STONE BY STONE

COLLABORATIVE CONSTRUCTION IN EXTREME ENVIRONMENTS

PÄR BRATT - MASTER THESIS PROJECT AT CHALMERS DEPARTMENT OF ARCHITECTURE - FALL 2015

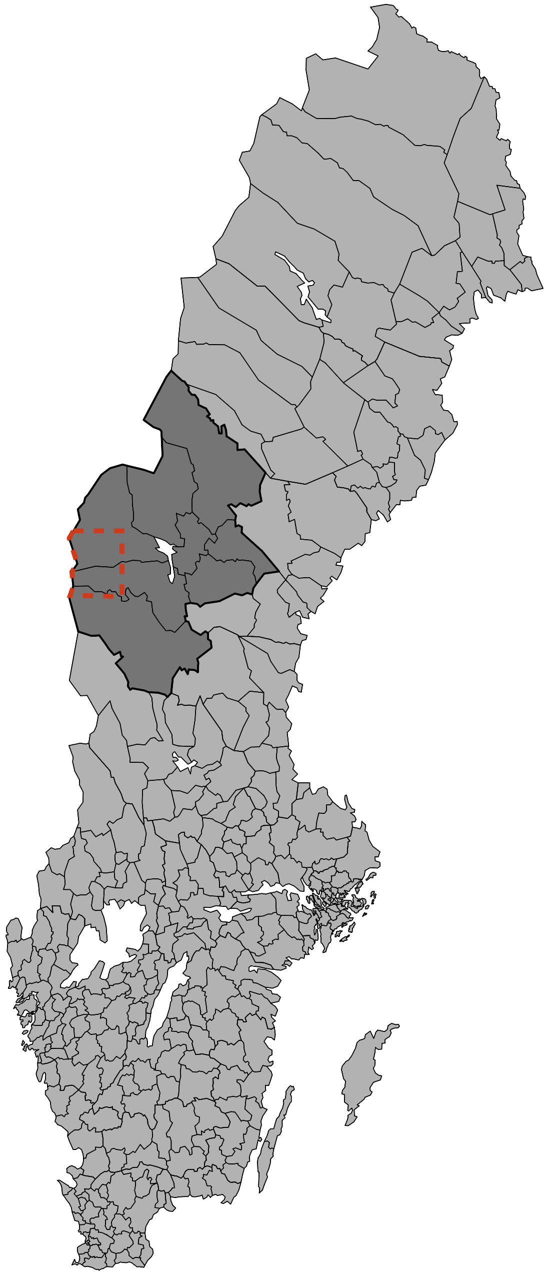
MOUNTAIN TOURISM

Summer or winter, by foot or on skis. The Swedish mountain hiking tourism has seen a distinct increase in popularity during the last couple of years. The more southern mountain regions are particularly increasing in popularity. The soothing and spacious environment attracts all kinds of people, and has become a fairy international arena during the past decades. Many cabins are being developed and expanded for the sake of increased comfortability but according to a recent study conducted by STF (the Swedish tourist association), there is an explicit request among younger visitors for the simple and self arranged mountain experience. But can a genuine dwelling experience in this harsh environment really be achieved from a comfortable jacuzzi in an all inclusive tourist station? This proposal for a stay-over cabin suggests an acceptance of the less comfortable for the gain of authenticity



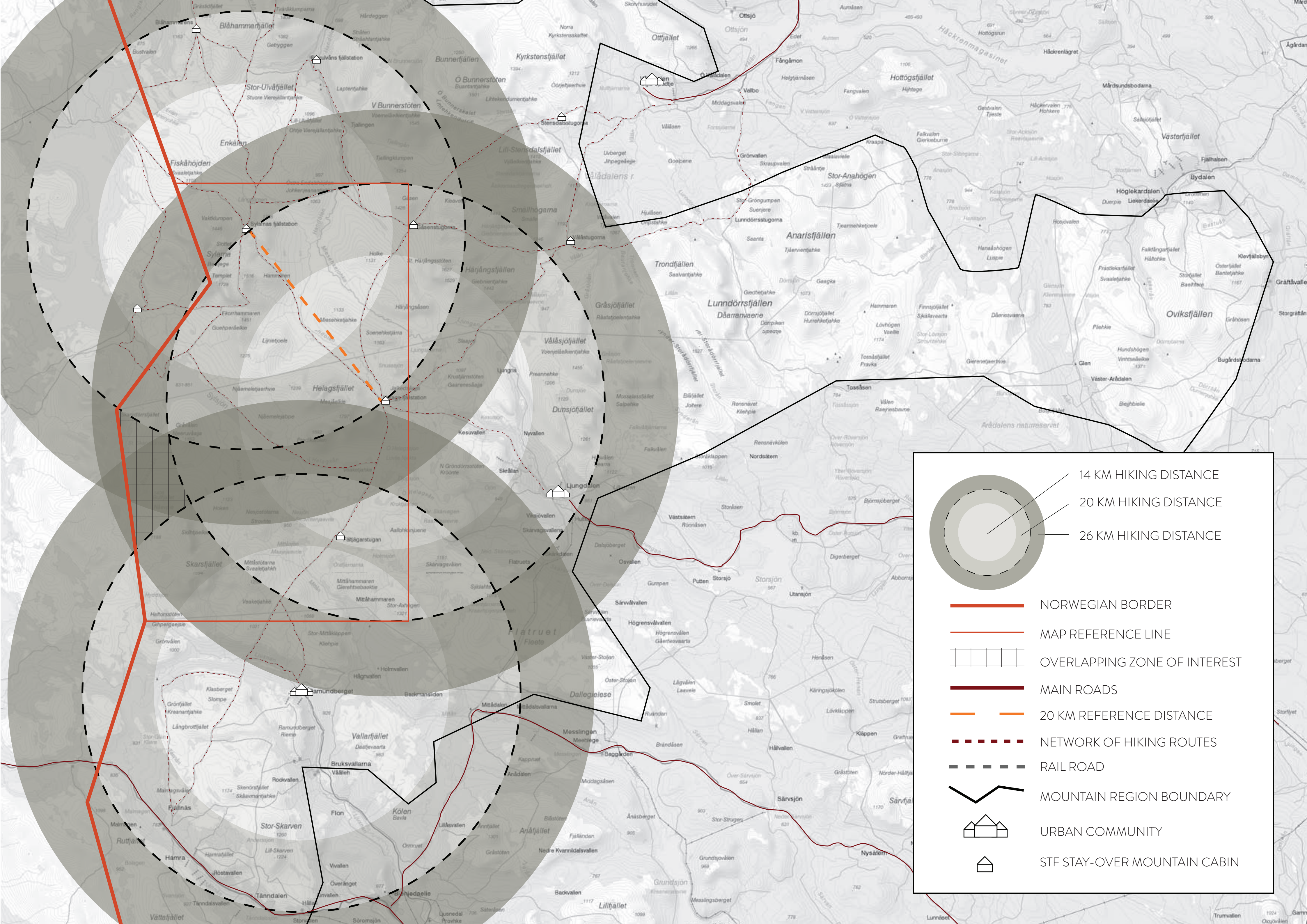

THE REGION

The region of interest for this project is located in the southern parts of the Swedish mountain chain in the twin counties Jämtland and Härjedalen. As oppose to the steeper and more drastic mountain landscape further up north, this mountain district is characterized by it's relatively flat, bare and undulating mountains providing unbroken sightlines for hundreds of kilometres. During the winter season, this creates perfect conditions for tour skiing between regional mountain cabins. The best downhill skiing resorts in Sweden are also located here. Jämtland/Härjedalen is a part of southern most area of Sápmi, the cultural region traditionally inhabited by the Sami people. This culture is omnipresent as soon as you leave the woodlands on your way towards the tree summit and the naked mountains. Peaks and massifs are often referred to by their Sami names, and depending on season, you might be fortunate enough to encounter reindeer herds.



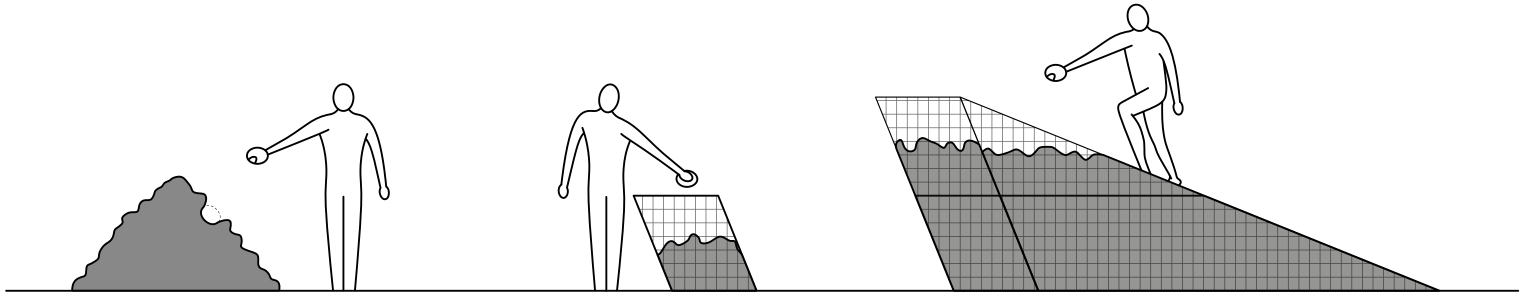
EXISTING NETWORK

The hiking routes in the mountain region of Jämtland/Härjedalen is connected by a series of stations. They vary in terms of comfortability and range from the small cabin huts to larger stations made up of clustered volumes with different functions. Most are connected to the electricity-grid. Stations are commonly separated by a one day marching distance. Trails are to a great extent defined by the locations of existing cabins. The overlapping zone on the map to the right represents a non exploited part of this network. A cabin in this region would connect and expand the network of both Swedish and Norwegian stations.


14 KM HIKING DISTANCE
20 KM HIKING DISTANCE
26 KM HIKING DISTANCE
NORWEGIAN BORDER
MAP REFERENCE LINE
OVERLAPPING ZONE OF INTEREST
MAIN ROADS
20 KM REFERENCE DISTANCE
NETWORK OF HIKING ROUTES
RAIL ROAD
MOUNTAIN REGION BOUNDARY
URBAN COMMUNITY
STF STAY-OVER MOUNTAIN CABIN
Blåhammarfjället
Bunnerfjällen
Kyrkstensfjället
Ottfjället
Hottögsfjället
Stor-Ulvåfjället
V Bunnerstöten
Enkälen
Fiskåhöjden
Lill-Stensdalsfjället
Stor-Anahögen
Vasterfjället
Bydalen
Höglekardalen
Smällhögarna
Anarisfjällen
Sylarna
Härjångsfjällen
Trondfjällen
Lunndörrsfjällen
Gråsjöfjället
Oviksfjällen
Vålåsjöfjället
Helagsfjället
Dunsjöfjället
Ljungdalen
Skarsfjället
Flatruet
Storsjön
Dallegielese
Vallarfjället
Bruksvallarna
Kölen
Stor-Skarven
Anåfjället
Tänndalen
Hamra
Funäsdalen
Lillfjället

SLOW-COOKING ARCHITECTURE

The mountain area is remotely located and has a sensitive terrain. The ambition is therefore to exclude heavy construction machines at all costs. The ancient tradition among mountain hikers to gather stones and build cairns to mark their presence, inspired me to think about this simple and analogue process as an architectural building method. With the building element sized down to human scale, the human body becomes a sufficient source of labour. Simple metal cages are filled one stone at a time by hikers visiting the site and demand will guide the building process and construction time. The process becomes a collaborative effort stretching over a long period of time and the ritual-like cairn building tradition is morphed into a creative process for the common good of all mountain hiking enthusiasts. It's a building process simple and analogue in the same way as the dwelling conditions of the finished shelter. Local stone is cheap and since labour is carried out by future cabin-dwellers and enthusiasts, costs can be kept at a minimum.

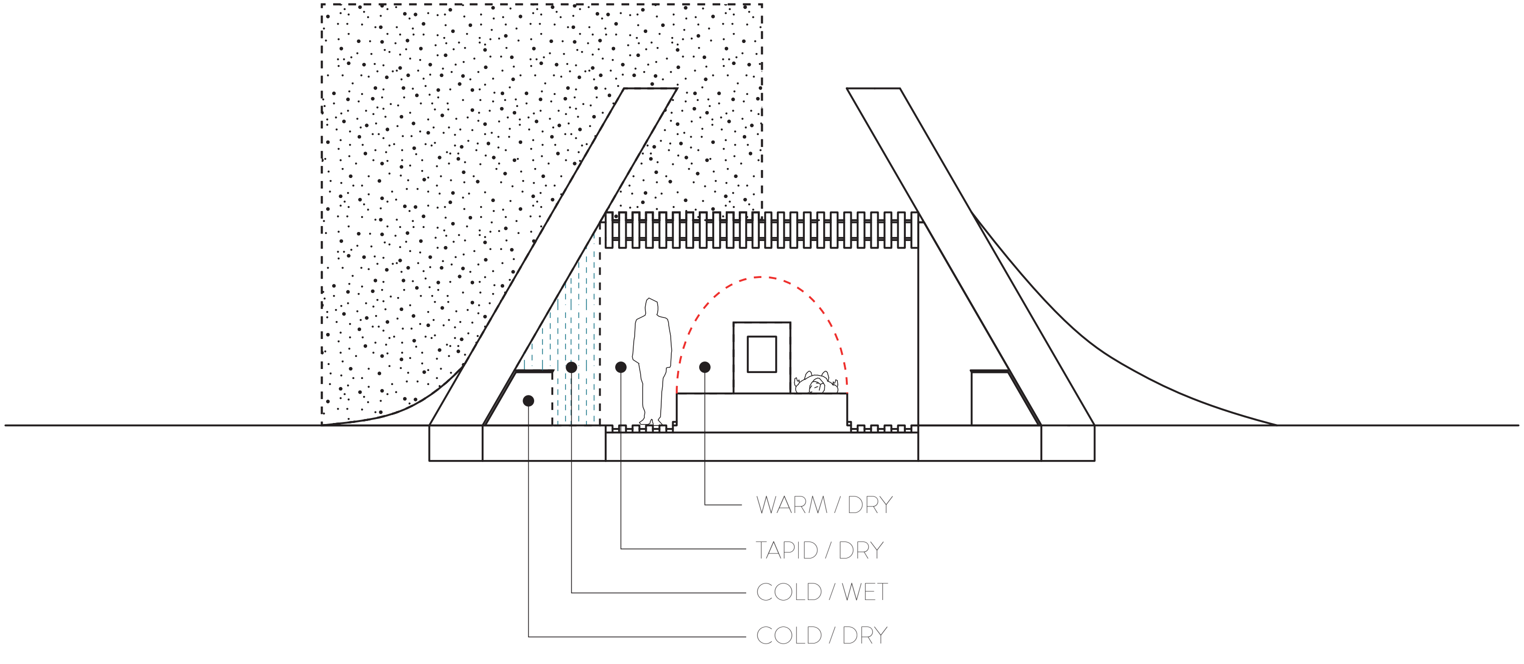


SNOW AND WIND

The site is located above the tree summit at 900 meters above sea level. There is nothing preventing the wind from propagating across the vast landscape. The area is also known for being the most snow intensive region in Sweden and the combination of these two forces of nature has a fantastic capability of creating shape and volume. This has been a major guiding influence in the design of this mountain cabin. Snow also has great insulation properties and the local flora and fauna has adapted to the harsh local conditions by taking advantage of this. The geometrical shape of the cabin structure is made to capture snow for the same reason. Wind direction and wall inclination determines how snow is packed against the structure. The unpredictable playfulness of the wind will keep changing the appearance and shape of the cabin throughout the winter season.

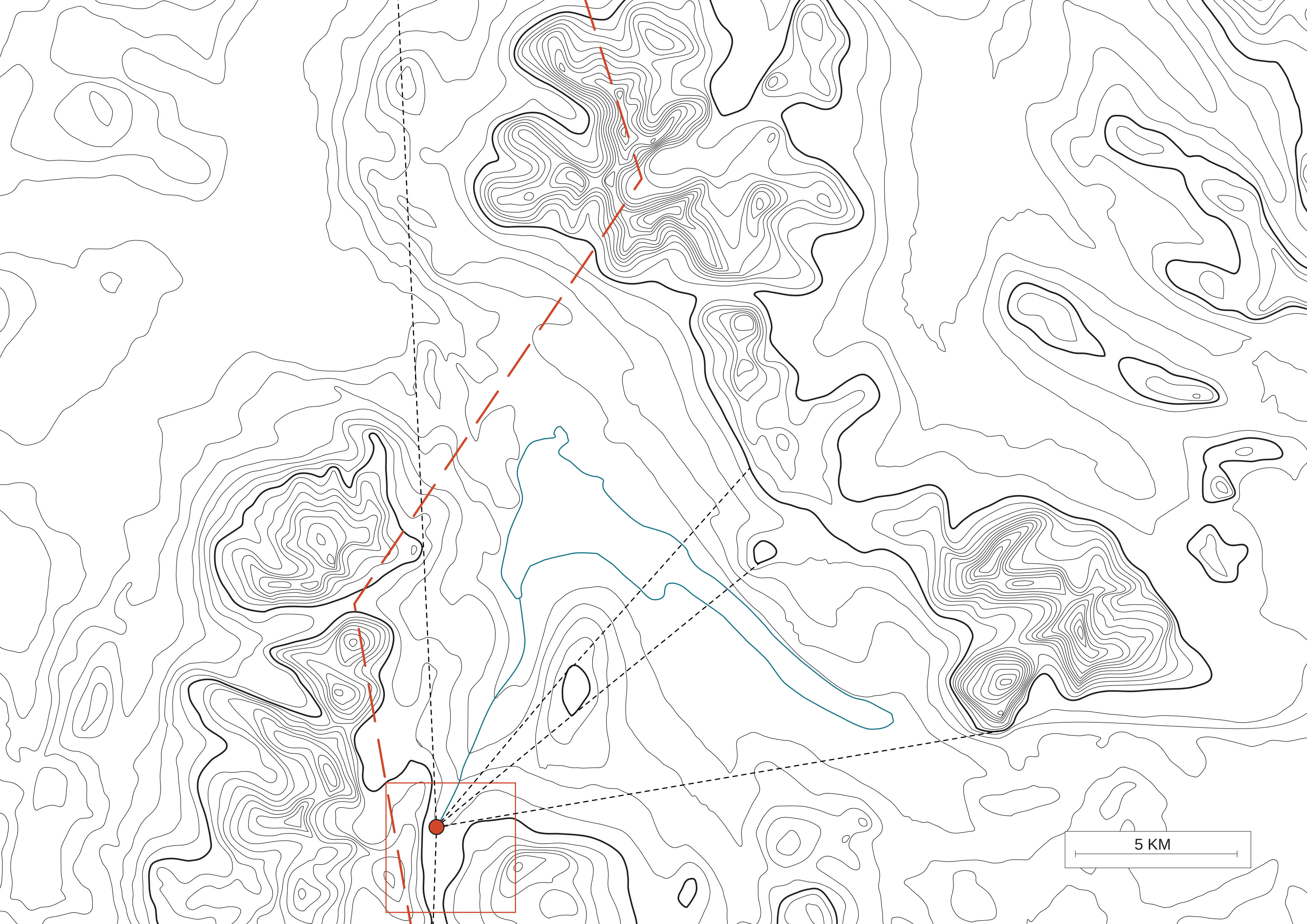
HIERARCHY OF COMFORTABILITY

The interior space is designed with the concept of comfortability in mind. As mentioned in the introduction text, it takes stand against an increasing trend of mountain cabins becoming more luxurious and comfortable offering a variety of services and convenience. If what's unique about wilderness is the untamed forces of nature, how much can we shelter us from that and still maintain an authenticity of wilderness? Melting snow and rain is allowed to seep through a part of the structure into a gravel floor underneath. The fireplace in the cabins core is essentially one big volume of thermal mass. It offers a micro climate where the dweller can be warm and comfortable enough while listening to the dripping melt-water and the wind pounding against the exterior wall like waves on break-water. The zones are divided into cold/wet, tapid/dry & warm/dry.


WARM / DRY
TAPID / DRY
COLD / WET
COLD / DRY

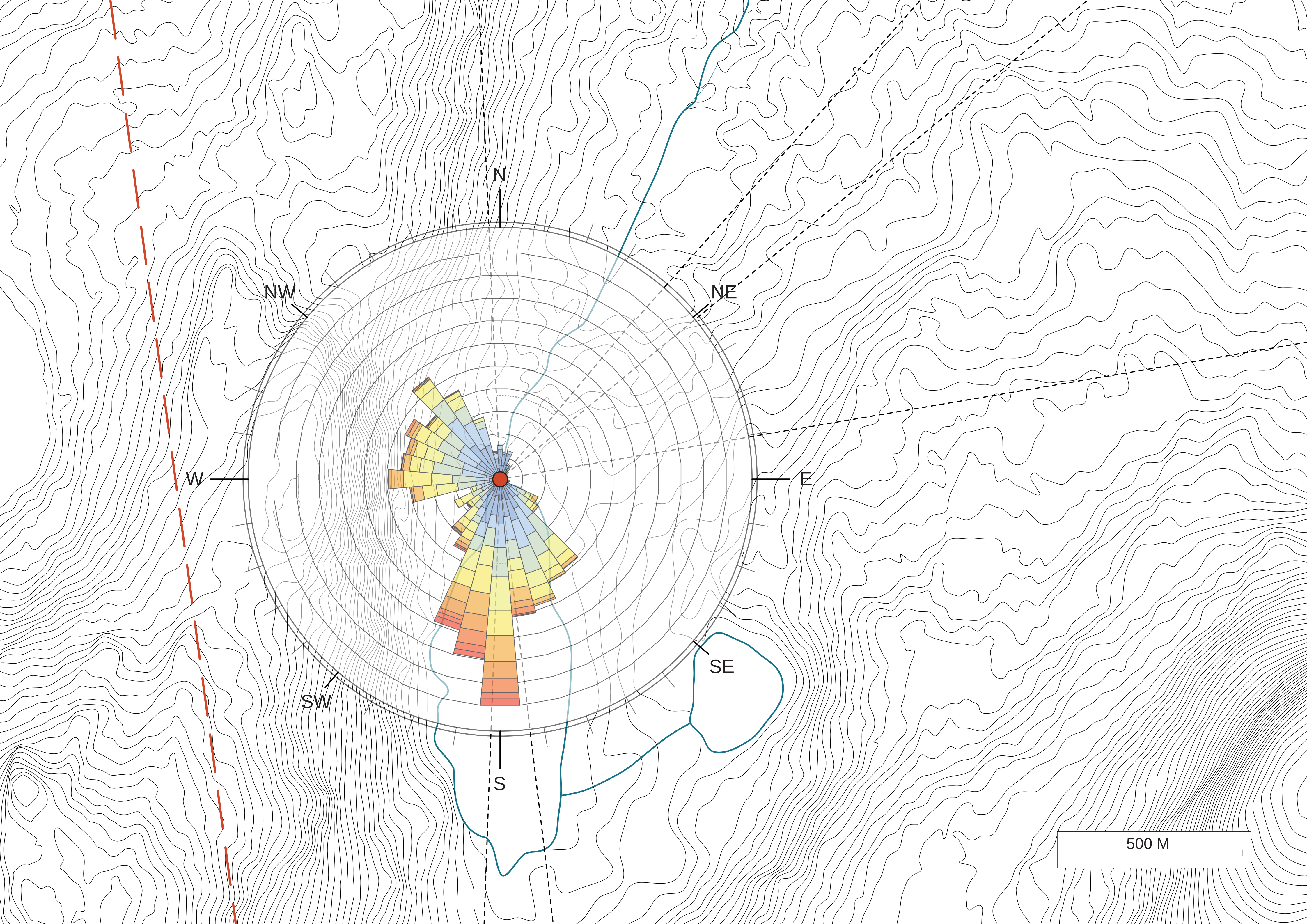
SIGHT LINES AND LARGER CONTEXT

The Scandes, which is the name of the mountain range running along the Swedish Norwegian border, is a relatively old and therefore heavily eroded belt of mountains. As a result of this, the terrain is characterized by vast and undulating terrain with unbroken sight-lines stretching hundreds of kilometres. The mountain cabin is located within close proximity to two of Swedens largest massifs, Helags and Sylarna. Maintaining the sightlines towards these astonishing massifs has been a high priority. North east of the cabin site there is a lake located on the Swedish side of the border but with it's outfall on the Norwegian side. There is a hydro-power station at this outfall and the water-levels are to a large extent controlled by this station. Along this lake there is a thousand year old pilgrimage trail. This is where Saint Bridges of Sweden supposedly walked on her way towards the Nidaros Cathedral (today Trondheim) and the grave of St Olaf.


5 KM

WIND CONDITIONS & FRESH-WATER ACCECCIBILITY

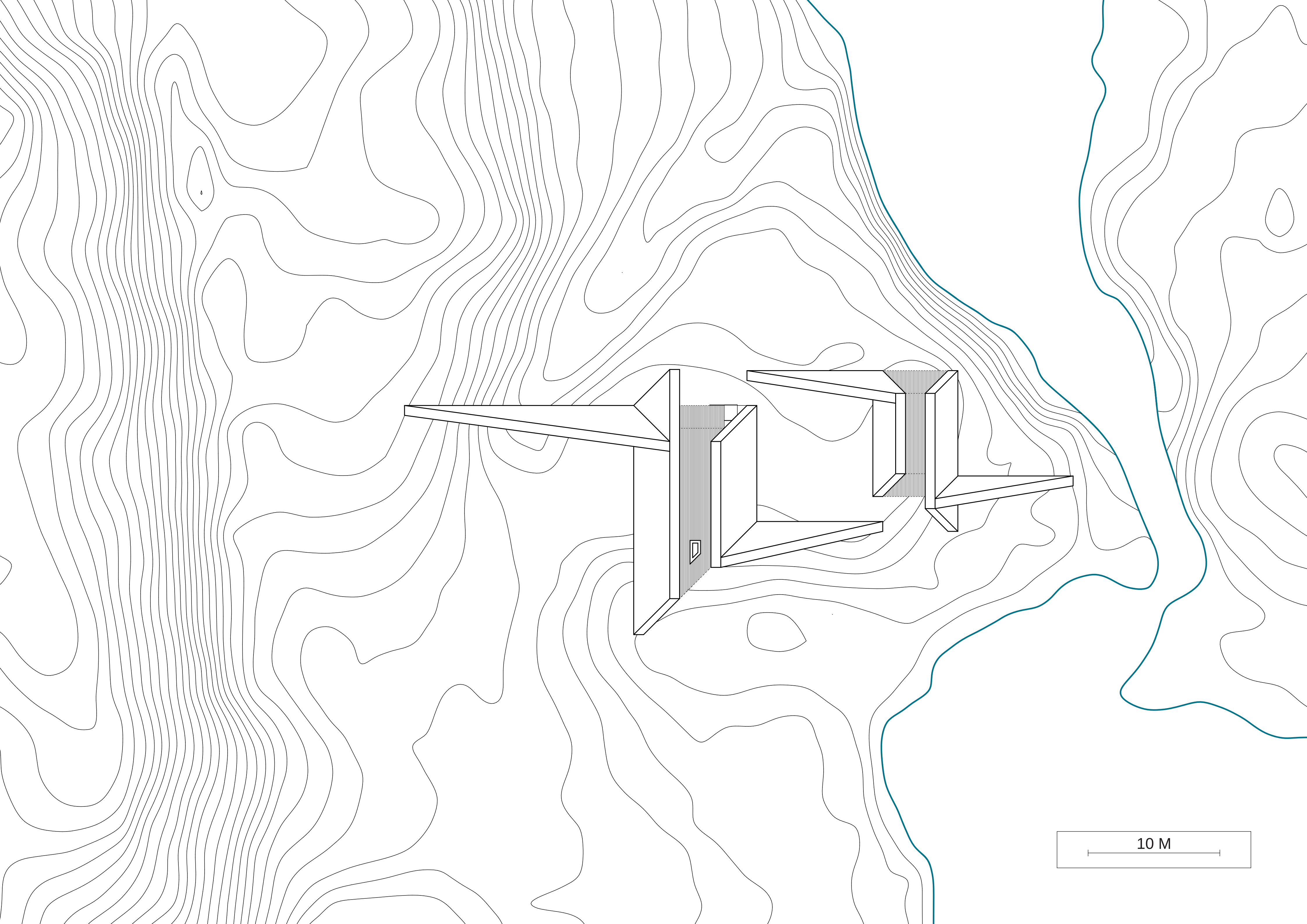
When choosing a more exact location for the cabin, wind and fresh-water accessibility was of great importance. Since the site is not at all connected to the electricity and water-grid, the cabin had to be located in close proximity to any of the creeks that eventually falls into the big lake. Along this particular creek, there are smaller lakes and pools and the cabin lays at the outfall of the one if these smaller lakes. The site is located in a dell-like situation and is therefore partly protected from winds. However, the site is above the tree summit so there is nothing stopping the winds from propagating in the landscape and the strategy in this projects has therefore been to accept the wind and make into an architectural feature. The combination of snow and wind has a tremendous ability to create shape and form. The wind rose below shows that winds are generally coming from either south or west. This is important in order to understand the angles and orientation of the cabin structure. It is designed to interfere with this shape-making game of mother nature.

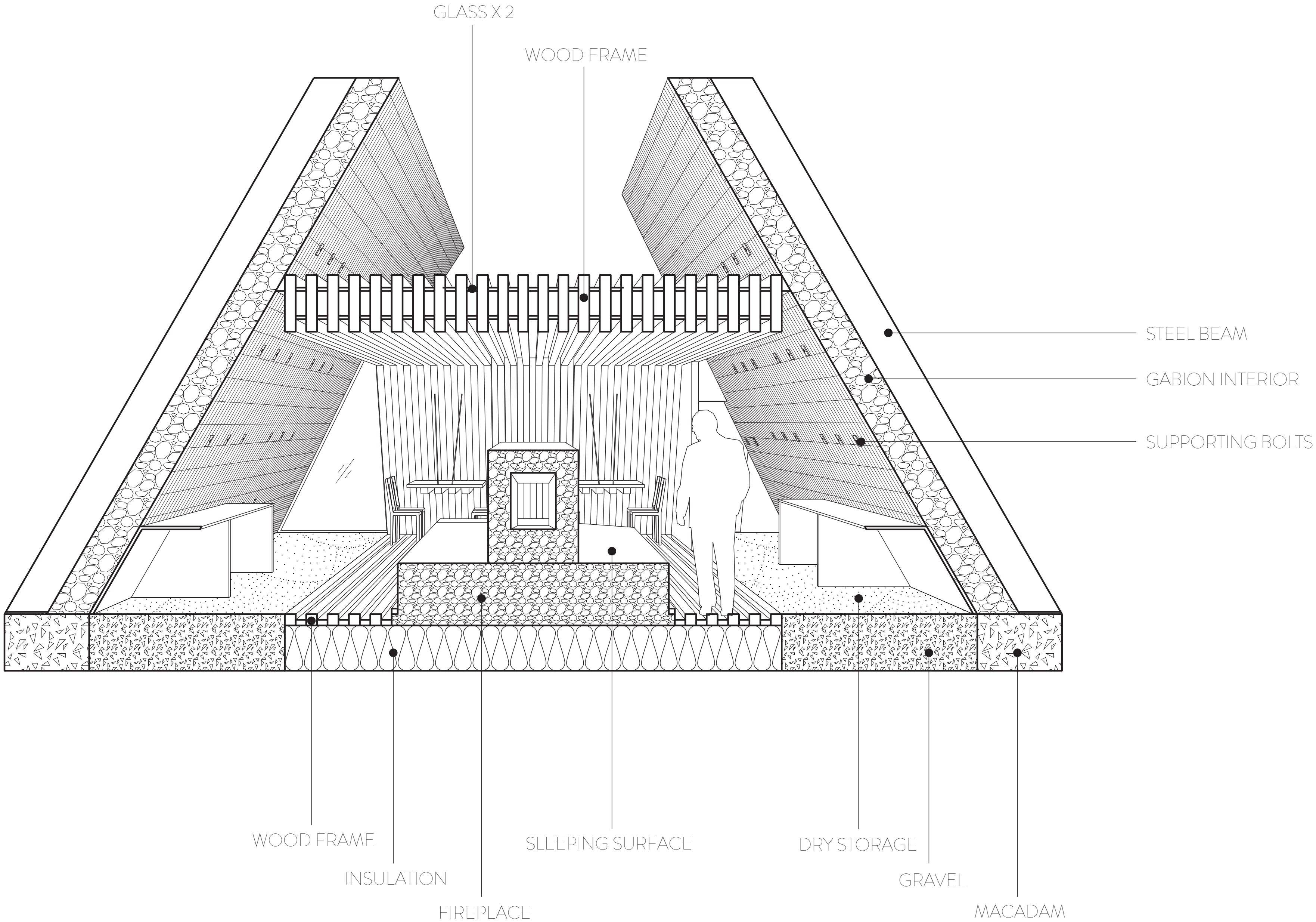


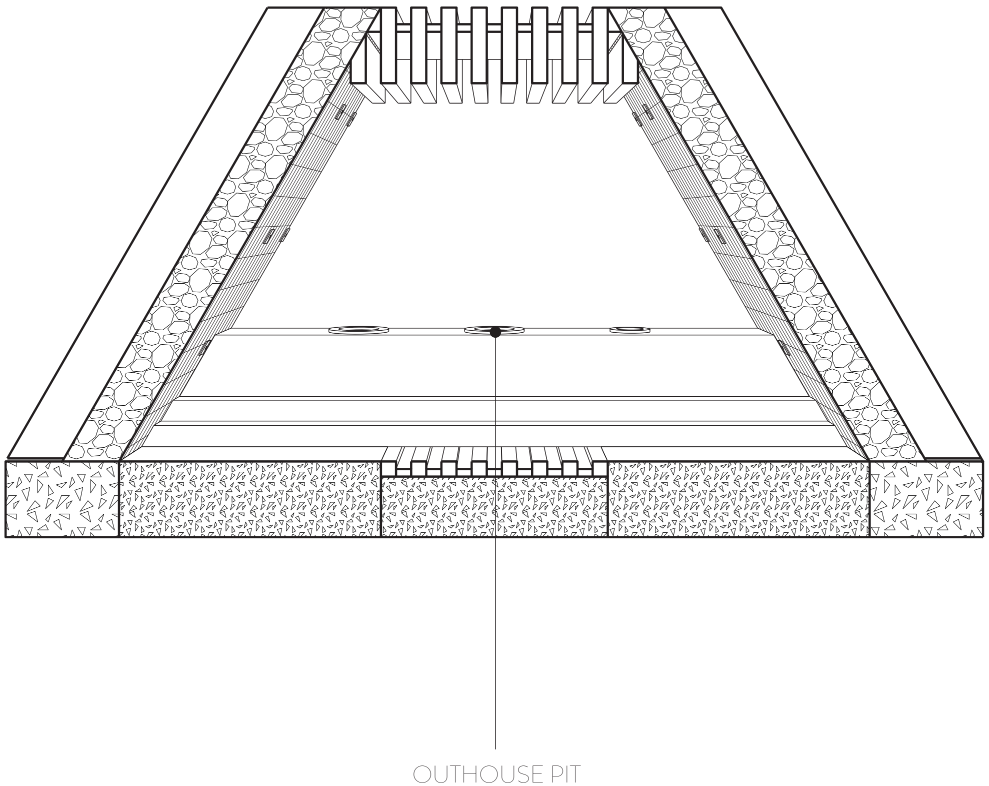
N
NE
E
SE
S
SW
W
NW
500 M

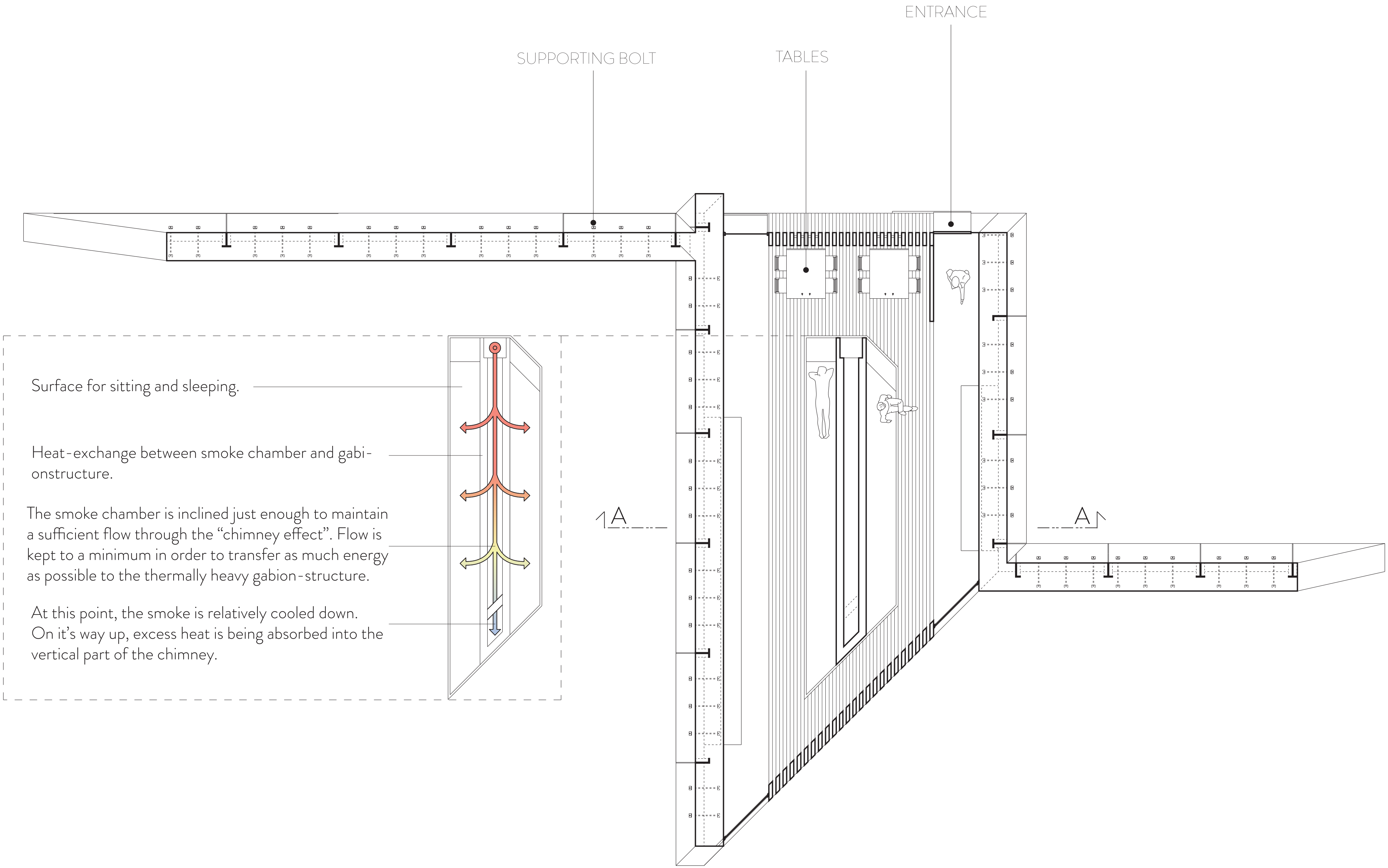
THE IMMEDIATE SITE

The cabin is located on a headland at the outfall of a small lake named “Biskopssjön” (The bishop lake). The amount of water is heavily connected to the seasons and during spring, when all accumulated snow starts to melt, the entire area is transformed into wet peat soil. The piece of headland on which the cabin is located is slightly elevated in order to avoid potential problems of the wet environment. The cabins geometrical structure is oriented with the wind direction in mind. During winter, these outstretched arms functions and snow catchers. This process slowly smoothens the borders between a strict artefact structure and the undulating soft landscape. The entrance to the main cabin is well protected from drifting snow so that there’s no risk of being snowed in. Far away from the background noises of urban life, the only thing visitors will hear at night is the sound of flowing water making it’s way down the mountain.

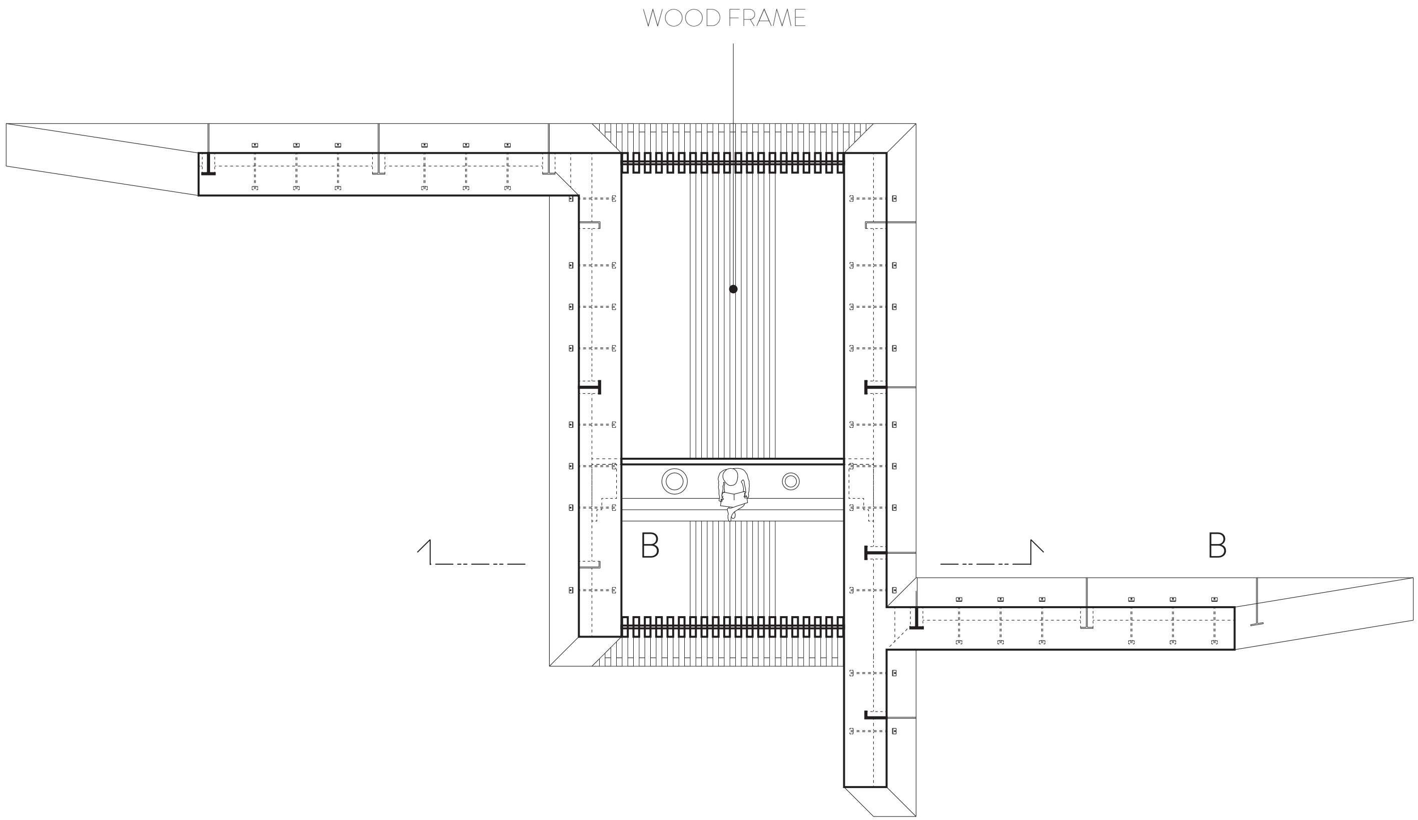

10 M


GLASS X 2
WOOD FRAME
STEEL BEAM
GABION INTERIOR
SUPPORTING BOLTS
WOOD FRAME
INSULATION
FIREPLACE
SLEEPING SURFACE
DRY STORAGE
GRAVEL
MACADAM


OUTHOUSE PIT

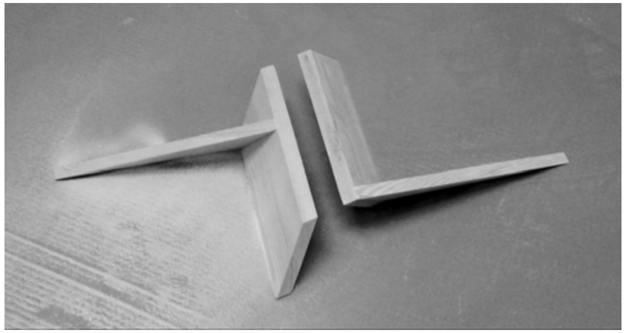
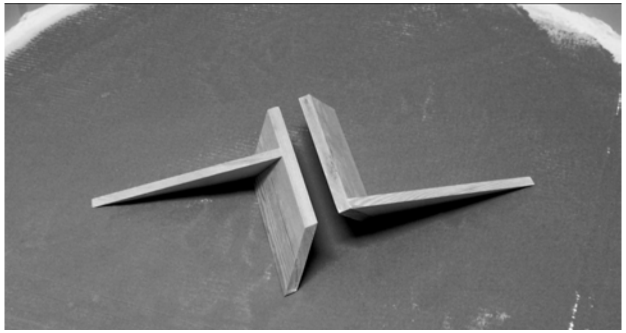
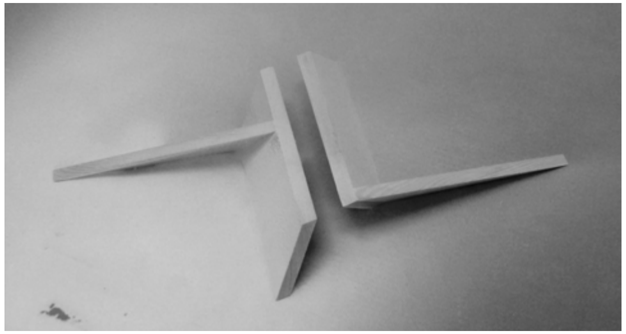
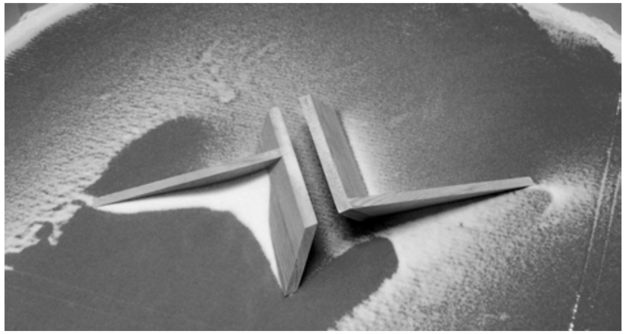
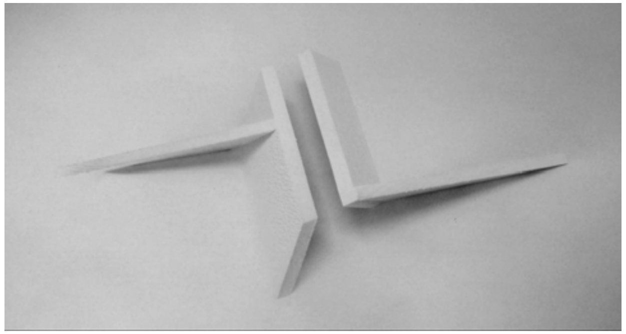
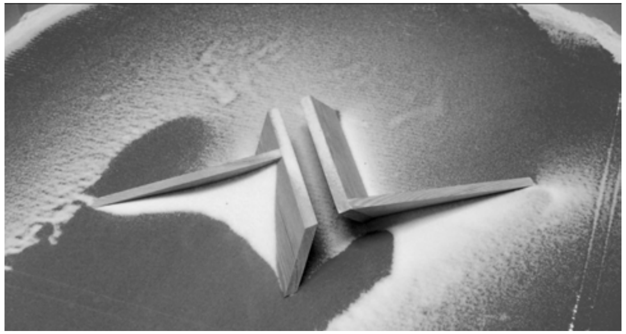
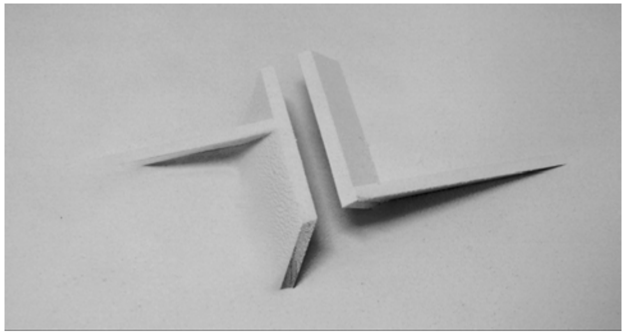
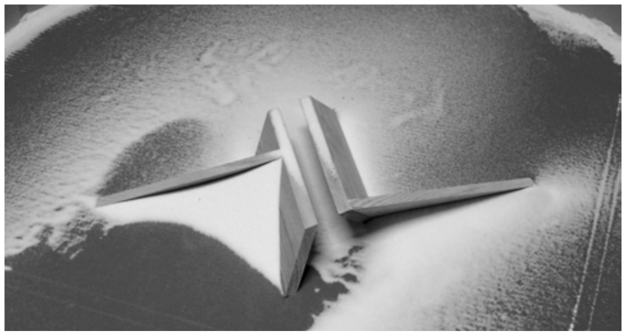


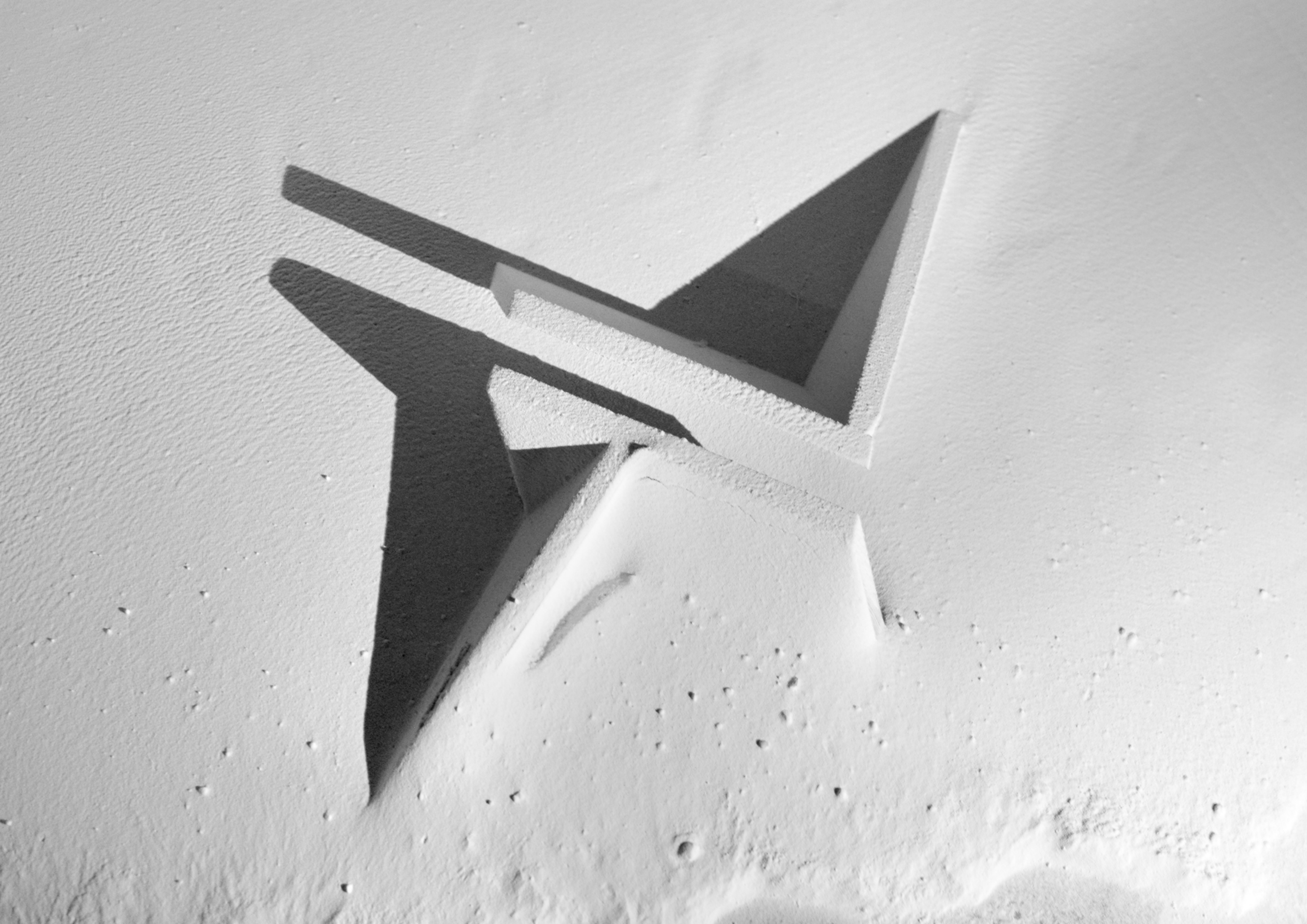
ENTRANCE
SUPPORTING BOLT
TABLES
Surface for sitting and sleeping.
Heat-exchange between smoke chamber and gabi-
onstructure.
The smoke chamber is inclined just enough to maintain
a sufficient flow through the “chimney effect”. Flow is
kept to a minimum in order to transfer as much energy
as possible to the thermally heavy gabion-structure.
At this point, the smoke is relatively cooled down.
On it’s way up, excess heat is being absorbed into the
vertical part of the chimney.
A
A

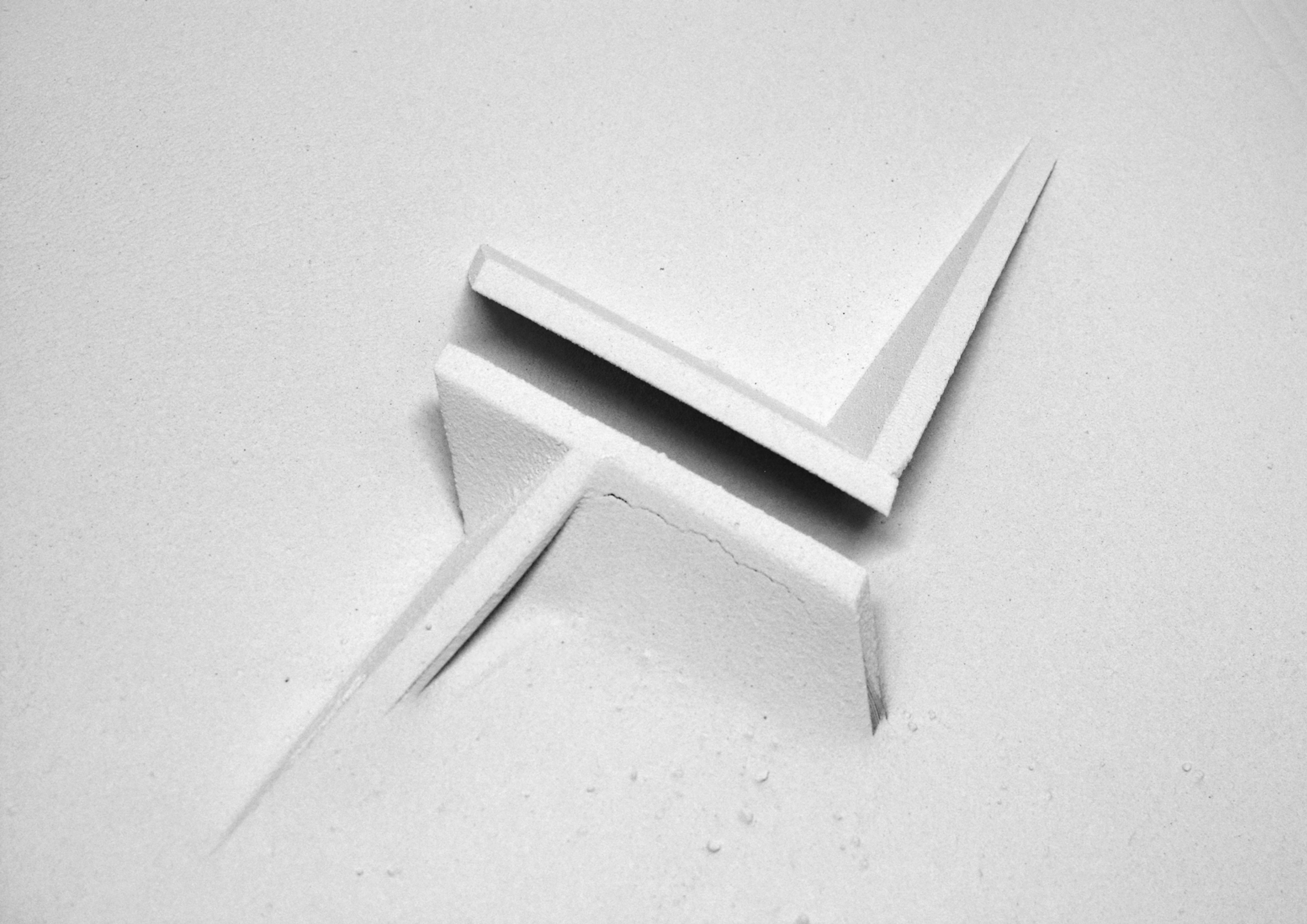

WOOD FRAME
B
B

AN EVER CHANGING VOLUME

The images above are from an physical experiment made to investigate how different structures interfered with drifting snow. Snow crystals behaves differently at different temperatures so in order to simulate the varying conditions I used different materials. The upper series was made with flour to represent the wet and packed snow with the ability to chunk and cluster. The lower series was made with salt to represent the cold, crispy and more sand like properties of snow. Wind was simulated by a compressor blowing air at an even pressure over a certain period of time. Before these experiments I had analysed weather data from the site in order to know from which directions I should expose the structure to wind. The orthogonal shape of the structure catches the snow and focus it towards corners where it slowly builds up against the walls. This effect was most apparent in the case with cold drifting snow represented with salt.





ARTEFACT IN AN ALIEN LANDSCAPE

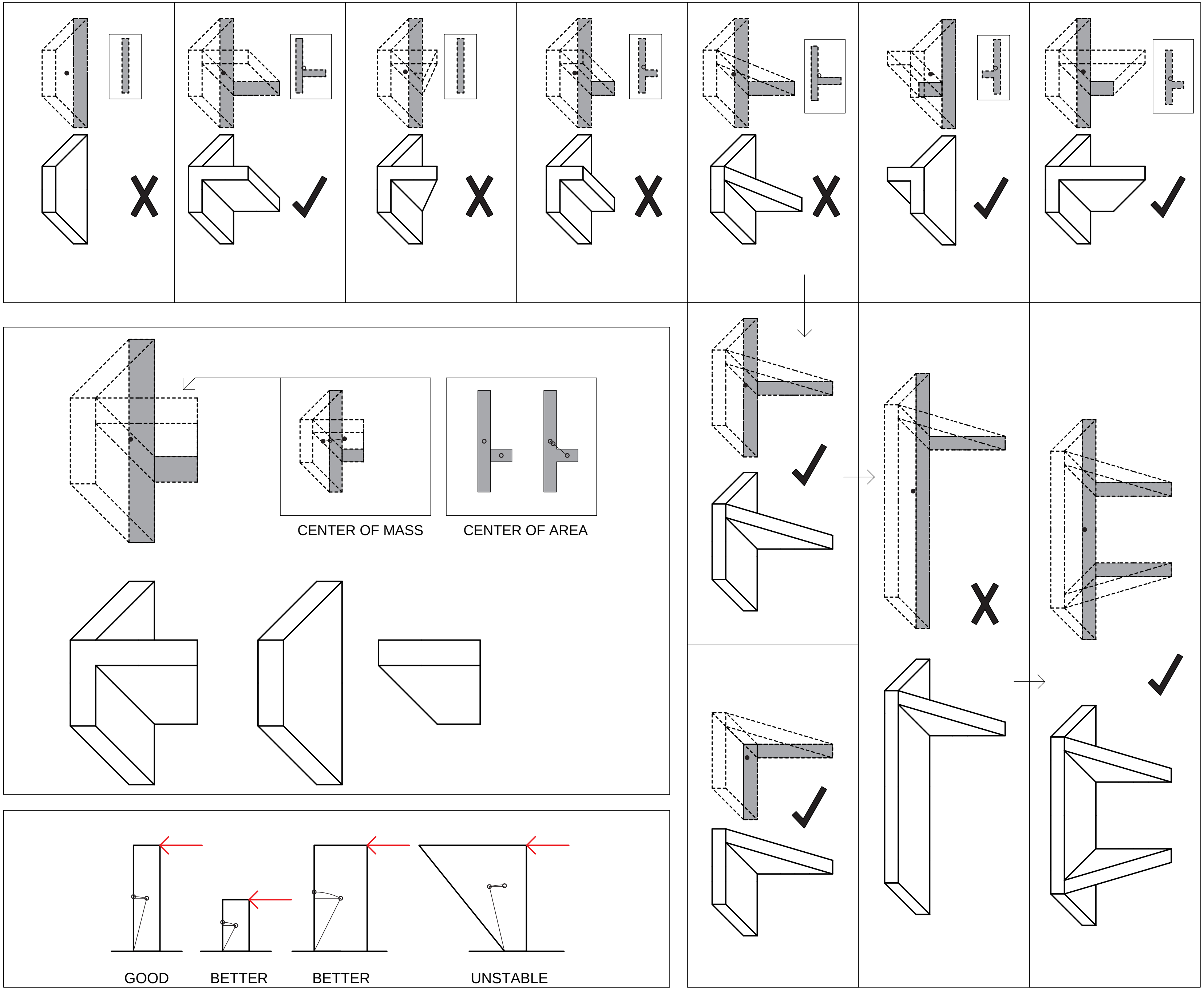
The design process takes it's point of departure in the way which we perceive our surroundings through shape and what happens with our understanding when these shapes are blurred and faded. A football on your lawn is still recognizable as a football underneath a thin bed of snow but at a certain point it becomes unclear weather what's underneath that patch of snow is a football, a pile of leaves or simply a random accumulation of snow caused by the wind. What's interesting about this is how surprisingly good humans are at distinguishing the artefact from the natural object, even when form and shape is blurred out. I wanted to embrace this sensation by emphasizing an orthogonal, typically man made, shape in my design. In an otherwise bare and undulating landscape of snow this is an alien volume and a witness of human presence.

A BALANCING ACT

Gabions are commonly used when constructing retaining walls or other kinds of fortifications. They are characterized by their heavy and stable properties and I decided to try and push the boundaries of what this type of structures could do. What could it look like and still function and be perceived as stable? Could it be stable but still be perceived as unstable?

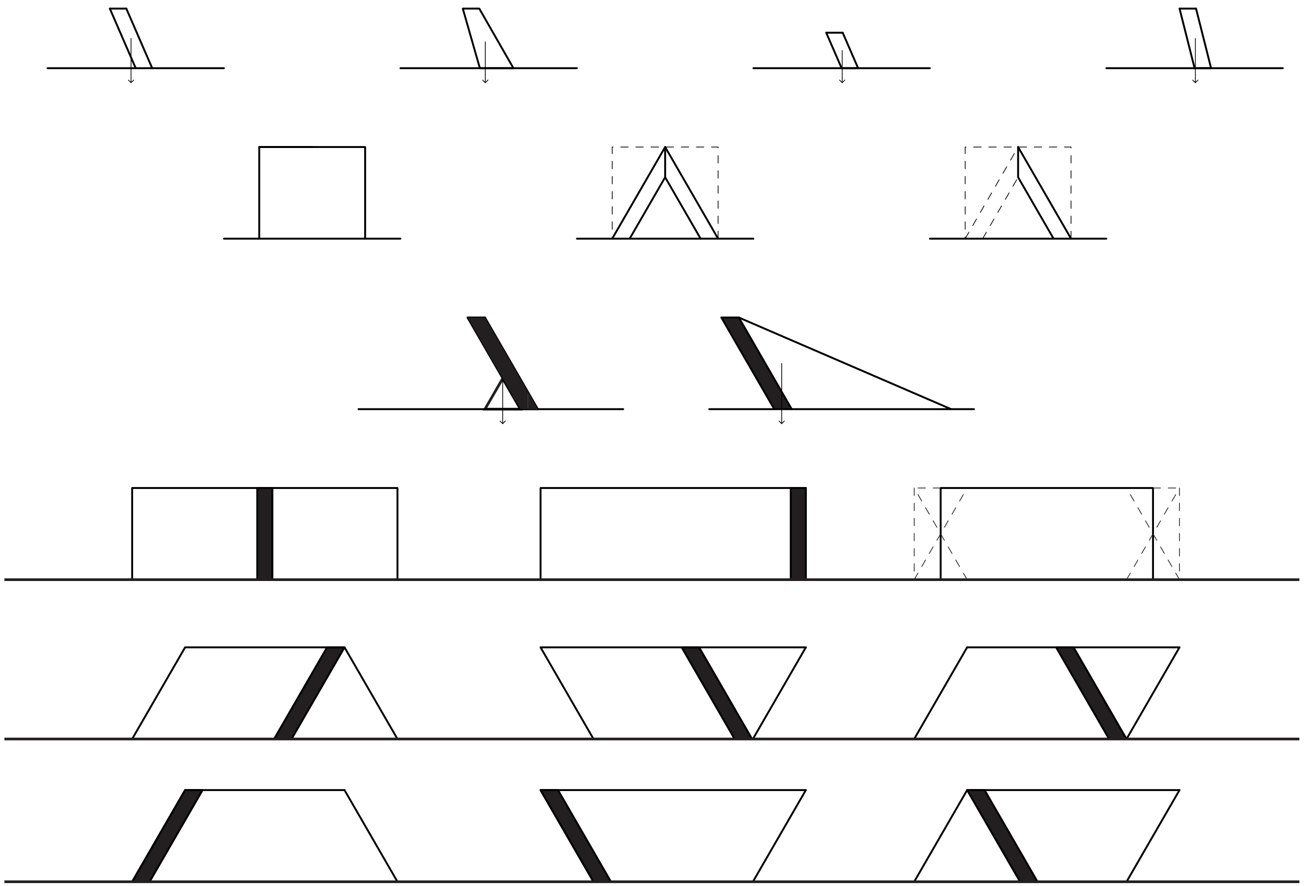
This question caught my attention and after some model experiments I started looking at two different methods of balancing a volume. An unbalanced volume could be stabilized by another volume supporting it's mass on the side where it's about to fall. The other option would be to stabilize it by another volume functioning as a counter weight on the opposite side.

With several free standing and structurally independent units, interesting space appeared in between them.


CENTER OF MASS
CENTER OF AREA
GOOD
BETTER
BETTER
UNSTABLE

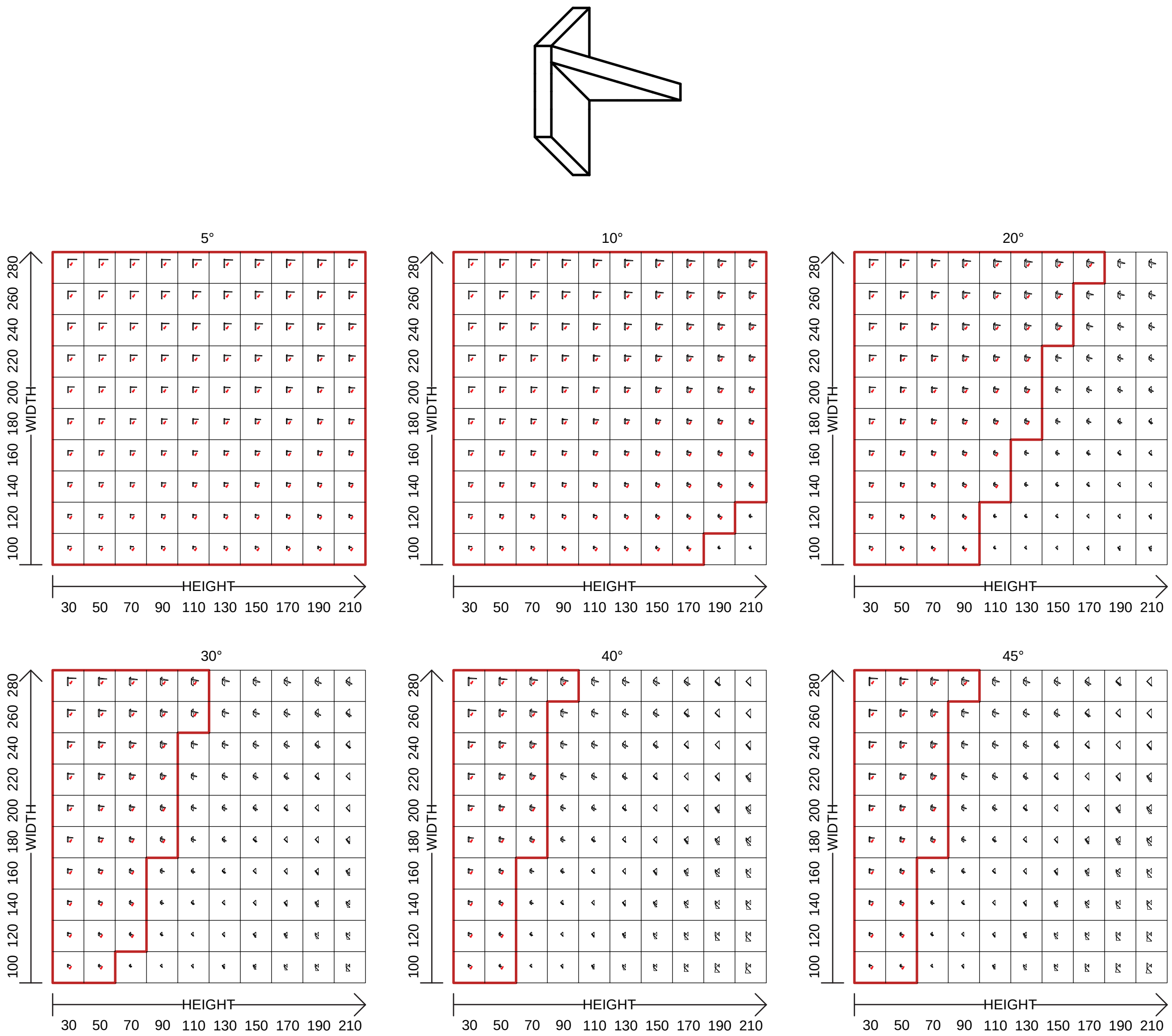
THE PHYSICS

In short, a volume is globally stable if it's centre point of gravity stays within the tipping point of it's footprint. A structures global stability depends on it's local stability and it was therefore of great importance to make sure local forces could transferred throughout the structure and into it's counter balancing part. This is ensured by clipping together the metal mesh of individual gabion cages as they are put in position and filled up with stones. To further stiffen the structure, metal beams divide the wall into segments. An important feature that neither gabions or metal beams are fixed into the ground. Each gabion wall is in balance thanks to the counter balancing effect of it's protruding tail.



THE BOUNDARIES OF BALANCE

The point of gravity can be lowered and pushed within the volumes footprint in different ways. The base can be widened, the height and inclination can be decreased. The diagram below shows how different shapes and volumes behaves when stretching it's proportions and angles. The red zone represents volumes that are globally stable. This experiment helped to visually the boundaries of when a volume is no longer stable and falls by it's own weight. The y-axis shows increasing height and the x-axis show increasing width. The different grids show different angles for the inclined wall. Eventually, it was the interior cabin space that determined the width of the structure. Height and inclination was then dimensioned to ensure stability. The final design is pushed to it's limits in terms of balance but leaves some marginal for forces caused by wind and snow since no calculations have been made on these kinds of loads.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WIDTH
HEIGHT
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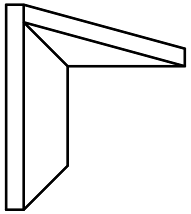
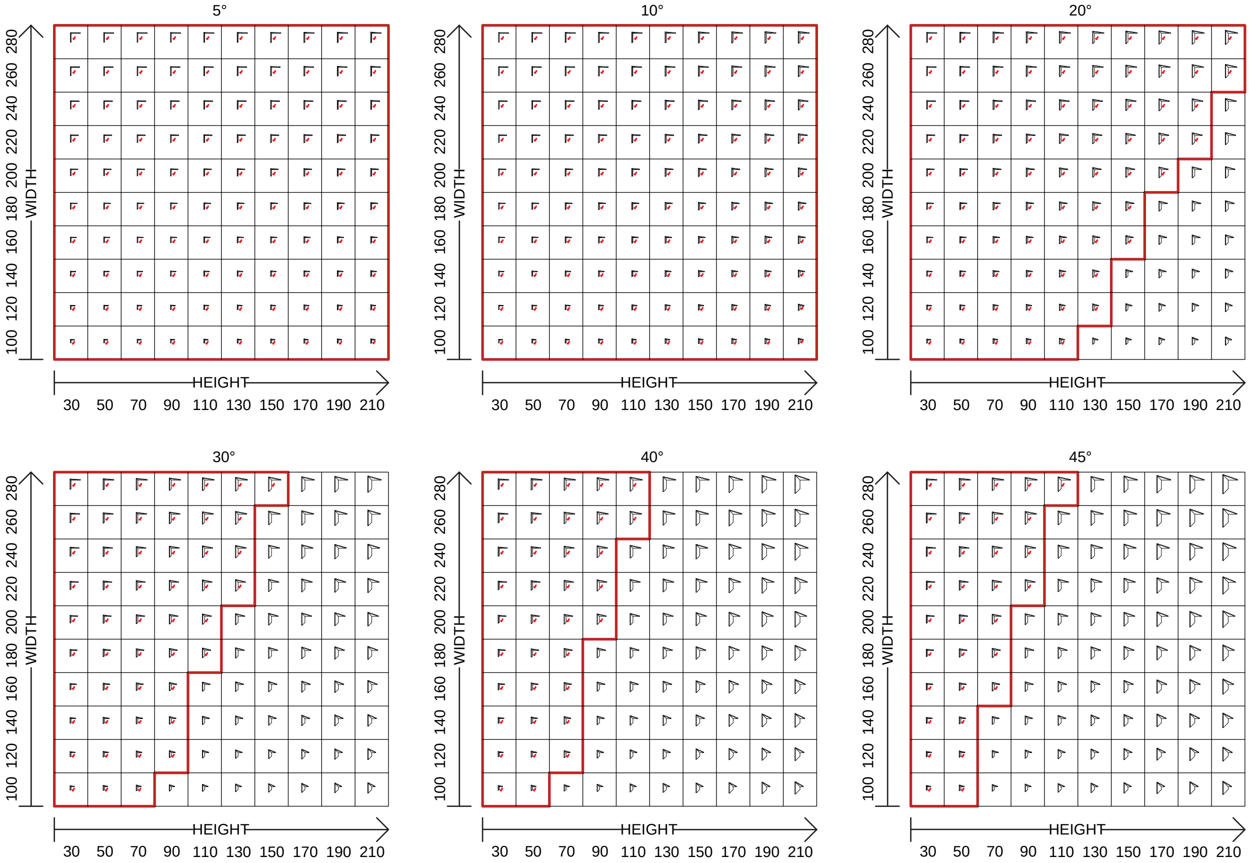
30 50 70 90 110 130 150 170 190 210

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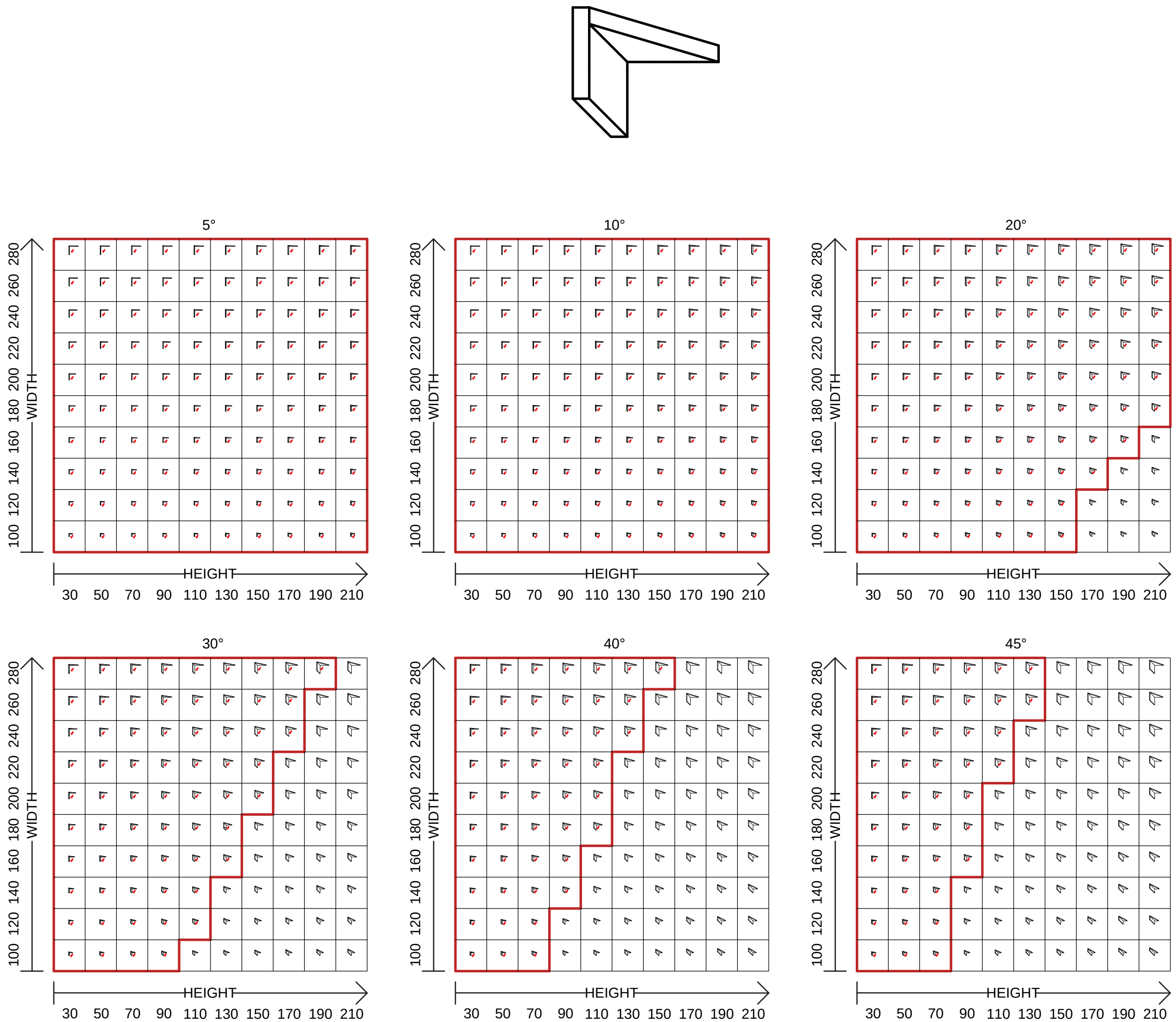

5°
10°
20°
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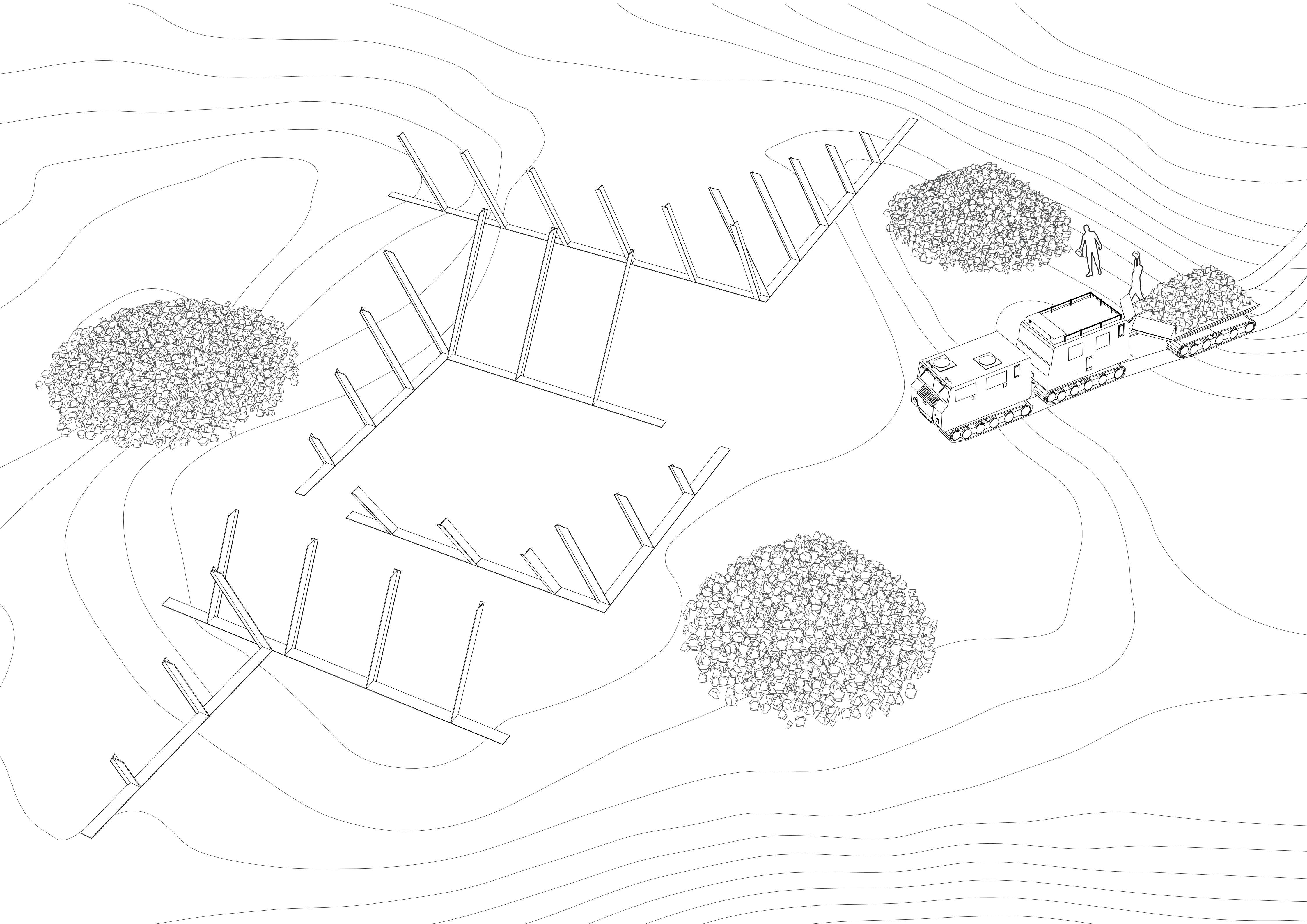
40°
45°
WIDTH
HEIGHT
100 120 140 160 180 200 220 240 260 280
30 50 70 90 110 130 150 170 190 210

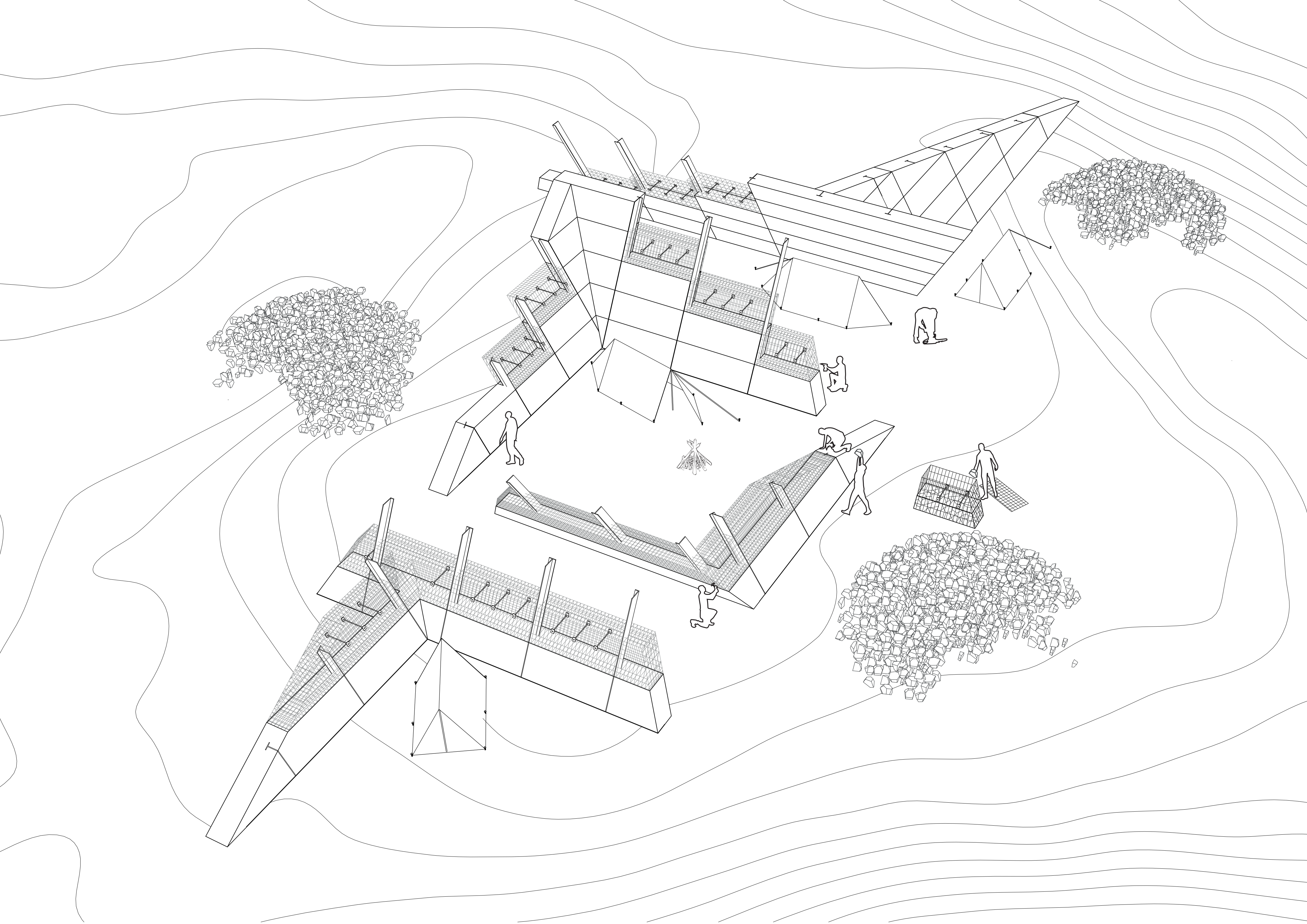
PHASE 1 - TRANSPORTATION OF STONE - YEAR 0

Stone from local region is gathered. The easiest and safest way to transport building material to the site without the risk of harming flora or fauna is during winter with the help of a tracked vehicle. Local stone from the nearby region is brought to the site and piled up in cairns. The decreasing size of these cairns will define the building process as much as the increase of the cabin structure itself. A structure made up of metal beams is transported in pieces and welded together on site. The purpose of these is to enable forces to be transferred more easily between individual gabion blocks.



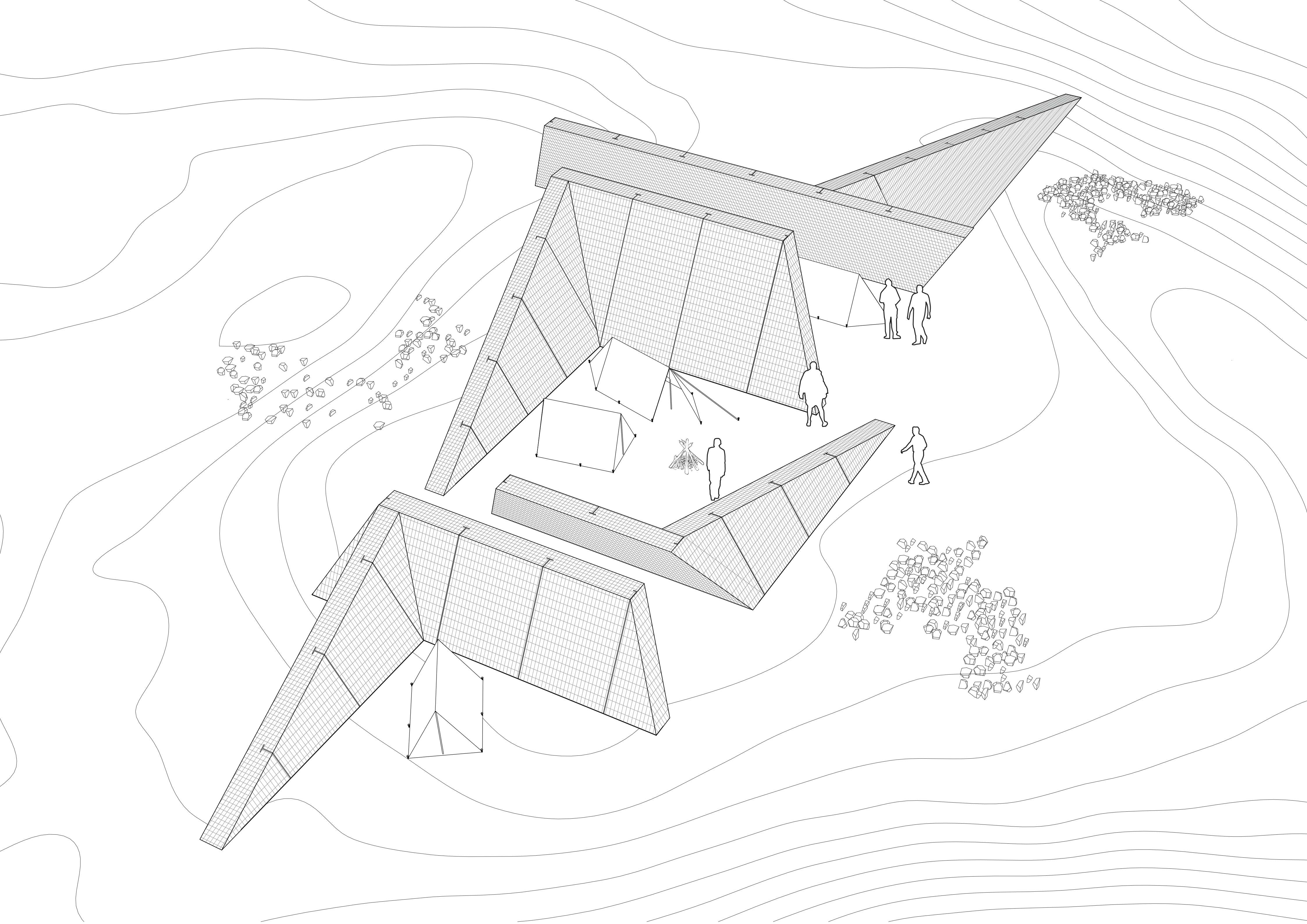
PHASE 2 - A SHELTER IN PROGRESS - YEAR 5

As years go by, more cages are put in position and filled up with stone. In a vast and flat landscape like this, any protruding object will serve as a wind shelter. During the years of construction, the structure itself will serve as a natural shelter and camping ground for hikers. The idea is that the collaborative building process becomes an attraction in itself and a reason for hikers in the region to pass this site and make their contribution by throwing a stone or two into the cages.



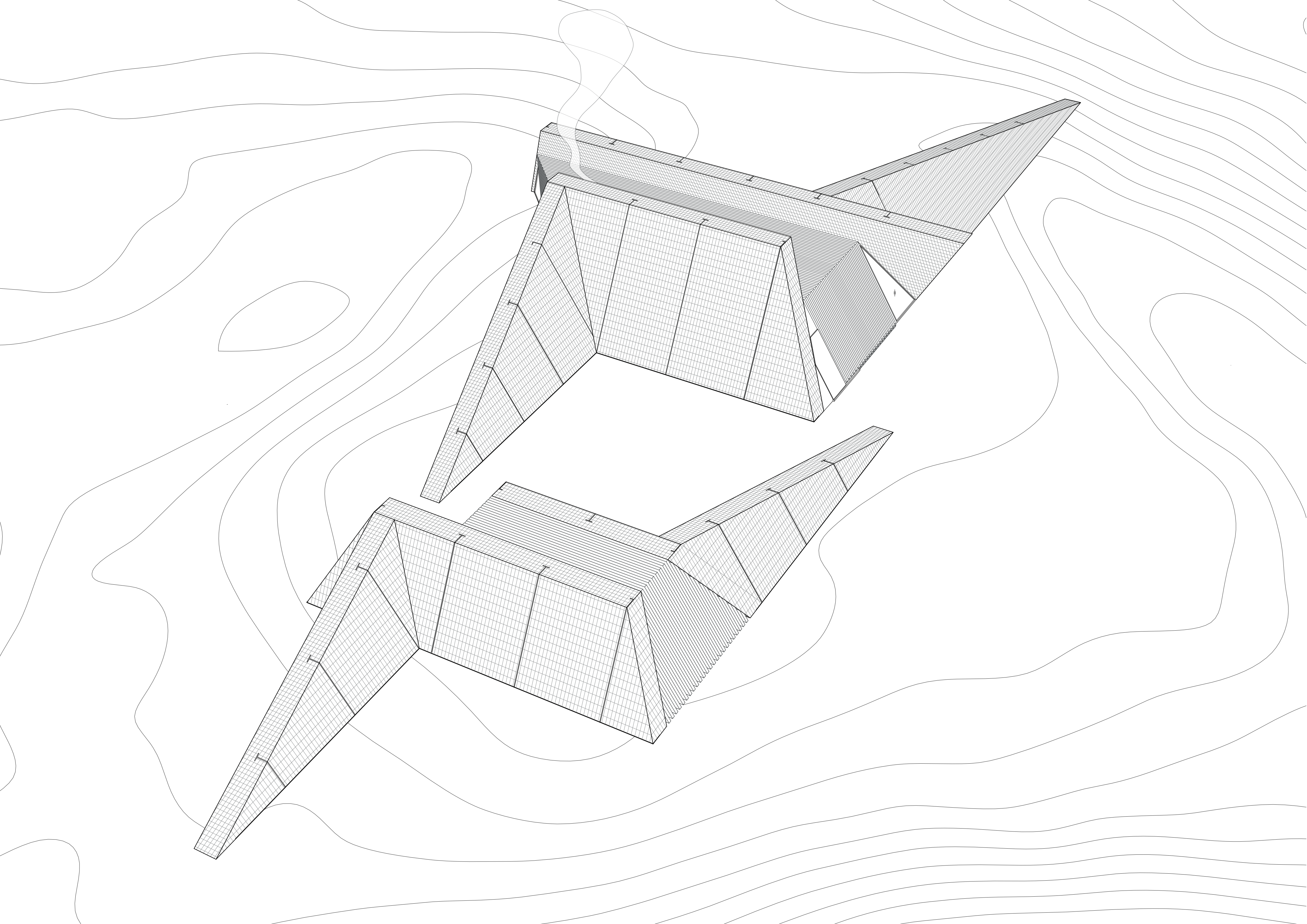
PHASE 3 - THE COMPLETED SHELTER - YEAR 10

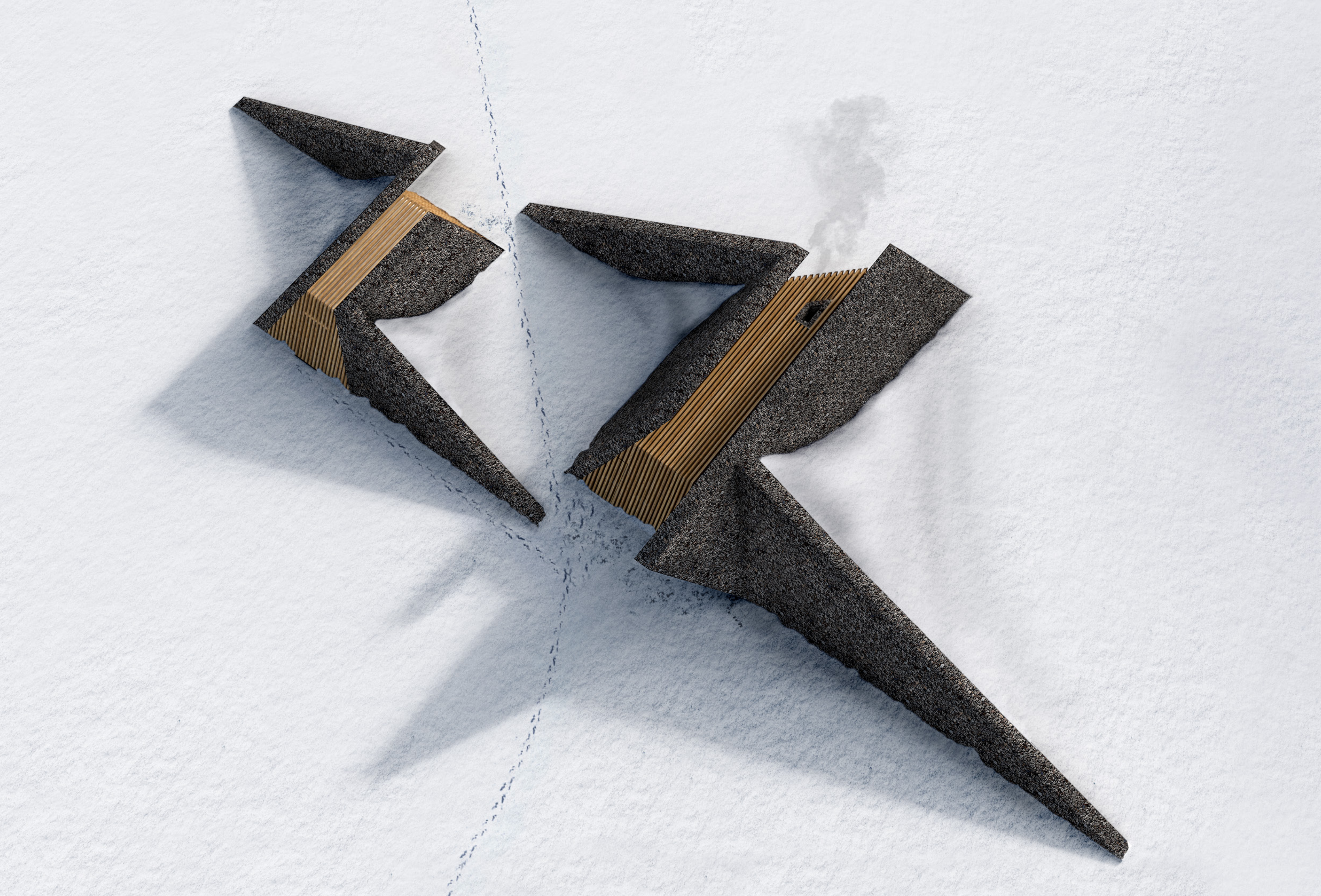
The time required to reach this stage depends completely on the future demand for a wind shelter. Tents are well protected when being set up on the lee side of the gabion structures. At this stage the structure has a mystic and almost unfinished feeling to it. A relic that makes no secret out of not being native to the landscape but with a final purpose unknown for many people passing by. Sleeping outdoors in tents or bivouacs during winter is not a hobby for everyone and it can be very challenging, especially during the colder winter months.



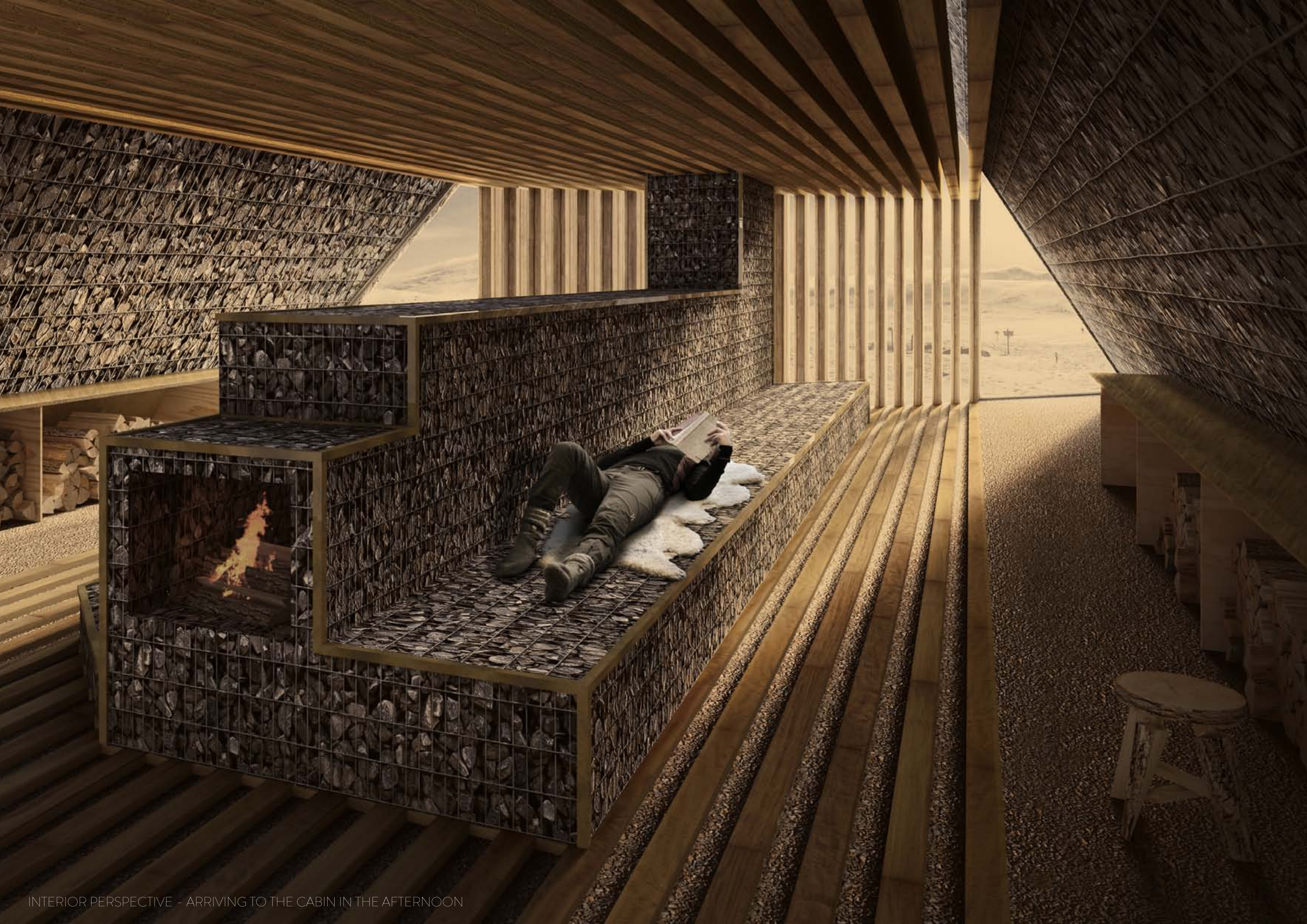
PHASE 4 - THE COMPLETED CABIN - YEAR 11

This stage is the exception to an other wise super-simple building process. This is the part of the story where life form finds the relic and adapts to the situation by inhabiting the space much like a hermit crab finding an empty shell. The interior cabin is supported by wooden frames that can be transported in pieces and assembled at site. It will be done by a building team during the snow free months of the year. Just like previous stages, this process requires no construction machines but some processes, like connecting prefabricated pieces correctly, requires skilled labour. Not all people would willingly sleep in a tent or bivouac outdoors during winter but with an enclosed space offering a sufficient level of comfortability, these people can now have access to the site.





AERIAL VIEW - FIRST SIGNS OF WINTER SEASON



INTERIOR PERSPECTIVE - ARRIVING TO THE CABIN IN THE AFTERNOON