THESIS RESEARCH FINAL:
BUILDING WITHIN OPEN-PIT MINES

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CLEANING BY GREENING - ADAPTIVE REUSE OF AMERICA'S OPEN-PIT MINES:

A Design Thesis Submitted to the
School of Design, Architecture, and Art
of North Dakota State University

by

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for the Degree of
Master of Architecture

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I - THESIS PROPOSAL

THESIS ABSTRACT:

Surface mines are a common sight in mineral-rich areas. One such area is the Mesabi Iron Range in northern Minnesota. These mines will eventually become abandoned, as many in the eastern United States, as well as many along the Mesabi Iron Range already have. Abandoned surface mines can be hazardous if they are allowed to erode, settle, or even collapse. As the United States becomes increasingly environmentally aware, this research may act as a partial solution to deforestation that occurs to expand our communities near these mines. The mines have already taken out forests, so why not build within them rather than expand further into our wilderness? This thesis will attempt to create a framework to reclaim these mines as symbiotic partner communities to the cities nearby rather than allowing them to sit vacant and deteriorate.

Figure 2 - Missabe Mountain Iron Mine, Virginia

THESIS NARRATIVE:

Surface mining is a common method of mining, and this occurs frequently in several areas of northern Minnesota - specifically along the Mesabi Iron Range. In the future, these mines will inevitably become abandoned, either due to anti-mining legislation, mineral seams running out, lack of need for these minerals, or other reasons. In any case, we will be left with huge holes in the ground. These truly colossal holes have already disturbed the natural environment they occupy, so why not turn that into a positive impact on the area? This thesis will culminate in a proposal to create a reclamation framework in these mines that pepper Minnesota's wilderness.

Several issues must be addressed in this thesis. One such issue is building on a slope or terracing the slope so that there is flat area (the mining companies already do this frequently in their mines), or a mixture of both.

Another area of research is the negative environmental issues that have already been caused by the mines.

Another still is how a thoughtful community of the future could benefit the region in place of the abandoned mines.

This project is also an opportunity to create a work-from-home model community. There are numerous inherent benefits of a group of people like this to become a community of the future post-COVID. Given the location of the mines in northern Minnesota, this community would be enticing for nature lovers, people who are interested in the novelty of living within a mine, history enthusiasts, or people that just want to leave the commotion of large cities.

THESIS NARRATIVE:

The motivation for this research project comes from my intense love of nature, history, and architecture. Preserving our wilderness for future generations is a top priority of mine, and this project gives a solution to one problem that will plague northern Minnesota - one of the greatest areas in our country - for decades to come. This project will also propose a framework for a community that respects the area's deep and storied history.

The goal of this thesis is to learn what makes a community successful, what are important sustainable community-level practices, and it will propose a framework for creating communities inside abandoned open-pit mines.

This research will show how successful case studies can be analyzed and applied to future designs.

PROJECT TYPOLOGY:

The proposed design will be a community masterplan framework within an open-pit mine.

Community: This development will give its inhabitants the ability to work, play, and commune with each other in its borders.

Within: Building directly between the mine's slopes.

Open-pit mine: A type of mine where earth is systematically stripped away from the top down - resulting in a massive, usually tiered depression in the landscape.

The proposed project would include elements of many typologies, such as homes, grocery stores, eateries, and parks.

Note - the project scope later changed during the spring semester after conversing with Dr. Bakr Aly Ahmed. Scope was refined to consist of: homes, community center, ski resort, visitor center, and green space.

Figure 3 - Home Interior

Figure 4 - Sultan Center Grocery Store

PROJECT TYPOLOGY:

Figure 5 - Rosewild Restaurant

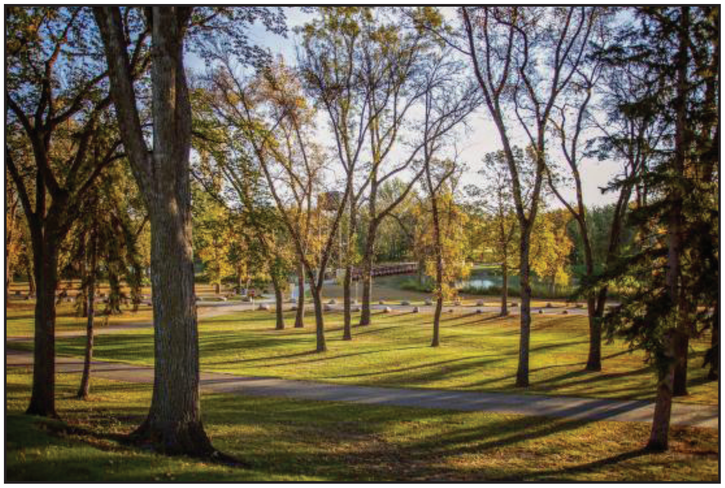


Figure 6 - Linwood Park

CASE STUDY 1:

ARCHITECTS - PROAH
TYPOLOGY - HOUSE
YEAR COMPLETED - 2016
LOCATION - CROATIA
AREA - 4,500 SQ. FT.

SUMMARY:

PROAH's house in Croatia was completed in 2016. It was designed to blend into the hills of the island of Vis through form, color, and material. The architects took inspiration from the site itself - through rocks, slope, and natural grottos. The home was intended from the beginning to be used without infrastructure of any sort, and uses passive strategies for both heating and cooling to help complete this goal. Concrete was used for load-bearing elements, while on-site stone was used for roof and wall cladding - blending in with its surroundings in both cases. All of these strategies manage to create a home that is environmentally conscientious in its daily use, while also being unobtrusive in appearance.

Figure 7 - Home Ground Level

CASE STUDY 1 CONTINUED:

ARCHITECTS - PROAH
TYPOLOGY - HOUSE
YEAR COMPLETED - 2016
LOCATION - CROATIA
AREA - 4,500 SQ. FT.

This home is nestled into the slope of its site. It manages to seamlessly blend in with its surroundings and respect the landscape.

Figure 8 - Home From Afar

Figure 9 - Terraces From the Side

The building terraces its roof rather than sloping it. This could prove useful for my design in creating agriculture and occupiable outdoor spaces for human recreation and interaction.

CASE STUDY 1 CONTINUED:

ARCHITECTS - PROAH
TYPOLOGY - HOUSE
YEAR COMPLETED - 2016
LOCATION - CROATIA
AREA - 4,500 SQ. FT.

The structure looks as though it is buried beneath stone over time, making it seem natural. It mimics the surrounding hills and blends in well. This is achieved through form, color, and material. That can be very useful for this thesis, as stone is abundant at its site as well.

Figure 10 - Home From Below

Figure 11 - Terraces From Above

The terraces are very visible from above. They seem to be almost peeled up from the ground.

CASE STUDY 1 CONTINUED:

ARCHITECTS - PROAH
TYPOLOGY - HOUSE
YEAR COMPLETED - 2016
LOCATION - CROATIA
AREA - 4,500 SQ. FT.

This graphic shows the thought process in creation of the front face of the dwelling. Taking sunlight into consideration will be a top priority due to northern Minnesota's hot summers and frigid winters.

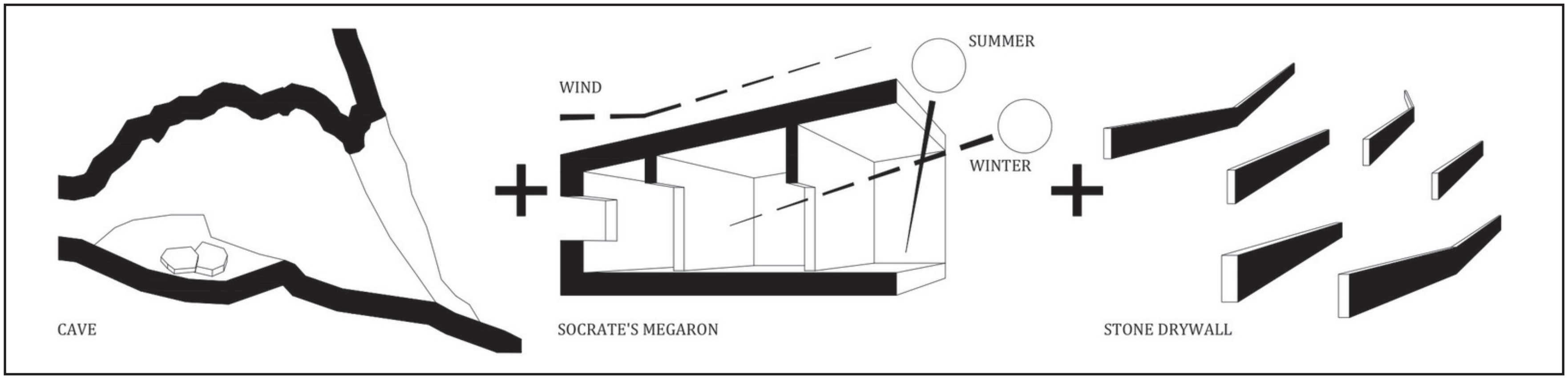


Figure 12 - Section Detail

CASE STUDY 1 CONTINUED:

ARCHITECTS - PROAH
TYPOLOGY - HOUSE
YEAR COMPLETED - 2016
LOCATION - CROATIA
AREA - 4,500 SQ. FT.

These graphics illustrate how relatively simple it is to achieve a blending from house to landscape. The home itself is a few rectangular prisms - nothing too fancy. However, the clever use of sloped retaining walls (which is not occupiable indoor space) is what blends the home seamlessly with the land.

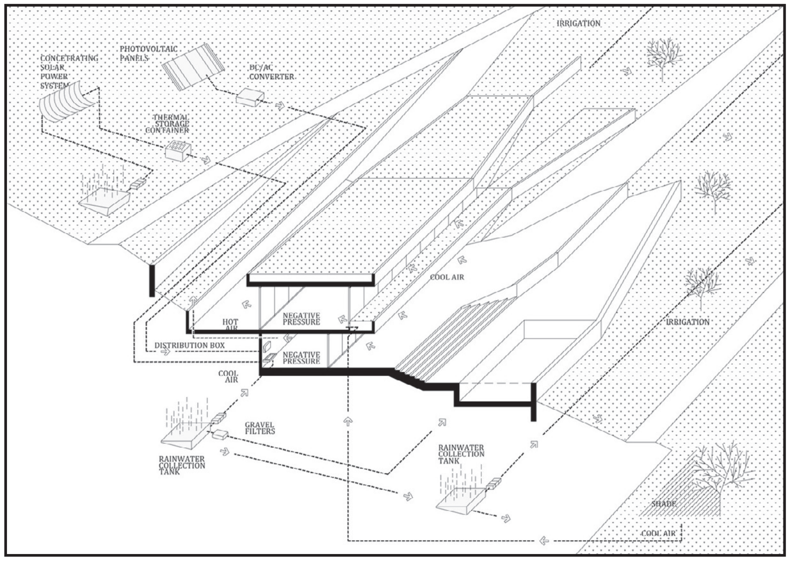


Figure 13 - Section Isometric

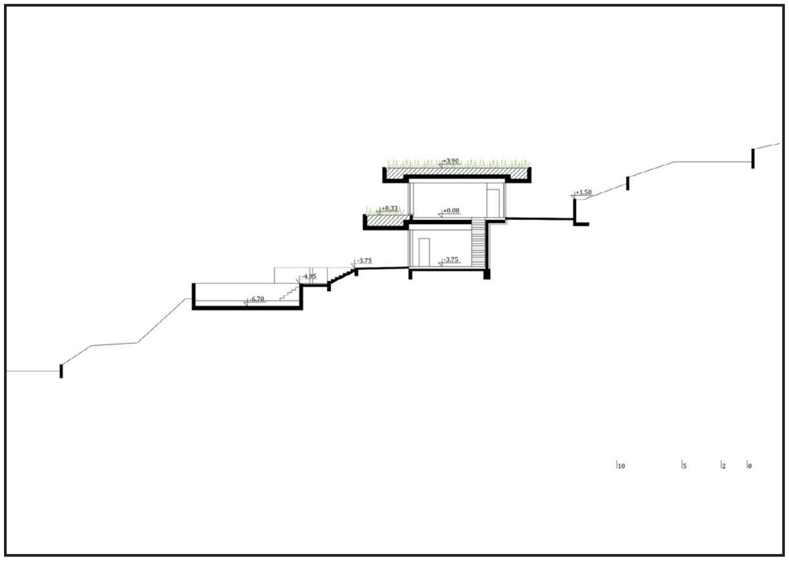


Figure 14 - Section Cut

CONCLUSIONS:

This case study tackles the issue of building on, or in this case, *in* a slope. The way the landscape becomes the roof, and the manner in which the home is terraced into the surrounding landscape, is an incredible inspiration to this thesis's project. The clever use of sloped retaining walls creates the illusion that the home is elegantly melting into the hill. Additionally, the home is built within the land, saving on cooling costs in the summer. The landscape-mimicking roof could potentially provide space for agriculture or recreation to take place in my project within the mine.

CASE STUDY 2:

ARCHITECT - ATHELSTAN SPILHAUS
TYPOLOGY - CITY - "MINNESOTA EXPERIMENTAL CITY"
YEAR COMPLETED - N/A
LOCATION - SWATARA, MINNESOTA
AREA - 55,000 ACRES

SUMMARY:

The Minnesota Experiment City (MXC) was a proposed city plan in northern Minnesota during the 1960s and 1970s. It was intended to be a model city for the future, using subterranean public transportation, "cable hung dwellings" from a central spire, "holographic information-energy structures", and a "forced air climate shield", among other elements. It was an ambitious project aimed at creating a self-sustaining city within a dome. It attempted to tackle issues like pollution, a pedestrian focused urban environment, and citywide climate control.

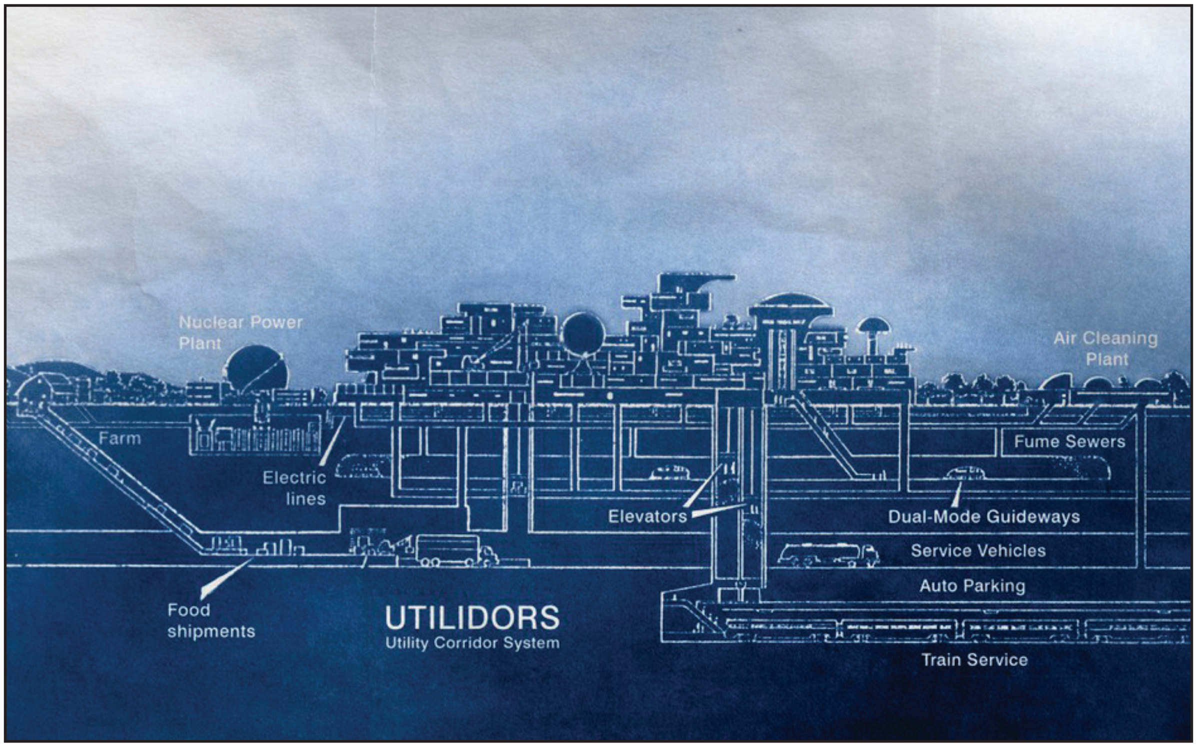


Figure 15 - MXC UTILIDORS Section Proposal

CASE STUDY 2 CONTINUED:

ARCHITECT - ATHELSTAN SPILHAUS
TYPOLOGY - CITY - “MINNESOTA EXPERIMENTAL CITY”
YEAR COMPLETED - N/A
LOCATION - SWATARA, MINNESOTA
AREA - 55,000 ACRES

Grand yet simple forms are straightforward to understand, and make organization of spaces easy to navigate. The overall layout seems enjoyable engage with, in part due to its simplicity.

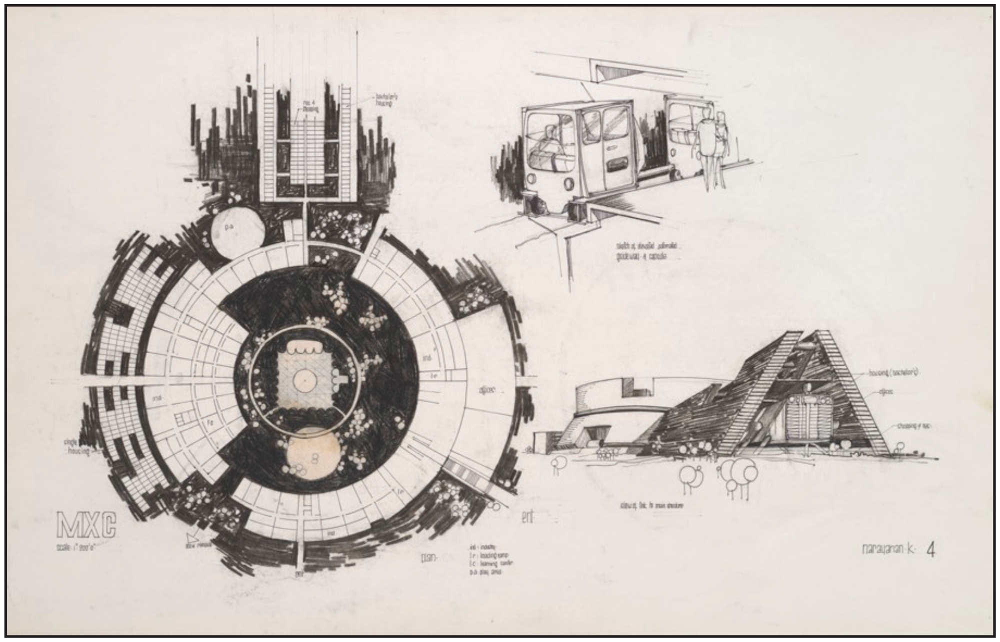


Figure 16 - MXC Plan

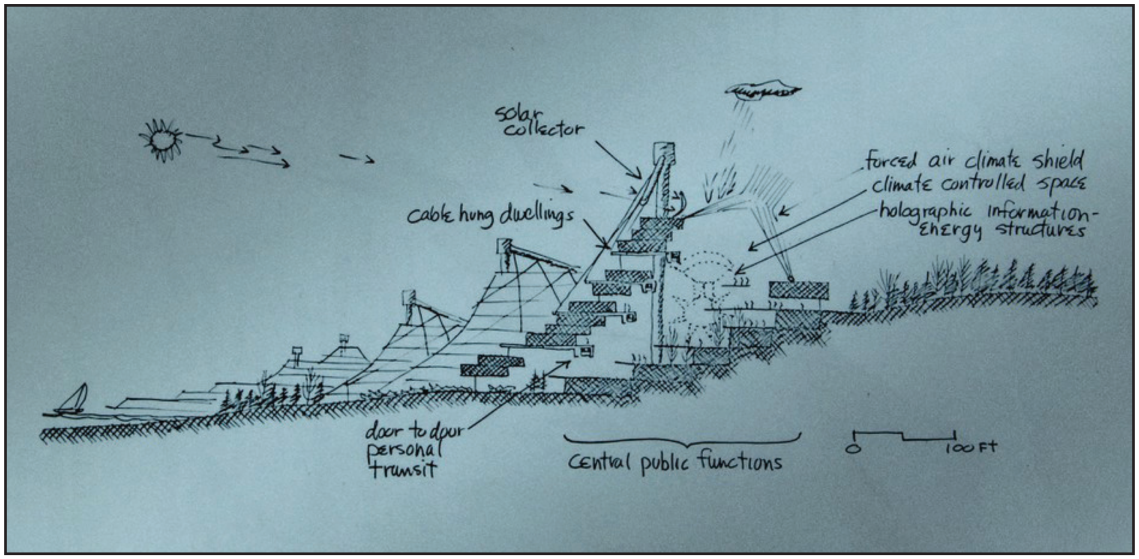


Figure 17 - MXC Section Proposal

Arranging dwellings on top of one another and draping shading devices above them is an intriguing way to deal with building on a slope. The residences are tightly packed to help increase urban density.

CASE STUDY 2 CONTINUED:

ARCHITECT - ATHELSTAN SPILHAUS
TYPOLOGY - CITY - “MINNESOTA EXPERIMENTAL CITY”
YEAR COMPLETED - N/A
LOCATION - SWATARA, MINNESOTA
AREA - 55,000 ACRES

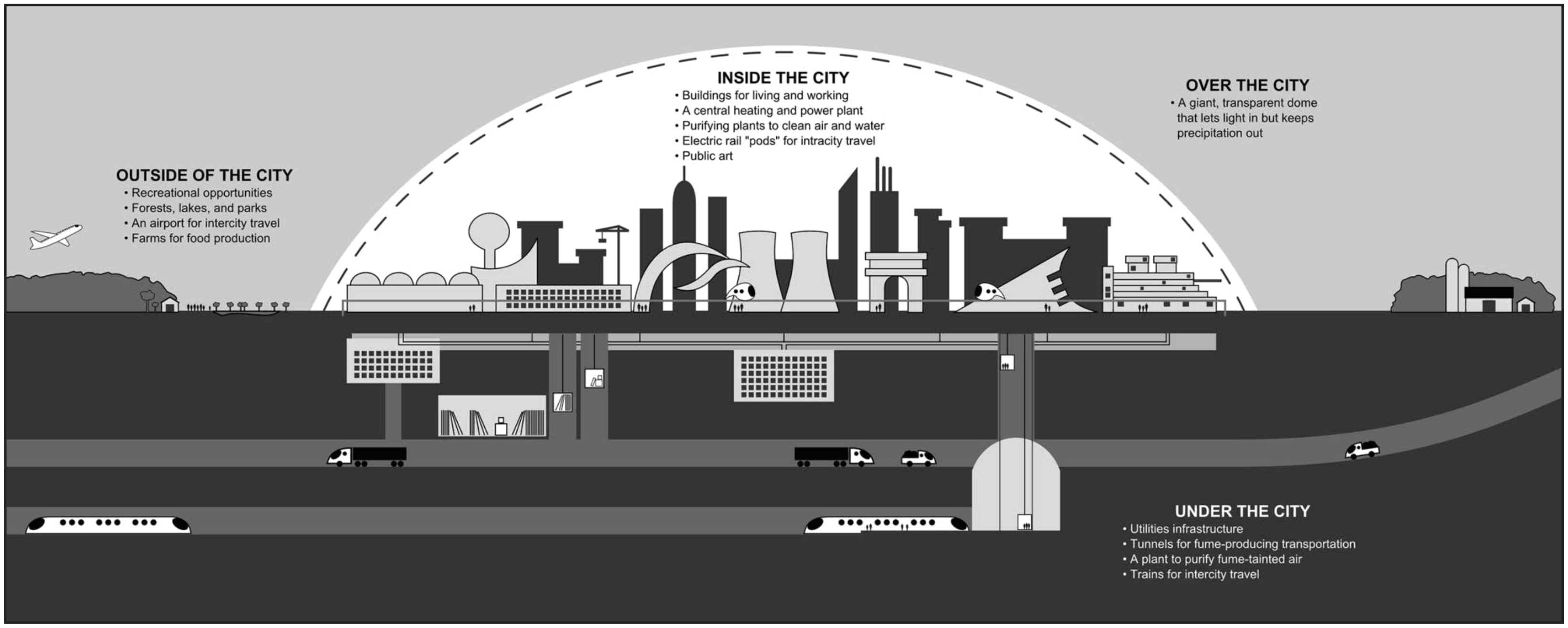


Figure 18 - MXC Infographic

CONCLUSIONS:

This case study is a very interesting and informative one. Some useful aspects of it that may pertain to this thesis are the following: intracity travel mechanisms, some sort of climate controlling apparatuses, buildings for both working and living within close proximity, and a pedestrian-focused development.

CASE STUDY 3:

ARCHITECTS - BIG
TYPOLOGY - MASTER PLANNING - "FUSE VALLEY"
YEAR COMPLETED - N/A
LOCATION - PORTO, PORTUGAL
AREA - 44 ACRES

SUMMARY:

Bjark Ingles Group's Fuse Valley is where several tech companies and various startups will call home in the near future. The proposed complex is set to open in 2025 in the city of Porto, Portugal. The program not only includes buildings for various companies, but also public courtyards, plazas, parks, and amphitheaters. The project aims to take advantage of its proximity to the Leca River by opening views to it and creating public spaces in the adjacent areas. The entire design attempts to make the most of daylighting and combine that with creating a biophilic environment inside and out to increase occupant happiness. The walkable roof adds to the user experience and total green space of the site.

Figure 19 - Fuse Valley Moneyshot

CASE STUDY 3 CONTINUED:

ARCHITECTS - BIG
TYPOLOGY - MASTER PLANNING - "FUSE VALLEY"
YEAR COMPLETED - N/A
LOCATION - PORTO, PORTUGAL
AREA - 44 ACRES

A walkable roof is something that this thesis will likely include. The slope on this project's roof is a differing approach to the home in Portugal, but still very effective and walkable.

Figure 20 - Fuse Valley Roof

Figure 21 - Fuse Valley Amphitheater

Outdoor social spaces are important in creating a sense of community. Fuse Valley achieves a natural look to their seating by embedding plants within it in an organic manner.

CASE STUDY 3 CONTINUED:

ARCHITECTS - BIG
TYPOLOGY - MASTER PLANNING - “FUSE VALLEY”
YEAR COMPLETED - N/A
LOCATION - PORTO, PORTUGAL
AREA - 44 ACRES

Abruptly ending the roof’s gentle slope creates the feeling of an urban canyon surrounding the streetscape. This provides shade for both pedestrians and building occupants, while also improving sense of space on the ground level.

Figure 22 - Fuse Valley Streetscape

Figure 23 - Fuse Valley Interior

Bright, expansive spaces are created inside the buildings by providing tall ceilings with floor to ceiling windows. Tall spaces provide opportunity to bring larger vegetation inside. This could be useful as a strategy to keep plants in peoples’ everyday lives during harsh Minnesota winters.

CASE STUDY 3 CONTINUED:

ARCHITECTS - BIG
TYPOLOGY - MASTER PLANNING - “FUSE VALLEY”
YEAR COMPLETED - N/A
LOCATION - PORTO, PORTUGAL
AREA - 44 ACRES

Figure 24 - Fuse Valley Courtyard

CONCLUSIONS:

This case study is an example of work done by one of the world’s most famous firms. There are several aspects of this project that can be utilized and adapted to the climate of Minnesota. Such aspects might include: walkable roof, green roof, indoor plantings, expansive courtyards and other public space in tended for gathering, biophilic diversity, and grand, bright interior spaces. Indirect summer sunlight and direct winter sunlight are a must for this thesis’s project. Large interior plantings are an interesting concept that may be implemented in some of the larger proposed buildings for this thesis.

MAJOR PROJECT ELEMENTS:

Residences - places for residents to live

Transportation - a means to get from above the mine down to the bottom without the use of a car

Surface Parking - a place where residents who choose to have a car may keep it above the mine

Agriculture Space - where the community may grow its own food

Dining - where residents and tourists alike may eat

Park Space - a place to enjoy the landscape

Energy Capture Elements - solar panels and geothermal systems to power the community

Rainwater collection system - to gather water for everyday use

Circulation - a means to move about the site

Figure 25 - Gondola

Figure 26 - Park Space

USERS:

The users of this proposal are those that live, work, and recreate in and around this community. They will be those that wish to move somewhere new, likely people that are either retired or wish to work from home. This could be someone who works online in a typical scenario, or someone like a video game streamer, Youtuber, or content creator. There are also a multitude of other types of occupations that could live here comfortably and work, such as: artist, woodworker, or even a fishing or hunting guide. These people may be those that want to get away from big city living, and they will likely be those that enjoy spending their spare time outdoors. There is also opportunity to commute to the nearby cities, such as Virginia, Eveleth, Chisholm, or Hibbing. There will be in-person jobs in this community as well, such as resort employee, visitor center curator, and farmer. Tourists may also come to this community as users.

Figure 27 - Snowshoeing

Figure 28 - Working From Home

Figure 29 - Fishing

CLIENT:

The client of this proposal might be a developer. Whoever funds this project could also manage it as an investment, as starting it organically like an ordinary city would take a lot of time.

There is also a possibility that a mixture of federal, state, and local governments could fund this project if they saw it as a worthy experiment, as the Experimental City was. (MXC did get mostly government funding before the project was shut down). They may do this in order to learn new things about communities that are constructed within mines as alternative reclamation projects.

SITE AND CONTEXT:

The site of this thesis was determined using a number of different factors. The Upper Midwest, specifically northern Minnesota and Wisconsin, is (in the case of several mines, *was*) rich in iron deposits. An ancient lake used to cover some of the region, and along its shores, iron was deposited. The result of those deposits are the several iron ranges shown in *Figure 31*. Several of these iron ranges no longer have active mines anywhere along them. The Mesabi Iron Range is perhaps the most famous in the region, if not the country. It is also home to the world's largest open pit mine, the Hull-Rust-Mahoning Mine in Hibbing. The Mesabi Range had the single highest volume of raw material for the war effort of WWII. (America's Story from America's Library, 2021) The war accelerated extraction of material from the region, and also accelerated the rate at which mines ran out of material and became abandoned. The Thunderbird Mine just outside of Virginia, Minnesota is another mine in the range, and is the reason that the largest bridge in Minnesota was recently erected. This mine is still currently operational and will be the site for this thesis' project.

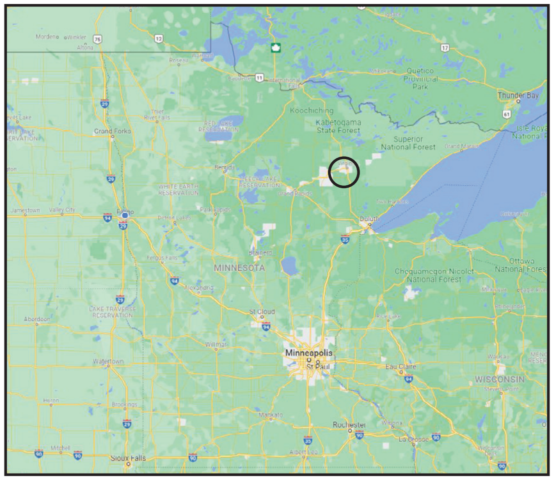


Figure 30 - Virginia Location

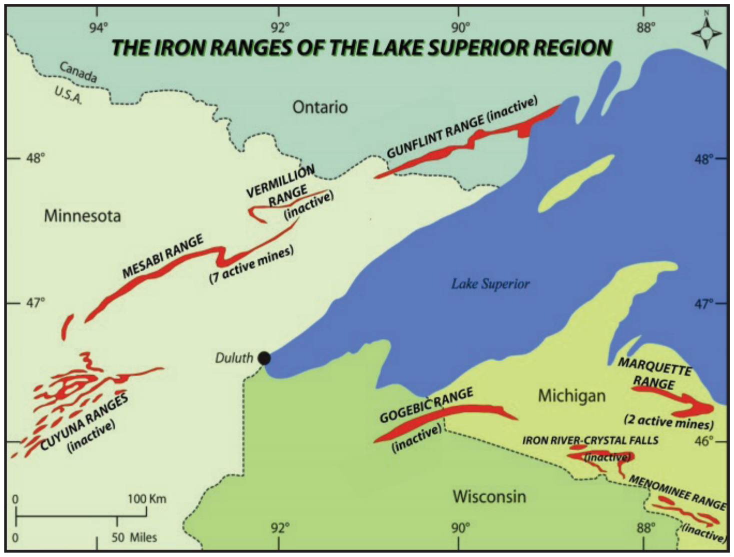


Figure 31 - Iron Ranges

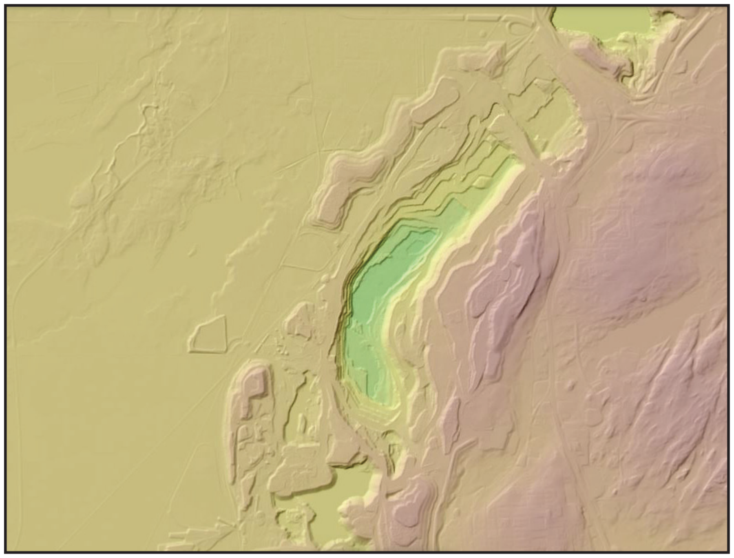


Figure 32 - Thunderbird Mine Topographic Map

PROJECT EMPHASIS:

The project emphasis will be adaptive reuse of the Thunderbird Mine and masterplanning of the community that will be built inside of it. Research will include the history of the area and analysis of the current surrounding towns to determine what must be included in this new development inside the mine. The community will be designed for the future, and special consideration and research will be given to how people working from home may thrive in this environment. This will likely include research into what makes a space enjoyable and what makes a community enjoyable to live in and successful.

GOALS OF THE THESIS PROJECT:

ACADEMIC:

1) Create an effective framework to reuse open pit mines once they become abandoned
2) Design a successful post-COVID work from home community that focuses on the collaboration and well-being of its inhabitants
3) Incorporate sustainable strategies in this project's creation and its use to further lessen its environmental impact

PROFESSIONAL:

1) Increase proficiency in sketching and modeling programs (Revit, Rhino)
2) Advance rendering skills
3) Advance presentation and layout skills

PERSONAL:

1) Become more efficient and focused in conducting meaningful research
2) Learn about the history of northern Minnesota and mining as a whole
3) Learn about new materials, sustainable practices, and building strategies

A PLAN FOR PROCEEDING:

DESIGN METHODOLOGY:

i) Various design methodologies should be considered in any thesis project, and I plan to use several. First, analysis must be conducted. What is to be analyzed will likely include:

- U.S. labor numbers relating to the COVID-19 pandemic and how that evolved the workforce to include more people that work from home
- Migration patterns pertaining to those that live in the U.S. to see if there is any recent trend of people moving to or away from rural areas and if that has changed due to COVID or other reasons
- Climate analysis for the region of northern Minnesota (hours of daylight, sun angles, rain totals, snow totals, wind)
- Information pertaining to mines, specifically the Thunderbird Mine (dimensions, volume, makeup of soil, history of the area)
- Water table information
- Case studies that deal with some issues that I will also encounter (building on a slope, harsh climate in both summer and winter, using sustainable practices, building with stone, etc.)
- Vegetation analysis to see what different requirements are for native plants (sun/shade plants, water necessities, etc.)

After this research is completed, the data will be analyzed and compiled into charts and graphics when possible, and writing when not. The project will be created after analysis of this data and taking each part of the findings into consideration. After the project is complete, the data will be re-analyzed to ensure it has all been considered.

ii) To analyze the research data, graphics will be used whenever possible for ease of viewing. These graphics will likely be in the form of charts, graphs, infographics, bubble diagrams, and more. Both analog and digital forms will be used for these methods - digital for quantitative data, and analog for qualitative data.

DOCUMENTING THE DESIGN PROCESS:

Documentation :

- Research will be compiled in this book in the form of hand-drawn graphics, computer-aided graphics, photos, charts, and written text
- Design will be created through programs such as Revit and Rhino
- Representation will be through programs like Photoshop and InDesign

Preservation:

- Scan hand-drawn elements
- Photograph models
- Update thesis book regularly
- Back up all files

Availability to others:

- Upload to the NDSU Institutional Repository
- Link to this material will in my portfolio and website

Presentation Intentions:

- Slideshow documenting process and design
- Presentation boards showcasing final design
- Final model

Interval of Collection:

- Date at the end of each schedule category

A PLAN FOR PROCEEDING CONTINUED:

PROJECT SCHEDULE:

OCT. 17 - 23: Begin to decide what sort of research will take place and how it will be conducted (refer to proposal final and go from there). Update Research Book.

OCT. 24 - 30: Continue to investigate how research will be put together while conducting preliminary research. Begin research proposal presentation. Update Research Book.

OCT. 31 - NOV. 6: Be at least 50% done with research proposal presentation.

NOV. 7 - 13: Complete final touches on research proposal presentation (Due Nov. 9).

NOV. 14 - 20: Use feedback from research proposal presentation and apply it to the research. Conduct research and update Research Book.

NOV. 21 - 27: Continue research, update Research Book. Research should be around 25% completion.

NOV. 28 - DEC. 4: Continue research, update Research Book. Research should be around 50% completion.

DEC. 5 - 11: Continue research, update Research Book. Research should be around 75% completion.

DEC. 12- 16: Complete final touches on Thesis Research Final (Due Dec. 16).

II - THESIS RESEARCH

ABANDONED MINE LANDS: A DECADE OF PROGRESS RECLAIMING HARDROCK MINES:

OVERVIEW:

This review will cover remediation efforts by government and private agencies, as well as private companies to improve abandoned mines, both underground and above ground. The efforts detailed in this reading span over several western U.S. states. Remediation efforts have improved wildlife, water quality, and ecology in each case study. The remediation efforts also improve the local economies and make the once-hazardous lands safe for wildlife and humans alike. This will apply to this thesis by detailing case studies that successfully improved abandoned mines from wastelands to safe and beautiful inhabitable places.

EFFECTS OF MINING:

Before the requirement of mining companies in the U.S. to return mine sites to roughly their original contours, mining companies often mined, then left the land as-is. The land they left behind is often poorly graded, containing areas of hazardous material, and overall unsafe for people to be around. Additionally, the waste materials that were unearthed and piled up (called “spoils” or “tailings”) often contain traces of heavy metals and left to erode and seep into surrounding waterways, killing much of the wildlife and destroying fishing opportunities. Even after it was required that companies tidy up before they leave, some go bankrupt and are unable to do so.

In the 1990s, the United States government and its agencies started getting serious about tackling the issues caused by abandoned mines. The Bureau of Land Management (BLM) was tasked with identifying, documenting, and remediating abandoned mine lands (AML) throughout the United States. This is no small task, as estimates are in the hundreds of thousands for numbers of underground and above-ground mines across the U.S. Remediation is often completed by closing up or blocking off underground mine openings or regrading and hauling away of hazardous material in above-ground mines. Solutions also include addition of soils when needed so that planting of grasses and trees may take place. Remediation of mines is needed due to the aforementioned detrimental effects to wildlife, as well as contaminated sources of drinking water caused by the runoff and seepage from old mines.

Figure 33 - White King Pond, Oregon

LITERATURE REVIEW:

ABANDONED MINE LANDS: A DECADE OF PROGRESS RECLAIMING HARDROCK MINES:

REMEDIATION EFFORTS:

This text explains in examples that fish had completely disappeared in some waterways in these states solely due to effects of abandoned mines: Arizona, California, Colorado, Idaho, Montana, New Mexico, and Washington. It also states that fish have returned to the affected waterways due to the successful remediation efforts that directly solved water quality issues. Mine remediation projects such as those pictured below greatly improve the quality of water in the region that was once negatively impacted by the mining operations and lingering materials.

Figure 34 - Bonanza Rawley Mine Before/After

Figure 35 - Buckeye-Enterprise Mine Before/After

ABANDONED MINE LANDS: A DECADE OF PROGRESS RECLAIMING HARDROCK MINES:

BENEFITS OF REMEDIATION:

Remediation efforts are often conducted by local companies, as the Bureau of Land Management awards the construction projects to local companies in an attempt to improve local economies. There are additional benefits to these projects other than temporary work for local companies. An important effect is the cleaner drinking water supply after remediation. Residents near an abandoned mine often do not realize the negative effect that abandoned mines can have on their water supplies. However, the supplies are greatly improved, and often return to pre-mining levels of all substances in the water. Another benefit of remediation and cleaner water is an increased interest in recreation and tourist appeal due to renewed aesthetic and natural beauty of the area. Cleaner water means more fish and wildlife, which leads to more fishermen and outdoor enthusiasts, which results in an increase in hotel stays, gas station visits, property values, etc.

SUMMARY:

Remediation efforts in both underground and above-ground mining scenarios make it possible for disturbed, barren, and sometimes hazardous mining lands to become enjoyable and occupiable once more. This is done through beautifying land and attempting to return it to a state that is similar to what is was before the mining occurred. The Bureau of Land Management is in charge of these procedures and is responsible for some of the funding, and the benefits are to the people, animals, and plants of the region.

> ***"Environmental impacts of mining can linger" ... "The BLM and the Forest Service are working hard to clean up mining sites to ensure continued enjoyment and use of public lands and the protection of watersheds and life within them."***
>
> - "ABANDONED MINE LANDS: A DECADE OF PROGRESS RECLAIMING HARDROCK MINES," 2007, p. 25

LITERATURE REVIEW:

ABANDONED MINE LANDS: A DECADE OF PROGRESS RECLAIMING HARDROCK MINES:


The Silver Crescent/Moon Gulch site in Idaho.

Figure 36 - Silver Crescent/Moon Gulch, Idaho

ASK BEFORE YOU BUILD - ABANDONED MINE LAND DEVELOPMENT GUIDE -

A GUIDE FOR LANDOWNERS, DEVELOPERS, AND OFFICIALS TO BETTER ASSESS THE HAZARD OF ABANDONED MINE LAND BEFORE BUILDING:

OVERVIEW:

This review will cover some of the negative effects of mining, both underground and above ground. Some history and statistics will also be visited pertaining to reclamation of mines and the troubles that go along with that process. This text is from the state government of Ohio and discusses mines in their region that are slightly different than my site, but many of the techniques and issues discussed are still relevant to this thesis.

WHAT HAPPENS WHEN MINING COMPANIES LEAVE:

Mining companies are almost never legally at fault in historic mine operations when something goes wrong on the land that the mines are located. Often times, they are also not responsible for any remediation efforts, as there were very few requirements about land conservation and overall safety at the time of construction and excavation.

Today, mining companies are required to return their mining site to roughly the original contours. However, mining companies occasionally go bankrupt and are unable to do so - leaving land in a state of disrepair and neglect. An example of this neglect is detailed in the reading:

> ***"The indiscriminate placement of steeply sloped unconsolidated mine spoil, prevalent on abandoned surface mines, can result in landslides that impact existing roads, structures and streams. Drainage from deep mines and strip mine impoundments can also saturate native soil units on unmined slopes and result in the instability of these slopes."***
>
> - "ASK BEFORE YOU BUILD - ABANDONED MINE LAND DEVELOPMENT GUIDE," 2011, p. 10

This passage details that if left unchecked, major instabilities can occur at the edges of mines and their slopes. These can be very dangerous if and when people explore open-pit mines, which is often done so illegally. Even if abandoned mine sites are closed off, dozens of people each year are injured or die due to injuries sustained while exploring.

LITERATURE REVIEW:

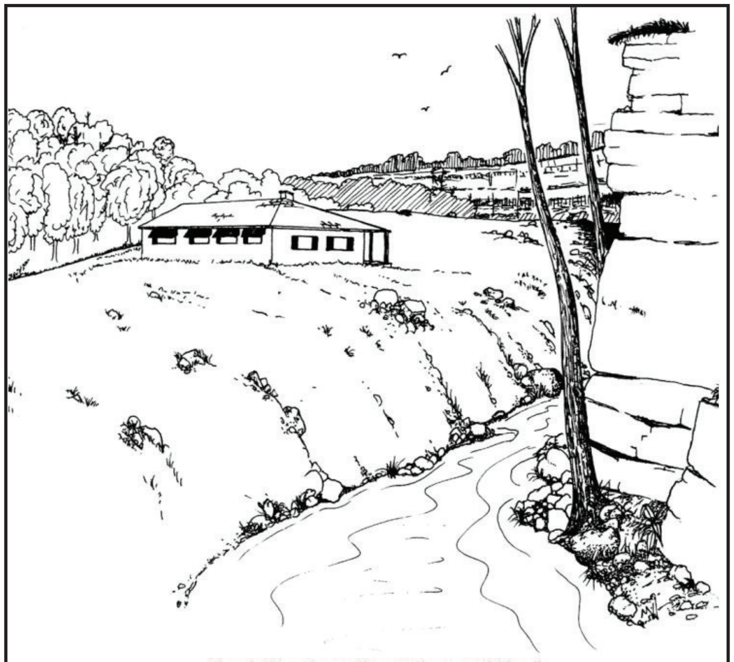
ASK BEFORE YOU BUILD - ABANDONED MINE LAND DEVELOPMENT GUIDE -

A GUIDE FOR LANDOWNERS, DEVELOPERS, AND OFFICIALS TO BETTER ASSESS THE HAZARD OF ABANDONED MINE LAND BEFORE BUILDING**:**

WHAT HAPPENS WHEN MINING COMPANIES LEAVE (CONTINUED):

> ***"Prior to the requirement of returning mine land to approximate original contour, vertical rock faces, called highwalls, were left as the last cut of the strip mining operations. Some highwalls exceed 100 feet in height. "***
>
> - "ASK BEFORE YOU BUILD - ABANDONED MINE LAND DEVELOPMENT GUIDE," 2011, p. 11

Structures built near highwalls - man-made cliff faces that are the last cut of a strip mining operation up to 100 feet high - are at great risk and should not be built there. Building near highwalls is semi-common practice, especially in eastern states where mining has occurred for longer than other parts of the country. They look more like natural wonders than man-made dangers, so structures are occasionally built near them.



Home built on mine spoil next to dangerous highwall.

Figure 37 - Structure Near Highwall

ASK BEFORE YOU BUILD - ABANDONED MINE LAND DEVELOPMENT GUIDE -
A GUIDE FOR LANDOWNERS, DEVELOPERS, AND OFFICIALS TO BETTER ASSESS THE HAZARD OF ABANDONED MINE LAND BEFORE BUILDING:

HOW THE PAST IMPACTS THE PRACTICES OF THE PRESENT:

Today, taxes are imposed on currently operating mining companies to create funding for remediation efforts that exist across the country. That funding is not nearly large enough to fix all mines, but it is a great help in the efforts to make old mines safe. As detailed in the last article's review, this funding, along with private funding and volunteer work, is what makes remediation possible. We are now able to learn from the long-lasting mistakes of past mining operations, and can often times do things differently so that those past mistakes do not occur in the future.

SUMMARY:

There are inherent dangers on abandoned mining land: steep cliffs, unstable soils, areas of toxic substances, severe erosion, and uneven settling. While there are risks on abandoned mine land, there are ways to fix these past mistakes. Steep areas can be leveled, harmful substances can be removed or covered, vegetation can be planted, and wildlife can be reintroduced. This article describes some of the instances of hazards on abandoned mine lands and goes into more detail about specific problems than the previous article.

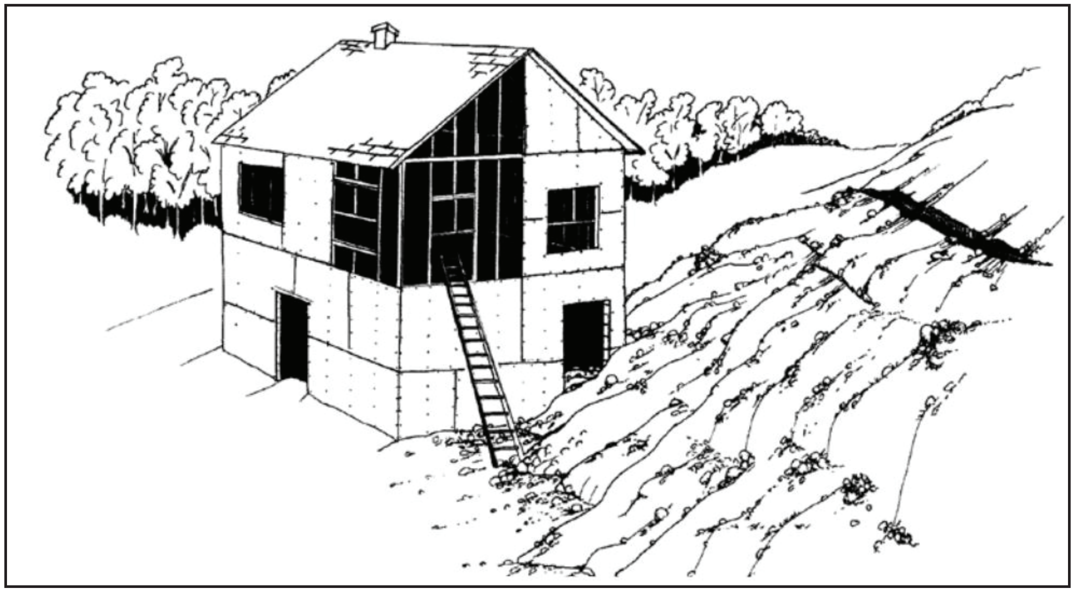


Figure 38 - Structure Near Mine Landslide

LITERATURE REVIEW:

ABANDONED MINE LANDS: A DECADE OF PROGRESS RECLAIMING HARDROCK MINES:

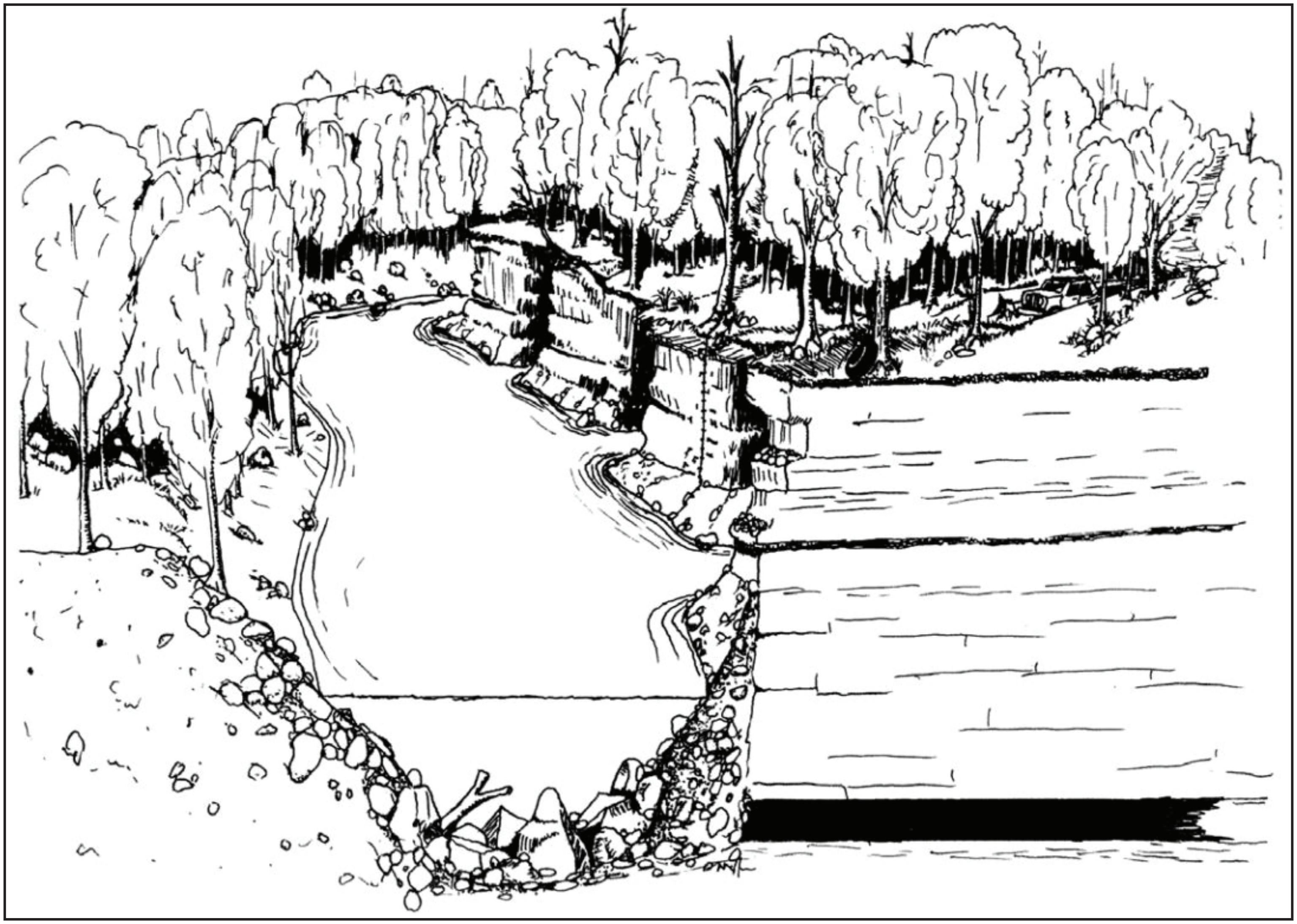


Figure 39 - Dangerous Highwall

LITERATURE REVIEW:

ASK BEFORE YOU BUILD - ABANDONED MINE LAND DEVELOPMENT GUIDE -

A GUIDE FOR LANDOWNERS, DEVELOPERS, AND OFFICIALS TO BETTER ASSESS THE HAZARD OF ABANDONED MINE LAND BEFORE BUILDING:

&

ABANDONED MINE LANDS: A DECADE OF PROGRESS RECLAIMING HARDROCK MINES:

SUMMARIES FROM EACH READING:

Literature Review #1: Remediation efforts in both underground and above-ground mining scenarios make it possible for disturbed, barren, and sometimes hazardous mining lands to become enjoyable and occupiable once more. This is done through beautifying land and attempting to return it to a state that is similar to what is was before the mining occurred. The Bureau of Land Management is in charge of these procedures and is responsible for some of the funding, and the benefits are to the people, animals, and plants of the region.

Literature Review #2: There are inherent dangers on abandoned mining land: steep cliffs, unstable soils, areas of toxic substances, severe erosion, and uneven settling. While there are risks on abandoned mine land, there are ways to fix these past mistakes. Steep areas can be leveled, harmful substances can be removed, vegetation can be planted, and wildlife can be reintroduced. This article describes some of the instances of hazards on abandoned mine lands and goes into more detail about specific problems than the previous article.

SUMMARIES COMBINED AND RELATING TO THIS THESIS:

Abandoned mines - both underground and above-ground - pepper the whole of North America. This thesis pertains to above-ground mines, and there is useful material in each article that will help in the formulation of this thesis's solution.

Although abandoned mines can be dangerous to be in and have harmful aspects off-site, these issues can be solved to make them safe. Through remediation - grading dangerous slopes, removal of harmful substances, and planting of grasses and trees - mines can be safe, beautiful places. This thesis is attempting to design a community in one of the above-ground mines, and these remediation tactics will need to take place during the execution of the design portion of the project. A community cannot simply be placed into a mine; these techniques must be considered and implemented.

PROJECT JUSTIFICATION:

IMPORTANCE TO ME:

The adaptive reuse of open-pit mines is important to me for several reasons. My love of nature is vast, and I see this project as an opportunity to propose a solution that preserves existing nature while tending to that which already has been tampered with. Additionally, I see how the COVID era has altered peoples' preferences in working, and I see an opportunity to change the way we work and live. That change can be driven by a new type of community that is focused on working from home, as many people now realize they wish to do, and collaboration through community. Together these two ideas - that of preserving nature and that of helping people live and work differently in the near future - can create a wonderful solution that displays my skills and passions.

HOW THIS WILL DEMONSTRATE MY KNOWLEDGE AND SKILLS:

This project can serve as a showcase for my skills that I heave learned over the course of the last four-plus years. I will be able to apply: urban planning knowledge, architecture techniques and creativity, model building and sketching abilities, as well as software capabilities. This project will act as a showcase for all that I have learned and will culminate with the conclusion and presentation of my findings and design.

Figure 40 - Pine Forest

PROJECT JUSTIFICATION:

IMPORTANCE TO THE SURROUNDING SITE:

The positive repercussions resulting from the successful implementation of this project are numerous. The main benefits to the immediate surroundings of the site can be placed into two broad categories: environmental and economic. The expansion of the city of Virginia may be placed inside the mine, which saves the surrounding forest from deforestation while also giving the mine a new purpose. As detailed in the "Literature Review" section of this document, there are also reasons that the surrounding environment would benefit immediately: severe erosion can be mitigated, steep cliffs can be regraded or contained, soils with uneven settling can be stabilized, and vegetation can be added to an otherwise barren site. Economically, the benefits are also notable. The increase in population would drive the existing economy to new heights, as many people (some of which may have significant disposable income) could then use their income to dine, shop, and recreate in Virginia and the surrounding region. Other businesses would also open or expand to Virginia to serve either products or services to the increased population.

IMPORTANCE TO THE ENVIRONMENT:

The area of the mine is roughly 935 acres - or about 1.45 square miles. A goal of this project is to bring more people to this area without eliminating more forested land that surrounds the cities of the region. By creating this community inside the mine rather than on forested land, that is a huge number of trees saved.

A conifer forest can be planted at a density of about 500 trees per acre in ideal conditions (this number may be smaller in the area surrounding Virginia, but I will use it for this calculation) (Loucks, 2020). Since the mine site is 935 acres, and if trees occur at a rate of around 500 trees per acre, that means up to 467,500 trees could be immediately saved by not creating open area to build new homes.

Another part of this calculation is the amount of carbon dioxide captured by the forest that will not be cut down. "According to the Arbor Day Foundation, in one year a mature tree will absorb more than 48 pounds of carbon dioxide from the atmosphere and release oxygen in exchange." (Mounce Stancil, 2019) If there are up to 467,500 trees in this area and each of them absorbs 48 pounds of carbon dioxide, thats over 22 million pounds on carbon dioxide being absorbed by trees that are saved from not creating a new city in their place. To put that into perspective, that chunk of forest negates the CO_2 emissions from over 2,200 cars. (EPA, 2021)

That is a significant positive environmental impact done by simply leaving the forest around Virginia alone.

PROJECT JUSTIFICATION:

IMPORTANCE TO ARCHITECTURE:

This project can have significant implications in the field of architecture - and can do so by creating a different kind of community. By focusing on the needs and wants of a population that almost exclusively works from home, different community-planning techniques and combinations of elements will be implemented that are unlike those of existing communities. Additionally, as we grow in our understanding of the consequences that architecture can have on our planet - (both positive and negative), new solutions need to be created. We can not continue as "business as usual" if we are to see a positive change in the way buildings effect an area. This project will attempt to serve as part of that new solution.

Figure 41 - Man Working from Home

Figure 42 - Woman Painting

Figure 43 - Paris from Above

HISTORICAL, SOCIAL, AND CULTURAL CONTEXT:

SUBTERRANEAN ARCHITECTURE AND BUILDING ON A SLOPE:

Sometimes, a challenge may arise in a building project where there may be not enough room for the required program, the environment may be too harsh for comfortable above-ground existence, there may be a significant slope on the site, or another reason. No matter the reason, choosing to build into the ground can have some fantastic consequences. Subterranean or partly-submerged architecture is uncommon compared to that which is above ground, but it can create many unique aspects and opportunities.

Some buildings in this thesis's design will be built into the earth, and note will be taken from buildings that have come before that also do so.

Figure 44 - Submerged Home

Figure 45 - Sancaklar Mosque

Figure 46 - Sassi di Matera, Italy

HISTORICAL, SOCIAL, AND CULTURAL CONTEXT OF THESIS:

BUILDING A COMMUNITY FROM SCRATCH:

For this project, I will attempt to design and model a community from scratch. In history, this concept is a relatively new idea. Throughout most of history, it was common for a city to grow organically, such as medieval cities growing around a castle or fortress. An example of such an occurrence is Ghent, Belgium (*Figure 47*). Cities that grew as the people did created an opportunity for the culture to grow with it. Older, more historic buildings would be at the very center, and newer buildings with newer styles would branch outward. Roads were created haphazardly - shaping lots and homes in the process.

Pre-planned cities, like New Haven, Connecticut (*Figure 48*) and Barcelona, Spain (*Figure 49*) are similar to what I will design. Cities like these attempt to create ideal areas and spaces for public parks and plazas, residential zones, commercial zones, government zones, and everything in between. Circulation patterns are also incredibly intentional. During the time that Barcelona was created, the idea of connecting two important places by a straight line road was prominent. By the time New Haven was created, the idea of the grid was more common. Cities like these immediately have a culture of their own. Yes, it can evolve through time, but that new pre-planned city instantly has an identity all its own.

Figure 47 - Ghent, Belgium

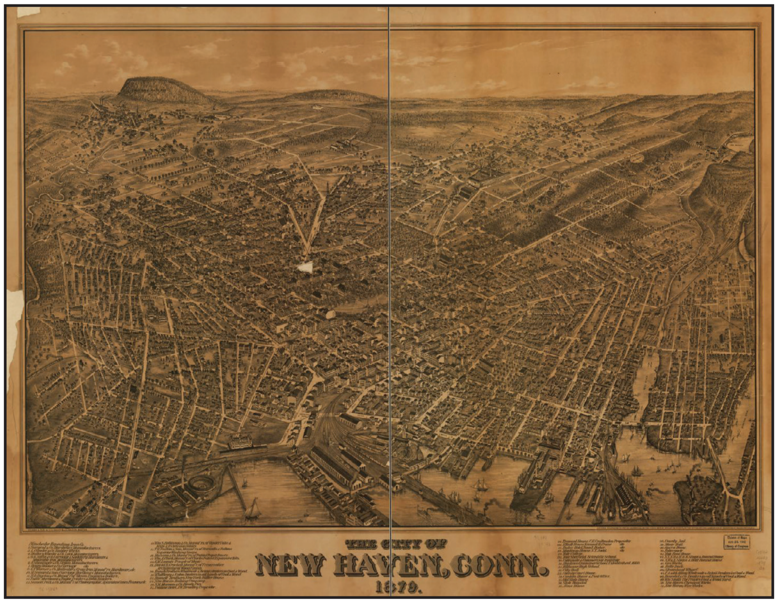


Figure 48 - New Haven, Connecticut

HISTORICAL, SOCIAL, AND CULTURAL CONTEXT OF THESIS:

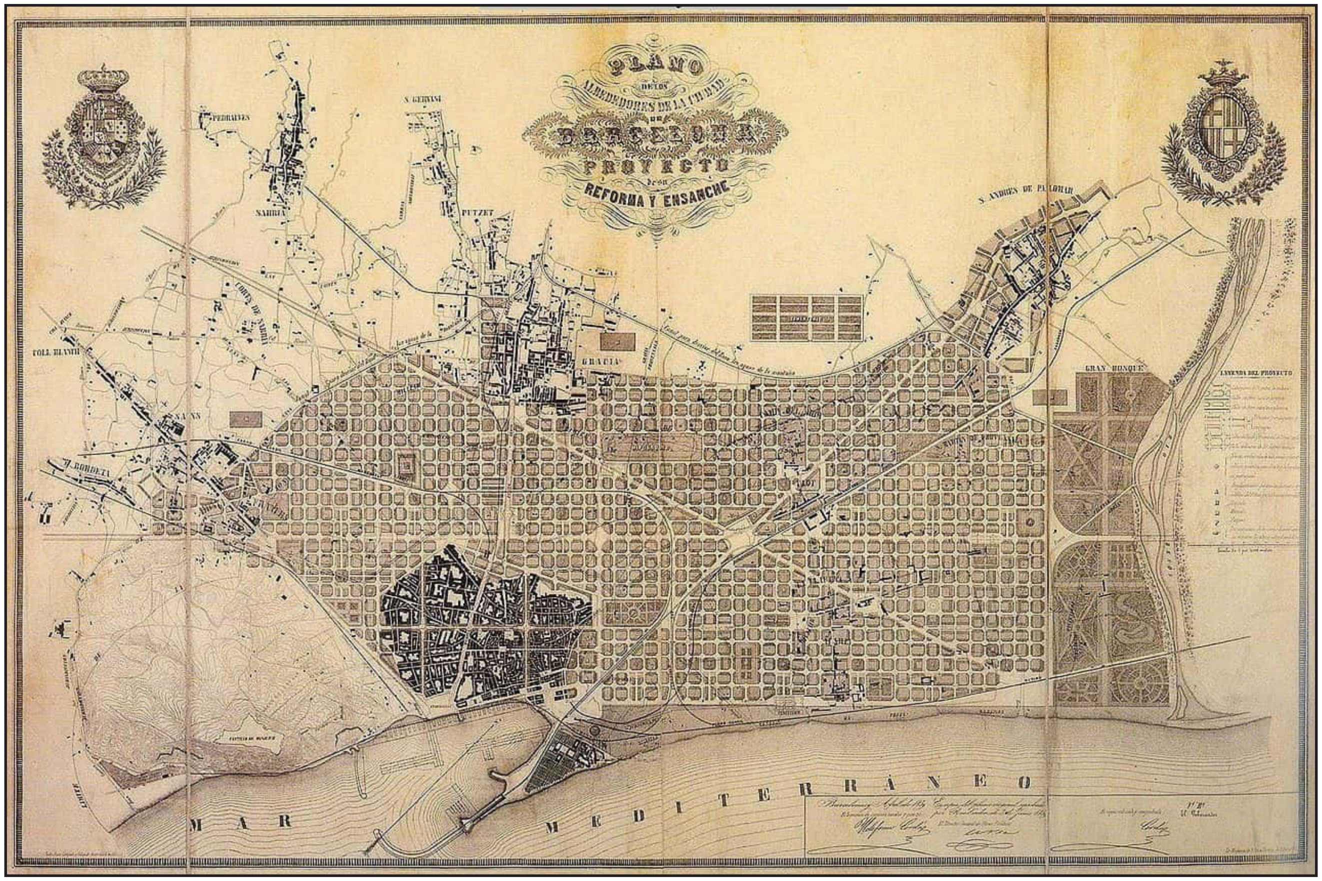


Figure 49 - Barcelona, Spain

HISTORICAL, SOCIAL, AND CULTURAL CONTEXT:

PAST MINE RECLAMATION PROJECTS:

Thousands of mine reclamation projects have taken place across the continent - everywhere from California to Ohio to Alaska. The project below was completed in Quebec in 2016. This site used to be a zinc and silver open-pit mine that was in operation during the 1950s and again in the 1980s. (Ministère de l'Énergie et des Ressources naturelles, 2016) Waste material had been eroding into nearby waterways, wreaking havoc on the plant and animal life.

The existing site was regraded, covered with soil that was able to sustain healthy plant growth, and planted with grasses and trees.

Figure 50 - Barvue Mine Before

Figure 51 - Barvue Mine During

Figure 52 - Barvue Mine After

PAST MINE RECLAMATION PROJECTS:

Pictured below is the reclamation of a mine site in Ehrenfeld, Pennsylvania. The piles of waste material were involved in landslides throughout the years after the mining company had left, and was in danger of destroying the homes below in the future.

Like the Barvue mine in Quebec, this project involved regrading, adding of soil, and planting of trees and grasses on the site of the old mine remnants. This reclamation project was awarded the 2020 National AML Reclamation Award by the U.S. Office of Surface Mining Reclamation and Enforcement - an office within the U.S. Department of the Interior.

Figure 53 - Ehrenfeld Mine Transformation

HISTORICAL, SOCIAL, AND CULTURAL CONTEXT OF THESIS:

WORKING FROM HOME:

A main user of this thesis's finished program would be those that would like to work their jobs remotely. According to Pew Research, about 20% of people worked from home before the COVID outbreak. As of their October 2020 study, 71% of people surveyed were currently working from home. 54% of people surveyed would like to work from home once the COVID outbreak has ended. (Parker, Menasce Horowitz, & Minkin, 2020) Again, over *half* of people surveyed want to work from home in the future.

Working from home is likely here to stay in some capacity, and will likely increase in popularity over the next several years. This only increases the amount of people who are able to live wherever they want; i.e. in this thesis's model city.

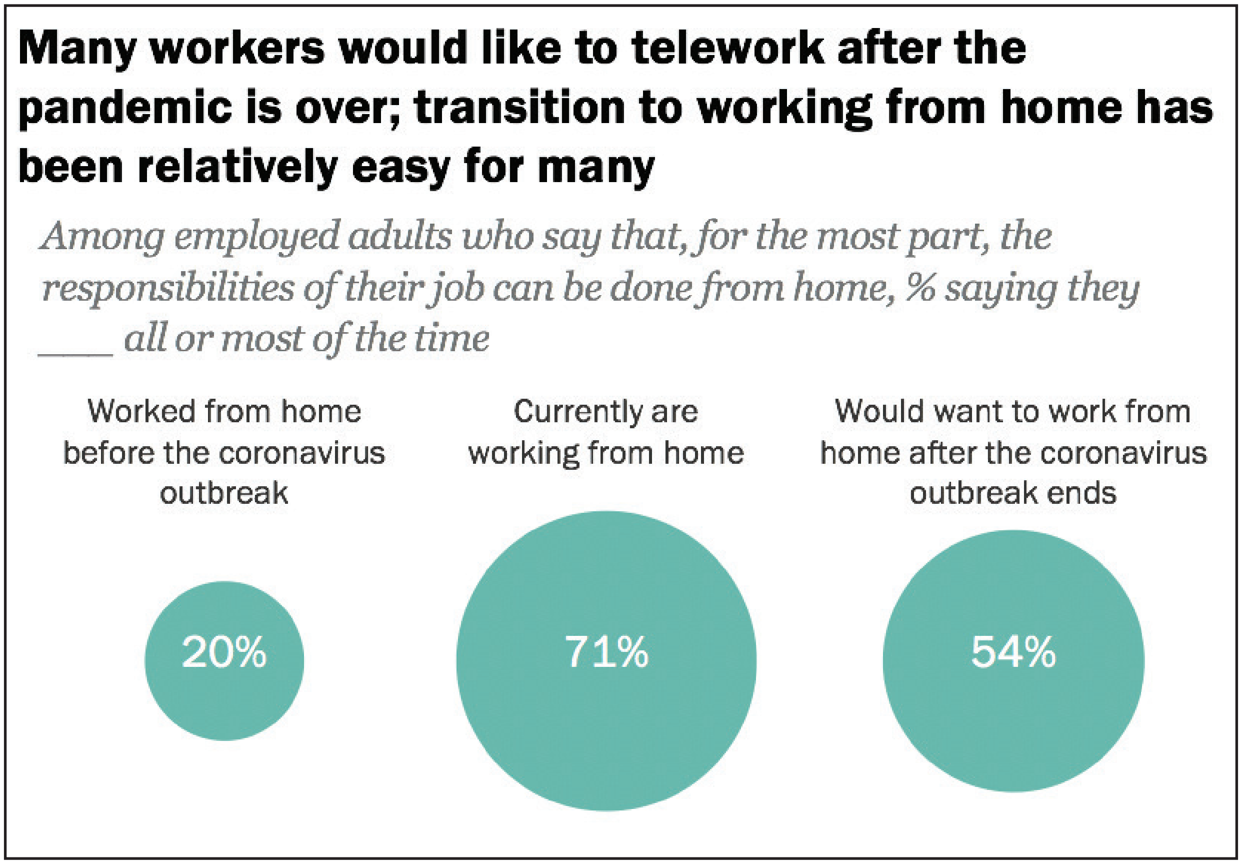


Figure 54 - Working from Home Survey

MINING IN THE MESABI IRON RANGE:

Mining on the Mesabi Iron Range began in 1892, after an iron deposit created by a now-receded inland sea was first successfully mined near the current-day city of Mountain Iron. Iron had been noted in the area for thousands of years by the Ojibwe, and other Europeans and white Americans attempted to mine for decades - unsuccessfully - until the Merritt family began the first successful mining operations. John D. Rockefeller got involved and owned that operation in 1894, and proceeded to form a business arrangement with Andrew Carnegie and Henry Oliver of Oliver Iron Mining Company. Through this agreement of mining, rail transport of the ore, and shipping of the ore, they formed United States Steel. (Tieberg, 2021)

Later on, this iron range proved monumental to both the industrialization of the nation, and later, the war effort. Minnesota actually produced more than 75 percent of all the iron used during the war. (America's Story from America's Library, 2021) Since those peak-level days, populations in the area have steadily declined for decades as ore deposits have began to run out and mines have either required fewer workers due to automation, or closed entirely.

Figure 55 - Oliver Mine in Virginia, 1894

Figure 56 - Union Mine in Virginia, 1915

SITE ANALYSIS:
HISTORY

VIRGINIA, MINNESOTA:

Virginia, Minnesota was incorporated in 1895 after iron ore was discovered adjacent to its current site in 1892. Besides mining, Virginia was also a hub for lumber milling. As mining originally was conducted underground, wooden supports were needed for walls and ceilings inside the mines. The wood that was not needed for mining was exported all across the country. At one time, Virginia had both the largest white pine mill in the world as well as the largest ore producing mine in the world. (lakesnwoods.com, 2021) Virginia was not only a hub in northern Minnesota, but a global-scale center of production and industry.

The economy exploded as soon as the city was created. Buildings were created seemingly overnight - an opera house (*Figure 57*), schools (*Figure 58*), a brewing company (*Figure 60*) - are just a few examples. The economic boom was very similar to that of a gold rush town. However, the prosperity lasted longer than most gold rush towns as mining continued heavily through World War II.

Figure 57 - Virginia Opera House

Figure 58 - Virginia Public School, 1895

VIRGINIA, MINNESOTA - CONTINUED:

The economy of Virginia has been on the decline since the end of the war. The crashing global economy of the 1980s resulted in layoffs, and further mineral depletion only worsened the problem. New ways of mining ore, specifically the mining of taconite, have helped keep iron available and the regional economy afloat, but it is not what it once was.

The aforementioned taconite mining is what is currently keeping mines in business. It requires a more difficult and costly process to extract iron from, but it nonetheless produces iron. Due to our ever present need for iron ore, the mines that are still in business need to keep expanding. Recently, the tallest bridge in Minnesota, the Virginia High Bridge (*Figure 61*), was erected to reroute U.S. Highway 53 in order to allow United Taconite to expand their mining operations north.

Populations have declined, as mentioned before. Between 1910 and 1960, the population of Virginia was steady around 12,000 to 14,000. Since 1960, however, the population shrank to around 11,100 in 1980, 9,200 in 2000, and 8,300 today. (worldpopulationreview.com, 2021) This shrinking population has even resulted in consolidation of two once-major school districts into one new one.

The dwindling population and stagnating economy could evidently use a burst of energy.

Figure 59 - Virginia, 1893

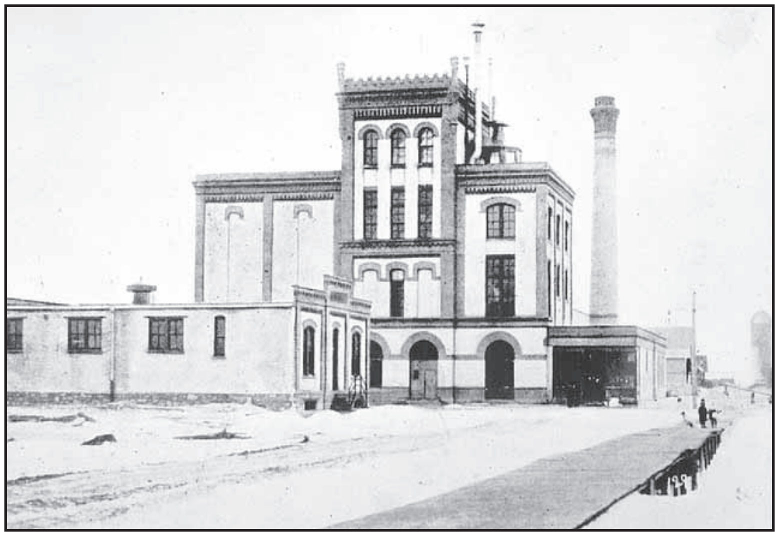


Figure 60 - Virginia Brewing Company, 1890

Figure 61 - Virginia High Bridge

The Thunderbird Mine, the site of this thesis, is a vast and impressive display of mankind's ability to change our landscape. It began its life as an undisturbed chunk of wilderness with untouched forest, lakes, and hills. Once iron was discovered, it slowly become a hole in the ground 2.3 miles long, over 1/2 a mile wide, and around 400 feet deep (700 if you count the hills of waste fill the mine has created nearby). The site no longer has its lakes, hills, or forests. What is now there consists of tiered rock for vehicular circulation and mining techniques, mounds where waste rock is moved to, and mining equipment. The cities of Virginia and Eveleth (to the north and to the south, respectively) can be seen in the images below.

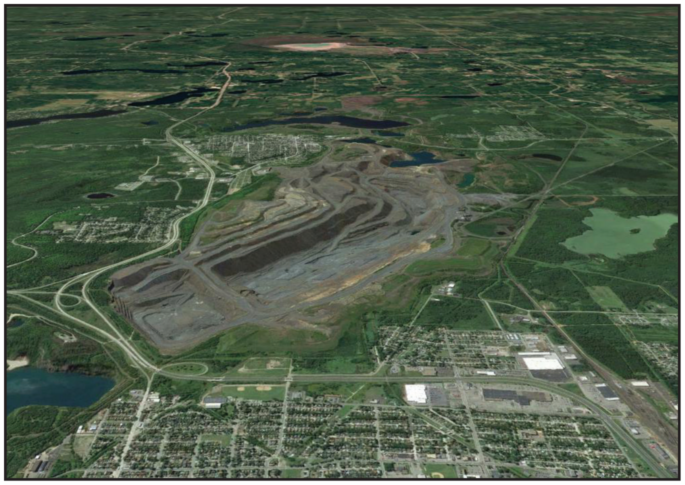


Figure 62 - Thunderbird Mine from the North

Figure 63 - Thunderbird Mine from the East

Figure 64 - Thunderbird Mine from the South

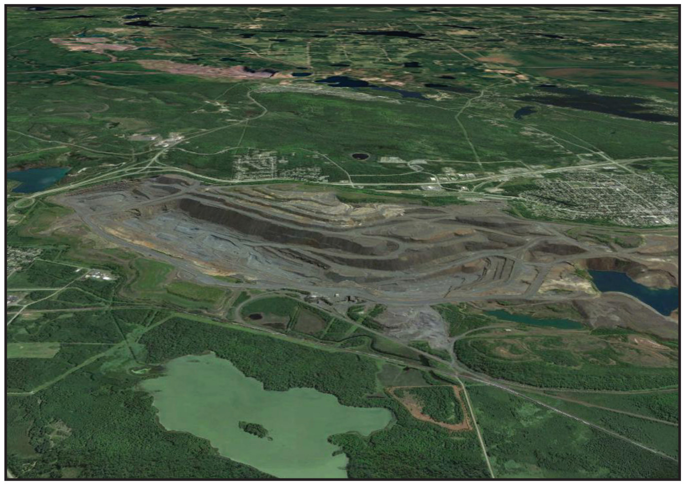
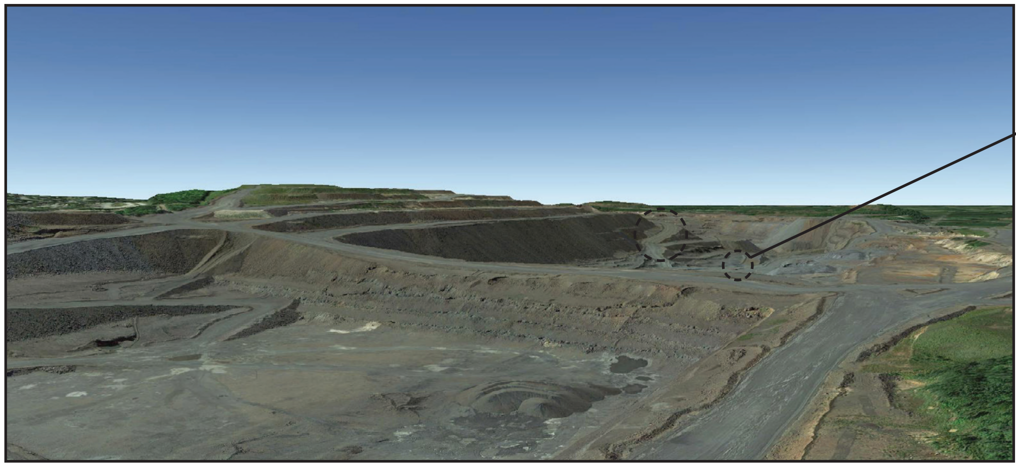


Figure 65 - Thunderbird Mine from the West

SITE ANALYSIS:
VIEWS

Pictured below are views from inside the existing Thunderbird Mine as it currently is. Prominently displayed are the terraced rocks (constructed in such a way that the walls of the mine will not collapse) and roads used by the mining equipment. It is on these terraces, slopes, and roads that this project will be built upon.

To get a sense of scale: in *Firgure 66*, the ramp that is circled in the center-right of the image is over a mile and a half away.



For scale, this tiny speck is a piece of mining equipment the size of a typical single-family home

Figure 66 - View A from the North

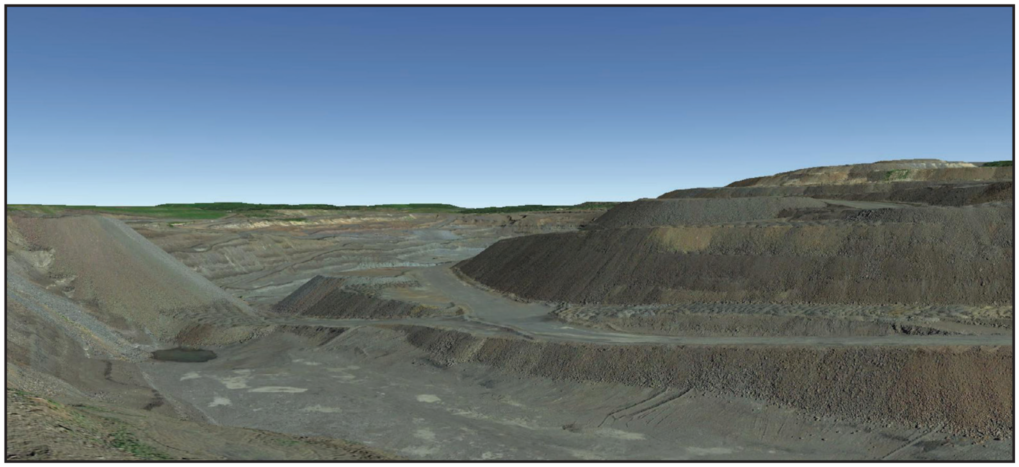


Figure 67 - View B from the South

Figure 68 - Site Map

The Thunderbird Mine is barely visible in these images below, but this is what is seen from a popular scenic outlook nearby.

Thunderbird Mine is distant, but present in the background

Figure 69 - Leonidas Overlook

Figure 70 - Leonidas Overlook in Winter

SITE ANALYSIS:
TOPOGRAPHY

The topography of the site is incredibly dramatic - some of the most intense elevation changes in the United States, not just Minnesota. The surrounding terrain is at an elevation of about 1450 feet above sea level, while the bottom of the site sinks down to about 1100 feet above sea level. The sides of the mine vary from gentle slopes to steep terraces to vehicular ramps.

The site used to have little variation it its slope, with the large hill on the eastern part of the site, shown below, being the only natural anomaly. It has grown in size due to the addition of waste rock material - hence the stepped, artificial look to it.

Topography is one of the defining factors of this site, and is one of the main elements to be considered by this thesis.

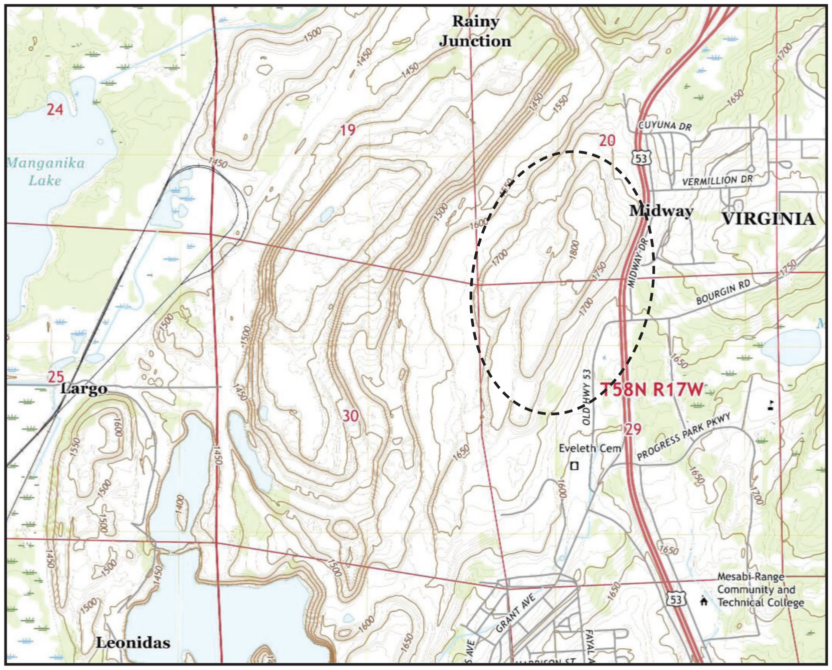


Figure 71 - Topography Map

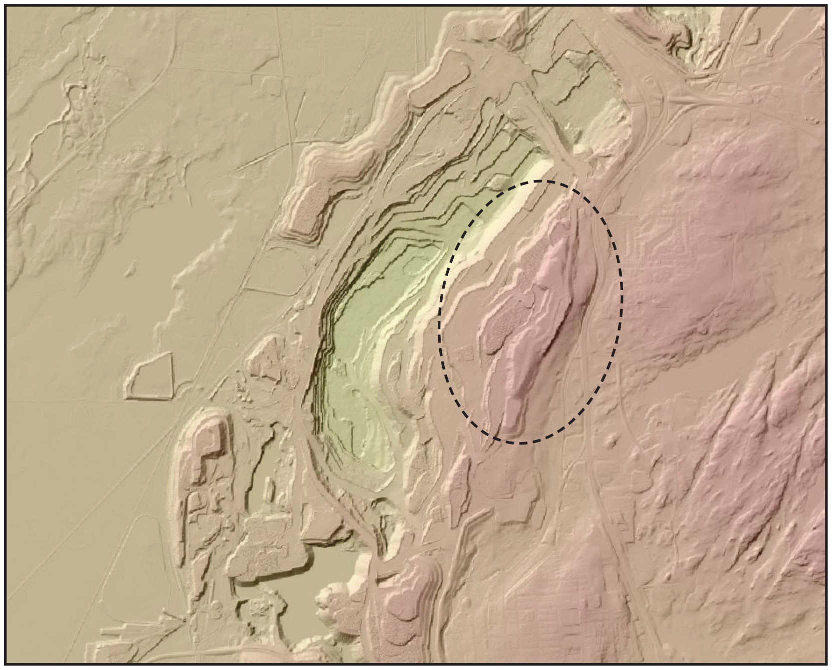


Figure 72 - Topography "Heat" Map

This site has undergone some of the most changes out of any site in Minnesota over the last several decades. Google started taking satellite imagery for public use in the 1980s (*Figure 73*), but the landscape began to be altered long before then. Below are a summary of the satellite images taken since the 1980s of the site and surrounding areas.

Figure 73 - Surrounding Area - 1984

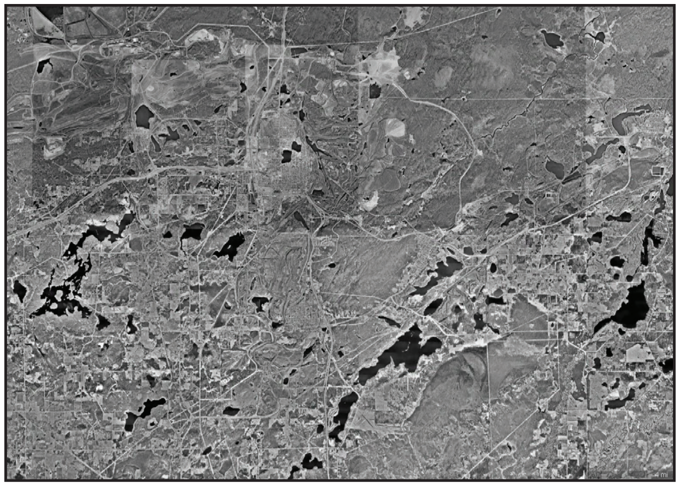


Figure 74 - Surrounding Area - 1995

Figure 75 - Surrounding Area - 2008

Figure 76 - Surrounding Area - 2020

SITE ANALYSIS:
VERTICAL LAND CHANGE OVER TIME

Pictured below is the culmination of the United States Geological Survey's (USGS) research pertaining to cut and fill throughout the United States. Clearly visible is the red marking in the Mesabi Range's area, indicating a wide spreading of waste fill as a byproduct of mining. If one looks closer, small blue dots within that region are visible. Those blue dots are where the actual mining occurs - the red is where the waste material is spread.

This map shows how significant mining is across the country. Most of the blue and red dots on this map are exclusively pertaining to mining operations - perfect locations for this thesis's framework to be enacted.

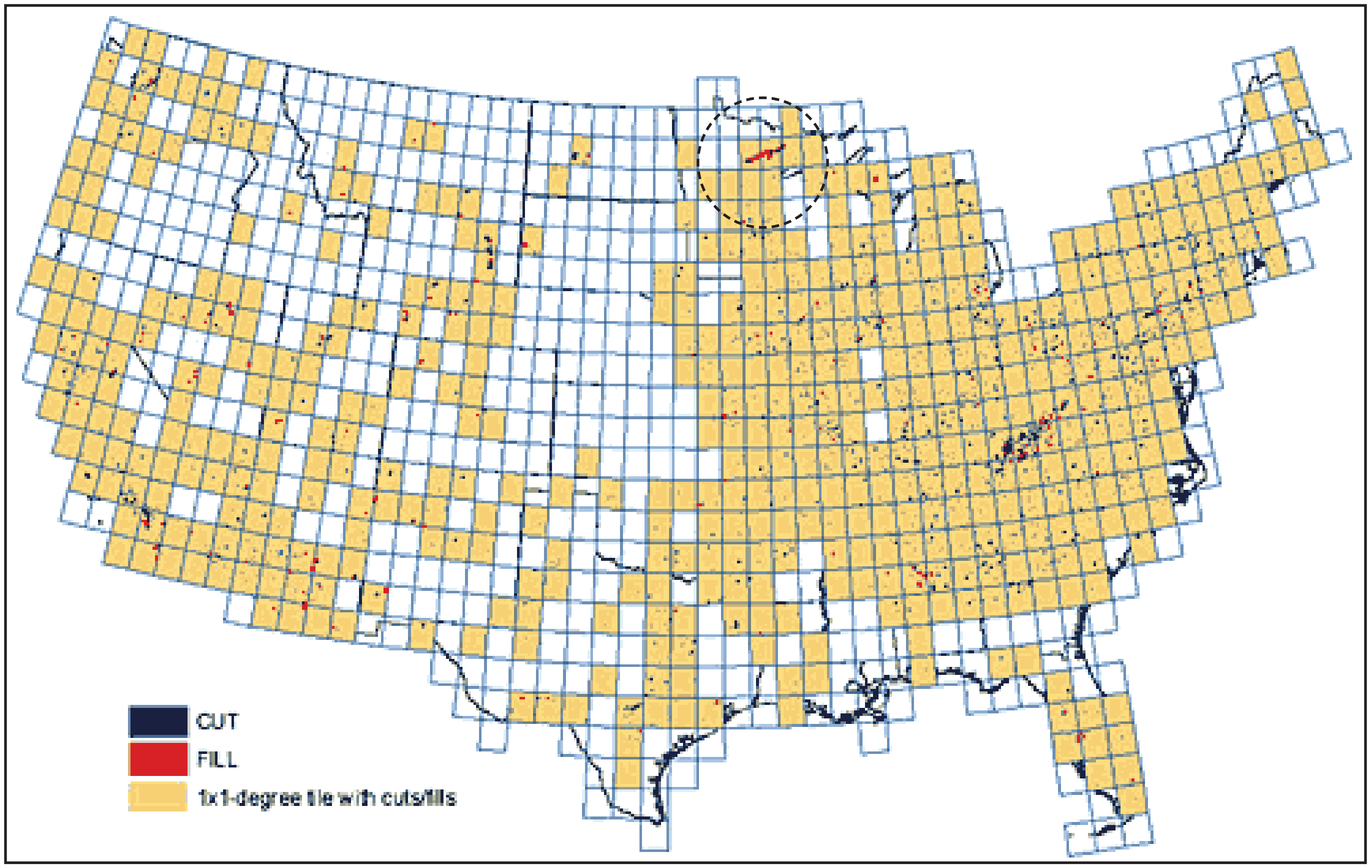


Figure 77 - U.S. Cut/Fill Map

The soils in the region are a mix of inceptisols, alfisols, histosols, and entisols (*Figure 78*). What is important to note for this project is that some of those soils are already iron-containing without the presence of the prehistoric sea depositing vast quantities of iron along its shore (the Mesabi Range).

Pictured below is bedrock geology for the state of Minnesota. Clearly visible is the Mesabi Range, shown in red, which explains the high concentration of iron mines in the area.

Mining can have a detrimental effect on soil in and around the site as described here, "Acid mine drainage is one of the primary sources of mining-related pollution. Mining activities increase the volume and rate of exposure of sulfur-containing rocks to air and water, creating sulfuric acid and dissolved iron. This acid run-off dissolves heavy metals such as copper, lead and mercury which leach into ground water aquifers and surface water sources, harming humans and wildlife." (Somarin, 2014) This will have to be considered, and remediation efforts would have to be enacted if the site were indeed contaminated.

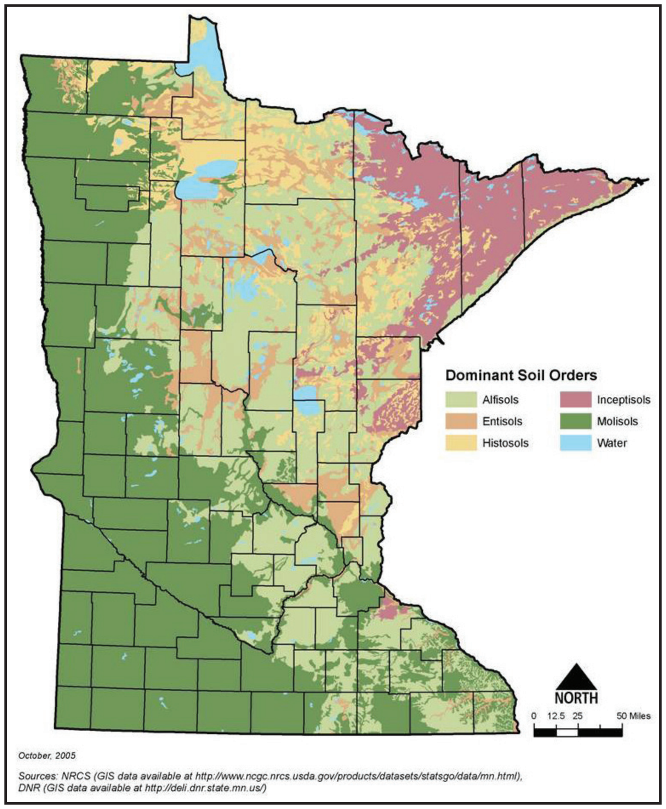


Figure 78 - Minnesota Soil Types

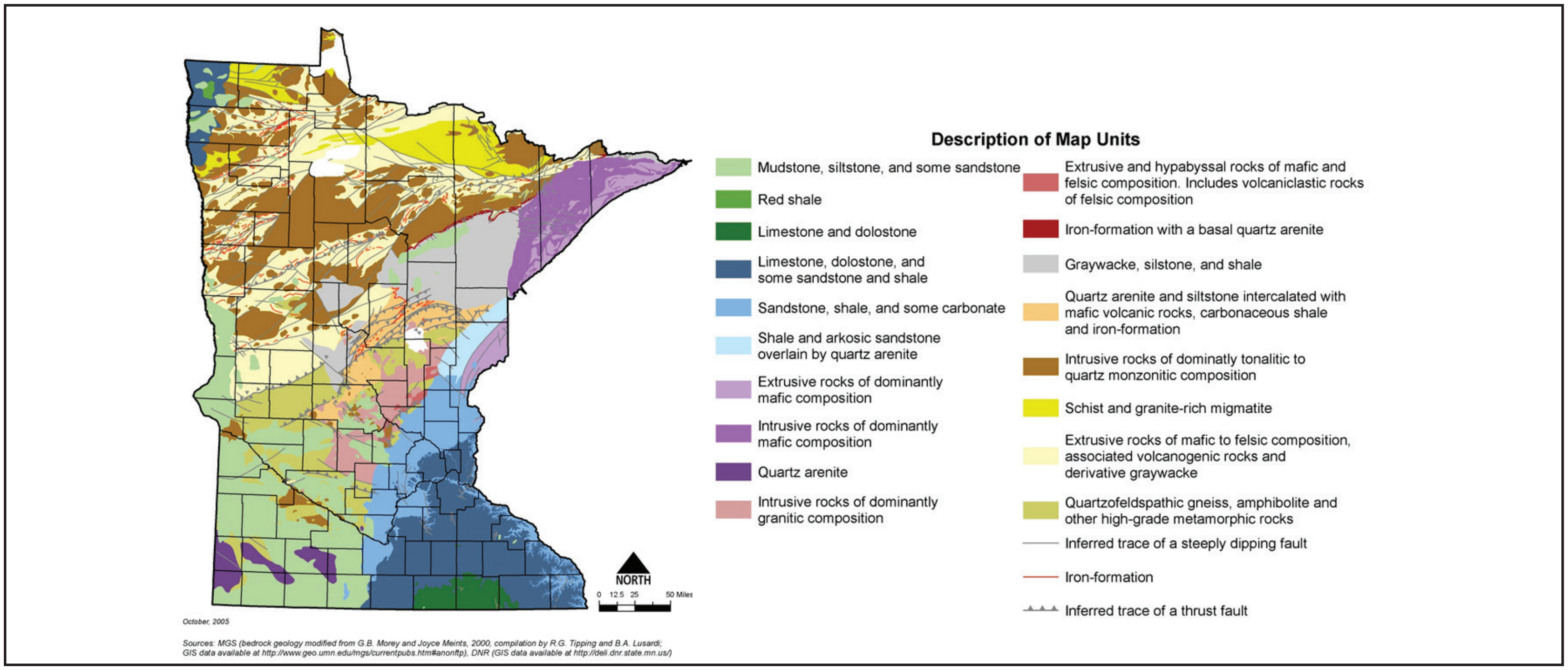


Figure 79 - Minnesota Bedrock Map

SITE ANALYSIS:
TEMPERATURE

Northern Minnesota is known for its harsh climate. Its hot summers and frigid winters are some of the largest temperature swings in the country. These temperature swings will be crucial to keep in mind for this thesis, as both hot and cold temperatures are present throughout the year. Below is temperature data from Embarrass, Minnesota - a city near Virginia.

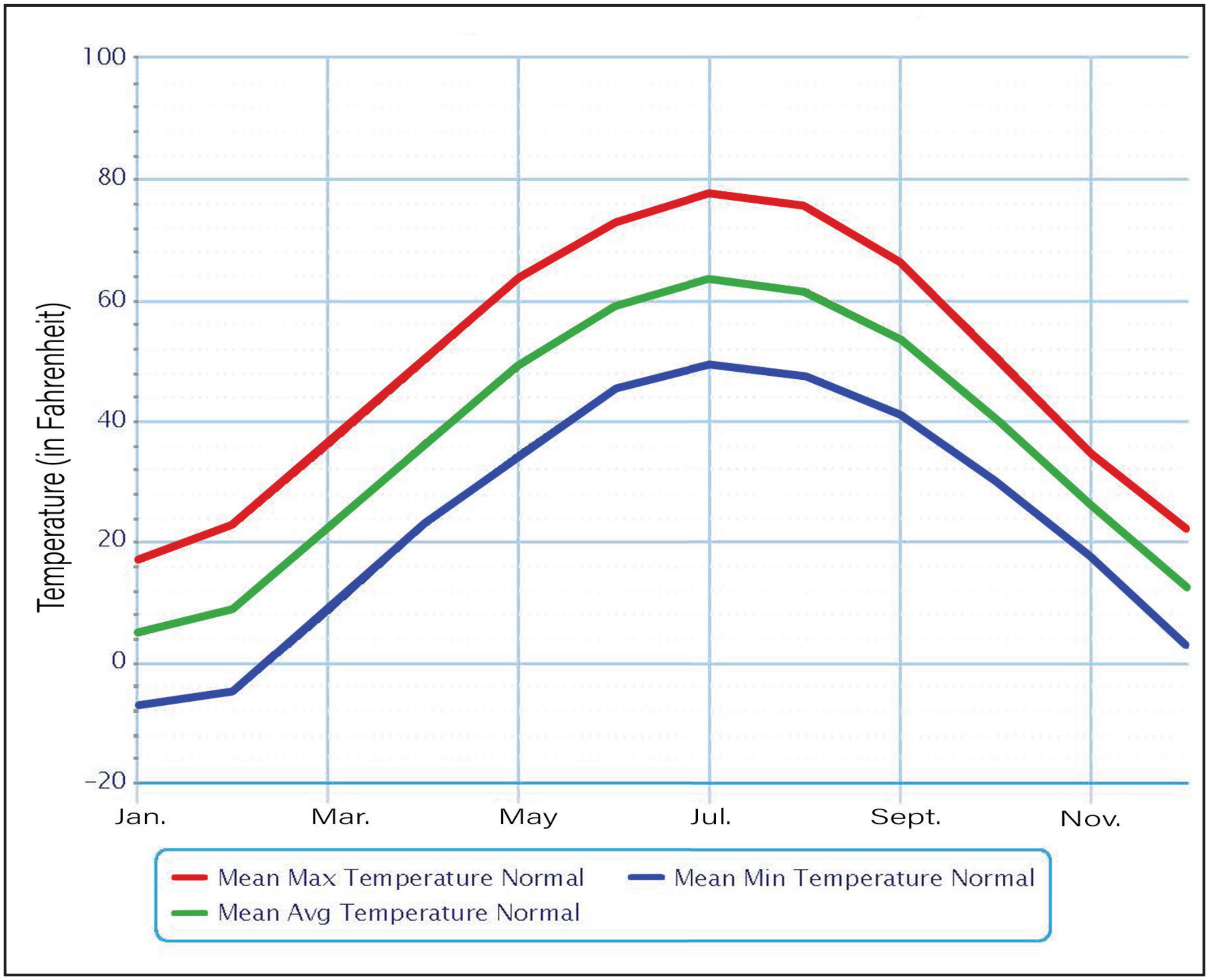


Figure 80 - Embarrass, Minnesota Temperatures

This region is also known for its intense winters - specifically - its snowfalls. Here, winter comes early and stays late. While winter is around, it tends to dump around 60 inches of snow throughout the year. The area also experiences an adequate amount of rain. Since snow is such a significant part of the fabric of the region, it will need to be given special consideration in the design portion of this project. The data below is gathered from the nearby city of Embarrass, Minnesota.

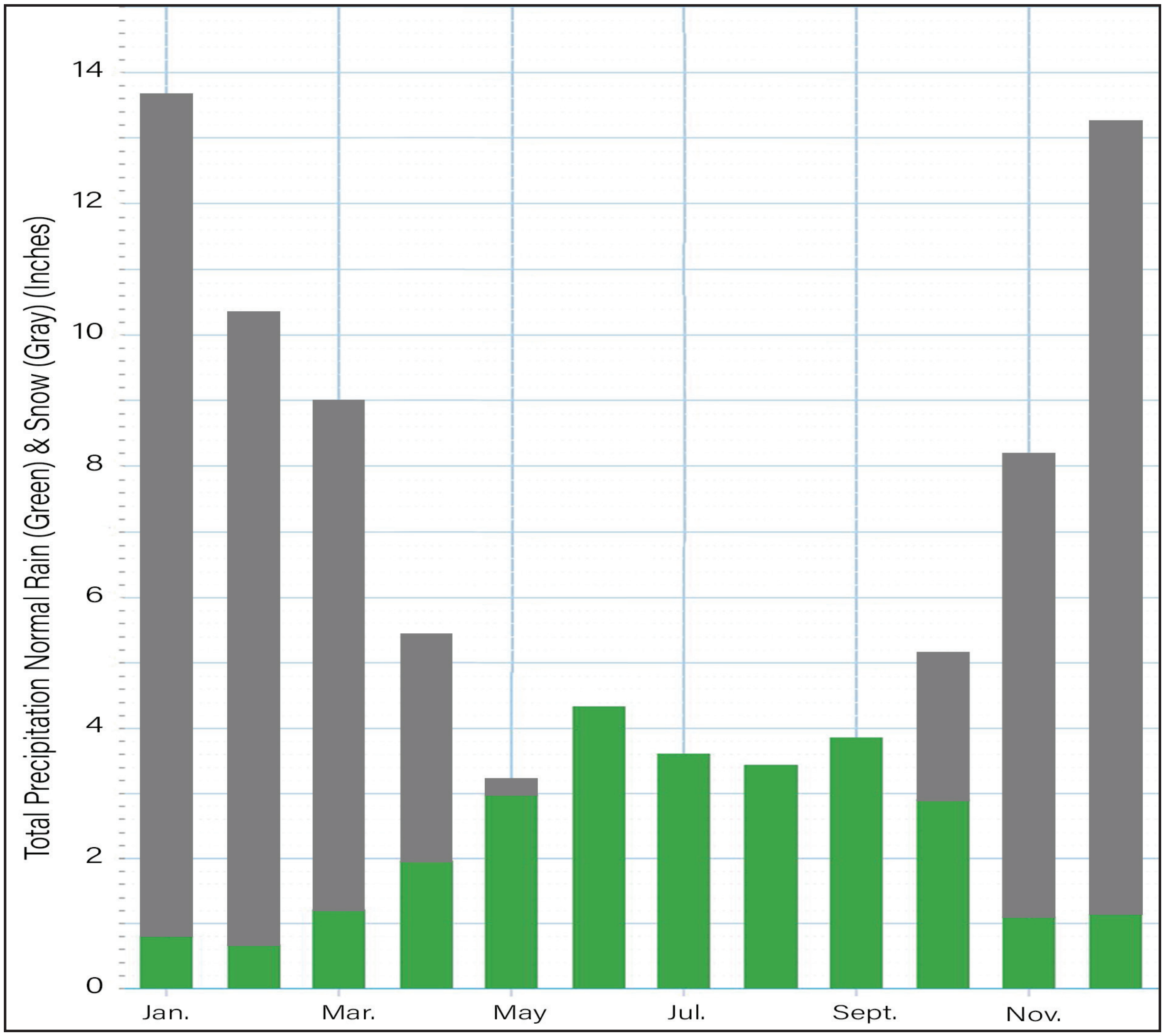


Figure 81 - Embarrass, Minnesota Precipitation

SITE ANALYSIS:
WIND ROSES

Pictured below are wind roses. Wind roses show the direction wind comes from for a particular location and the intensity in which it blows. These charts come from the weather station in Eveleth, Minnesota - near the southern end of the Thunderbird Mine.

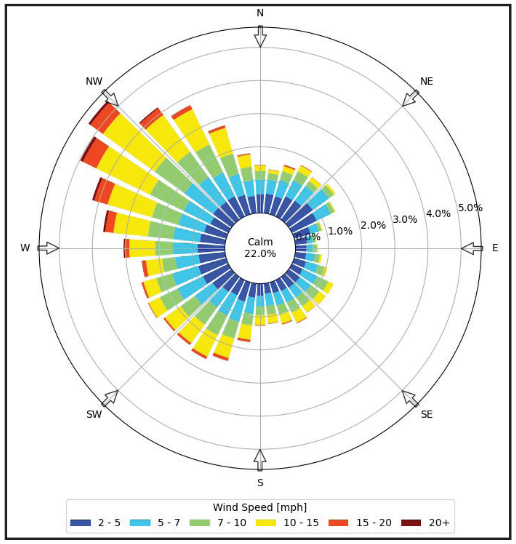


Figure 83 - January

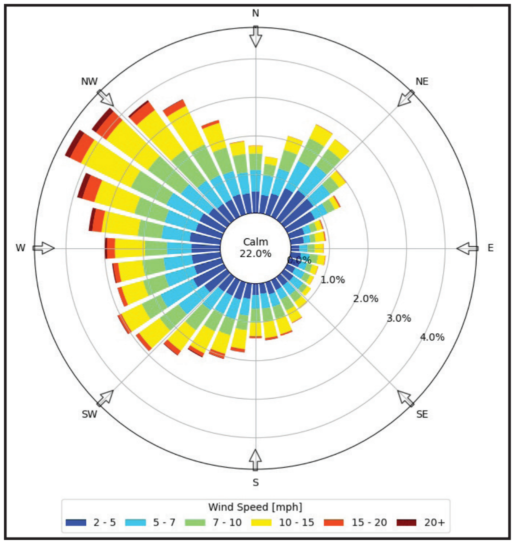


Figure 84 - February

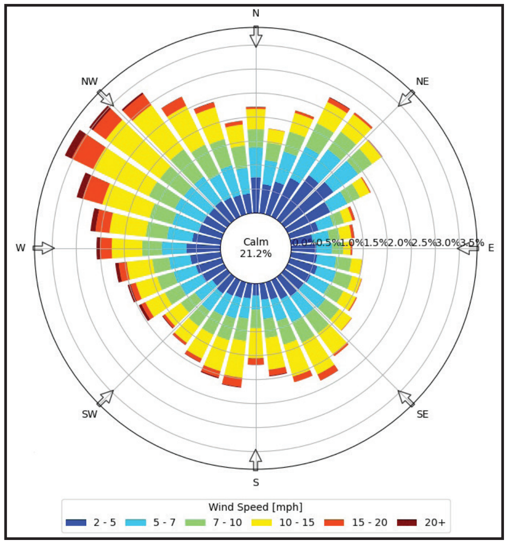


Figure 85 - March

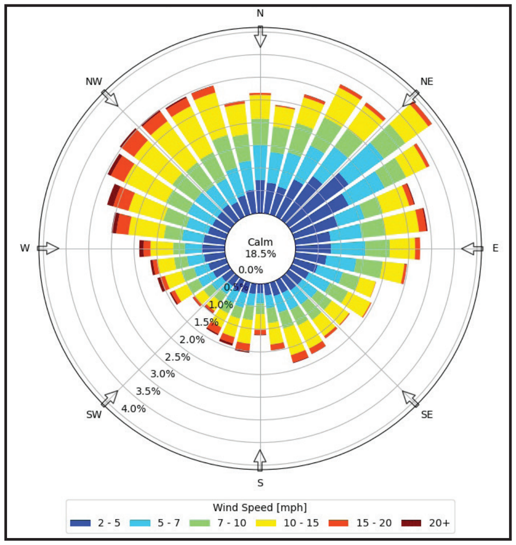


Figure 86 - April

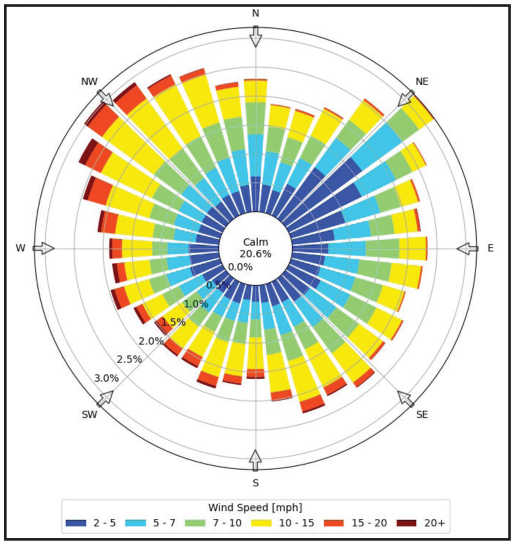


Figure 87 - May

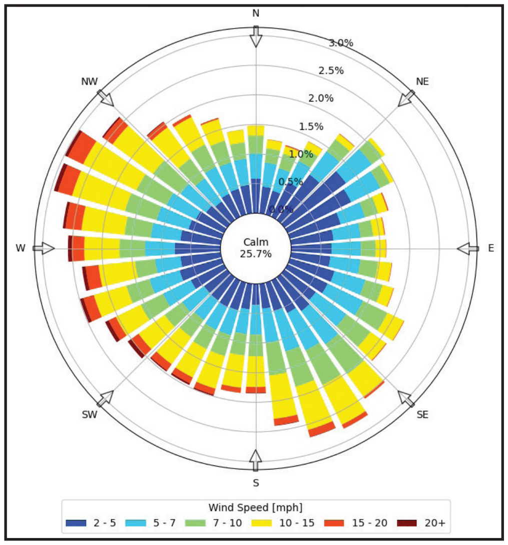


Figure 88 - June

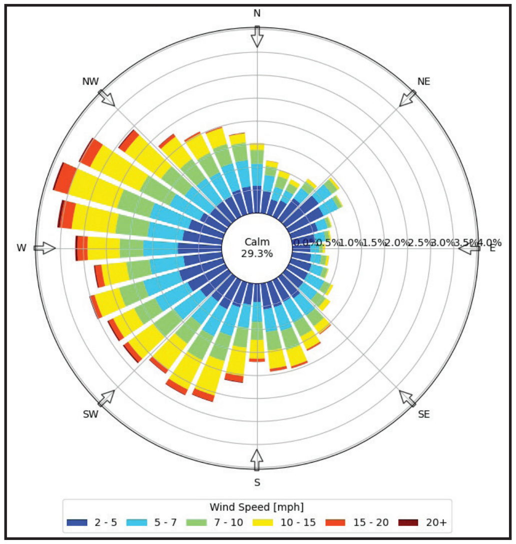


Figure 89 - July

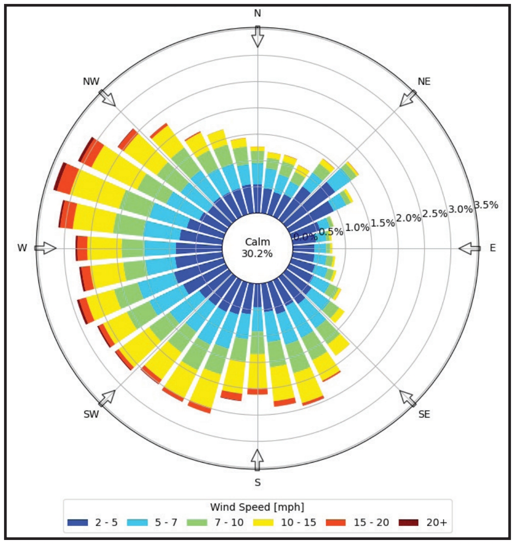


Figure 90 - August

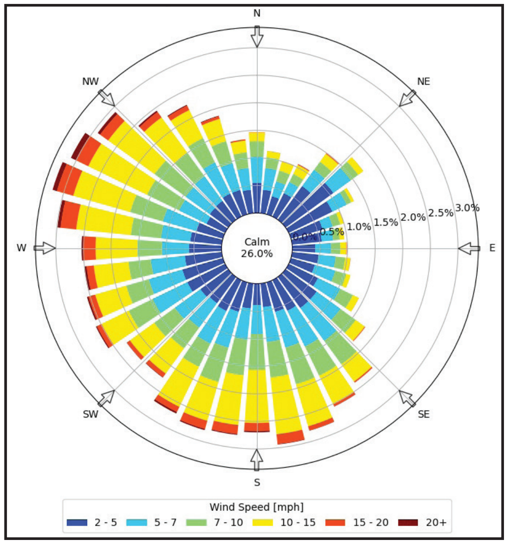


Figure 91 - September

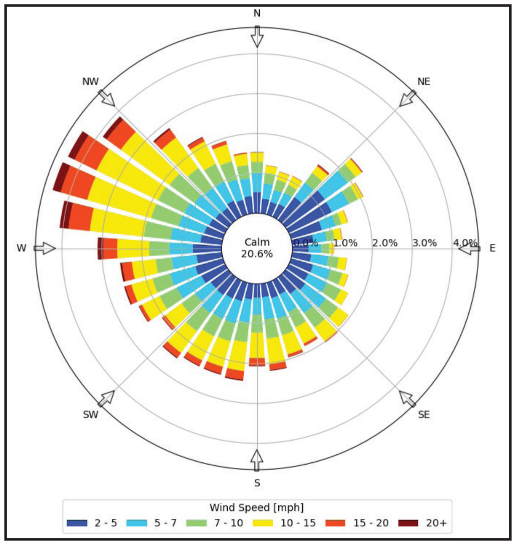


Figure 92 - October

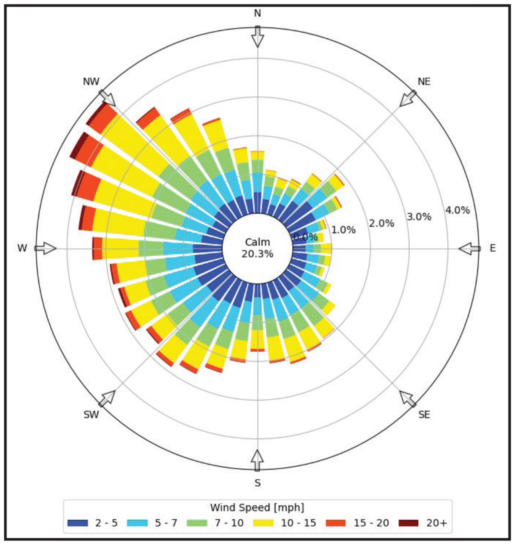


Figure 93 - November

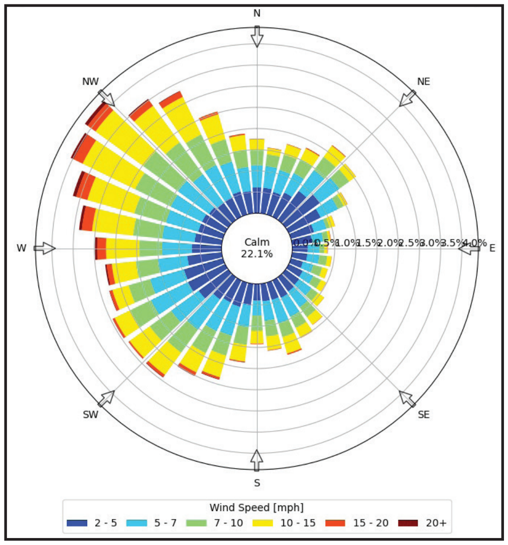


Figure 94 - December

SITE ANALYSIS:
SUN

Sun this far north varies greatly in both time present and intensity. On the summer solstice, the sun rises just after 5:00 and sets after 9:00 - meaning that there is around 16 hours of daylight.

By contrast, the sunrise on the winter solstice occurs just before 8:00, while sunset occurs a bit after 4:00 - totaling only about eight and a half hours of daylight - roughly half of the summer total.

In the summer, the sun's altitude reaches heights of nearly 55 degrees. In the winter, it sinks to about 7 degrees. These figures must be taken into account for elements like shading devices and passive heating. These drastic changes with the seasons add an additional level of difficulty compared to a site farther south. (suncalc.org, 2021)

Figure 95 - Sunset in Virginia, Minnesota

Figure 96 - Winter Sunset in Virginia, Minnesota

Notice the difference in where the sun rises (orange line) and sets (red line) on the summer solstice (*Figure 97*) compared to the winter solstice (*Figure 98*). The sun spends its time in very difference parts of the sky depending on the season due to the site's far north latitude.

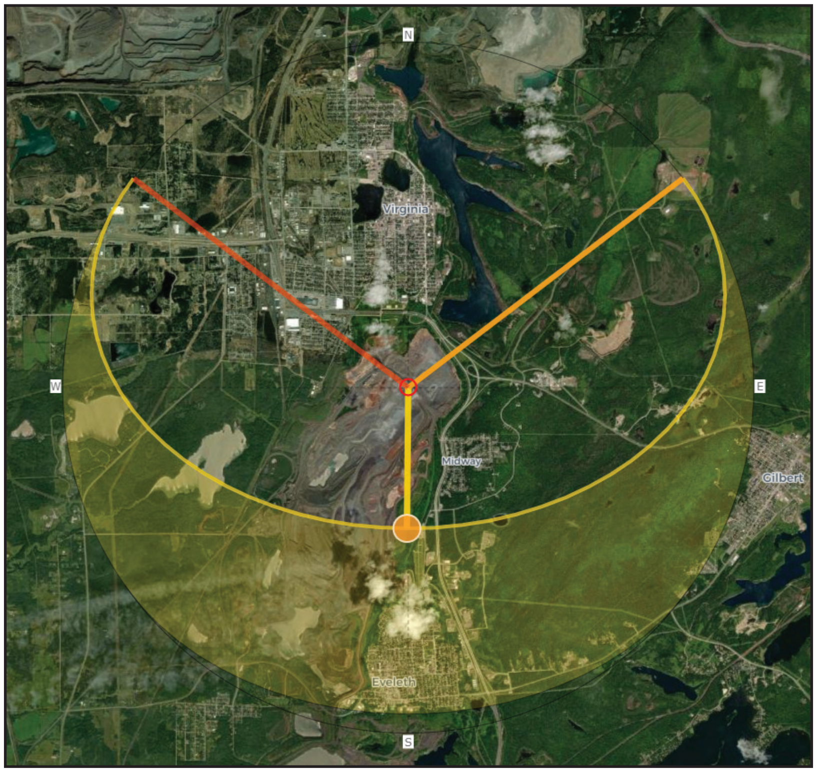


Figure 97 - Sun Path on Summer Solstice

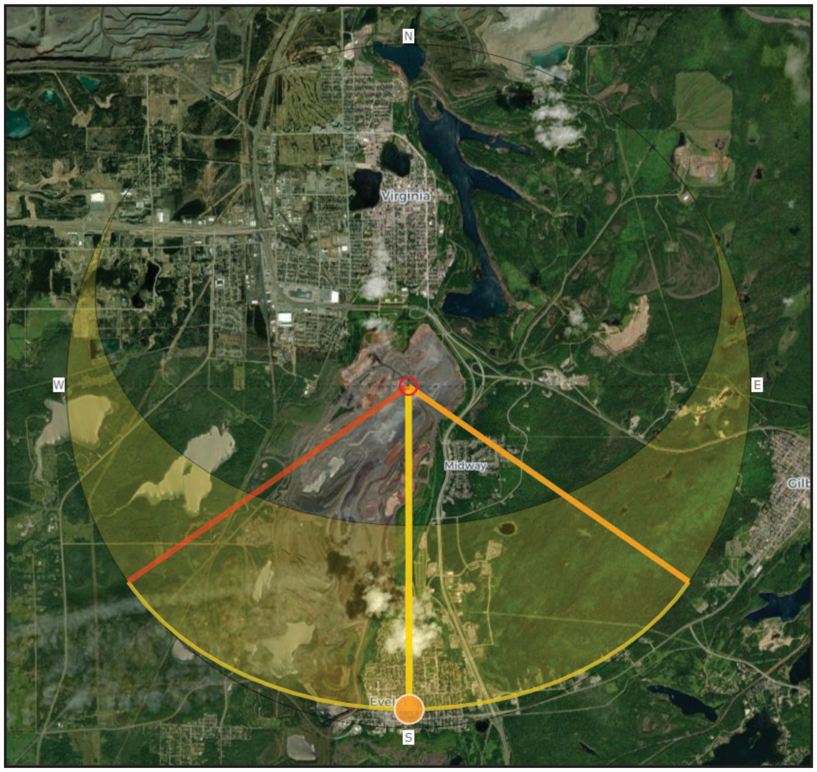


Figure 98 - Sun Path on Winter Solstice

SITE ANALYSIS:
ECONOMY

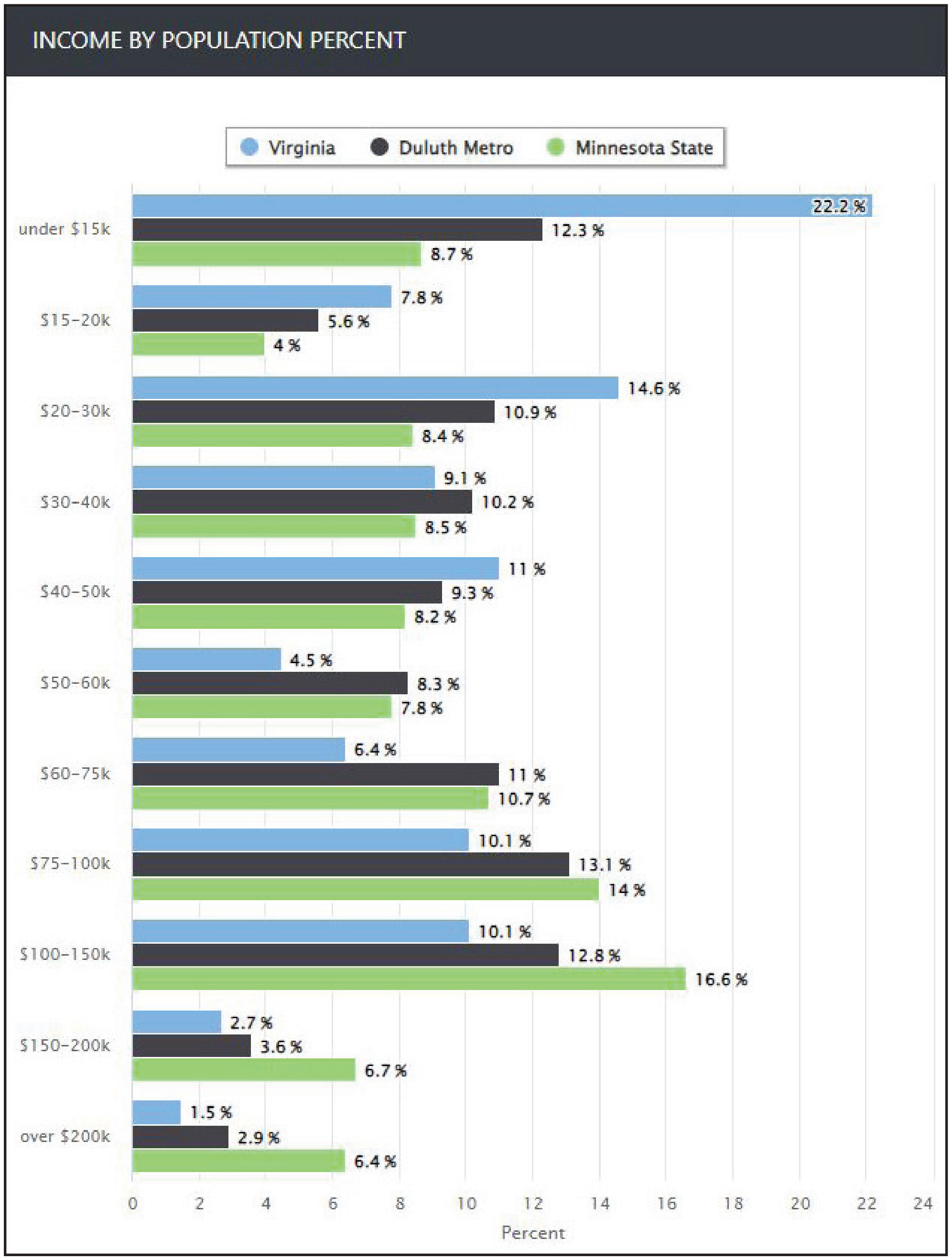


Figure 99 - Virginia, Duluth, Minnesota Incomes

The once-bustling economy of Virginia in the days of the first discovery of iron ore and World War II are long gone. The whole Mesabi Range has been struggling economically for decades, especially after the collapse of the U.S. steel industry in the 1980s.

Since those days of prosperity, things have only declined. A Virginia resident now has an average income of about $21,000 a year (over $7,000 less than the U.S. average). The median household income in Virginia is about $33,000 a year (a staggering $20,000 less than the U.S. average). Virginia's poverty rate of 25.5% is more than double the overall 9.7% rate in Minnesota.

24/7 Wall ST, a financial online newspaper, conducted a study of cities across the United States. They used various social and economic metrics to create a list of ""worst" places to live in each state. Based on Virginia's high crime rate and under-preforming economy, it has been named as Minnesota's "worst" city. (Stebbins, 2021)

Figure 99 shows how Virginia residents' incomes compare to others in Minnesota.

With this project, a goal is to reignite failing mining city economies, just like that of Virginia, Minnesota.

OVERALL REQUIREMENTS IN THE CITY

These aspects of the city should be those that are required by residents, but don't detract from the cities above the mine (Virginia, Eveleth, etc.). Aspects such as a school, restaurants, and retail shops were considered, but those would take away even more people and activity from the already suffering businesses in the nearby cities.

- Homes
- Grocery store
- Convenience store
- Exercise space
- Clinic
- Public gathering space
- Public green space
- Circulation paths
- Parking spaces at the top of the mine (no vehicles inside the mine)
- Vertical circulation up and down the mine
- Farming on top of buildings
- Lake at the bottom of the mine
- Solar panels
- Some sort of attraction (such as ski slope)

Note - the project scope later changed during the spring semester after conversing with Dr. Bakr Aly Ahmed. Scope was refined to consist of: homes, community center, ski resort, visitor center, and green space.

Figure 100 - City Square

Figure 101 - Public Green Space and Circulation

PERFORMANCE CRITERIA:
SPACES THAT WILL BE REQUIRED

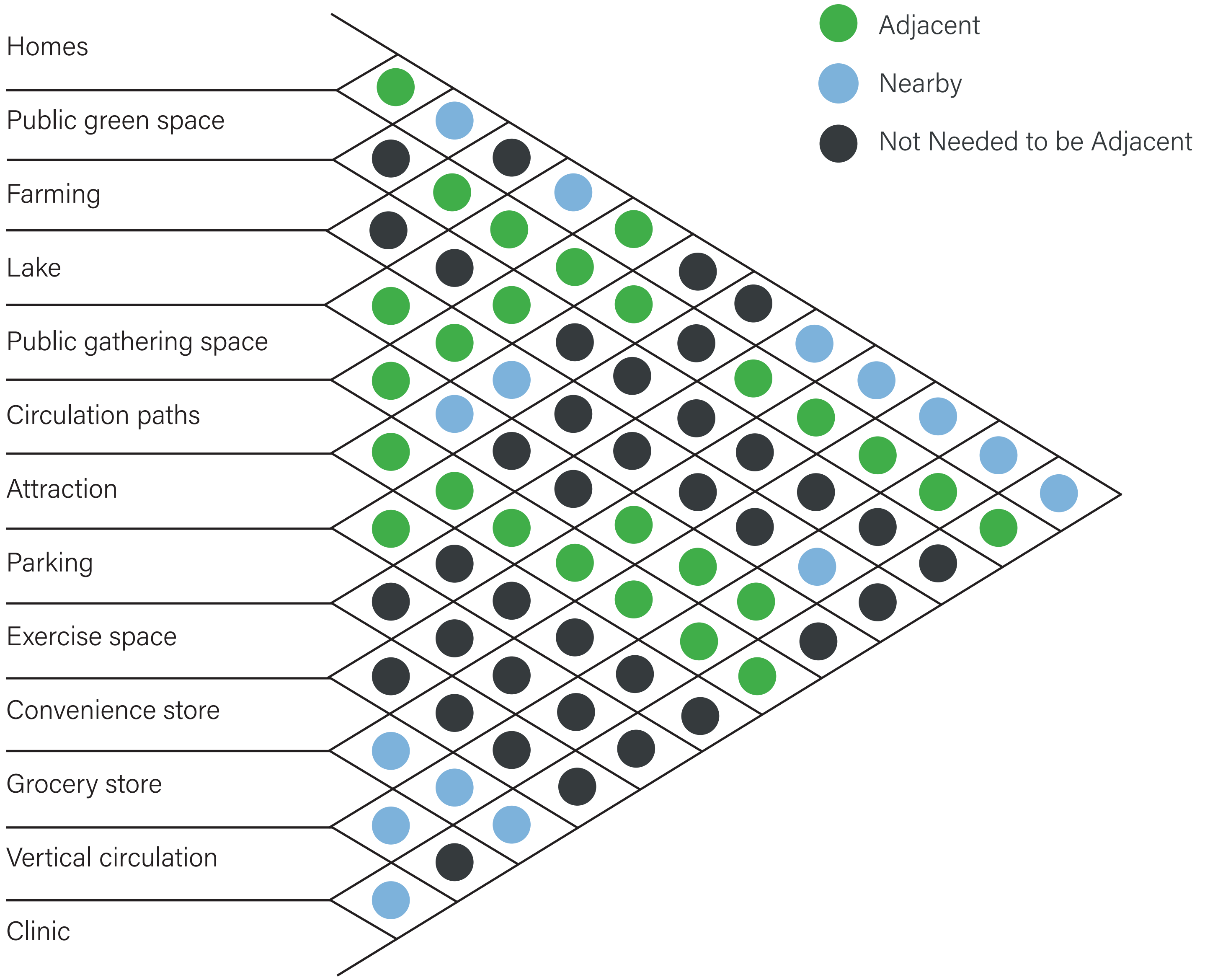
Figure 102 - Amager Bakke Powerplant

Figure 103 - Urban Lake

SPACES:	PERCENT ALLOCATION:
▪ Homes	30%
▪ Public green space	20%
▪ Farming	20%
▪ Lake	10%
▪ Public gathering space	5%
▪ Circulation paths	5%
▪ Attraction	3%
▪ Parking	2%
▪ Exercise space	2%
▪ Convenience store	1%
▪ Grocery store	1%
▪ Vertical circulation	1%
▪ Clinic	1%

Note - the project scope later changed during the spring semester after conversing with Dr. Bakr Aly Ahmed. Scope was refined to consist of: homes, community center, ski resort, visitor center, and green space.

PERFORMANCE CRITERIA:
INTERACTION MATRIX



Note - the project scope later changed during the spring semester after conversing with Dr. Bakr Aly Ahmed. Scope was refined to consist of: homes, community center, ski resort, visitor center, and green space. This matrix is accurate besides the elimination of grocery store and convenience store

PERFORMANCE CRITERIA:
ENVIRONMENTAL PERFORMANCE & IMPACT

Since the site is in northern Minnesota, winters are very cold and summers are hot. To make this a city for the future, passive strategies will be used in heating, cooling, and lighting. This will be crucial as this is an extreme climate, and active heating, cooling, and lighting could become quite costly without these measures.

THERMAL PERFORMANCE:

Temperatures must be comfortable indoors in this project - between 65 - 75 degrees. This goal will be achieved by strategic placement of windows, overhangs, material usage, and orientation of buildings.

NATURAL LIGHT:

Natural lighting should automatically be adequate if thermal performance is adequate. This is because thermal performance should be mainly achieved by natural light. This goal of adequate sunlight will be achieved through ample window usage and optimization of building orientations.

PERFORMANCE CRITERIA:
SUMMARY

SUMMARY:

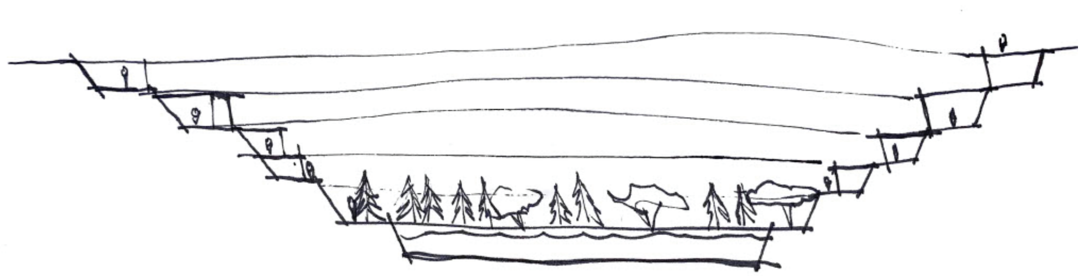
In summary, it is important that this thesis's design project be designed with people, natural environment, wildlife, region, immediate surroundings, and history in mind. Each of those must be respected and considered in the execution of this project. A successful iteration of this project will be one that creates a model community of the future where people are able to work from home effectively and happily. There must be ample opportunity to succeed here, and this new community must be complimentary to the cities it is surrounded by, both culturally and economically. This project must also include the spaces mentioned in the interaction matrix, and they must be situated according to that matrix. This is for the benefit of the inhabitants and visitors of the site. In short: this project must be designed with all the previous sections of this manual in mind to be successful.

Figure 104 - Museum of Ethnography in Hungary

III - DESIGN SOLUTION

MINE DENSITY AND USAGE:

Early concepts for this thesis involved filling most of the mine's surface with new buildings (shown below in the form of section cuts). Upon further research and consideration, this was deemed unnecessary. This is due to a number of factors. One reason was that the area does not need that many buildings and building typologies - filling the mine with buildings would more than double the area's population, which is not feasible to achieve in one swift phase. Another reason for not filling the mine's surface with buildings is that it would be environmentally irresponsible. The majority of the surface can be returned to nature by way of forest or prairie plantings.

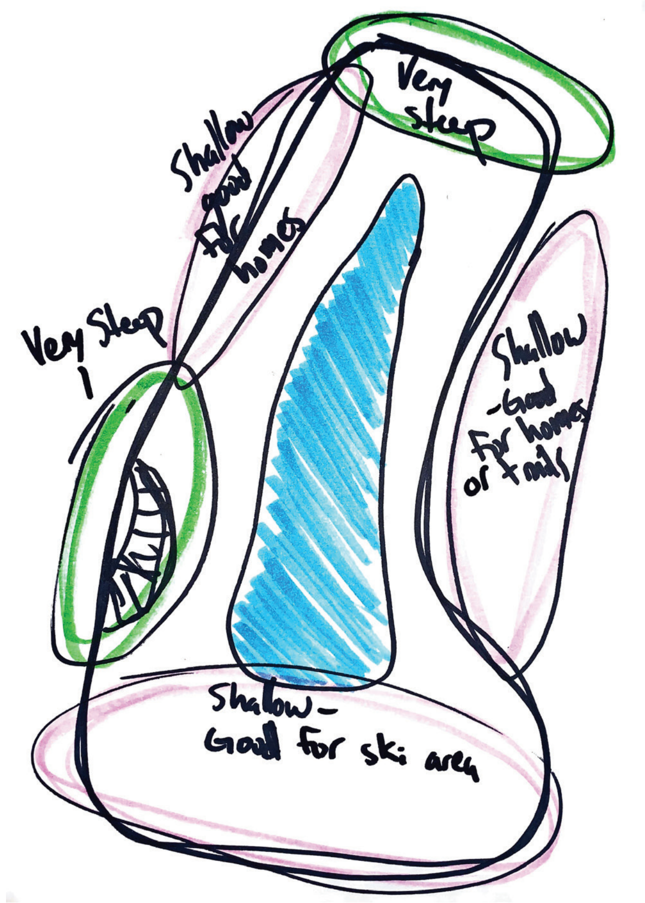


PROCESS DOCUMENTATION:
CONCEPT EVOLUTION

SITE SLOPE ANALYSIS:

Once it was decided that the whole of the mine would not be used for structures, essential buildings were determined and key areas of the mine were chosen for structures. Vital building types for this project became clear: homes for permanent residents, a community center for them to work and gather, a ski resort to bring tourists to the area, and a visitor center to learn about and appreciate the mine itself.

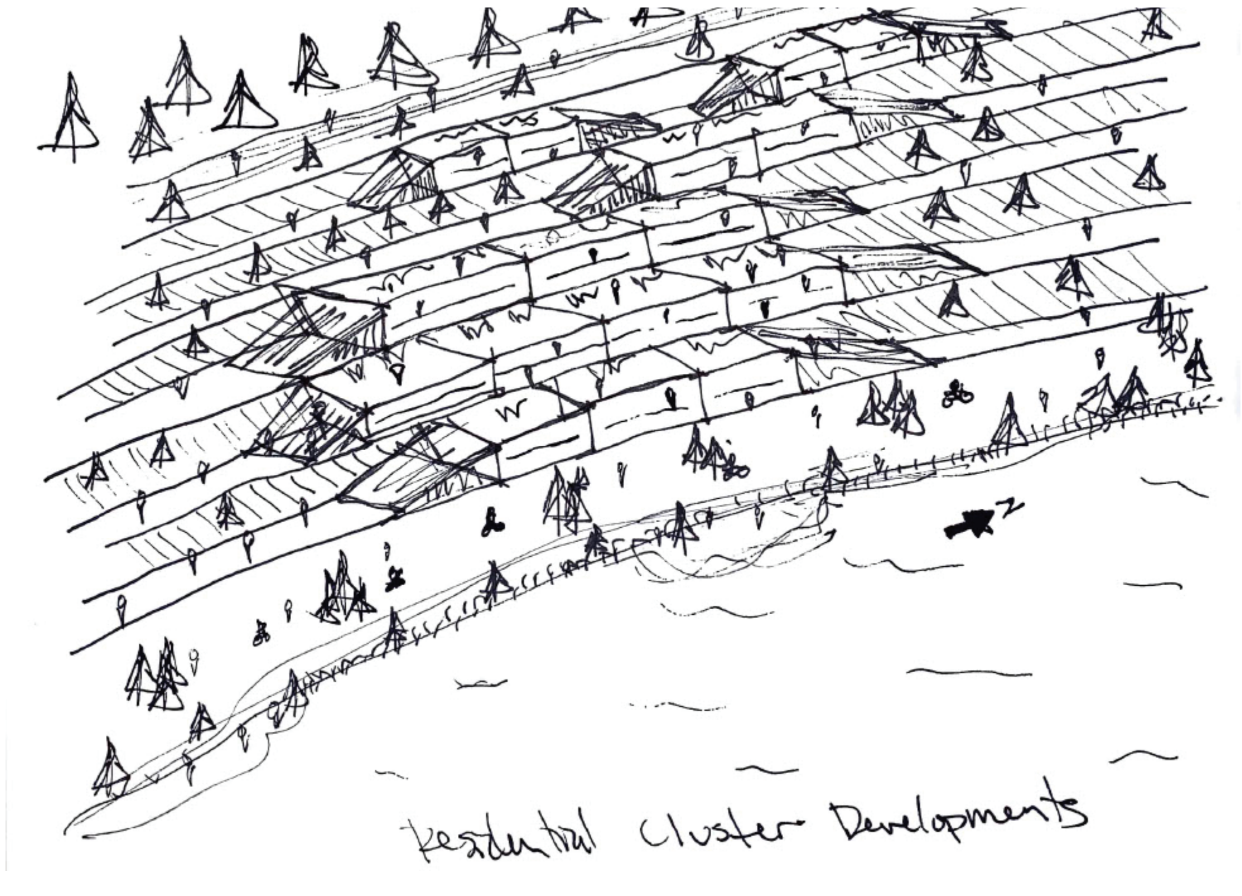
Below is a sketch of the site slope analysis where areas were determined to be conducive for certain building types. Areas circled in green were identified as being very steep - conducive to buildings with overhangs (visitor center) or stepped in nature (residential clusters). Areas circled in pink were identified as being shallow in slope - good for the ski resort and community center.



RESIDENCES:

Residences were placed on a steep slope and in clusters for several reasons, including the following

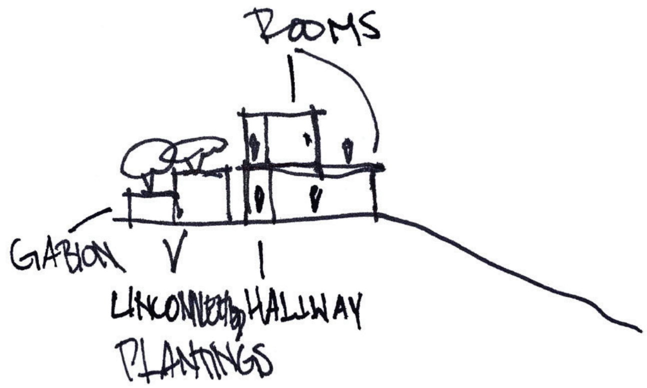
1 - Every resident gets a fantastic view.
2 - Residents live close to each other - good for community and for condensing underground circulation.
3 - The rooftops of homes act as yards, gardens, and circulation for their neighbors above.
4 - The compact connectedness allows for less separate structure, heating, and cooling.
5 - The forms were simple and able to mimic the existing topography for minimal additional excavation.
6 - The existing topography is stable and strong - courtesy of the mining companies.

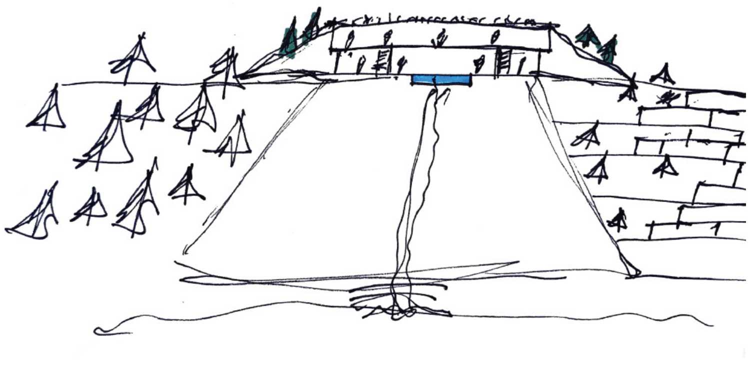


PROCESS DOCUMENTATION:
CONCEPT EVOLUTION

SKI RESORT, COMMUNITY CENTER, AND VISITOR CENTER:

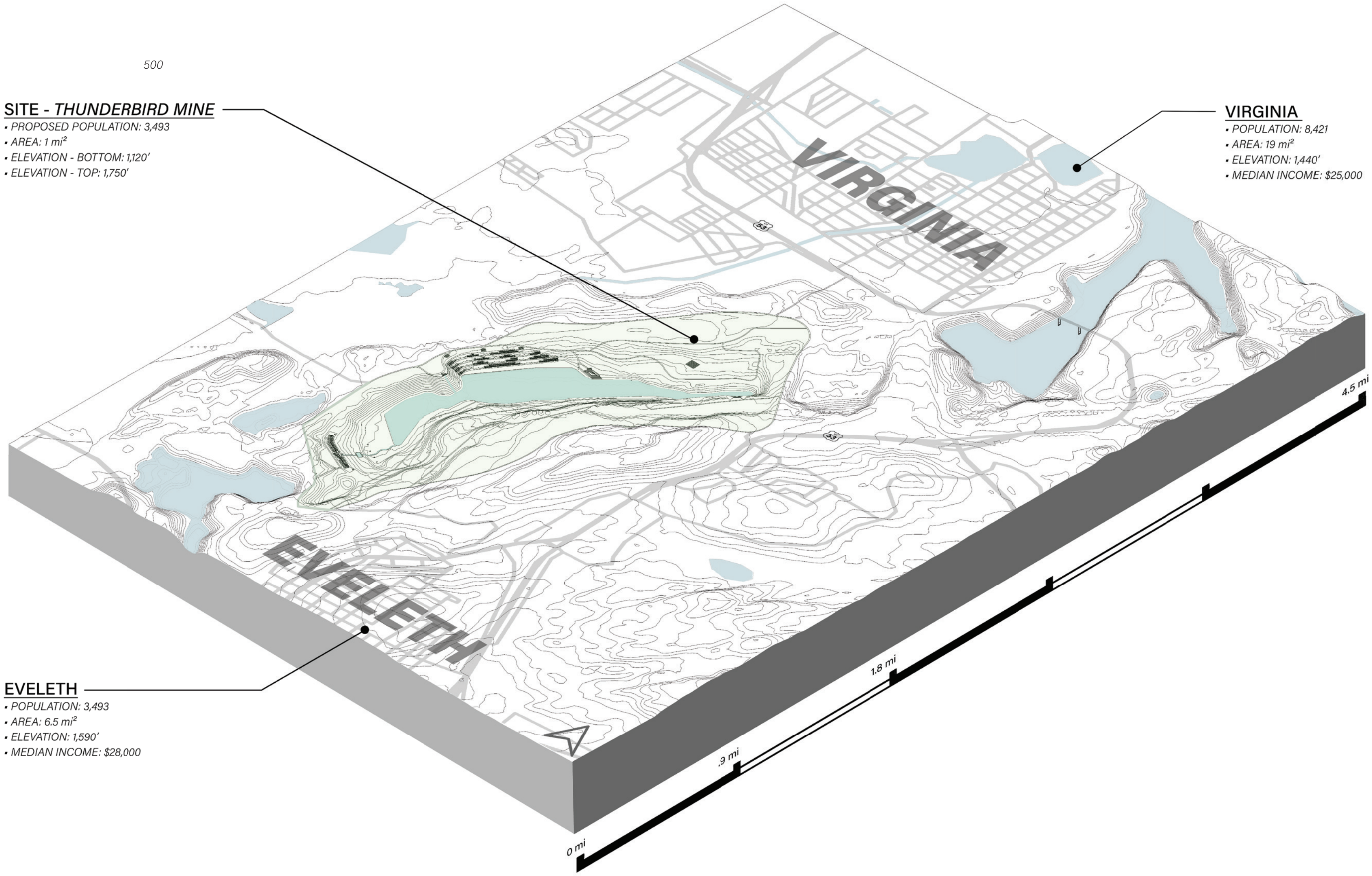
These buildings all came to be by looking closely at their own site. Each one is directly influenced by its site in form, position, and orientation, among other aspects. For example: the ski resort incorporated a cantilevered area to appreciate the majesty of the mine and to immerse the person experiencing the site within the mine. Similar strategies were used in the visitor center. The community center was arranged on its site to create a space that sits inside the earth while simultaneously creating a bright space that embraces its surroundings. The final designs are presented later in this book.





SITE DESIGN:

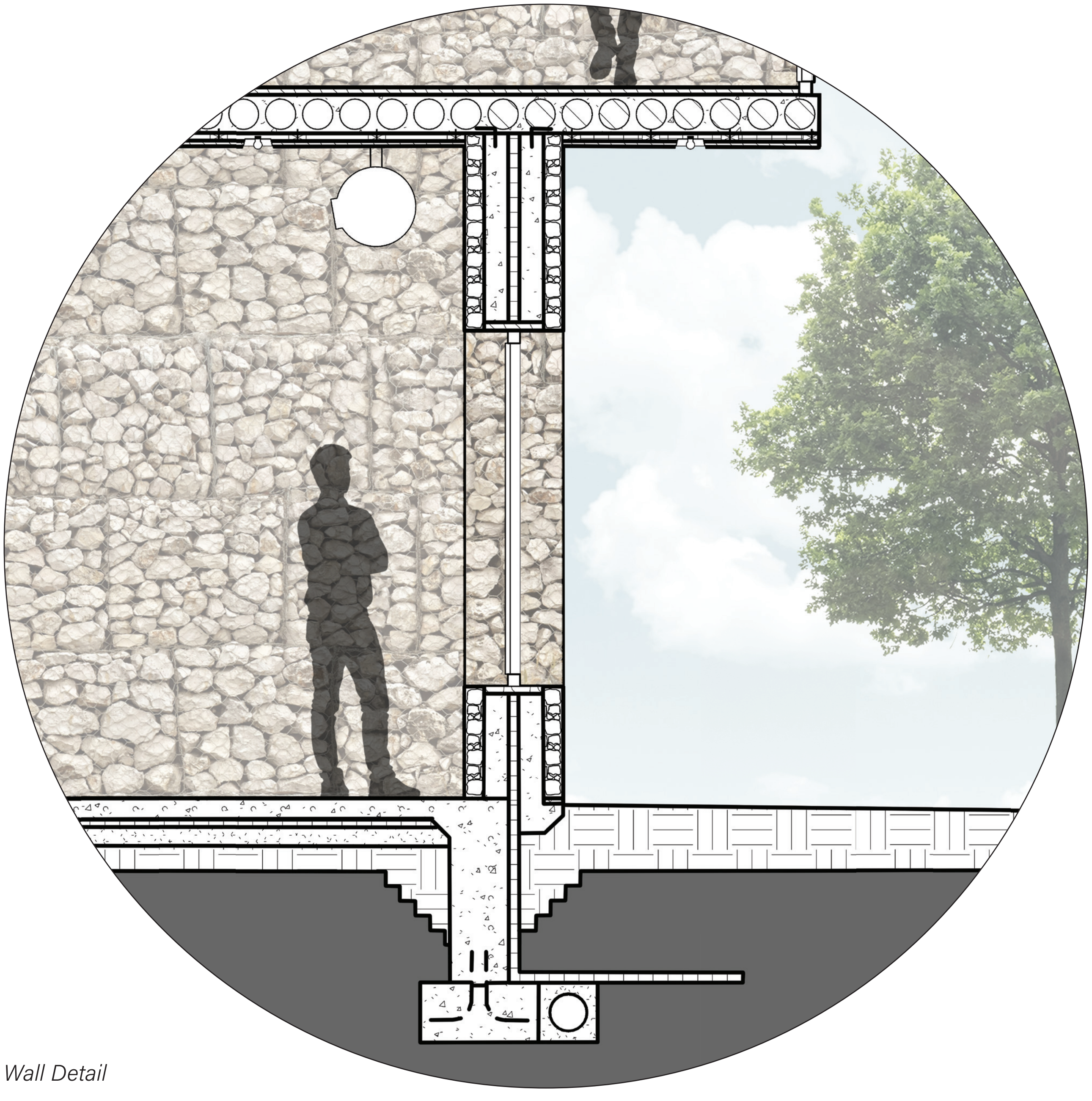
The site design of this project was inspired by both the dramatic topography and the relationship between the site and the surrounding cities. Building typologies were connected by roads and pathways that suited the topography while providing direct, yet scenic circulation. Other site manipulations that occurred were regrading areas to accommodate building pads and smoothing the area containing the ski slope.



PROCESS DOCUMENTATION:
DETAILING

DETAILING:

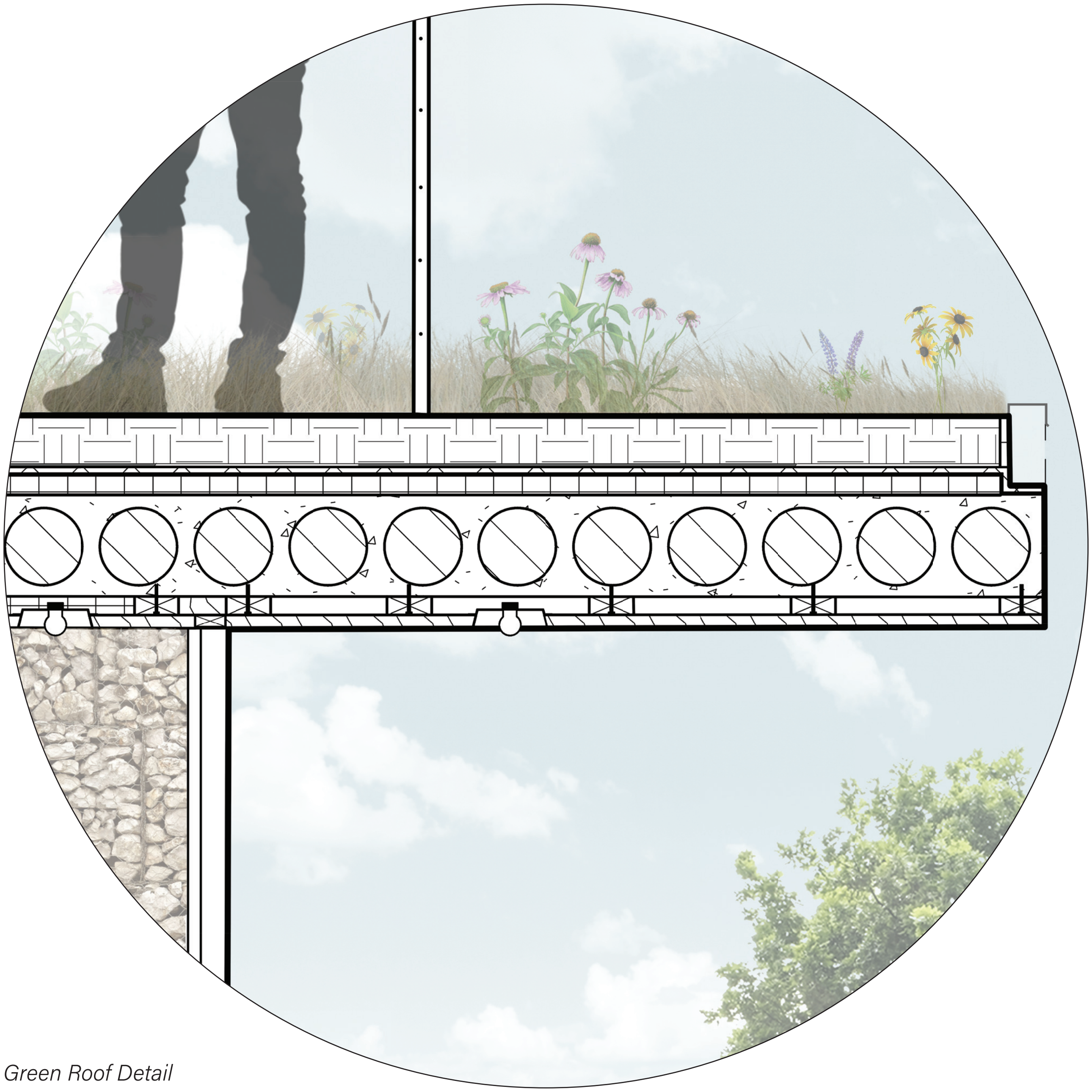
There were a few unique aspects about the designed buildings that I felt were important to highlight as details. These details were created with the assistance of Professor David Crutchfield to inform the viewer how typical gabion cage walls and green roofs might work in this project.



Wall Detail

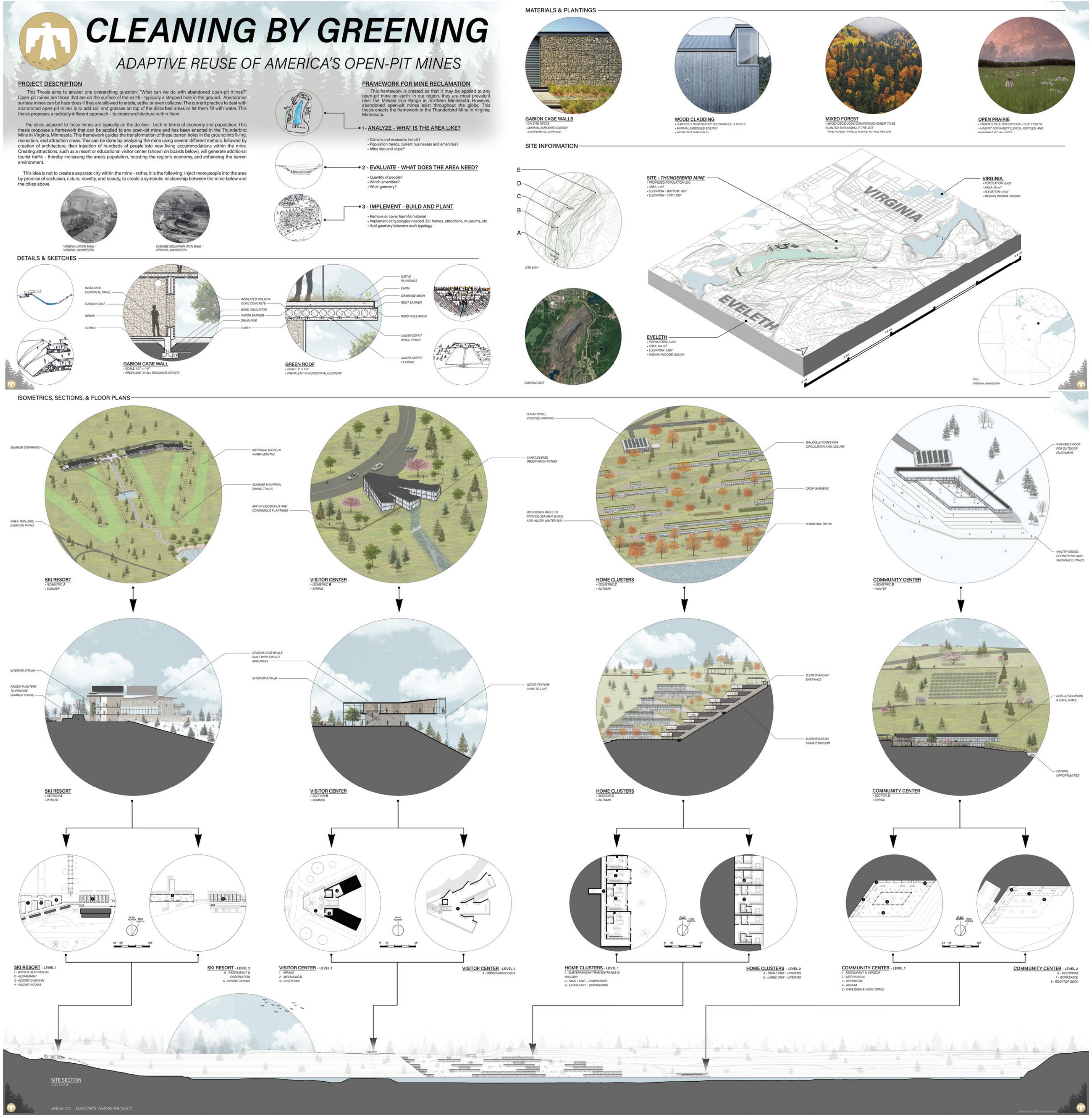
DETAILING:

Gabion cage walls and green roofs were used throughout this project. The former due to the extreme prevalence of useful rock and the latter because this creates a more healthy environment within the mine.

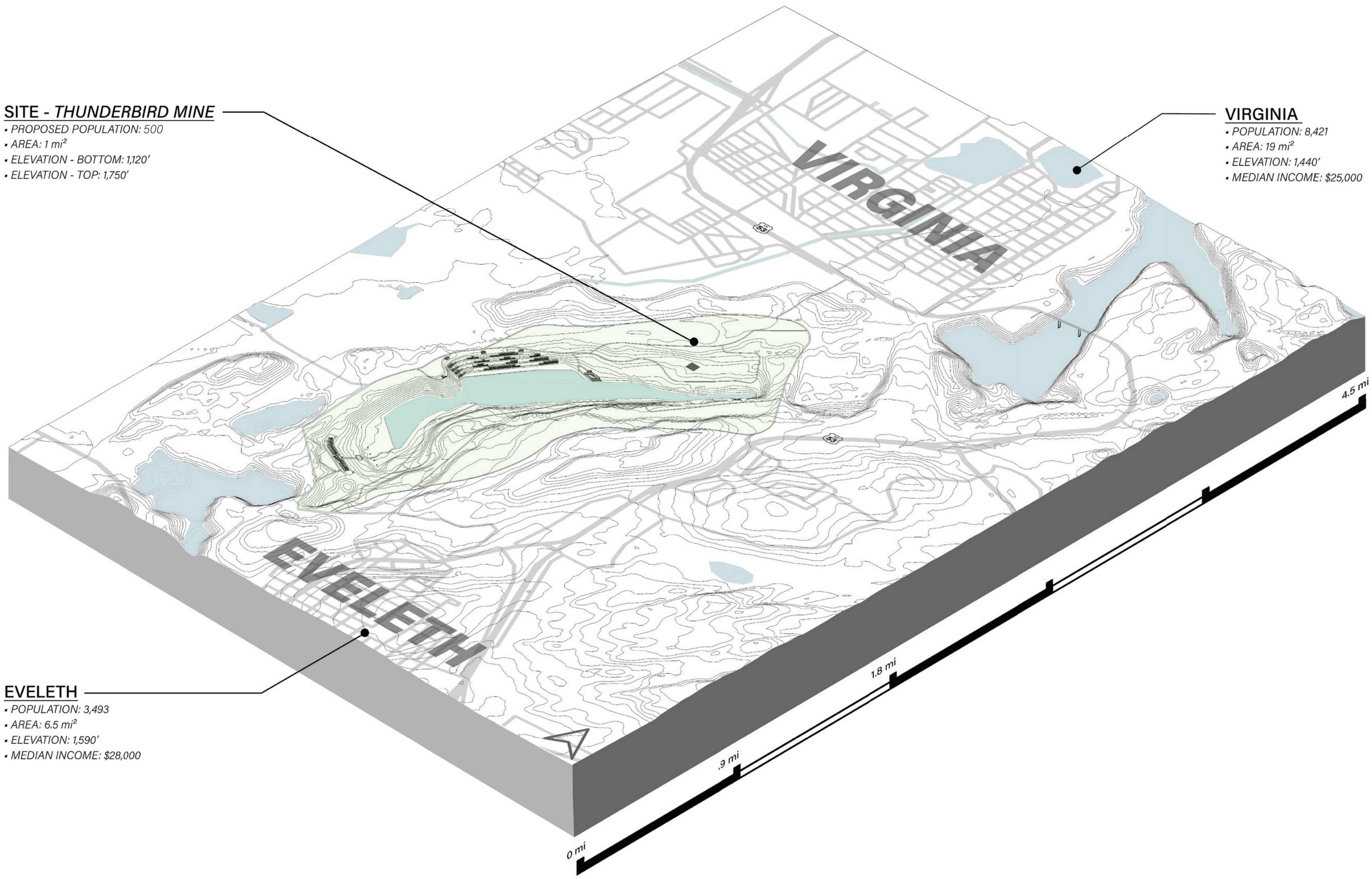


Green Roof Detail

PROJECT SOLUTION DOCUMENTATION:
PRESENTATION BOARDS

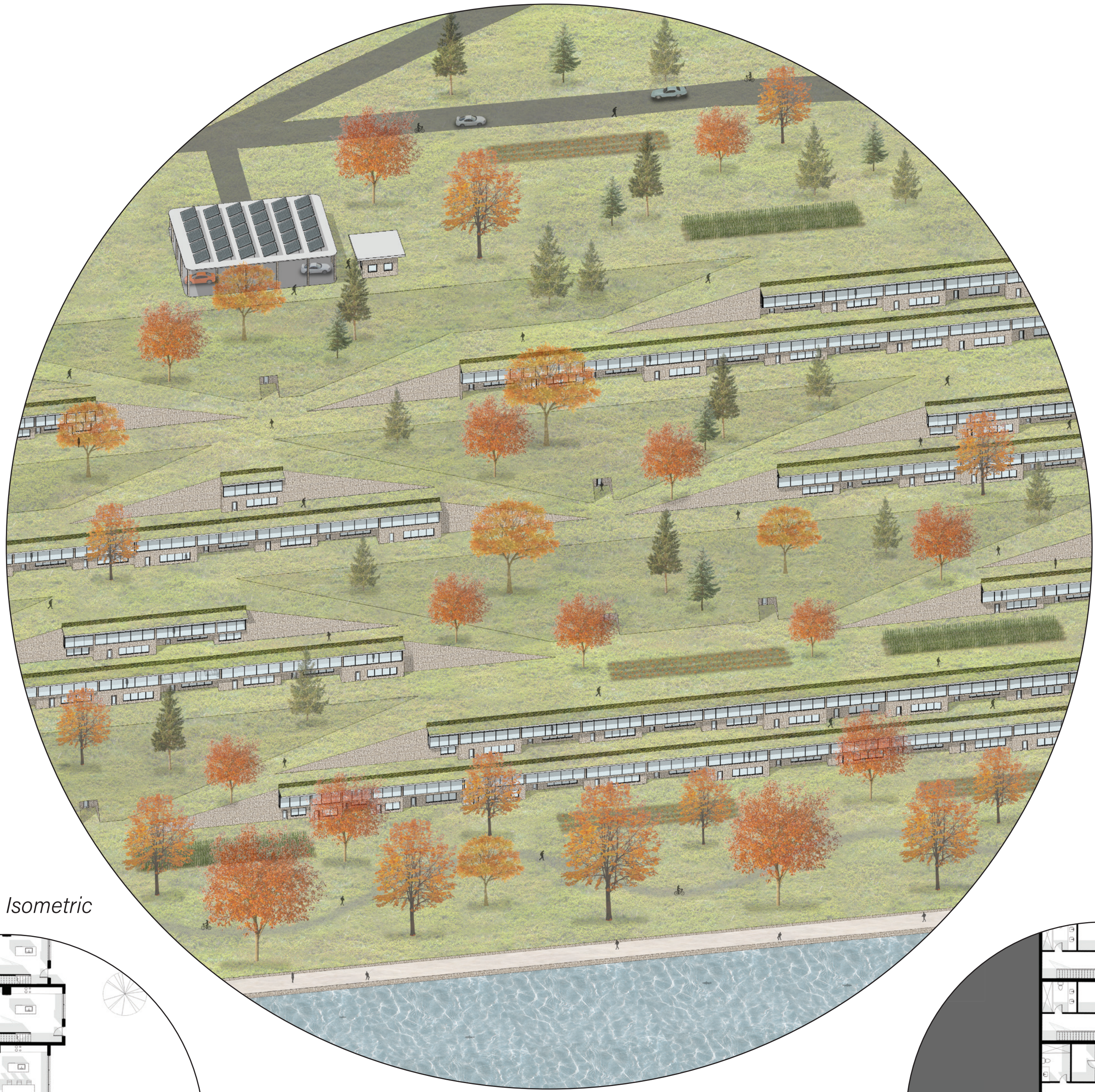


PROJECT SOLUTION DOCUMENTATION:
PRESENTATION BOARDS - SITE ISOMETRIC

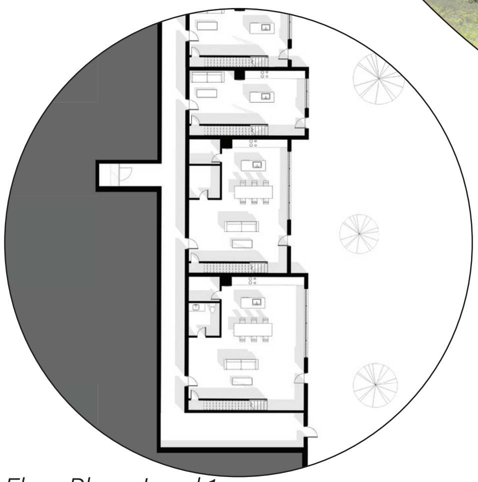


PROJECT SOLUTION DOCUMENTATION:

PRESENTATION BOARDS - HOUSING CLUSTERS



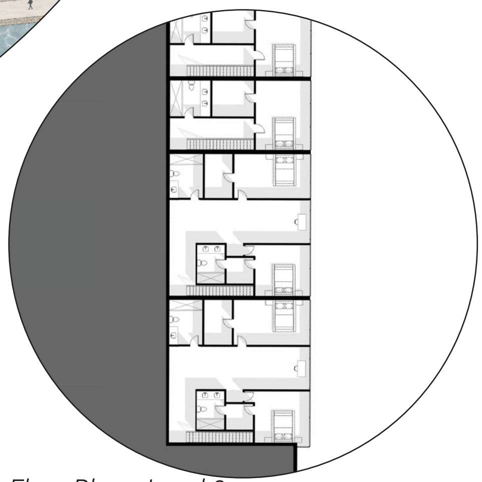
Isometric



Floor Plan - Level 1

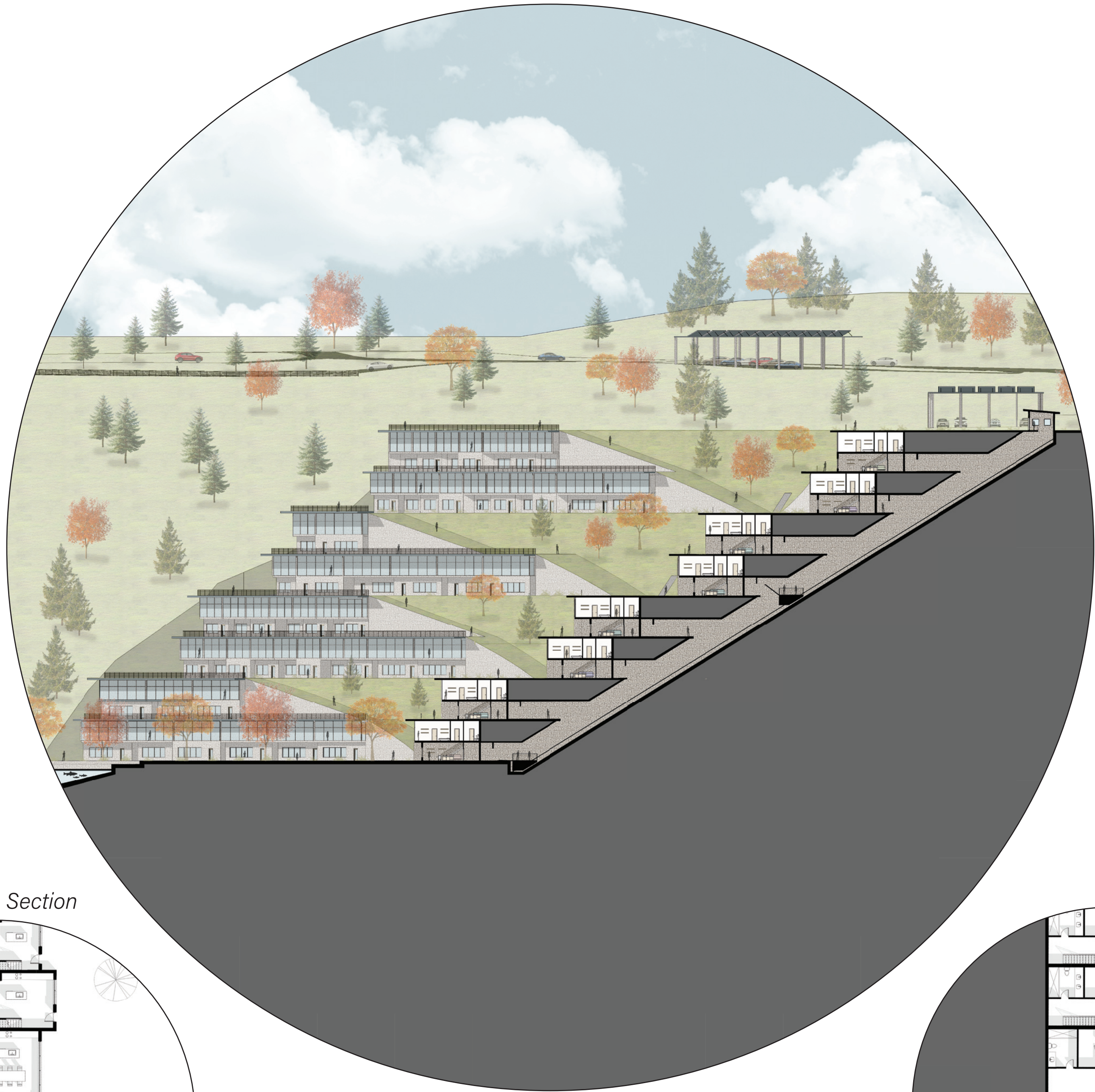
FEATURES SHOWN:

- Deciduous trees to provide summer shade and allow winter sun
- Solar panel covered parking
- Walkable roofs for circulation and leisure
- Crop gardens
- Shoreline paths



Floor Plan - Level 2

PROJECT SOLUTION DOCUMENTATION:
PRESENTATION BOARDS - HOUSING CLUSTERS



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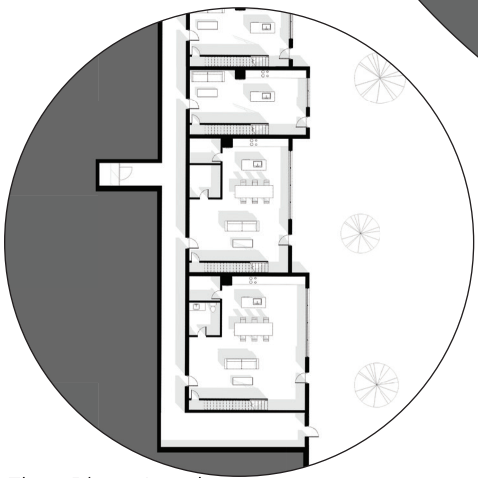
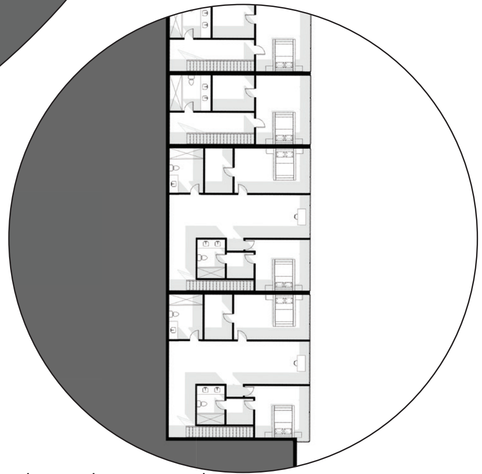


Floor Plan - Level 1

FEATURES SHOWN:

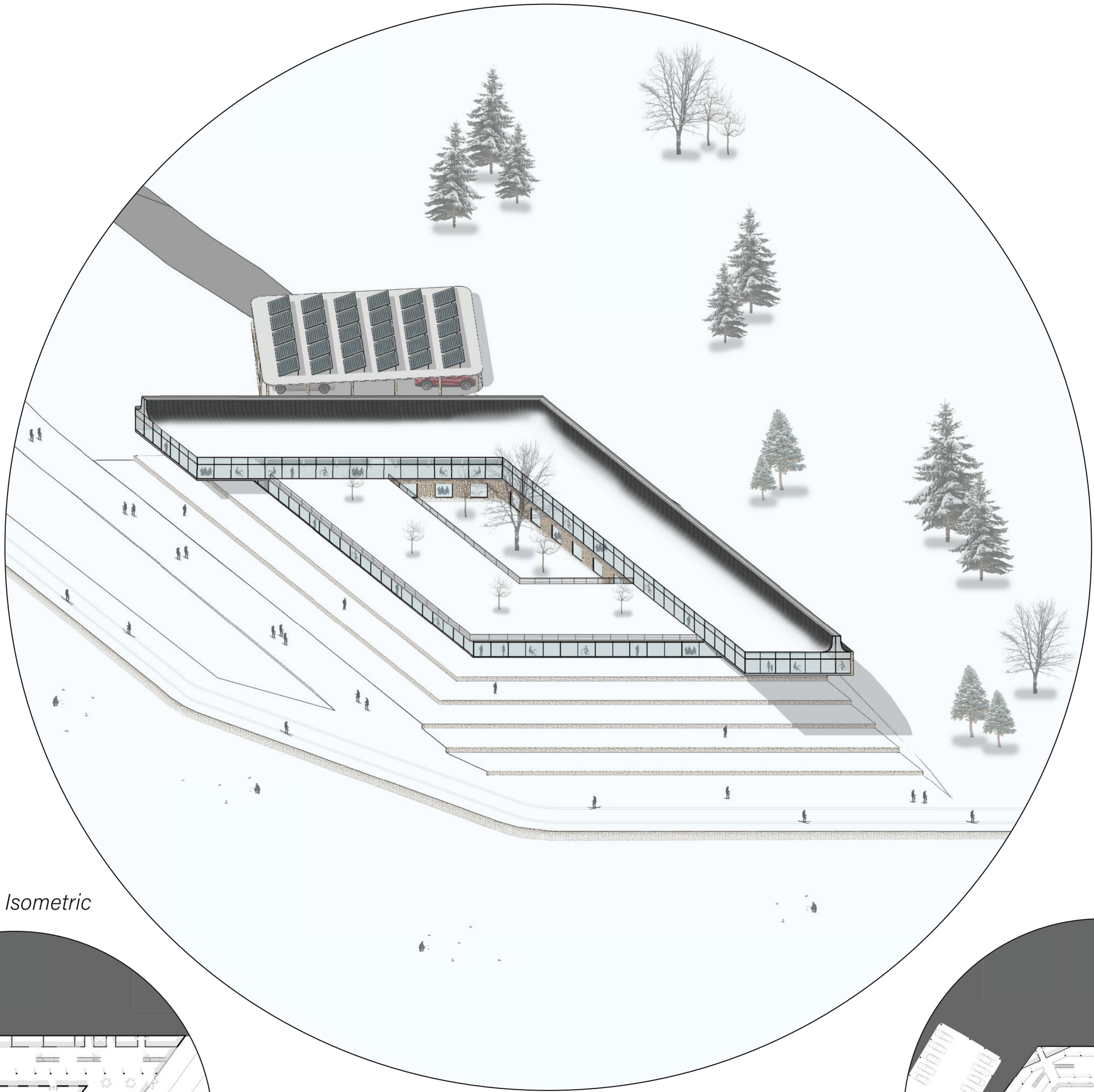
- Subterranean entrance
- Subterranean corridor
- Tree and native grass plantings
- Gabion cage walls built with on-site materials



Floor Plan - Level 2

PROJECT SOLUTION DOCUMENTATION:

PRESENTATION BOARDS - COMMUNITY CENTER



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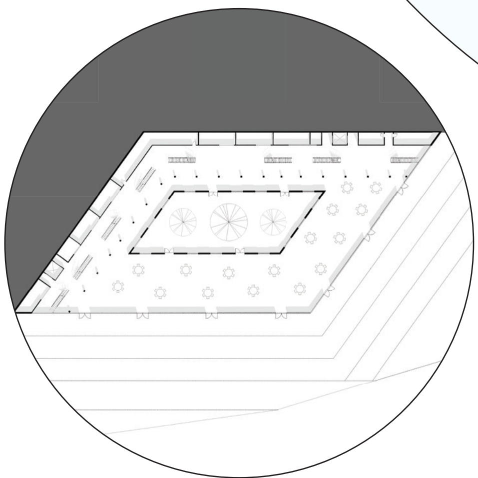
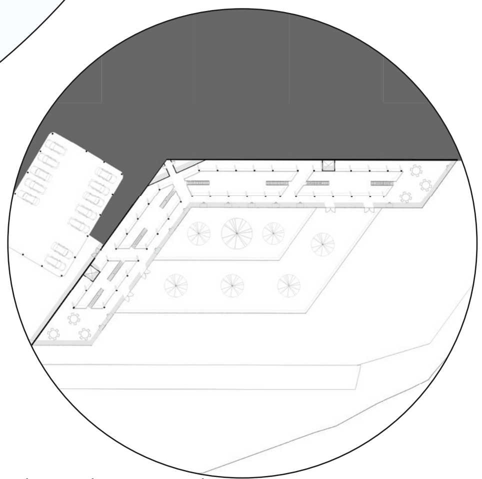


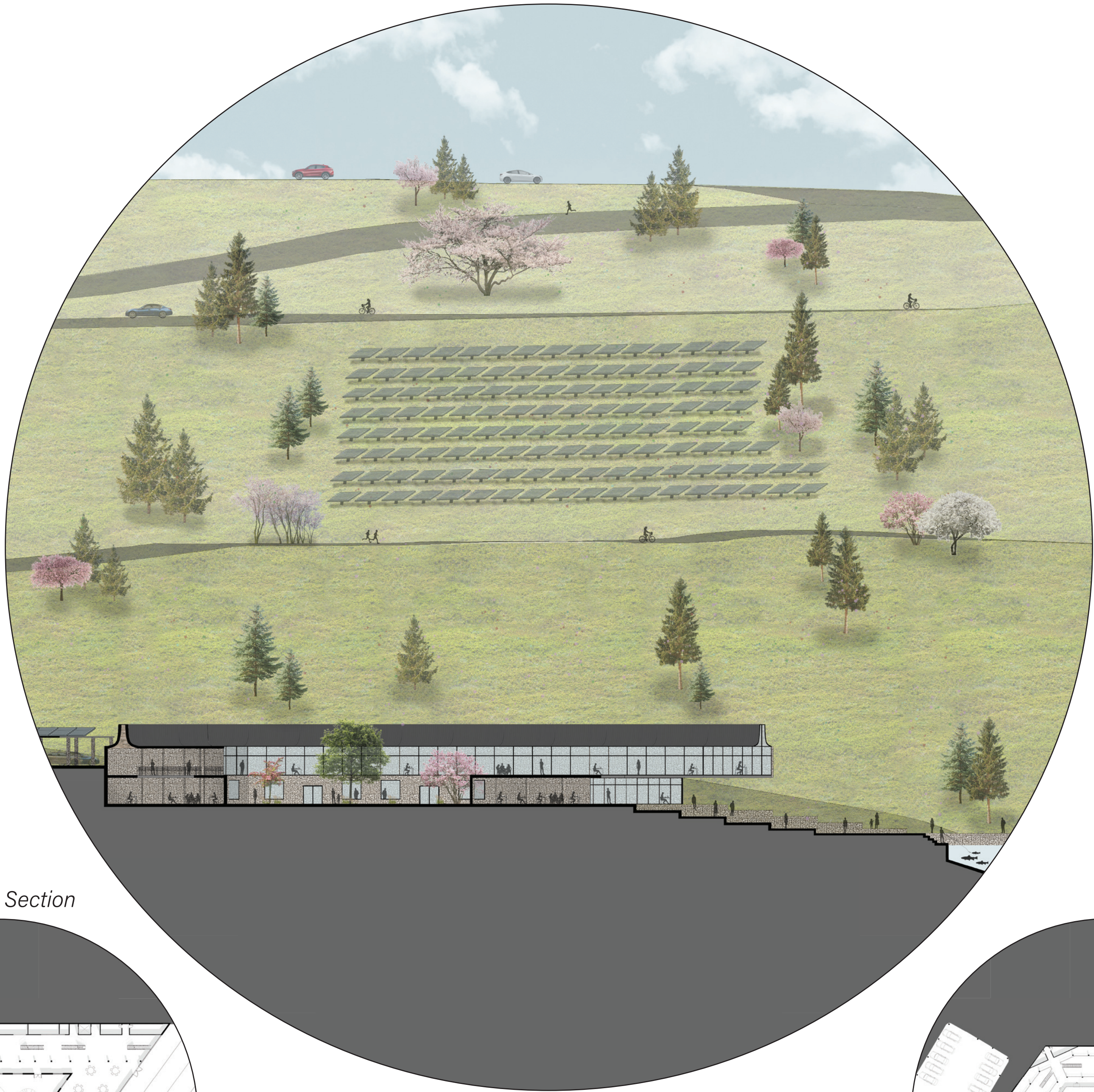
Floor Plan - Level 1

FEATURES SHOWN:

- Walkable roof for outdoor enjoyment
- Winter cross-country ski and snowshoe trails



Floor Plan - Level 2



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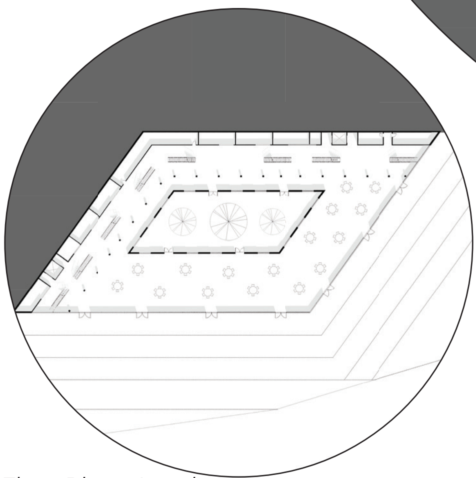
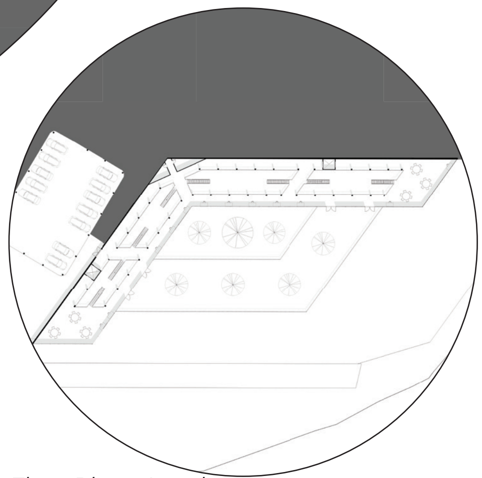


Floor Plan - Level 1

FEATURES SHOWN:

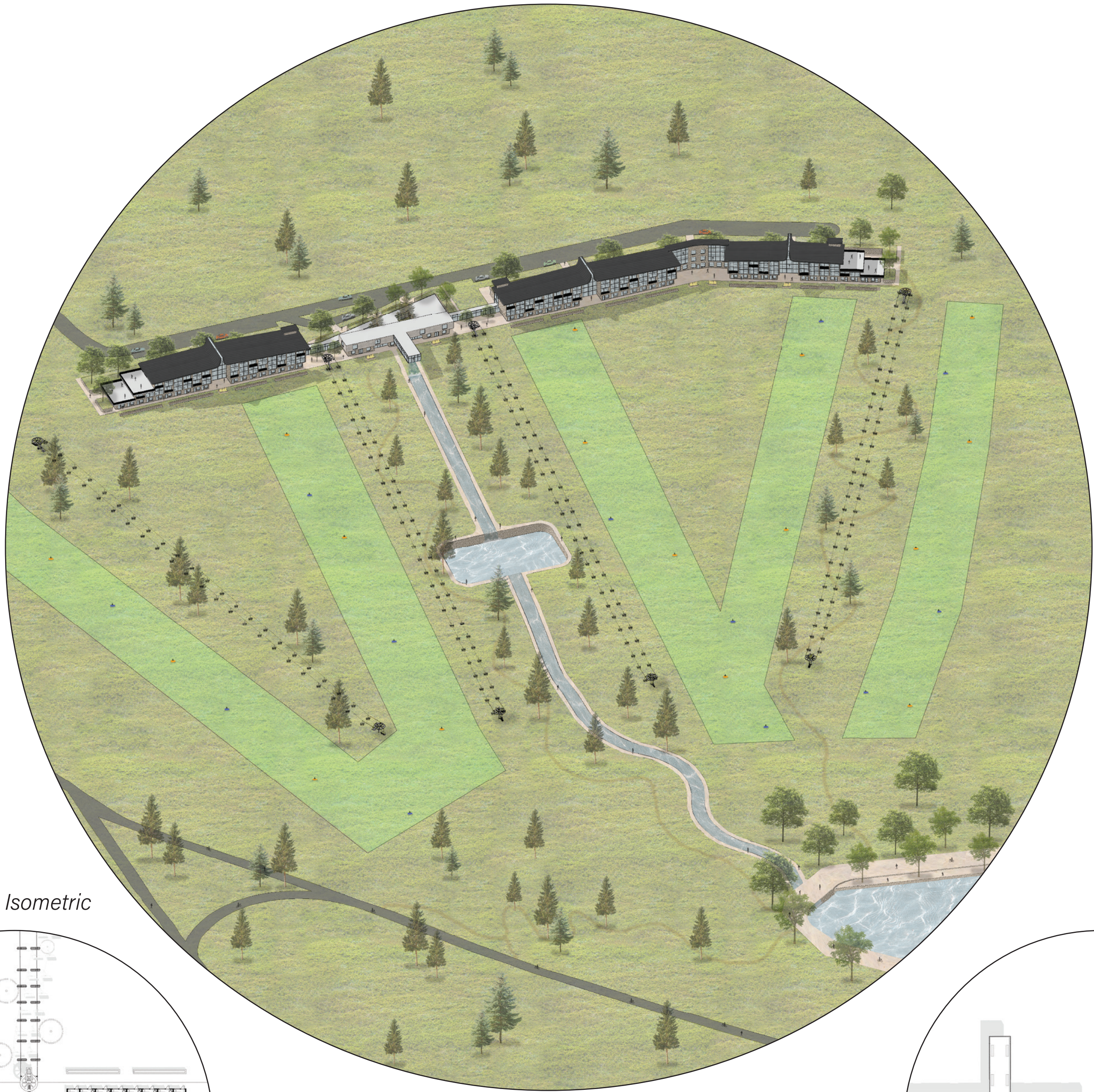
- Dual-level work and cafe space
- Fishing opportunities
- Gabion cage walls built with on-site materials



Floor Plan - Level 2

PROJECT SOLUTION DOCUMENTATION:

PRESENTATION BOARDS - SKI RESORT



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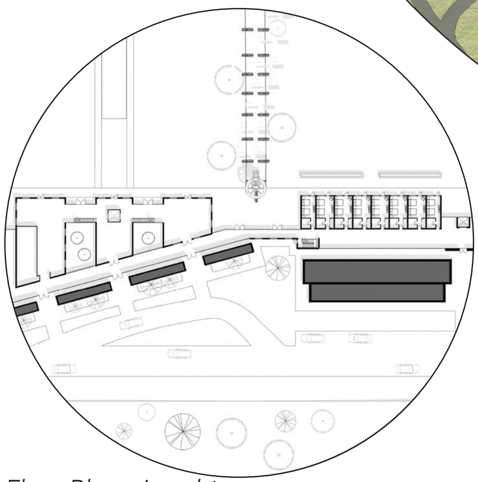
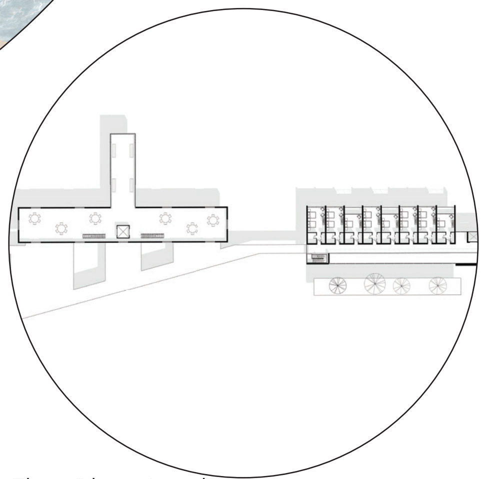


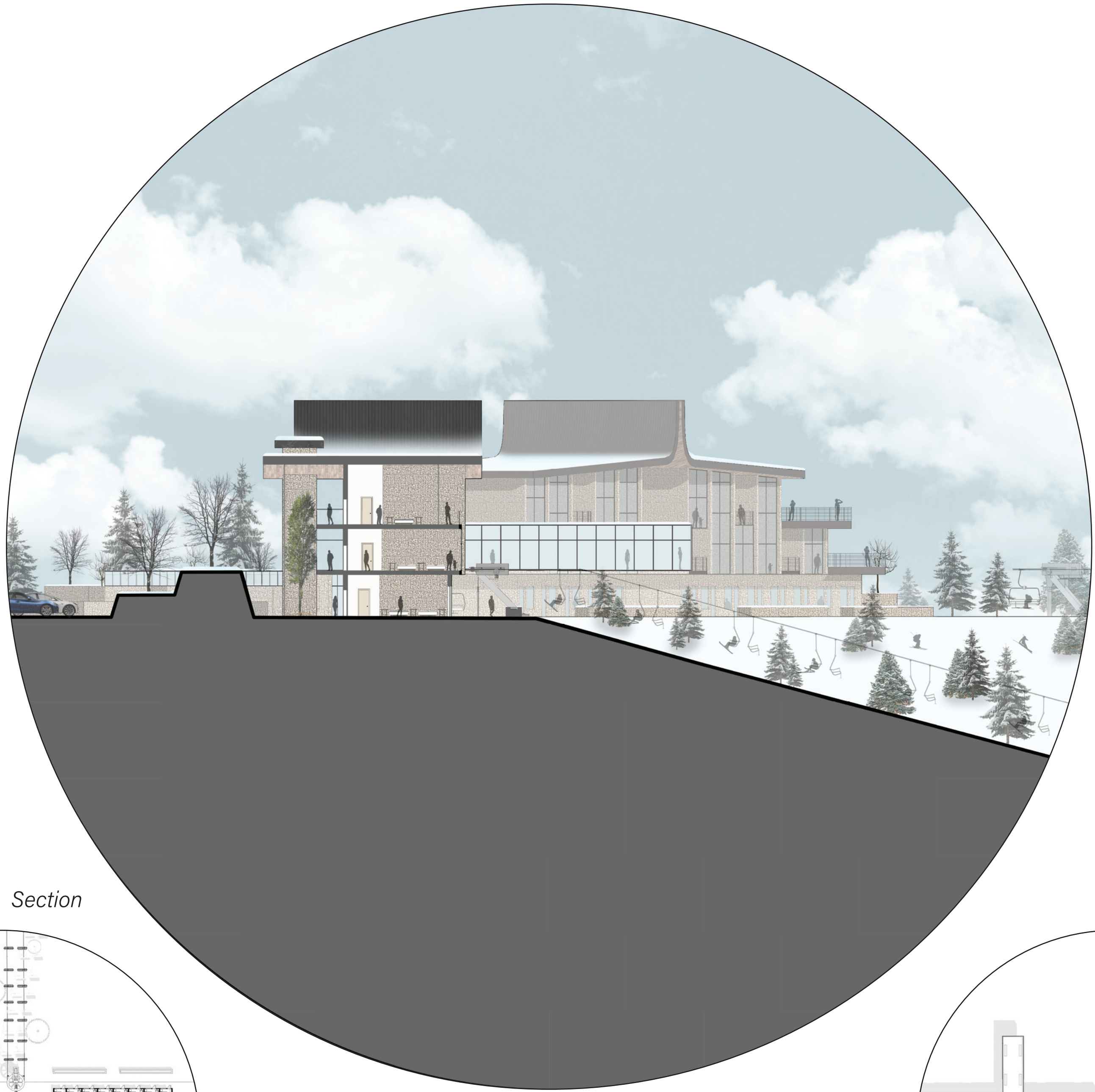
FEATURES SHOWN:

- Summer swimming
- Walk, run, bike exercise path
- Artificial slope in warm months
- Summer mountain biking trails

Floor Plan - Level 1



Floor Plan - Level 2



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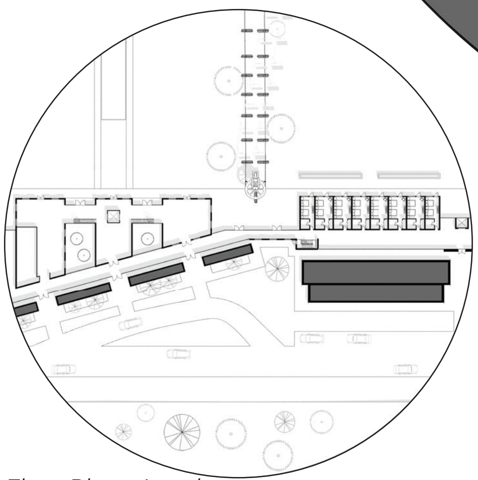
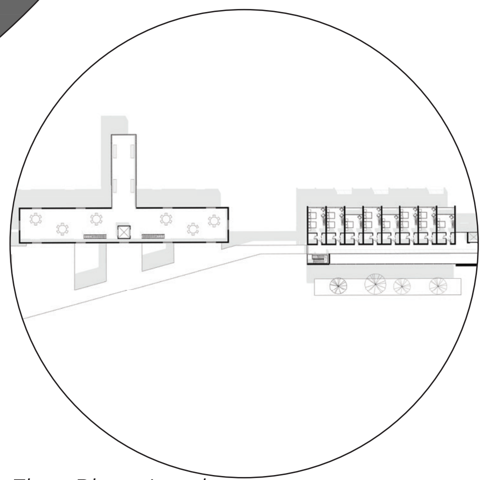


Floor Plan - Level 1

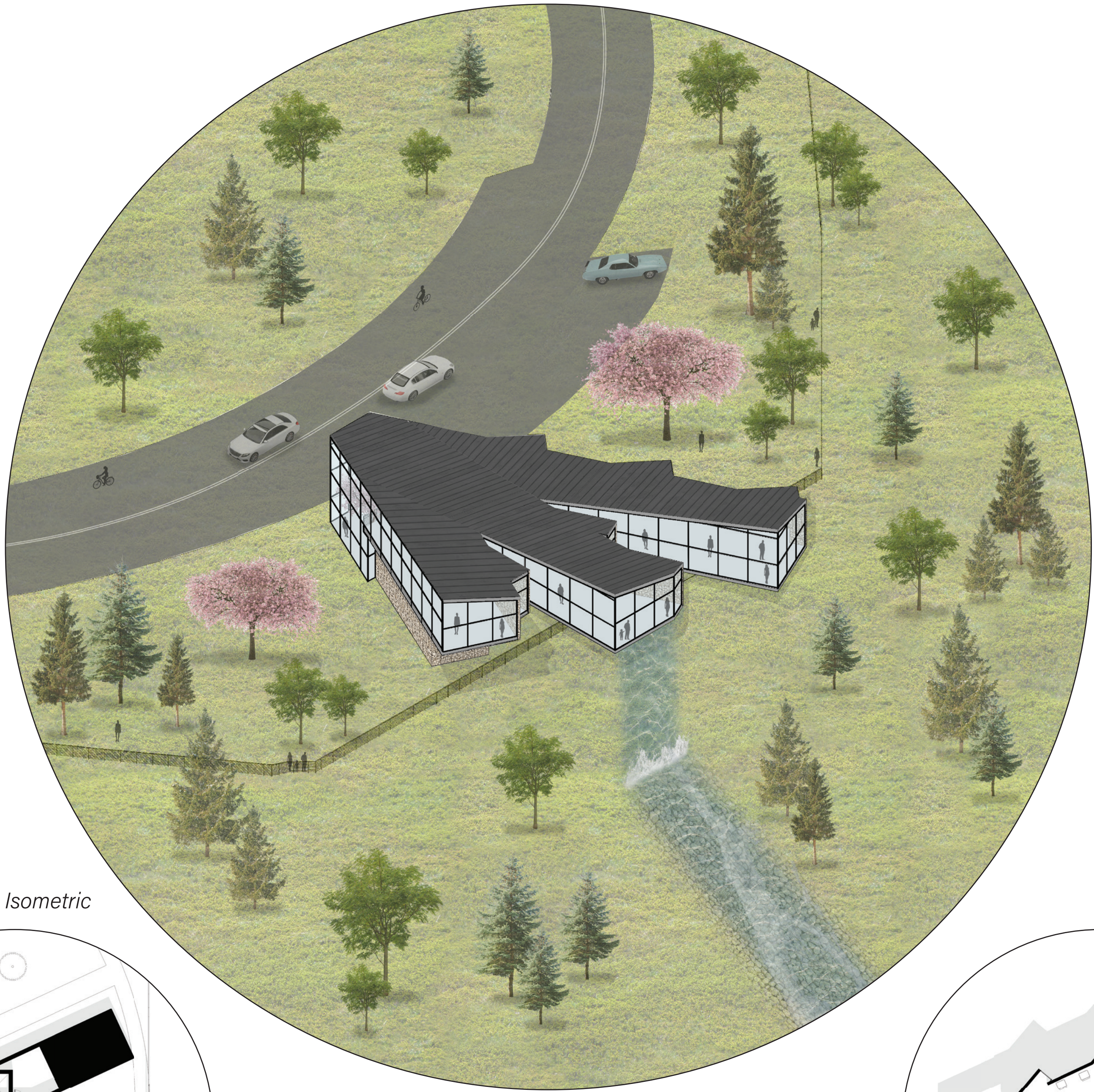
FEATURES SHOWN:

- Interior atrium
- Raised planters to provide summer shade
- Gabion cage walls built with on-site materials



Floor Plan - Level 2

PROJECT SOLUTION DOCUMENTATION:
PRESENTATION BOARDS - VISITOR CENTER



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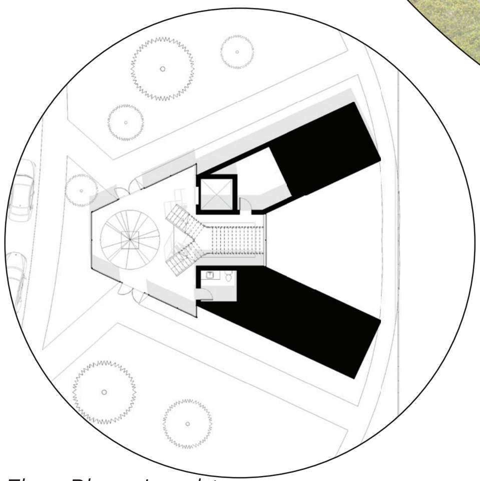
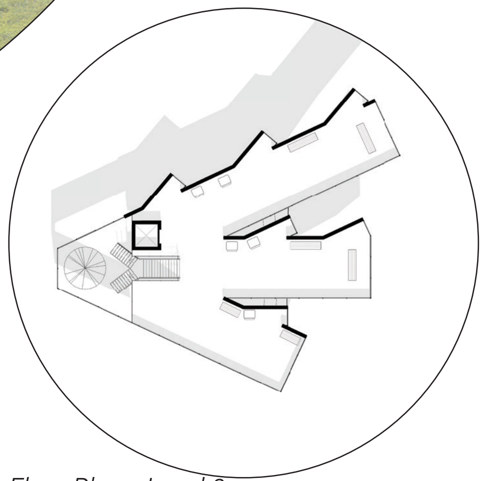
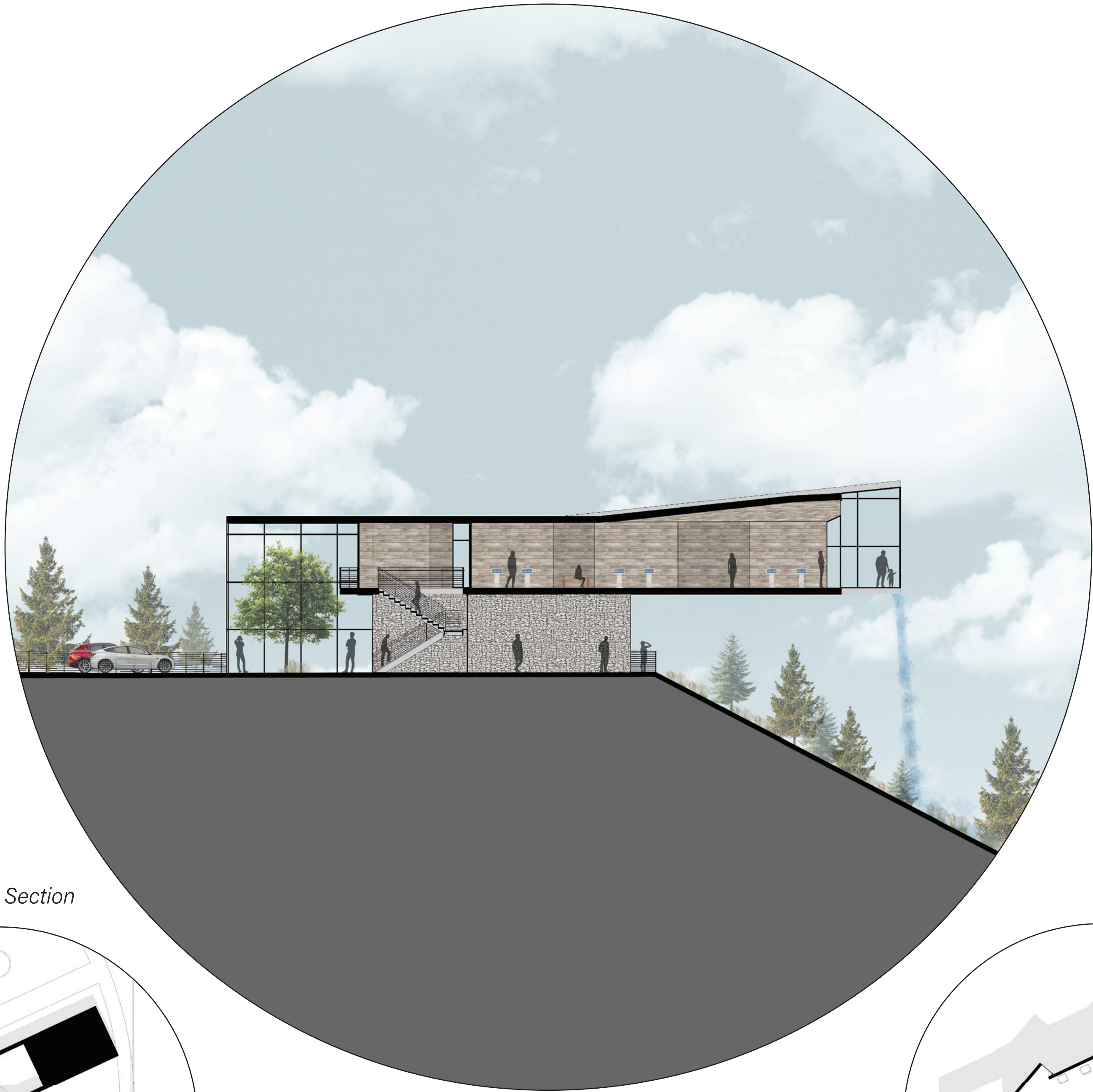


Floor Plan - Level 1

FEATURES SHOWN:
- Mix of deciduous and coniferous plantings
- Cantilevered observation wings



Floor Plan - Level 2



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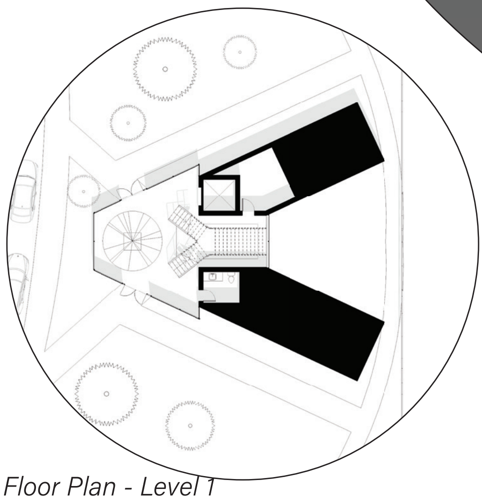
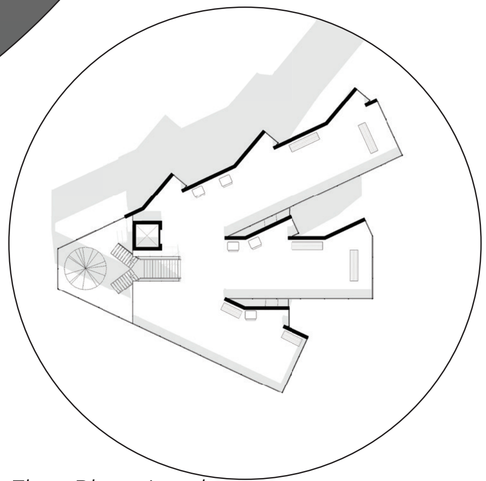


Floor Plan - Level 1

FEATURES SHOWN:

- Interior atrium
- Water feature runs into lake
- Gabion cage walls built with on-site materials

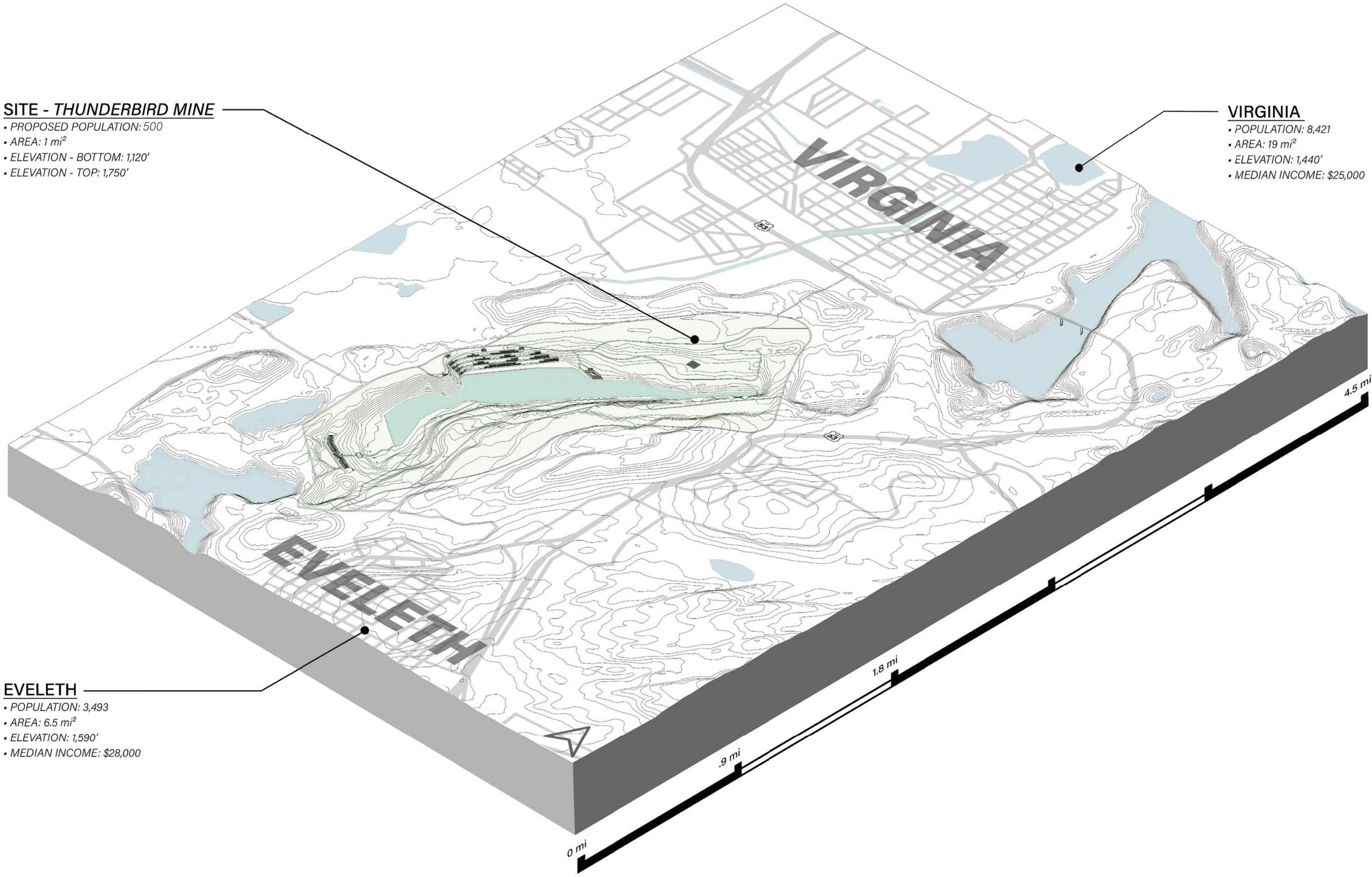


Floor Plan - Level 2

PERFORMANCE ANALYSIS:
RESPONSE TO SITE AND CONTEXT

RESPONSE TO SITE AND CONTEXT:

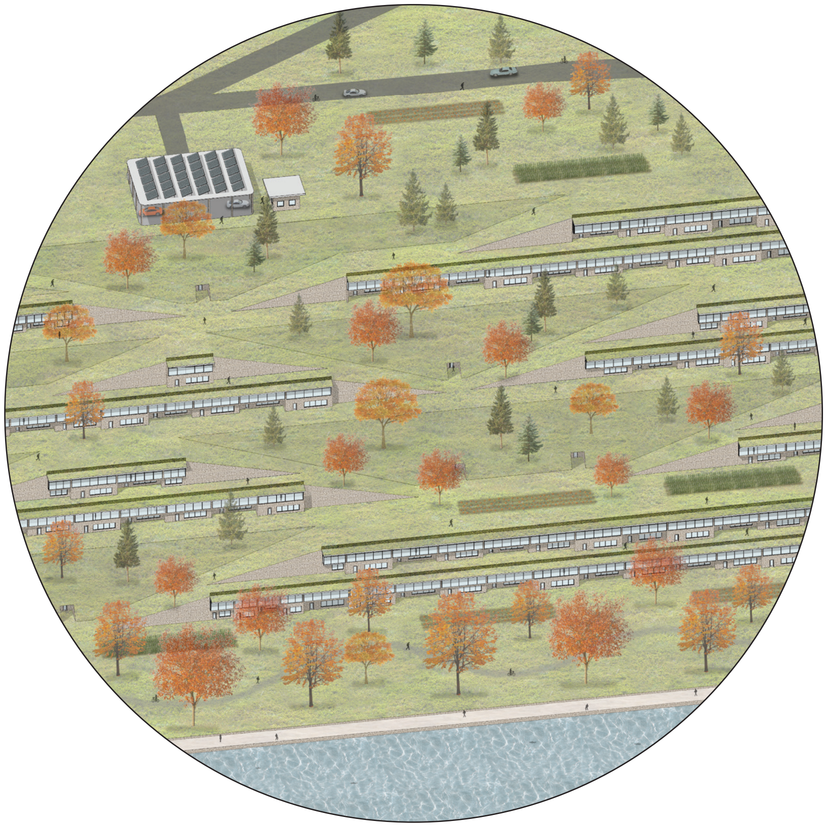
This thesis' solution responds to the physical, historical, social, and economic context by thoughtfully creating a solution to multiple problems that plague the region. Firstly, the project responds to the physical context by considering and becoming directly influenced by slope, geology, precipitation, sun angle, material, and other factors. Secondly, the historical context was considered when deciding materials and building typologies. Thirdly, this thesis considers the social context by determining how many people and what the target groups might be to benefit the region. Lastly, this thesis considers the economic context by acknowledging the suffering economy and proposing a solution that brings permanent jobs as well as year-round tourist flow to the area.



CASE STUDY 1 - HOUSE BY PROAH:

This thesis takes partial inspiration from the residence designed by PROAH in that the residences in this thesis are built into the landscape. They are terraced to mimic the surrounding landscape (steep stepped sections of the mine created by the mining companies) and nestling each home into the hillside. The flat roofs in the residence designed by PROAH also served as partial inspiration for the walkable roofs with gardens and grasses in this project.

Figure 11 - Terraces From Above



Residential Clusters

PERFORMANCE ANALYSIS:
RESPONSE TO TYPOLOGICAL RESEARCH

CASE STUDY 2 - MINNESOTA EXPERIMENTAL CITY:

The never-constructed Minnesota Experimental City never got very far along in its design. There were several different iterations of it and it never had one final cohesive design. However, several key aspects that were in some of those proposals partially inspired aspects of this thesis. For example, this thesis implemented residences that were very dense, even stacked on top of each other. The sketch below on the left had a similar solution to building homes on a slope as what I designed. Iterations of the MXC also had solar collectors, significant public space, underground circulation, nearby food production, and the lure of close proximity to outdoor recreation - all things offered in the solution of this thesis.

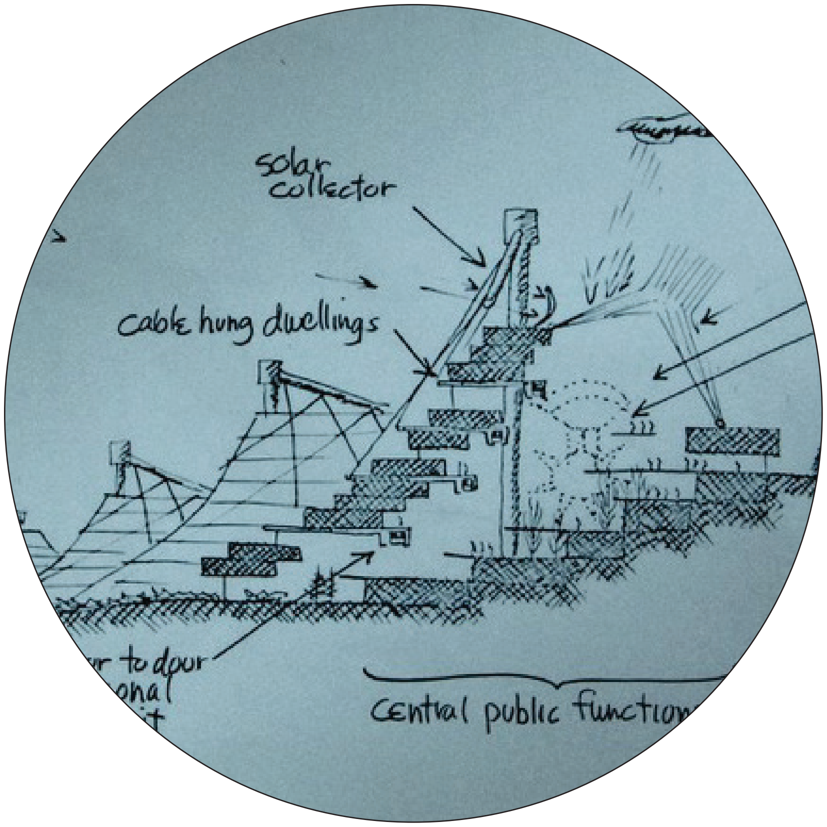
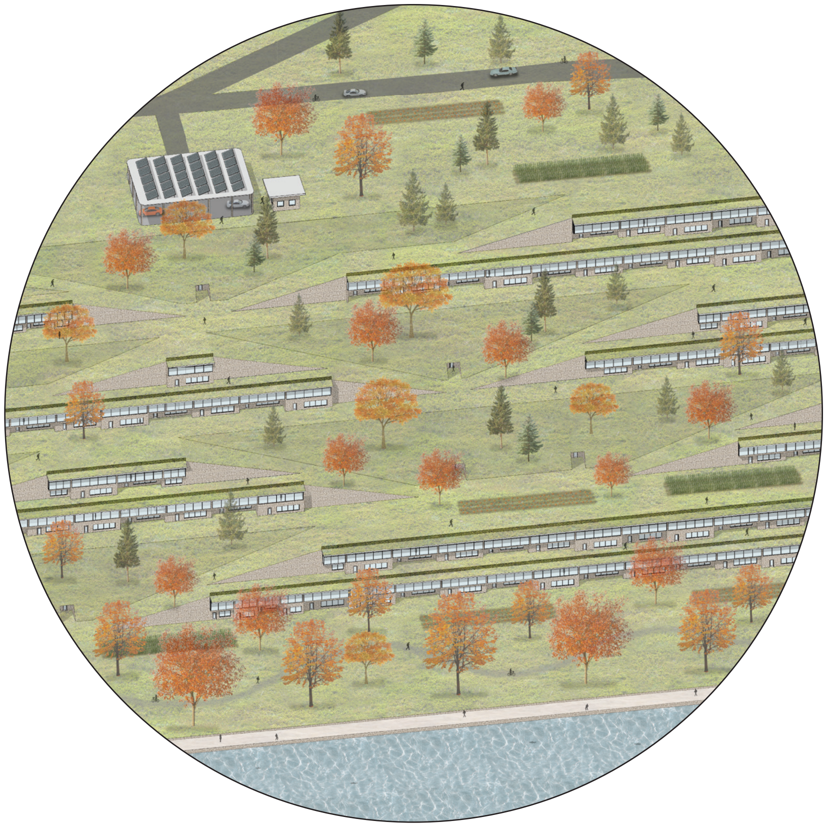


Figure 17 - MXC Section Proposal

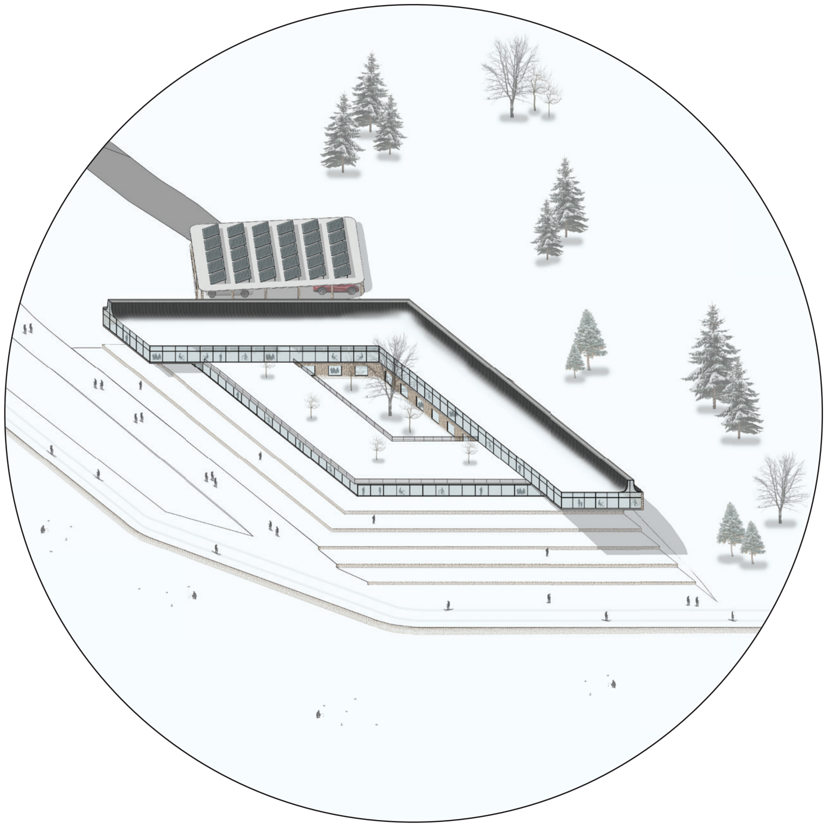


Residential Clusters

CASE STUDY 3 - FUSE VALLEY BY BIG:

Fuse Valley is a group of buildings on a campus designed by BIG. Its elements include several large and airy buildings, pathways between them, walkable green roofs, and outdoor terraced seating. The community center designed in this thesis incorporates those features as well - glass walls letting in lots of daylight, nature and lakeside paths surrounding, a walkable green roof for working, dining, and leisure, and lakeside terraced green space. I adapted aspects that Fuse Valley shares with my design to ensure they meshed with the surrounding context and target group.

Figure 21 - Fuse Valley Amphitheater



Community Center

PERFORMANCE ANALYSIS:
RESPONSE TO GOALS AND PROJECT EMPHASIS

FRAMEWORK CREATION:

The most important aspect of this thesis project was the creation and successful implementation of a framework that could reuse open-pit mines across the planet. The created framework could be applied anywhere, and consists of the following three simple steps:

1 - ANALYZE -
- Climate and economic trends?
- Population trends, current businesses and amenities?
- Mine size and slope?

2 - EVALUATE -
- Quantity of people?
- Which amenities?
- What greenery?

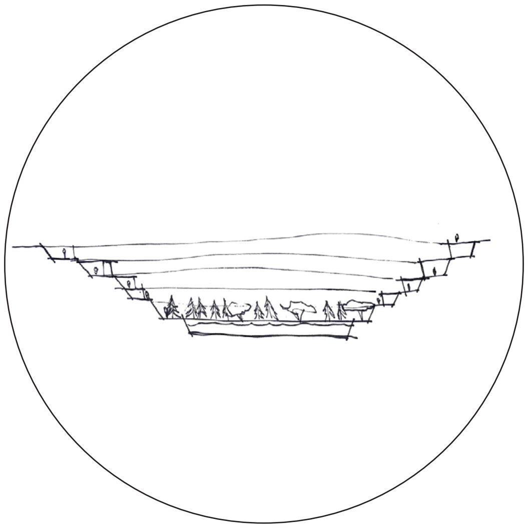
3 - IMPLEMENT -
- Remove or cover harmful material
- Implement all typologies needed. Ex: homes, attractions, museums, etc.
- Add greenery between each typology

ANALYZE

WHAT IS THE AREA LIKE?

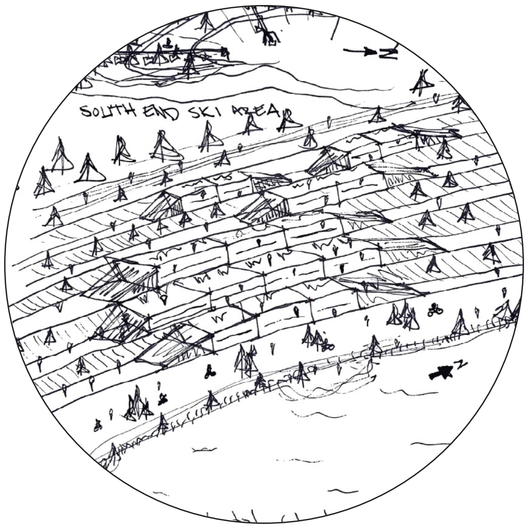
EVALUATE

WHAT DOES THE AREA NEED?



IMPLEMENT

BUILD AND PLANT



ACADEMIC, PROFESSIONAL, AND PERSONAL GOALS:

This project helped me to achieve several goals in three key areas: academic, professional, and personal.

My academic goals were attained - I created a framework for reclaiming and reusing mines, designed a post-COVID habitat for people of the future, and incorporated sustainable strategies in its design through gabion cage and wood use.

The professional goals I set out at the beginning of this project were also achieved. I increased my proficiency Revit significantly. Specifically, I learned a lot about site manipulation on a large scale and integrating buildings neatly within the modeled landscape. I also advanced my rendering abilities in Photoshop. A conscious decision was made to use exclusively Photoshop in the rendering process because I already feel very comfortable with programs such as Lumion. I saw this as an opportunity to advance Photoshop skills. Lastly, presentation creation and delivery skills were advanced as well. My presentation went well, I was calm, and I felt confident during both presentation and critique portions.

Personal goals were the other major category of goals. I was successful in honing my research skills - conducting research in a more timely and meaningful way. Additionally, I learned many things about the state of Minnesota and the mining region of the Mesabi Iron Range. The gained knowledge of the physical, historical, social, and economic aspects were very important for me to learn. Lastly, I learned about materials, sustainable practices, and building strategies as I had set out to do. I learned about costs of gabion cage walls, sustainability of well-managed forests in our region, as well as building details pertinent to my building types.

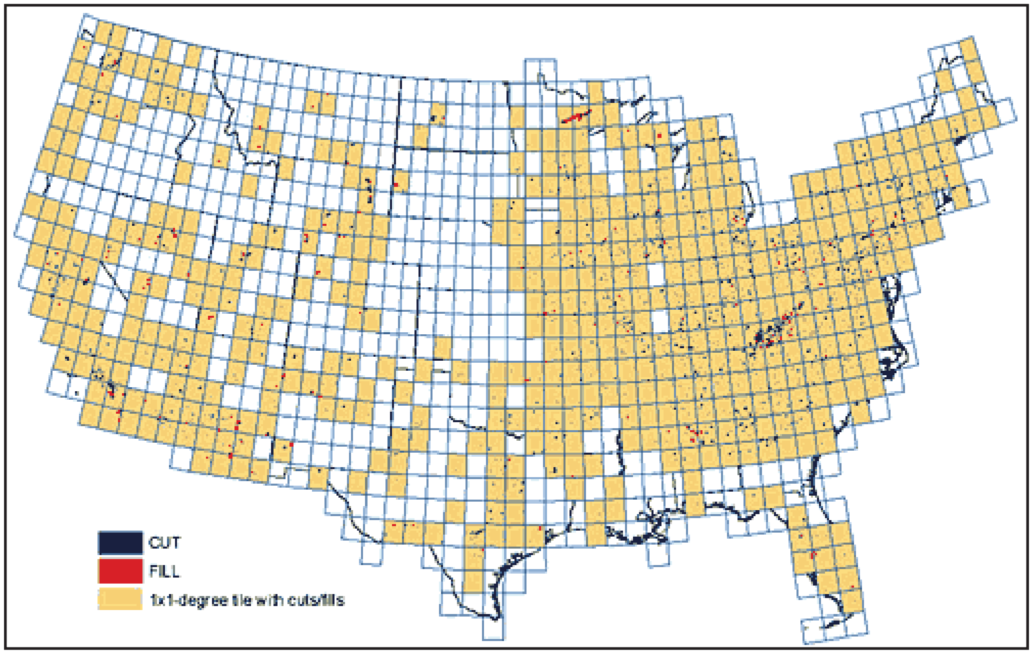


Figure 77 - U.S. Cut/Fill Map

CRITIQUE OF APPLIED RESEARCH METHODS:

TYPOLOGICAL RESEARCH:

This thesis took inspiration from several case studies in building usages and forms. While the end result is significantly different than the reviewed typological precedents, they were helpful in inspiring thoughtful considerations throughout the designs.

HISTORICAL RESEARCH:

The historical research that was conducted was absolutely necessary in order to create a successful thesis on this topic. This region in which the thesis takes place has one of the richest histories in the whole of Minnesota, and there are many subcategories within that. Many important people played a role in the history of this region, and this area played a fundamental part in the history of our nation. The historical research created rationale for several overarching decisions made near the beginning of this project and was vital to the whole process.

QUALITATIVE RESEARCH:

Qualitative research, such as site analysis and literature reviews were also vital to core-level decisions made in this thesis. The qualitative aspects to the research directly informed decisions related to form, building typologies, building locations, and building arrangements, among other decisions. Without the qualitative research, this project would have had far less basis to be what it has become.

DIGITAL PRESENTATION:

CLEANING BY GREENING

ADAPTIVE REUSE OF AMERICA'S OPEN-PIT MINES

Master's Thesis Project by Jacob Edwards

Jacob Edwards - Spring 2022 - ARCH 772

PRESENTATION OVERVIEW

1 THESIS TOPIC OVERVIEW

2 HISTORY OF THE PROBLEM

3 MY SOLUTION

Missabe Mountain Iron Mine, Virginia

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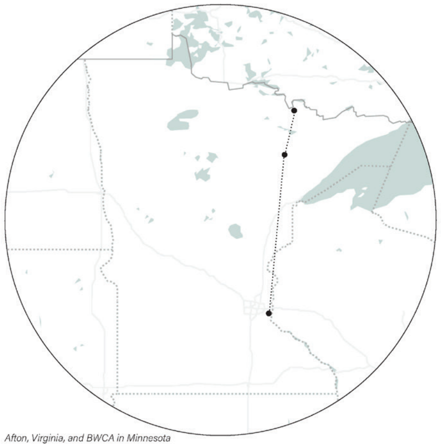
DIGITAL PRESENTATION

1 THESIS TOPIC OVERVIEW

HOW THIS THESIS WAS CHOSEN



Afton, Virginia, and BWCA in Minnesota

Virginia, Minnesota

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1 THESIS TOPIC OVERVIEW

WHAT IS AN OPEN-PIT MINE?

Fargo, Twin Cities, and mines

Thunderbird Mine - Virginia, Minnesota

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1 THESIS TOPIC OVERVIEW

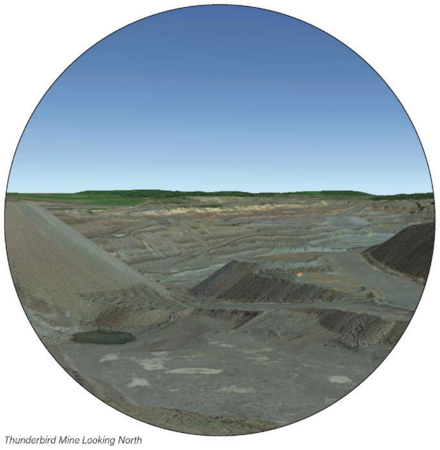
WHAT IS AN OPEN-PIT MINE?

Thunderbird Mine Looking North

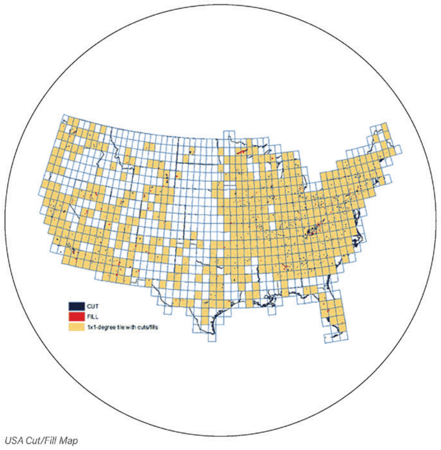
Thunderbird Mine Looking South

1 THESIS TOPIC OVERVIEW

WHAT IS AN OPEN-PIT MINE?



Thunderbird Mine Looking North



USA Cut/Fill Map

DIGITAL PRESENTATION

1 THESIS TOPIC OVERVIEW

DANGERS OF EXPOSED ROCK

Acid Mine Drainage

Results of Acid Mine Drainage

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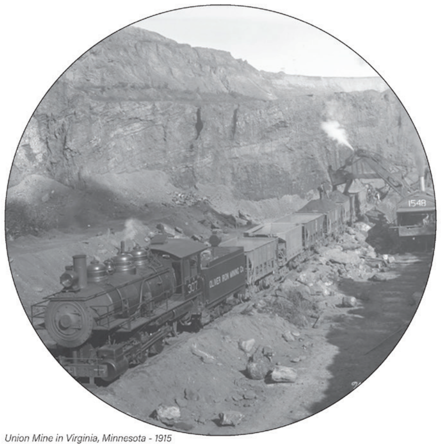
2 HISTORY OF THE PROBLEM

HISTORY OF THE MINES



Union Mine in Virginia, Minnesota - 1915


Death Penalty Bill Signed by Kean; He Calls for Execution by Injection

Recession Silences the Mines Of the Minnesota Iron Range

...lture of Japan Blossoming in America

New York Times Article - August 7, 1982

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2 HISTORY OF THE PROBLEM

HISTORY OF THE BUSINESSES

Virginia, Minnesota - 1893

Virginia, Minnesota - Present Day

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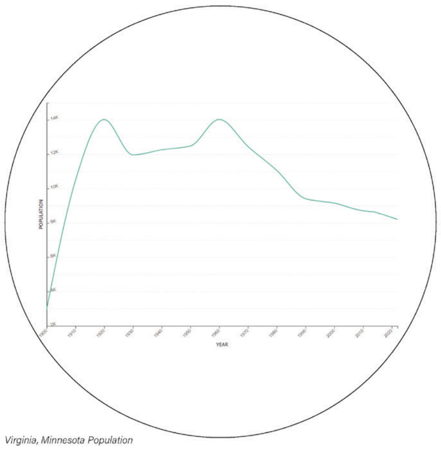
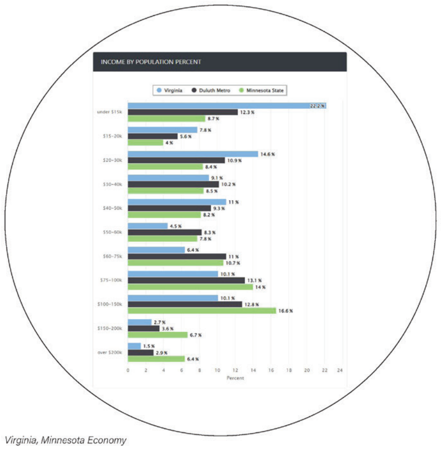
2 HISTORY OF THE PROBLEM

HISTORY OF THE PEOPLE



Virginia, Minnesota Population



Virginia, Minnesota Economy

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DIGITAL PRESENTATION

1 & 2 - SUMMARY

ECONOMY

POPULATION

MINING

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2 HISTORY OF THE PROBLEM

WHAT IS THE CURRENT SOLUTION? - OPTION #1

Leonidas Overlook

Old Mine Filled With Water

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2 HISTORY OF THE PROBLEM

WHAT IS THE CURRENT SOLUTION? - OPTION #2

Barvue Mine, Quebec BEFORE

Barvue Mine, Quebec DURING

Barvue Mine, Quebec AFTER

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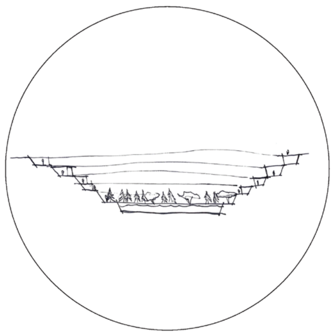
3 MY SOLUTION TO THE PROBLEM

COMBINE EXISTING SOLUTIONS WITH ARCHITECTURE INTO A NEW FRAMEWORK- OPTION #3

ANALYZE
WHAT IS THE AREA LIKE?

EVALUATE
WHAT DOES THE AREA NEED?



IMPLEMENT
BUILD AND PLANT

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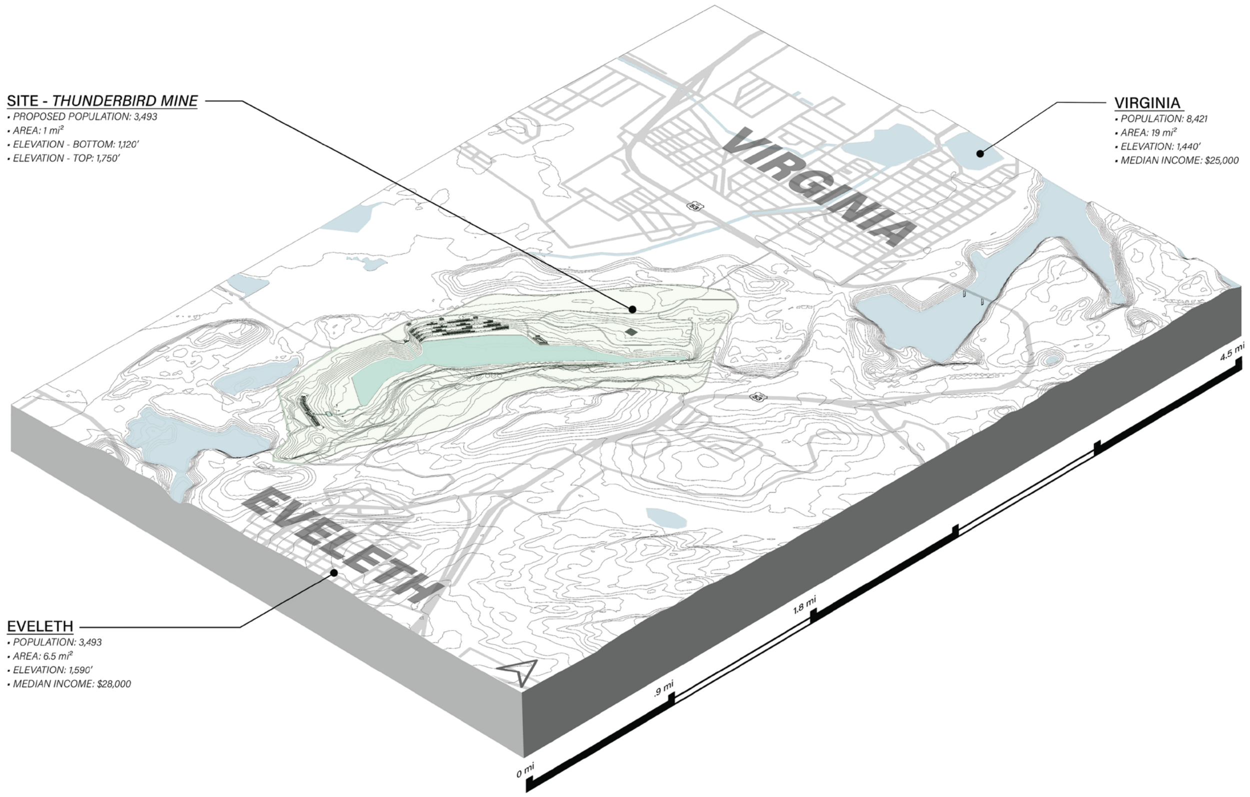
3 MY SOLUTION TO THE PROBLEM

COMBINE EXISTING SOLUTIONS WITH ARCHITECTURE INTO A NEW FRAMEWORK- OPTION #3



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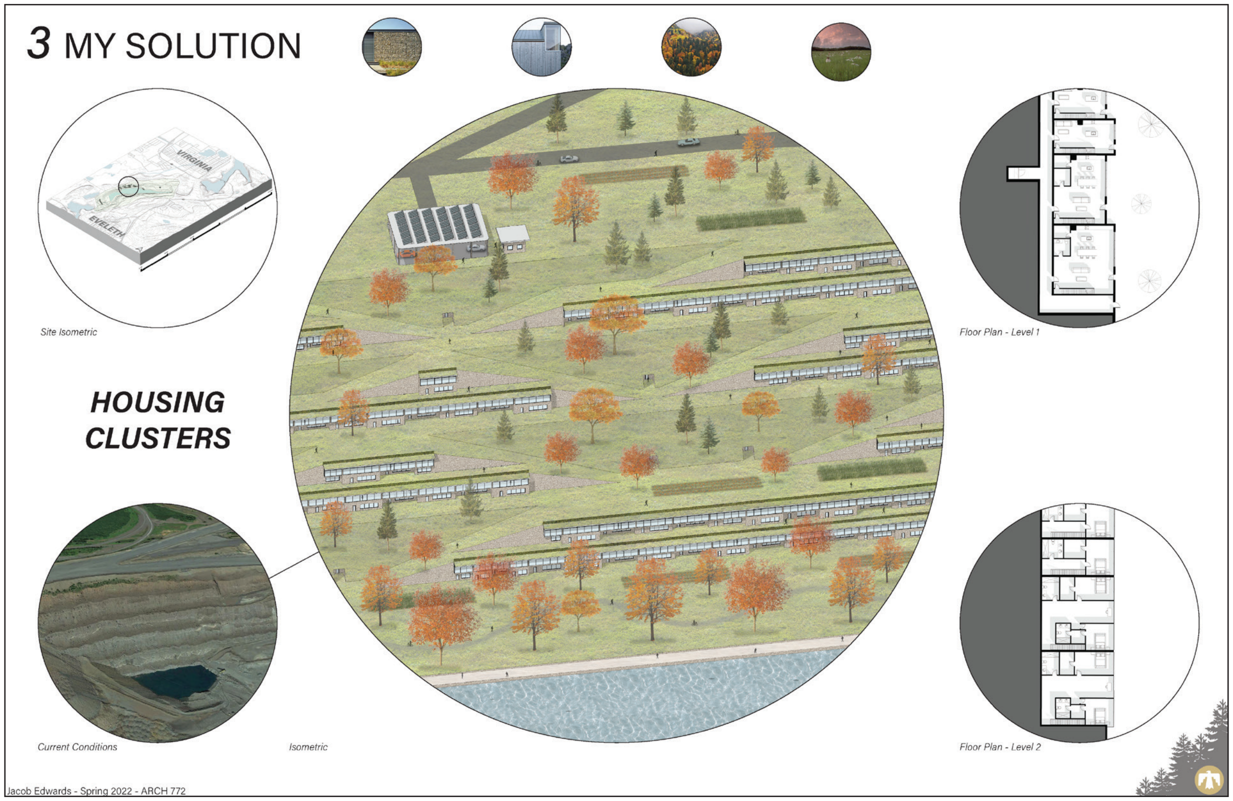
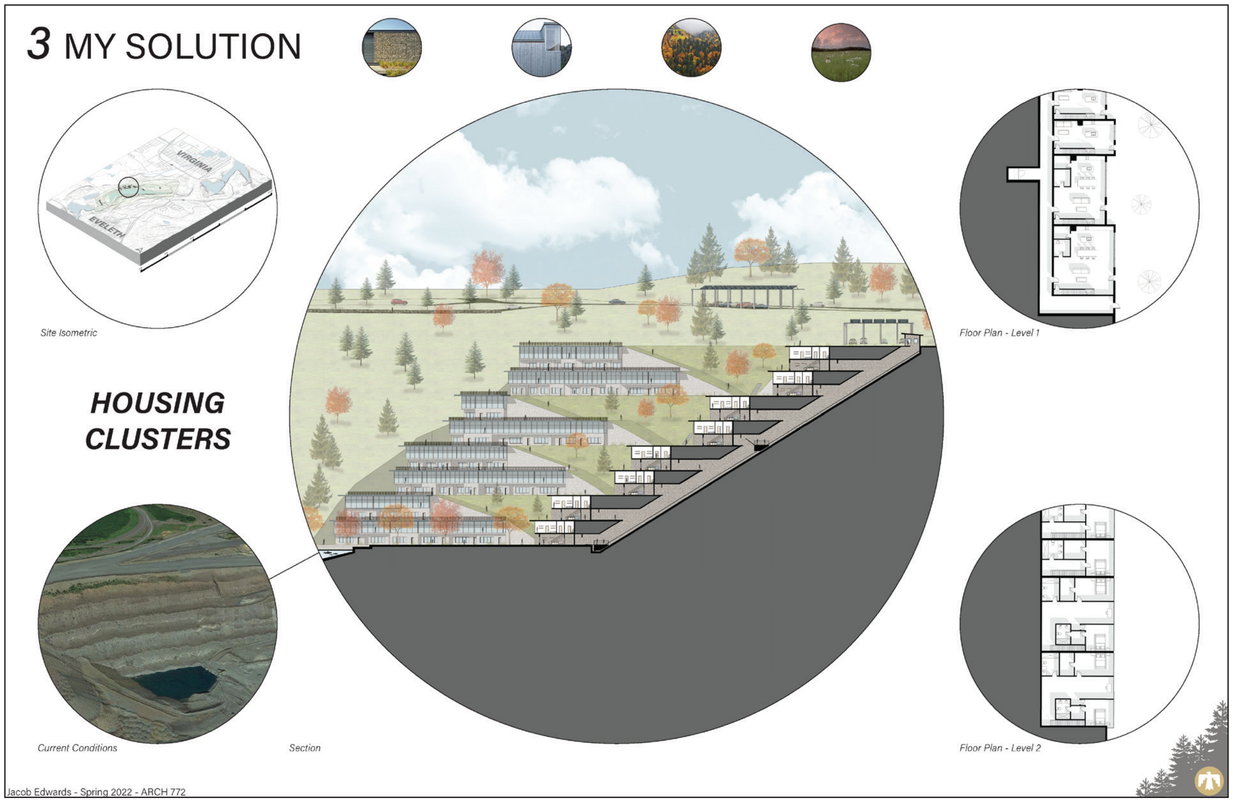
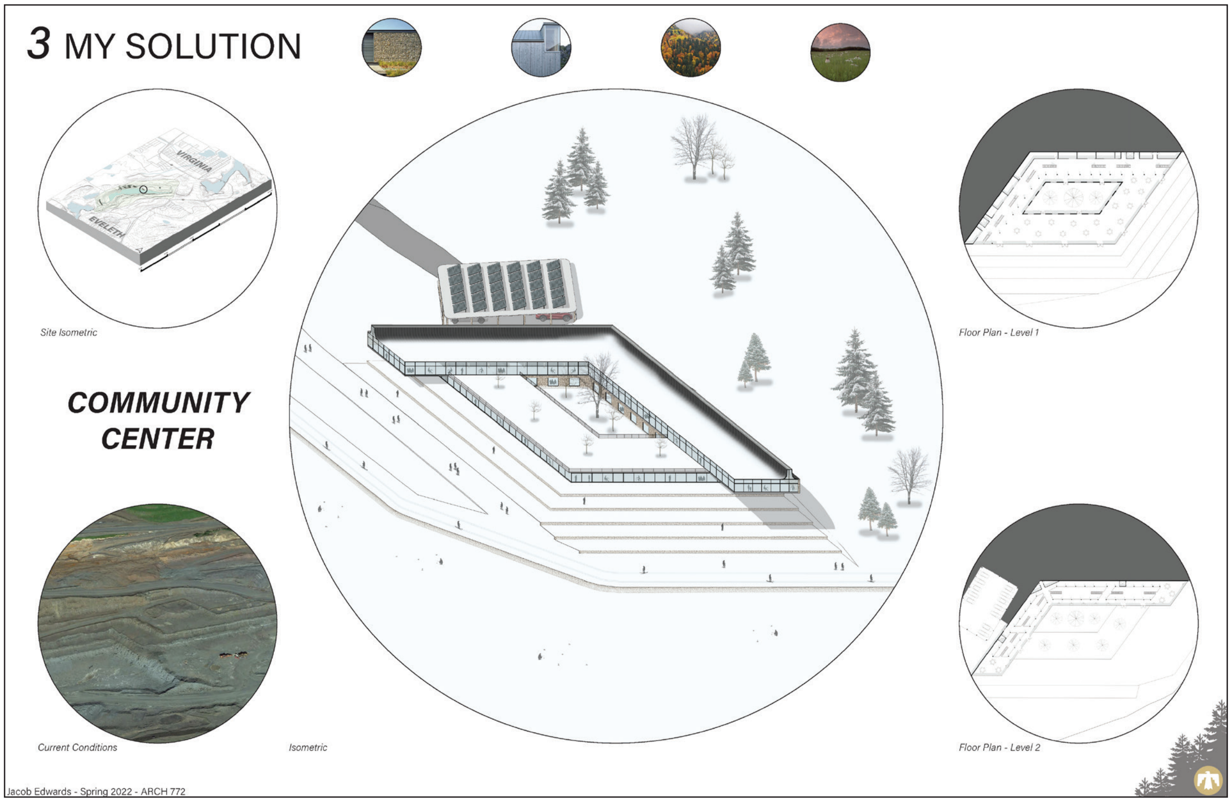
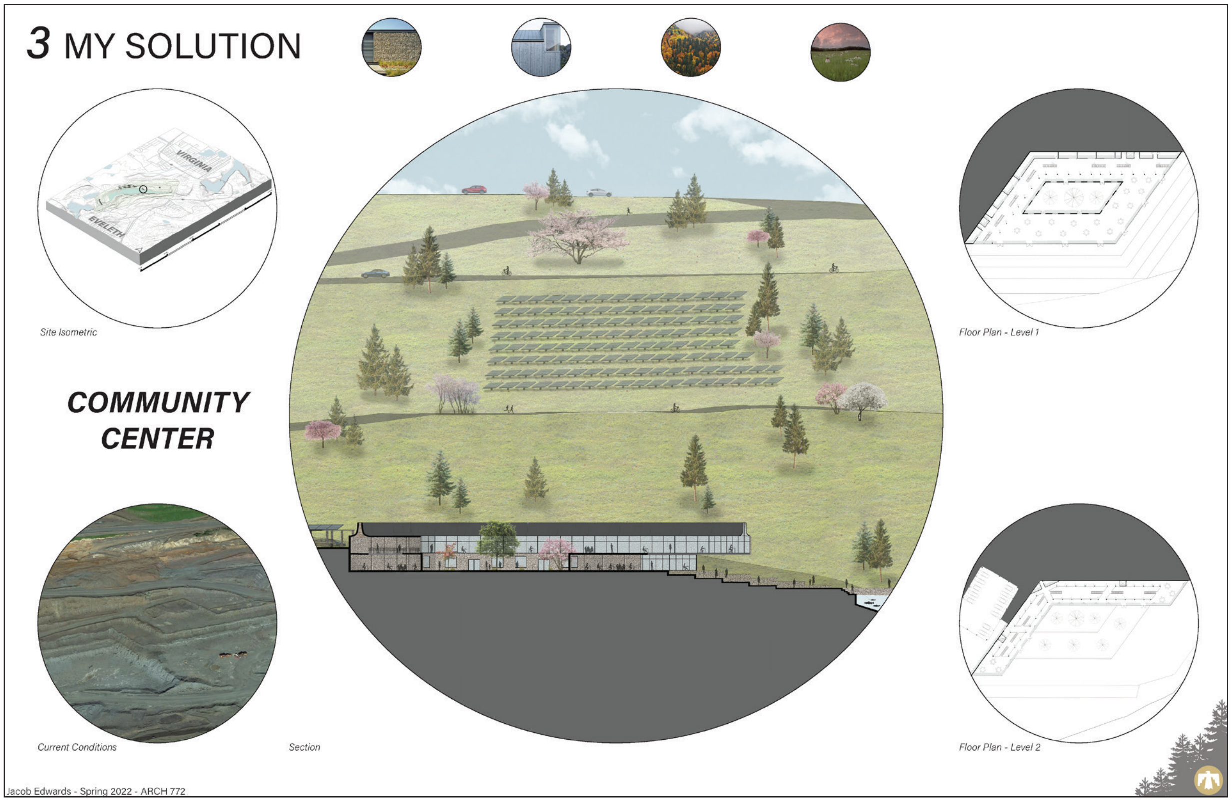
DIGITAL PRESENTATION:





DIGITAL PRESENTATION





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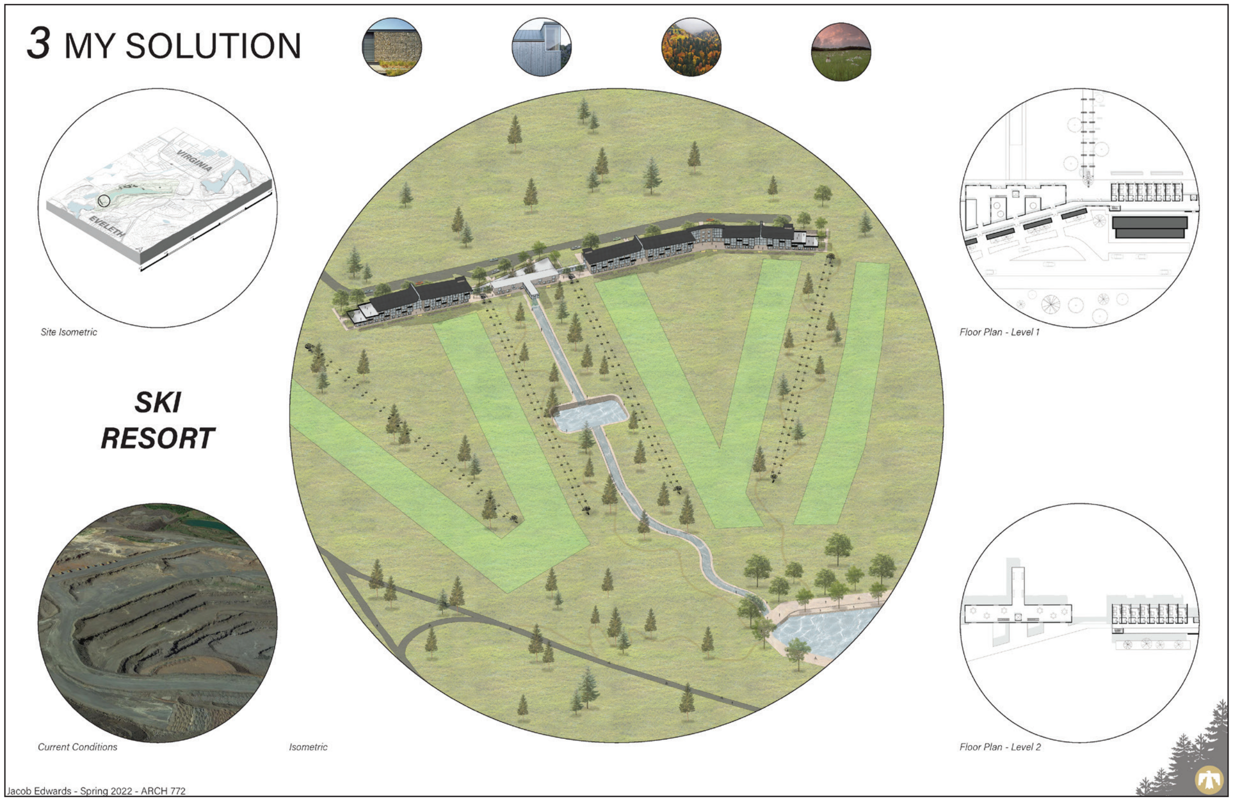
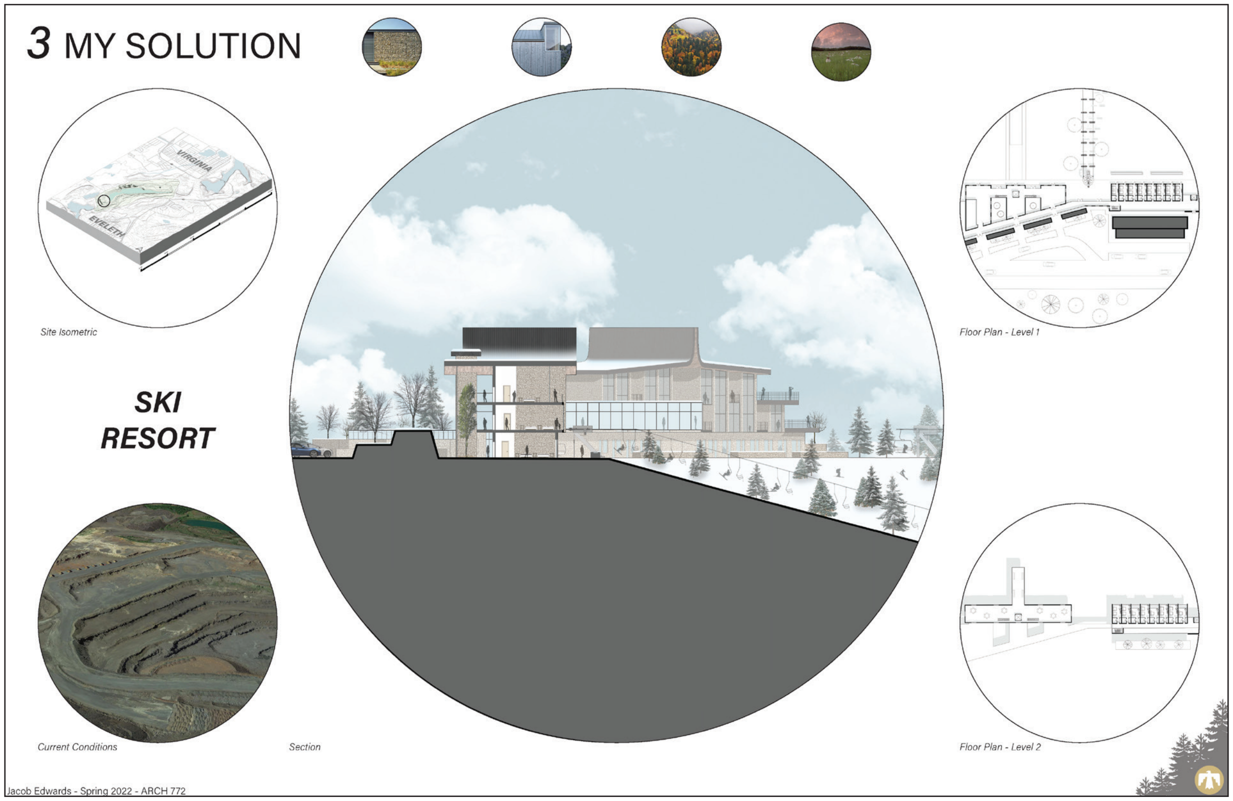
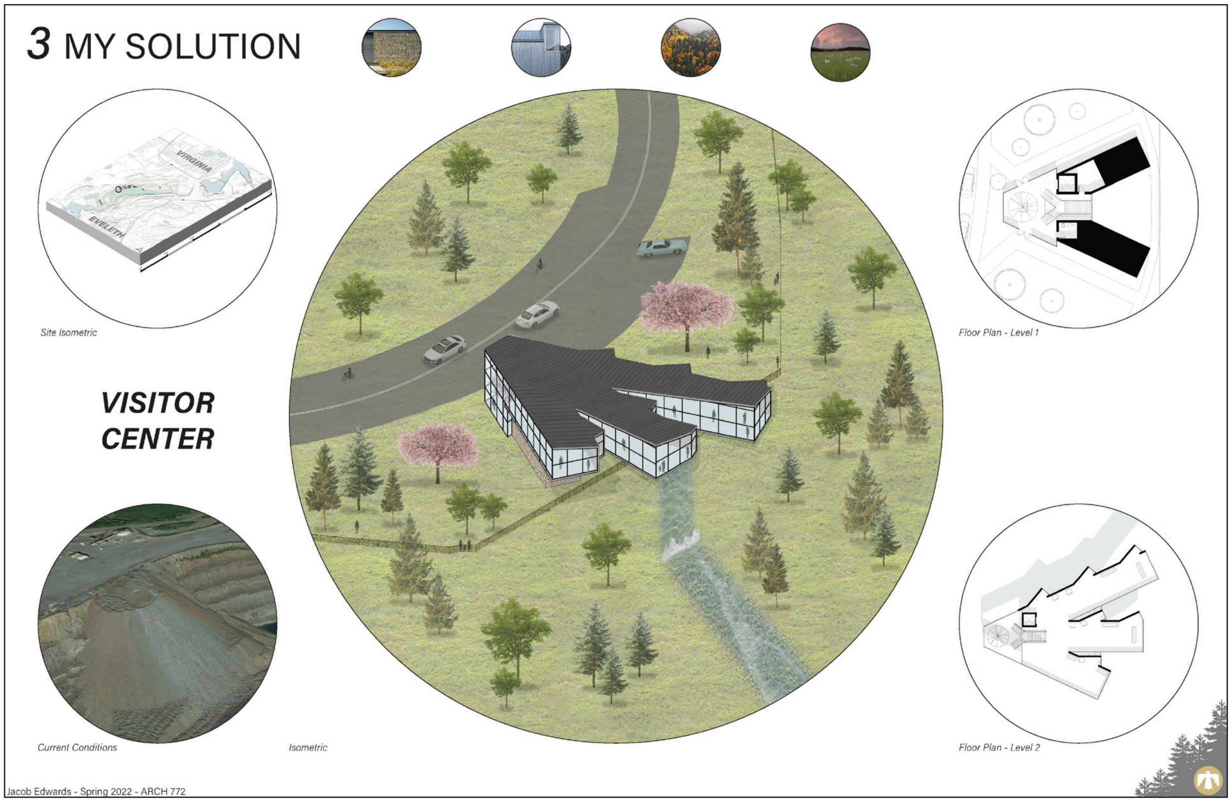
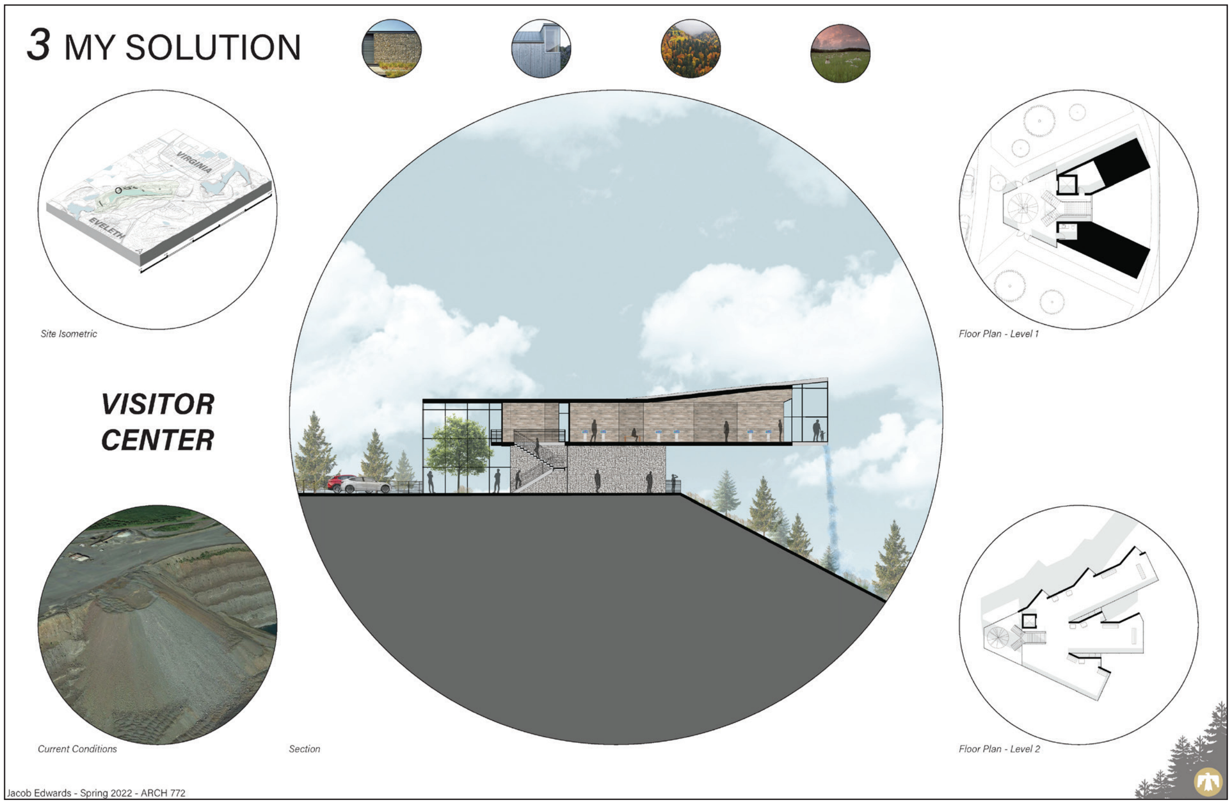




DIGITAL PRESENTATION





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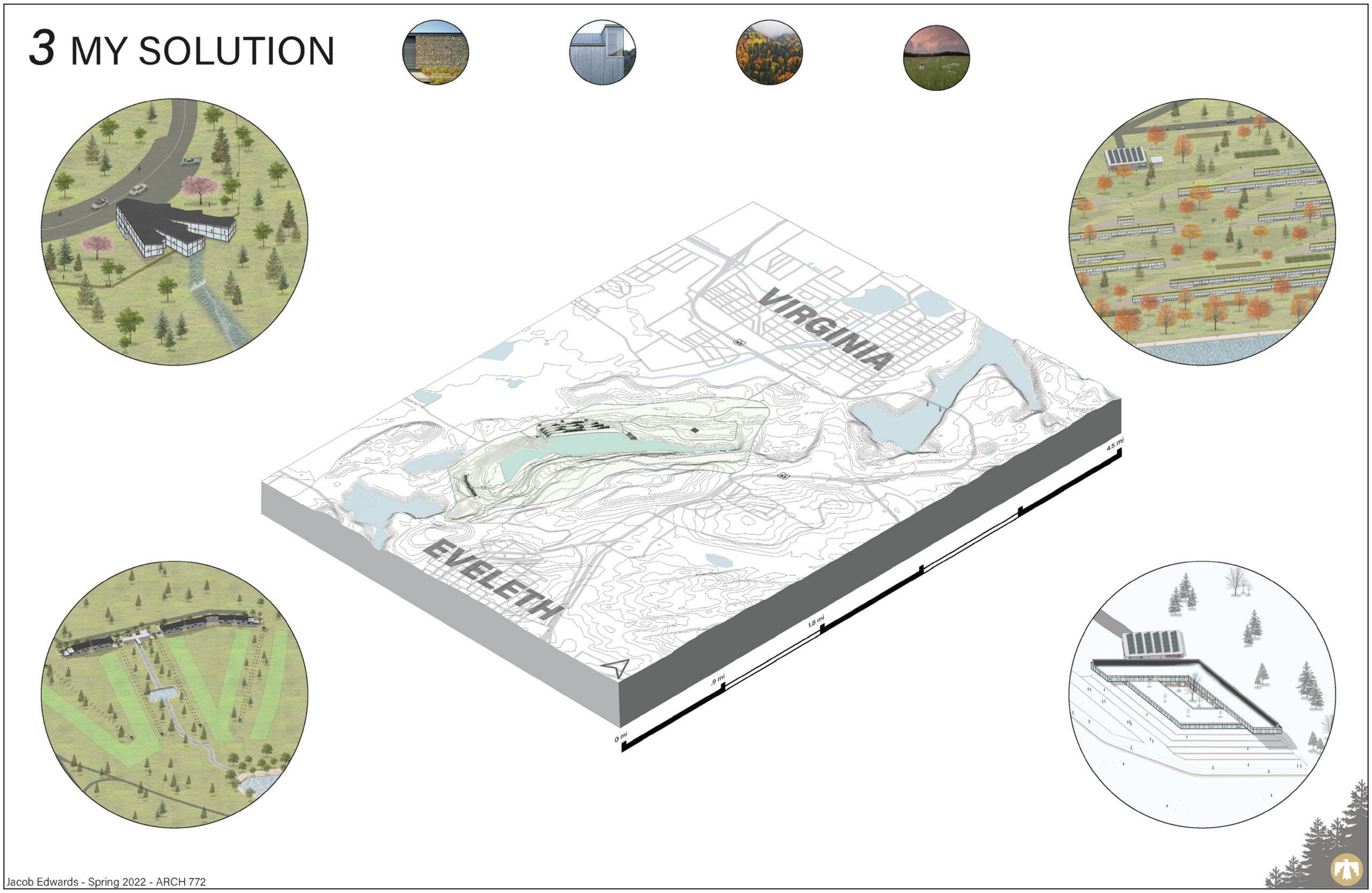
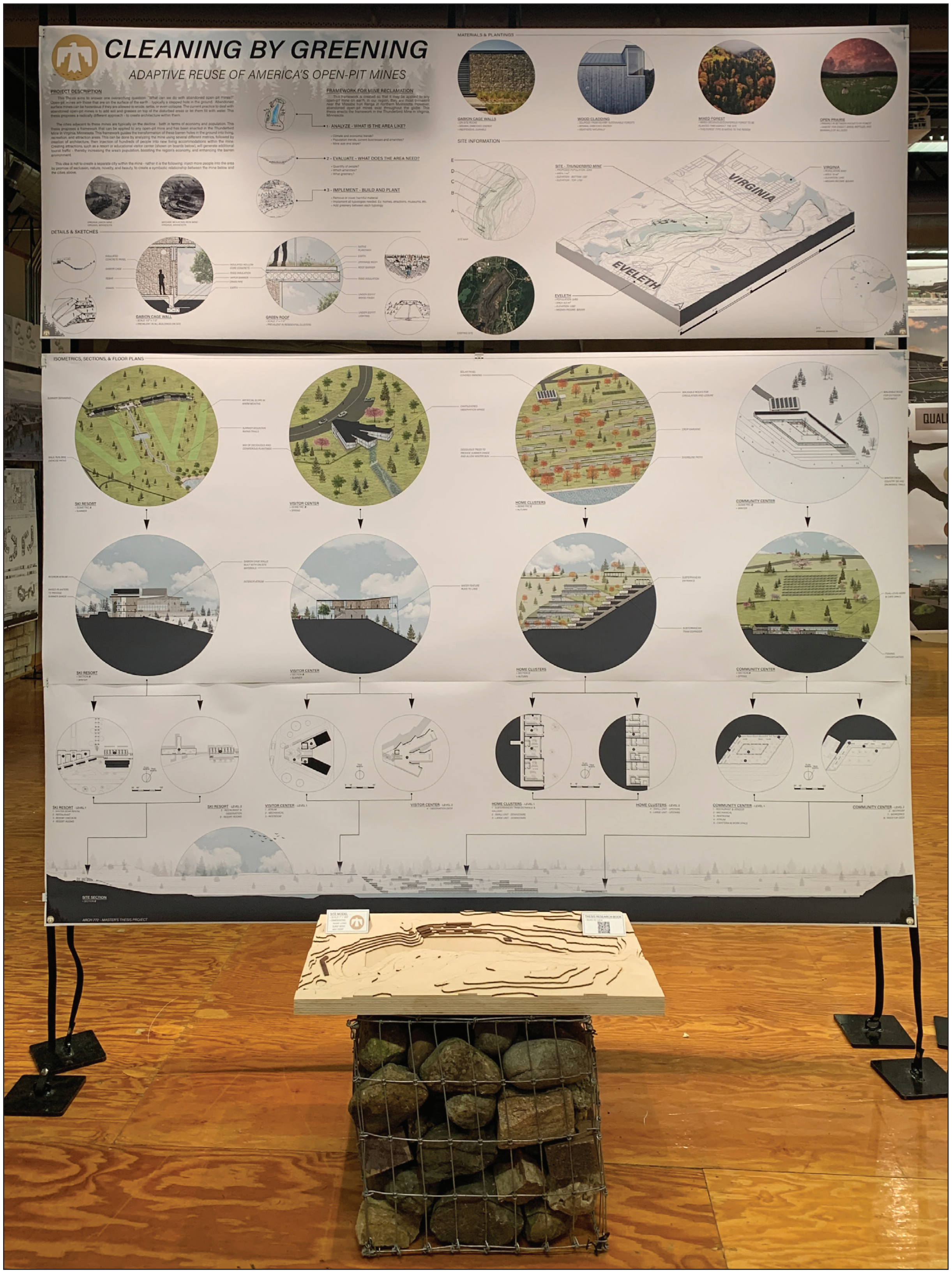


PHOTOGRAPH OF PROJECT INSTALLATION:



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APPENDIX
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APPENDIX:
PREVIOUS DESIGN STUDIO EXPERIENCE

2ND YEAR: 2017-2018

- FALL STUDIO: DARRYL BOOKER |
  - MEDITATION GARDEN PROJECT | MEDITATION ROOM AND LANDSCAPING
- SPRING STUDIO: CINDY URNESS |
  - DWELLING PROJECT | SINGLE FAMILY TINY HOME
  - AFFORDABLE HOUSING PROJECT | APARTMENT COMPLEX

3RD YEAR: 2018-2019

- FALL STUDIO: NILOUFAR ALENJERY
  - POST-APOCALYPTIC MUSEUM PROJECT | MUSEUM AND STORYTELLING
- SPRING STUDIO: REGIN SCHWAEN
  - HOME FOR THE 21ST CENTURY | BUILDING WITHIN THE FARGO FLOODPLAIN
  - EARTHSCRAPER PROJECT | GROUP PROJECT, COMMERCIAL BUILDING

4TH YEAR: 2019-2020

- FALL STUDIO: MARK BARNHOUSE
  - CAPSTONE | HIGH RISE BUILDING
- SPRING STUDIO: AMAR HUSSEIN
  - MARVIN WINDOWS HOME PROJECT | SINGLE FAMILY HOME
  - MIAMI MASTERPLANNING PROJECT | GROUP PROJECT, MASTERPLANNING

5TH YEAR: 2020-2021

- FALL STUDIO: LANCE JOSAL
  - FARGO BULLET TRAIN MASTERPLANNING PROJECT | MASTERPLANNING
- SPRING STUDIO: BAKR ALY AHMED
  - THESIS | MASTERPLANNING, RESIDENTIAL, COMMERCIAL, LANDSCAPING