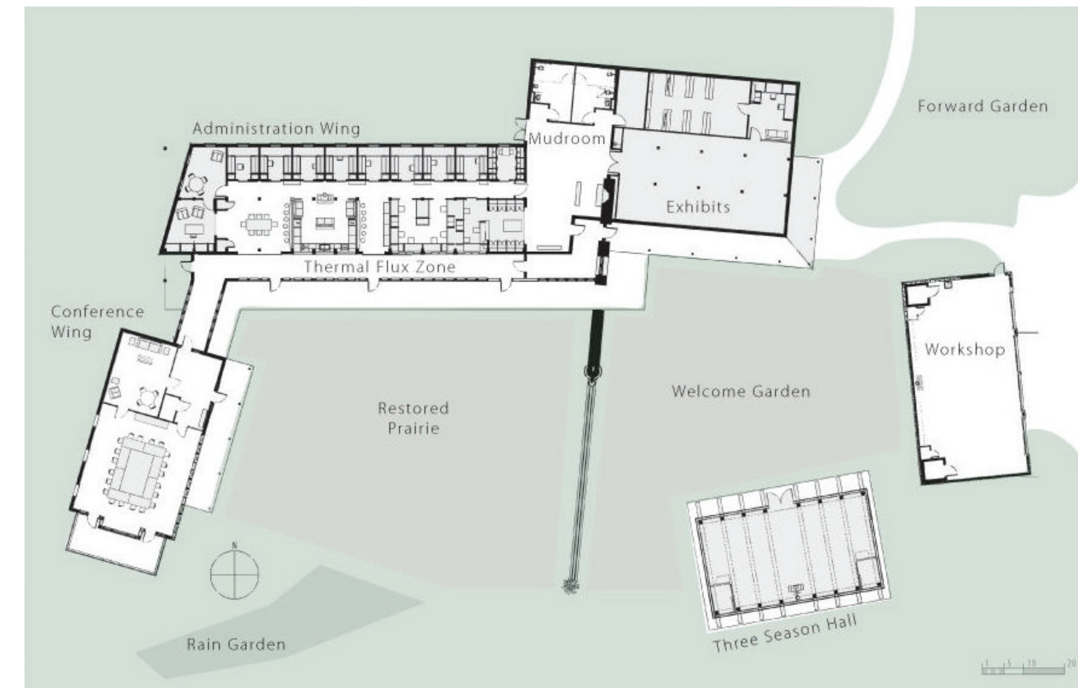


FIGURE 6 | Floor Plan (TWKA, 2008)

A fairly simple plan, section and elevation of the building bring the building close to just blending in with the nature around it. It provides an example of how to build on a site in the woods without intruding on the nature around it.

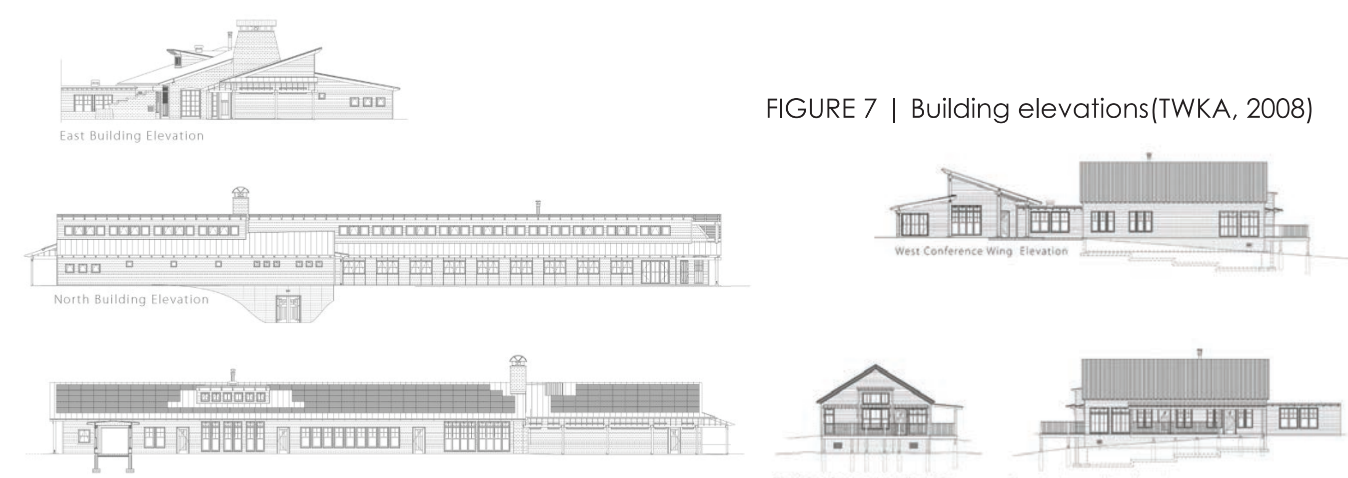


FIGURE 7 | Building elevations(TWKA, 2008)

FIGURE 8 | Interior (TWKA, 20008)

This project was chosen for its carbon neutral design and forward-thinking integration. The project team and center set goals right away for what they wanted to achieve and then the worked for them. Solving the problem of how to work these ideas into my project will be difficult but it can be done as shown here. Not only does the building have these sustainable aspects, but it is completely comfy for those who work and visit there. The weathering of the materials is another strong statement from the center, that when you think a worn grey piece of wood needs to be replaced, it will still be there for many years to come as the whole building ages with it. The use of local materials and simple, yet complex design decisions can greatly help my design much like it did with the Legacy Center.

FIGURE 9 | Wall Weathering (TWKA, 2008)

UNIVERSITY OF MINNESOTA BELL MUSEUM
ST. PAUL, MINNESOTA

Architect: PerkinsWill
Status: Completed 2018
Size: 89,860 Sq Ft
Typology: Natural History Museum
Interactive | Learning Landscape | Discovery

FIGURE 10 | Landscape (Perkins+Will, 2018)

The Bell Museum has been around for 144 years, moving from building to building over the years. This is the latest in the iterations and the most sophisticated of the designs. The driving idea behind the museum is linking people, nature, and the environment together. The building has three large “story box” windows, these are based on Francis Lee Jaques paintings of the Minnesota landscape. These spaces are meant to give the visitors the sense of seeing how nature takes shape in both the past, and the present outside the windows. These are cantilevered to get the point across even more and walking past the building one can only wonder how they are supported.

The Bell also includes a few sustainable practices both through materials and design choices. The wood cladding on the building comes from Minnesota forests and is thermally modified to transform it into a long-lasting building facade that will last 50 years. The steel paneling is to represent the area’s iron mining history. The glass of the building even has a specially fritting to deter birds from hitting it while still providing the views for those inside.

Storm water is collected from the whole site and filtered down into holding tanks and a pond located on the site. It is then used to water bee gardens and the rest of the surrounding environment. (Perkins+Will, 2018)

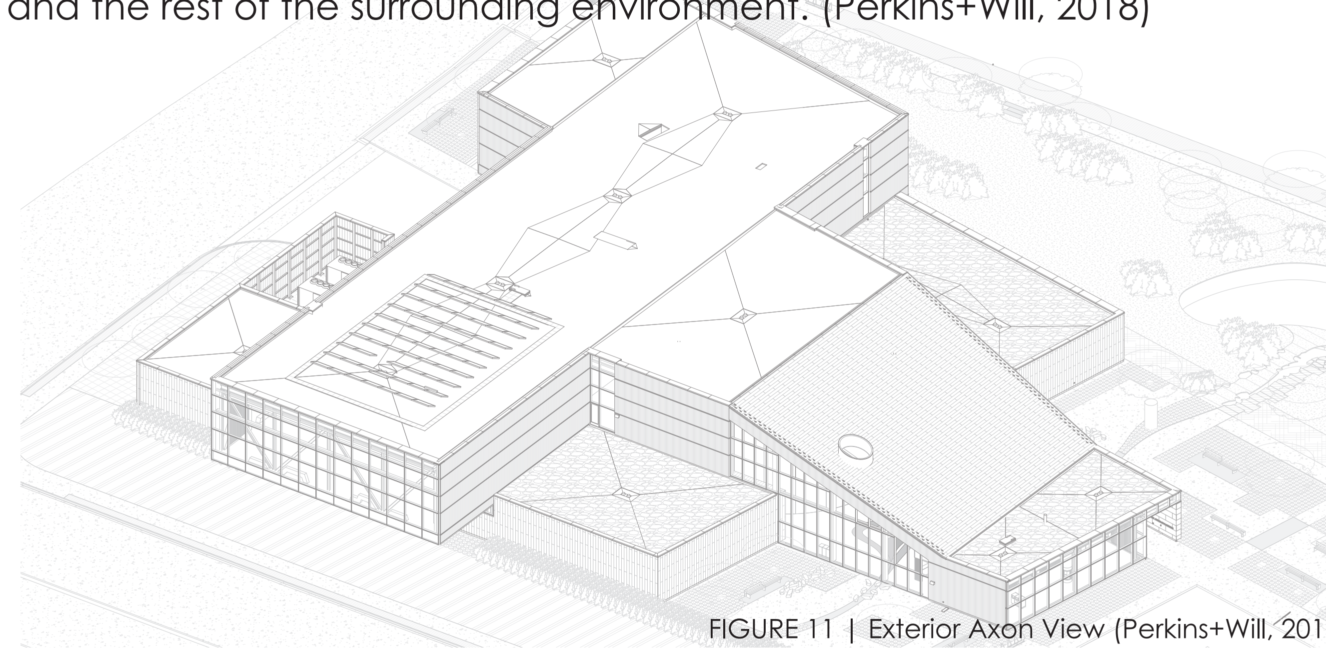


FIGURE 11 | Exterior Axon View (Perkins+Will, 2018)

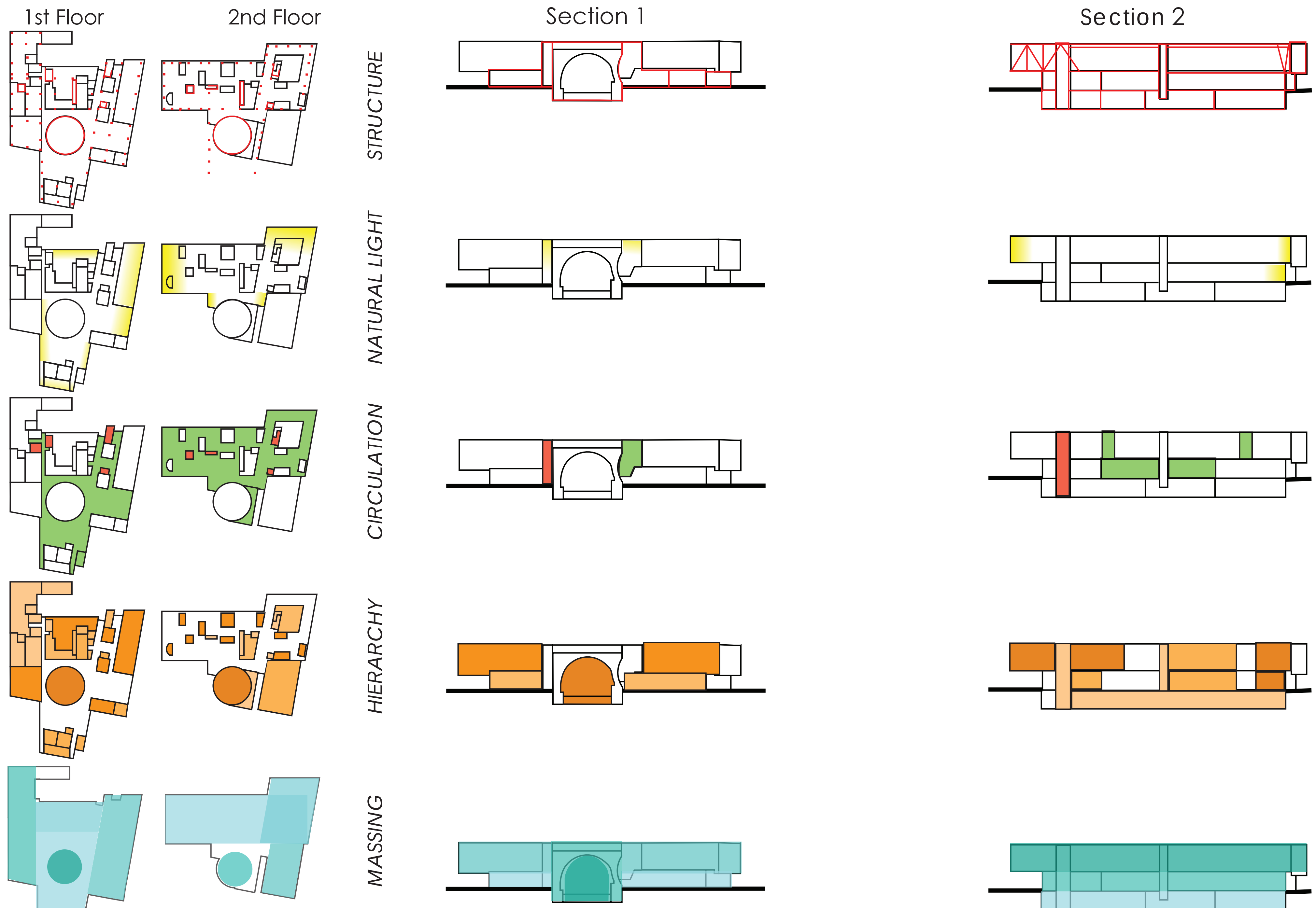


FIGURE 12 | Building Analysis

A special thanks to Perkins & Will for providing me with the construction drawing sheets

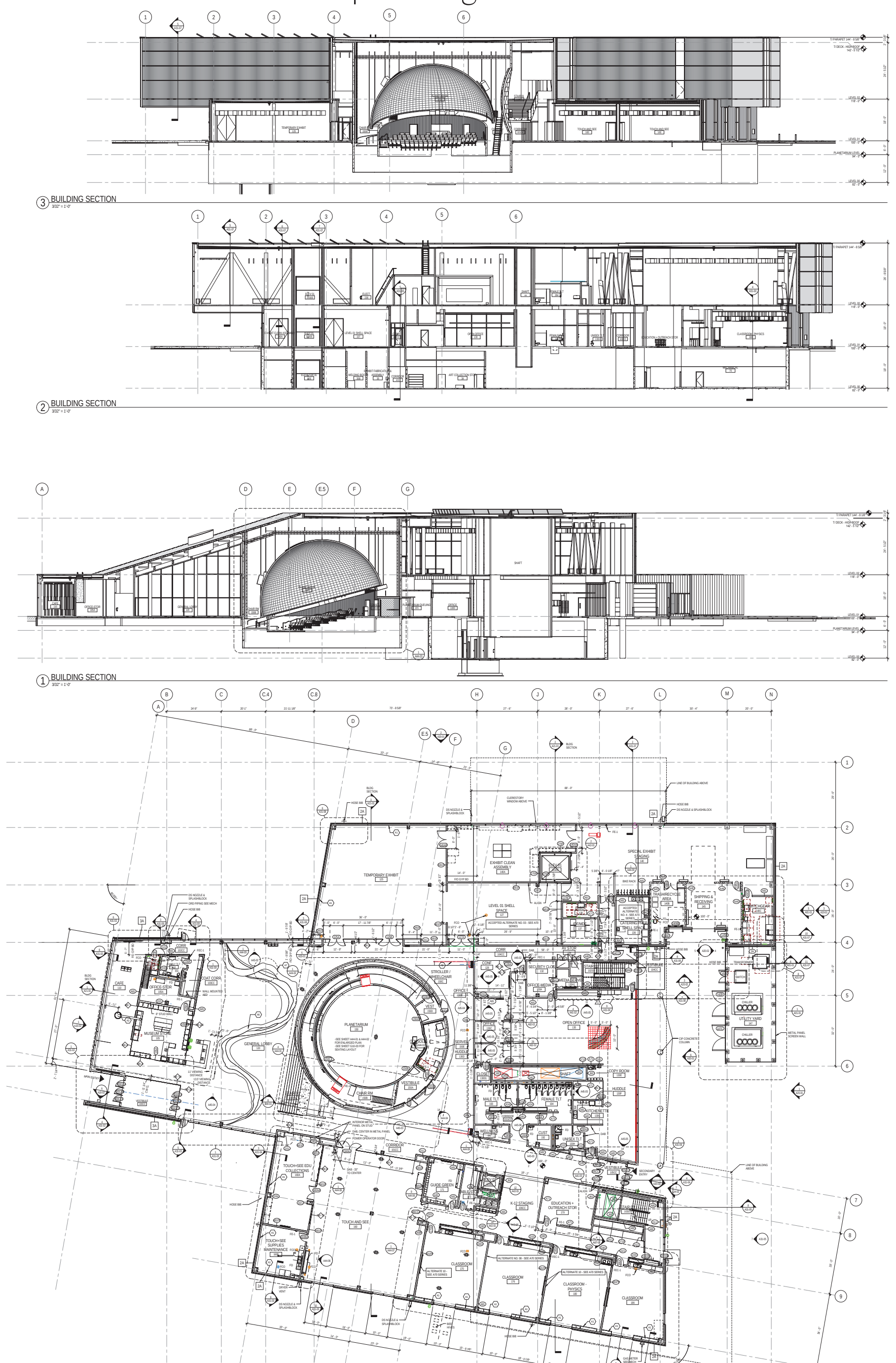


FIGURE 13 | First Floor plan and Sections (Perkins+Will, 2018)

The Museum seems like a pretty straight forward building from the outside, but after learning about it inner workings it is far from it. Its massive cantilevering floors and twisting interior paths create an experience that one if sure not to forget.

The Bell Museum was selected as a case study for its mix of learning and program elements that it incorporates through its spaces. Before even starting the case study, I thought it was just another natural history museum, only to be surprised that it also had a planetarium. This is the mix of disciplines that I am looking to achieve in my eventual design. Its use of sustainable exterior cladding shows that you can use a simple material like pine and create something beautiful and long lasting at the same time. This mixing of different groups blurs the lines and creates a single flowing space that is expressed on both the outside and interior of the building.

FIGURE 15 | Lobby (Perkins+Will, 2018)

FIGURE 14 | Story Box (Perkins+Will, 2018)

FIGURE 17 | Interior Glass (Perkins+Will, 2018)

FIGURE 16 | Facade Design (Perkins+Will, 2018)

THEODORE ROOSEVELT PRESIDENTIAL LIBRARY
MEDORA, NORTH DAKOTA

Architect: Snohetta
Status: Ongoing
Size: Unknown
Typology: Library
Landscape | Stewardship | Learning

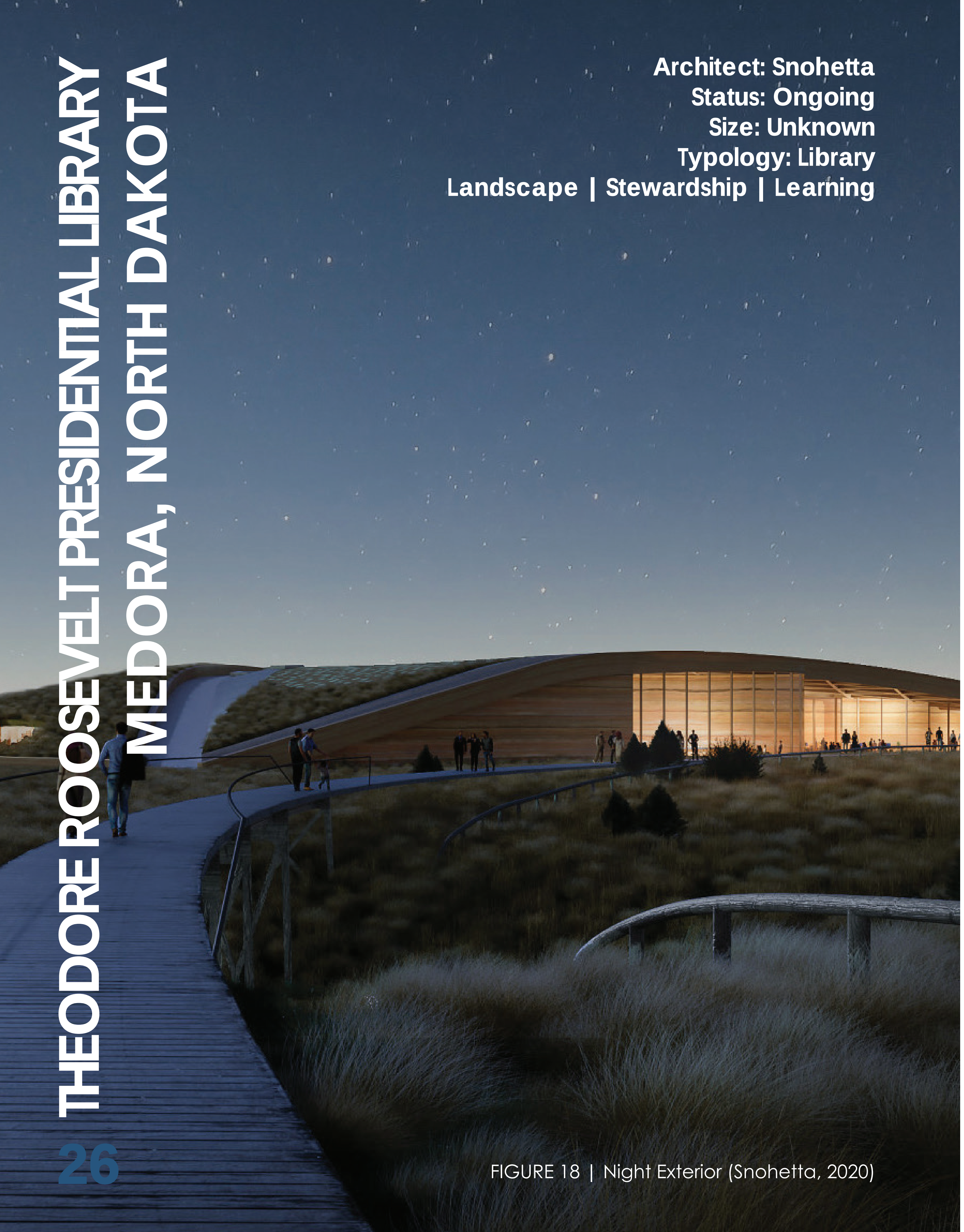


FIGURE 18 | Night Exterior (Snohetta, 2020)

Located on the top of a butte overlooking the North Dakotan landscape, the Theodore Roosevelt Library seems to spit open from the plains. Not only is there the library on the site, but there is a large walking loop that links up with the local Maah Daah Hey Trail with small contemplation pavilions to view and learn about the landscape. The building is broken up into two sections with the large roof covering the whole building. The roof is accessible so you can walk up and around on it. It is stated that the roof with have stunning views of the butte and be perfect for star gazing on clear nights.

The library will be constructed of local, sustainable materials and it will be pushed to be a new energy standard for the area. Not much is known about the inner workings of the building yet as Snohetta was just announced to be the winners of the design competition. Given their previous track record and their commitment to create wonderful working buildings, this is sure to be on people's must see lists for their projects. (Snohetta, 2020)

FIGURE 19 | Day Exterior (Snohetta, 2020)

STRUCTURE: The Exposed structure seems to be large LVL sections that span lots of the interior spaces. There is concrete and steel mixed in this the structure.

LIGHTING: All the lighting comes from the two sides of the uplift. Lots of glass allows it to pass through unobstructed bringing it into the whole building.

CIRCULATION: Based around the central gathering space, the building is split into two pieces.

HIERARCHY: The two main spaces on either side command the most attention besides the slopping ceiling. Within them accented materials break up the hierarchy.

MASSING: One large mass with two halves and then divided up more from there.

FIGURE 22 | Snowy Interior (Snohetta, 2020)

FIGURE 20 | Site (Snohetta, 2020)

FIGURE 21 | Views (Snohetta, 2020)

This project is all about its rural site and how it reacts to its surroundings. This is important to my design in the sense that I want to place my site in a similar manner. The views, the site, and the minimal impact are all things that a building dedicated to sustainability and researchers should have.

While it was difficult to find anything technical on the building, it was still a great case study to see that it is possible to build large structures further out into the plains. It would've been nice if it had gone through some North Dakota winters or had a few years' worth of energy data to speak for its sustainable measures, but some brief descriptions and images where enough to draw me in.

FIGURE 23 | Cloudy (Snohetta, 2020)

TAIPEI WEATHER STATION
NEW TAIPEI CITY, TAIWAN (COMPETITION)

Architect: IMO Creations
Status: Schematic Design
Size: 32,000 Sq Ft
Typology: Weather Station
Fins | Wind Tunnel | Relationships

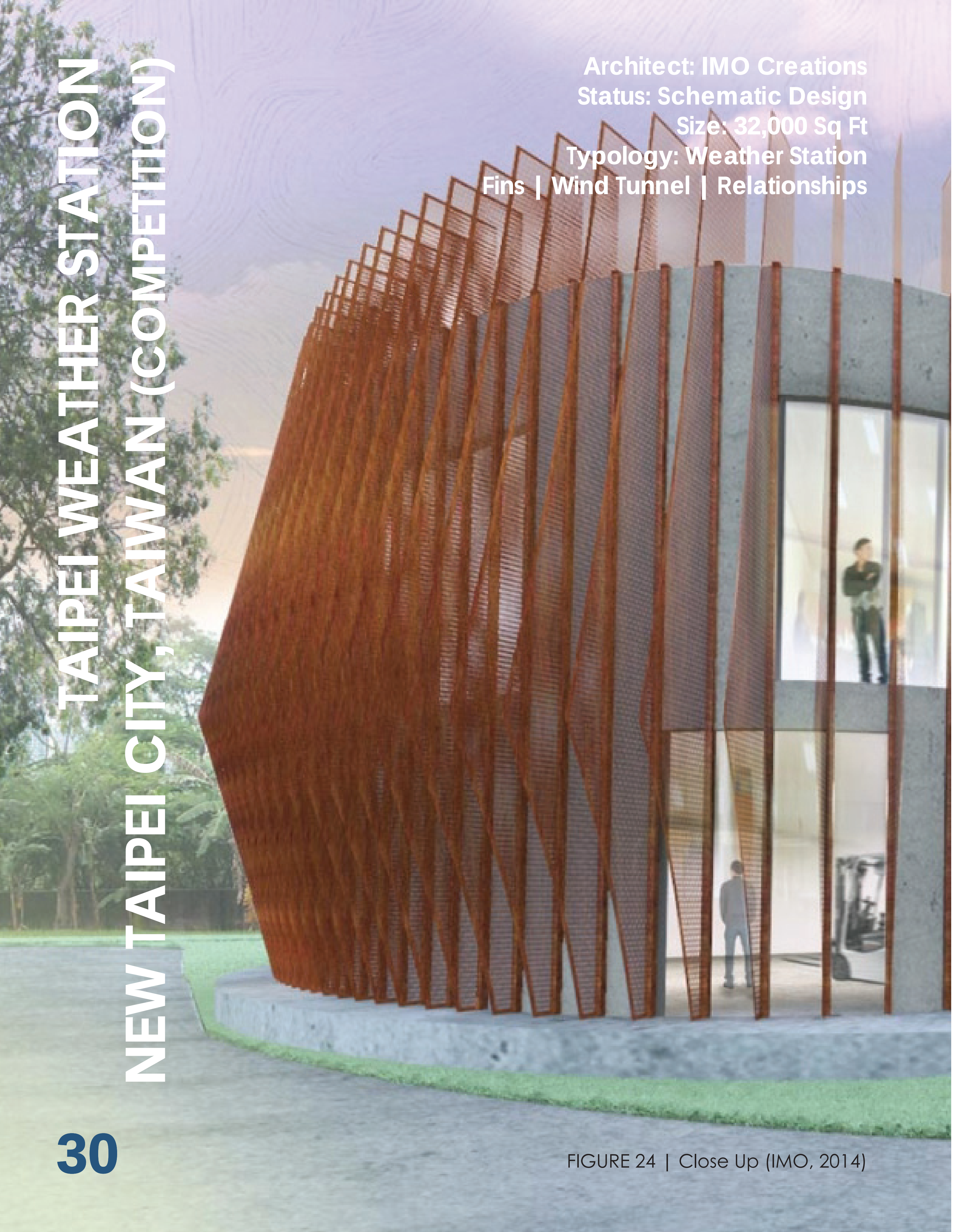


FIGURE 24 | Close Up (IMO, 2014)

This was also a design competition winner in Taiwan. The architects wanted to reflect the calm nature of the site and not disturb it too much through their proposal. They mentioned the smell of the grass and the leaves of the old trees as inspirations for the building. The three main building forms are joined together by a flowing roof that is meant to blend the whole building in with the ground around it. It is mainly concrete to create the forms, with some steel mixed in.

The weather stations main purpose is to conduct research, and not be completely open to the public. It comprises of responsive fins, meteorological instruments, weather station, sensors and equipment, wind tunnel, offices and small visitor areas. The wind tunnel in the basement is one of the most powerful ones in Taiwan and will be used to conduct wind studies on a multitude of items. The fins are responsive in a way that they can move and shade the building in different ways throughout the day. (IMO, 2014)

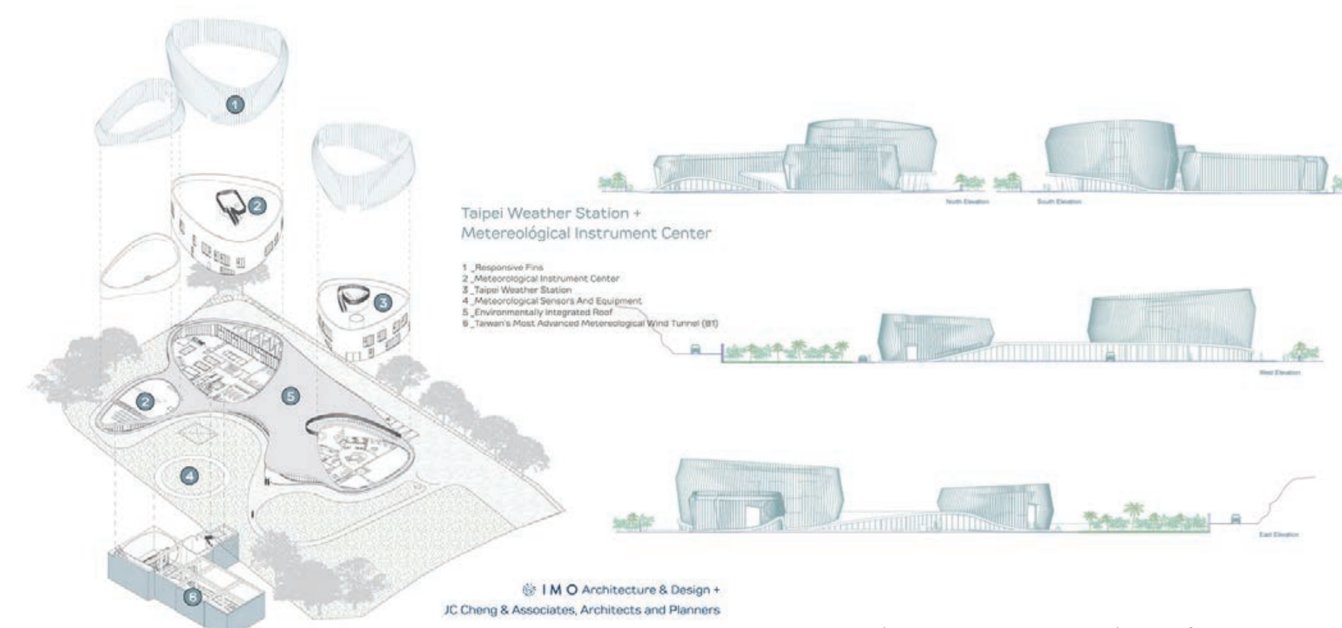


FIGURE 25 | 3D view and elevations (IMO, 2014)

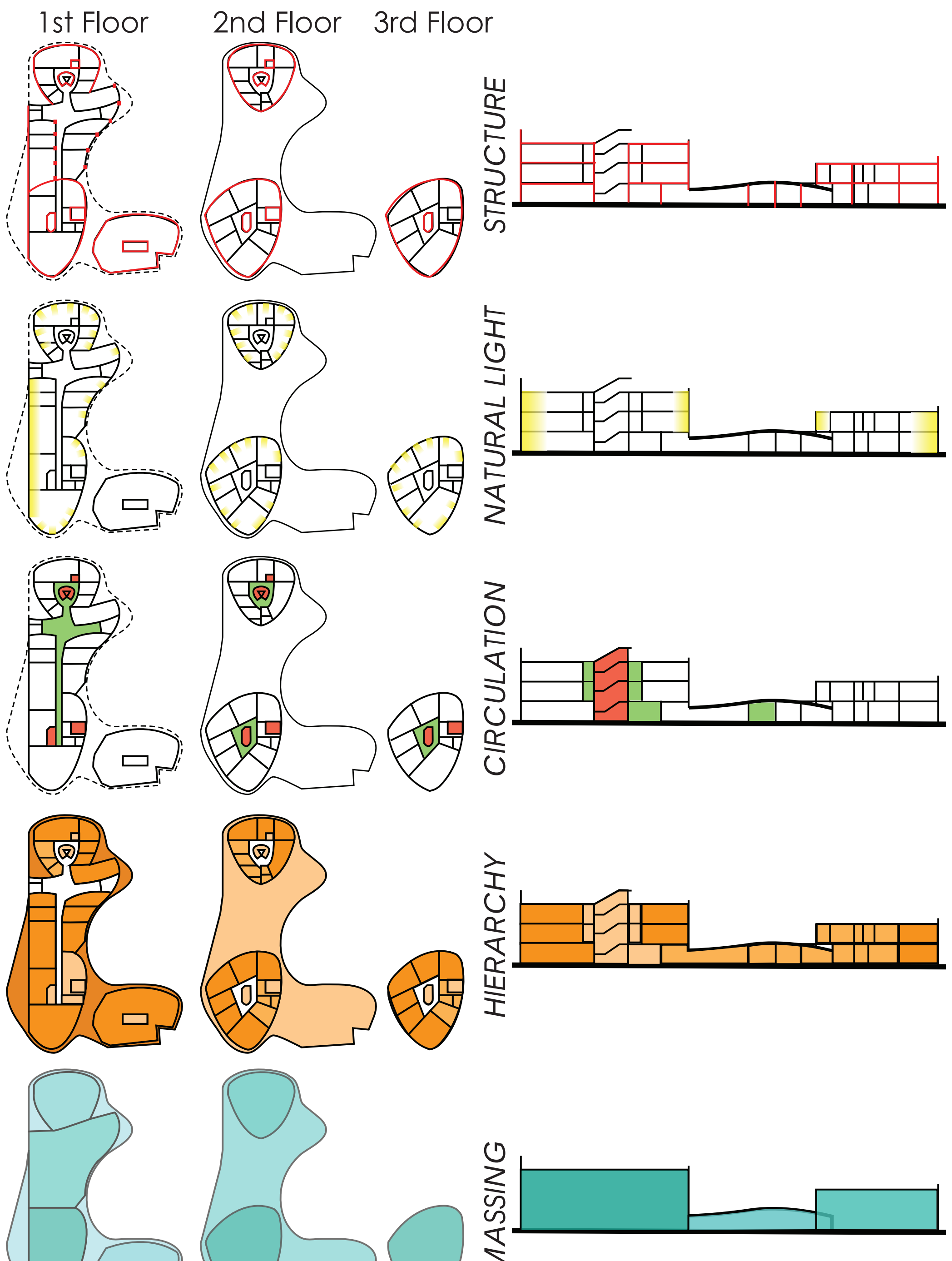


FIGURE 26 | Building Analysis

This weather station was designed for a specific environment and it wasn't just a box with the equipment stored in it. It provides a place where someone might want to go learn about the weather or see how people study it. While it responds to its site well, it could have integrated some sustainable design practices to increase its overall performance. These are some of my goals for a weather station, but with more sustainable design and learning opportunities built in.

FIGURE 29 | Site (IMO, 2014)

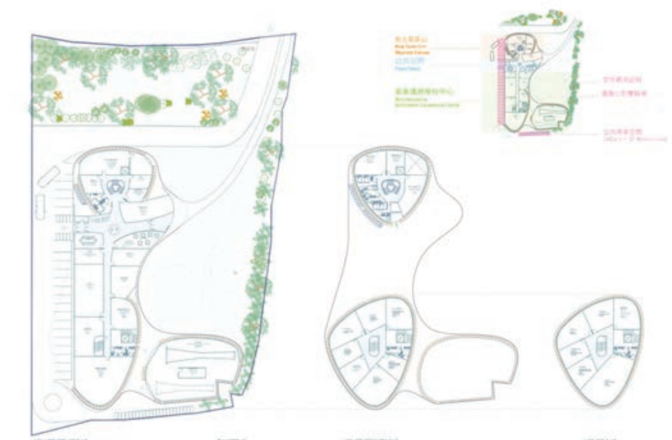


FIGURE 28 | Plans (IMO, 2014)

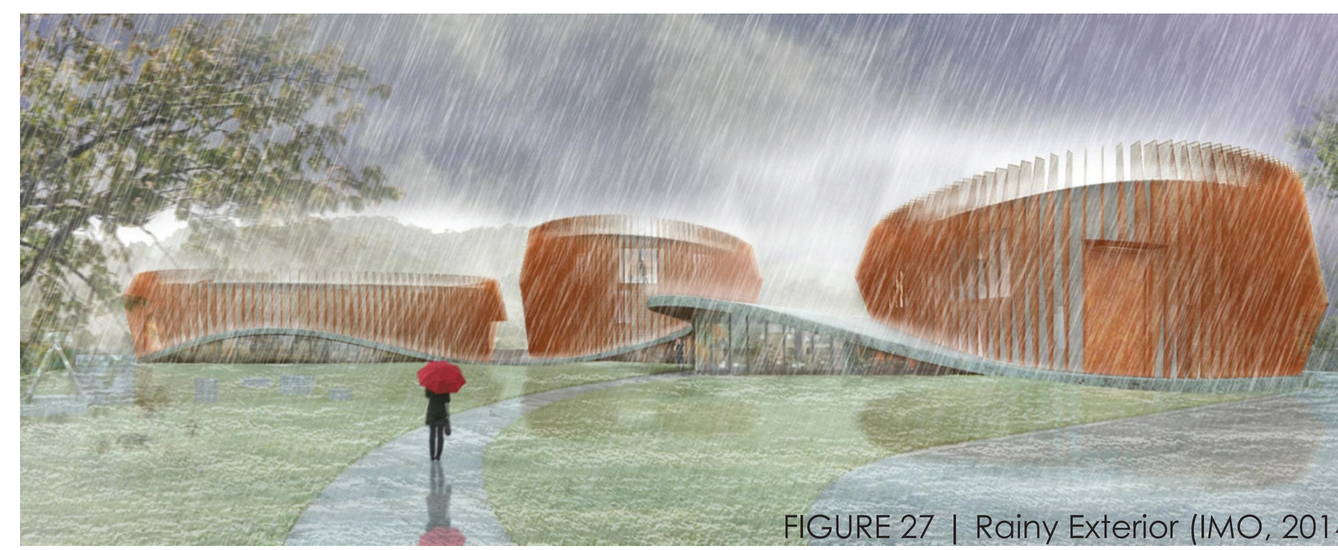


FIGURE 27 | Rainy Exterior (IMO, 2014)

The preceding president studies where a series of buildings each with a few values of design ideas that I had wished to implement into my ideas. With the idea for a learning research museum that focuses on the weather and climate change, it was difficult to find one single building that represented what I am aiming for. Not much changed after doing the studies, besides some ideas on the eventual design or how to think about beginning to lay out elements. Most of them reinforced my idea by either showing large structures can be built in the plains or how a building can achieve carbon-neutral energy use.

COMMON CHARACTERISTICS:

The most common theme in each of these case studies was their commitment to use sustainable and local materials that reflected the sites history or the stories that they wanted to tell. Having a building reflect the surrounding environment materiality is something that I will be doing with my design.

UNCOMMON CHARACTERISTICS:

Each project was so different from the next. The most uncommon characteristic was the carbon-neutral design while the others never talked about any sort of LEED rating to the extent that the Aldo Leopold Center did. This shows just how special it is to have deigned something that way, and how much of a challenge it would be to make a project meet those goals. Over the years technology and materials have gotten better, so to attempt a building on its level now some new techniques might have arisen. Only through working through all aspects of a building and thinking about ways to integrate sustainable practices will it get close to being as environmentally friendly as possible.

UNDERLYING CONCEPTUAL IDEAS:

The effect these studies had on my underlying idea is that I need to push my design and try new things to make it better. Throwing on green spaces just to have them isn't going to be enough, it all must be part of the big picture if it is to be a successful design.

EFFECTS OF DIFFERENT SITES:

While they were each on different types of sites, each responded to it in its own unique way. This is what I will have to do to strengthen my building's connection with the area.

EFFECTS OF DIFFERENT BACKGROUNDS:

The cultural and social background affected me the most. It has to be in a place where people want to learn about what you are presenting or have an established sense of place with the project.

FUNCTIONAL RELATIONSHIPS

Similar functions should be grouped together, spreading out administrative rooms in galleries makes no sense. Stacking, aligning, or dividing functions to create a flow is important so that it doesn't interrupt the people or the processes going on in the building.

SPATIAL RELATIONSHIPS:

Multiple focal points aren't a bad thing, and the same for hierarchy. Something should draw people in and want them to learn more about the spaces or what is around a corner is crucial to having a successful building.

TECHNICAL ISSUES:

Each case study had some element that was technically impressive. For some it was a large sloping roof or large cantilevered spaces, these will make or break a design. Only through thinking through these thoroughly can relating them into the rest of the building can they be something truly special.

OBSERVATION PLATFORMS | PLANETARIUM | WEATHER RADAR | WEATHER EQUIPMENT | RESEARCH FACILITIES SEISMOGRAPH | BATTERY ROOM | OFFICES

These where the spaces that I associated with the working professionals and required places for a weather station to function. These will be some of the main spaces that will define the project.

LOBBIES | CONFERENCE HALLS | FOOD/CAFÉ | LIVING QUARTERS CLASSROOMS | THEATRE | GALLERIES LEARNING SPACES

These are the supporting spaces and some that will be spread around the site in multiples. The living space is for traveling scholars or researchers who need to take an overnight stay. This is the same with the cafe and it can also just be an attraction to get people out to the site.

OUTDOOR SPACE | GARDENS | SOLAR ARRAY WEATHER SHELTER

This is the site surrounding the building. These spaces are sure to grow as the design begins to take shape. Walking paths with viewing platforms and places for contemplation and learning is my main plan for now to bring people around the site. The solar array is something that will be utilized to help power the building and the weather shelter is in case there is an emergency at the site.

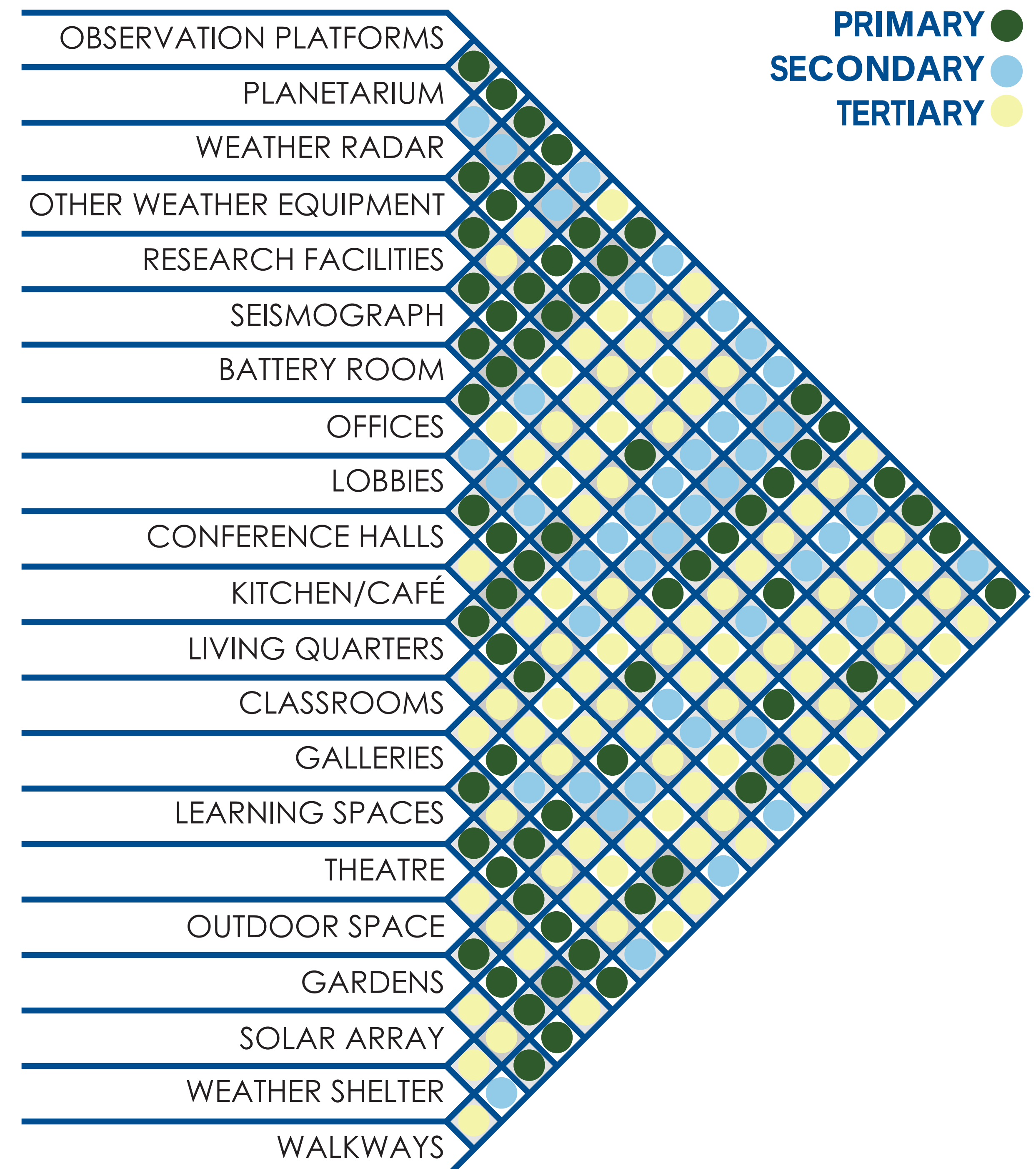
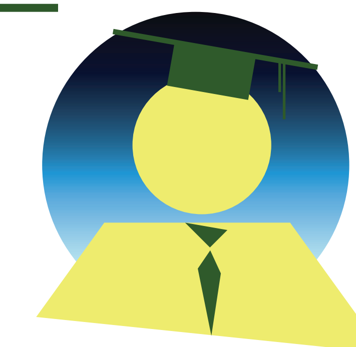


FIGURE 30 | Space Matrix

STUDENTS

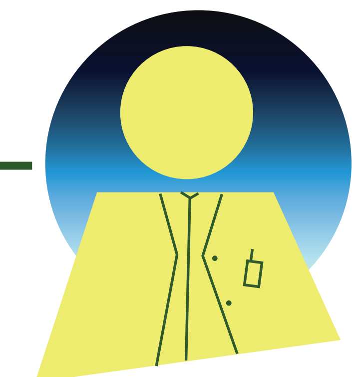


– To learn and grow their knowledge about the world around them. They are there to participate.

THE PUBLIC

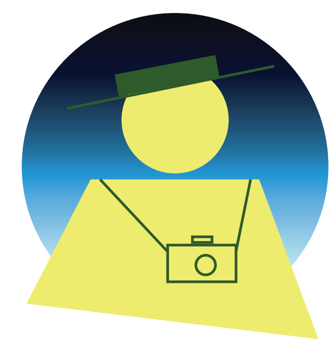
– People who are curious about the research going on and want to support the learning being done there.

RESEARCHERS



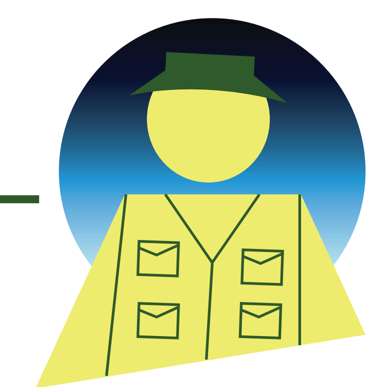
– Those who have dedicated themselves to the profession, some of which will work in the facility and some which travel from afar.

PHOTOGRAPHERS



– The perfect place for photographers to set up and join in the research by documenting the weather, earth, and stars.

WEATHER/SPACE/EARTH ENTHUSIASTS



– Professionals/non-professionals who care deeply in the work being conducted at the research facility.

REGION: Midwest
STATE: Kansas
CITY: South of Alma, Kansas

The idea for the site location came from being able to see miles on end in any direction with very little blocking your view as you look towards the horizon. Same as here in Fargo, sunsets are amazing with the sprawling views. The site would also have to be “vulnerable” to as many weather conditions as possible to broaden the range of research conducted there. These might include rain and snow, thunder and lightning, or even tornadoes and earthquakes.

The advantages of having a site almost in the middle of nowhere is the clean an unobstructed climate that the complex would sit on. This would allow viewers and researchers to see storms miles away or be free to study the stars without light pollution. I will always remember the road trips taken out west by my family and being able to watch a lightning storm approach for hours. Or being able to see the sun touch every bit of land as it slowly climbed in the mornings. This is the experience I want others to have at this site, a place to view nature in all its beauty while creating a space that minimally impacts it.

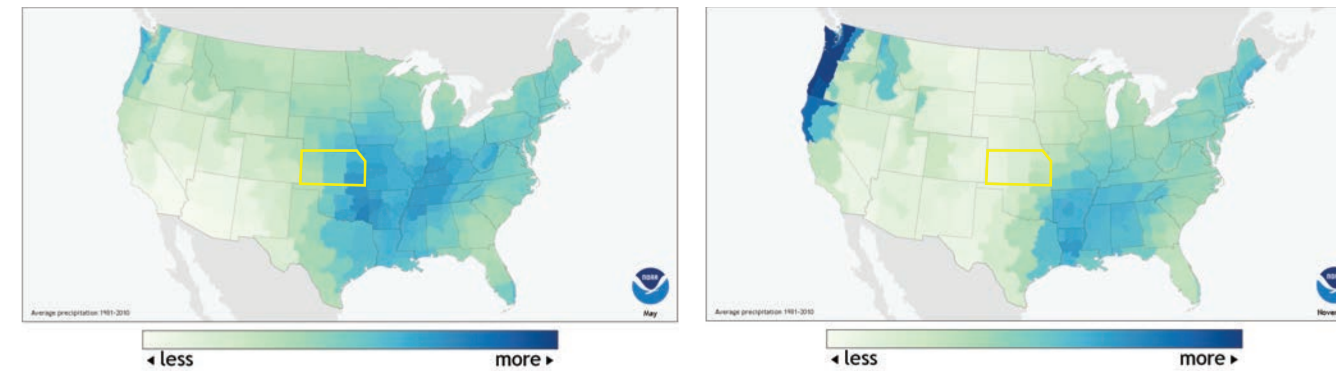


FIGURE 31 | Precipitation (NOAA, 2019)

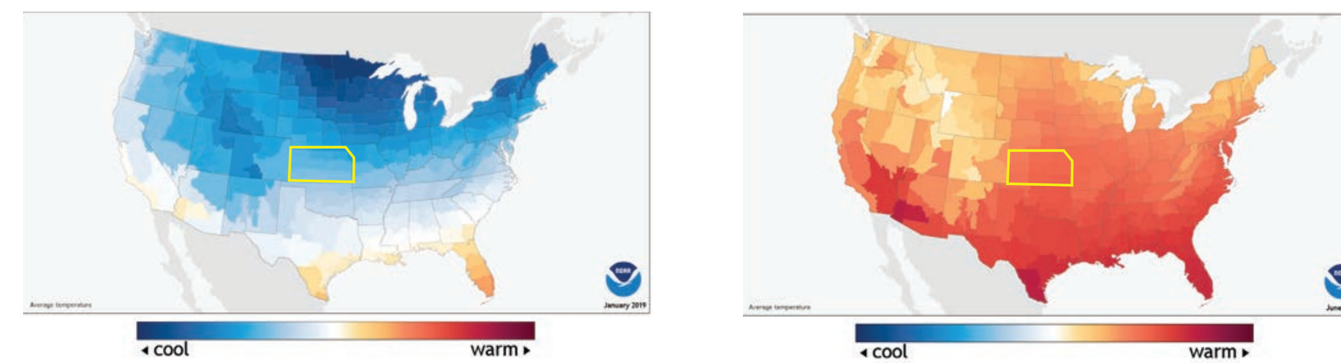


FIGURE 32 | Average Temps. (NOAA, 2019)

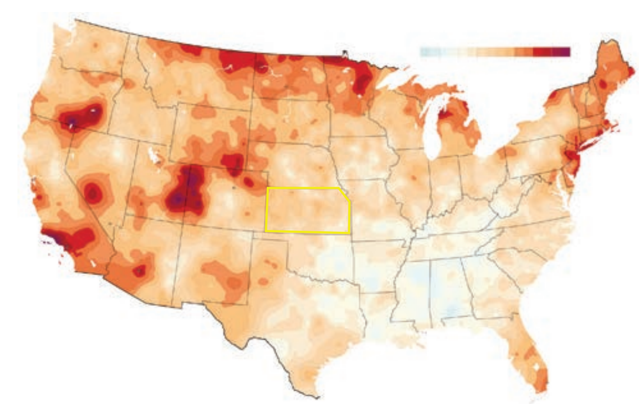


FIGURE 33 | US Temp. Change (Walls, 2019)

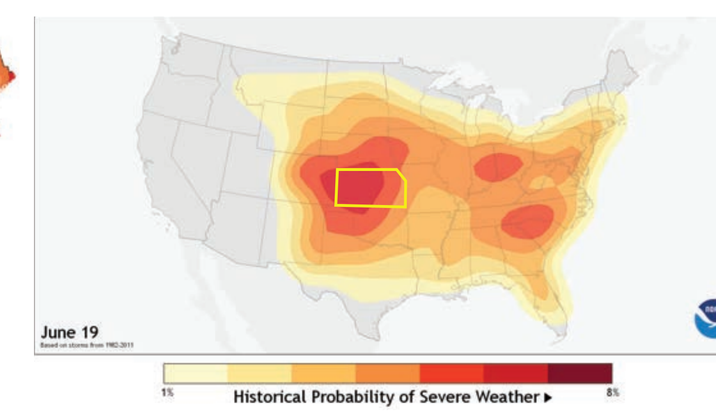


FIGURE 34 | Severe Weather (NOAA, 2019)

SO WHY KANSAS?

After looking up weather maps and comparing temperatures, severe storms, climate change, landscape, and even seismic activity, they all lined up over the Kansas area. The Flint Hills where then selected for their ecological status and the views and valleys that it offers. It contains some of the last tall grass prairie land in the United States and is rural enough where the landscape is largely unharmed. The specific site a few miles south of Alma was picked in partial because of its relationship with photographers from the area. It is just south of the Skyline Scenic Byway, which follows a ridge where you can see for miles and a great place to take pictures of the Milky Way. It is also 20 miles east of the main Flint Hills scenic drive dove Highway 177. I picked a different extension of that ridge because of its topography and that it offers a more wrap-around view of the surrounding landscape and is slightly closer to main roads. This all combines to create the idea location for weather research, views, and astrology. It is also flanked by two creeks on either side of the hill with some decent tree cover which could be used as local building materials. To the east and north are views of other hills and valleys, while to the west it is mostly views of the horizon with some hills in the distance. South of the site is the rest of the "peninsula" of the ridge.

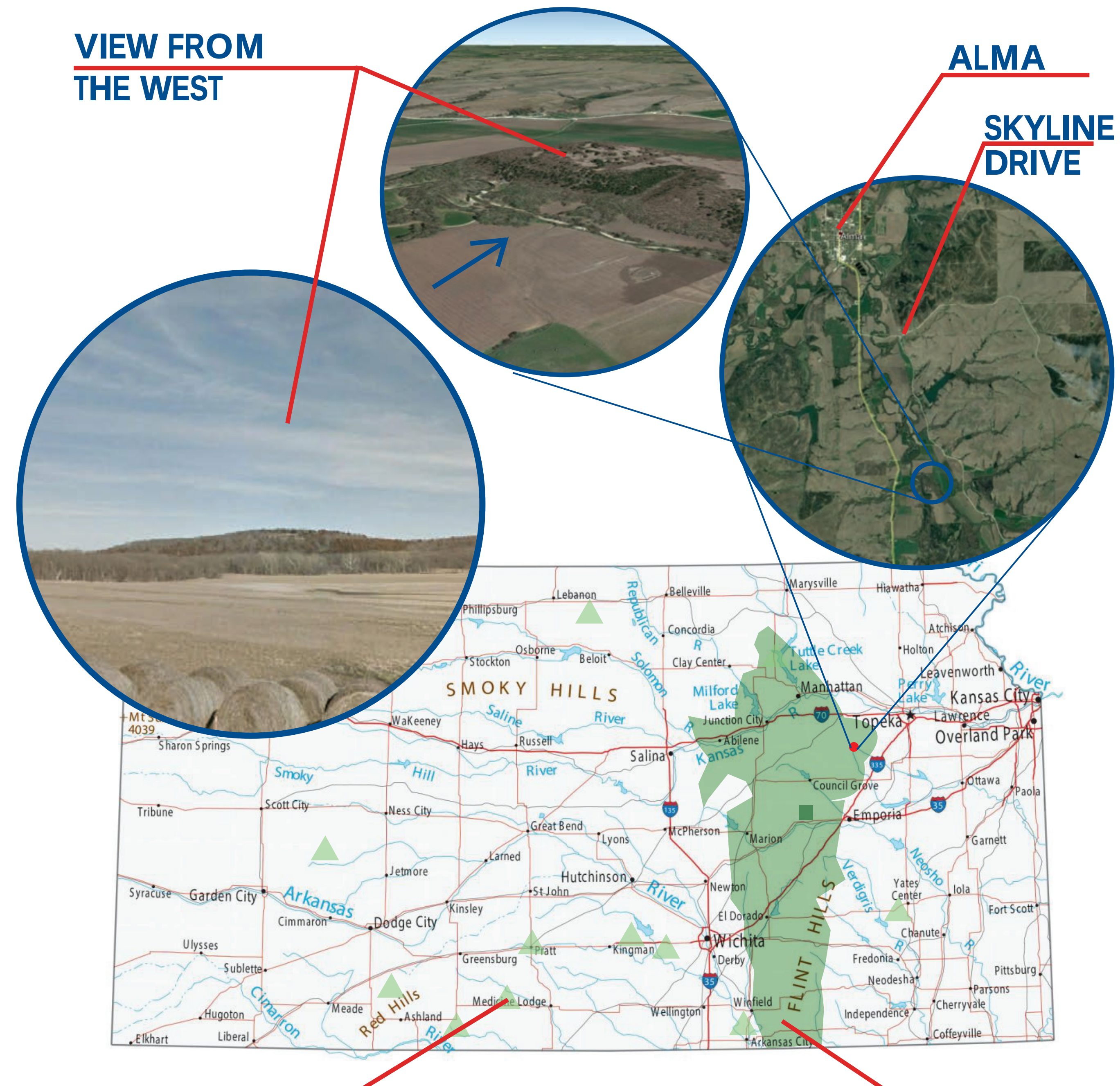


FIGURE 35 | Site Maps (Google, 2020)
Kansas Map (GISGeography, 2020)

The main challenge with this site is its rural location, and all the other problems stem from that. Design wise, obtaining topography maps might be a little more difficult and if this project was to be real, land acquisition would need to take place and possibly some new zoning. Just by looking at the site, it does seem to have lots of topography changes which can be an issue, or an opportunity for a creative solution. The project would also have to have some sort of housing and food on-site for those who make longer trips to the facility and for lunch breaks. With the Flint Hills being a natural prairie, burning is conducted every year around April to replenish the fields. This releases tons of O3 into the atmosphere and has become a problem for the climate in the region. My main idea is to blend the building in with the surrounding environment, and to do so while not disturbing the views around the site or the region will be something that I'll have to be careful about.

FIGURE 36 | Flint Hills Meteor Milky Way (Shannon, 2001-2020)

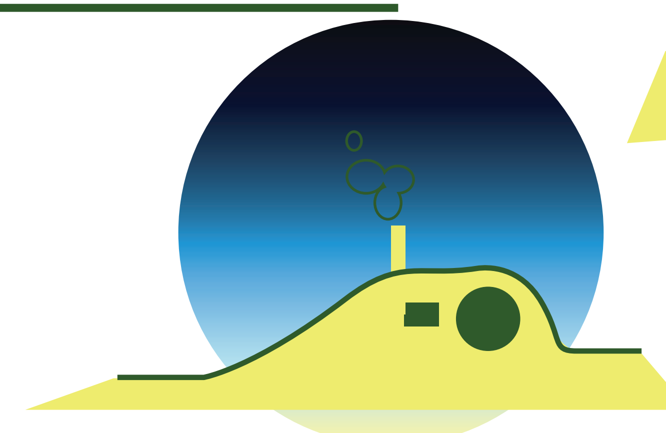
CLIMATE CHANGE

Creating spaces that allow researchers to study the effect of climate change both naturally and caused by the building. This will be studied both locally and globally as the facility would lend its resources to researchers around the globe.

SUSTAINABLE DESIGN

As many strategies that are feasible to integrate into the project to create a green building to reinforce the study of climate change. Also provides a way of learning for those who visit.

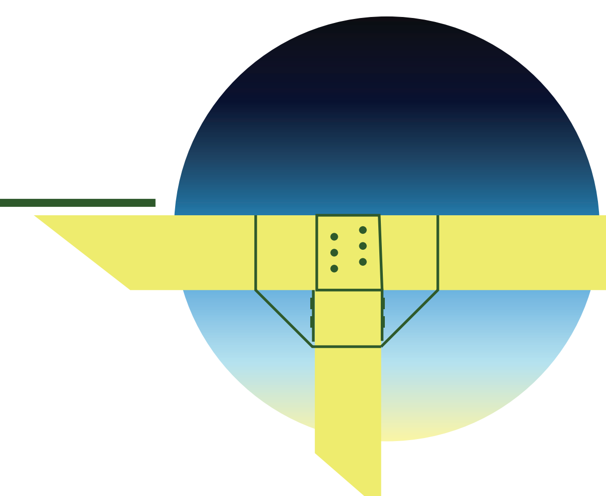
INTEGRATED LANDSCAPING



A building that sticks out in the middle of the plains is not the goal. The goal is to blend the building into its surroundings to make it in harmony with nature.

With an emphasis on the views both from and around the building, special consideration will be given to creating moments within the project that frame the beauty of nature.

SEVERE WEATHER CONSTRUCTION



If the project is placed in a zone of severe weather, especially tornadoes the construction of the building should be one that can withstand a beating from winds and flying debris. This would manifest itself in building techniques, layout/special design, and structure of the building.

GOALS OF THE THESIS PROJECT

THE ACADEMIC

With the topics of sustainable design and climate change, I hope that learning more about these topics now can help me in later practice. And to show to the best of my ability how a building can be designed to be one with nature.

THE PROFESSIONAL

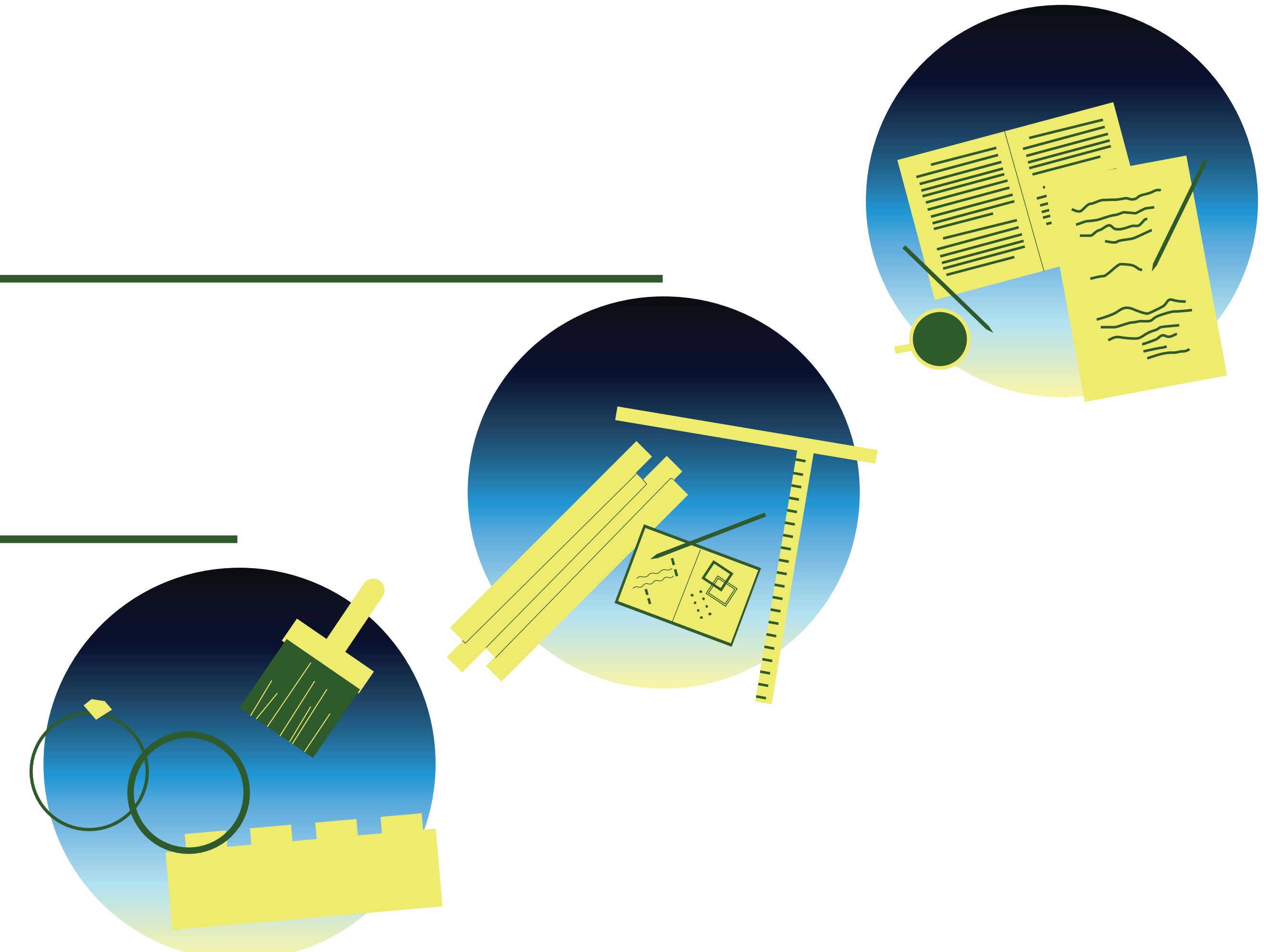
Going along the lines of creating a sustainable building, learning more about climate change and how it can be affected by our design decisions.

THE PERSONAL

Natural phenomena is an interest I've had for a while. Learning more about how these events happen is something I'd like.

My overall goal of the project is to create a beautiful design solution and project that I am satisfied with.

To make time to plan my wedding



DEFINITIONS OF RESEARCH DIRECTION: what problems need to be solved before proceeding?

THEORETICAL PREMISE/UNIFYING IDEA

Precedents in outstanding sustainable design and future green goals. Climate and energy goals for the region and nation

PROJECT TYPOLOGY

What the region needs/wants. Case studies of similar projects or groups of projects

HISTORICAL CONTEXT

Is there any significant to the surrounding area culturally or symbolically? What has happened in the region in the past? How would a building affect the history of the site, or the future of the site?

SITE ANALYSIS

Visiting the site and requesting information from either local governments or possibly state governments about the area. Other organizations might also be interviewed or researched for additional information. Online databases that contain relevant information

PROGRAM REQUIREMENTS

Through case studies and interviews with professionals, the program will take shape as input is gathered on what works and what doesn't

A PLAN FOR YOUR DESIGN METHODOLOGY

Exploration into unifying idea
Design iterations
Thorough research
Drawing conclusions

ANALYSIS

QUALITATIVE:

Through groups and interviews. Past simulations on energy and sustainable design. Direct observations, archives, and past research

CORRELATED:

Patterns and what has worked in the past

CASE STUDIES:

Comparisons between buildings and their solutions

DOCUMENTING THE DESIGN PROCESS

By sketchbook
By sources document
By research book
Through digital models
Through physical models

PRESERVATION
Scanned drawings/notes
sketchbooks
File backups
Photographs
Digital portfolio uploads
Physical book printed at conclusion

AVAILABILITY TO SCHOLARS
Submitted to NDSU Institutional Repository
Research and book available upon request

PRESENTATION
Final Boards | Book | Model
Revit, Rhino | Lumion | Adobe Photoshop | Adobe InDesign | Adobe Illustrator | Hand Drawing

INTERVAL FOR COLLECTING
Everything will be documented at the time of completion or shortly after due dates for leeway.

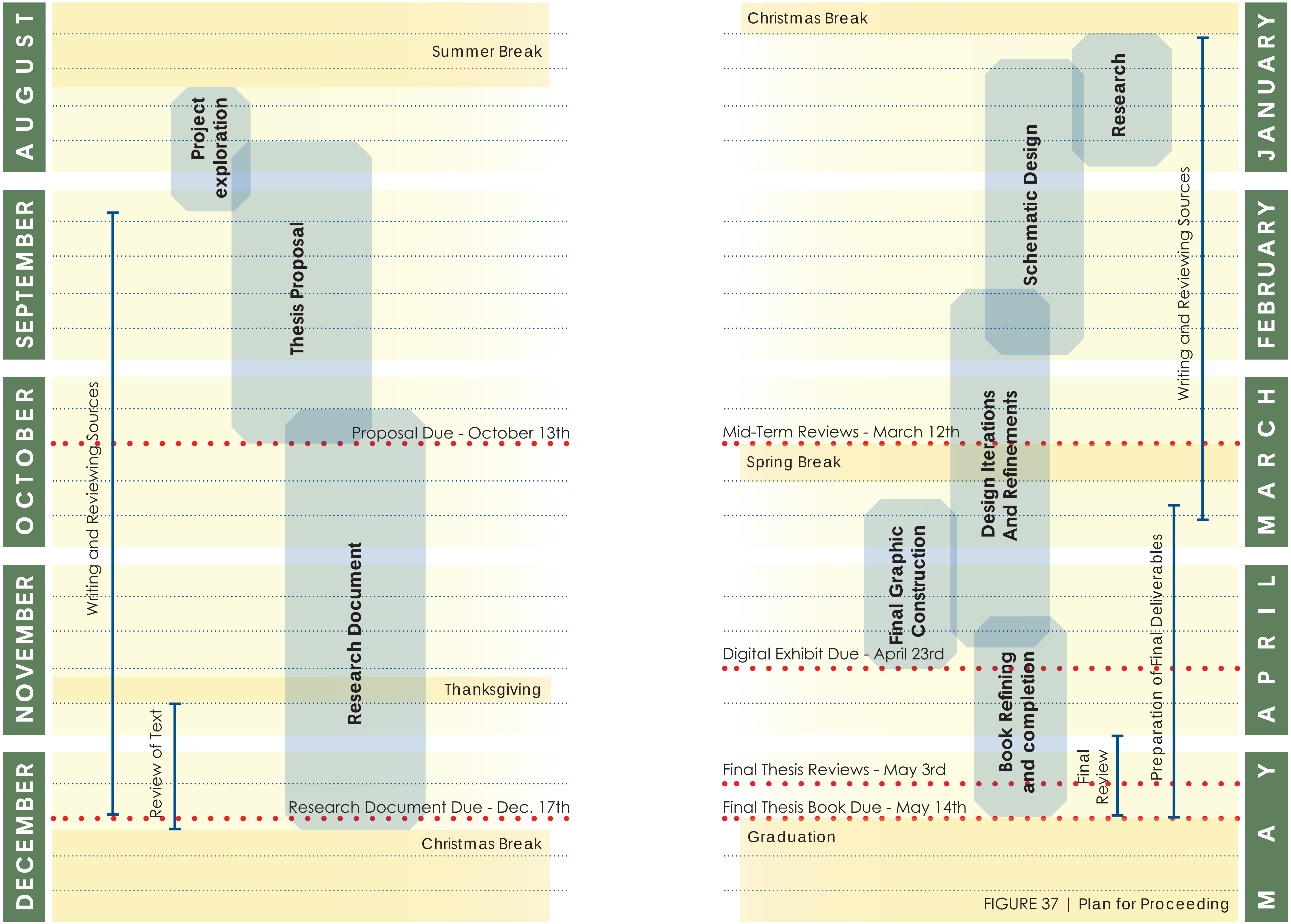


FIGURE 37 | Plan for Proceeding

The research behind this project stems from wanting to learn more about how to design a regional sustainable building, how that building can reach zero carbon emissions, stand up to severe storms, and be integrated into the landscape to create one seamless building.

For context, Our World In Data did a study on the global CO2 emissions for all aspects of our lives. Energy makes up the largest section with 73.2% while architecture is 17.5%. This is only the energy use in buildings as lots more goes into the materials and construction of every project undertaken. My building would fall under the commercial sub-set of building energy use at 6.6%. The unifying idea of reducing all these categories through teaching people about what they can do to reduce their own emissions is the goal of this project.

The following literature reviews cover a range of these topics from bioclimatic design, building structure, and how to reach a net zero energy building. These all influence how my project will be created and what steps will be taken along the way to completion.

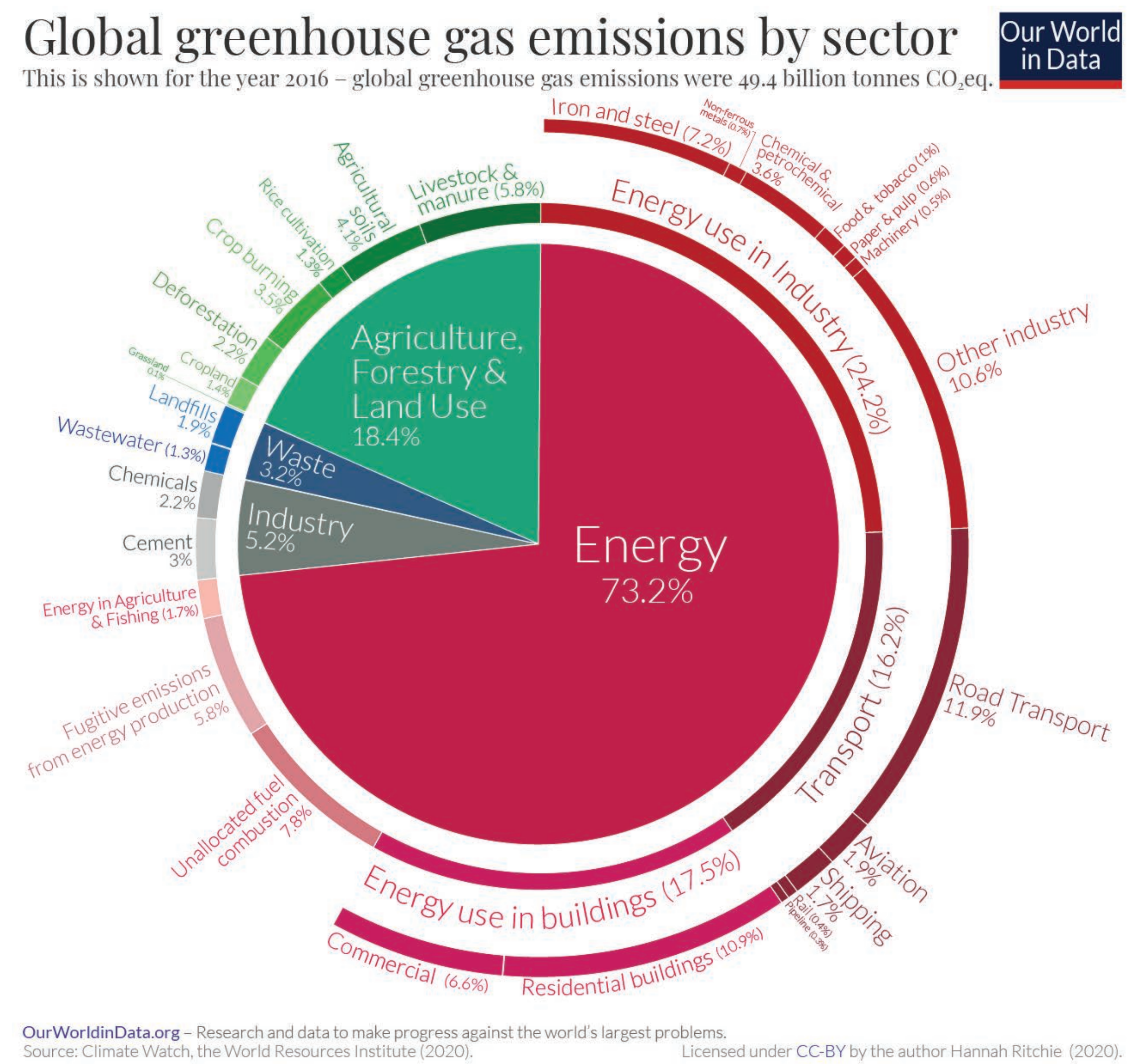


FIGURE 38 | Global Emissions (Our world in Data, 2020)

DESIGN WITH CLIMATE: BIOCLIMATIC APPROACH TO ARCHITECTURAL REGIONALISM – VICTOR OLGYAY

Some chapters based on cooperative research with Aladar Olgyay

"The problem of controlling his environment and creating conditions favorable to his aims and activities is as old as man itself." When this book was first published in 1963, it was ahead of its time in explaining and something of how the environment affects our buildings in more ways than just how to position it on the site. This is still true today when harmful climate change is becoming more and more of a problem that buildings can help solve and reverse.

The book is broken up into three parts, the approach, interpretation of architectural principles, and application. Each part is then broken up into sections that go over the different effect6s that weather and the climate can have on buildings. The pages are filled with useful diagrams and charts explaining things such as how wind affects building forms or how to position opening and shading devices to reach to different climates. These all are under the idea that doing so will decrease the amount of energy a building uses to achieve these outcomes.

Part 1 - Climatic Approach

The earth has a wide range of climate conditions that are then changed both daily and seasonally by the rising and setting of the sun and tilt of the earth. Then each region in its geology adds another level of microclimates and more variables that designers need to consider when designing their projects.

Different species of animals have different ways of adapting to the weather. Some have large fur coverings and other use their ears to cool themselves. Some build nests and homes in communities, and each one responds regionally to its climate. Mankind has to deal with the same problems and conditions that these animals do, we just have more complex tools to create the space that we inhabit. It states that man can reasonably live any place on the planet where food is available on a regular basis. Ellsworth Huntington goes further in this idea and states that the idea range for humans to live in somewhere temperate (40-70 degrees), rain in all seasons, and has some type of change in the weather that can bring winds and a moderate amount of change. Humans are able to be inventive and defy the odds and live in just about any area.

The examples that the book provides of this are the Native American settlements and structures throughout north America. The climate regions for each one is cool, temperate, hot-arid, and hot-humid, and each one had a completely different lifestyle and building type. Igloos where the solution for cool temperatures to make sure of insulating snow and directing the entrance away from the wind to retain as much heat as possible. Temperate structures where light and easily movable in the case of migrations and keeping the rain out. Hot-arid structures attempted to reduce the amount of heat the building would absorb by grouping dwellings together to reduce exterior walls. And hot-humid one would have few walls and be elevated to allow for the passage of natural breezes through the space to keep the occupants cool. Around the world similar buildings could be found with some variations in the styles or what materials where available to build with. This is the regionalism that designing for the climate demands, using the local resources and building something that works extremely well for the given environment.

Designing for a climate-balanced project can be broken down into four steps: Climate Data –> Biological Evaluation –> Technological Solutions –> Architectural Applications. Analysis and measurements lead to a diagnosis of the area which then turns into technologies on how to solve/improve the performance of the building, and that becomes the architectural response. The goal is to balance the climate within the building that is comfortable to those inside and can then adapt to a range of conditions in the one site. The rest of the books follows along these steps to guide you in your projects. This rough guideline and suggestions are something that will be helpful for me once design begins and through the whole process over all the iterations. Examples and charts are provided from the four climate zones mentioned before to try and provide as wide a range of examples as possible. Lots of the research into the climate of the building has already been done in the site section of this book, and more is to come as things start to form and get more specific to my design solution.

The next few sections cover the bioclimatic chart, sun and shadow graphs, heat/solar gain, and wind. While each of these is important by itself, it is once you start to overlap the data and begin to get an idea of how a structure on the site might be situated or arranged.

Part 2 - Interpretation of Architectural Principles

Part two begins with selecting a site and effects the weather has on different site conditions. One of the first topics is of air movement and how that affects the temperature around topography. It states that plateaus and valleys are the coldest with the side of the hill being slightly warmer.

This is also affected by the way wind runs up the slopes of hills on one side and creates eddies on the opposite. Manmade objects in these environment can disrupt this and either cause more heat to be trapped in the building or create new ways for wind to move about the site. It is important to study each decision and how it impacts its surroundings or how it might be advantageous to increase the microclimate of the site for the better.

One of the most important aspects of life is the sun, and for humans life revolves around it in more ways than one. Olgyay talks about the importance of orienting your building to make the most of the sun and its heat, whether it be avoiding it or welcoming it. He also states that the sun and wind are the two most important factors that influence building orientation. The main problem that faces homes is trying to keep a consistent interior temperature throughout the day, but because of solar radiation and heat gain there tends to be the problem of overheating at some point in the day. This is common in the evenings when the radiation is high, and the spaces have been heating up throughout the day. This can be solved through orientation and space placement to minimize these effects.

Shading devices, both built and natural, can help to mitigate solar heat gain or provide opportunities for adaptation. The facades and skin of a building provide the first line of defense again the elements and can greatly influence how the interior feels based on what happening outside. A full glass window, as sleek as it is, offers very little protection from radiation and heat transfer. Shading devices, specialized glass, and wall types can all affect how the building is going to perform. These can become the major element of the building or create a visual hierarchy amongst a composition, and they're styles are endless. Not only do they help with the weather around them, but they are all site specific and work on the building that they where designed for only. These need to be researched and tested to see what proves to work the best in the given environment.

Material and color changes also have a large range of affects on how the surface will perform. Natural vegetation can also be extremely effective. As it grows in the summer it can shade faces of a building that otherwise would get to hot but recede in the winter when sunlight is more welcome to heat spaces when needed.

Plants and native fauna can also influence or give us insight on how they grow and what we can learn from them in our own designs. Looking at plants regionally the differences of their leaf structures gives us clues as how they store and gain energy. The optimal configuration is where the least amount of heat is lost in the winter and the minimal amount is gained in the summer. The surface area and structure of each plant creates is distinctive look whether it be a large leaf from a hot-humid zone or a small stem group in colder zones. In architecture, Olgyay states that a square is the most effective shape because of it high internal volume and low exterior surface. But he later states that a square is not the idea form for a house but rather an elongated rectangle in the east-west direction in any location and north south works well in cooler locations. Temperate zones, like the one that my project is in, have the most freedom in form but elongated forms and east-west orientation are still the most desirable. This works great for my location as it will be built on and around a ridge and will have to respond to many climate variations.

Wind and flow patters are an important part of any design. Olgyay walks through many sizes of openings and configurations of walls to illustrate how wind travels though different spaces. This can be used to naturally ventilate buildings or show how a wind tunnel or eddies are created. An example show is how a small opening with a larger opening opposite it can quickly bring air into the space and increase its velocity.

Heights, sizes, interior walls, the number of, and position of openings all affect the airflow in and around the building and would need to be studied at each step. Louvers or obstructions in opening also drastically change the air flow and can even re-direct it based on the occupants needs.

There is also a whole section on materials and temperature lag through walls and roofs, which is then broken up into the four climate zones. The importance here was to pick materials and insulations that are appropriate for the region and the sides of the building that need the most attention. Making sure that the whole building can function properly in both extremes in its environment.

Part 3 - Application

Olgyay stresses the importance of bringing together all the knowledge gathered from the research to create a well informed and versatile building that reacts to its surroundings and is comfortable to those who inhabit it. Regional bioclimatic design should reflect the environment that the building resides in. (Olgyay, 1963)

Conclusion

This reading has shown me a clearer path as to how to create a building that responds to its climate and is unique to its environment. With my unifying idea of a sustainable, environmentally friendly building, the more that my building will respond and blend in with nature the better. Graphs, charts, simulations, and explorations will all have to be utilized to make sure that all the variables are covered, and each decision or change is though about how it will affect everything around it. This shows me that the whole design process will have to be interwoven extremely tight in order to create the most successful of projects.

DESIGNING SUSTAINABLE ARCHITECTURE FOR NATURAL DISASTERS – ADAM LATHAM

This article is about how Australia has dealt with or is planning on dealing with natural disasters that occur within its borders. It becomes relevant for my project because most of the ideas and disasters that they have are applicable to any place in the US that might experience similar weather patterns. Latham states that in Australia damage costs have risen from around $50 billion a year to $200 billion, and it is expected to continue to rise as weather patters grow more severe and more frequent.

It is better to design a building that is sustainable and can withstand a wide range of conditions up front rather than trying to fit or retrofit building to bring them up to an acceptable standard. The article is divided up by a some of the different weather conditions and then some solutions that can be implemented to counteract them. The following sections are rainfall and floods, bushfires, heatwaves, and cyclones. While some of these aren't things that we experience here in the US, they can be adapted to fit our region.

Heavy Rainfall and Floods

The two large considerations for designing with water in mind are the types of materials you are using and how the structure and form are put together or arranged. While Kansas isn't known to flood, there could be rainfall that might affect or damage the site or building I it becomes to excessive.

There is a list of common materials that are non-water resistant that should be avoided in high water areas. These include plasterboards, carpets, plywood, vinyl, and some tiles. While those should be avoided.

There is also a short list of materials that are highly water resistant to use which include: closed cell foam, concrete that is water resistant, treated timber, and different types of bricks that have been rated for water. While certain materials can create beautiful facades, sometimes they cut corners in water proofing or in other area to achieve curves or a certain look. It would also be important in my project to make sure that not only are they water resistant, but that they are sustainably sources and add more than just resistance to the building. Materials that can act in more than one way would be the most advantageous.

Lots of these points become mute if the structure behind the materials is not built to stand up to floods or heavy rain. In flood prone areas, building higher than flood planes is a must. There is a small creek on the site but from what I found it never if rarely floods, but any construction that happens around water sources will be water resistant. Site drainage or collection needs to be considered so water build up doesn't become an unforeseen problem down the road. Roofing is probably the most important part of a building that is impacted by the weather. Roofs should be sealed properly and direct water away from the building or into collection areas. They should be designed to the standard of a once-in-a-hundred-year storm. Details and connections between walls and other parts of the building need to be studied not only to prevent any leaking but also so it doesn't get ripped off in a storm.

One good option for site water control presented was through water resistant gardens. These can act like a buffer between the building and the rest of the site or as collection areas spread around. This can take many forms, like rain gardens, permeable surfaces, decks, or ditches that can store water.

Bushfires

Bush fires are not a problem in Kansas, but farmers and ranchers do burn off fields every year. For Australia, they are still working out the best and most cost-effective ways to deal with this problem, for now it is mostly through sprinkler systems and fire-resistant materials. These can be carried over into the building protection against regular fires. The region of the flint Hills has been burning fields for a while but is starting to run into opposition due to all the gases released during this process. This could be used as a learning tool to show how harmful that is or other more sustainable ways that it can be done.

Heatwaves

Like stated in the proposal, parts of the United states have experienced warming faster than other areas, Kansas has so far experienced moderate warming from climate change. The summers to get rather hot there and this could begin to cause problems as more and more hot days happen throughout the year. The two main sections that Latham talks about are heat resistant materials and passive design strategies.

First is passive design. We have had a whole class on techniques and have been implementing it into projects ever since, and this will be no different. These strategies are all about lessening carbon emissions from the building while still creating the level of comfort a fully active building would have. He talks about wind paths, solar access, natural ventilation and the ideal orientation. These can almost all fall under the category of ideal orientation. Without orienting your building properly, you lose out on solar heat or position it in less than desirable wind paths. This will be one of the main focuses of my project as I want to make the most use of the site as I can and make a stable, passive building for all seasons.

There are many strategies for natural ventilation including things like stack cooling or operable openings. Each variation and design option will be tested to see what works best. These principles will also be translated into keeping my building heated in the colder months as you don't want cool air filling the space all year round. Some passive design principles can work double duty and function in both seasons.

Next is material choice. This can be as simple as what type of paint you use on the walls or the installation of a green roof. The two ways a material can be useful are either ones that keep heat out of the building like glazing options of materials that can trap and store heat and release it slowly once it begins to cool down. When materials do end up expanding or contracting from the heat, it is important to have joints that can hold up to these changes in the structure. These joints should also not be areas where hot and cold can pass thorough easily.

Any powered components of the building should be powered by sustainable systems, such as solar arrays, wind power, or even hydro. These will all end up being explored and tested to see what ends up being the most feasible, or maybe it will be a combination of these.

Cyclones

Latham is referring to hurricane force winds in this section as the norther part of Australia is prone to cyclones much like Florida is prone to hurricanes. These will be comparable to tornadoes for the use of my project as Kansas is in Tornado Alley. It is one of my main goals to design a structure that can withstand tornado force winds while sustaining minimal damage.

Overall improvements of not creating wind traps, providing appropriate flashing, vents for winds to travel through, and impact resistant materials can go a long way in protecting a building.

Wind tunnel simulations, both digital and physical can be a good help in figuring out how high winds react to a building's form. That combined with research into materials and making sure that they have been tested to be safe for high winds and potential impacts that a tornado might cause. The structure of the building should also be reinforced to resist the highest wind levels. This should be done through reinforced wall and roof connections so they can't be ripped off the building. This also translates to bracing and structural connections throughout the building. Reinforced walls and openings can also help protect the interiors and structure of the building. (Latham, 2020)

Conclusion

While these suggestions and examples where put forth for Australia, the information can be used for rural Kansas as well. Each of these sections will be dived into more but bases of examples that work are a nice start. Like the previous reading, all these sections will come together and work in harmony to end up creating something that is both functional and aesthetically pleasing.

DESIGN RESILIENCE – PAIGE MAGARREY

Arco House by Pezo Von Ellrichshausen is a building in Chile that was designed to withstand a range of severe weather conditions. It is a small, four story building for an artist that is covered in glass and steel. They provided many strategies and techniques used in the construction to make sure that it could withstand severe weather. It is broken up into flood proofing, earthquake mitigation, fire proofing and hurricane resistance. Each section has short descriptions on products used and what they where used for. The most important products here where listed under the earthquake and hurricane protection. For the structural connections in the building, they used high strength steel connections and combinations of steel-concrete beams that are both elastic and rigid. There are also dampers in the foundations and at wall connections to reduce and lateral forces on the building. While my project isn't in the most earthquake prone zone, these simple solutions can strengthen the building to not only seismic forces but also against wind loads. All the glass in the building is composed of hurricane proof glass that can withstand high winds or is resistant to objects in the air. This is done through lamination or polycarbonate materials that are combined with the glass to keep it from shattering when it is impacted by flying debris. Because of the open and light filled project that I want, glass options and constructions will be highly looked at because of the importance of protecting the interior of the building. (Magarrey, 2014)

Conclusion

This case study provides some great real world applications and products that I can then transfer into my project. Although small, these products can easily be transfered to a large scale project and just as useful with the right research.

ARCHITECTURE AND NATURE: A FRAMEWORK FOR BUILDING IN LANDSCAPES - ANDREEA CUTIERU

Regional architecture has always been around in the profession. With building's being built so that they only fit on their site and if they were to be moved, they wouldn't fit anywhere. The problem with architecture in nature is that it invites people to the site and takes away the natural beautify if done poorly. The juxtaposition of the built environment and the natural landscape is a careful balance that each architect does in a different way. The way we build things in nature takes a few different forms as well. They can be dwellings, paths, experiences, views, but each one should be done in a manner that doesn't interrupt the environment around it. A large problem that the author writes about is the increase in tourism to these natural locations for both the architecture and the environment. That this increase has the opportunity to ruin the once rural and peaceful sites with the buzz of constant tourists. She labeled it important to design an experience that limits their ability to damage the site but doesn't obscure their views. There are then some project examples of buildings in different regions and design styles. Peter Zumthor's view on the topic was "I venture to claim that we all immediately sense if the relationship between the building and the landscape in which it has been placed is disrupted if the landscape is enriched through the architectural intervention". The main considerations when designing a space in the landscape are to learn the landscape, study vernacular architecture, create experiences, minimize interventions, and work with the climate.

Using local building materials and creating a building that looks like it belongs help it age with the environment. A building doesn't necessarily have to blend right into the environment, but it needs to reflect the landscape that it is in. They need to be focused on the human experience through interactions and views of nature. (Cutieru, 2020)

Conclusion

It is not an exact checklist of things to do for a project because each project is unique in both context and typology. This provides professional examples and advice on how to design a building that is integrated well, but they still acknowledge that every person has different priorities. I will be seeking out other's reactions to design solutions and iterations as the project progresses to see if I'm going in the right direction.

APPROACHING ZERO – JOANN GONCHAR

A building that creates all the energy that it uses throughout the year used to be a far-off idea but is slowly becoming a reality. Not only are these single-family houses, but school, government buildings, laboratories, and commercial buildings. For awhile we where designing buildings that had reductions of 20%, maybe 30% of carbon emissions, but with an increase in technology and solutions, 100% reduction in emissions is possible. There are a few different ways that this can be achieved. Either the building itself generates all the energy it uses, or the site and the building together generate the power, either way, renewable energy is the way to go. The International Living Future Institute is one of the organizations that monitors the buildings as a third party and the author refers to throughout the article.

The first project talked about is the J. Craig Venter Institute in La Jolla, California. This project was especially ambitious as laboratories tend to use up a lot of power, but a large solar array on the roof of the building was devised to cover the building's needs as well as changing how the laboratories and the people inside, worked. The project team stated that they first where able to reduce the energy needed through property orientation, narrow plans, and an efficient building envelope. They then worked with the clients to re-work the equipment and recommended higher efficiency machines and ways to reduce the plug loads in the building. They also worked in lots of natural lighting, operable windows, and a culture that was committed to keeping the building at net zero. There are a few other projects talked about with different aspects of what they did to ensure a net zero building. The common theme with those was the inclusion of LED lights and the appropriate air handling systems.

Even with LEDs being more expensive upfront, the benefit was that they would use less energy and last way longer that traditional lighting methods where natural light was unavailable. Air handling systems where combined to both heat and cool buildings as well as use reduced energy to do so. Combinations of all these things helped the buildings use less energy and create enough for what did require it.

A problem mentioned with some projects is that if something goes wrong, breaks, or the culture is not there to keep up the net zero energy, the project can fall behind in its energy production to use ratio. It also states that not all project make the cut the first year of operation as things are adjusted and people become comfortable in the space, but by the second or third year the project is running smoothly. In an interview with a contractor for one of the projects, he talks about the biggest hurdle for net zero energy buildings currently is the cost of some of the systems to run the building. But that prices where slowly going down and he suspected a rise in highly efficient buildings in the coming years. (Gonchar, 2014)

Conclusion

This article relates well to the idea that a weather station research lab and learning space could be designed to meet a net zero energy goal. While larger buildings are becoming more and more popular, the work that goes into them is essential to begging right away in planning out the systems. Natural ventilation, daylight, reduced plug loads, and a whole host of other topics need to be covered throughout the project.

Relating all this back to the unifying idea of a learning space for the public about climate change and sustainability and project goals such as reduced carbon emissions and regional architecture, the main take away is system integration. This to me is the most important aspect of projects that are attempting to drastically reduce their energy needs, how they create their own energy, how a building can stand up to a range of severe weather, and be one with the landscape that it site in.

The findings in these readings like where as stated, building integration and a thorough design process are required to construct a successful project will all these different aspects. Not prioritizing one over the other is going to make sure that each category of design will be met with the same level of detail throughout.

Each reading and review brought with it a different aspect that will help in the design of this project. Lots of the calculations, simulations, and data on how the building performs or its optimal performance will be listed later in this document, but for now the literature helped in establishing criteria to follow or suggestions to think about all the way through the project. Sun charts, wind patterns, material choices, views, systems, and many more will be worked out in tandem to ensure the best of projects to my ability will be achieved.

The creation of a space for people to learn and appreciate natural phenomena and leave taking with them the knowledge of how to make the world a better place is the top priority. Architecture that can stand on its own as a learning tool for all ages will be strived for.

Natural phenomena are a big part of everyone's lives, and I've always been fascinated by storms, the sky, and space, so it makes perfect sense that I'd want to pursue this project. It not only allows me to learn more about these topics but designing a space that would help teach others about it while also working sustainability into the project. This project allows me to combine everything that I've learned the past years. Structure, site design, materials, form, light, passive and active systems and so many more. It gives me the opportunity to show to the best of my ability how all these systems can work together to create a wonderful space and overall thesis project. More and more environmental regulations being put in place and goals to make buildings emit zero carbon by certain years, why not get a head start learning about these things and familiarizing myself with design aspects that can help reach those goals. The 2030 challenge is the main goal that I will be designing for, along with other building standards that promote carbon neutrality. It is through this push to design a sustainable and ecofriendly building that I hope to learn the most about and test my skills. That along with construction methods related to severe weather and the challenges that come with designing a space that is both open for nature but can hold up in severe conditions. By the end, hopefully I would have a better understanding or at least have a starting place for future development.

On the topic of skills, I want to push this project in every aspect. From the renderings to the physical model. I want to bring the highest quality I can to this project and that will develop and add to my skills. The site was picked because of its rural location, impressive views, and the history of the Flint Hills. It needed to be high up to see over adjacent valleys and close enough to a town as to be accessible. These factors all combine to justify why the site was picked and will also eventually influence the design choices. It also presents a unique challenge with the topography and how rural it is in powering and adapting to its surrounding landscape. The technology in the project is all based around research and improving the building's performance. This is necessary to monitor how the building is doing and to keep functions running smoothly. Lots of research will be done into this subject to be as accurate as I can in the spaces designed. This will eventually be a problem that everyone is going to have to solve, sustainability and carbon neutrality, that is. It is the perfect project for me to solve because I am a student and can spend the time working and developing this project. Designing a carbon neutral building up to the 2030 challenge and incorporating all the aspects of natural phenomena that I want will be difficult, but it's the ideal project to develop my skills and create new ones.

HISTORICAL CONTEXT METEOROLOGY

FIGURE 39 | Equipment (Johnston, 1848)

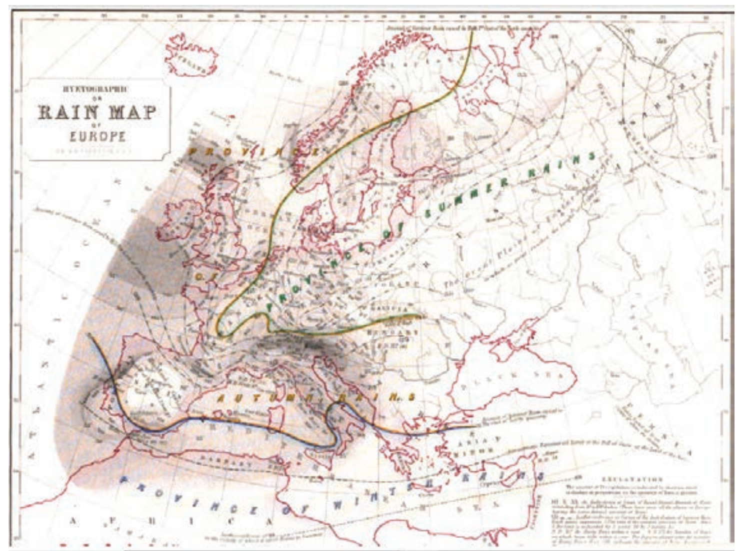


FIGURE 40 | Europe Map (Linehan, 1899)

FIGURE 41 | IBM 7090 (Weather Breau, 1965)

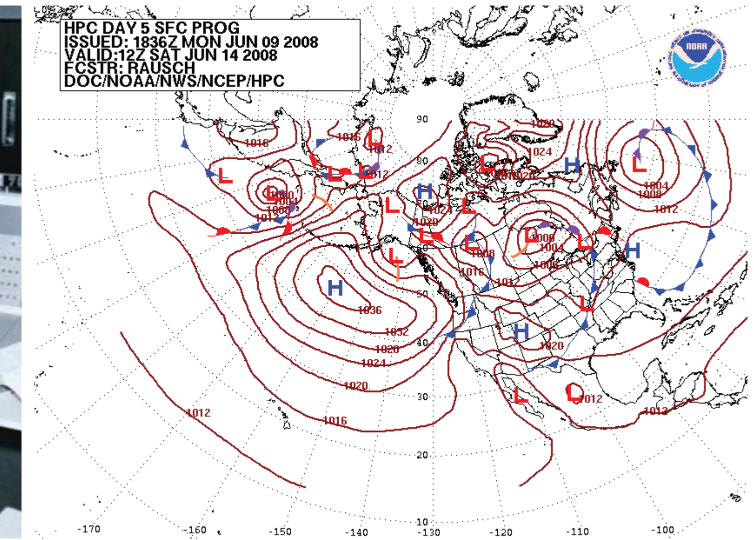


FIGURE 42 | 5 Day Forecast (Prediction Center, 2008)

1650

INDEPENDENT

When meteorology first began, it was individuals recording whatever they saw fit and they had only the tools at their disposal. There was little communication between them because of limits of how far knowledge could travel. There where no standards in the United States and any input from foreign nations was largely ignored.

1814

VOLUNTEERS

Groups of people slowly began to come together to establish their own organizations with different standards between each one. They where mostly focus on climate observation as their instruments hadn't gotten to the stage of predicting weather or figuring out how natural phenomena forms. There was a controversy between three main groups on how storms form and proper recording methods. The Smithsonian meteorological project began consolidating these groups and providing standards, tools, and a sense of unity. This is the time when climate change started to be majorly monitored and how storms formed. Communications and organization began to bring more programs together and the creation of a national storm-warning system in 1870.

1870

MILITARY/GOVERNMENT

With the creation of the storm-warning system, the nation's multiple groups where combined into one under the U.S. Army Signal Service. By the end of the 1870s, research had become international. The military would slowly relinquish its control and it would be handed over to the Weather Bureau of the Department of Agriculture. The budget would improve to over $1,000,000 a year in the late 1890s. They weren't meteorologists yet, but paid professionals who would watch the instruments, launch balloons, and relay data to Washington. The government was highly active in funding during this time period and lots of progress was made to unify the nation in its recording and publishing of findings.

1920 - PRESENT

PROFESSIONALS

Universities and professional tracks where created in this time, which was well behind other scientific professions. Hydrodynamics and thermodynamics where used to advance the models of weather research and they could now figure out weather conditions on multiple levels of the atmosphere. The focus then shifted to being able to predict weather patterns and more accurately figure out how the atmosphere behaves. Computers would completely change the game and be able to create even more advanced weather models. Atmospheric dynamics became the big problem that was trying to be solved. The Global Atmospheric Research Programme was established to unite a wide range of research stations to improve forecasting. Technologies and improvements are always taking place.
(Hoy, 2020)

ANCIENT GREECE

IDEAS

In the time of the ancient Greeks, they believed that humans could somewhat alter the climate around them by planting or removing trees, plowing fields, or irrigating deserts. Many of these where widely believed until around the dust bowl of the 1930s when plowed fields did not bring rain with them. All these ideas where localized to each civilization and not believed to have an effect on the planet as a whole.

1820S

THE GREENHOUSE

In the 1820s, Joseph Fourier, a French mathematician and physicist proposed the idea that the suns energy reaching the earth has to be balanced in some way by radiating energy. Some of this energy was retained in the earth's atmosphere, much like a standard glass greenhouse. This energy is trapped and provides heat for the surface. His theory would prevail and lead to further research over the next 40 to 50 years.

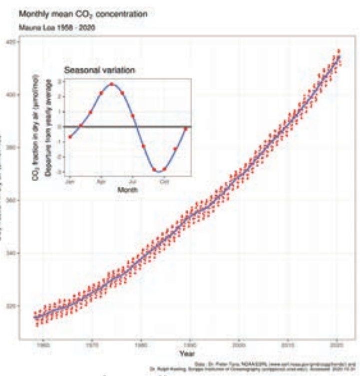


FIGURE 43 | Keeling Curve (Delorme, 2020)

1890S - 1930S

WELCOMING WARM

Before we began to worry about the planet getting to hot, people where liking the idea of a warmer climate that would be more pleasant for those living in some colder regions. A few percentages increase in CO2 emissions into the atmosphere would seem helpful to achieve this and by the 1930s some had theorized that the planet had already begun to warm up following the industrial revolution. Guy Stewart Callenda was the first to bring this to light with studies done on North America in the 1930s. He was largely met with criticism but that would lead to more attention on the subject and eventually some government funded monitoring stations for global warming.

1958

KEELING CURVE

A monitoring station was established on top of Hawaii's Mauna Loa Observatory. Its purpose was to record CO2 levels in the norther hemisphere. Data gathered from the station would reveal a saw-toothed upward curve of rising CO2 levels. More advanced computer modeling was creating chats that would show doubling of CO2 levels would create a 3.2F raise in global temperature over the next century, but for them a century seemed rather far away.

1970S

COOLING

After WWII, the rise of aerosols pollutants would reflect more of the sun's rays off of the earth. The idea of causing the earth to cool to the point of another ice age caught on and Time Magazine even posted an article titled "Another Ice Age?". This would only last for a short time as aerosols would become more regulated and the global temperatures would then resume to rise.

1988 - 1996

HEATING CONTINUES

1988 was the tipping point for some experts. It was recorded as the hottest summer up to that point and in the United States many wildfires and drought. Scientists began being worried and more and more attention and resources where put forward to monitor and possibly reverse the heating. The Intergovernmental Panel on Climate Change would be established under the United Nations to scientifically study its effects. Researchers began to study and theorize on what would happen if the climate continued to warm. This included everything from severe storms to ice caps melting to droughts. Flooding of coastal cities and impacts on nations became the primary concern.

1997 - 2016

IN AND OUT AGREEMENTS

The first international effort to slow the pace of CO2 emissions and global warming was adapted in 1997. This would be the Kyoto Protocols and would call for a 5% reduction of the 90s total emissions by 2012. This would include the United states, the European Union, and 41 other nations, until the US would pull out in 2001. In 2015, another agreement would be written to stop the raise of 2 degrees Celsius which was seen as catastrophic for the environment. This would be the Paris agreement and would include 197 countries promising to regulate their carbon emissions, until the US would pull out in 2016.

NOW

HOW ARE WE DOING?

The United Nations Climate Action Summit, realizing that some climate change is inevitable, capped the acceptable raise in temperature to 1.5 degrees Celsius as a goal for the end of the century. They also set a goal of achieving net zero emissions by 2050. In the field of architecture, there are also challenges in place for buildings to reduce the amount of carbon they emit in both construction and use. Climate change is on most people's mind with electric cars and recycling being popular around the world, but there is still a long way to go to reach carbon neutrality.

(History.com, 2017)

FIGURE 44 | Arrowheads (Flint Hills, 2020)

INHABITANTS

11,000 BC - 1800S

Clovis Points (arrowheads) have been dated as far back as 11,000 BC along streams. There was then evidence found of the Woodland people living in the region from about 0 AD to the 15th century. Thriving cultures before the European's arrived had been found. In the 1800s, the Flint hills where hunting grounds for two different Native American tribes. The Osage where in the south while the Kaw where in the north, which would eventually lead to the state bing called Kansas.

TRAINS TO TRUCKS

1890S - 1940S

Trains began to make their way into the region starting in the 1890s. They would be the main source of supplies and cattle for the region until WWII when trucks would begin to over take them as the primary way of transportation. Population continued to grow in the region and ranchers continued to expand their property as time went on.

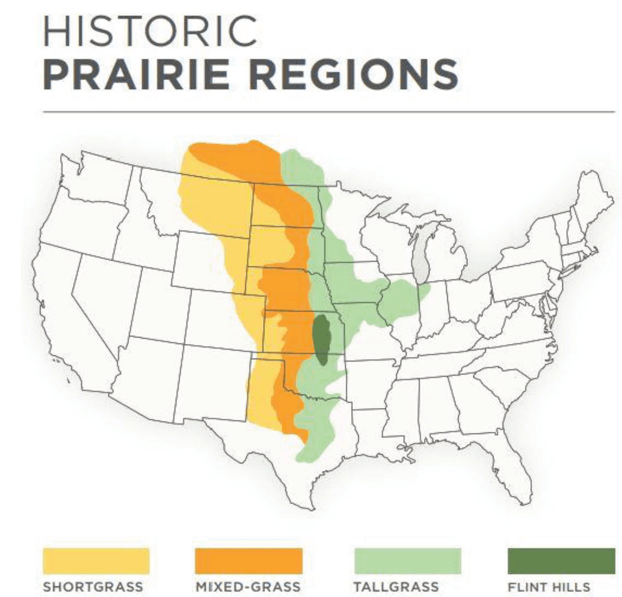


FIGURE 45 | Historic Prairie (Discovery Center, 2020)

PERMIANMESOZOIC

BEGINNINGS

The Flint Hills began their formation during the Permian period when lots of the Midwest was covered by multiple large inland lakes which deposited limestone. During the Mesozoic, the upheaval of the rocky Mountains and the drying of the lakes created the Great Plains. Erosion was extremely slow at this time because of the limestone layers that had formed, and because of little upheaval from the Rocky's the region remained unchanged for a large portion of its life.

LAST ICE AGE

LOOKS

The region would be gifted its current looks mostly from the end of the last ice age. Glaciers reached all the way into the northern most region of the flint hills we know today. As the temperature slowly began to climb again, grasses would be the first to return to the region. Because of the lack of rain and higher temperatures, trees where discouraged from growing, and as the climate got warmer for trees, the tall prairie grasses had already taken hold of the region leaving no room. Fires where common in the grasslands as thunderstorms where common. The erosion during this time would create the flint outcroppings and rolling hills that we know today. William Least Heat-Moon states it "allows you to catch your breath, to gather your thoughts, to feel the calmness of, the oneness with Nature."

1852-1890S

RANCHING

The rocky, limestone and shale filled hills of the region make it difficult to grow crops in the hills. 1852 was the start of a major influx of cattle ranching in the area. This brings along with it a large amount of settlers and communities where starting to be established. Grazing cattle where a common site during this time period. Lots of cattle had been moved up from Texas and views of the mythic American Cowboy began in this time.

1996

TALL GRASS

In 1996, the National Parks Service created the Tall grass Prairie National Preserve. The 11,000 acre site is home to some of the last remaining natural tall grass that used to stretch from the Dakotas down to Texas.

TODAY

FLINT HILLS

Today, only about 4% of the native prairie grass remains from years of settlement and cultivation of the land. There are some areas of protected native prairie grass within the flint hills but it makes up an even smaller portion. Non-native plants and animals have also been brought into he region which does become a threat to the native wildlife there. The continued burning of fields, which ranchers say it increases the quality of their livestock, has begun to be under scrutiny and people are trying to figure out a better way to manage the fires and reduce the amount of O3 released into the air in a very short period of time. Visitors of all types now travel to the Flint Hills to view its natural beauty and learn more about the region's unique history.
(Historical Overview)

SITE INTRODUCTION

Like stated earlier in the document, the site is located just south of Alma, Kansas in the Flint Hills. The region is marked by series of hills and valleys that have flint spread throughout, which gives the region its name. This specific site was picked for multiple reasons.

First, it is far enough away from major cities where it still feels rural without lots of man-made objects around it. This lends itself to being able to see the landscape in all directions for a variety of viewing opportunities like the setting sun or an oncoming storm. Its location is also close to an area that photographers go to get pictures of the milky way because of the low light pollution in the region.

Second was to experience a wide range of weather conditions. With Kansas being in the center of the United States it experiences everything from rain to snow, and tornadoes and lightning storms. This is one of the more important decisions as I wanted the facility to be able to research as much as possible and people to be able to learn about all sorts of weather conditions.

This turned into the perfect site for people to travel to from all around the nation with it being positioned in a central location. My goal is to be as inclusive as possible on the site to preserve its integrity while respecting the environment. All these reinforce the unifying idea of teaching people about the environment and the world around them.

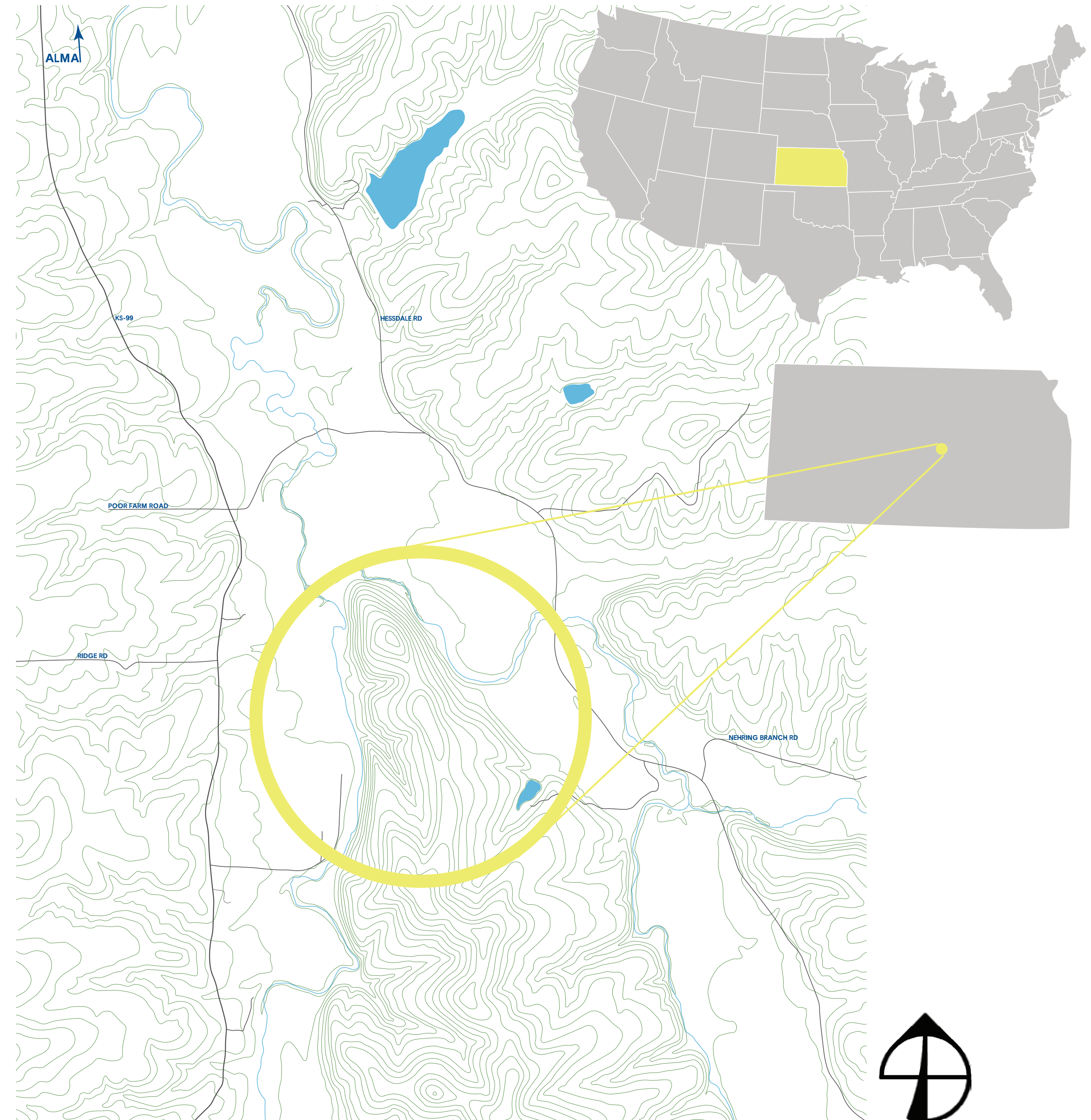


FIGURE 46 | Site Location

TOPOGRAPHY AND SLOPE

The topography on the site was chosen because it allows for multiple level changes and interesting design solutions to make use of the whole site and integrate the building into the landscape more than a flat sight might do. The slopes of the sight are just enough where assistance will be used to help visitors traverse the site, but not too much where landslides are frequent.

LIGHT AND AIR

Because of the unobstructed sky surrounding the hills, the light quality is good throughout the year. The sun shines for averages of 50% in the winter and 75% in the summer.

The air quality is also good because of the open sky throughout most of the year. The only time where the quality decreases is when ranchers are burning off their fields in spring. This releases tons of smoke and in turn CO_2 into the atmosphere and has become a concern for environmental health.

DISTRESS

There seems to be very little distress on the site that is out of the ordinary. An occasional dead tree or spots of dirt amongst the grass. There are a few empty houses in the area of the site, and some rusting farm equipment on people's property in various areas as well. Any of these problems I wish to solve once the site is developed and hopefully prevent or anticipate and more distress that might be caused.

The East-West cut of the site has a average slope of 2 3/4" / 1' over an overall height change about 200 feet (1060' - 1260').

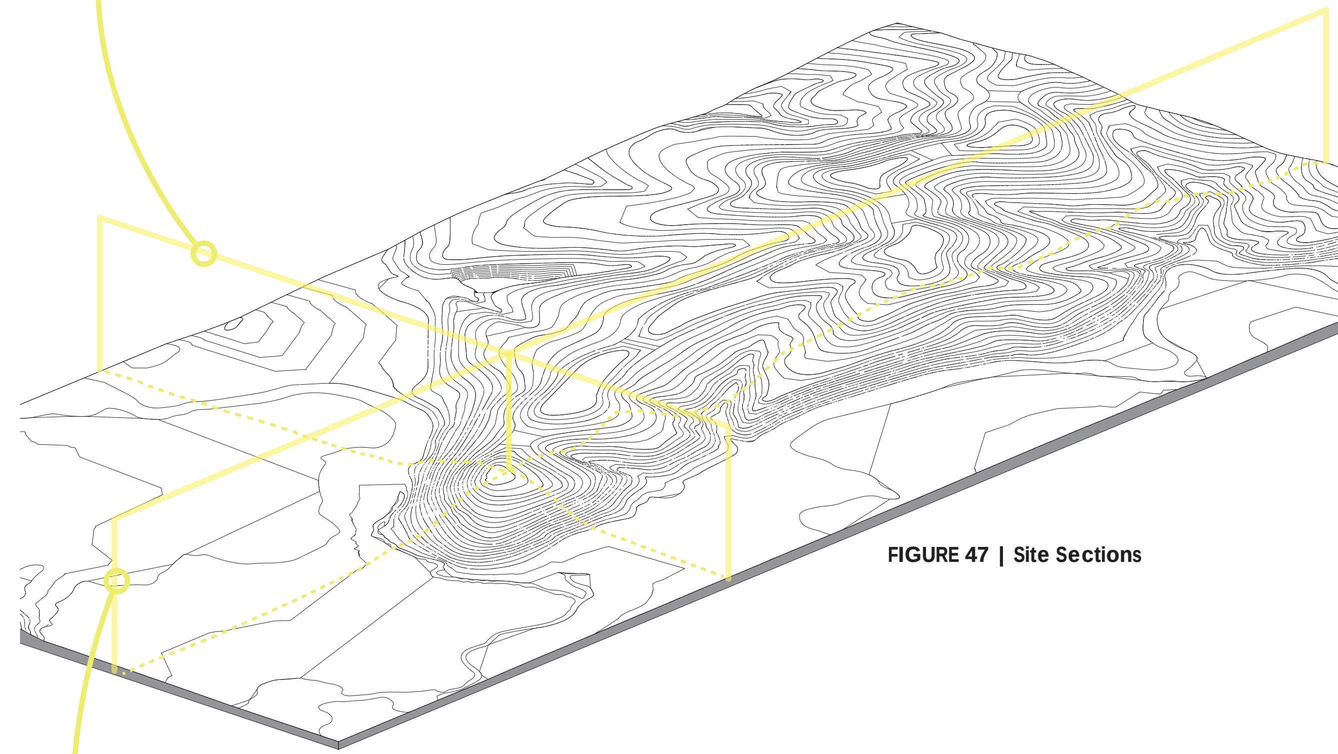
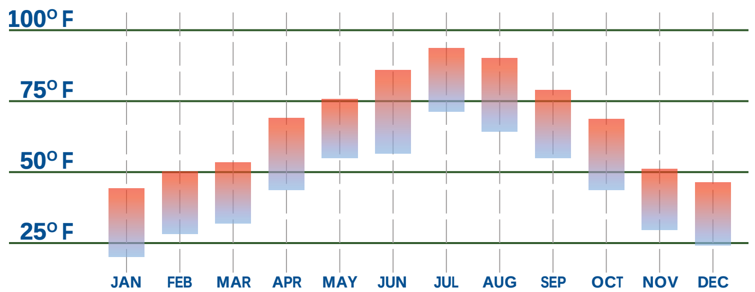


FIGURE 47 | Site Sections

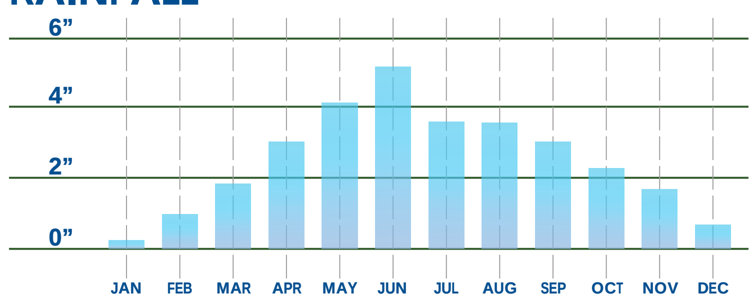
The North-South section cut has an average slope of 2 3/8" / 1' on the north side while the south side varies from 1" /1' to 3" / 1'. There is less elevation change overall in this direction but there are some high points that reach up to 1380 feet above sea level.

TEMPERATURE



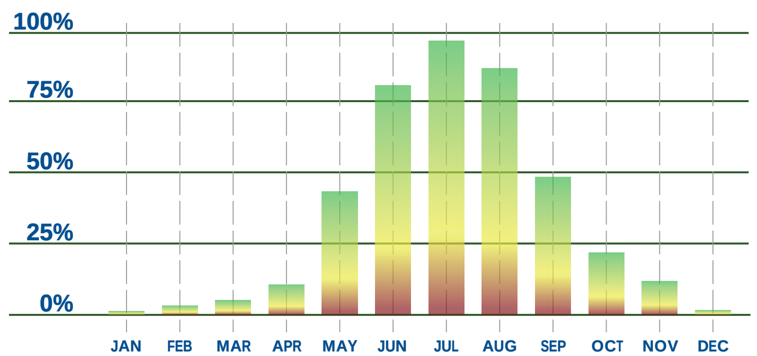
The temperature shifts from 22 Degrees to 92 degrees throughout the year. This presents the site with a range of strategies that will be needed to heat or cool the building throughout the year.

RAINFALL



It snows very little in the region during the winter months, and an average of about 5 inches of rainfall per month in the summer months. This could have effects on the small stream nearby and fill ponds.

HUMIDITY



During the summer months, it does get hot and humid where one might not want to be outside or spaces require shade and cooling.

FIGURE 48 | Weather Charts

SITE CHARACTERISTICS

Like stated earlier, the site is very rural with not a lot built around it. The slopes and valleys of the area create the perfect place to build a research facility that's integrated into the landscape. While the flint Hills doesn't have lots of tree cover due to the rocky soil, this site has a band of trees surrounding it due to the small stream that runs on both sides of the outcropping. While some trees will ultimately need to be cleared, they will be re-purposed within the project to some capacity.

The only man-made object in the top of the ridge on the site is a small rock stacked wall that runs the property line of two adjacent parcels. Other than that, it's just the grass and trees. There is some sand and fine soils that are right next to the stream.

The north, east and west of the site are hills down towards the small creek and the south side of the site continues with the gentle up-and-downs of the top of the hills.

VIEWS AND VISTAS

A site visit was not possible at this time due to travel restrictions. The only good views of the site is the following images from the road on the west of the site.

FIGURE 49 | Street View (Google, 2020)

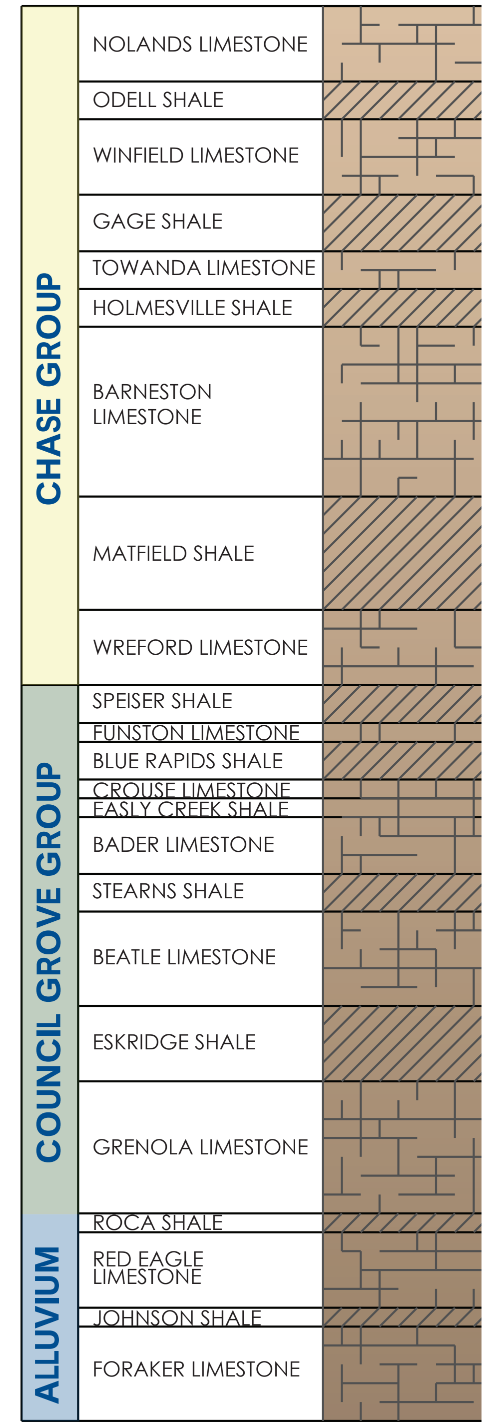
FLINT HILLS GEOLOGY

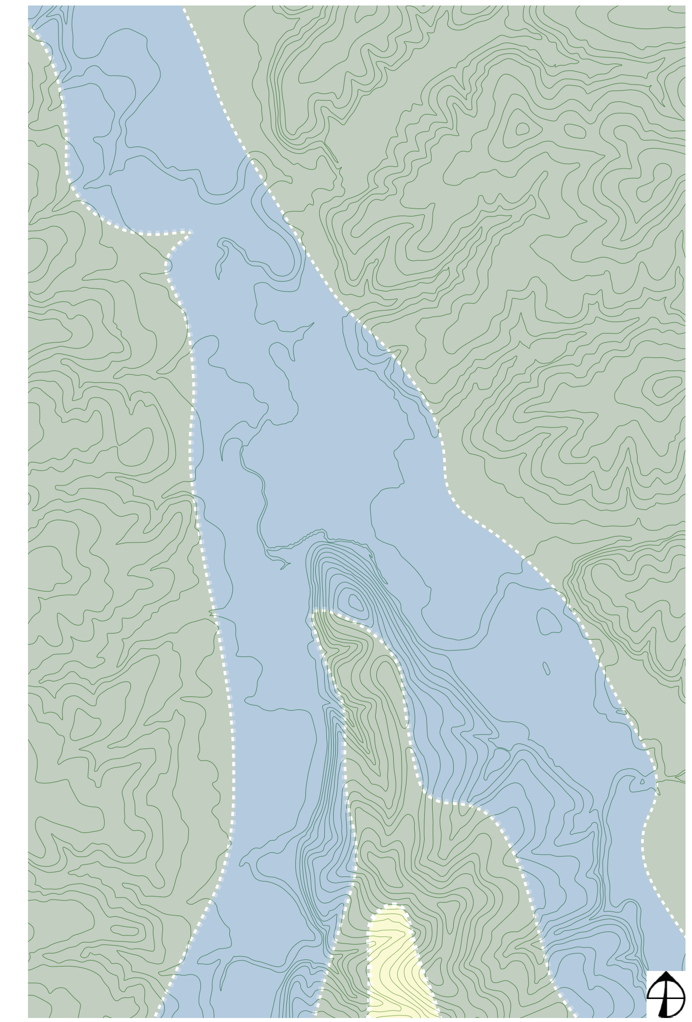
During the Permian period, much of Kansas and the surrounding area was a shallow sea that deposited the layers of limestone and shale in the region. It also deposited chert, or flint, into the region which eroded into outcroppings, giving the region its name. As the seas withdrew, it eroded the valleys and hills that make up the region today, with some small streams and rivers still slowly working their way through t the land. This flint was also used by native Americans and settlers to make tools and jewelry as it breaks into sharp edges and is easily polished.

Barneston limestone is home to many fossils and in some areas large caves and openings. It is the thickest of the layers ranging from 20 to 60 feet in thickness. Because of the alternating layers and rocky outcroppings, it made the land unsuitable for farming and is used for grazing instead. Many of the hilltops are also covered in a rocky gravel as the flint has been left behind as the limestone and shale erode. (Miller, 2011).

EFFECTS ON THE UNIFYING IDEA

Foundation wise, the limestone layers are enough to rest larger buildings on. The layers of the rocks also provide opportunities to view them on the side of the hills or to cut into them and get up close to what lies within. Limestone can also be used as building materials throughout the project. Considerations will have to be considered if seismic activity where to pop-up in the region like is has closer to the Oklahoma border.





Chase Group and Council Grove Group: Highest points of the site. It is composed of roughly 335 ft of alternating shales and limestones.

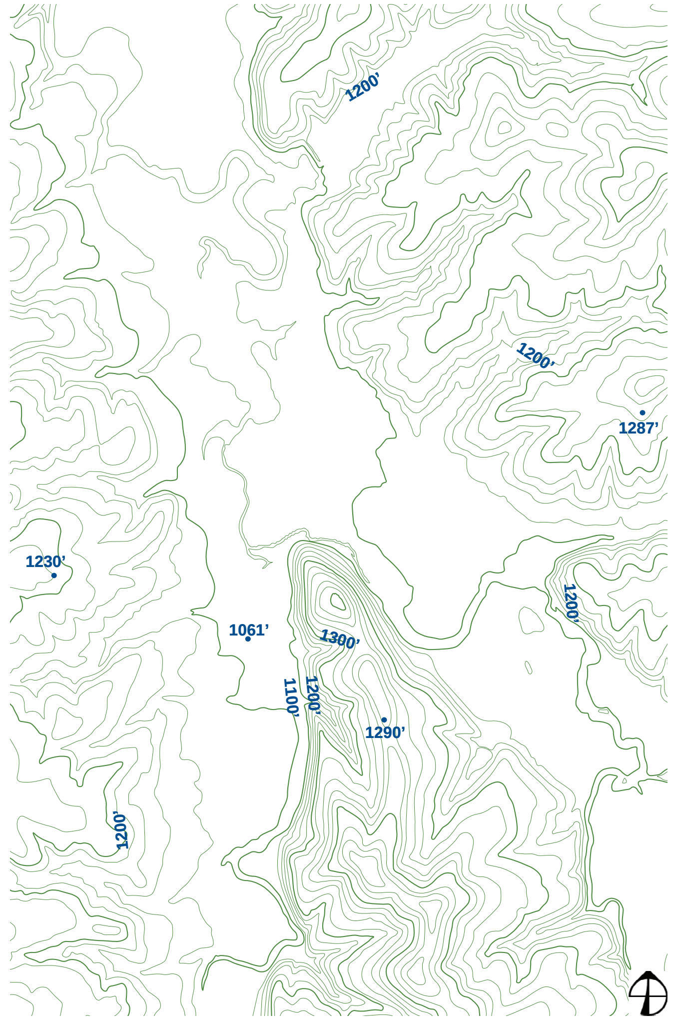
Alluvium: Thin layers of clay, sand, and gravel that have been deposited by the stream.

The water table seems to be between 920/935 feet above sea level, so the site is at least 100' above the water table.

FIGURE 50 | Geology Chart

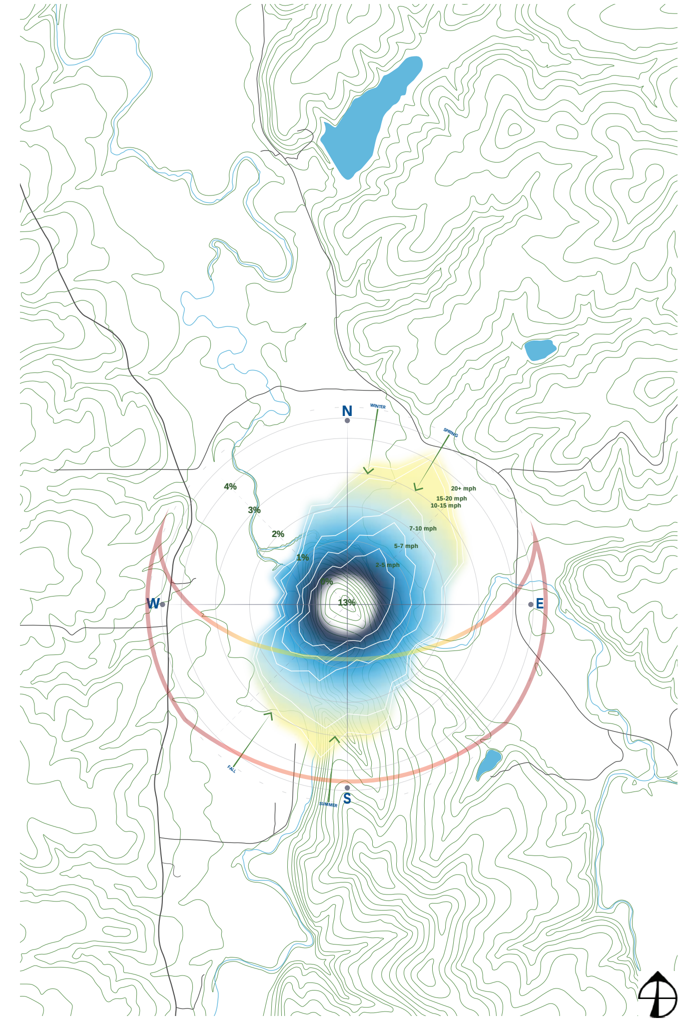
MAPS

Each map helped me to understand the characteristics of the site in the physical attributes that it contains. These can then be expanded upon in the final design to make the most efficient use of each of them.



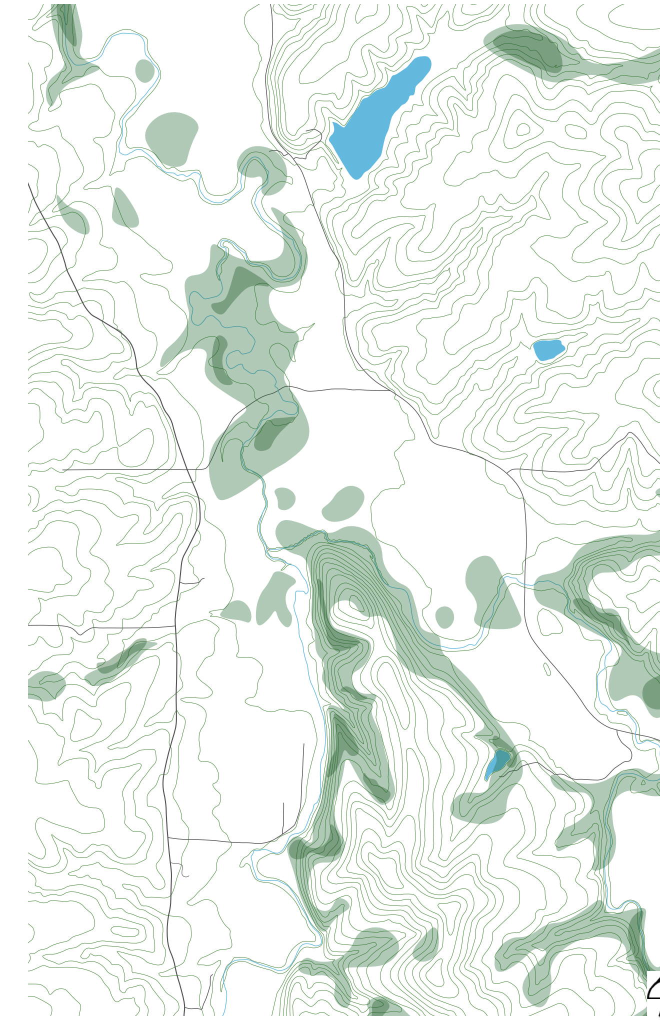
CONTOURS

The site contours are each placed at 20' intervals with the lowest point on the site being 1061 feet and the highest being 1388 feet. This allows for lots of exploration in verticality around and within the site as well as providing stunning views as you make your way to the top.



SUN AND WIND

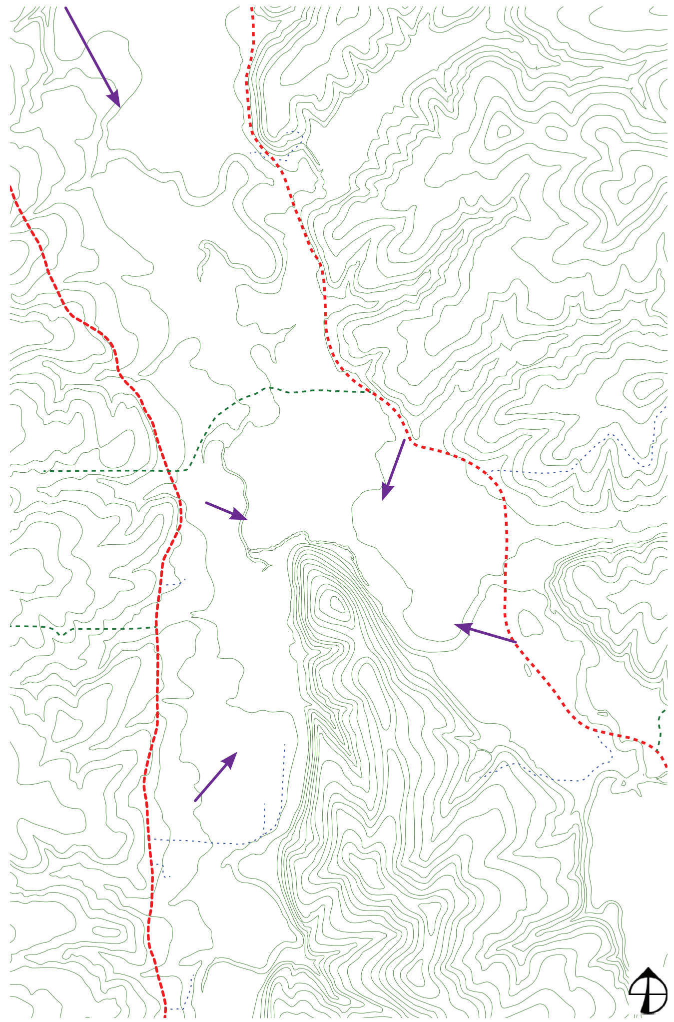
Shown above is both the sun and wind diagrams. Being on the top of a hill results in more sun access but as you travel down the hill to the north you start to get shade. The wind comes from two main directions the different times of the year which could each be shielded by the landscape itself in dividing up program uses for each season. The sun's altitude ranges from 74 Degrees to 25 Degrees.



TREE COVER AND WATER

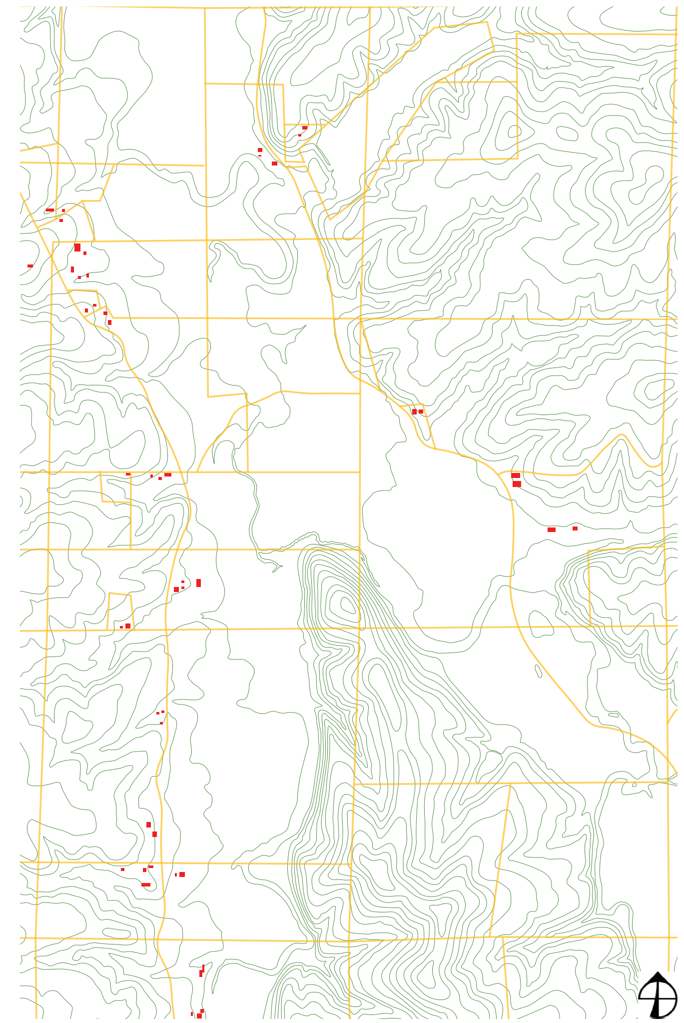
Most of the trees on and around the site are deciduous while there are small grouping of coniferous trees within them. In the summer they provide lots of shade on the hill tops while in the winter it looks very barren with lots of open branches. There is also a small stream that runs north and eventually into the Kansas River. There are also small ponds around, one of which is a reservoir for the city of Alma. These can both be used as learning opportunities in the facility.

FIGURE 51 | Site Maps



CIRCULATION AND NOISE

The roads out here aren't traveled very much. The site is just off the scenic byway and some of the more major highways. However, any cars passing by, especially trucks, could cause some minor noise problems as they pass. There is also a train that passes through Alma which could carry noise all the way to the site. There are two main roads on either side with a connection just north of the site. The site is in the middle of a few large towns which connect to the highway on the west side of the site.



PARCELS AND BUILDINGS

Being south of Alma, there isn't a whole lot of built structures. Most of the land is used for grazing and privately owned. My site sits between a few different plots of land so it would have to be acquired and the previous owners would have to be compensated. Some of the buildings on the site are vacant and falling apart, and some parcels have small stone walls of fences along some of the borders.

MASS AND VOID

While the built environment is very limited on the site, the natural environment provides its own mass and void relationship in the region. One can imagine the rivers and erosion it took to carve out these pathways as we see them today. This also lends itself to the site that is visible from almost every angle as you are passing by.

ENERGY CONSUMPTION

This will go along with environmental performance and how energy is consumed and released in my building. The 2030 challenge and WELL Building Standard will both be used as templates on how the building performs. My goal for the 2030 challenge is to at least hit the 2020 goal of 80% carbon reduction in the design, with 100% being the ultimate goal. Well Building Standard's goal will be Gold but striving for platinum. Analysis will be based on simulations and publications.

ENVIRONMENTAL PERFORMANCE

Measures here will be lighting levels, thermal zones, and other aspects. MEEB will be one of the main sources of benchmarks that should be met in each aspect. The main goal in environmental performance is to meet the 2030 challenge. These will be obtained through simulations and energy modeling in digital models as the building develops. Tools like Insight and ElumTools plug-in for Revit will be used to generate the simulations. The outputs of these simulations will be adjusted to meet standards and recommended performance values. Referencing documents and publications throughout to make sure that I am on track is how I will judge my decisions and the final product.

PSYCHOLOGICAL IMPACT

This will be measuring aesthetic values and views to and from the site. The values on how these are assessed are from peers and input that will be received. People can be shown renderings, material choices, and drawings to analyze. The more people that say that they like it the more successful it will be.

ENVIRONMENTAL IMPACT

This is going to be how the building affects the environment it sits in and everything from materials, to energy consumption. These will be put against the 2030 challenge and WELL building standards. Models and drawings will be used to judge these over the semester. The criteria will be the publications and charts provided by WELL and the 2030 challenge.

CODE COMPLIANCE

Code compliance will be used to judge the building primarily on its structural design relating to natural disasters/severe weather and movement throughout the site and building to make sure that it is accessible to everyone who would come and visit. This will be judged based on feedback and referencing design elements with the code.

EXECUTIVE SUMMARY

In summary, most if not all my building will be subject to some type of performance criteria that I will be trying to meet. That combined with a wide variety of spaces and functions will make it difficult to craft a building that can deliver on all fronts. WELL building standards and the 2030 challenge are the two main judges of how my building performs. My personal goal is to create a building that is the most sustainable and environmentally friendly project that I can do on the chosen site. The views and aesthetic choices of my building will be discussed with peers to gauge reactions and garner feedback on what might need to be improved and what is working well. Renderings, drawings, details, and simulations will all be used to get the information that is needed to judge my design according to the appropriate criteria. This all will help to reinforce my idea that teaching people about nature and natural phenomena around them will increase their care for the world and in turn slowly reverse the effects of hurtful climate change. As time goes on through the project goals and progress will be monitored as many things will have to be tracked to make sure that I am on track to meet or exceed my goals.

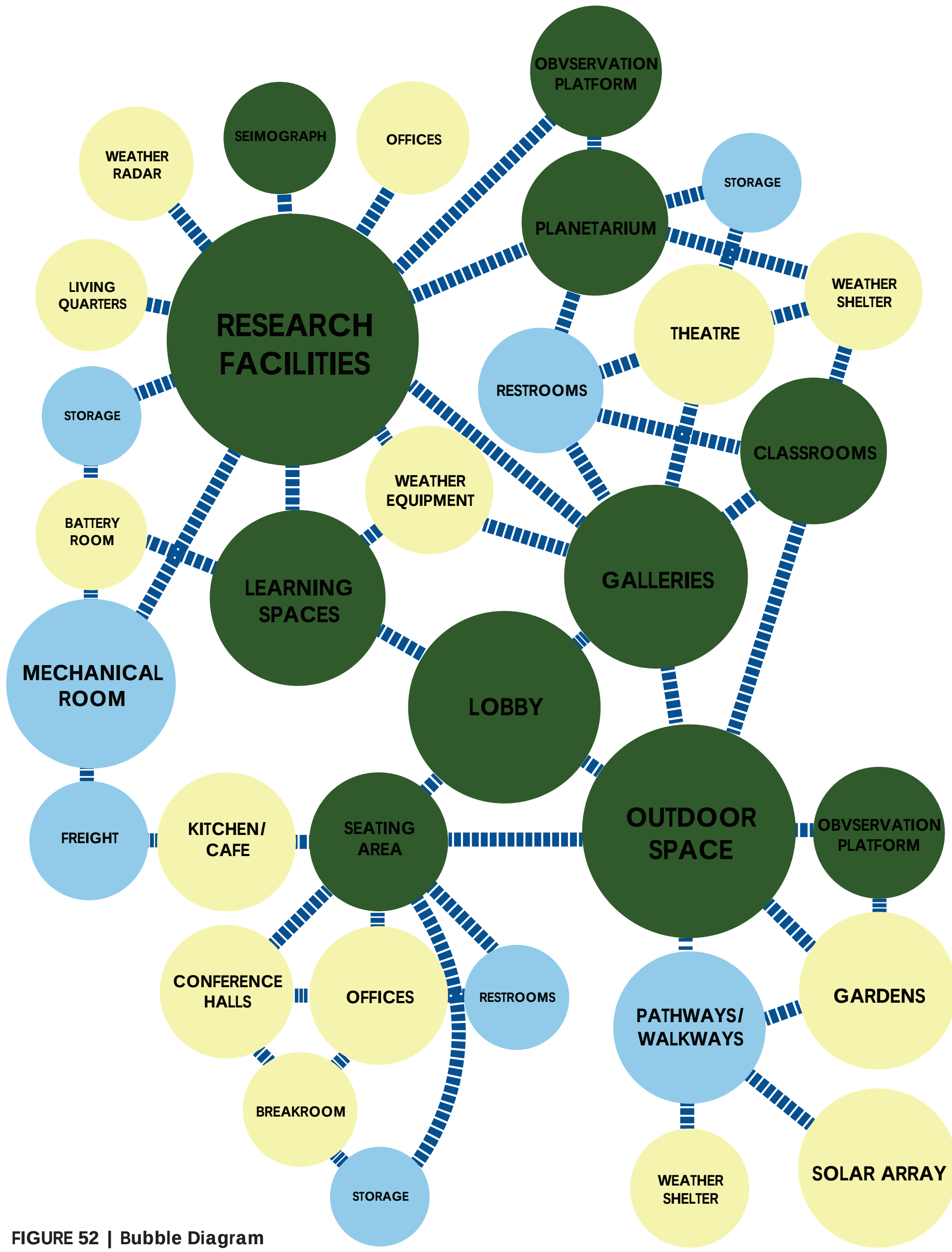


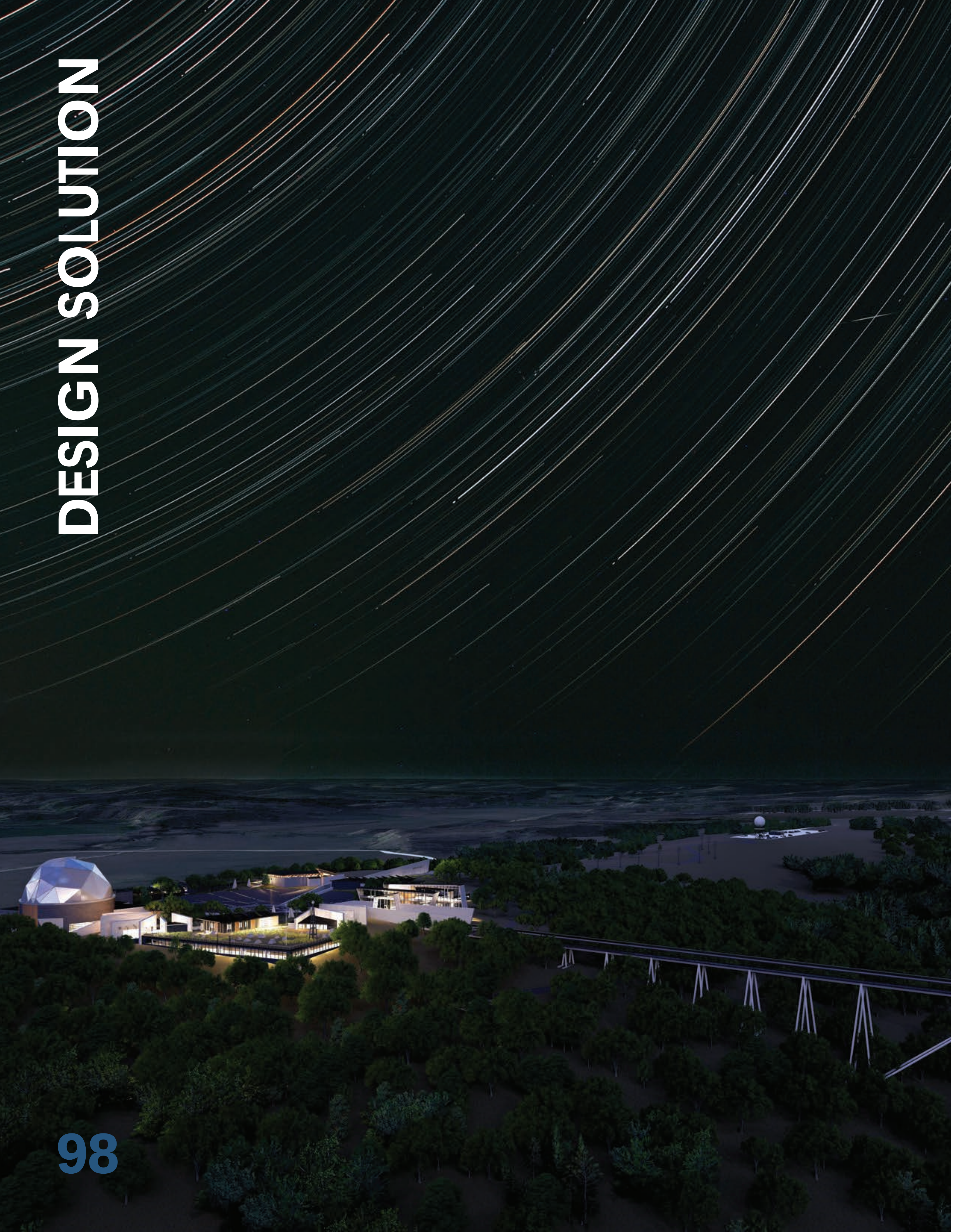
FIGURE 52 | Bubble Diagram

The spaces listed below are the beginnings of what might be contained in my project. As progress develops and more insight is gained, some of these spaces might expanded or changed. Iterations of layouts and functions are expected to happen as there is often no one right answer but possibly multiple functional ones.

	SMALL		MEDIUM		LARGE	
	SQ FT	%	SQ FT	%	SQ FT	%
Observation platforms	1000	2%	2000	3%	4000	4%
planetarium	2000	5%	4,500	7%	7,000	7%
weather radar	200	0%	300	0%	400	0%
weather equipment	400	1%	600	1%	1000	1%
research facilities	4000	10%	7000	10%	10000	10%
seismograph	200	0%	300	0%	500	0%
battery room	2000	5%	3000	4%	5000	5%
offices	750	2%	1000	1%	1250	1%
lobbies	600	1%	900	1%	1200	1%
conference halls	500	1%	800	1%	1100	1%
kitchen/café	1500	4%	1750	3%	3000	3%
seating area	1500	4%	1750	3%	3000	3%
living quarters	700	2%	1000	1%	1300	1%
classrooms	800	2%	1300	2%	2500	2%
galleries	3000	7%	5500	8%	9000	9%
learning spaces	1500	4%	3000	4%	4500	4%
theatre	1000	2%	1350	2%	2000	2%
weather shelter	600	1%	800	1%	1000	1%
restrooms	1500	4%	2000	3%	2600	3%
freight	600	1%	900	1%	1200	1%
storage	400	1%	600	1%	800	1%
mechanical	2000	5%	4000	6%	6000	6%
circulation	14000	34%	23000	34%	35000	34%
TOTAL	40750	100%	67350	100%	103350	100%

FIGURE 53 | Space Table

DESIGN SOLUTION



In the heart of Kansas, the flint outcroppings that line the valleys are the driving force of the building form. Millions of years of stratification and erosion have revealed the stone at the surface. The building is a learning tool with integrated sustainable building practices and interactive learning spaces focused on green building techniques and natural phenomena. The three areas of focus at the facility are earth, sky, and space. Educating people of all ages about the weather, climate change, and sustainable design will inspire new views of the world and actions to take care of it.

DESIGN SOLUTION | PROCESS

Through many iterations of sketches and models, the final form of the building took shape. Primary forces of change would be flint, the basin, and the pulsar map as ordering principles. The sketches move between more dramatic solutions to more subtle ones, eventually achieving a harmony. Site integration and phenomena specific spaces would also change how the spaces and layouts would come together.

Sketches such as the planetarium and observatory or how the building sits in the top of the hill were sketched separately then combined in a later sketch with pieces that worked well from other ones.

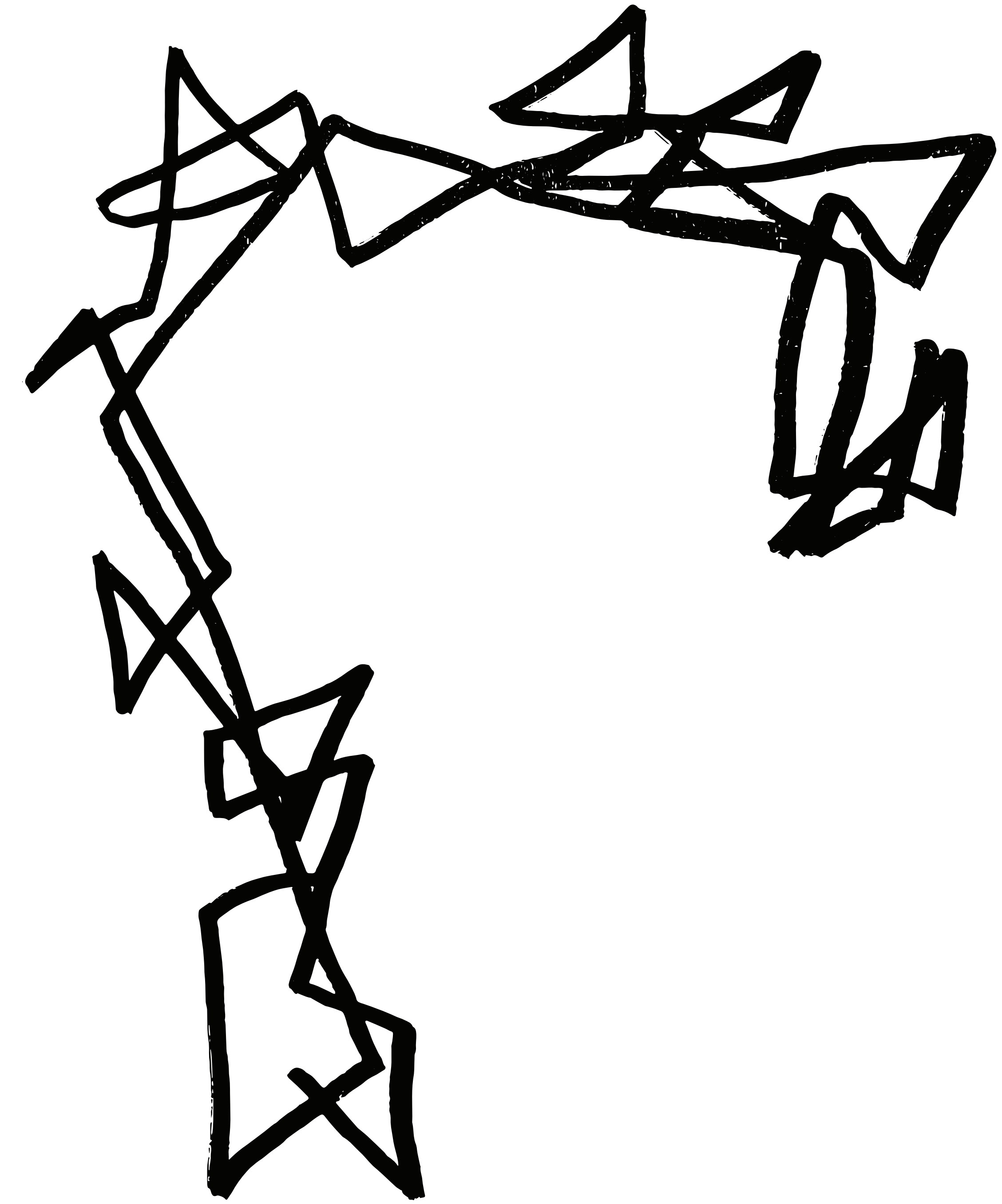
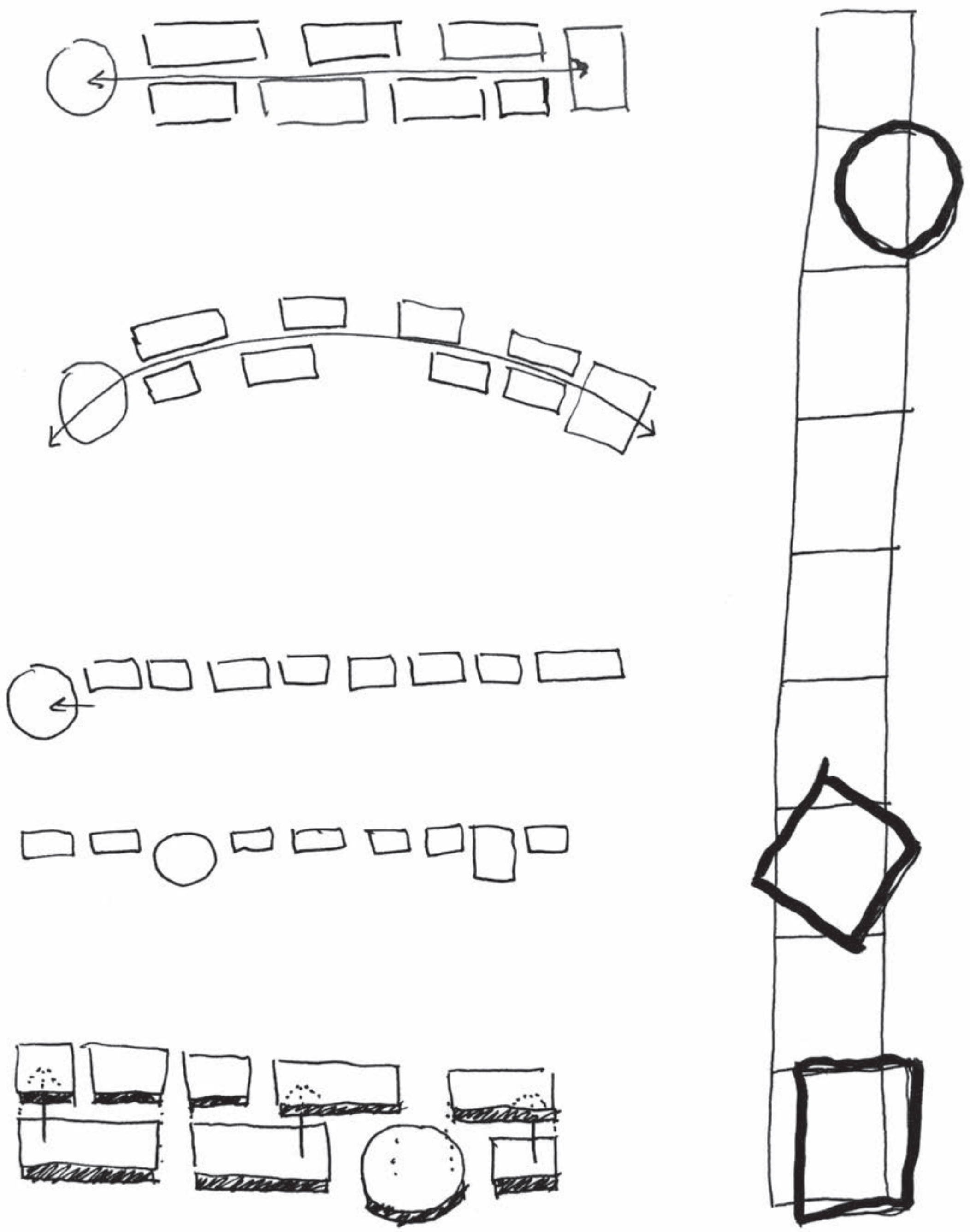
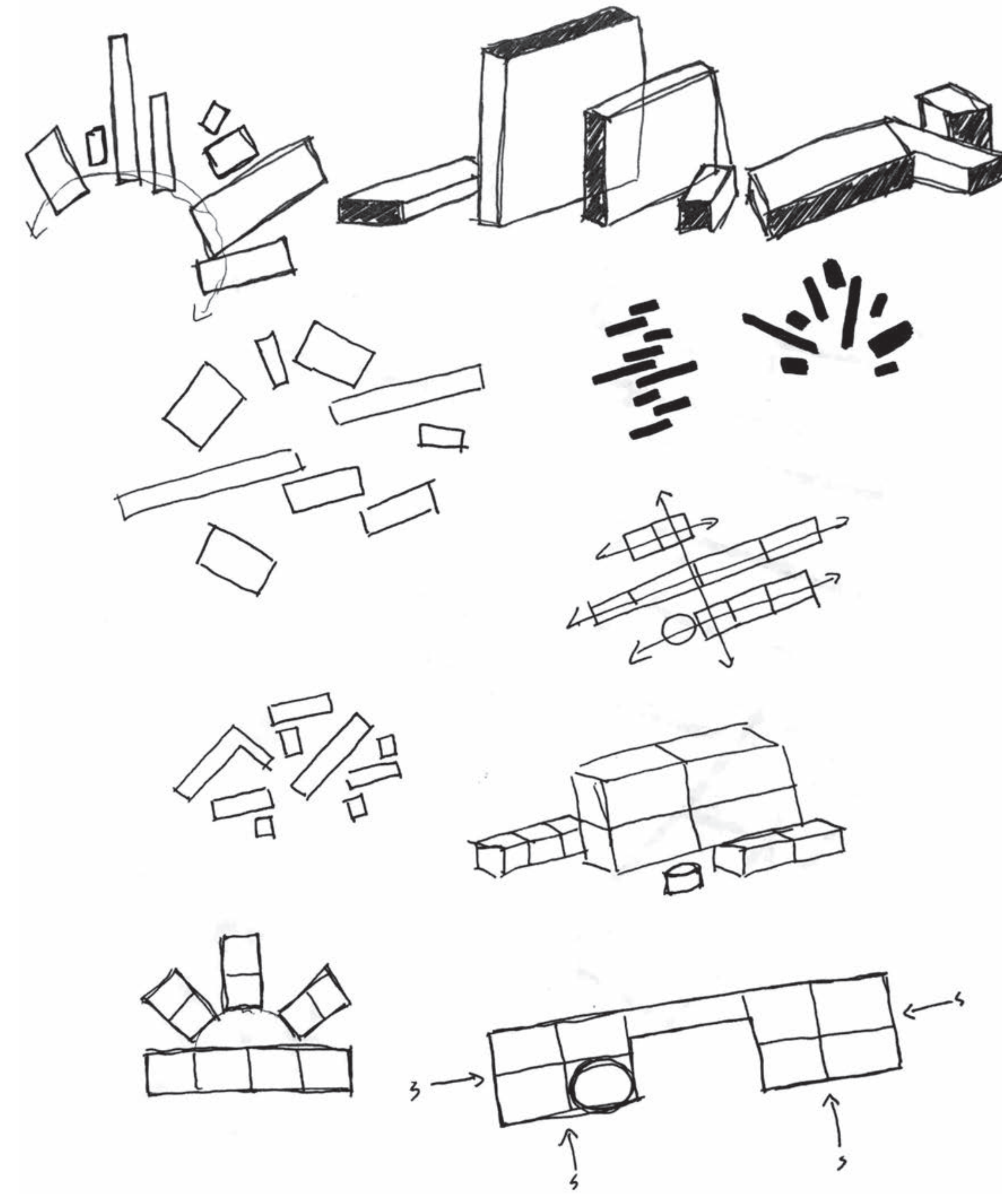
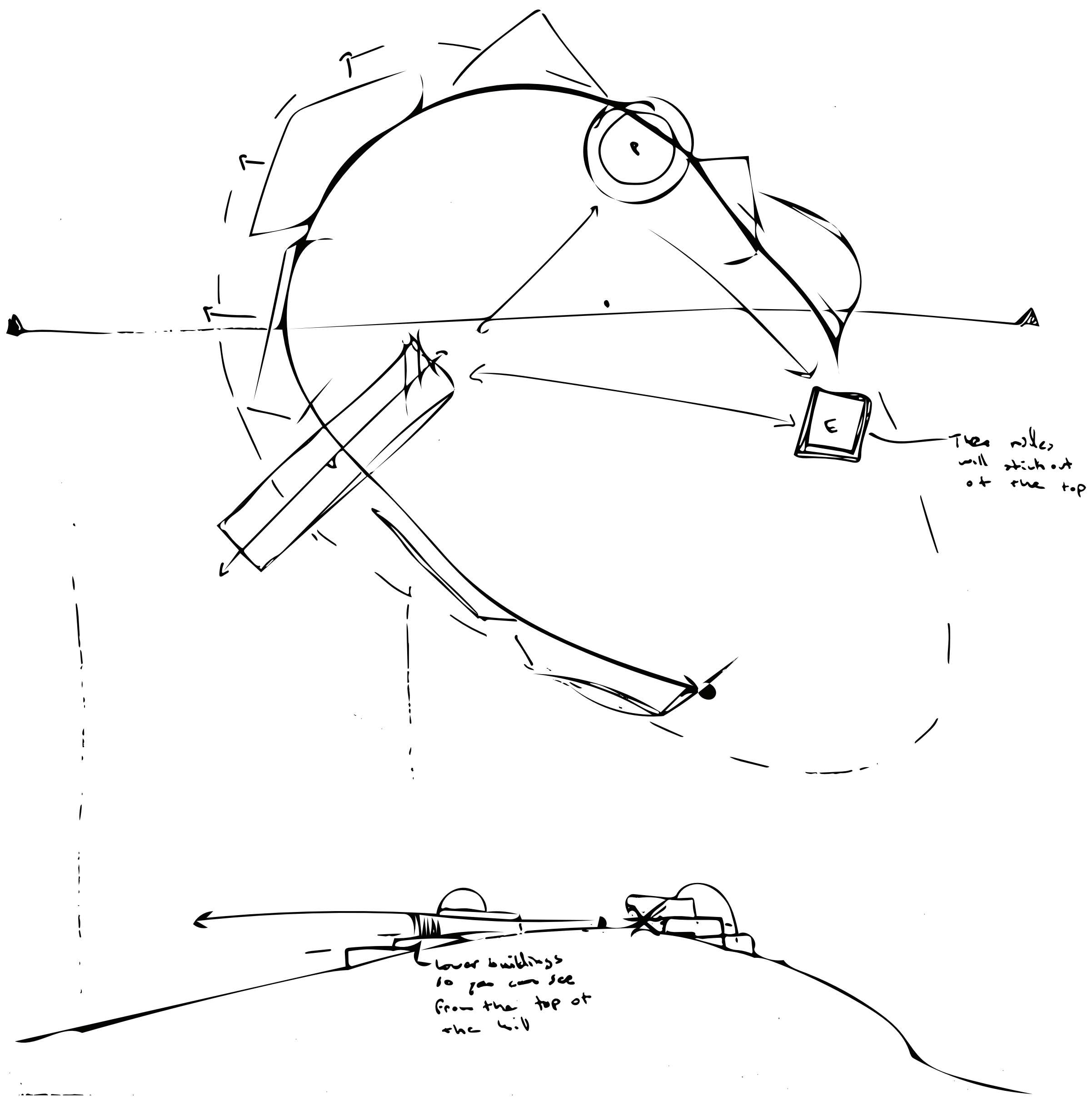
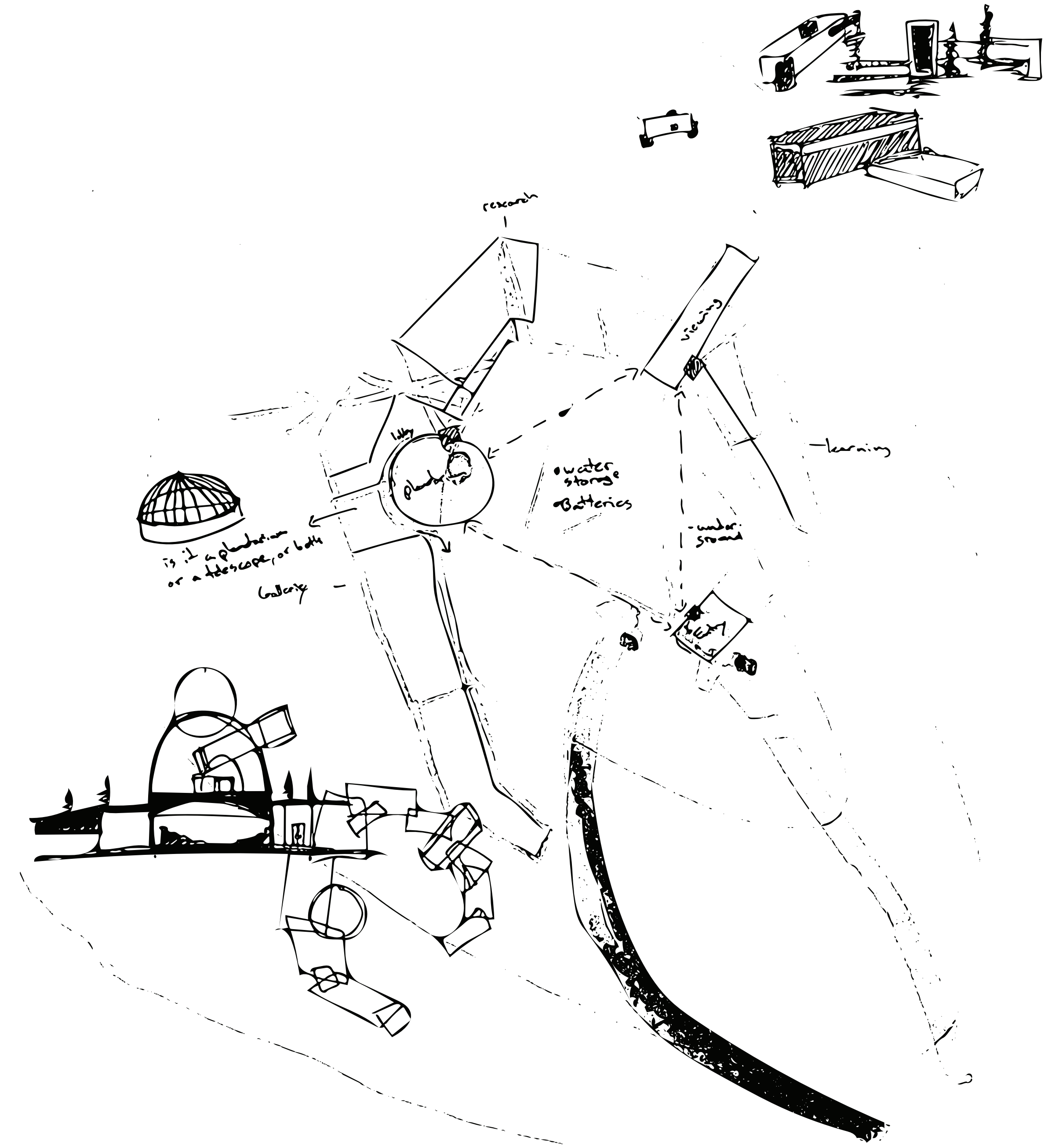


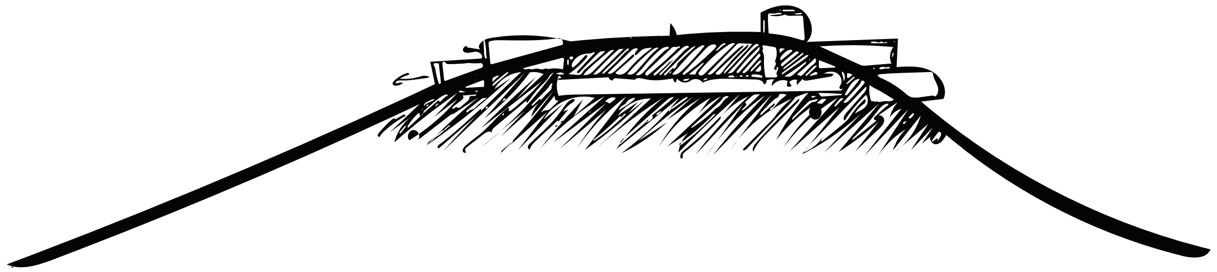
FIGURE 54 | Sketches

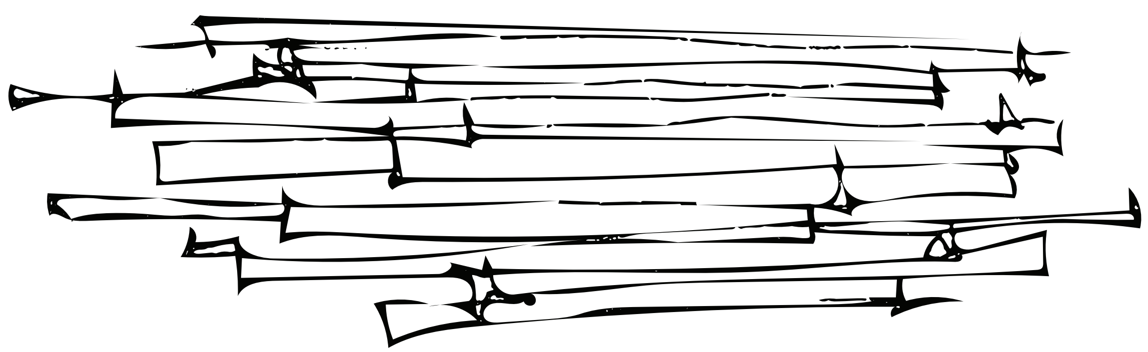


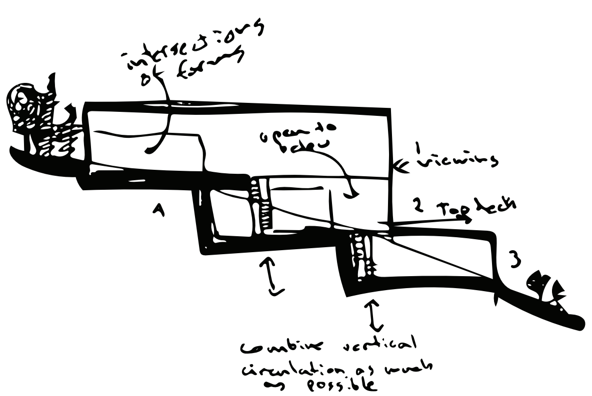



These will stick out of the top
lower buildings so you can see from the top of the hill

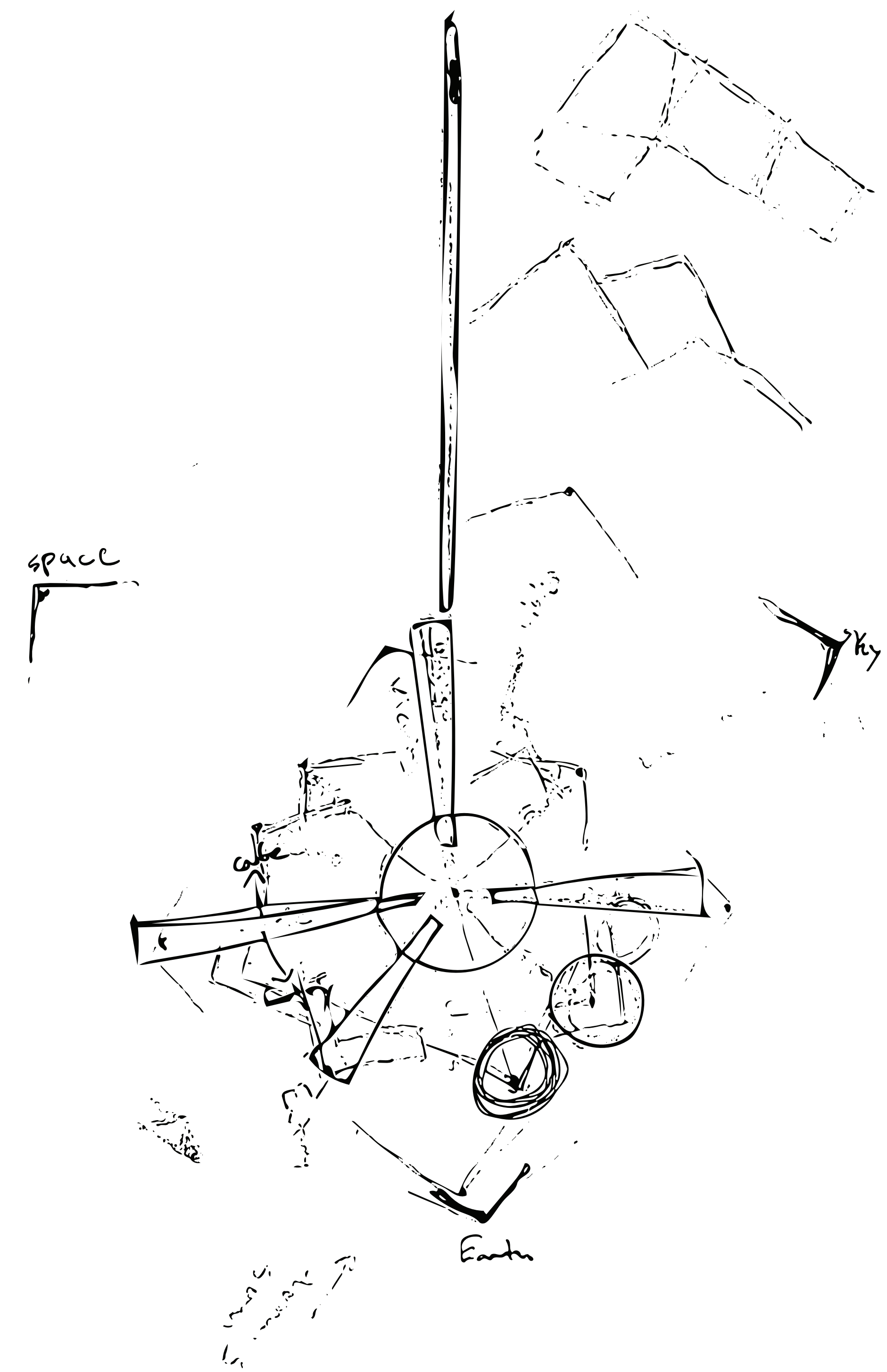

research
viewing
learning
lobby
water storage
Batteries
under ground
is it a planetarium or a telescope, or both
Gallery

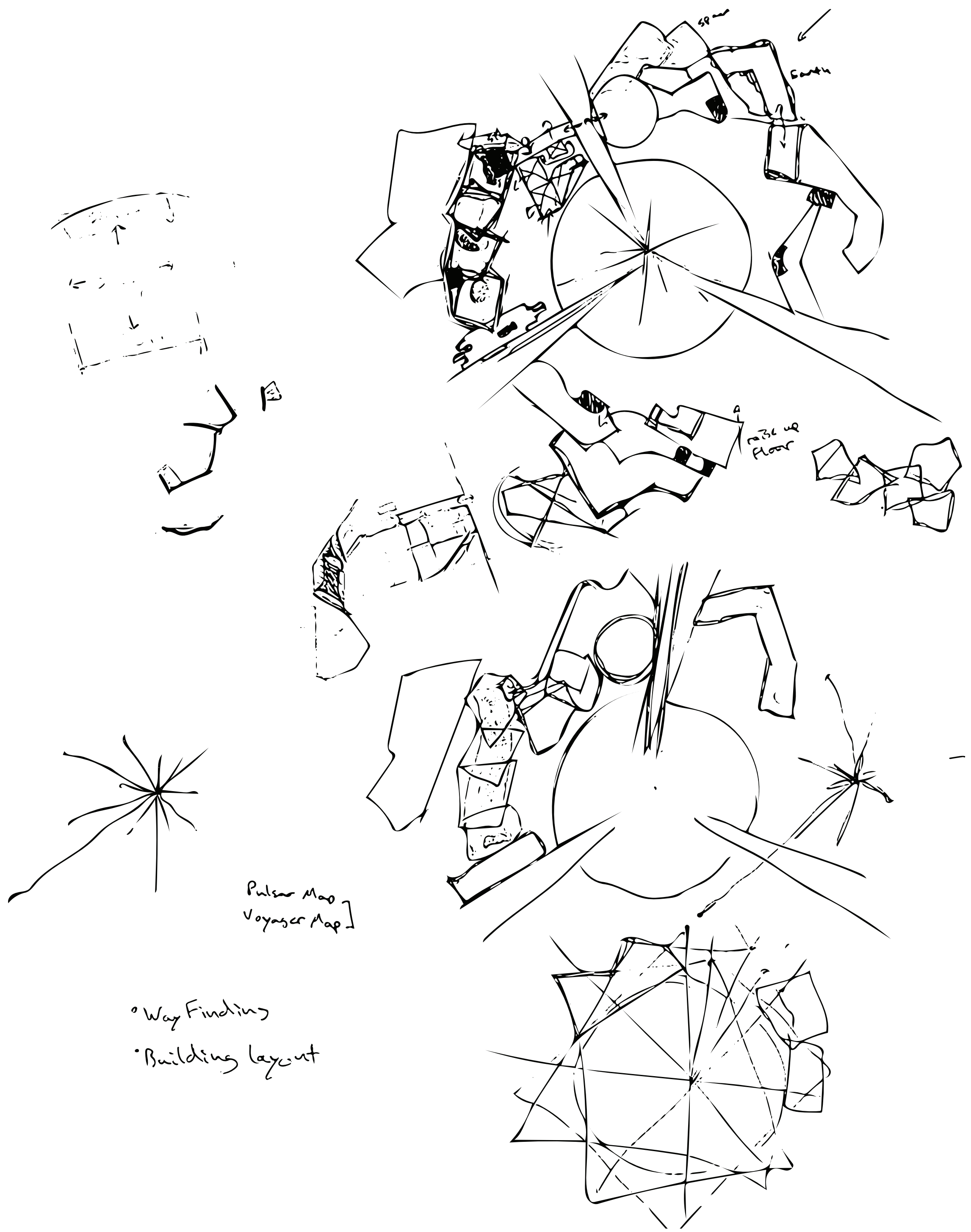


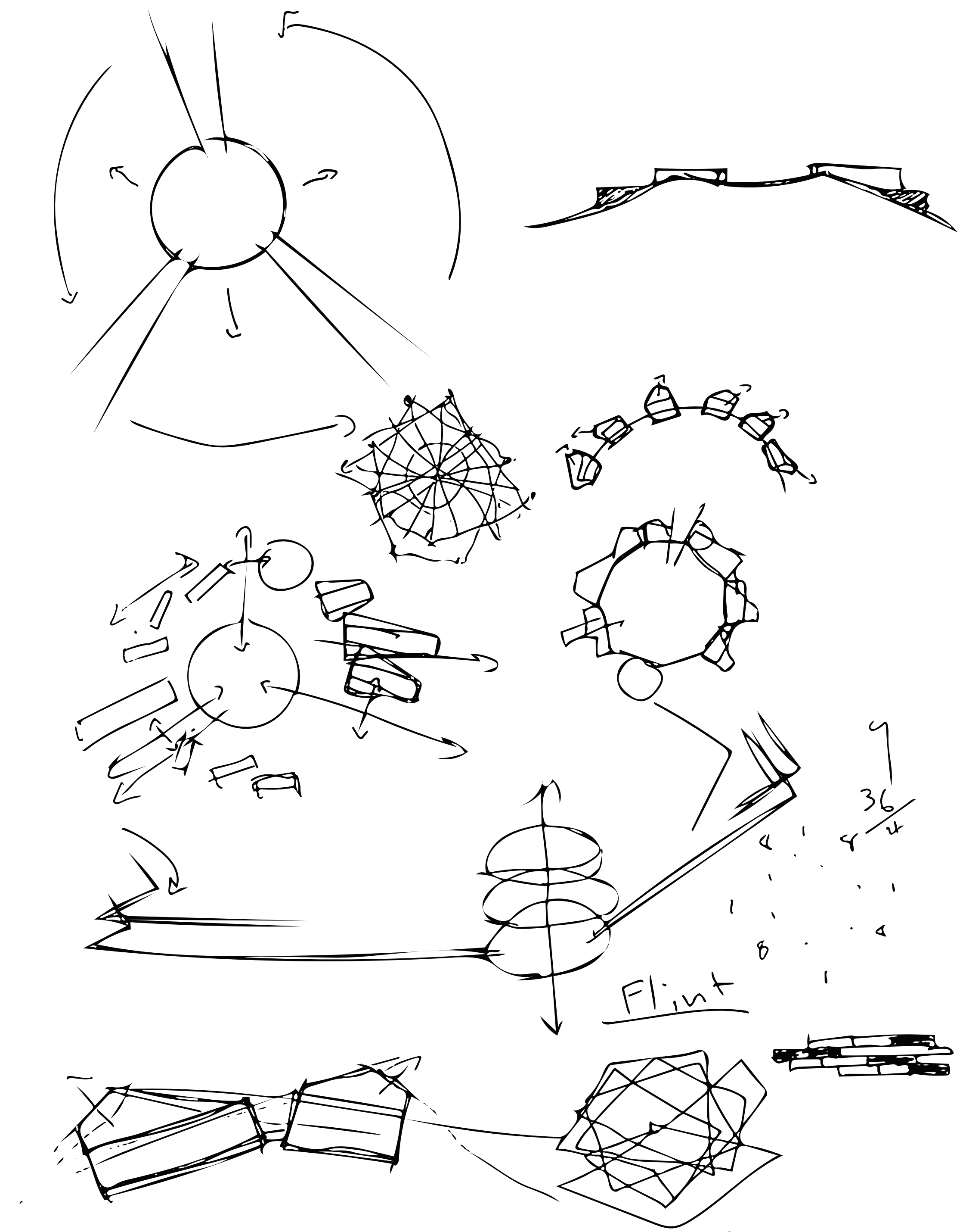


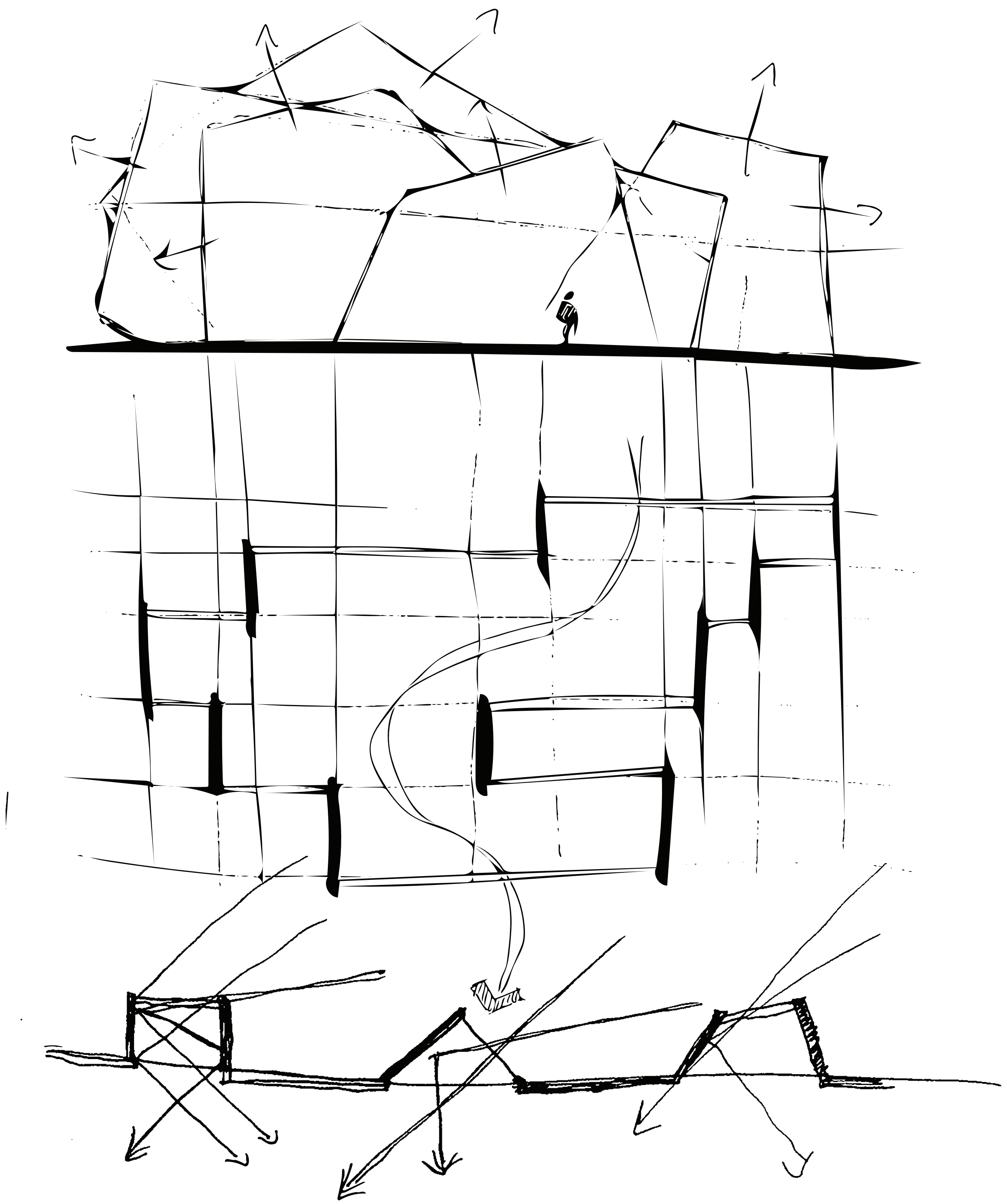

intersections of forms
open to below
1 viewing
2 Top deck
3
combine vertical circulation as much as possible

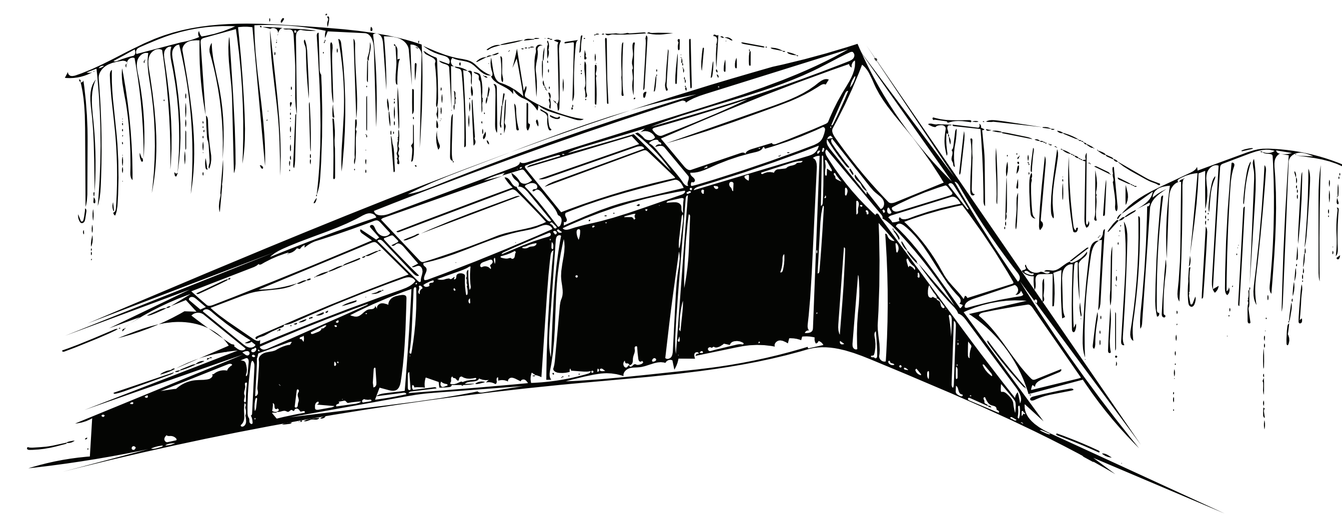

Entry

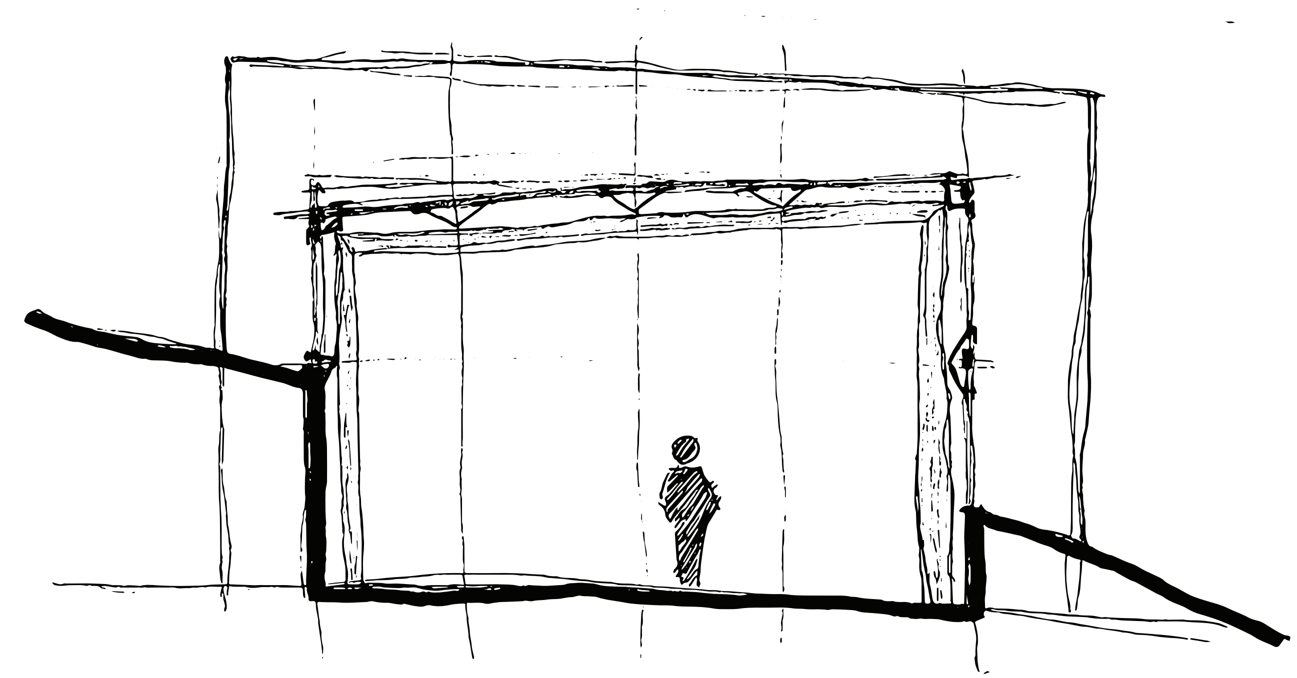

space
Sky
Earth

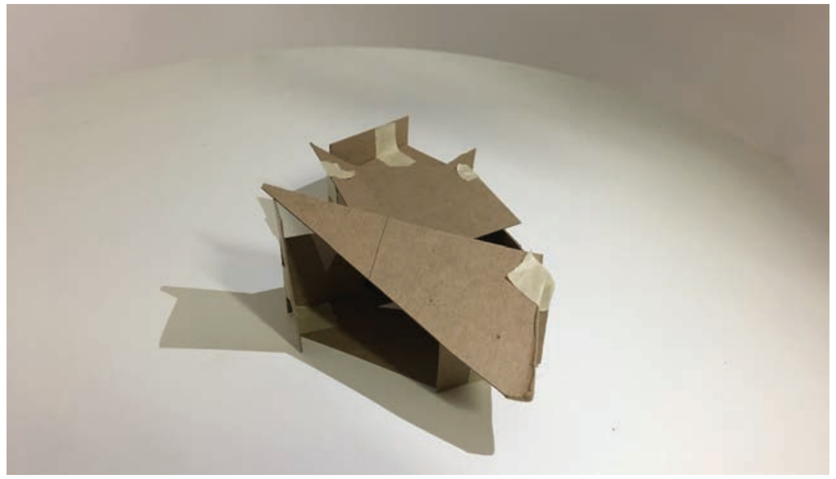

Pulsar Map
Voyager Map
• Way Finding
• Building layout

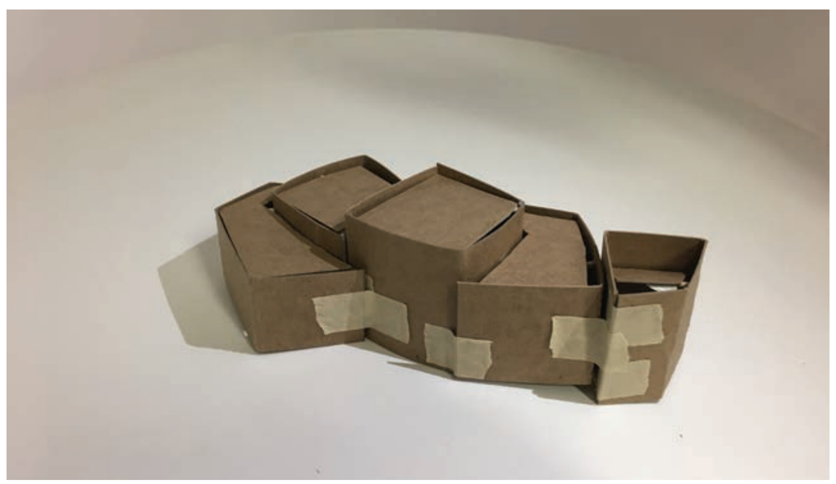

Flint

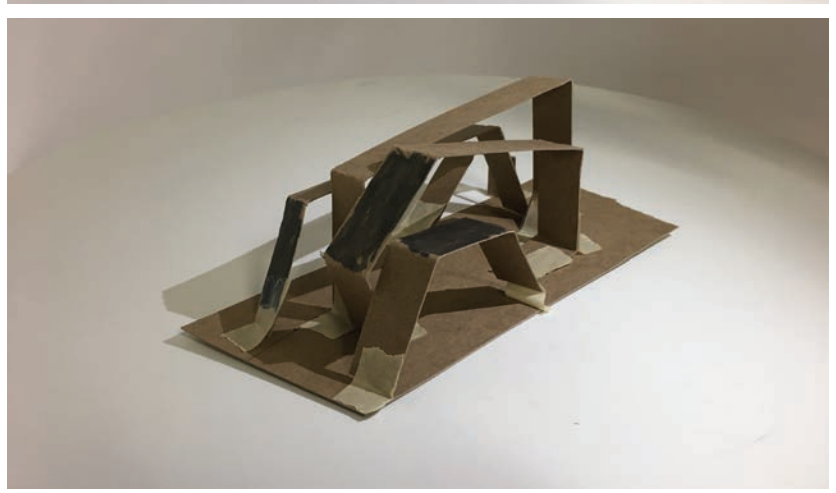








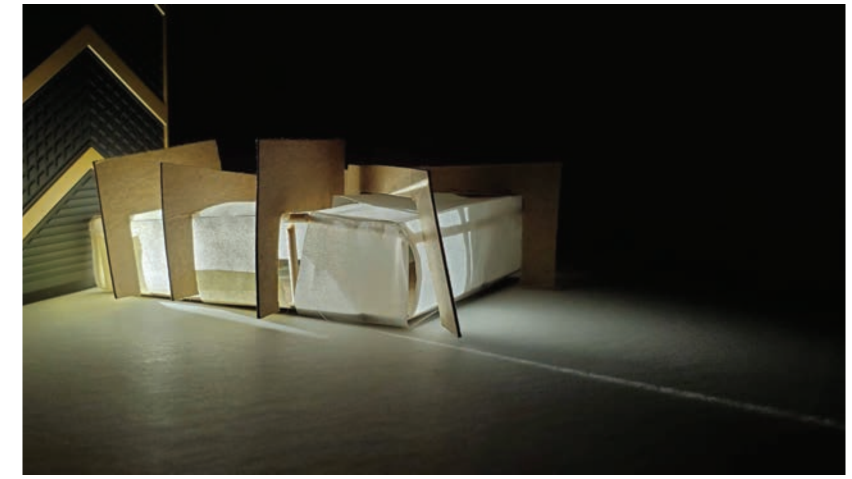




MODELS

Physical models completed during the semester aided in figuring out spatial layouts and light conditions in specific spaces.

FIGURE 55 | Models



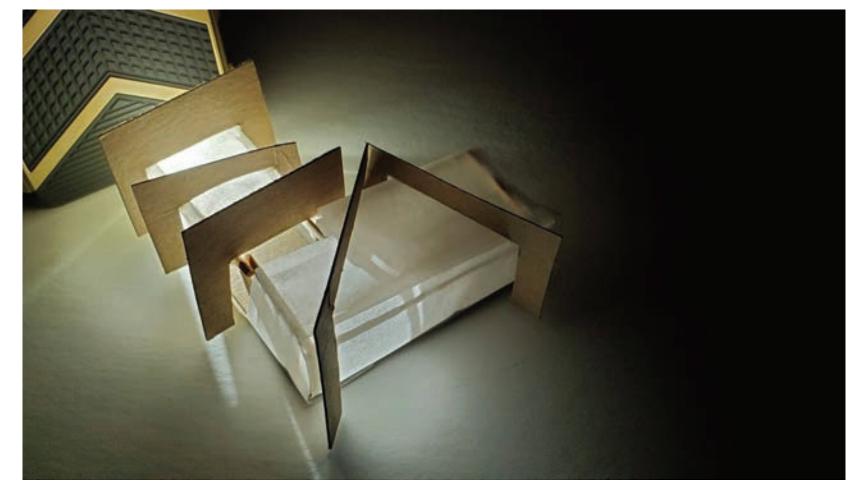


FIGURE 56 | Board

RESPONSE TO THE SITE OR CONTEXT

The building wraps around the site while also being embedded in it. Wind paths and sun access both played large roles in planning spaces and the cut throughs into the basin as to not create wind tunnels or large swaths of shade over spaces that need more light.

The location is well known for its stargazing and photography potentials. The complex includes walking paths, viewing areas, a Doppler radar, and wind turbines.

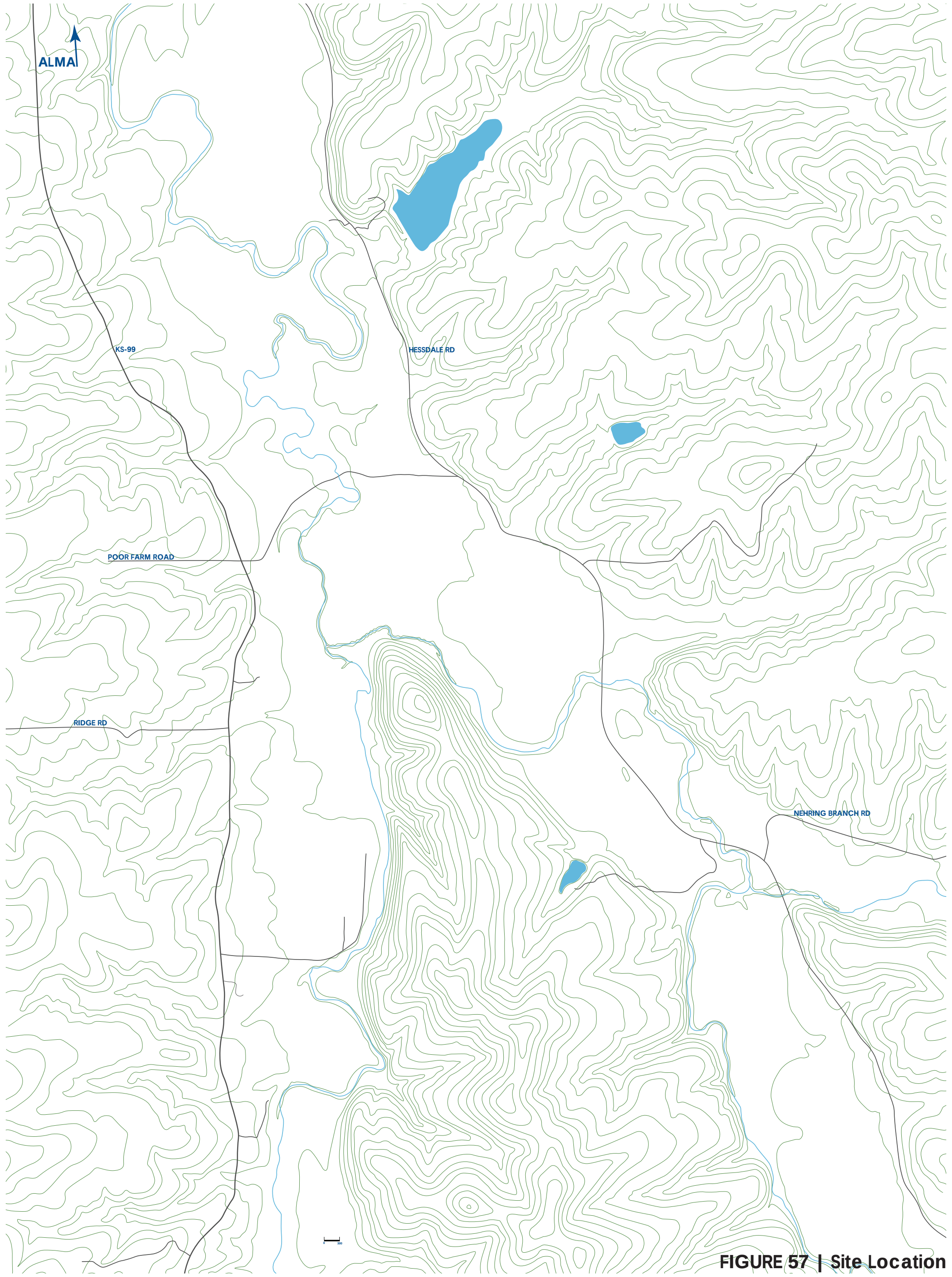


FIGURE 57 | Site Location

FIGURE 58 | Sections

Slim building forms hug the hillside creating a 360° view of the surrounding valley. Flint outcroppings and the stratification of rock became the primary driving force of the form.

Inspired by Jai Prakash Yantra, an Indian structure that tracks the suns movement and other celestial bodies, the basin takes shape to center the form at the top of the hill, creating a space of experience.

Rotated squares based of these points create the rough shapes of the footprint. Elevation changes shift the squares vertically to create a layering effect of the spaces.

14 pulsars, rapidly spinning dying stars that emanate distinctive pulses relative to our planet, was created as a way of other intelligent life to find us. These pulsars became the points at which major elements began.

The building sits at a peninsula of the region, both becoming highly visible and allowing the best views.

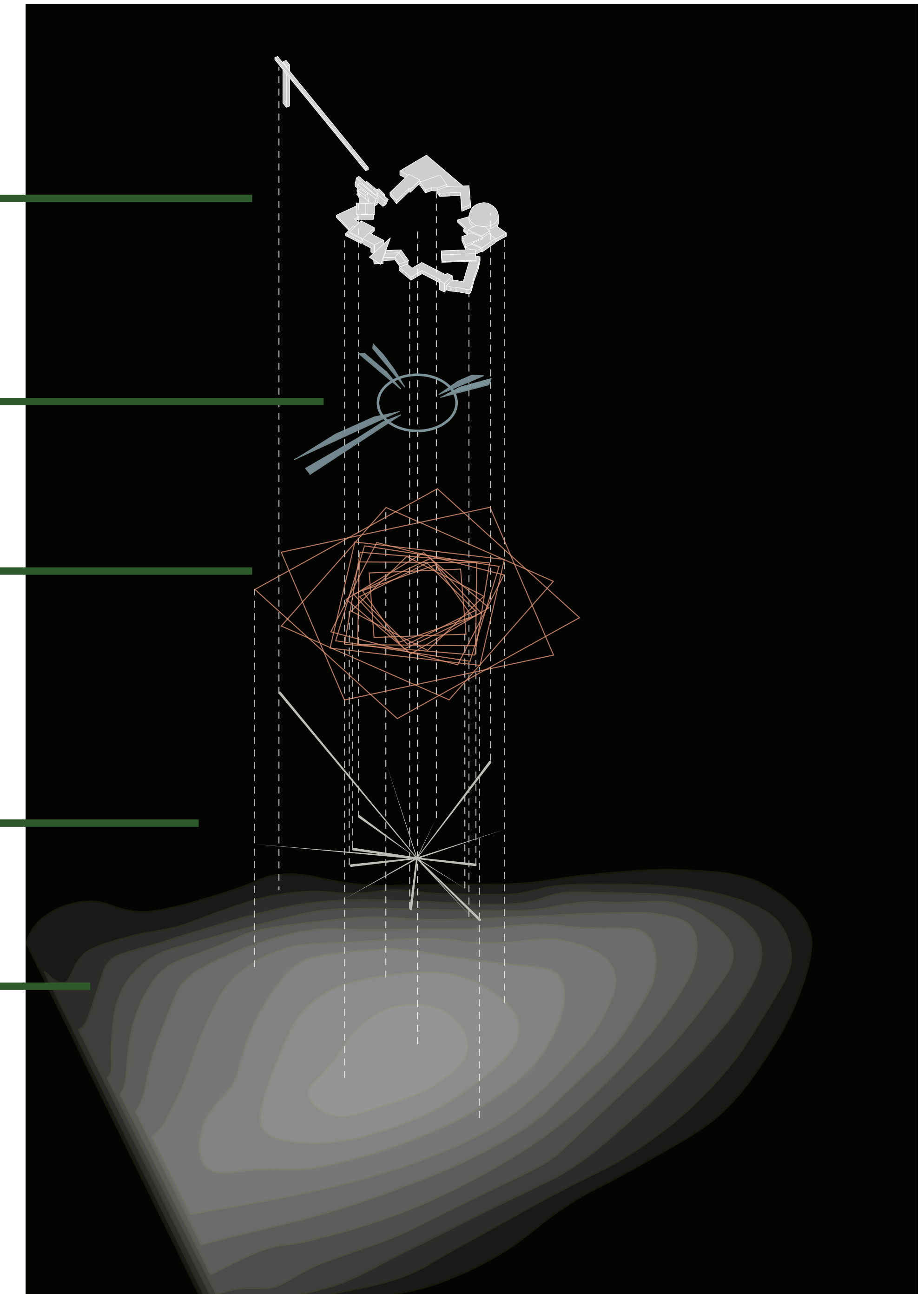


FIGURE 59 | Form Inspiration Diagram

FIGURE 60 | Sitre Plan

RESPONSE TO THE TYPOLOGICAL AND PRECEDENT RESEARCH

Responses from the precedent research took the forms of:
Site specific materials from the Aldo Leopold Center, regional architecture from the Theodore Roosevelt Library, planetarium and sustainable practices from the Bell Museum, and labs from the weather center. Each of these was adopted to the needs of the project and location.

Circulation and connections from the original spatial planning changed the most with the addition of the basin that ties the complete together. Some spaces moved closer while some have indirect paths that require the visitors to go outside to each of them without going through other spaces.

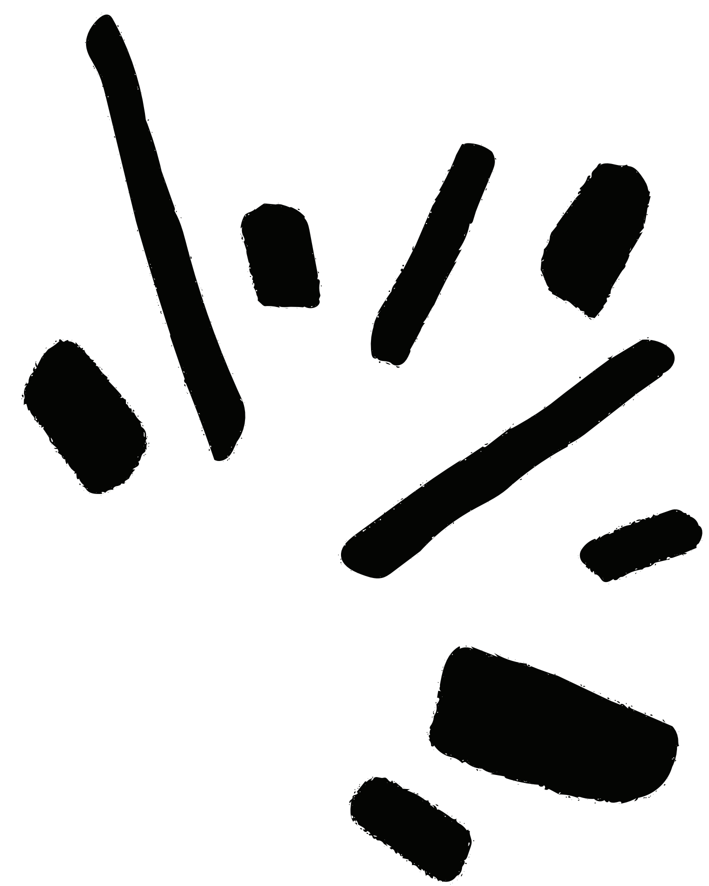


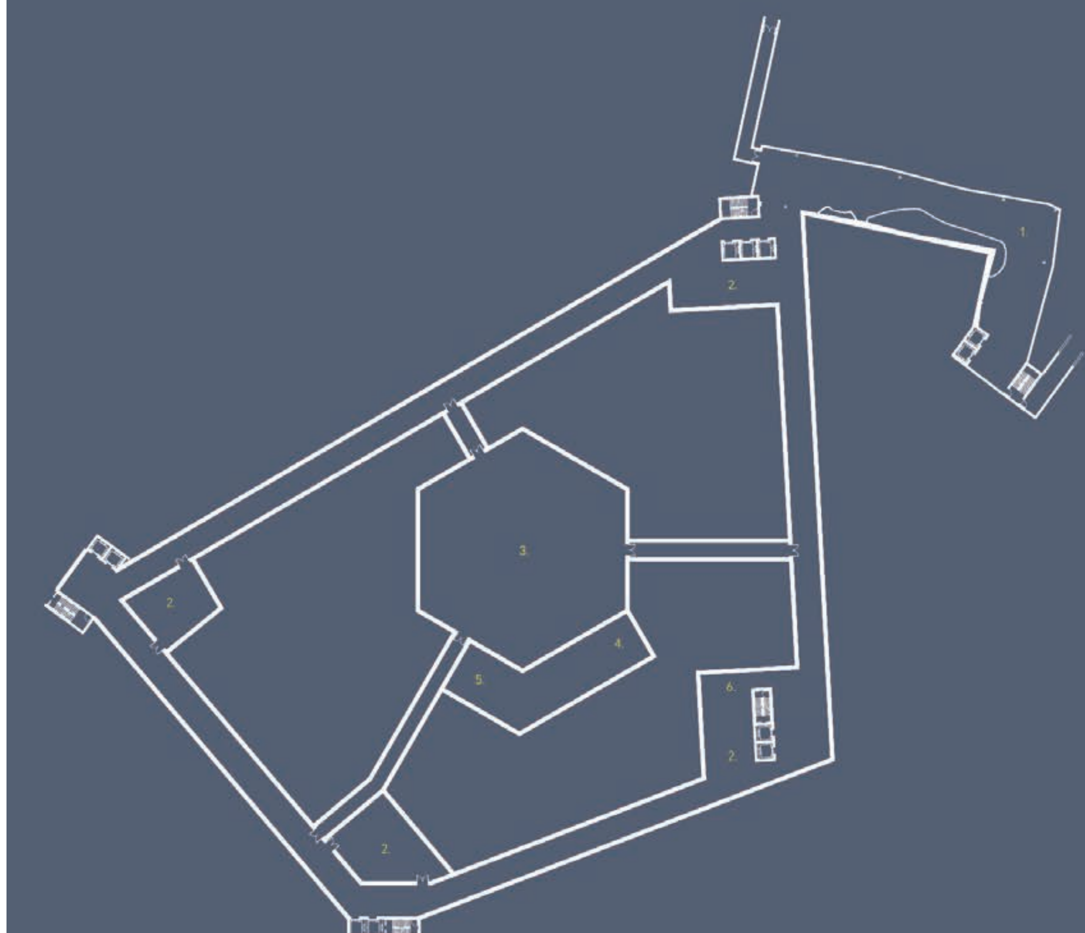
FIGURE 61 | Form Sketch

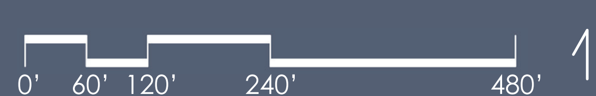
FIGURE 62 | Earth Gallery

FIGURE 63 | Space Gallery

FIGURE 64 | Entry


FIGURE 65 | Laboratory





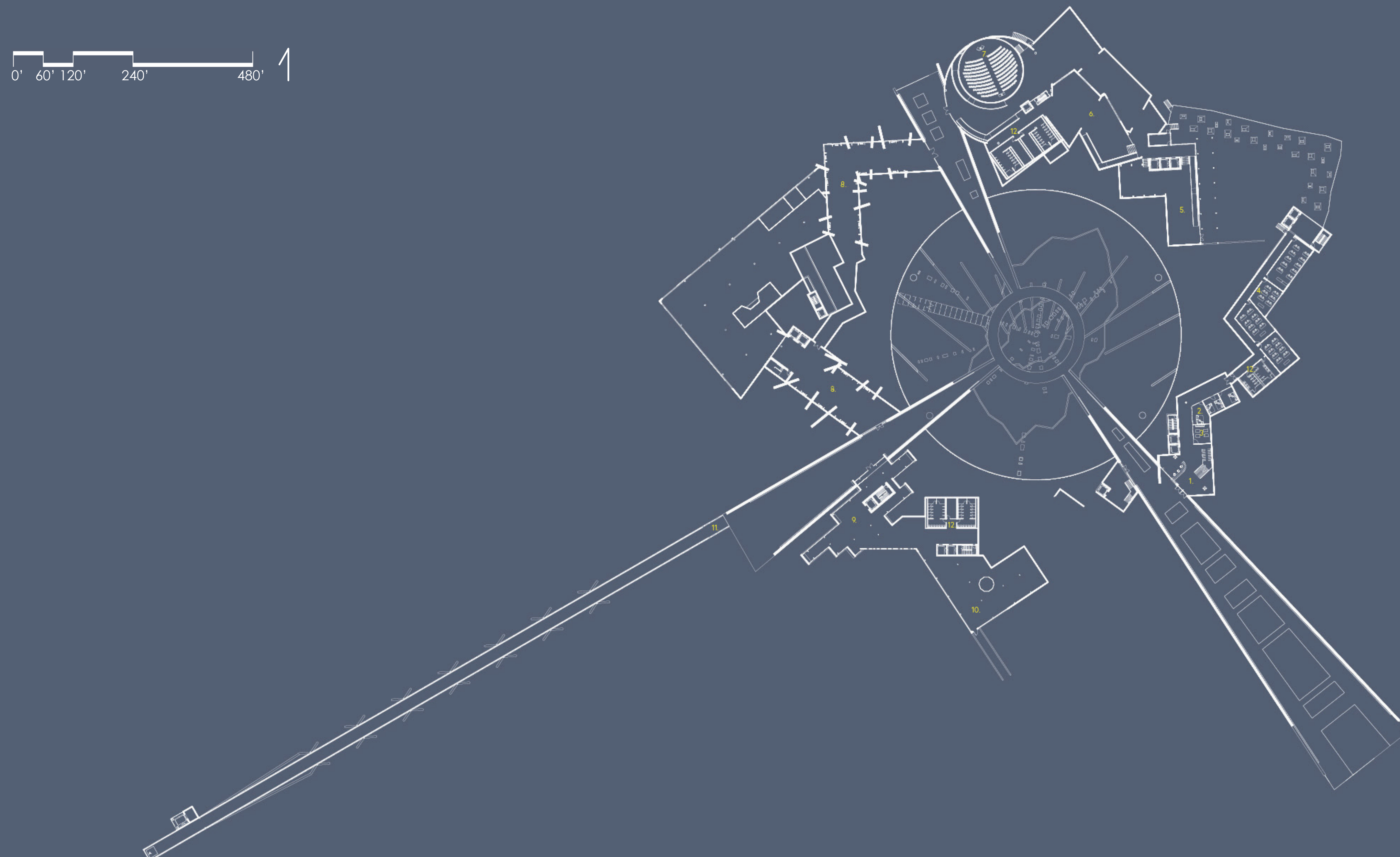
L. 01

1. earth gallery
2. weather shelter
3. mechanical/sustainable systems
4. water storage
5. battery storage
6. storage

L. 02

1. laboratory
2. lab offices
3. wind tunnel
4. private staff entrance
5. tour entrance

FIGURE 66 | Plans



L. 03/4/5

1. entry/reception
2. staff offices
3. freight staging
4. classrooms
5. event space
6. space gallery
7. planetarium
8. sky gallery
9. lower viewing
10. demo labs
11. solstice bridge
12. restrooms

FIGURE 67 | Plans

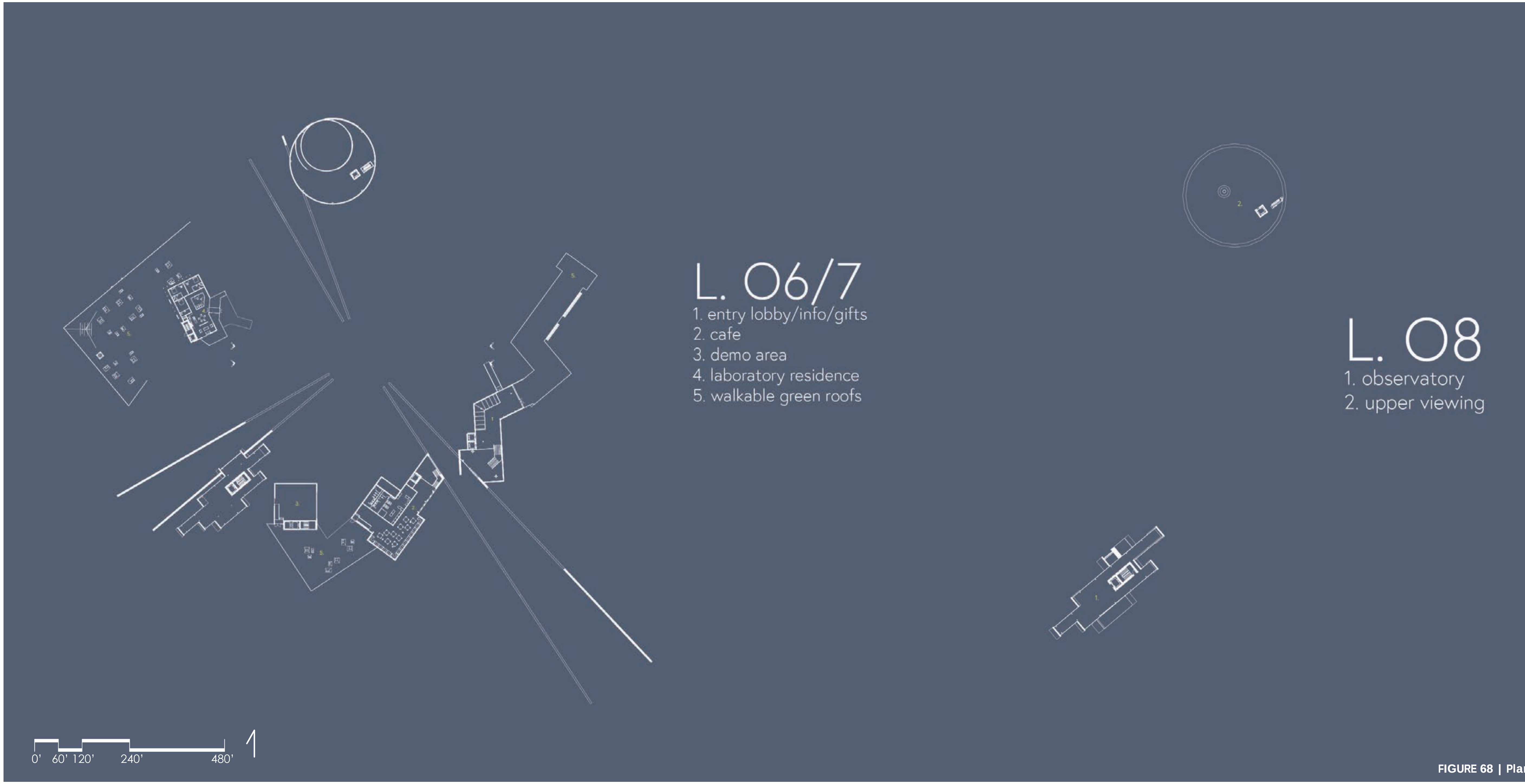


FIGURE 68 | **Plans**

THE ACADEMIC

Through readings and referencing charts, I learned a lot about how to design for the climate and how all these systems can work together.

THE PROFESSIONAL

Areas that had lots of glass or spaces that needed more artificial light had to be balanced to make sure that energy produced by the building would be enough to support it on most days.

THE PERSONAL

Each aspect here I feel as though I have accomplished in one way or another. I am pleased with the overall quality of the project and had time to explore what I wanted to.

CLIMATE CHANGE

The flexible lab space and demo spaces combined with radars and weather detection methods create the perfect opportunity for a wide variety of study into natural phenomena.

SUSTAINABLE DESIGN

By integrating sustainable design techniques into the building form and plans, i.e., the living machine pond and shallow footprints for daylight, the building becomes a learning tool itself.

INTEGRATED LANDSCAPING

Minimal height and earth insulation blend the building into its surroundings while still providing views and experiences in all directions.

SEVERE WEATHER CONSTRUCTION

Extra strong glass and a robust structural system create spaces that are able to stand up to less-than-ideal weather without inhibiting the aesthetics of the spaces.

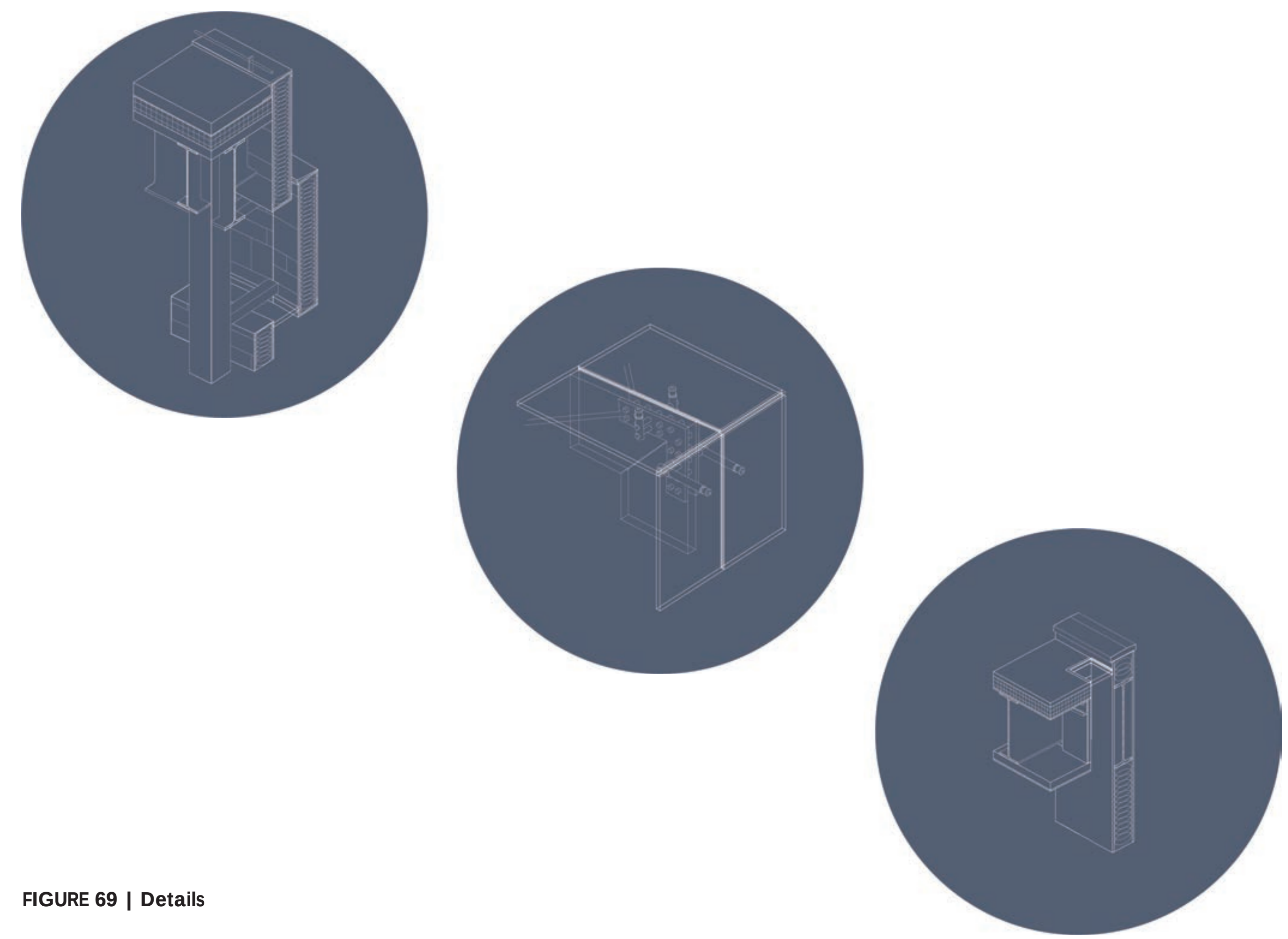


FIGURE 69 | Details

FIGURE 70 | Basin

FIGURE 71 | Sky Gallery

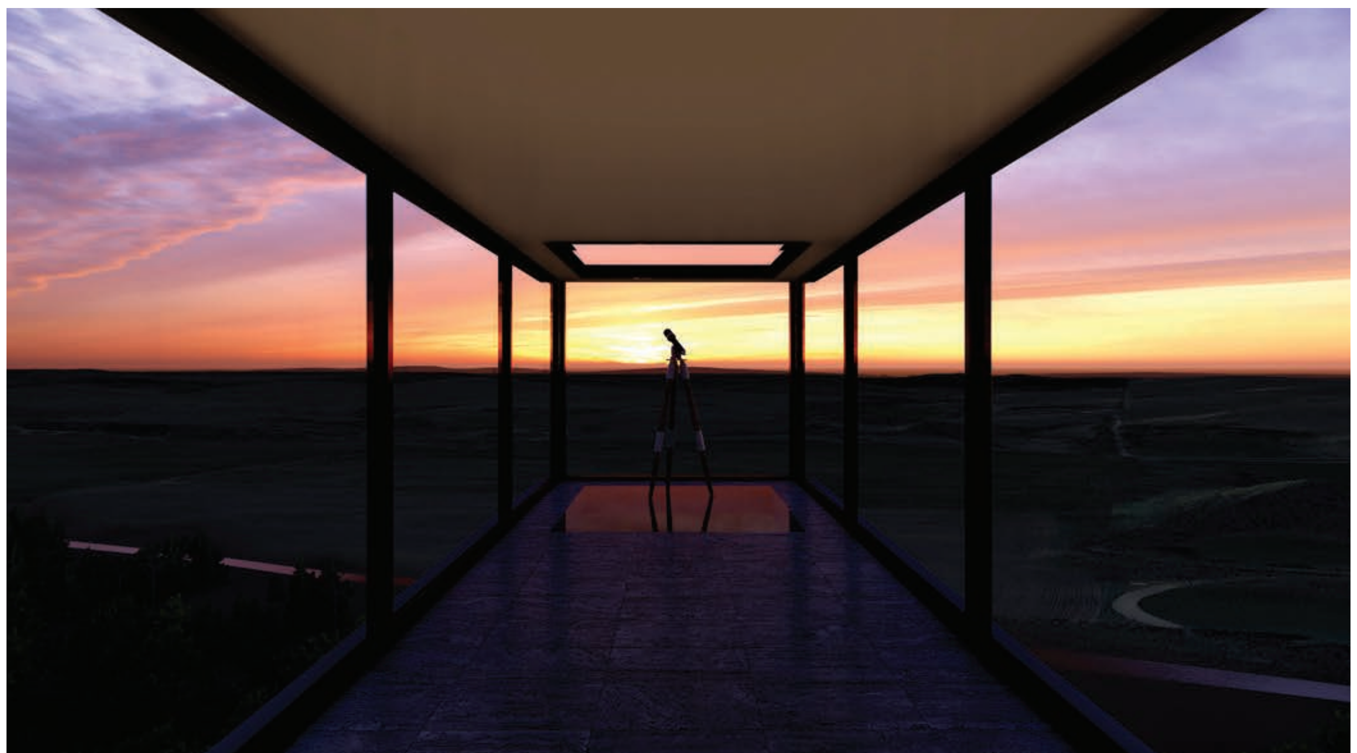


FIGURE 72 | horizontal Viewing

FIGURE 73 | Vertical Viewing

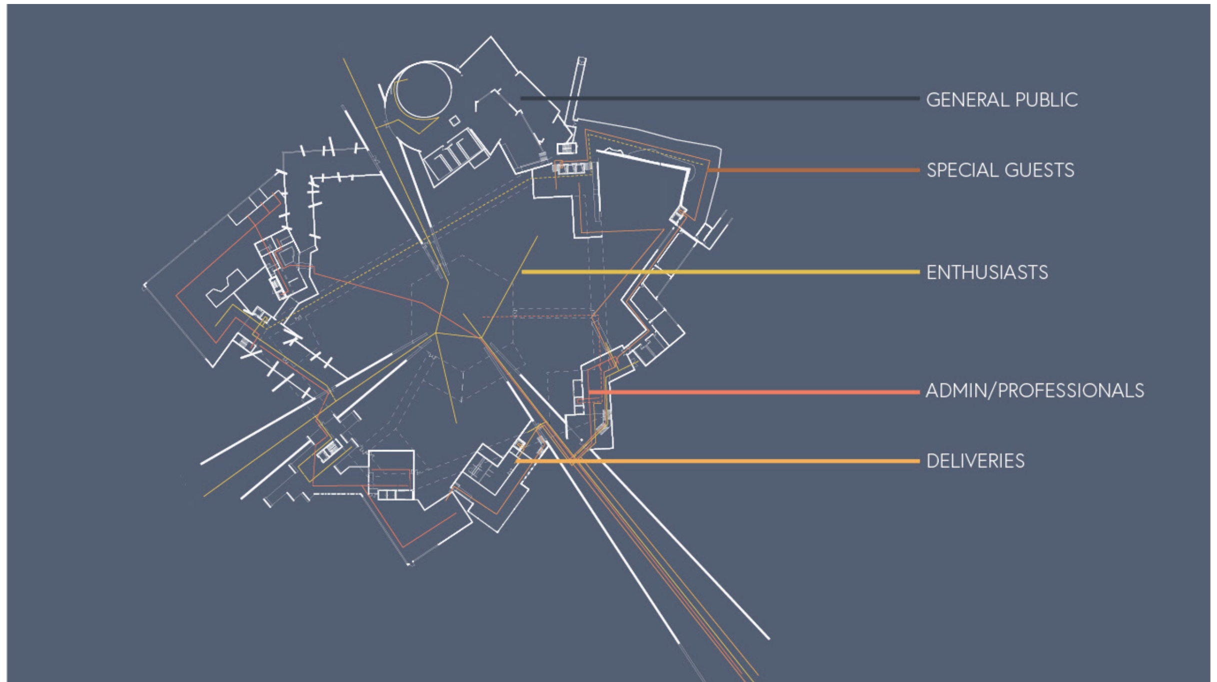


FIGURE 74 | Circulation

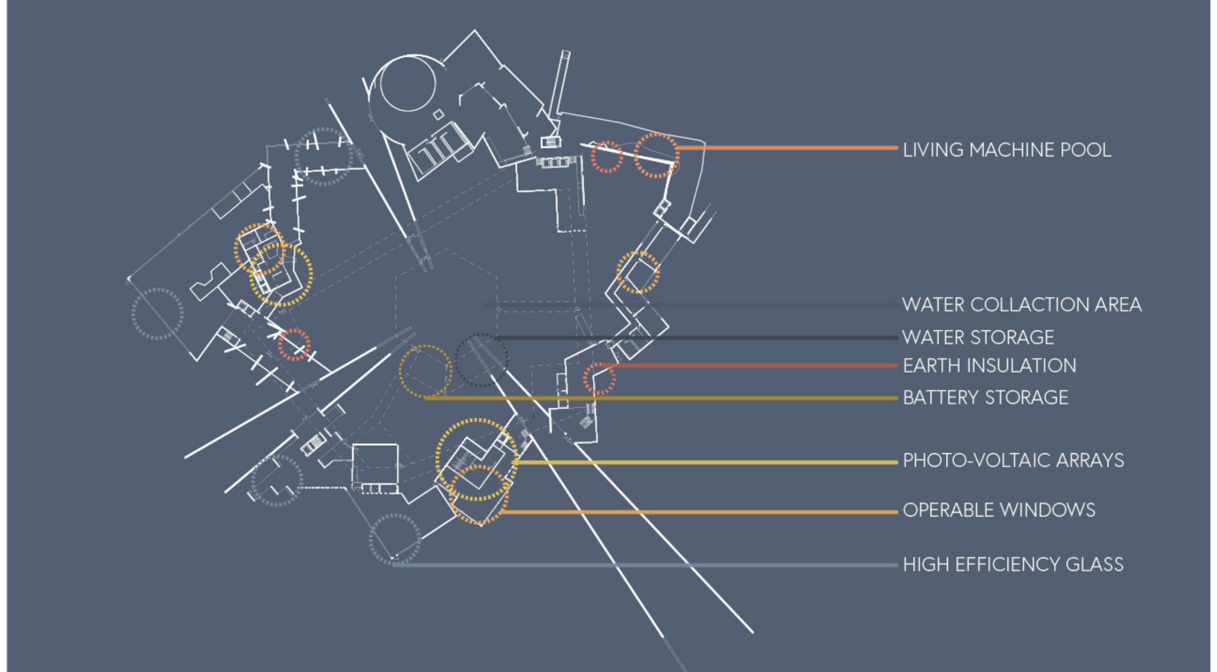


FIGURE 75 | Sustainability

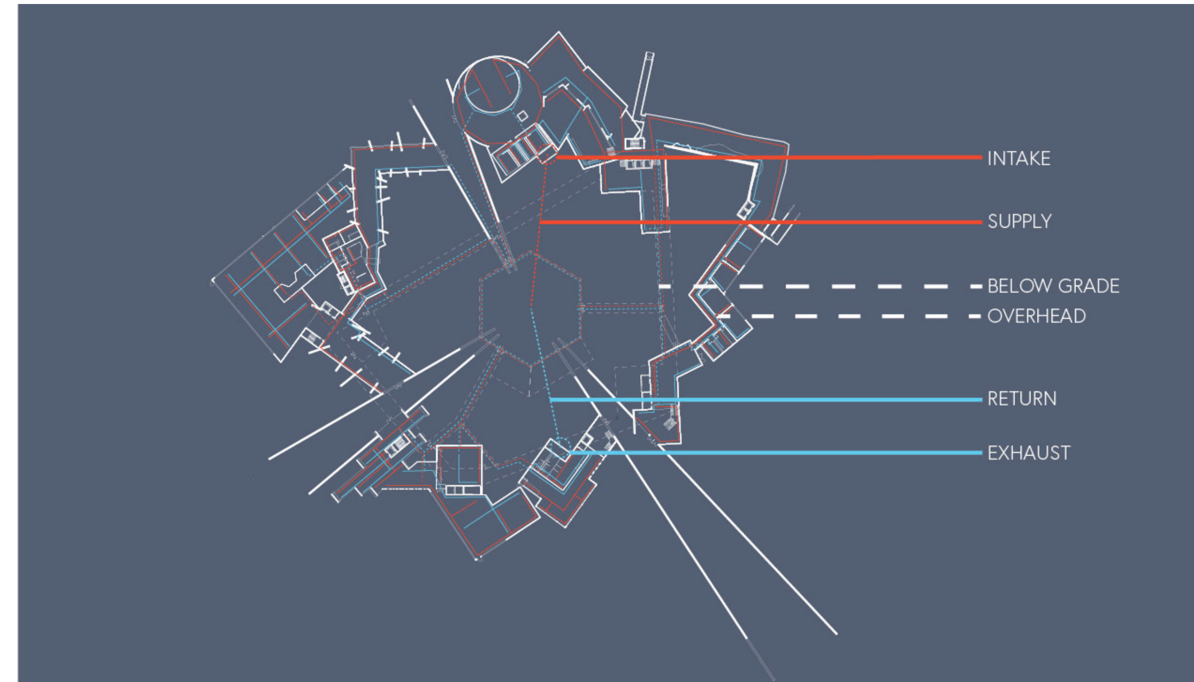


FIGURE 77 | HVAC

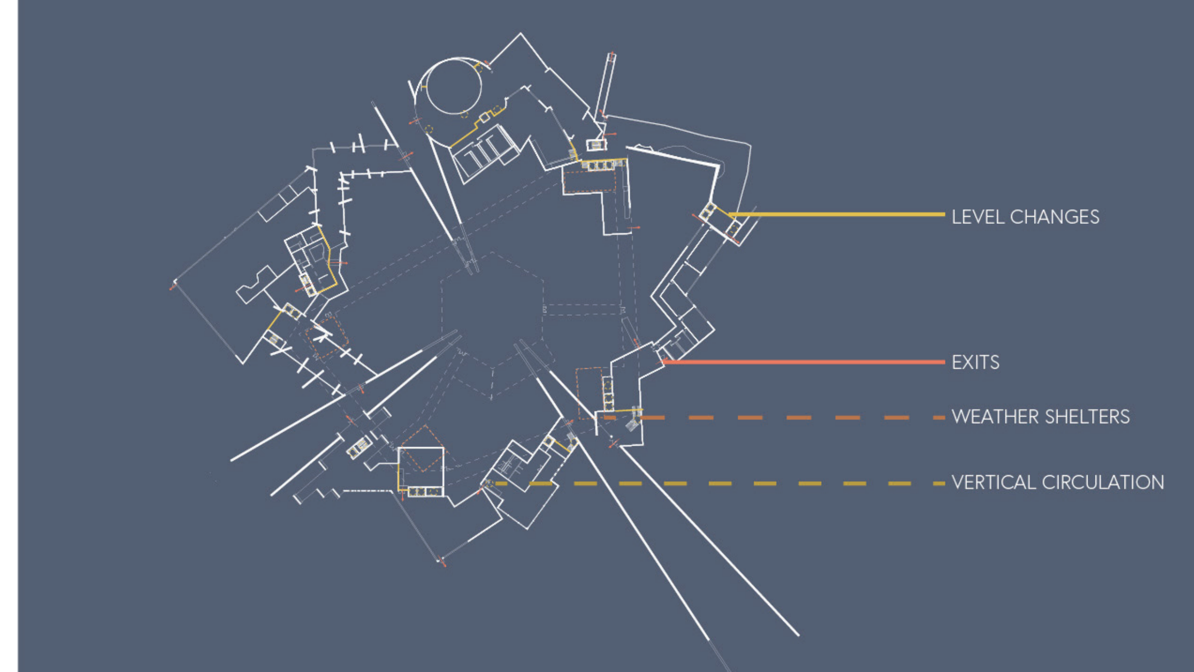


FIGURE 76 | EGRESS

MATERIALS

Large swaths of trees and rocks had to be removed for the building site. Any trees that were not able to be replanted were cut up and used as flooring, siding, or structural elements throughout the project. Stone quarried on-site was used as exterior cladding and tiling. The steel and concrete structure is strong enough to withstand tornado-strength winds and impacts and provide shelter to inhabitants in the event of a storm.

ENERGY AND WATER

High efficiency Photo-Voltaic arrays and vertical axis wind turbines are used to generate 400,000 kWh of electricity per year for the complex. Energy use is reduced by shallow floor plans and LED lighting which allow ample daylighting and low-energy artificial lighting. Additionally, the building is capable of catching roughly 1.3 million gallons of water per year.

HEATING AND COOLING

Ground source heat pumps and earth tubes provide year-round climate control. Enhanced filtering systems eliminate mold and other unwanted particles. Operable windows and night ventilation reduce the amount of energy required for heating and cooling.

SYSTEM INTEGRATION

Permeable surfaces, butterfly roofs, earth insulation, and material usage are different sustainable systems integrated into the building forms. They provide elegant shapes and spaces while serving a second function. The sustainable practices and interior spaces of this project earn the Gold WELL Building standard.

CRITIQUE OF APPLIED RESEARCH METHODS USED IN THE THESIS PROJECT

Research methods used from readings and public opinion where very helpful in developing my project as the semester went on. Being able to visit the site and talk to residents would have been even more helpful to get input on design choices. Simple daylighting analysis in certain spaces helped with determining room configurations or opening sizes and locations to optimize natural light.

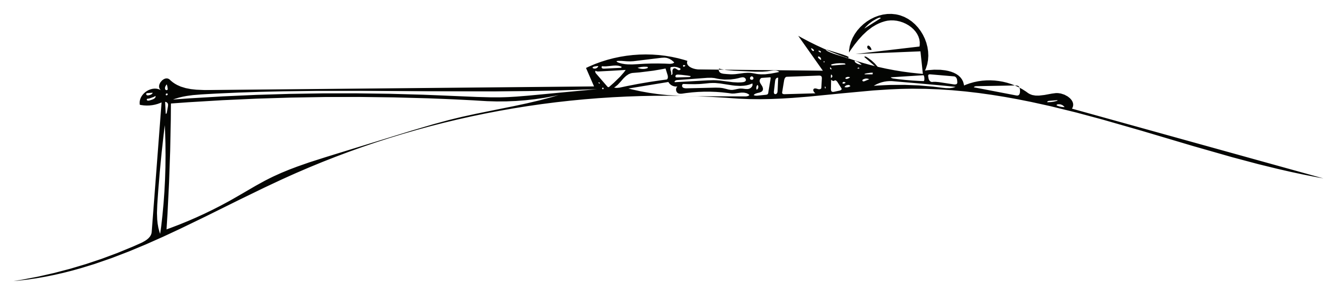


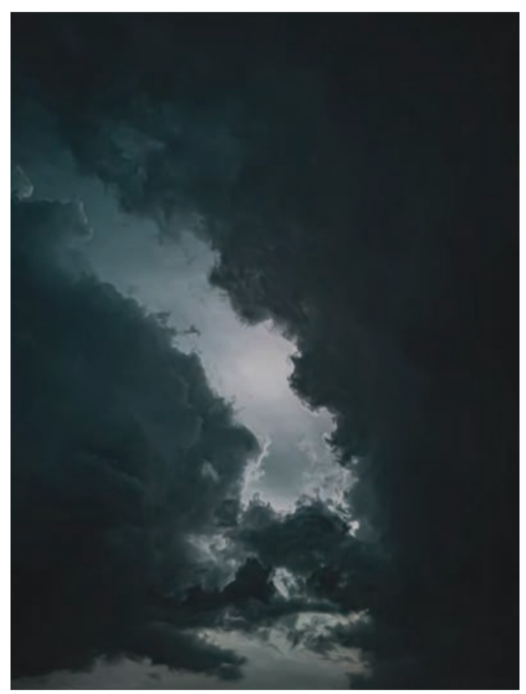
FIGURE 78 | Building Sketch

INSPIRATION

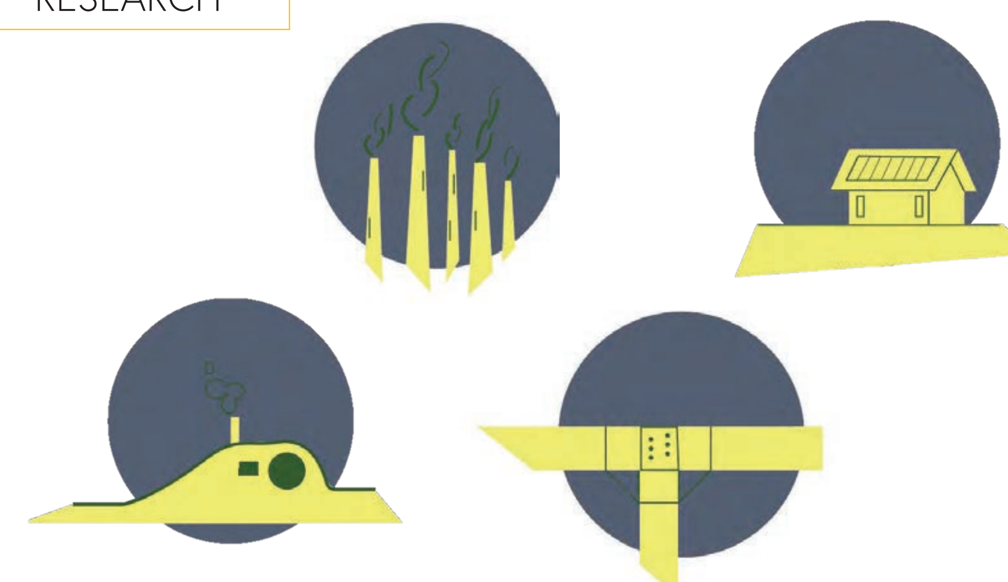
- FLINT
- KANDINSKY
- WEATHER
- JANTAR MANTAR

PREMISE

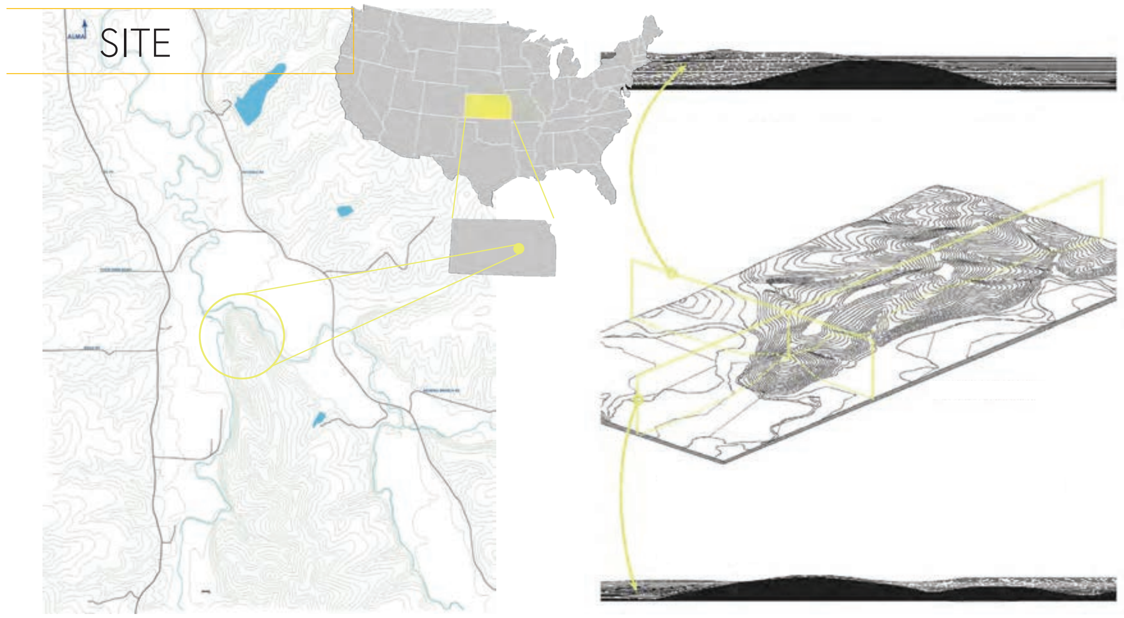
With our climate changing and a focus on more sustainable built projects, we can only wonder if these efforts are enough to offset the carbon footprint that architects create. Through the creation of a research facility to monitor and observe natural phenomena, researchers and the public can study and learn about the weather and climate that surround us. Educating people of all ages about the weather, climate change, and sustainable design will inspire new views of the world and actions to take care of it.



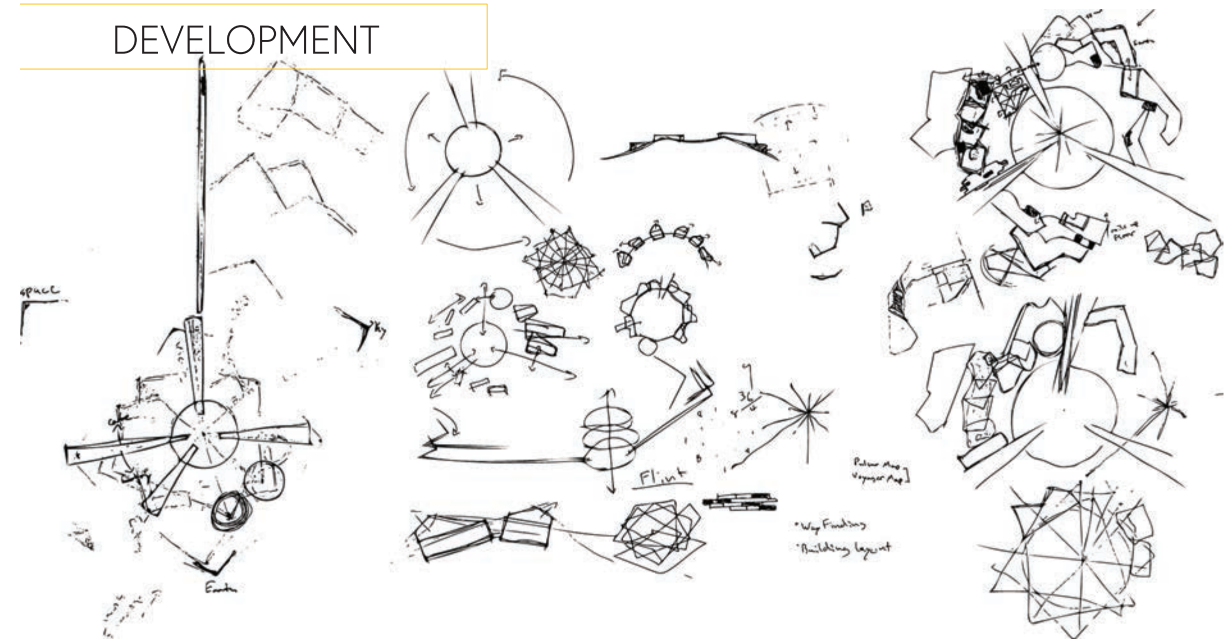
RESEARCH



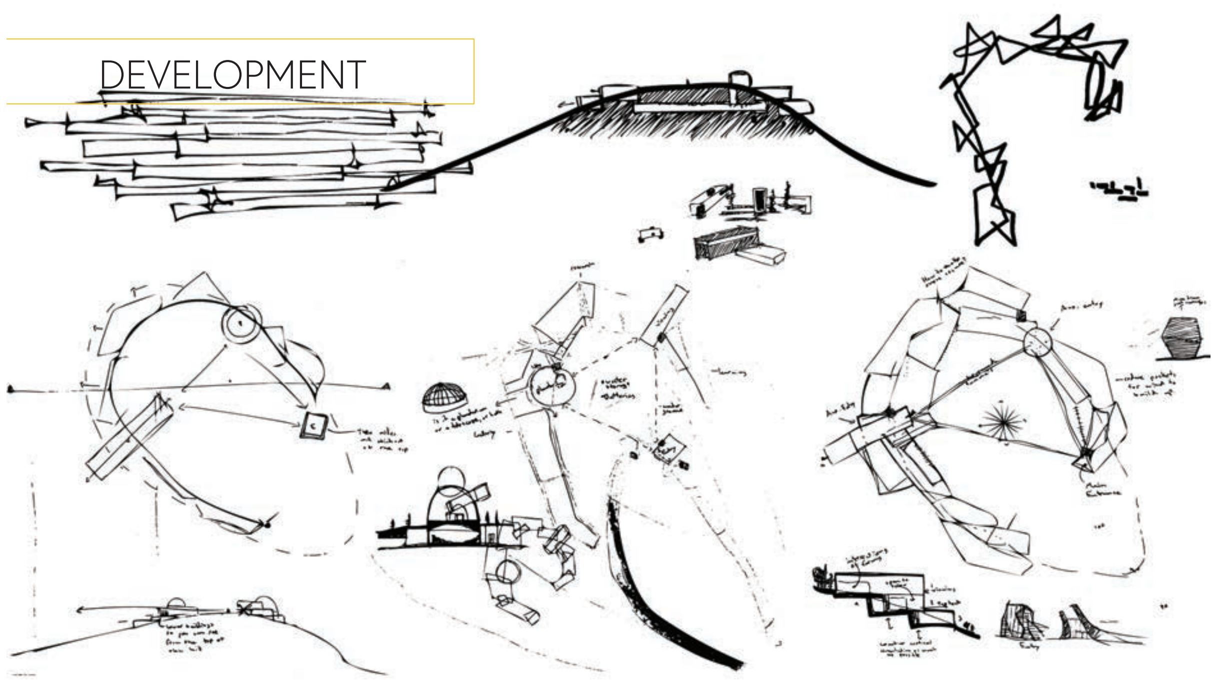
SITE



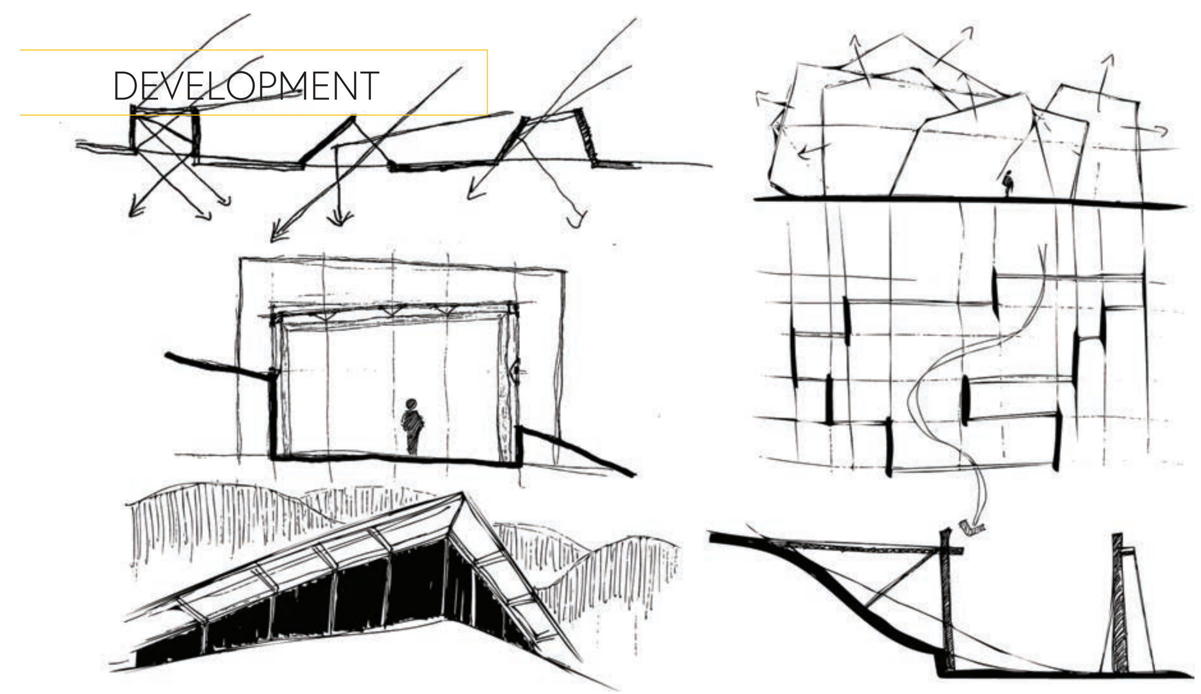
DEVELOPMENT



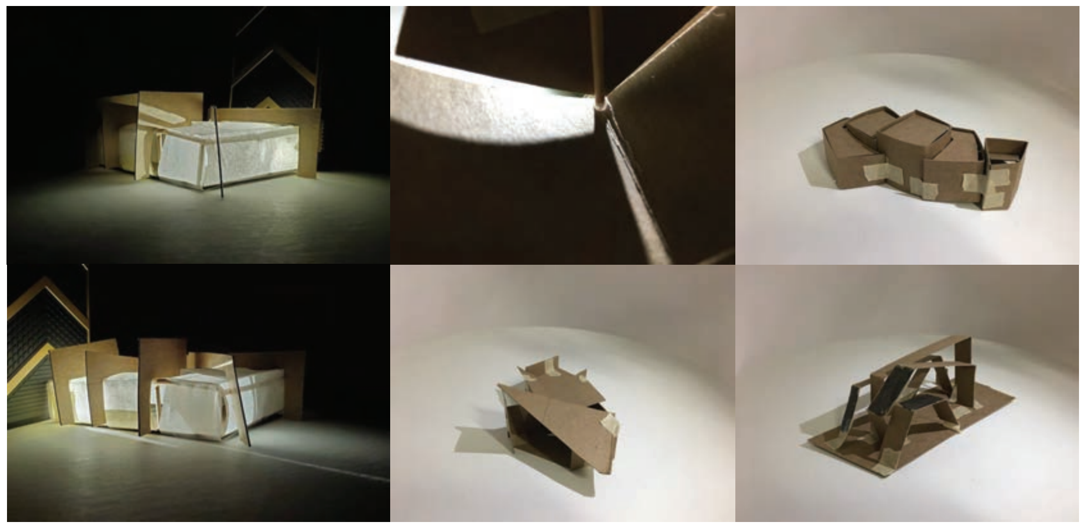
DEVELOPMENT



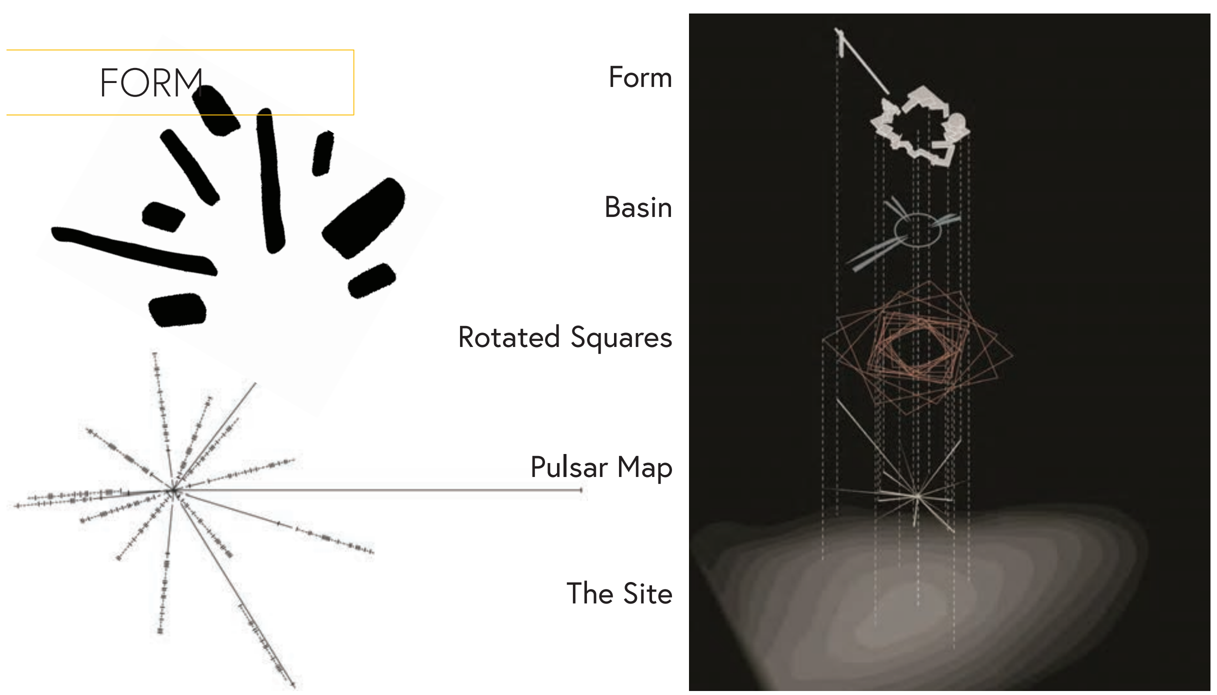
DEVELOPMENT



DEVELOPMENT

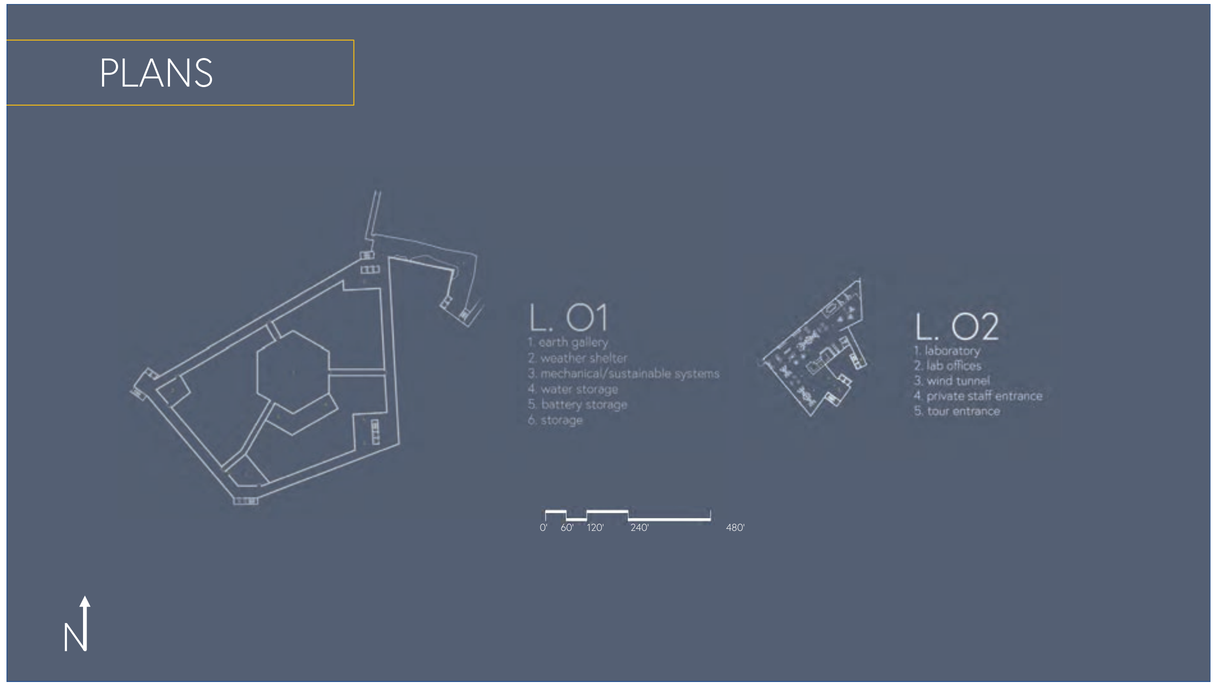


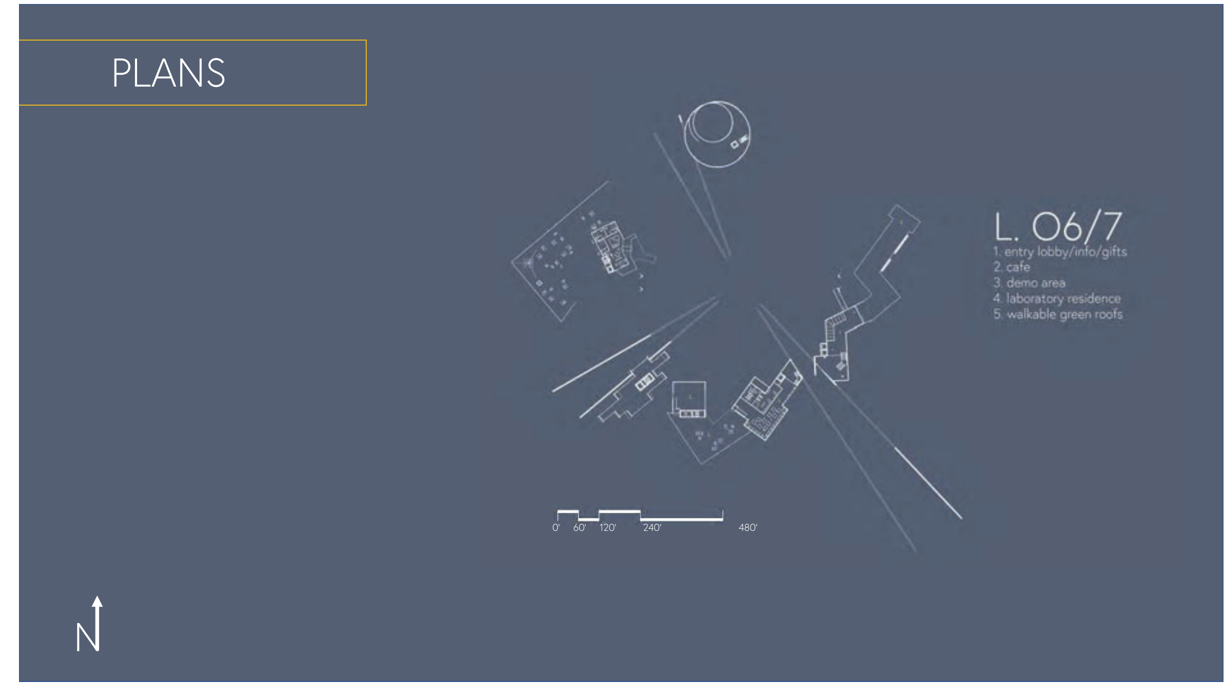
FORM

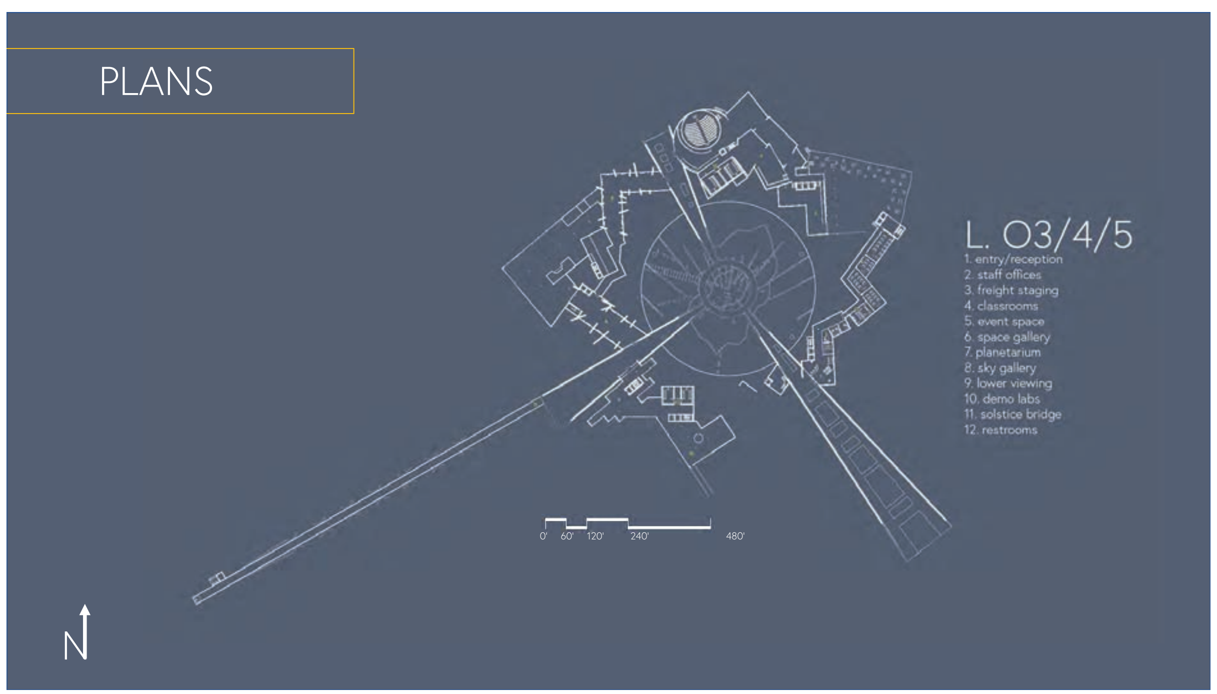


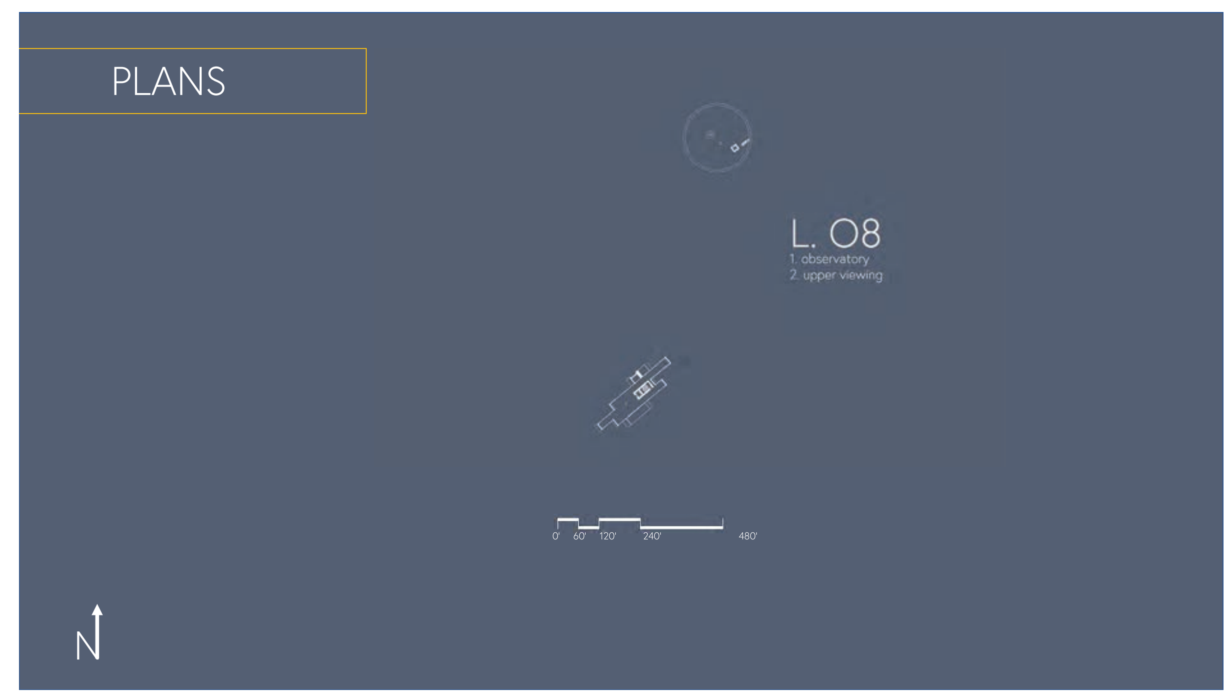
DESIGN SOLUTION

SITE PLAN


PLANS
L. O1
1. earth gallery
2. weather shelter
3. mechanical/sustainable systems
4. water storage
5. battery storage
6. storage
L. O2
1. laboratory
2. lab offices
3. wind tunnel
4. private staff entrance
5. tour entrance
0' 60' 120' 240' 480'
N


PLANS
L. O6/7
1. entry lobby/info/gifts
2. cafe
3. demo area
4. laboratory residence
5. walkable green roofs
0' 60' 120' 240' 480'
N

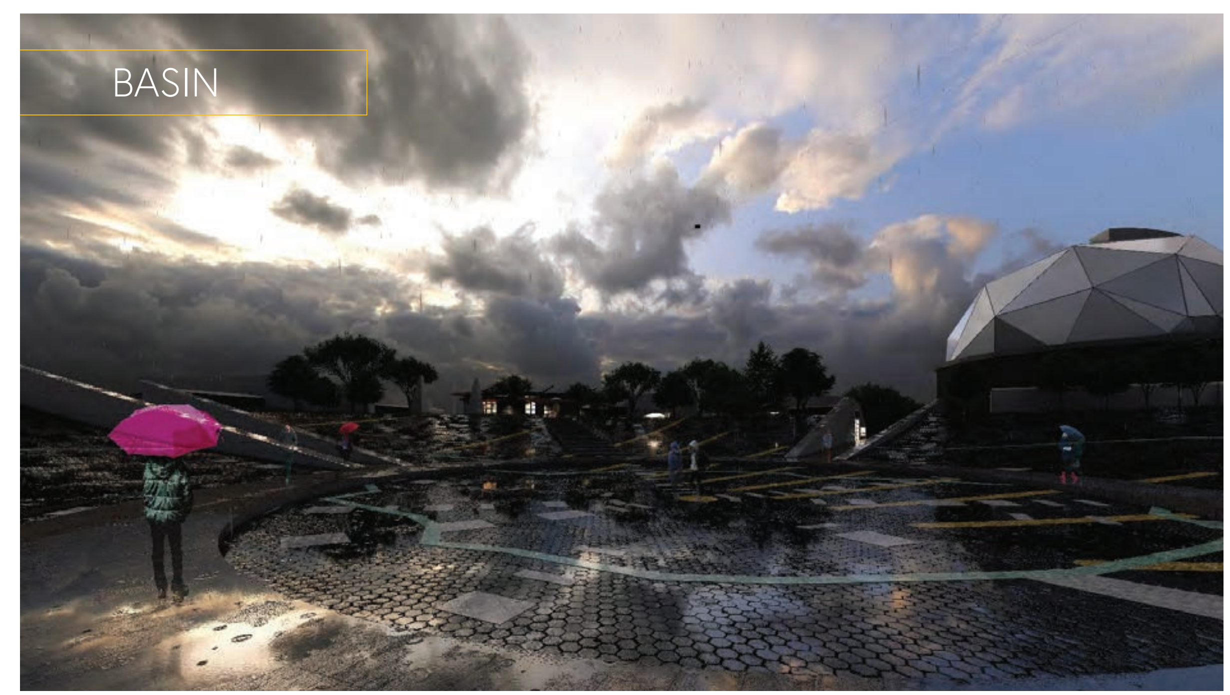

PLANS
L. O3/4/5
1. entry/reception
2. staff offices
3. freight staging
4. classrooms
5. event space
6. space gallery
7. planetarium
8. sky gallery
9. lower viewing
10. demo labs
11. solstice bridge
12. restrooms
0' 60' 120' 240' 480'
N

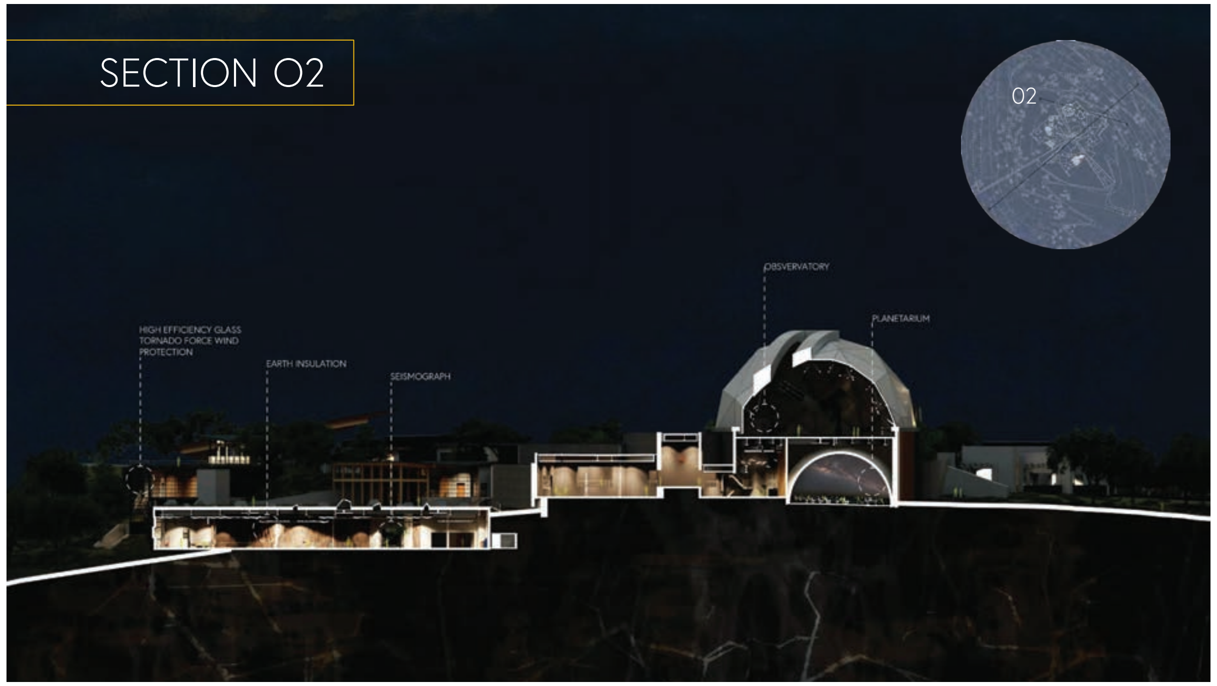

PLANS
L. O8
1. observatory
2. upper viewing
0' 60' 120' 240' 480'
N


SPACE

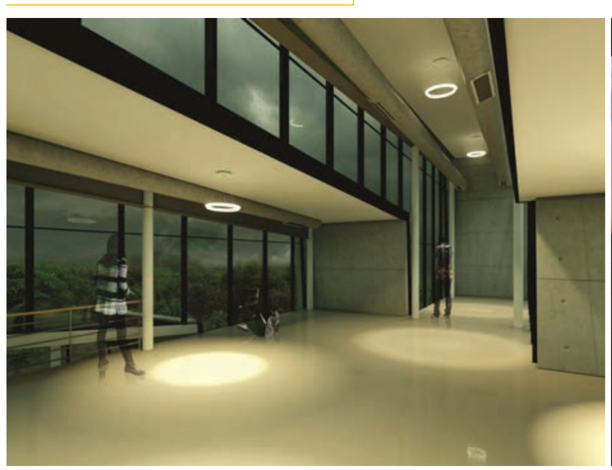

EARTH

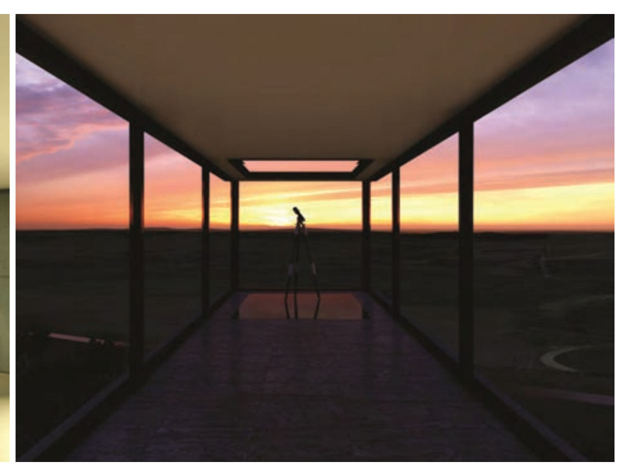

SKY


BASIN

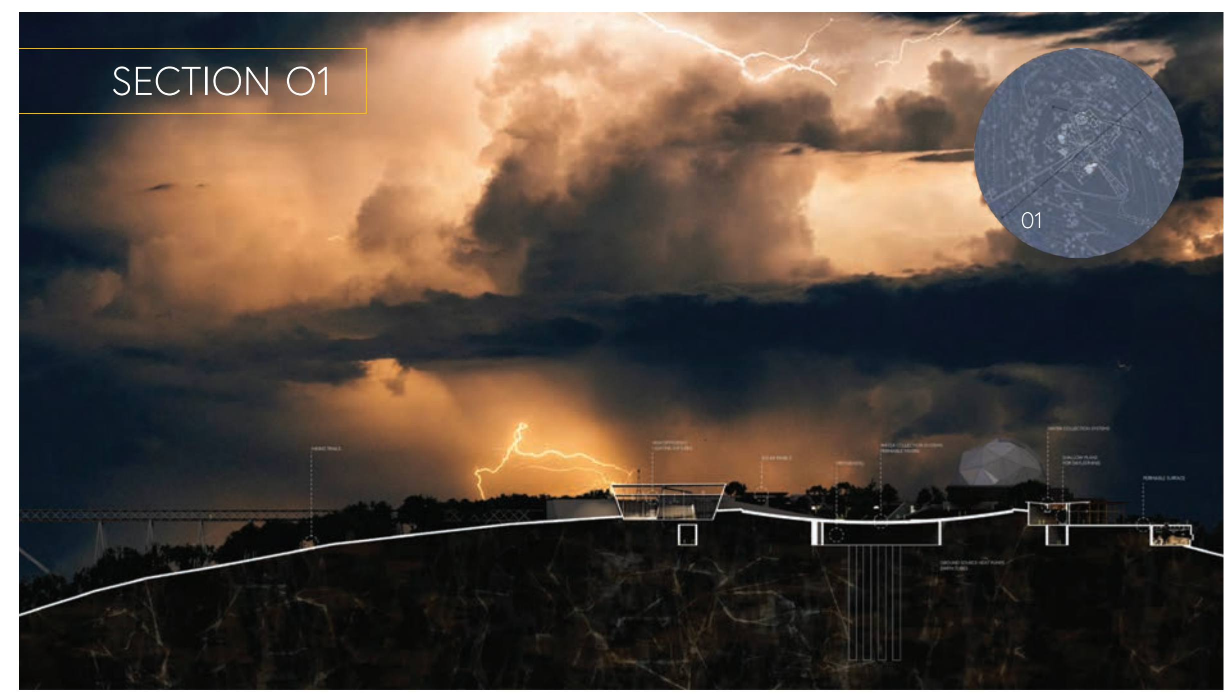


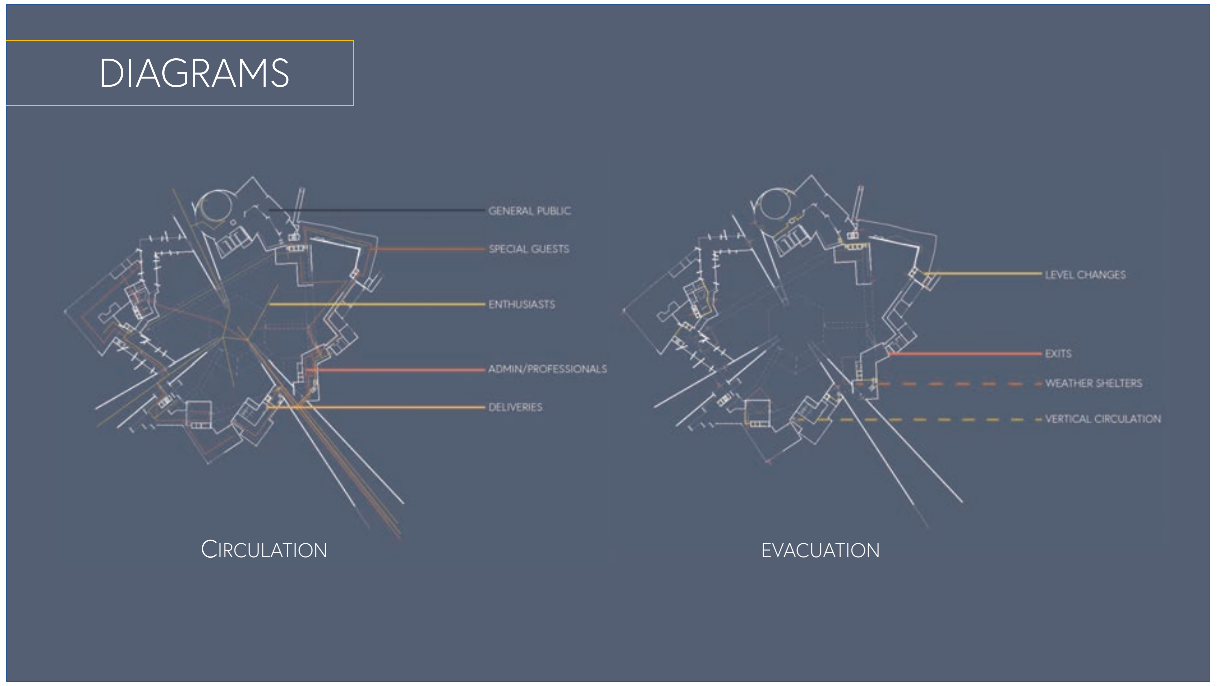
VIEWING

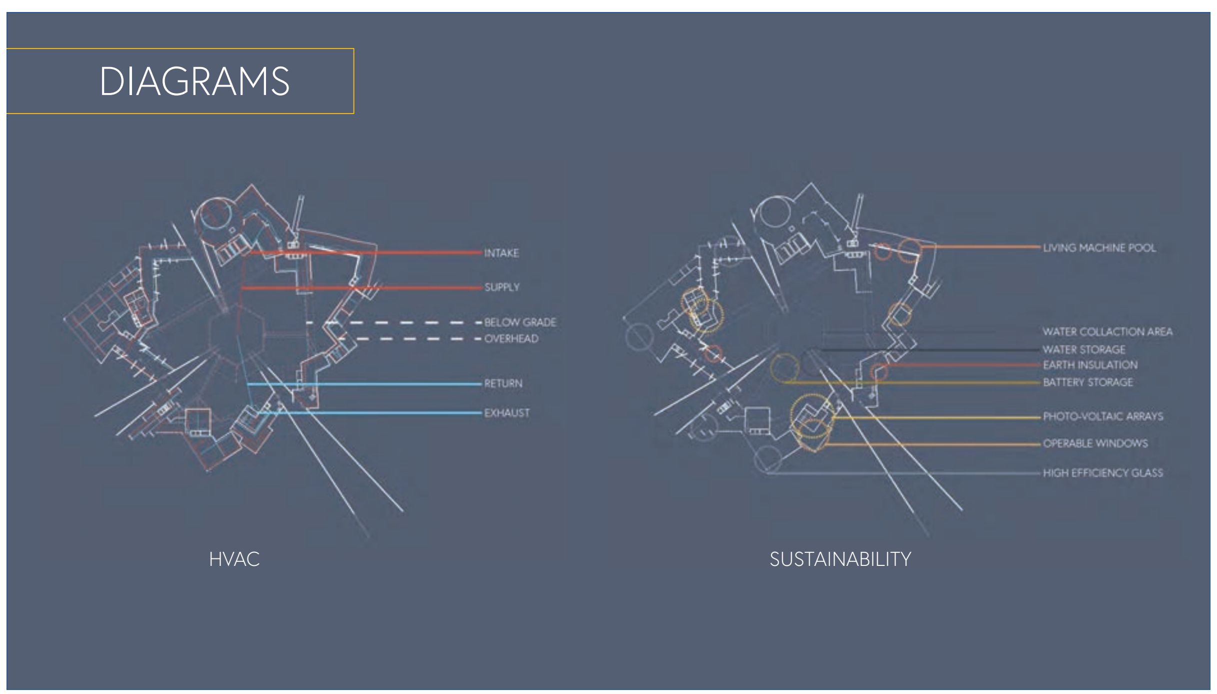


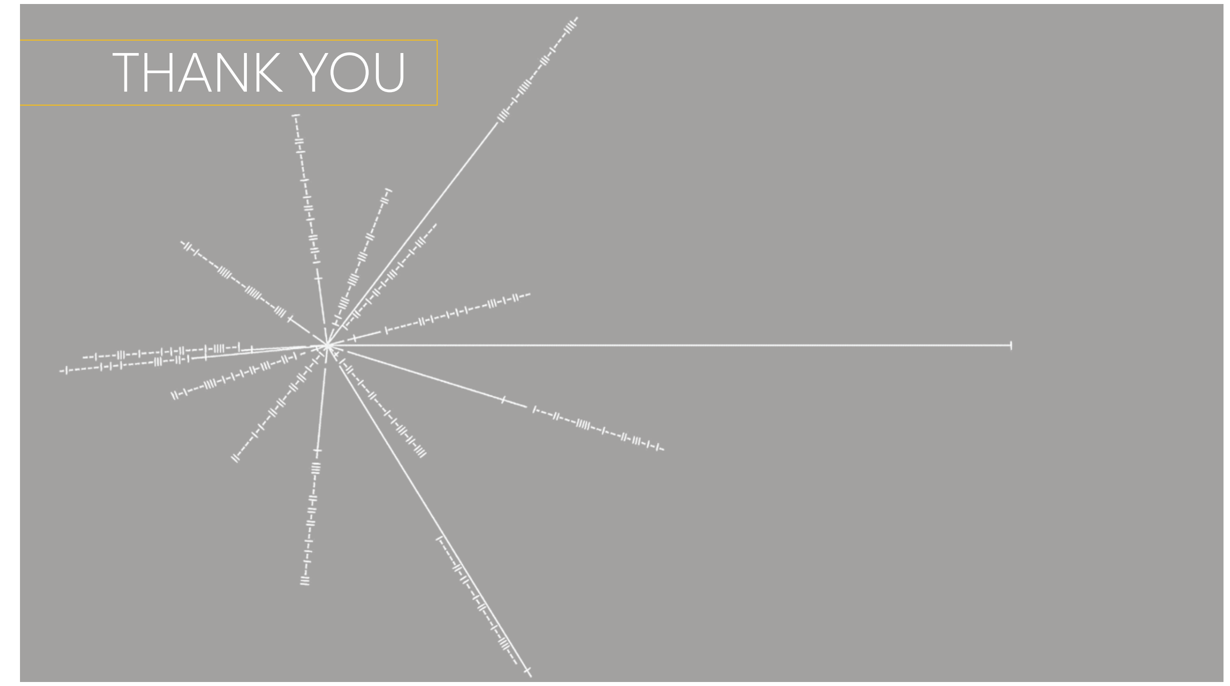


ENTRY | LAB




DIAGRAMS
GENERAL PUBLIC
SPECIAL GUESTS
ENTHUSIASTS
ADMIN/PROFESSIONALS
DELIVERIES
CIRCULATION
LEVEL CHANGES
EXITS
WEATHER SHELTERS
VERTICAL CIRCULATION
EVACUATION


DIAGRAMS
INTAKE
SUPPLY
BELOW GRADE
OVERHEAD
RETURN
EXHAUST
HVAC
LIVING MACHINE POOL
WATER COLLACTION AREA
WATER STORAGE
EARTH INSULATION
BATTERY STORAGE
PHOTO-VOLTAIC ARRAYS
OPERABLE WINDOWS
HIGH EFFICIENCY GLASS
SUSTAINABILITY


THANK YOU

REFERENCE LIST

2030 Challenges. (n.d.). Retrieved (20, Nov, 2020), from http://architecture2030.org/2030_challenges/

Altomonte, S. (2008). Climate Change and Architecture: Mitigation and Adaptation. Journal of Sustainable Development, 97-112.

Cutieru, A. (2020, October). Architecture and Nature: A Framework for Building in Landscapes. ArchDaily. Retrieved 20 Nov 2020. from <https://www.archdaily.com/950043/architecture-and-nature-a-framework-for-building-in-landscapes> ISSN 0719-8884

Flint Hills Discovery Center, KS: Official Website. (n.d) Flint Hills Discovery Center, KS | Official Website. Retrieved (5, Dec, 2020) from: www.flinthillsdiscovery.org/.

Flint Hills: Rocks and Minerals. (1999). Kansas Geological Survey. Retreived (14, Nov, 2020) from: https://geokansas.ku.edu/sites/default/files/docs/FH_factsheet1.pdf

Gonchar, J. (2014). Approaching Zero. Architectural Record, 202(10), 172.

Herzmann, D. (n.d.) IEM: Site Wind Roses. Iowa Environmental Mesonet. Retreived (12, Nov, 2020) from: mesonet.agron.iastate.edu/sites/windrose.phtml?station=FRI.

Historical Overview of Meteorology in America. (n.d.). Colby College. Retrieved from http://www.colby.edu/sts/97guide/history.html

History.com Editors. (2017, Oct). Climate Change History. History.com, A&E Television Networks. Retrieved (22, Nov, 2020) from: www.history.com/topics/natural-disasters-and-environment/history-of-climate-change.

Hoy, J (2020). Flint Hills History and Folklife. Emporia State University. Retrieved (22, Nov, 2020) from https://www.protecttheflinthills.org/information/Flint%20Hills%20History.pdf

IMO. (2014). Works - Weather Station. Retrieved September 29, 2020, from IMO Creations: https://imocreations.com/works/weather-station/

Krueger, J. (2008, May). 2008 Top Ten Winners - Aldo Leopold Legacy Center. Retrieved September 28, 2020, from The American Institute of Architects: https://www.aiatopten.org/node/135

Kubla Washatko Architects. (2008). Leopold Legacy Center. Retrieved September 30th, 2020, from The Kubla Washatko Architects: http://tkwa.com/leopold-legacy-center/

Latham, A (2020, May). Designing Sustainable Architecture for Natural Disasters. Latham-Australia. Retrieved 20 Nov 2020 from https://www.latham-australia.com/blog/design-buildings-extreme-weather

Miller, K. (2011, Oct.). Geology of the Kansas Flint Hills: Ancient Ice Ages, Sea Levels, and Climate Change. FlintHillsGuide, Retrieved (14, Nov, 2020) from: www.scifaithkansas.net/guide/FlintHillsGuide.html.

NOAA. (2000-2020). Maps & Data. Retrieved September 20, 2020, from Climate.Gov: https://www.climate.gov/maps-data/data-snapshots/start

Olgyay, V., & Olgyay, A. (1963). Design with climate: bioclimatic approach to architectural regionalism. Some chapters based on cooperative research with Aladar Olgyay. Princeton University Press.

Snohetta. (2020). Projects - The Theodore Roosevelt Presidential Library Competition. Retrieved October 5th, 2020, from Snohetta: https://snohetta.com/projects/512-the-theodore-roosevelt-presidential-library-competition

Will, Perkins &. (2018). Works - University of Minnesota Bell Museum. Retrieved October 7th, 2020, from Perkinswill.com: https://perkinswill.com/project/bell-museum/

IMAGE REFERENCE LIST

Delorme (2020). Keeling Curve. [Graph]. Retrieved from https://commons.wikimedia.org/w/index.php?curid=40636957

Flint Hills Archaeological Conference. (2020). Munkers Creek dart points. [Picture]. Retrieved from http://www.flinthillsarchconf.info/final-program-and-abstracts

GISGeography (cartographer). (2020). Map of Kansas – Roads and Cities [Street Map]. Retrieved from https://gisgeography.com/kansas-map/

Google. (2020). [Views of the Flint Hills South of Alma, Kansas]. Retrieved October 10th, 2020, from https://www.google.com/maps/@38.9463195,-96.2613863,23050m/data=!3m1!1e3,

Google. (2020). [Views of the Flint Hills South of Alma, Kansas]. Retrieved October 10th, 2020, from https://www.google.com/maps/@38.9296049,-96.2921249,2353a,35y,43.53h,52.33t/data=!3m1!1e3,

Google. (2020). [Views of the Flint Hills South of Alma, Kansas]. Retrieved October 10th, 2020, from https://www.google.com/maps/@38.9573011,-96.272687,3a,60y,79.91h,88.51t/data=!3m6!1e1!3m4!1sjSEH6HvkQ3MJ90fxHW92aQ!2e0!7i13312!8i6656

Hydrometeorological Prediction Center. (2008). Day 5 pressure forecast. [Simulation]. Retrieved From https://commons.wikimedia.org/w/index.php?curid=37193836

IWO. (2014). Rainy Exterior [Digital Rendering]. Retrieved from https://imocreations.com/works/weather-station/

IWO. (2014). Close up Exterior [Digital Rendering]. Retrieved from https://imocreations.com/works/weather-station/

IWO. (2014). Site Plan [Digital Drawing]. Retrieved from https://imocreations.com/works/weather-station/

IWO. (2014). Floor Plans [Digital Drawing]. Retrieved from https://imocreations.com/works/weather-station/

IWO. (2014). 3D Diagram and Elevations [Digital Drawing]. Retrieved from https://imocreations.com/works/weather-station/

Johnston, A. (1848). The Physical Atlas of Natural Phenomena. [Illustration]. Retrieved from https://en.wikipedia.org/w/index.php?curid=56170616

Linehan, S. (1899). Aims and Methods of Meteorological Work. [Illustration]. Retrieved from http://www.photolib.noaa.gov/htmls/wea00920.htm

NOAA (2000-2020). [US Severe Storm Probability] [Digital Image]. NOAA. Retrieved from https://www.climate.gov/maps-data/data-snapshots/probseverewx-dayofyear-spc-0000-06-13?theme=Severe%20Weather

NOAA (2000-2020). [Average Monthly Temperature] [Digital Image]. NOAA. Retrieved from https://www.climate.gov/maps-data/data-snapshots/averagetemp-monthly-cmb-2019-06-00?theme=Temperature

NOAA (2000-2020). [Average Monthly Temperature] [Digital Image]. NOAA. Retrieved from https://www.climate.gov/maps-data/data-snapshots/averagetemp-monthly-cmb-2019-01-00?theme=Temperature

NOAA (2000-2020). [30 yr. Average by month. Precipitation] [Digital Image]. NOAA. Retrieved from https://www.climate.gov/maps-data/data-snapshots/averageprecip-monthly-1981-2010-cmb-0000-05-00?theme=Precipitation

NOAA (2000-2020). [30 yr. Average by month. Precipitation] [Digital Image]. NOAA. Retrieved from https://www.climate.gov/maps-data/data-snapshots/averageprecip-monthly-1981-2010-cmb-0000-12-00?theme=Precipitation

Perkins & Will. (2018). Story Box [Photography]. Retrieved from https://perkinswill.com/project/bell-museum/

Perkins & Will. (2018). Exterior Landscape [Photography]. Retrieved From https://perkinswill.com/project/bell-museum/

Perkins & Will. (2018). Lobby [Photography]. Retrieved From https://perkinswill.com/project/bell-museum/

Perkins & Will. (2018). Façade Design [Photography]. Retrieved From https://perkinswill.com/project/bell-museum/

Perkins & Will. (2018). Exterior Glass [Photography]. Retrieved From https://perkinswill.com/project/bell-museum/

Perkins&Will. (2015). Level 01 Floor Plan. (Sheet A10-01). [Architectural drawing]. Retrieved from Perkins & Will

Perkins&Will. (2015). Exterior Axon Views. (Sheet A20-00). [Architectural drawing]. Retrieved from Perkins & Will

Perkins&Will. (2015). Building Sections. (Sheet A21-01). [Architectural drawing]. Retrieved from Perkins & WillU. S. Weather Bureau. (1965). IBM 7090 console used by a meteorologist [Photography]. Retrieved From https://commons.wikimedia.org/w/index.php?curid=67804793

Ritchie, H. (2020). Global Greenhouse Gas Emissions by Sector. [Illustration]. Retrieved From https://ourworldindata.org/ghg-emissions-by-sector

Shannon, M. (2002-2020). Flint Hills Meteor Milky Way [Photography]. Retrieved from https://www.mickeyshannon.com/photo/flint-hills-meteor-milky-way/

Shannon, M. (2002-2020). Texaco Hill Sunset [Photography]. Retrieved from https://www.mickeyshannon.com/photo/texaco-hill-sunset/

Snohetta. (2020). Night Exterior [Digital Rendering]. Retrieved from https://snohetta.com/projects/512-the-theodore-roosevelt-presidential-library-competition
Snohetta. (2020). Day Exterior [Digital Rendering]. Retrieved from https://snohetta.com/projects/512-the-theodore-roosevelt-presidential-library-competition
Snohetta. (2020). Site [Digital Rendering]. Retrieved from https://snohetta.com/projects/512-the-theodore-roosevelt-presidential-library-competition
Snohetta. (2020). Interior Snowy [Digital Rendering]. Retrieved from https://snohetta.com/projects/512-the-theodore-roosevelt-presidential-library-competition
Snohetta. (2020). Cloudy [Digital Rendering]. Retrieved from https://snohetta.com/projects/512-the-theodore-roosevelt-presidential-library-competition
Snohetta. (2020). Views [Digital Rendering]. Retrieved from https://snohetta.com/projects/512-the-theodore-roosevelt-presidential-library-competition
The Kubala Washatko Architects. (2008). Wall Weathering [Photography] Retrieved from https://www.aiatopten.org/node/135
The Kubala Washatko Architects. (2008). Interior [Photography] Retrieved from https://www.aiatopten.org/node/135
The Kubala Washatko Architects. (2008). Elevations [Digital Drawing] Retrieved from https://www.aiatopten.org/node/135
The Kubala Washatko Architects. (2008). Site Plan [Digital Drawing] Retrieved from https://www.aiatopten.org/node/135
The Kubala Washatko Architects. (2008). Building Section [Digital Drawing] Retrieved from https://www.aiatopten.org/node/135
The Kubala Washatko Architects. (2008). Exterior Walkway [Photography] Retrieved from http://tkwa.com/leopold-legacy-center/
The Kubala Washatko Architects. (2008). Wood Cutting [Photography] Retrieved from https://www.aiatopten.org/node/135
Walls, M. (2019). [United States Temperature Change Map] [Digital Image]. The Washington Post. Retrieved From https://www.washingtonpost.com/graphics/2019/national/climate-environment/climate-change-america/

PREVIOUS STUDIO EXPERIENCE

2ND YEAR

FALL *Milton Yergens*
Teahouse - Moorhead, MN
Boathouse - Minneapolis, MN

SPRING *Darryl Booker*
Small Dwelling - Cripple Creek, CO
Multifamily Dwelling - Fargo, ND

3RD YEAR

FALL *Regin Schwaen*
Visitor Center, Coopers town, ND (Wood)
Viewpoint of Fjords, Geirangerfjord, Norway (Brick)

SPRING *Emily Guo*
Senior living community, Xian, China (Steel)
Native American Museum - Fargo/Moorhead (Concrete)

4TH YEAR

FALL *Amar Hussein*
High Rise - Miami, FL

SPRING *Paul Gleye*
Urban Block Renewal, Brussels, Belgium

5TH YEAR

FALL *Ronald Ramsay*
Brutalist Train Station - Agincourt, IA

THE AUTHOR
BENJAMIN E. GUTOWSKI

HOME TOWN: PLOVER, WISCONSIN
[redacted]

FIGURE 79 | Personal Picture