ROBOTS, SHEEP, AND ARCHITECTURE

Graduation report
Studio Borders and territories
Main mentors: Filip Geerts/ Stefano Milani

Second mentor: Mauro Parravicini/Piero Medici

Niek van der Gugten
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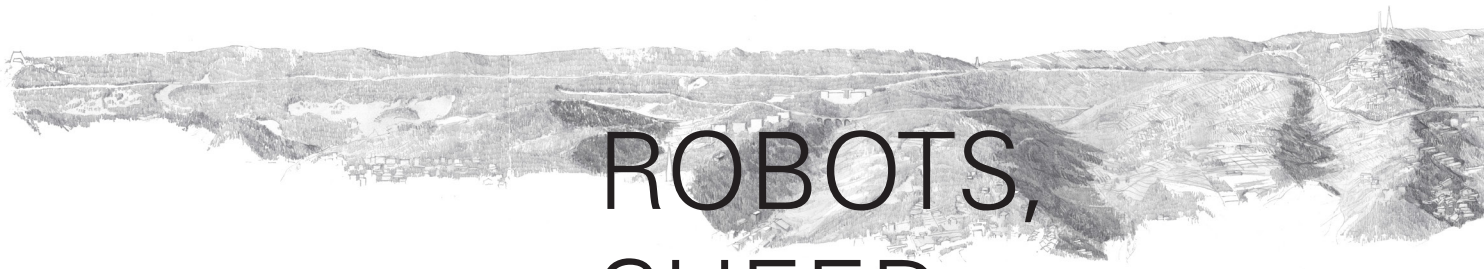
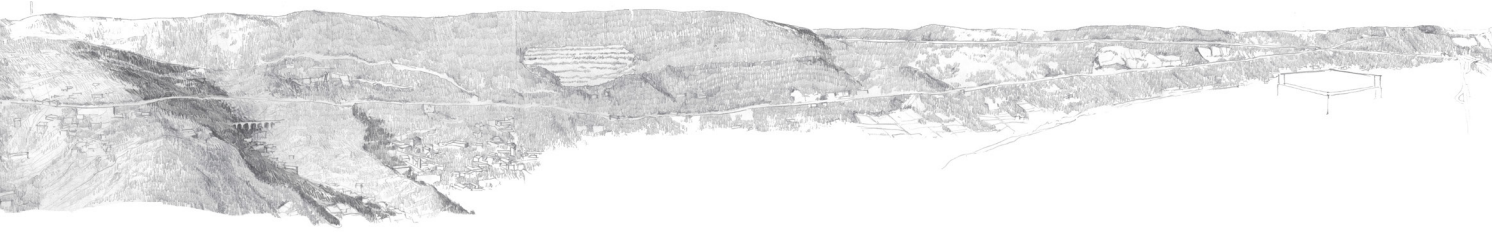


ROBOTS, SHEEP, AND ARCHITECTURE



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ROBOTS, SHEEP, AND ARCHITECTURE
introduction

The project focuses on Trieste, more specifically the classic karst plateau edging the city, capturing it between itself and the adriatic. Here, at a former practice terrain of a caserma, through robots, sheep and architecture, the semi natural grasslands once so familiar of the Karst re emerges.

The intention of the project is to revitalize the semi-natural dry grasslands and offer an exploration of an alternative for landscape maintenance. Instead of just planting trees, which can easily be the go to these days, it shows that it can also be done differently. Embracing the semi, of the semi natural, allows for an alternative that goes beyond the dualistic approach of nature and culture. With advanced technological developments,traditional techniques are revisited and improved, to alter and revitalise the territory, resulting in a more sustainable karst environment. Furthermore, the project offers a very direct relationship between the removal and placement of materials. Expanding on vernacular techniques, almost all the materials used are directly found on the site, and used with very limited displacement, and used without mortar or other fills.

The landscape of the classic Karst has been under continuous change. In the past two millennia, agriculture and the need for wood have led to deforestation, resulting in an almost treeless karst in the 19th century. Illustrated by the name given to the area, and subsequently the geological category, as karst means dry, stony land. The past 200 years have shown a turnaround, as the habsburgs actively intervened in the balance between the dry grasslands - resulting from deforestation and agriculture- and the forest. Regulations preventing grazing and further cutting of the forest were accompanied by replanting trees, starting in 1842. As this strategy proved successful, a reforestation act was adopted in 1885, which systematically regulated the process of planting black pines. The reforestation continued until the mid twentieth century. Now, as spontaneous forestation continues, mostly due to land abandonment, the karst is almost completely covered in forest. This has also resulted in the loss of geomorphic features such as the dolines. Without maintenance, the karst would be completely covered in a forest consisting of non-indiginious species.

Objectively, this might not be seen as a problem. Forests naturally support a greater biodiversity in comparison with dry grasslands, and have a stronger functioning ecosystem. It prevents soil erosion, as seen with the extensive agriculture. Furthermore, (spontaneous) reforestation is associated with ''rewilding'' and mostly regarded as something positive.

However, roughly a hundred years after the habsburgs tree planting initiatives, the outlook has changed. What was seen as a degraded landscape, is now valued differently. Tree planting using non-indeginious species is mostly seen as a bad practice, and the value of the dry grasslands is recognised; now an endangered and declining habitat in europe. Specifically the dry grasslands of the classic Karst have been recognized as a Natura 2000 habitat in 2004.The grasslands that have formed over time have become one of most diverse dry grasslands of Europe. These are semi natural grasslands and human made forms such as the dry stone walls have become an integrated part of it, functioning as habitat for a variety of species, preventing soil erosion and supporting microclimates.

Besides the objective value of these semi-natural dry grasslands, we might also consider its subjective value, as before the classic karst changed so drastically, these grasslands, human altered dolines and dry stone walls constituted its landscape identity. The aesthetics of the deforested karst was what gave it its name in the first place. Although a forest might be preferred, as a mere wild backdrop for trieste, to give its residents a whiff of weekend nature within a half hour drive, the semi-natural grasslands are an just as important part of the karst landscape, and worth maintaining. The remnants of this past, roughly two millenia lasting ''dry grassland identity'' should be preserved for future generations.

Acknowledging the grasslands as a vital habitat of the karst landscape and its identity, the project creates an alternative to revitalize the area. Specifically the project focuses on a former practice terrain from the military. With the use of landscape robotics, small topographical changes and dry stone walls will be constructed to enable indiginious species to re-emerge in the area. The architecture to support this strategy, utilitarian buildings as a hangar, sheep stable and shelter are built from the material gained by the excavations, aiming for a balance between excavation and erection, dug out and built up.

A WILD SIDE
The role of the landscape in our view of others

Culture vs nature

Take any dystopian movie or game from recent popular culture, and nature is depicted as something taking over the city. In The Last Of Us 2[1], Seattle, deprived of humans, has turned into a green and wild jungle. In I Am Legend[2], wildlife roams the streets of New york -although still hunted by the only man left alive. Not too different from these dystopian images, was Berlin after the second world war. On the ruins of the city, spontaneous vegetation began to grow, creating braches[3]. These images suggest nature as an opposite of the urban, and dominated by it. Nature seems to thrive only when human culture seems to fail.

This distinction between culture and nature, or urban and nature is nothing new, and can already be seen in prehistoric myths of mother earth and father sky, as well in Nietszche's depiction of the apollonian and the dionysian[4]. It has become a dominant distinction in western thinking. As a distinction alone, used as a descriptive or observational category, it is not directly problematic, but in western thinking it 'takes on the form of an oppositional dualism that implies unequal, hierarchical relationships between the relata.'[5]. As Plumwood argues, these unequal relationships necessary for dualism, are typical for domination and as such move past a descriptive realm into a prescriptive one. This idea of dominating the other makes the urban/natural dualism problematic for those others, both human and nonhuman nature, as they are depicted as requiring domination[6].

As such, the nature/urban dualism has been instrumental to rationalise morally questionable behavior towards nature and naturalised others. For example, when the European invaders set foot on the new world, they reference the immense beauty and sublime qualities of the North American landscape. The environmental purity of the landscape was shown in contrast with the corruption of civilised Europe, as to prove the moral superiority of the new world. Here the dualism construct proved to be limber, as it was simultaneously used to justify the conquering of the ''savage'' natural wilderness, and its inhabitants; the native americans, who were similarly described as savages.[7] These dualistic understandings of civilization and nature, or urban and natural have real effects on which spaces qualify as nature, or 'wilderness' as well as for those others that live within those spaces. How we view nature, and others who live within, and how we practise our relationship with them, is greatly influenced by this nature/urban dualism. This dualistic thinking has been as important in the image of the karst and its inhabitants.

The karst as barbaric

The karst plateau, bordering the adriatic on one side, the alps on the other, has always been seen as a place of the others. In 1910, the population was mostly Slovene, as opposed to Trieste, which had a large population of italians. Nowadays, the karst still cloakes the border between Italy and Slovenia as a frontier. Before the Austrian empire, the karst and the adjacent alps formed the border between ''civilised'' , mediterranean europe, and slavic countries.

1. Naughty Dog. The last of us Part II, game. (2019)

2. Lawrence, F. I am legend, movie (2007)

3. Gandy, M. Nature urbana, documentary. (2017)

4. Akkerman, A. Urban planning and design as an aesthetic dilemma. (2020)

5. Murdock, E. Nature Where You Are Not, (2019) p. 1

6. Plumwood, V. Feminism and the Mastery of Nature (1994)

7. Murdock, E. Nature where you are not (2019)

The opening in the mountain range facilitated passage for all barbaric invaders, from mongol tribes, to Alboin, king of the Lombards, and later Tito with his partisans. The natural environment of the karst, and the specific geological features: bare rock, caves and sinkholes, have aided in constructing an image of these lands and others as barbaric.

In my karst and my city, written in 1912, slataper plays with the myth of his barbarian origins as a way to set himself apart from traditional italian culture. Although he mentions his true origin as being raised in the Italian countryside, he 'would like to tell you that I was born in the Karst'[8]. The karst region, a natural untamed wilderness, functions as a site for barbarism, while the city functions as the opposite: 'Then I came here (Trieste), tried to tame myself, learned Italian, made friends with the most sophisticated young people'. Throughout his writing there is continuous dualistic vision between his karst and his city, between nature and urban. With it, the others, living on the karst are portrayed as barbaric, uncivilised people. This becomes even more apparent when he describes his journey from the karst towards the city, rolling down the mount Kal, or monte Calvo, at the edge of karst. During his journey towards the city, he stops and meets a slovenian peasant, who he describes as a mongol descendant.

'Mongol with hard, swollen cheekbones, like stones just covered with earth, dog with bluish eyes. Why do you stare at me? You stand there dazed, while they steal your arid pastures, those who are afraid of your bora. You have a barbaric soul'.[9]

Slataper merges the characteristics of the karst and its inhabitants, as both untamed, and within this constructed dualism, consequently, in need of taming. Later, he addresses the same peasant with: 'S'ciavo, want to come with me?....You came to land no one could inhabit, and you farmed it.'[10] S'ciavo is triestine dialect that denotes both slave and slav. He Invites him to the Italian fields, and appreciates his Slavian strength. The harsh terrain of the karst is recognised in the image of a strong barbarian, who is able to withstand the land and the bora. But at the same time, the Slovene is seen as inferior, depicted in the word ''S'ciavo". The natural/urban dualism produces both a romanticised primitivism where the wild can make you a man, as the idea of a lesser uncivilized nature.
Off Course the Karst is not the only reason for the negative image of the Slovenes, from an Italian perspective during the start of the twentieth century. Most notably, the irredentism of that time played a huge role in creating a superior image of the italians. Especially in Trieste, far enough from ''home" to elevate the myth of their historic civilization and national identity. Also the geographical positioning of the plateau has been historically the gateway for foreign (barbaric) invaders of the Mediterranean ''civilised" basin. But, it is also geological.

8. Slataper, S. My Karst And My City, (1912) p. 1

9. Slataper, S. My Karst And My City, 1912 p. 25

10. Slataper, S. My Karst And My City, 1912 p. 25

11. Morris, J. Trieste And The Meaning Of Nowhere, 2001 p. 131

12. Morris, J. Trieste And The Meaning Of Nowhere, 2001 p. 132

The karst as wilderness

'The permanent element of dissent in Trieste, though, Its immovable reminder of an alternative world of strangeness, harsh challenge, mystery and unconvention... the city's real zone of disorder is the Karst. ...even now it remains an antithesis of civic normality.'[11]

Jan Morris Describes the Karst as a wild side, a rough opposite of the city. Partly due to the placement of the border between slovenia and italy, but her description is largely based on its geological features; the rough rocky landscape, scarce in soil, scattered with holes and caves and underground rivers, ruled by a fearsome bora. The same features she recognised in the mendip hills, near Bristol. These hills, a karstic highland as well, induced a similar image of mystery and wilderness, lived in by wild beasts and outlaws.[12] Slataper describes the karst in a similar way. The specific geological features of Karst, provoke an idea of wild nature, more so than other landscapes. Perhaps this is why it is a popular backdrop for filming fictional, magical, barbaric worlds, such as Lord Of The Rings or Game Of Thrones.

The depiction of the karst as wilderness has been problematic in constructing the view of the others who live within the karst environment, or are associated with it. The concept of wilderness embodies the urban/natural dualism[13], and this dualistic thinking has resulted in viewing nature, or more specifically the karst as something separate, opposite from the civilized, human. With it, these depictions lead to a misunderstanding of humans who live in it. Seen as just as wild as the landscape, inferior and in need of domination, or strong and simple, induced by a romantic primitivism. Even more recently by Jan Morris description, the image of wilderness prevails. Furthermore, it dismisses the human activities that led to the current state of the landscape, such as deforestation, quarrying, pollution and soil exploitation. Although sparsely populated, the Karst has never really been a wilderness, without human interference. Even the name, meaning barren, stoney land is a result of centuries long deforestation. In our relationship with nature, the concept of wilderness and the dualistic thinking it embodies can be harmful. Beyond the nature culture dualism lies a better understanding of nature, its native inhabitants and our role in it.

11. Morris, J. Trieste And The Meaning Of Nowhere, 2001 p. 131

12. Morris, J. Trieste And The Meaning Of Nowhere, 2001 p. 132

13. Cronon, W. The Trouble With Wilderness, (1996)

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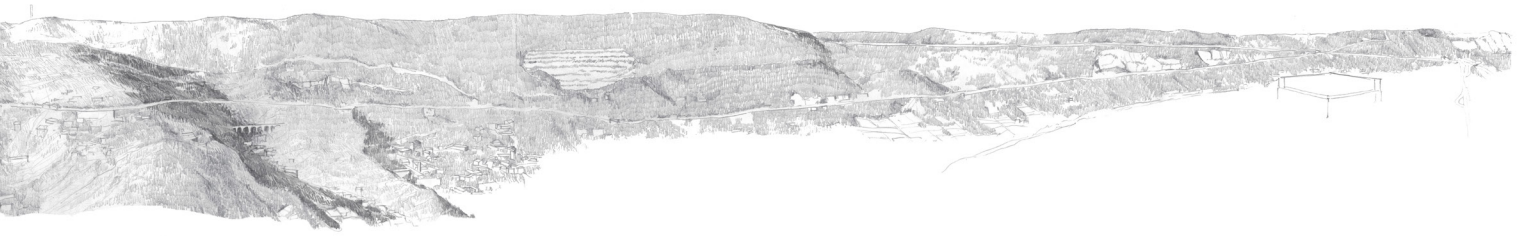
ROBOTS, SHEEP, AND ARCHITECTURE

RESEARCH



TERRITORY MAP

A territory between others

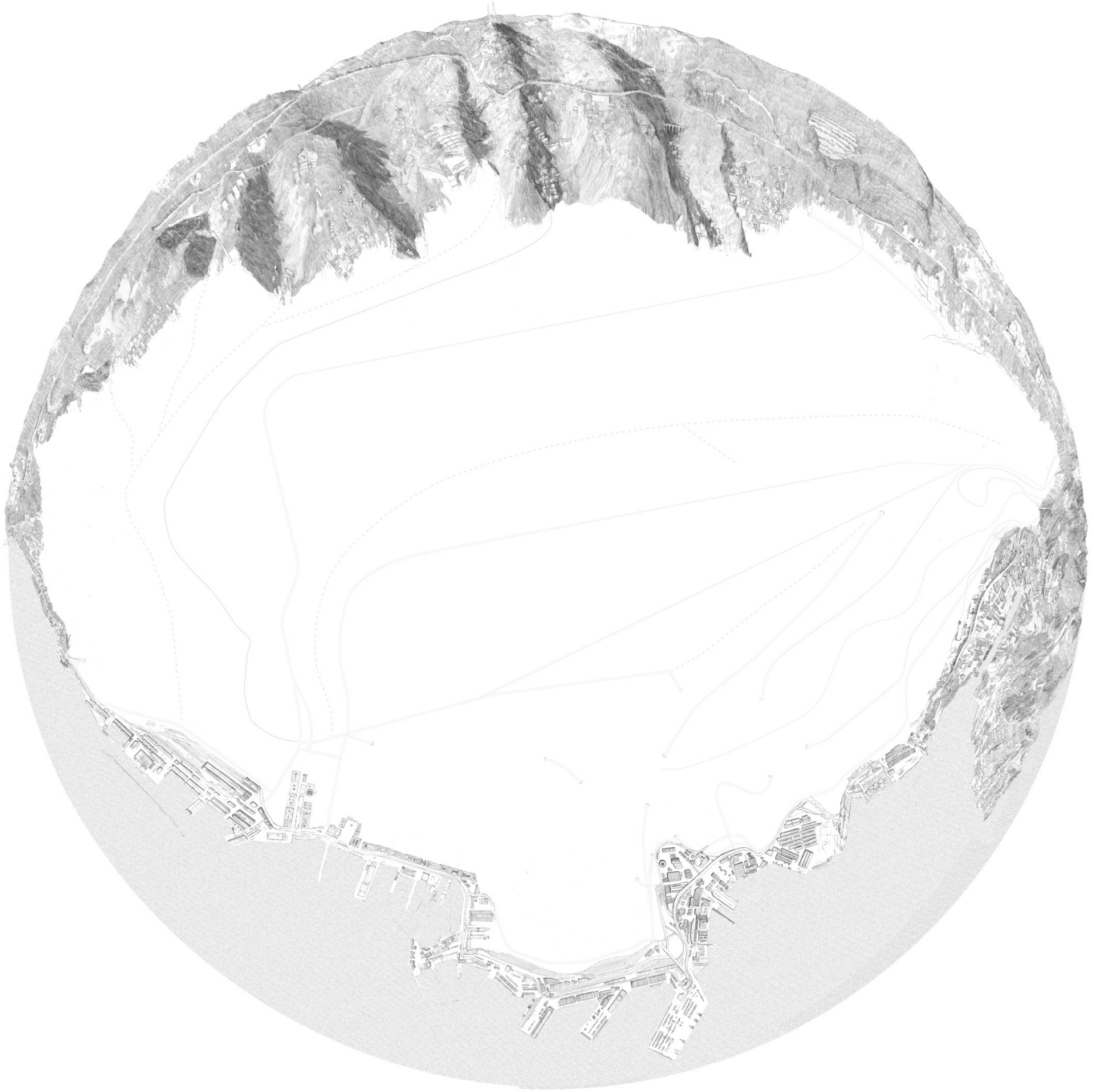
Trieste was founded as a minor harbor city by the Romans. The city which is enclosed by the Karst ridge and the Adriatic sea witnessed a great development after joining the Austrian-Hungarian empire. Trieste's role under the Habsburg empire was to be a port for Vienna. Before this era, Trieste was a provincial sea-town. Austrians' willingness in creating a port resulted in overcoming the difficult terrain of the Karst plateau and a railway connecting Trieste to Austria was created. As the port of Vienna, the city obtained great importance and caught the attention of the royal family. Trieste became the fourth largest city of the empire and developed itself to a cosmopolitan metropole. However, handed over to Italy, Trieste had no organic purpose. Centuries later Jan Morris describes the city as having "declined into torpor", the streets "half-empty", or as the demise of a "cosmopolitan project" (Morris, 2001).

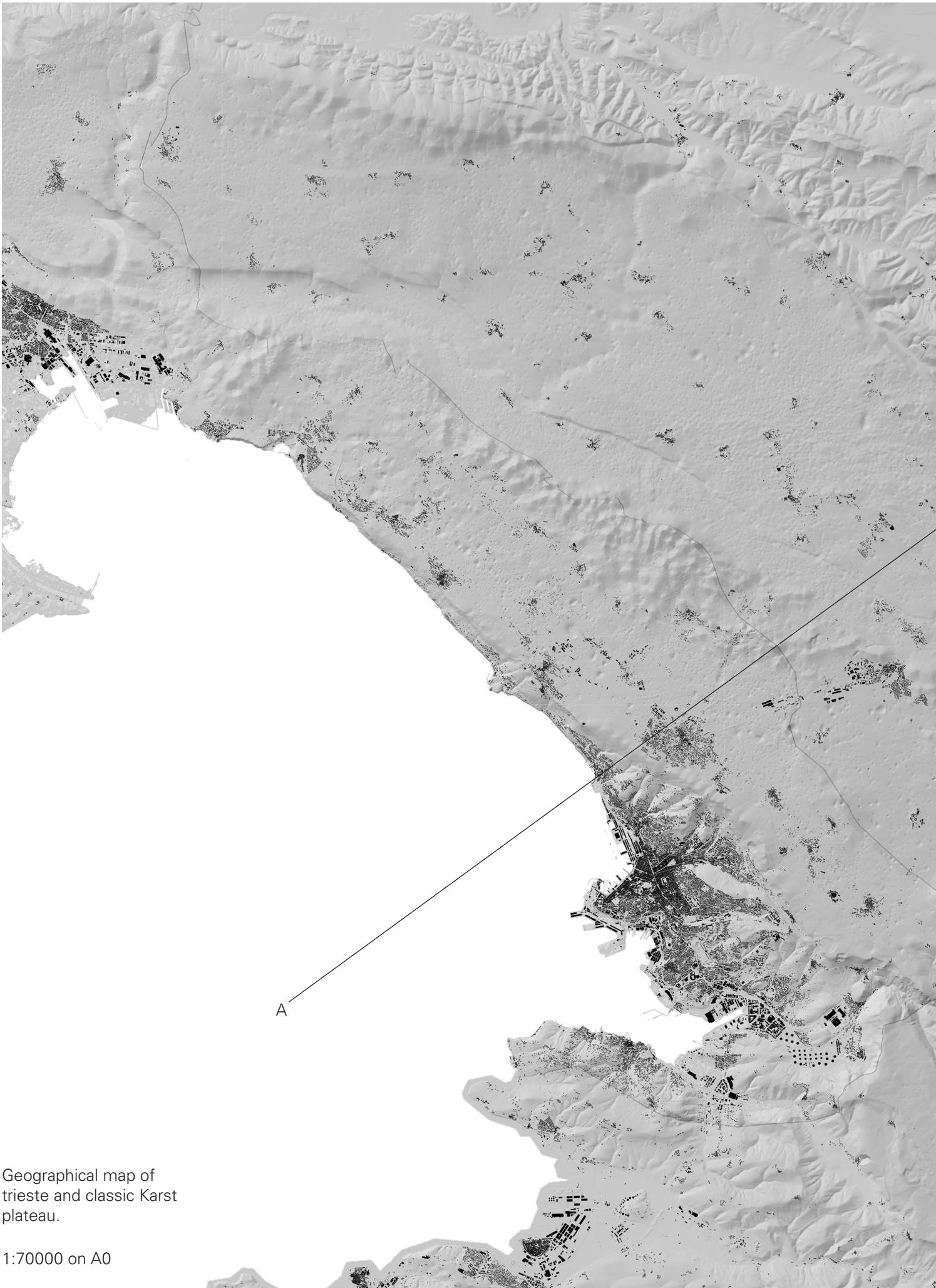
Being trapped between the past and the present, the Karst and the port and the negligence of the city and the development of the port. Trieste presents itself as a palimpsest, trapped in-between.

In the process of mapping and fragmentation and further through the excursion in the city, it becomes more evident how Trieste is a reflection of others. A city confined by its surroundings, the Karst and the Adriatic, between the Balkans and Italy. Finally this leads to a decision to leave out the fragments of the urban fabric, resulting in a suggestive mapping of Trieste only displaying the karst and the harbour, leaving the city as a void only readable by its surrounding fragments.

Handdrawn suggestive map of trieste as a void surrounded by karst and harbour.

printed on 1800x 1800mm





Geographical map of trieste and classic Karst plateau.

1:70000 on A0

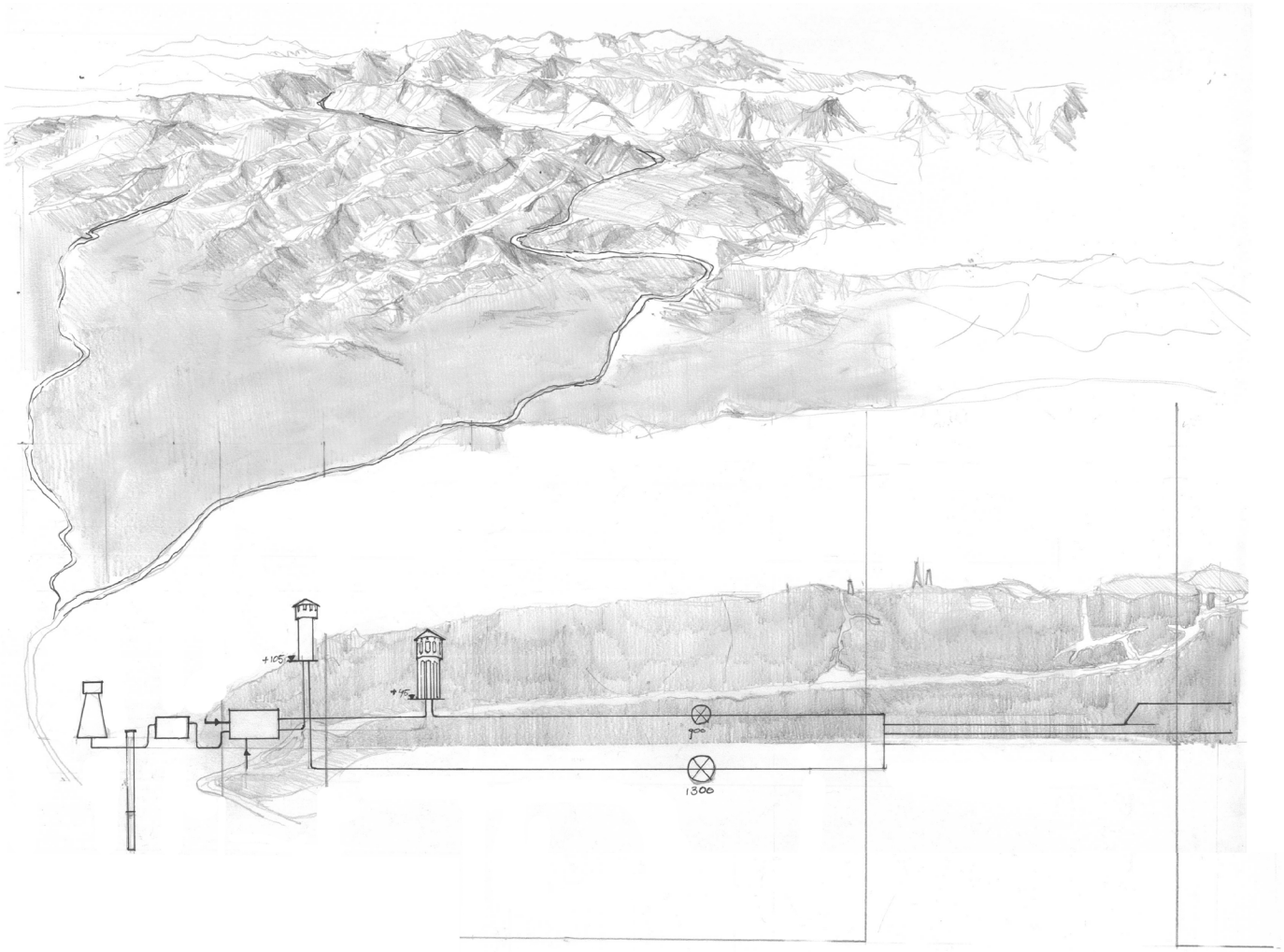
B

FRESH WATER SUPPLY
Survey

The fresh water supply for trieste and karst municipalities comes from far, showing the difficulty of retrieving drinking water from the karst area on a city scale.

The Romans already retrieved their water from far: the Timavo spring near Monfalcone. Here the underground river Reka resurfaces to quickly end up in the adriatic sea. When Trieste was under habsburg control, functioning as the ''harbor of Vienna'', it grew exponentially. A reliable source of fresh water supply was needed. This initiated the scientific research of the karst plateau, and its elaborate cave system. However, it was difficult to retrieve water directly from the Reka river, going underground at the Skocjan caves. The Austrians therefore ended up at the Timavo spring as well for their water supply. Nowadays, the water supply of Trieste and its Italian hinterland reaches even further. The timavo springs were too unreliable as a water source, and due to the hydrological functioning of the karst, susceptible for pollution. The timavo springs still function as part of the water system, but merely as a back up, not the main supply. The main supply became the isonzo river on the venetian planes. Here groundwater is pumped up and led to Trieste through two lines, one along the seabed, and one along the coastline. With use of piezometric towers, already used by the Austrians, the pressure for transport is maintained. For further distribution the water is pumped up to several reservoirs on high places that serve their surroundings, including the municipalities on the karst plateau.

hand drawn elevation on city scale and regional, explaining the water supply. printed on A2, 120g/m2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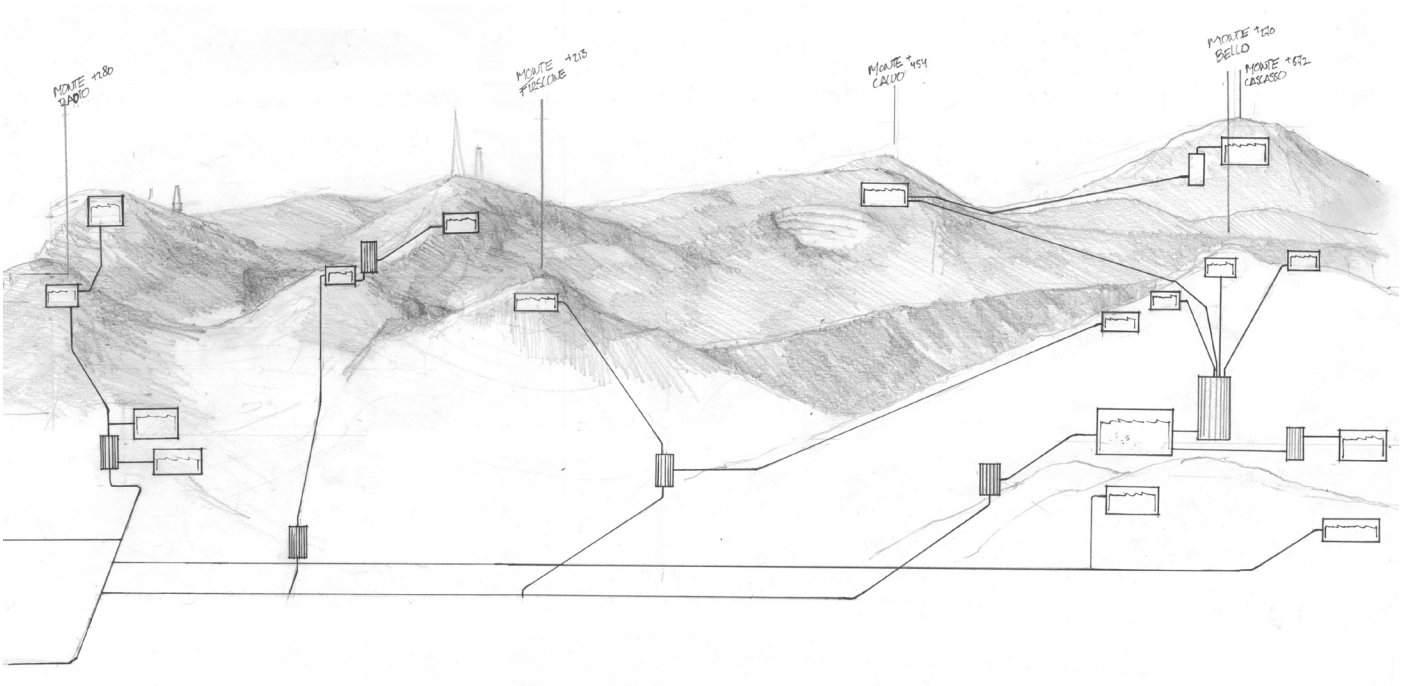

MONTE RADIO +780
MONTE FILETTONE +713
MONTE CALVO +454
MONTE BELLO +510
MONTE CASSASO +572

VIRIBUS UNITIS
Thing

The story of the dreadnought Viribus Unitis, the flagship of the Austrian empire sails through the contested history of Trieste. With this drawing the story is told through the reconstruction of the ship by retrieving the separated elements found in various locations connected to its history. Partly true, partly fictional, the drawing shows Trieste's contested history as a geopolitical slapstick and underlines the absurdity of a landlocked country (austria) as naval power.

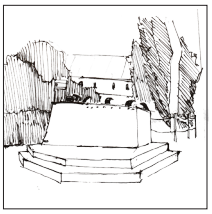
The SMS Viribus Unitis was constructed in Trieste as the flagship of the Austrian navy. Its name stems from Frans Joseph's personal motto: with united forces. It saw little warfare through its life, but played an important role in the start of the first world war. Franz Ferdinand and his wife Sofie traveled with the ship to Bosnia, and after their assasination their bodies were transported back to Trieste on the ship. The arrival of the SMS Viribus with the bodies of Franz Ferdinand and Sofie was the beginning of the end for the Austrian empire, as well as Trieste. The Ship was stationed in Pula, which replaced Trieste as a naval base. At the end of the war, the Austrians already recognised their defeat in october 1918, and the fleet in Pula was transferred to newly formed (neutral) Yugoslavia. However, reportedly unaware of this transfer, the Italians sank the ship in november 1918. Two men of the Italian army rode a primitive manned torpedo into the bay of Pula. They placed a canister of TNT with a timer for two hours later on the hull of the Viribus Unitis. Without breathing equipment, they had to remain above water and were imprisoned by Croatian marines occupying their new ship. They confessed to what they had done, and the ship was evacuated. However, they did not reveal the location of the bomb and as time progressed beyond the set timer, the croatian marines started to doubt their confession. The ship was repopulated, and the bomb exploded quicly after, sinking the ship in 15 minutes, killing more then 300 sailors with it.

section of viribus Unitus and its wreckage scattered through Trieste's history

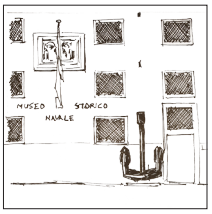
Printed on A2, 1:200

1. Graves of Franz Ferdinand and his wife Sofie Chotek. Artstetten Castle, Austria

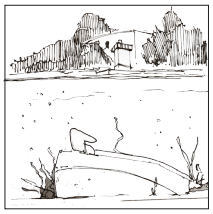
2. Hofburg Vienna, propeller



3. Venice, Hull of ship



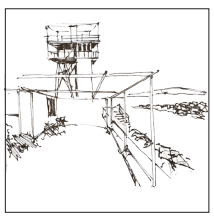
4. Venice, Anchor



5. Pula, Shipwreck

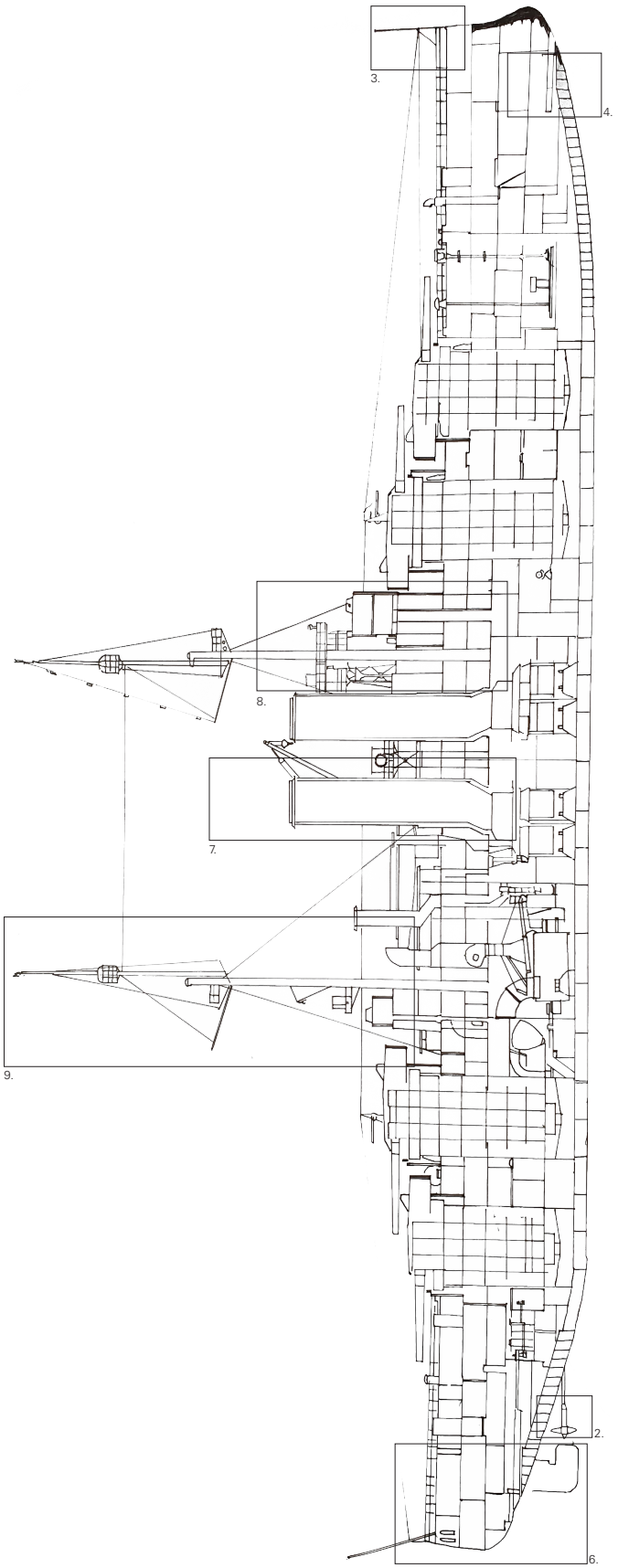
6. Pula, Graves of Croatian crewmembers

7. Trieste, Chimney



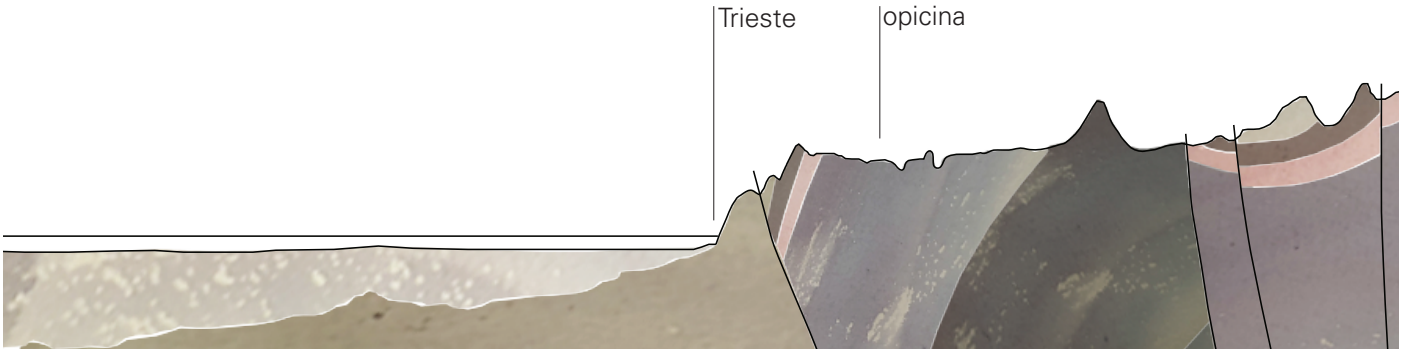
8. Trieste, Commando bridge

9. Nanos, Mast



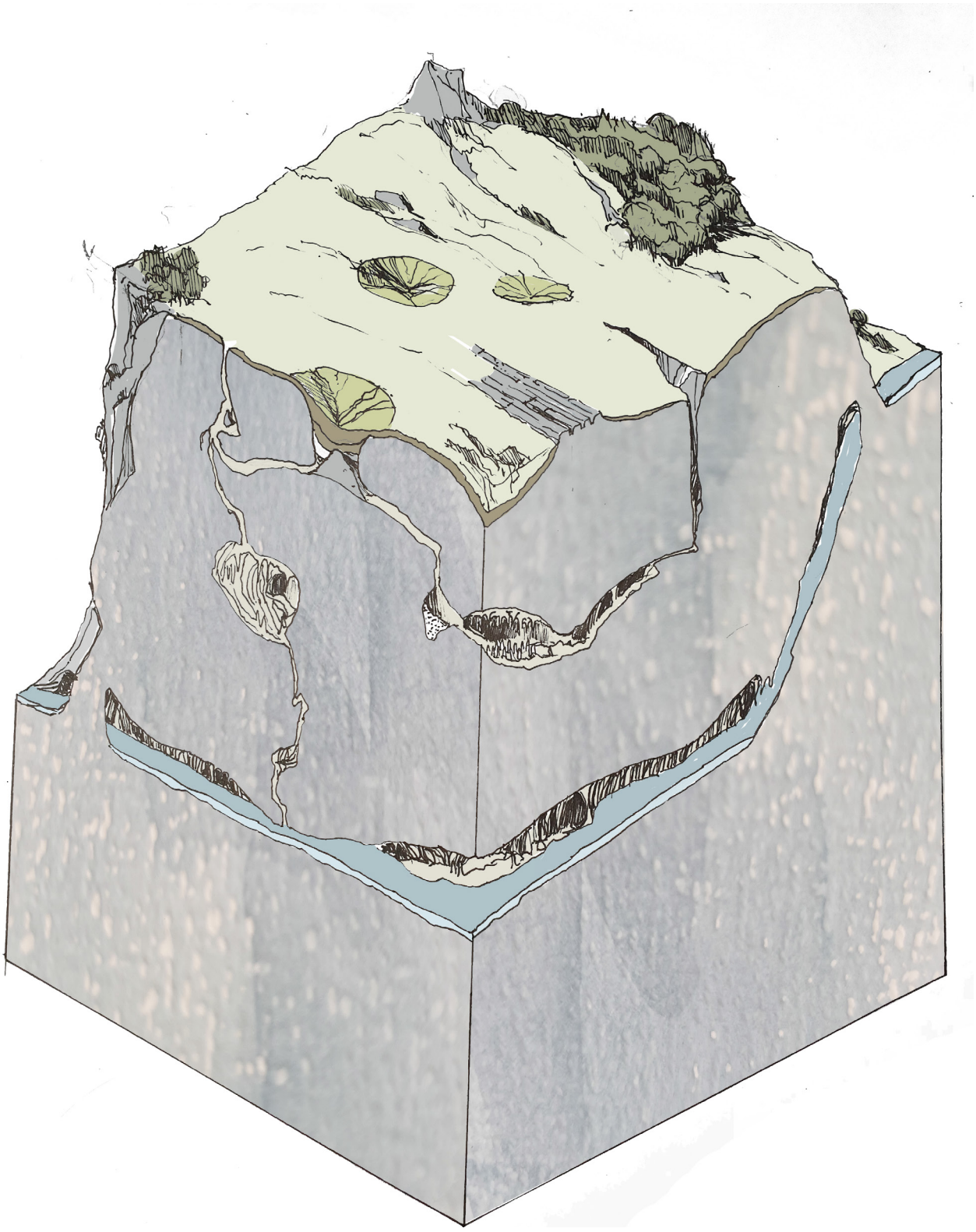
CLASSIC KARST
Survey

The first two drawings are made after a survey of classic karst plateau, located directly north of Trieste, in both Italy and Slovenia. The name given to the area, later became a geological category means dry, stony land. The geological layer of limestone is what makes the karstic landscape unique. Limestone dissolves through rain, creating interesting geomorphic features that are represented here. Both collapsed and solution dolines (sinkholes), Limestone pavement, caves and disappearing rivers and lakes. Created by both chemical and mechanical hydrological erosion. The soil layer is often thin, or completely disappeared. Only within the bottom of dolines a thicker, richer soil is cumulated, used for agriculture. Without a thick soil layer, water quickly trickles down through canals in the limestone layer. As a result, the classic karst lacks surface water.



Section AB of the classic Karst plateau from the Adriatic through Trieste.

- Marine sediment
- Flysh
- Alveolina limestone
- Liburcana limestone
- Aurisinia limestone
- Monrupino member



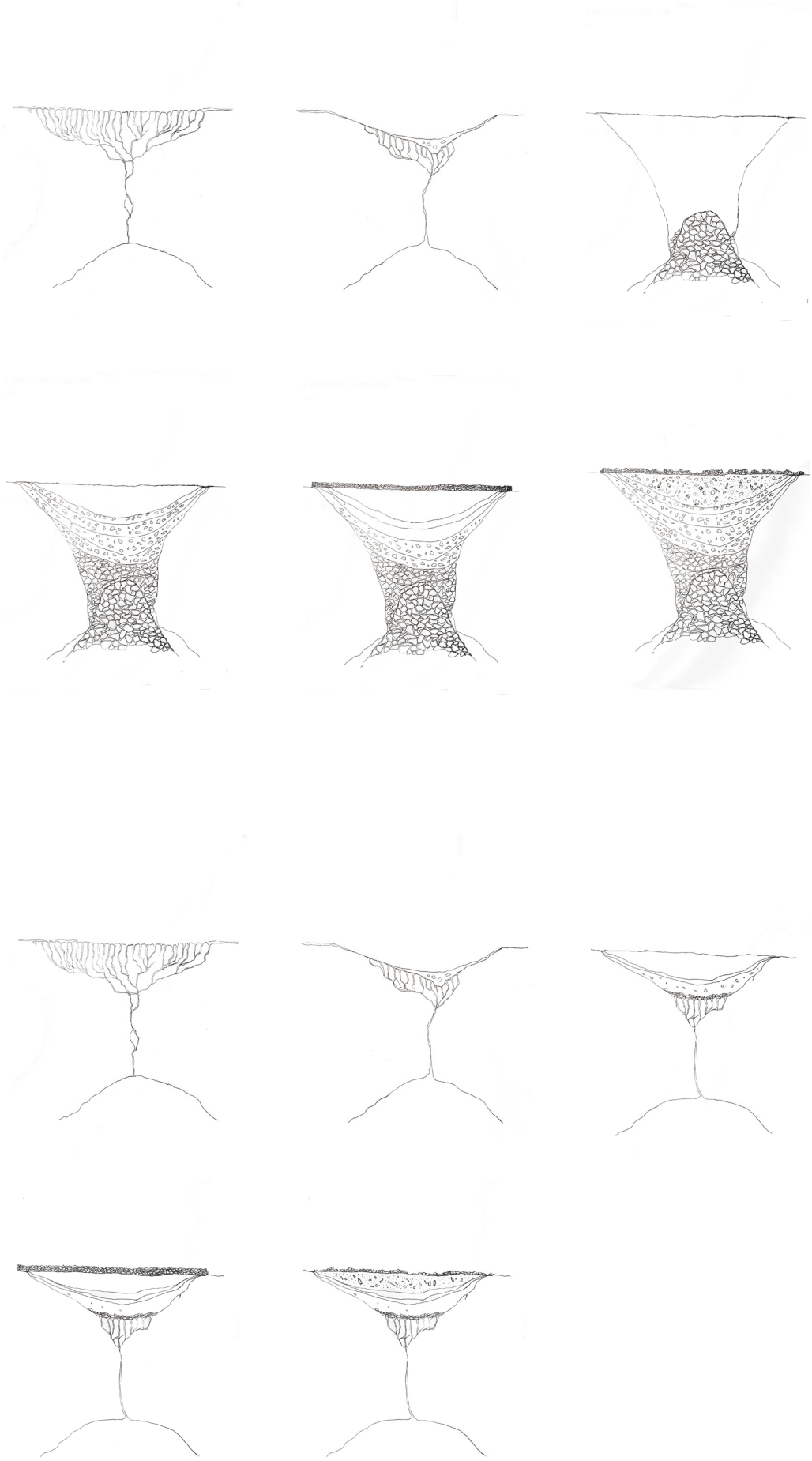
Hand drawing colored
with photoshop,
Printed on A2
120g/m2

CLASSIC KARST
Survey

This more impressionistic rendering of the karst landscape is a more subjective understanding of the landscape, its features and its landscape identity.

Here, the landscape is seen as a semi natural landscape, with integrated human alterations and structures. The harsh climate and thin soil layer has led to alterations of geomorphical features such as the doline. With small alterations and the natural presence of a thicker, richer soil (known as terra rossa), the dolines were used for agriculture. The immense presence of limestone rocks above and within the soil made stone clearing obligatory for further use of the land. The stones removed from the land were used in dry stone walls and shelters for shepherds. Starting as a byproduct of the land clearing for agricultural use, the walls have become an integrated part of the semi natural landscape of the classic karst, functioning as habitat for a variety of species, preventing soil erosion and supporting microclimates.

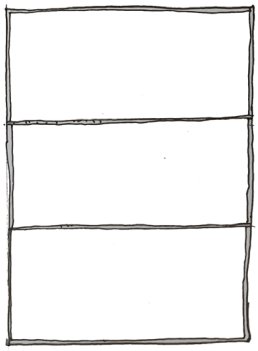
Acrylic painting of karst.
400 x 500 mm
300g/m2



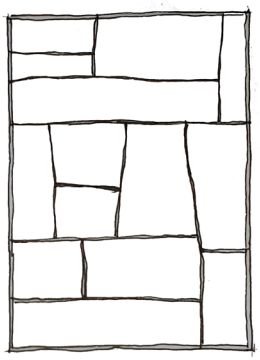
The life and death of a doline. shows the development of a two types of doline through time. At the top acollapsed doline, and a solution doline in the bottom

Waste dumping in doline, near Kriz village, Slovenia. source: Zega, M., March 2009

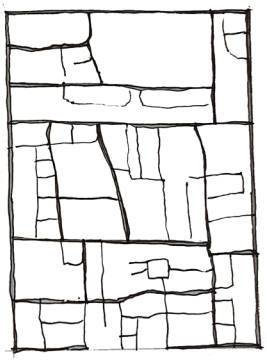
Remains of a mechanical excavated doline to extract furtile soil known as terra rossa. Source: Zega, M., March 2010



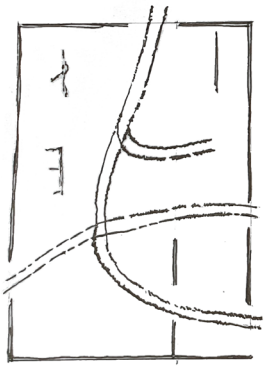
Interpretation of dry stone wall development. first walls are large, surrounding big rectangular plots, mostly used as pastures



walls are made inside the previous plots, as a result of an increase of administrive boundaries, due to the division of plots between numerious heirs



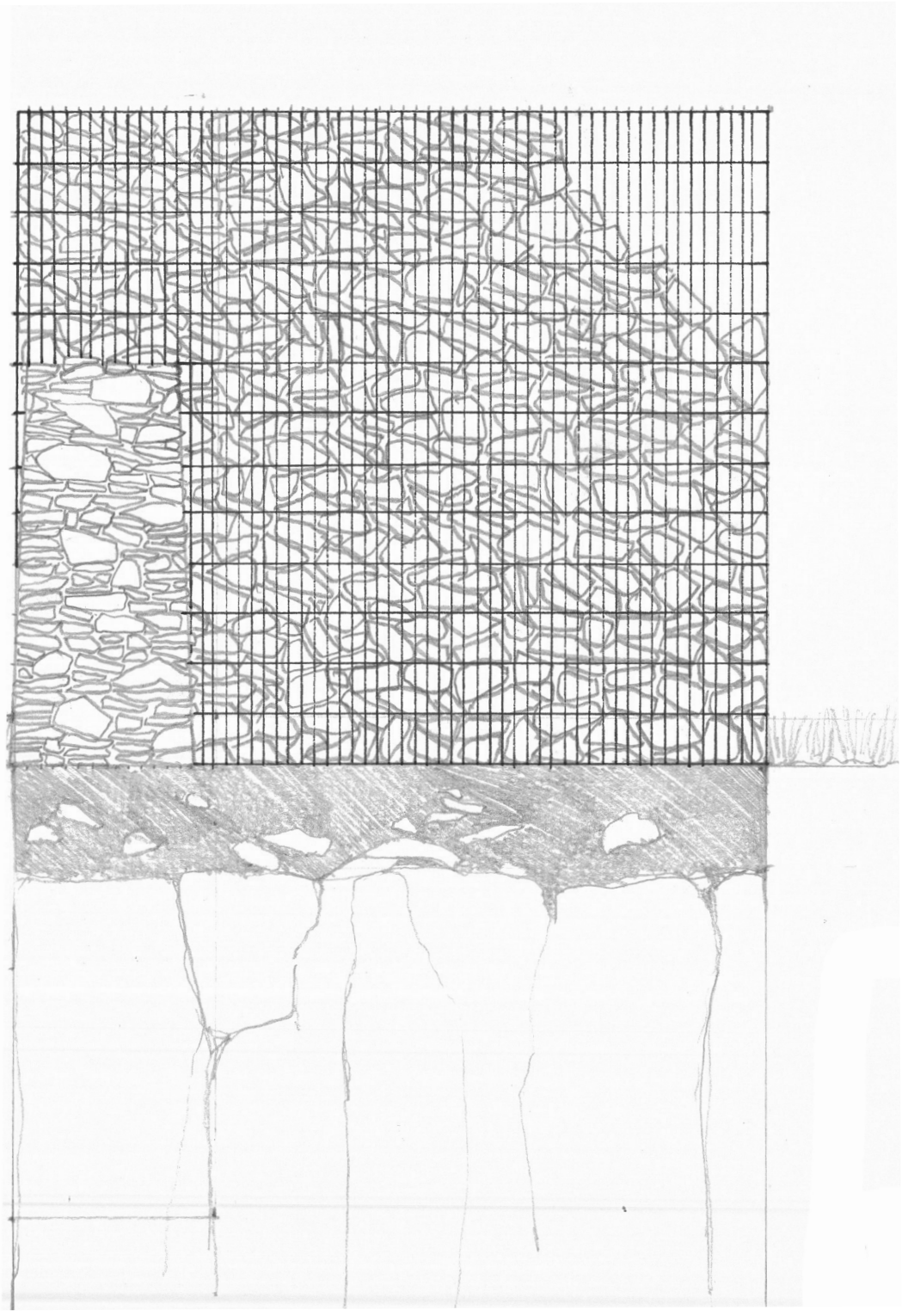
further fragmentation and stone clearing, resulting in even more walls. Changing the crops that are farmed has created a need for deeper soil and thus more stone clearing.



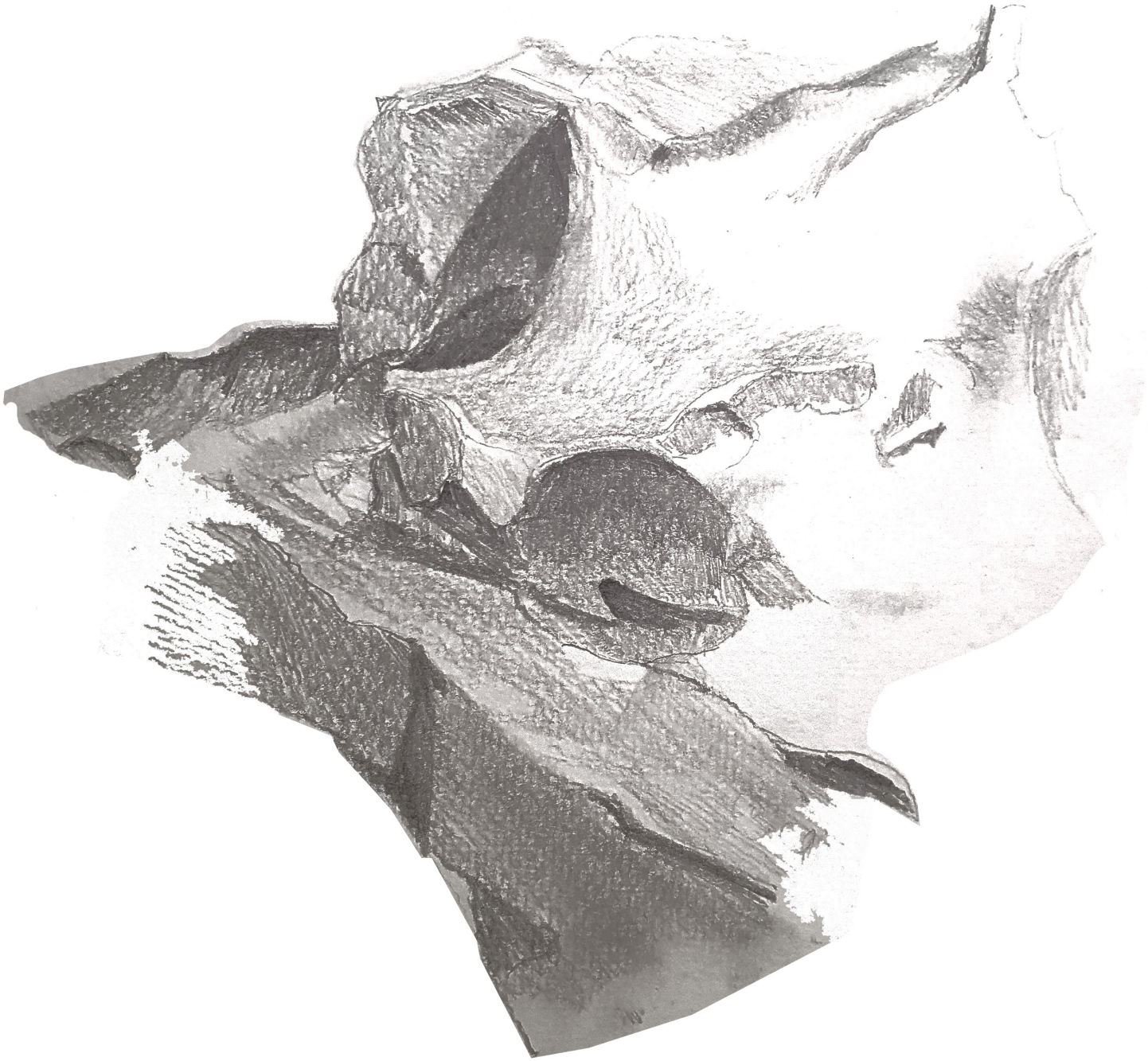
to allow agricultural machines to enter and work on the plots, walls have been destroyed. Or the walls have detoriated because the agricultural function has been lost, and the maintenance is labour intensive.

dry stone wall under construction, using a wooden construction for reference

Dry stone wall. The color of the limestone indicates the age of the wall. The yellow brown stones have been recently excavated, the grey stones have already been eroded top soil.



Limestone x three.
As found in the ground,
constructed in dry stone
wall, and contained.



Portrait of limestone. Underground, water creates soft edges and smooth surfaces.

Already during Roman times, Kras - meaning stony land- was already deprived of its once dense forest. in the first millennium B.C. it was a humid sub mediterranean forest, mixed, but mostly deciduous.

500

1000

1150

The town of trieste created laws to appoint forest guardians, and prevent goat breeding.

Deforestation intensified during the middle ages, as the forest was cut to create pastures, used for construction, for firewood and for charcoal and resin.

1320

The forest was further cut down to support ship building in Venice. in 1320 the Arsenale Nuovo was build, and the production peaked during the beginning of the 16th century

1771
the Duchy of Carniola (incorporating most of the Kras, parts of neighboring Pivka and Istria) introduced formal forest regulations

1500

Stone clearing was a continuous process on the karst, but accelerated during the 19th century, as sheepherding was changed to farming with cattle. This required good crops of hay, and therefore smooth pastures that could be harvested.

1851
formation of kras forestation society. active measures were taken, not the least because of the need of wood for shipbuilding.

1850-
deforestation came to a halt, as a result of switching to coal as main fuel and migration into town relieving stress on the countryside.

1881

reforestation acts for the region of trieste passed, followed by acts for Gorizia in 1883 and Istria in 1886.

1953
In 1953 goats were banned throughout the Dinaric Karst, including the Yugoslav part of the Kras

the reforestation projects were succesfull, but changed the forest to be dominated by black pines.

2000-
50 % of the Karst is now covered with forrest, which is mixed, but dominantly black pine.

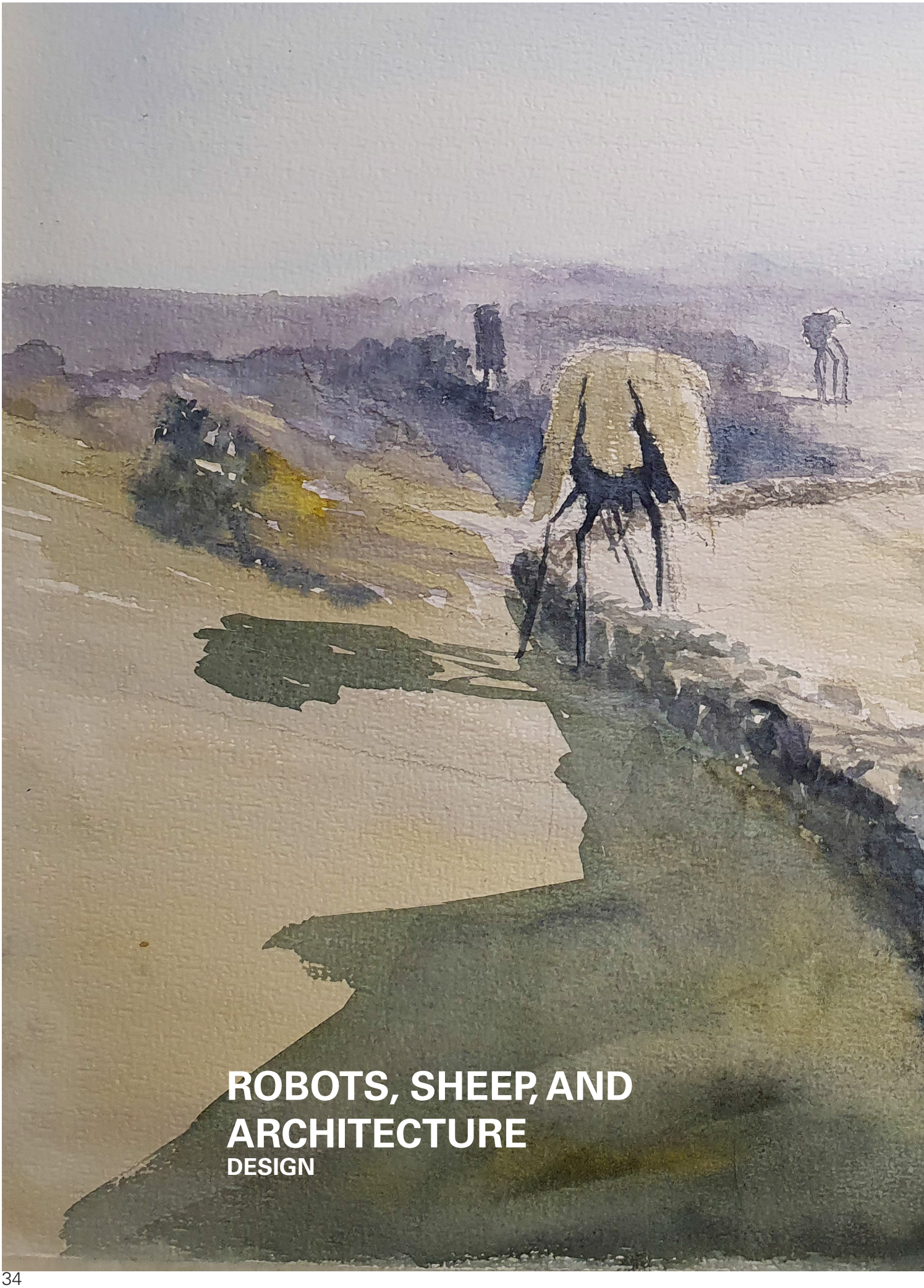
2000

CHANGING KARST
Survey

The karst has changed a lot over time. Already in roman times the Karst was known as a barren rocky area. This only continued further during two millenia. It was only in last hundred years that this drastically changed. Under Habsburg control, people grew wary of the depriving wood supply. As fuel, but as well to build the austrian fleet. a large aforestation plan was set up, and eventually executed, starting from 1854. In 1923 95.000 black pines, 5.000 elm, 4.000 sofora, and 1.900 other vegatation were planted, only to be followed by more.

However, roughly a hundred years after the habsburgs tree planting initiatives, the outlook has changed. What was seen as a degraded landscape, is now valued differently. Tree planting using non-indeginious species is mostly seen as a bad practice, and the value of the dry grasslands is recognised; now an endangered and declining habitat in europe. Specifically the dry grasslands of the classic Karst have been recognized as a Natura 2000 habitat in 2004.
Besides the objective value of these semi-natural dry grasslands, we might also consider its subjective value, as before the classic karst changed so drastically, these grasslands, human altered dolines and dry stone walls constituted its landscape identity. The aesthetics of the deforested karst was what gave it its name in the first place. Although a forest might be preferred, as a mere wild backdrop for trieste, to give its residents a whiff of weekend nature within a half hour drive, the semi-natural grasslands are an just as important part of the karst landscape, and worth maintaining. The remnants of this past, roughly two millenia lasting ''dry grassland identity'' should be preserved for future generations.

Tree planting initiative 1923. photo retrieved from https://www.gssg.it/



ROBOTS, SHEEP, AND ARCHITECTURE

DESIGN

LOCATION
Site

The drawing shows a height map of the site used as starting point for the project. On the edge of the karst plateau near the village of Trebiciano. Just behind the hill, invisible from the city, but only a couple of kilometres from the adriatic. The site consists of a former practice terrain of the caserma, and the former caserma itself. The caserma has been abandoned and has fallen into decay. Most buildings still remain, but in poor condition. Large hangars for the tanks have disappeared, leaving behind large slabs of concrete, and the remains of its foundation. Through the use as a practice site the soil layer has been reduced to low quality and thin amount. The site offers an interesting starting point with two distinct conditions: the ruins of the caserma as a non-natural site and the practice terrain as a heavily damaged natural environment.

The former practice terrain is still deprived of trees, allthough you can see the tree line already creeping up. Ideal as a starting point, keeping the trees cut to a minimum. allthough the grassland needs a reduction of the forest, it is not the intention to erase it completely. Both can exist together.

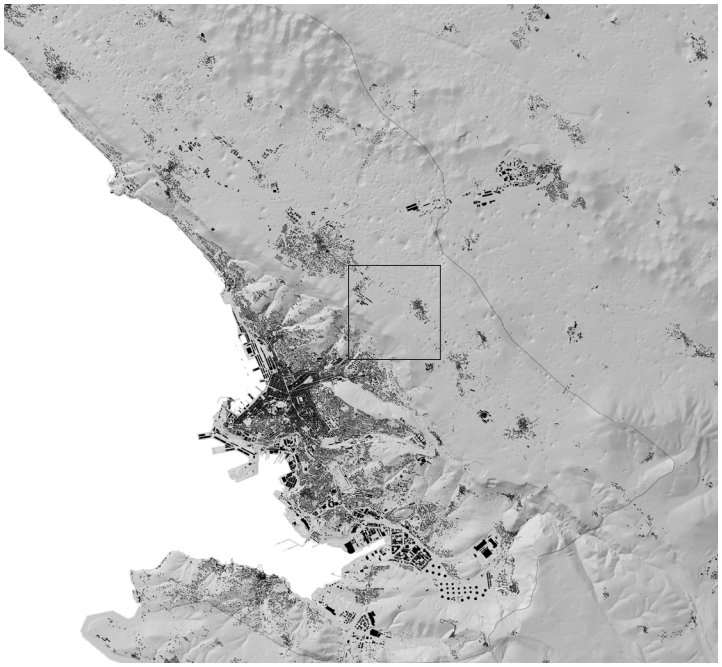
Furthermore, the former function provides an interesting contrast in the position of the machine. Where the war machines literally scared the ground, now they provide healing.

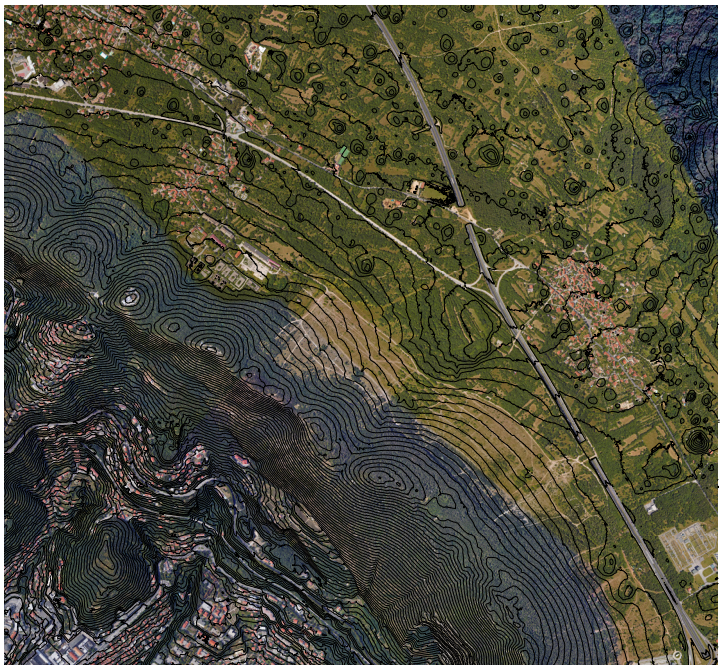
Geographical map of trieste and classic Karst plateau.

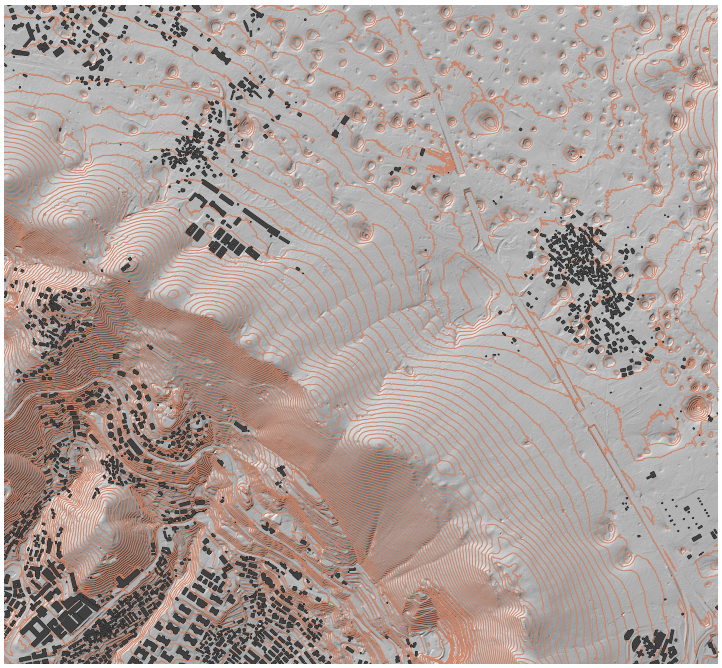
1:70000 on A0

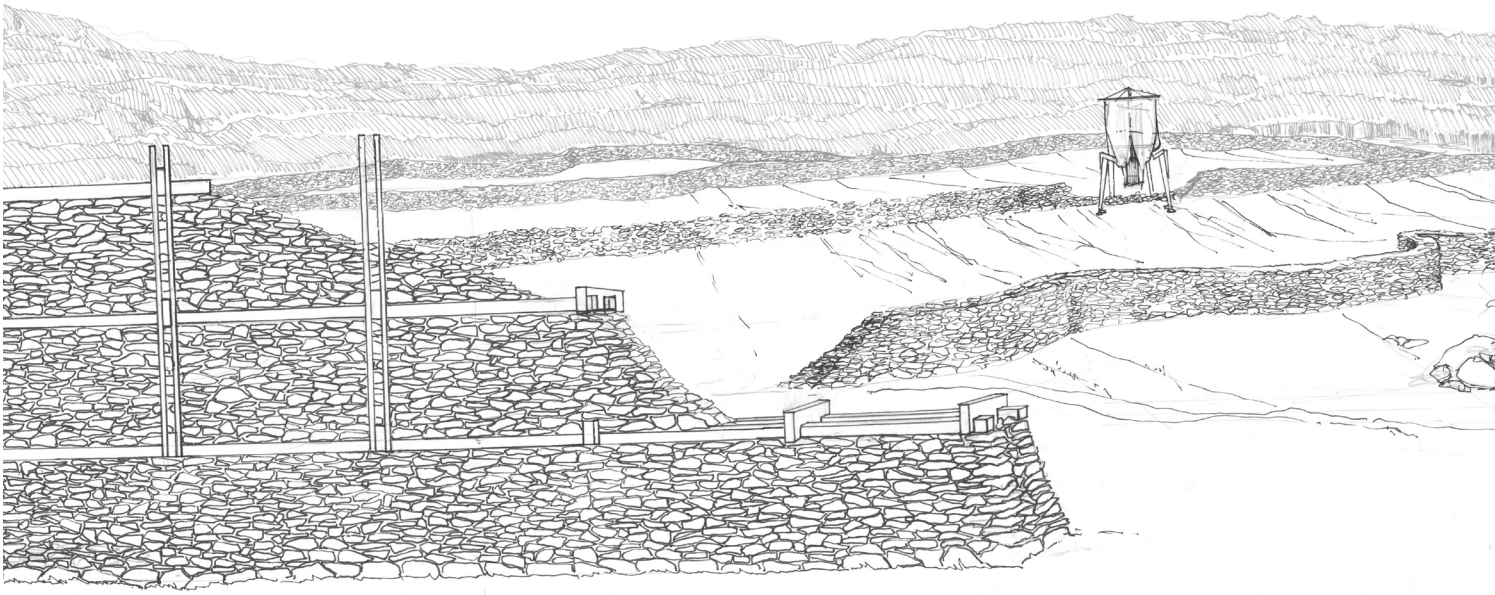
Google earth view with heightlines of location, 1:10000 printed on A2

Heightmap of location, revealing the many dolines of the area 1:10000 printed on A2

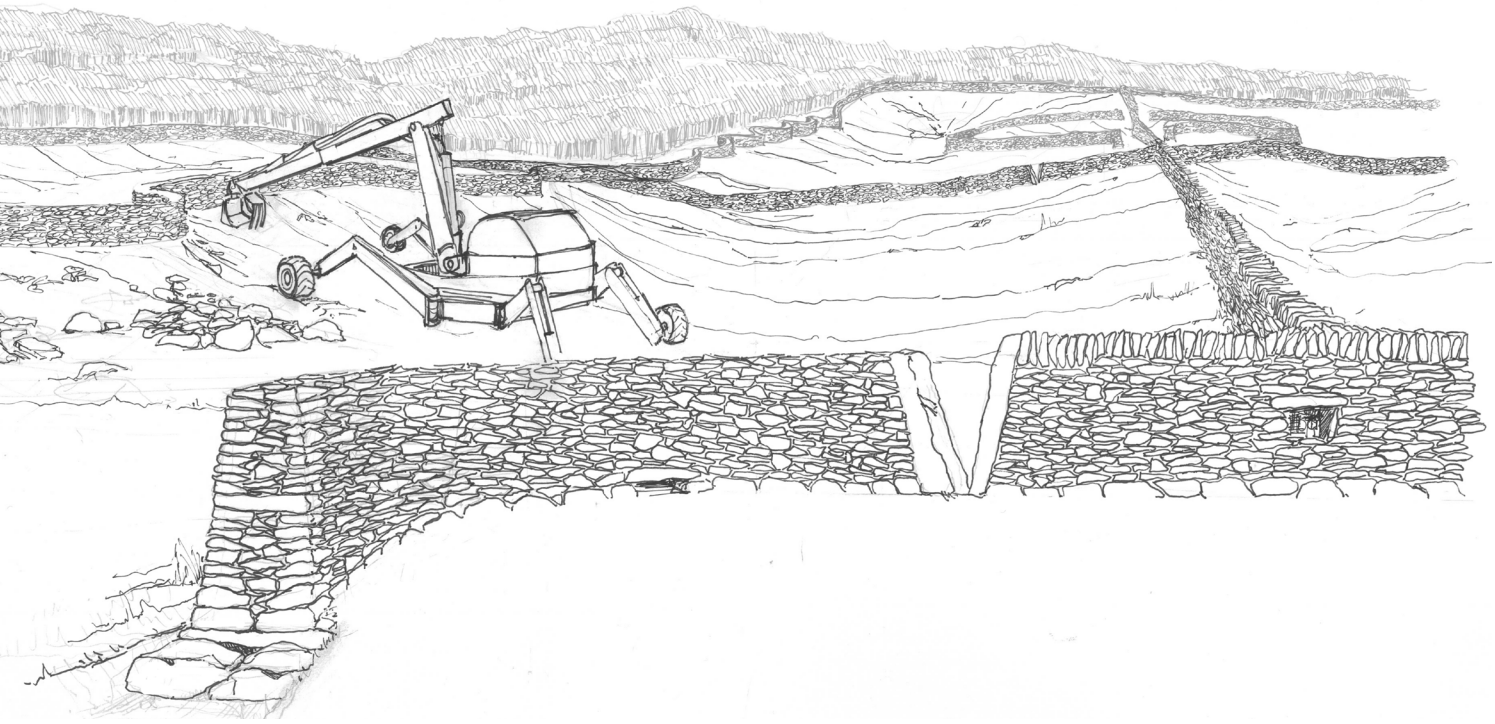








hand drawn example of the machines at work, excaviting and building walls simultaneously. Showing wall building techniques for both structural and landscape walls



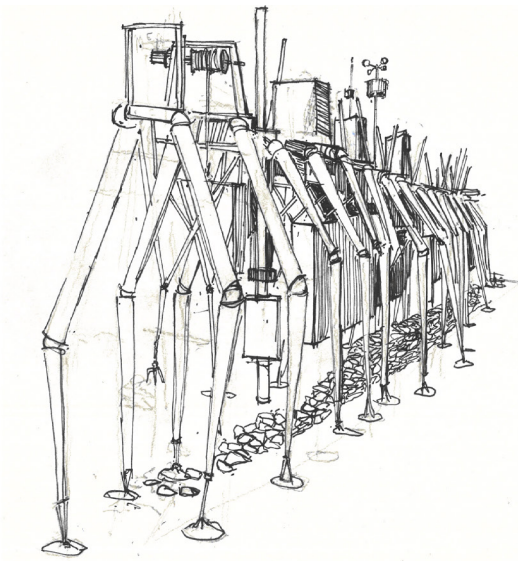
LANDSCAPE ROBOTICS
Part

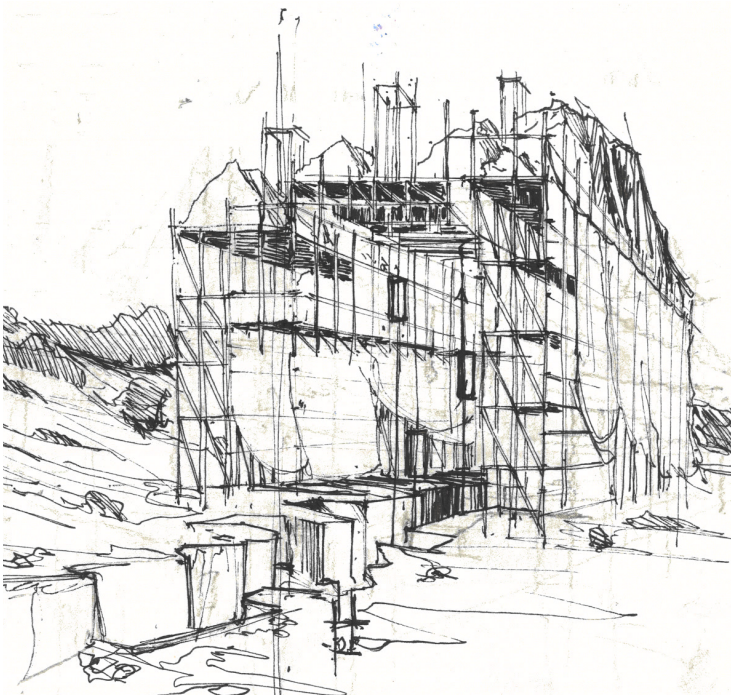
Top: ETH Zurich stone printing robot, photo retrieved from arch2o.com

The vernicular, traditional techniques of dry stone wall building is a essential part of the functioning of the semi natural grasslands. However, due to the retraction of agricultural functions, the need for maintenance and labour intensive demands of the techniques, another approach is needed. The project explores this possibility based on current technical developments, as seen in the two references above. ETH Zurich stone printing robot (top) uses rope and stone that is dropped in layers on top of each other. The other opts for precision. Below is another autonomous excavator from ETH Zurich using a different approach: starting with a small catelog of stones scanned in using Lidar sensors, the program decided which is the best fit for the next stone. It envisions the wall, and provides the best next piece for it.

Bottom: Johns, R.L., Wermelinger, M., Mascaro, R. et al. Autonomous dry stone. Constr Robot 4, 127–140 (2020).

The projects builds on the possibilities of today, and explores these machines and their position in the landscape further. Furtermore, with this project, excavating and erecting autonomously are directly combined on site, through collaboration of different machines. Keeping material displacement minimal, and valueing the material gained as much as the hole left behind





Robots within the landscape, producing a dry stone wall with found stones. Long legs provide mobility across walls.

A movable producting line, that leaves a trace of his path behind in a printed wall.

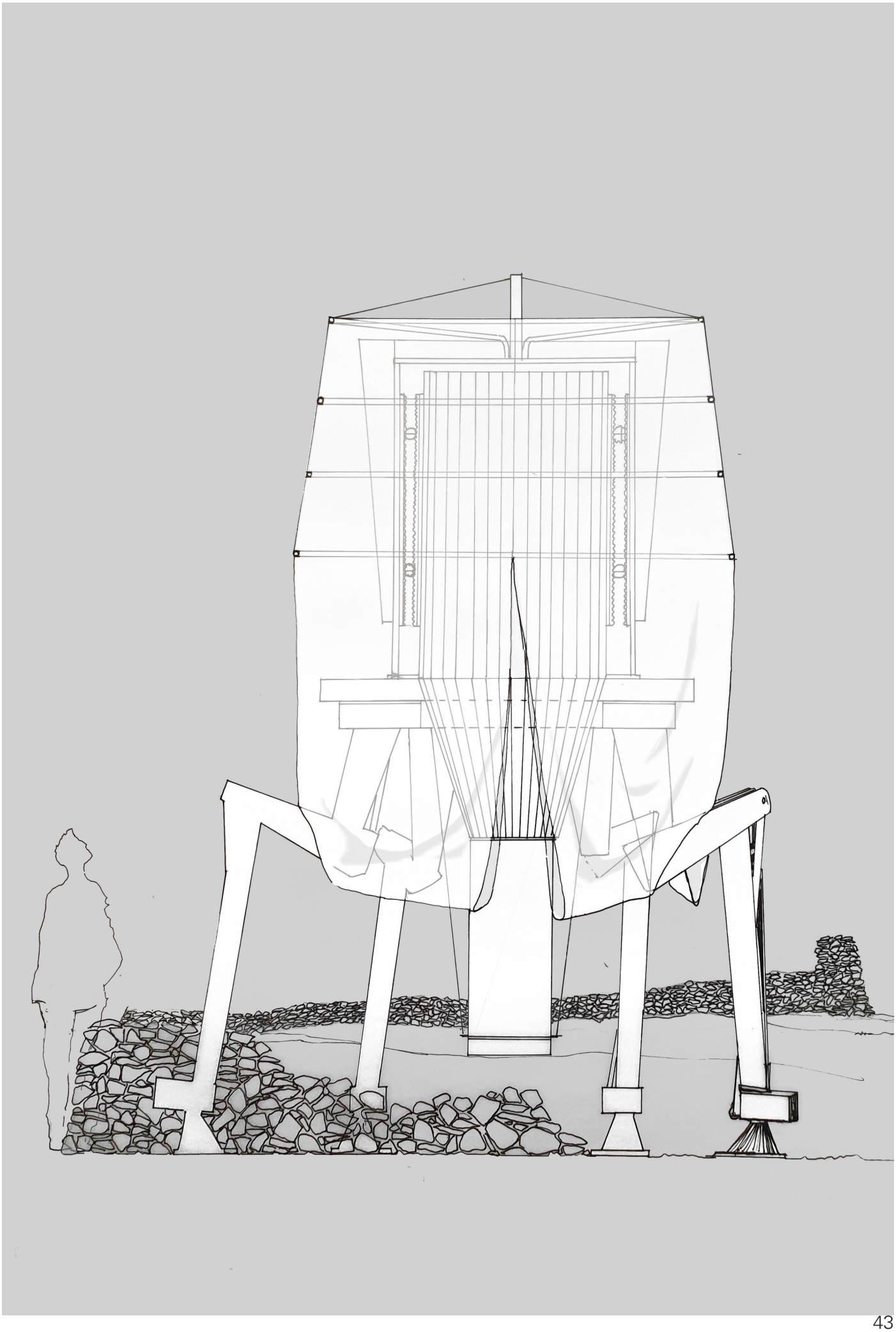
Static excavation machine, located on the former practise site of the adjacent caserma

A SYSTEM TO MAINTAIN
Part

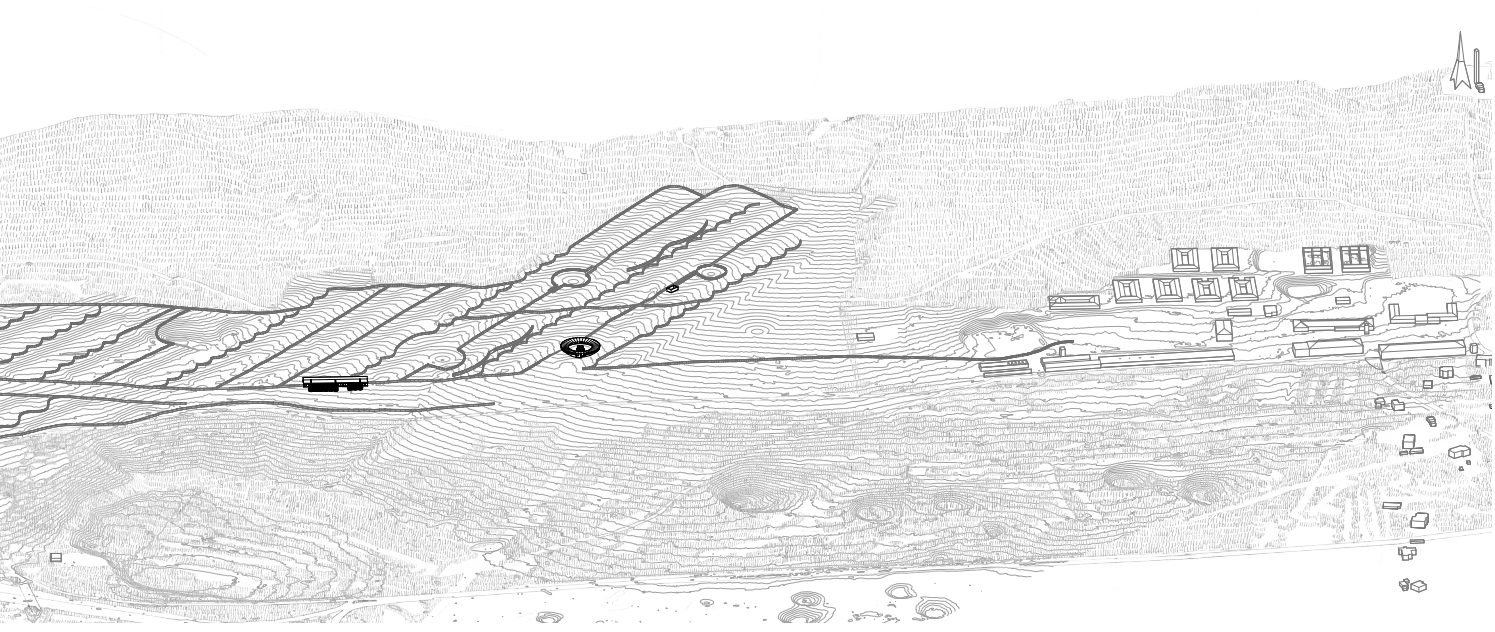
This panel focuses on the robotic system that should maintain the landscape. As such, they become part of the landscape itself. This drawing was used to explore the possibilities and aesthetics of the machine, as an element in the landscape. This machine functions as a 3d printer, printing dry stone walls. The stones used are collected by a different machine, that excavates the stone, while adjusting the soil layer on site. In this exploration i dressed up the mechanical, to hide its technical presence behind a facade of softer, textile material.

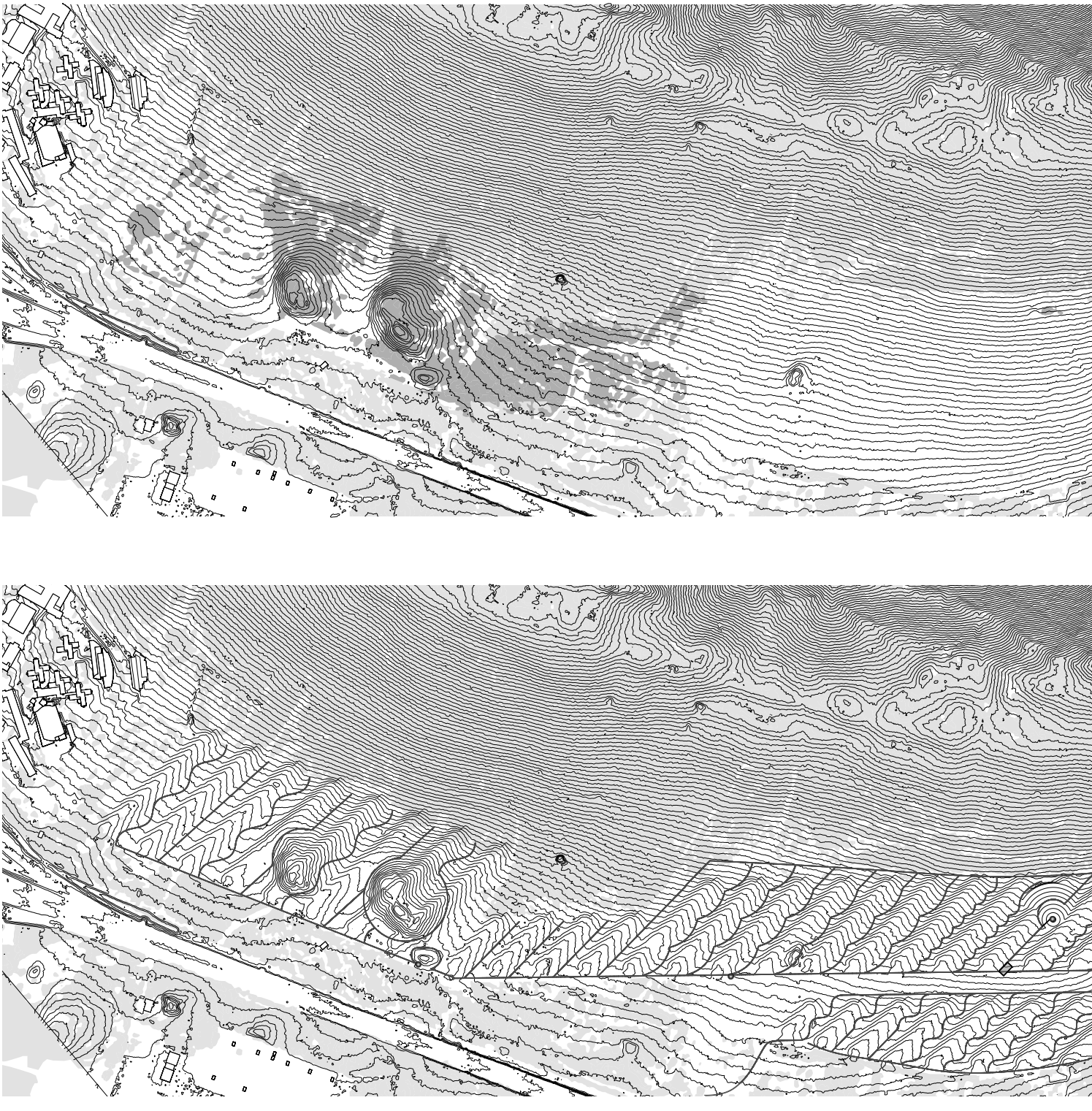
Envisioning the machines themselves helps to set the architectural assignment. The scale, mobility, charging possibilities and functioning are important factors for the design of the architecture surrounding or supporting the robotic maintenance system.

Sectional drawing of wall printing robot. 1:20 printed on a2, 120g/m2

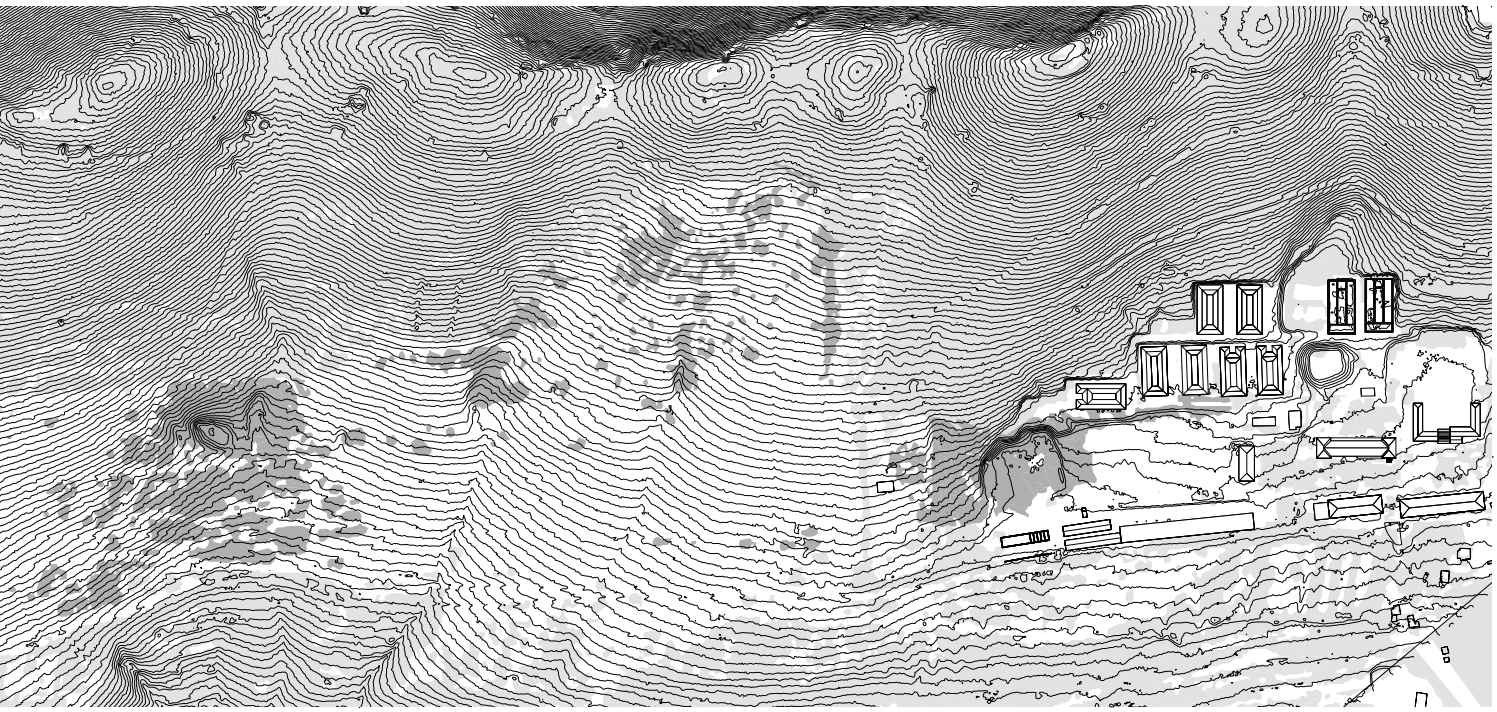


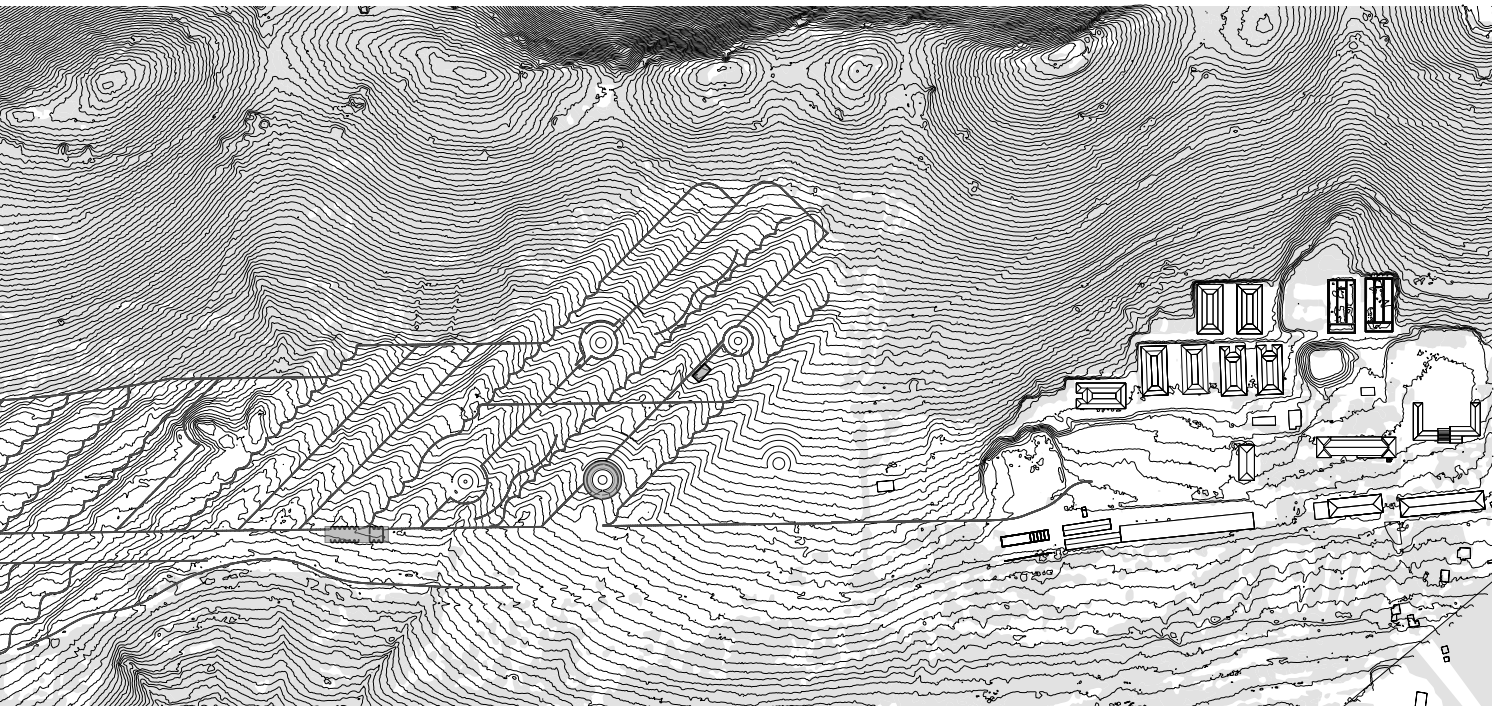
Isometric drawing of the location, with the topographical changes visible in heightlines and the pattern of walls in dark grey

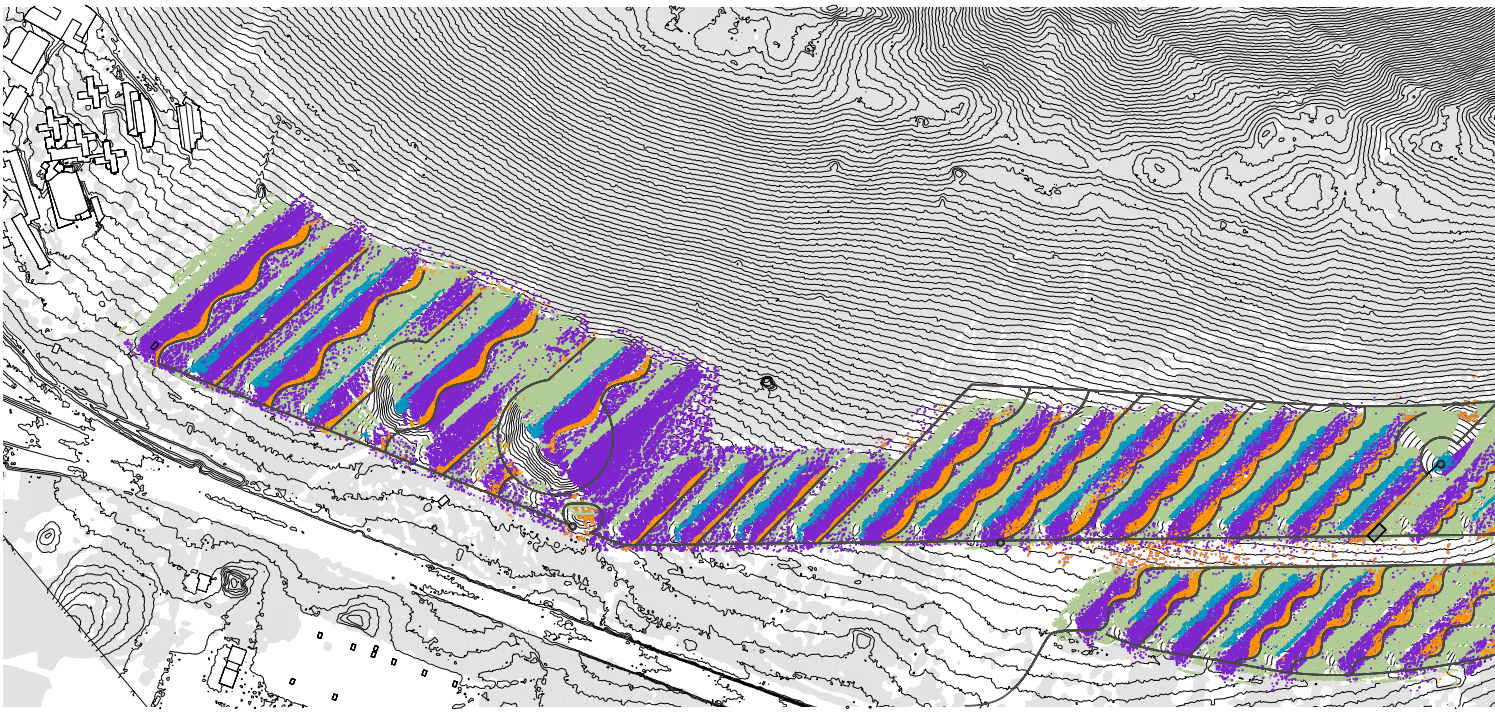




Plan of the project site, top shows the current state. below shows the topographical changes and build up walls. 1:2000 printed on 420mm x 1485mm





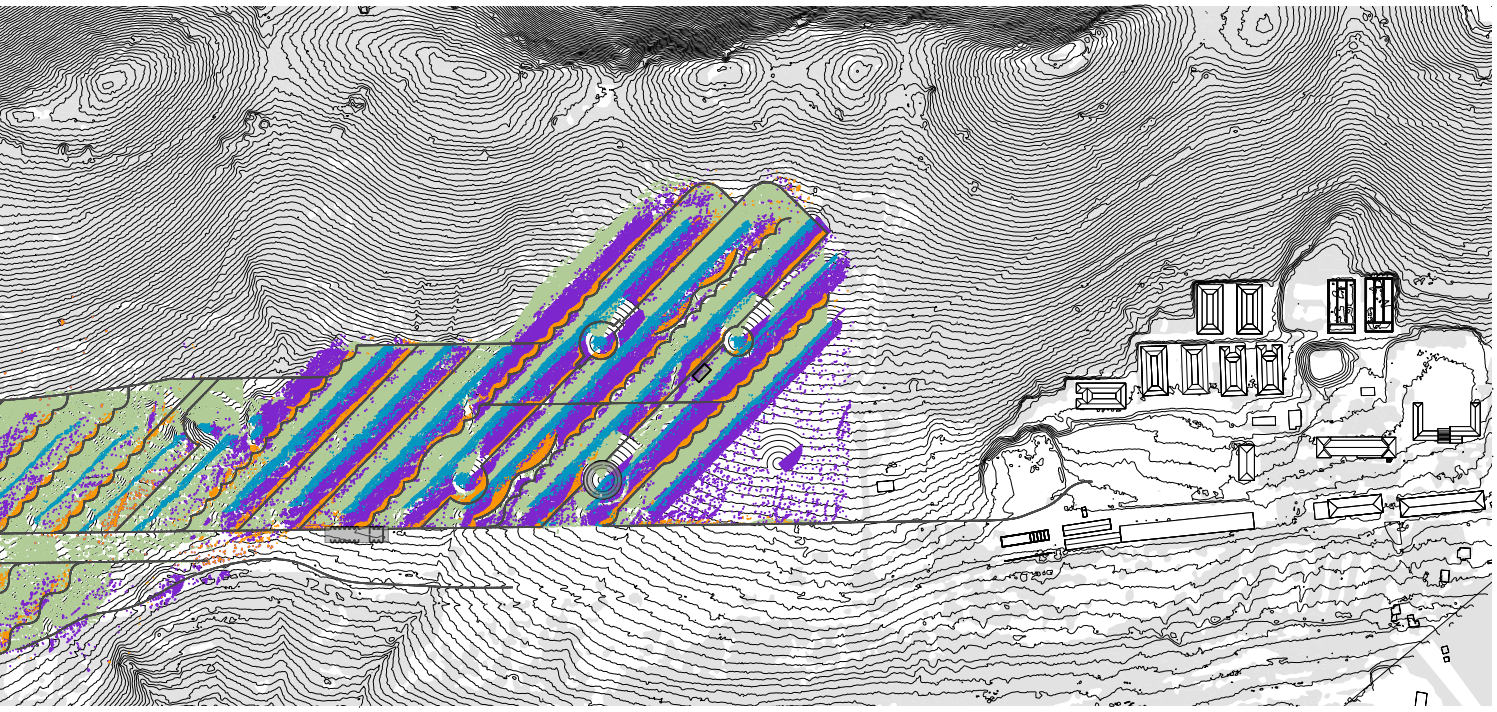


MICROCLIMATES
Site

To start, the site will be made continious along the slope, cutting down the forest prohibiting this. The wood will be used in the construction of the buildings.

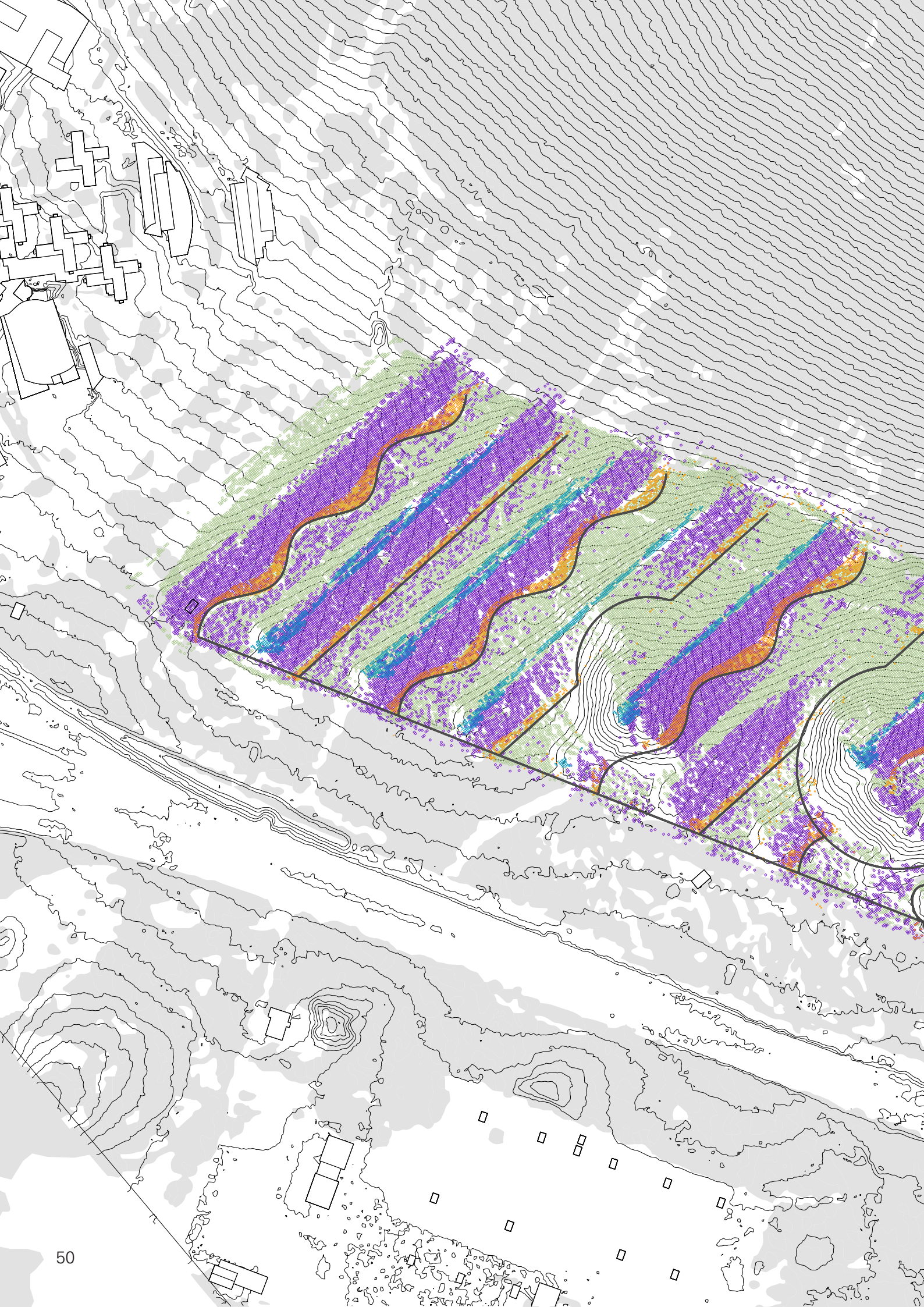
The site will be altered by topographical cuts, relative to the landscape. The cuts will provide a steeper slope on the north side 8 - 10 degrees, and a easier slope on the south of 6 degrees. they will only have a maximum depth of 1.5 meter, to prevend harmfull alterations. With the cuts, soil will be displaced but not removed, only the limestone is taken out, to use for the dry stone walls and buildings. directly after the excavation, the stone can be used to build the walls.

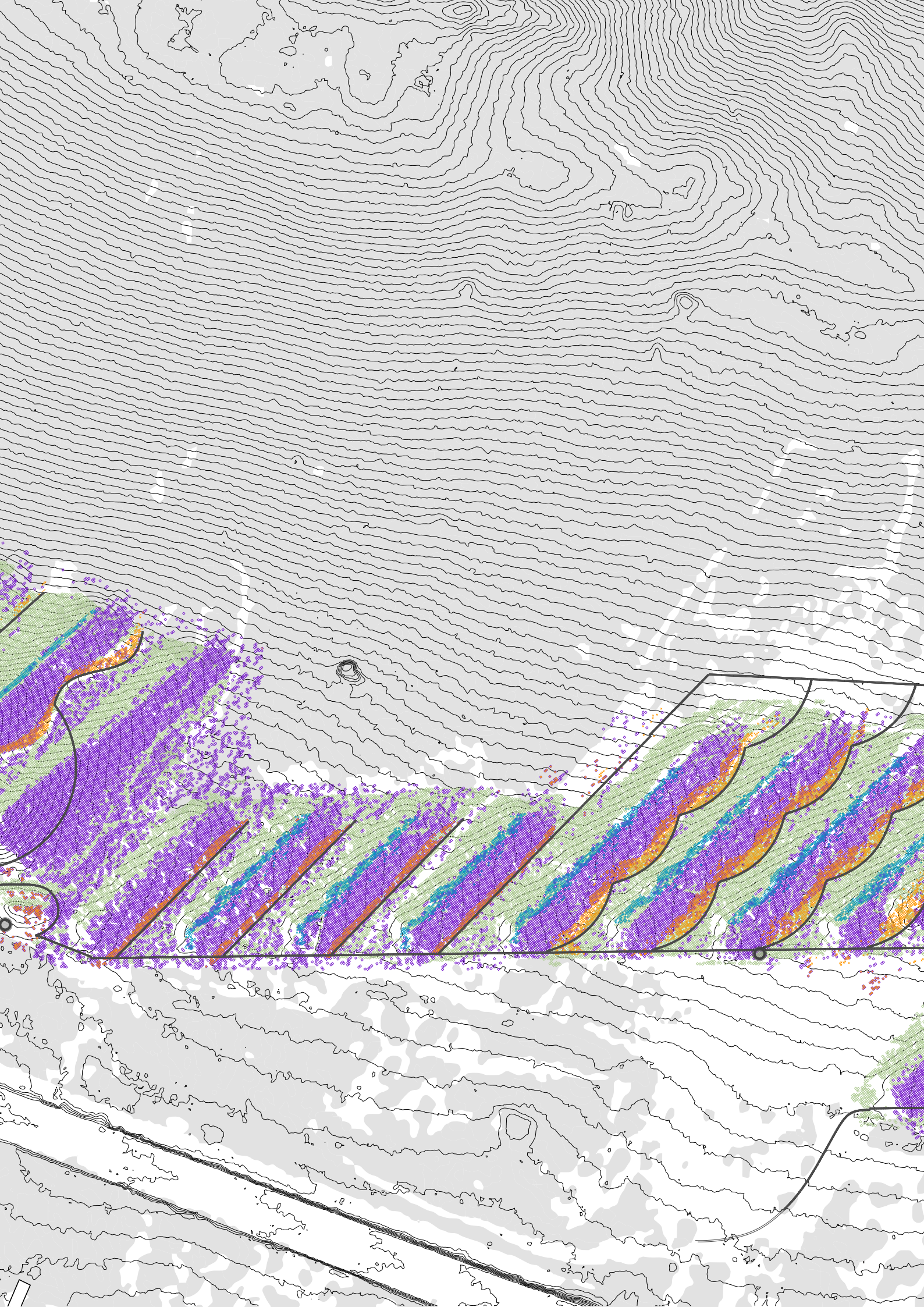
Above is the resulting map, after these topograhical changes. calculated on slope and aspect value, the colors represent north facing slopes (green), south facing slopes

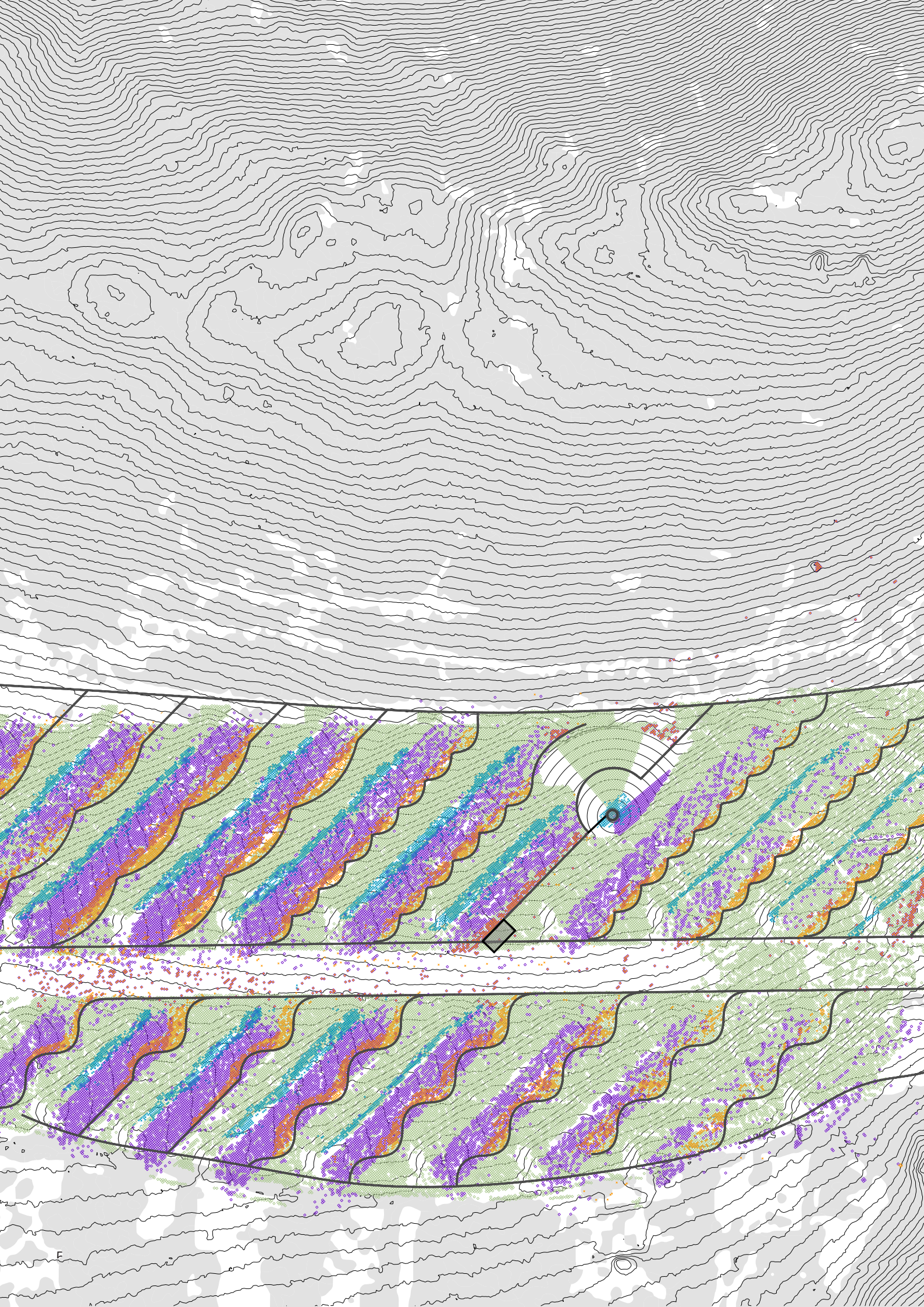


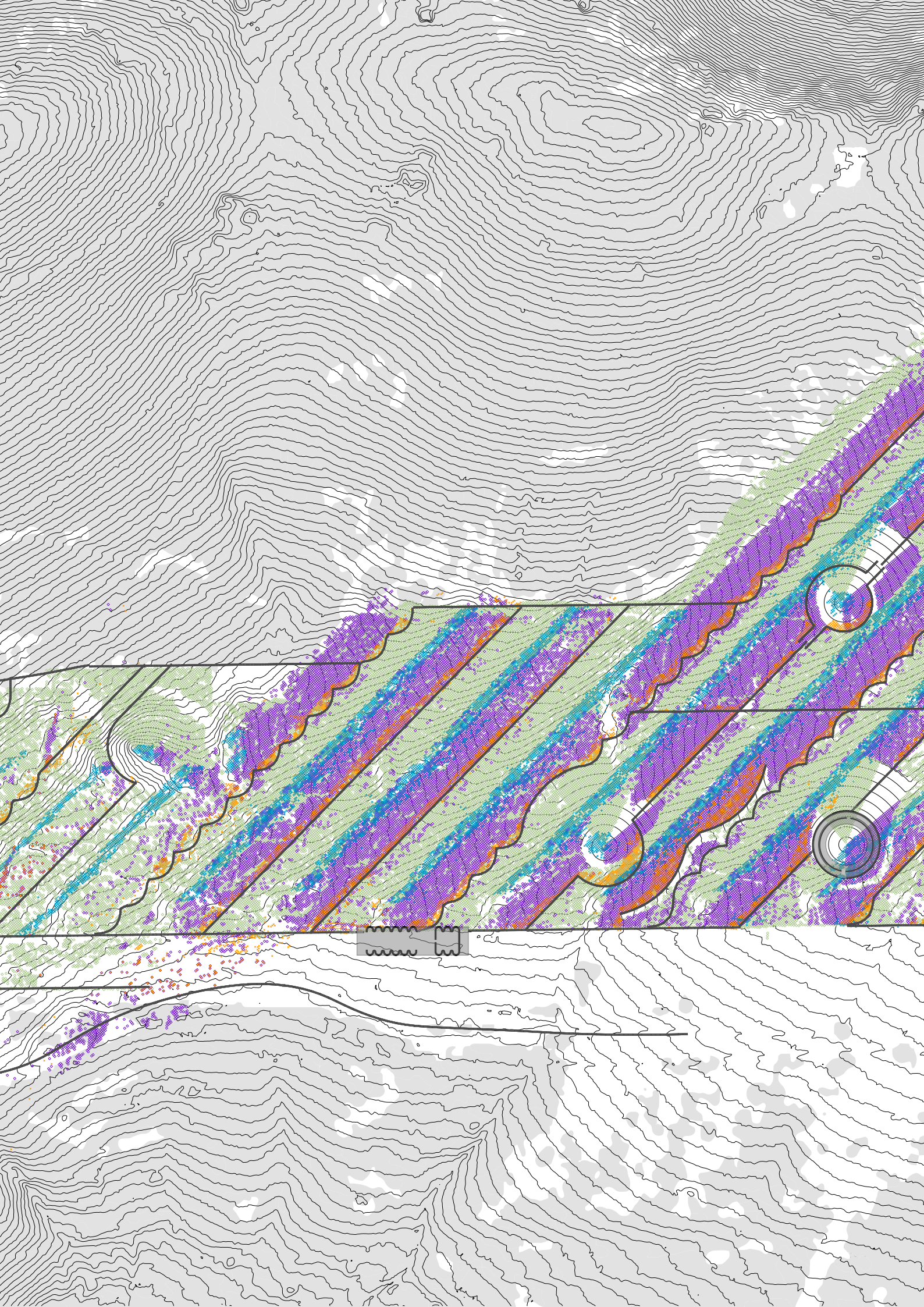
(purple), wet places based on the water path and in orange places with less wind and higher temperatures due to the dry stone walls. In the long areas the cuts are broken up by a dry stone wall, to prevent an extreme water runoff, as these cuts centre the stream more. The walls are build in curves to create microclimatic pockets. The diameter differs to create variable conditions, prefered by different species. Along the area 6 deeper centric cuts can be found, simulating the conditions of doline's: common geomorphical features of the Karst plateau. With the loss of natural ones, these will provide the much needed habitat for various species.

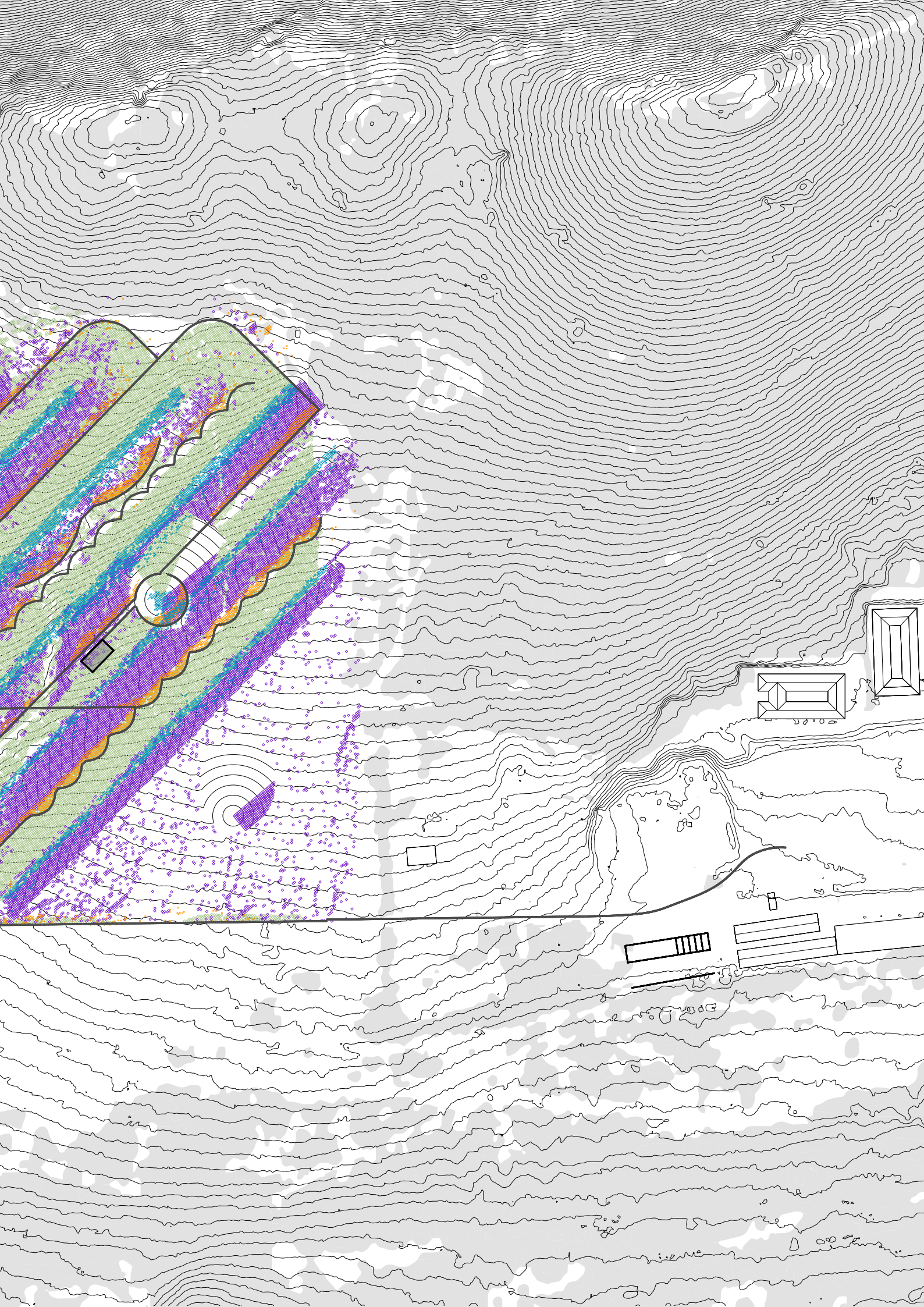
Plan of the project site, 1:2000 printed on 420mm x 1485mm 120 gr.











The project takes time. First step is to cut the wood, and clear a continious grassland. The walls and topgraphical changes will be made almost simultaneously. When enough stones have been found to provide a selection, the walls can be build. Starting at the caserma, working towards the left.

As the changes are made, it takes some time to regrow the karst species mentioned in the following pages. within a 4 year difference, sheep will be brought in to graze the grassland, and prevent woody species from growing up. This will also offer a new transhumance route, as most of southern, lower pastures have disappeared.

Over a Total of 20 years, the entire area can be changed with just a few robots. However, after there is still work to be done: maintaining the drystone walls, making adjustments based on natural changes over time. But this will require less robotic force, and they can migrate towards a new site in need of revitalising.

Plan of the project site, 1:2000 printed on 420mm x 1485mm 120 gr.

SUPPORTED SPECIES
Site

The plant species listed here, reference the boxes and crosses displayed on the long map of the area, 1:2000. Every square is 1 square meter in reality, which represents the scale of the available data. The topograhical changes made to the landscape provide not only the limestone needed to build the walls, but are equally imported as remaining form. Excavation and erection are in equilibrium. The cuts provide a more diverse landscape with different slopes and aspects, that support a variety of microclimates. the cuts feature a moderate slope on the south (6 degrees) and a steeper slope on the north (8-10 degrees) With the walls, these cuts provide a nurturing environment, for the Karst species mentioned above, and many more. The once practice terrain of the caserma can slowly regrow as a semi natural grassland.

The species mentioned above are all non wooden species, meaning no trees or shrubs. Due to afforestation, the semi natural grasslands are threatened all over europe. The classic Karst is already covered for 90% in forest. recognised as a habitat 2000, the semi natural grasslands as a supporting habitat for many species needs to regain some of the area lost to forest.

To maintain the area as a semi natural grasslands, it needs work. Sheep will moderately graze the grasslands to prevent the forest from taking over.

Indicates North facing steeper slopes, with a lower temperature.

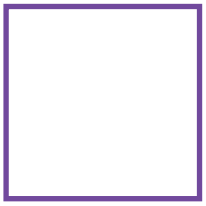
indicates south facing slope, less steep, warmer.

Indicates south facing walls, providing: more radiation heat, a more stable temperature and less wind.

indicates lower places as water path, provides more water, deeper soil and lower temperature

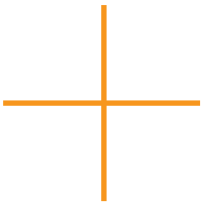
Sectional drawing of wall printing robot. 1:20 printed on a2, 120g/m2

Bromus erectus

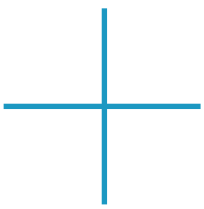


Sesleria juncifolia

Ssp. variegata



Cymbalaria muralis



Allium ochroleum

Carex flacca

Ruta divaricata

Seseli gouanii

sedum album

Lathyrus latifolius

Briza media

Artemisia alba

Asplenium trichomanes

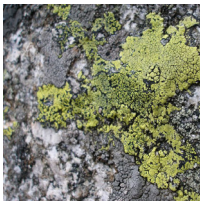
Ononis spinosa

Danthonia alpina

Serratula lycopifolia

Caloplaca teicholyta

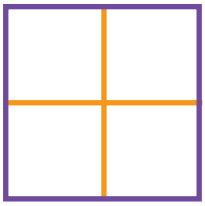
senecio lanatus



Rhizocarpon geographicum

Polygala nicaeensis

Satureja Montana

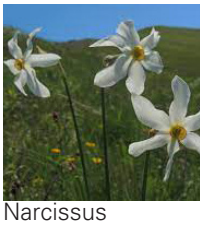


Botryochloa ischaemum

Cleistogenes serotina

Lactuca viminea

Crocus reticulatus



Narcissus radiiflorus

Muscari botryiodes

Fritillaria tenella

Pulsatilla montana

Potentilla tomasiniana

Scorzonera hispanica (wild form)

SUPPORTING STRUCTURES

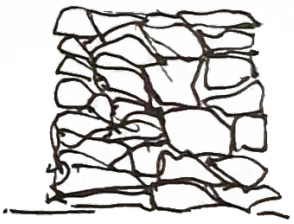
Site

The dry stone walls can be build up with various techniques, to gain a supportive role towards the landcape. As buffers for water, slowly distributing it to the soil, or as a corridor for fieldmouse that want to cross a field. When keeping these different species in mind, by making a small gap at the bottom, or a nesting place at the top, the walls are no obstacles, but habitats and protection.

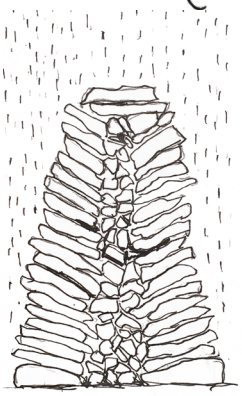
Curving walls can provide pockets of heat, supporting more thermophilious species. a closed off environment, or a south facing wall can provide a beekeep. The collaboration between man -or, robot- made structures and nature are what makes the semi natural grassland so unique.

The repeated cut made in the landscape, is relative to the existing condition, creating a variety of situations. The sketch on the right shows the measurement in a simple way: more steeper slopes on the north, longer less steep slopes on the south. Especially these provide much needed situations the previously did not existed on this side of the mountain.

Vertical (France)



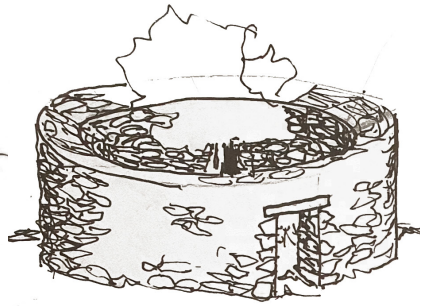
horizontal

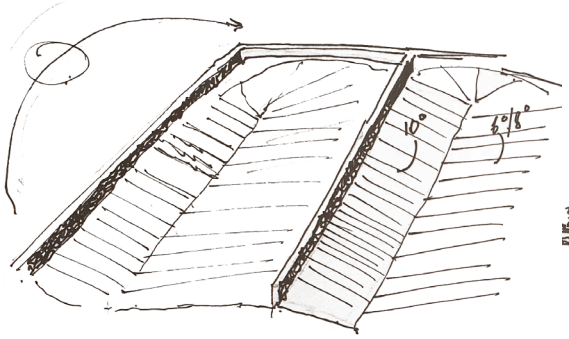


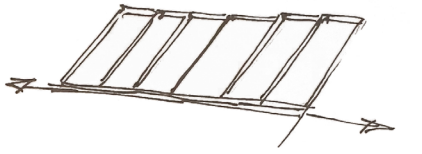
captures rain and delays.

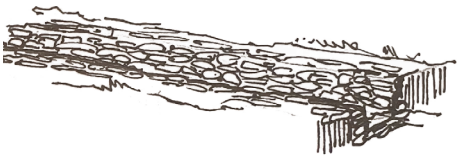
Nesting aid for insects (south facing wall.)

Refuge amphibians (North facing wall)

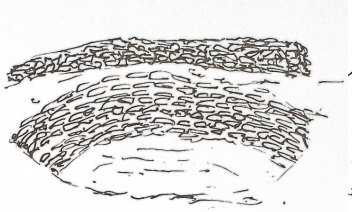




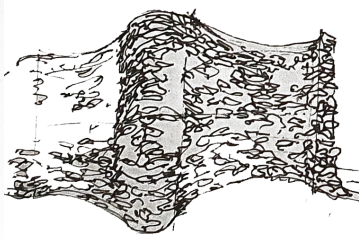




gramery / spain

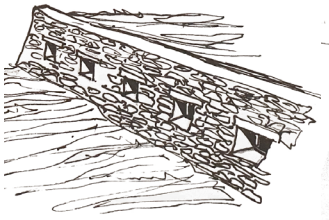


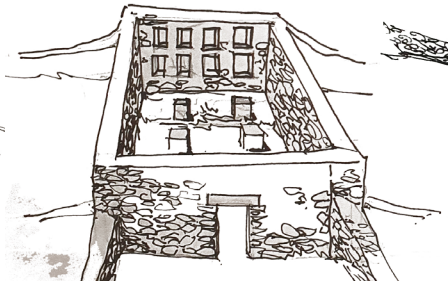
Dry stone covered dolline

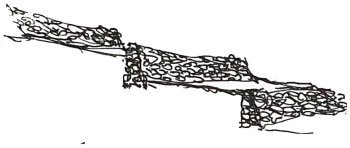


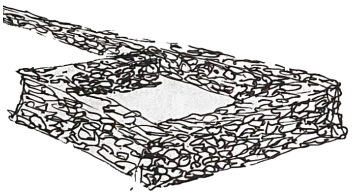
wired control / capture.

Timespan shelter / Italy

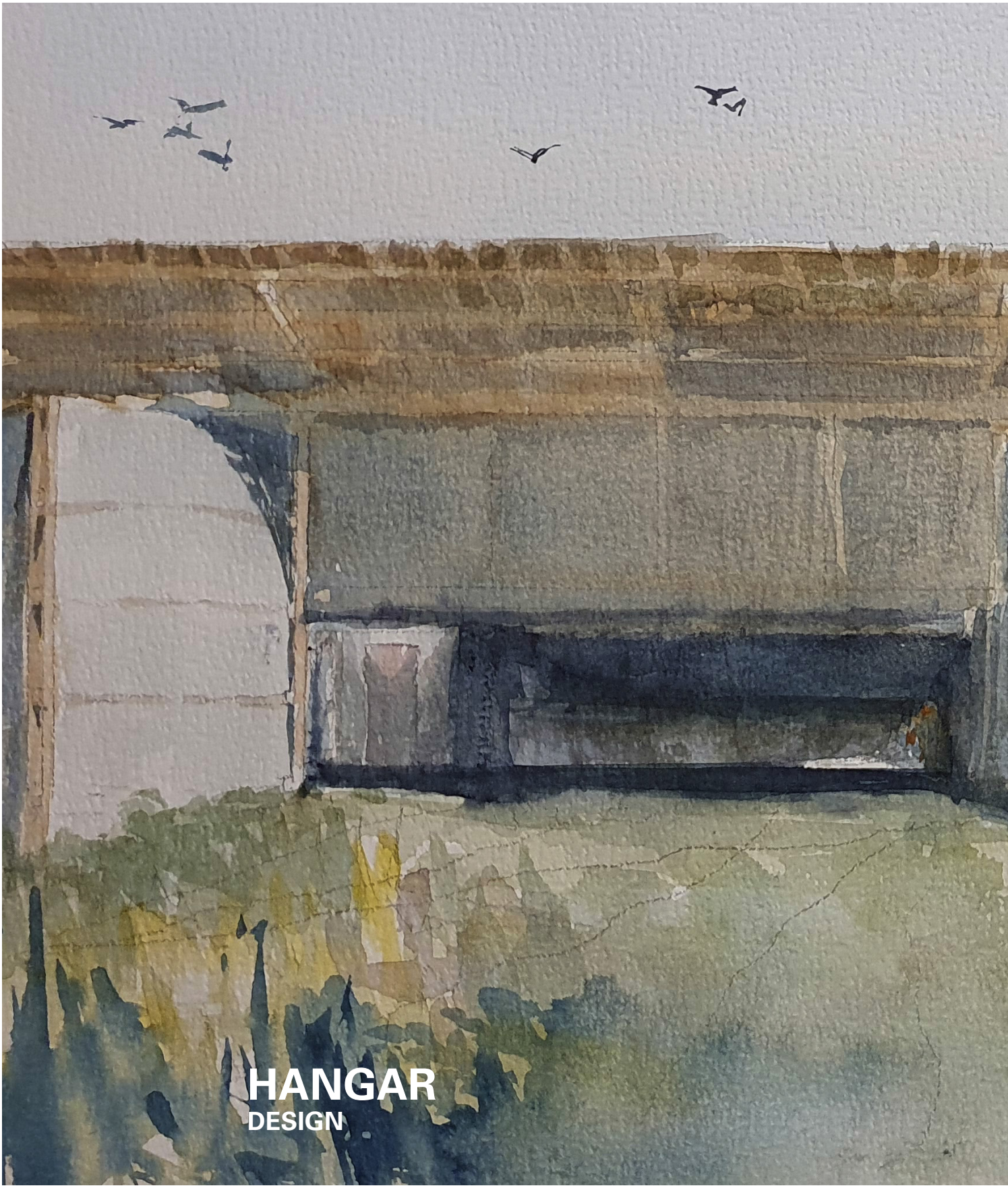








Storm enclosures.


HANGAR
DESIGN

HANGAR
Design

The hangar scrapes the landscape on its long side, along the main wall that goes through the whole area as a main route. On one side the hill going up, the other the end of the terrain. In this position it offers a central place for the robots to recieve maintenance, while also functioning as an entrance to the area. On the large roof water is collected and brought to six water barrels, highlighted in red, found between the curved dry stone walls. The curved walls provide pockets of daylight coming in, providing a interesting play of shadows during the day. On both sides the large vierendeel carries the roof 4.8 meters further then the walls, providing a large overhang.

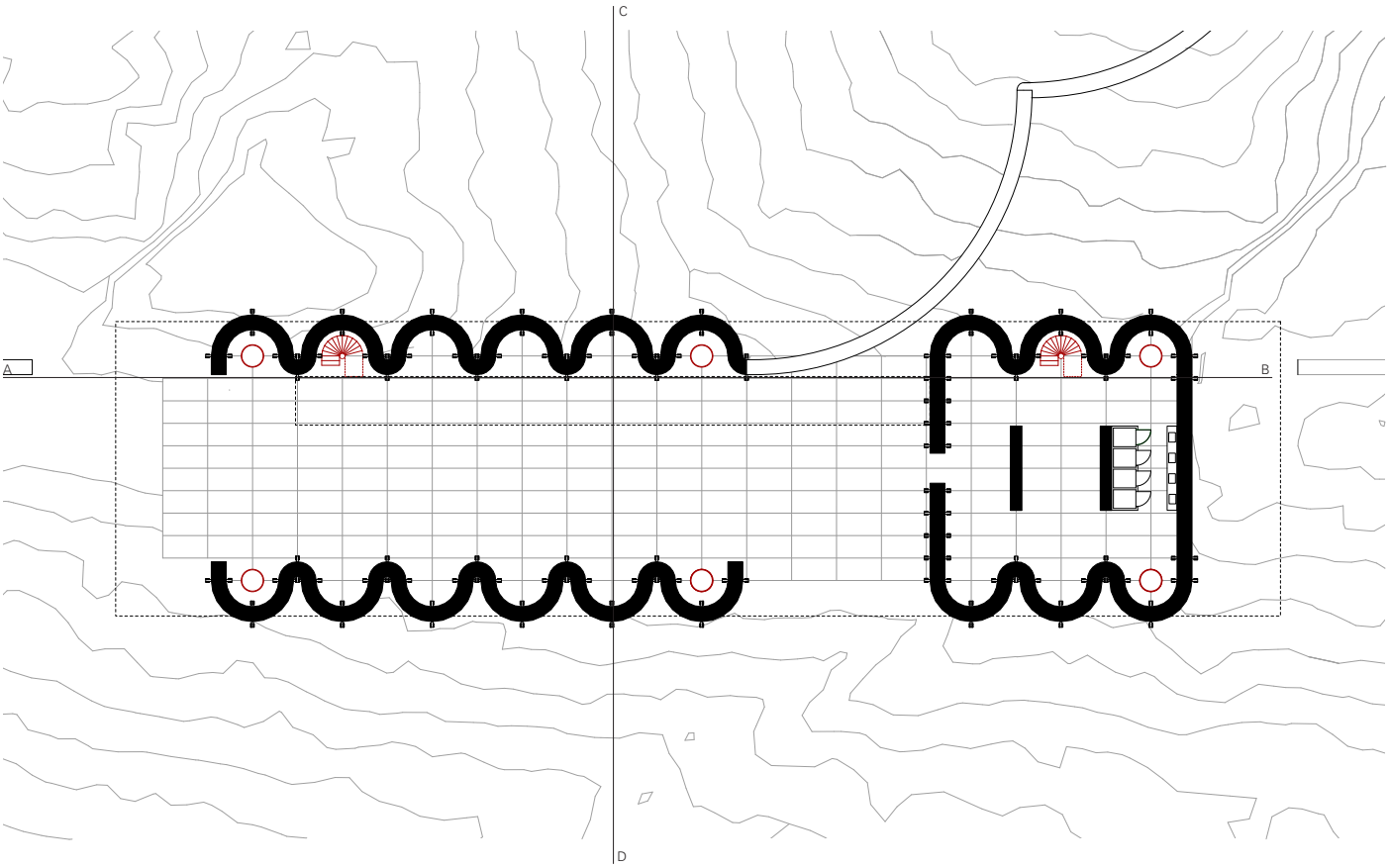
The hangar is opened on one side, so the robots can easily acces the hall. the other side provides a small place for the employees. on this side, the landscape provides easy acces to the second level. The long balcony through the hall offers accessibility from a different height, as some of the robots are four meters high.

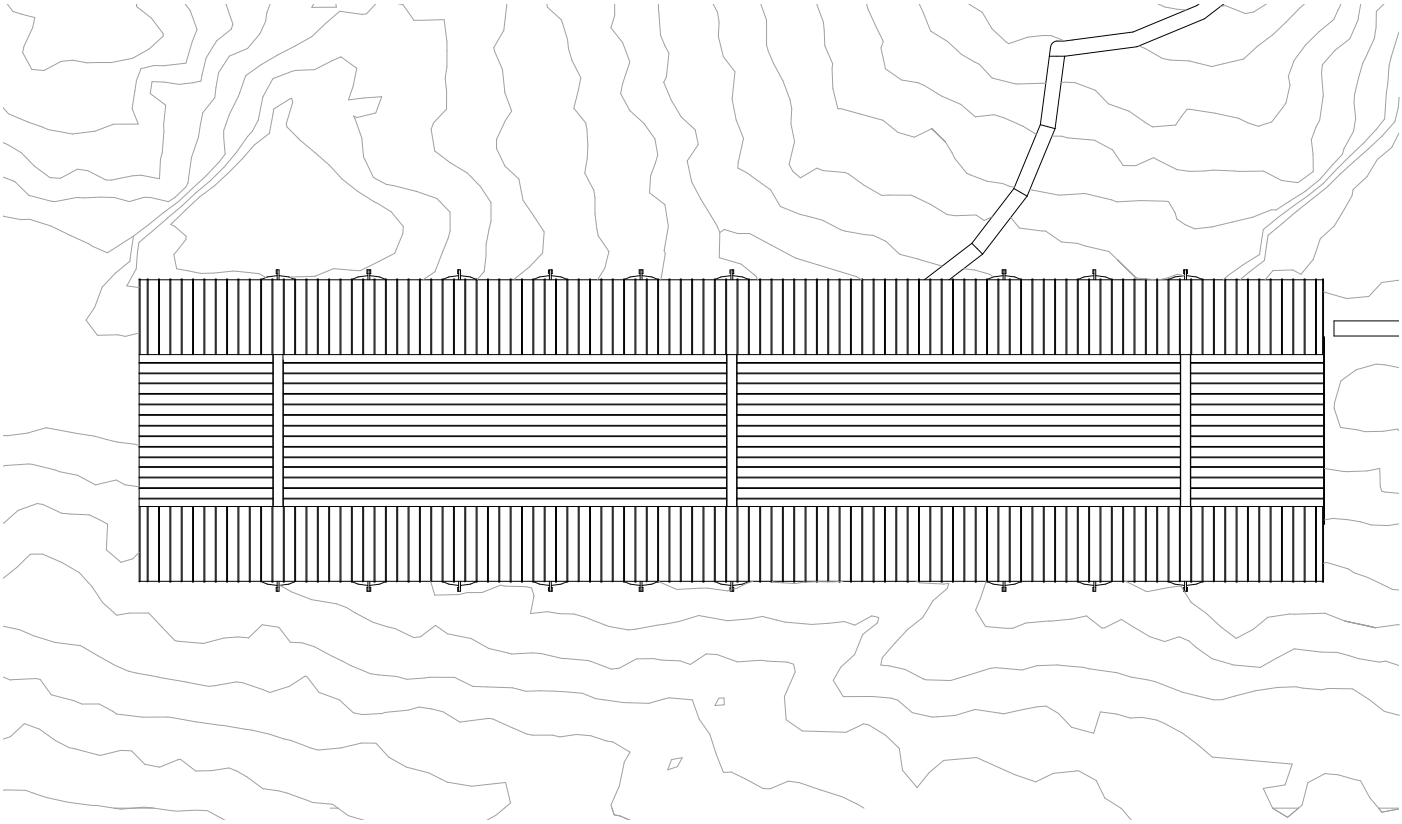
Axometric construction drawing
The dry stone walls curve to provide stability without needing buttresses. Horizontal wooden beams, connected to the vertical pillars keep the stones in place, together with gravity. The vertical pillars hang on the outside, and go all the way to the ground on the inside. On the wooden pillars and the walls rests the wooden roof. A repetitive truss caries the metal clad roof. A long vierendeel provides the strength for the opening of ten meter.

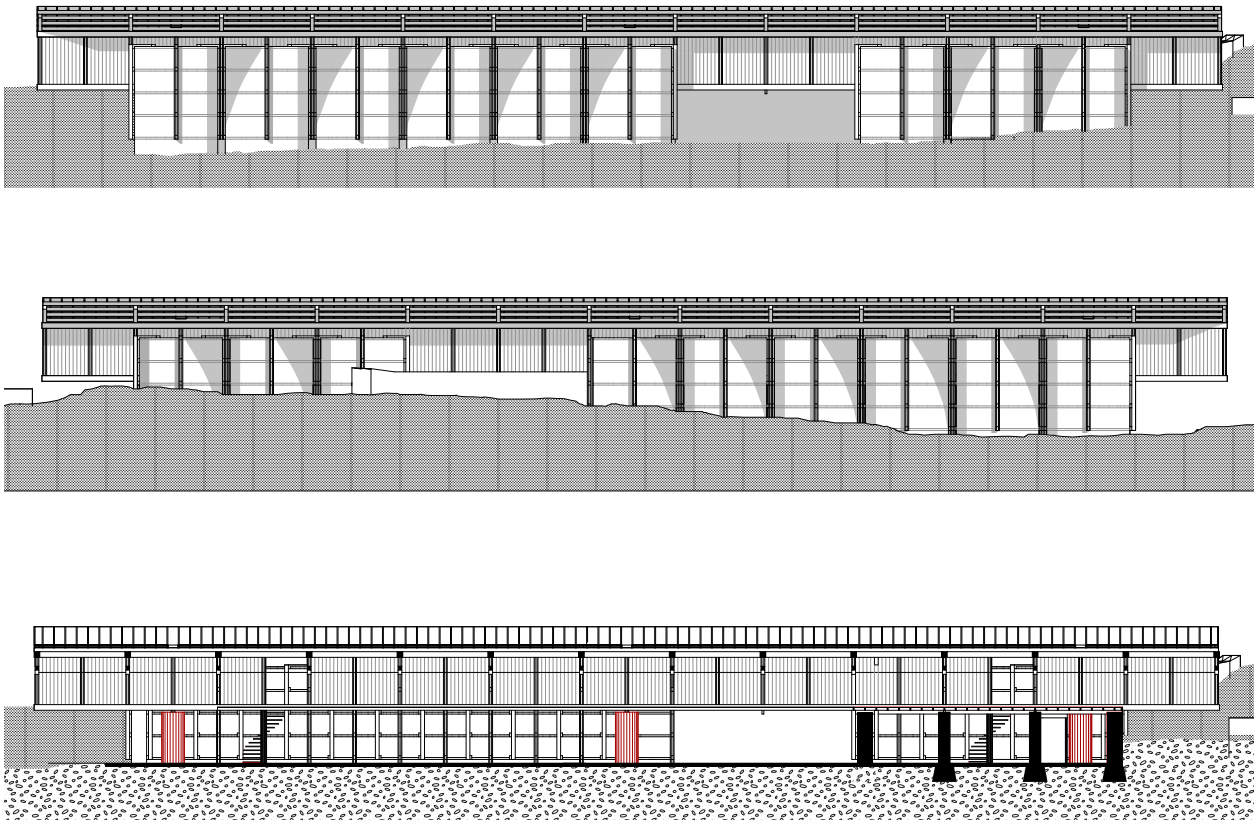
Title page: Impression of the exterior of the Hangar, opening up on one side.

Right page: Ground floor plan, 1:400

Right page: Roofplan and situation, 1:400


C
A
B
D





Top:
elevation North/east
1:400

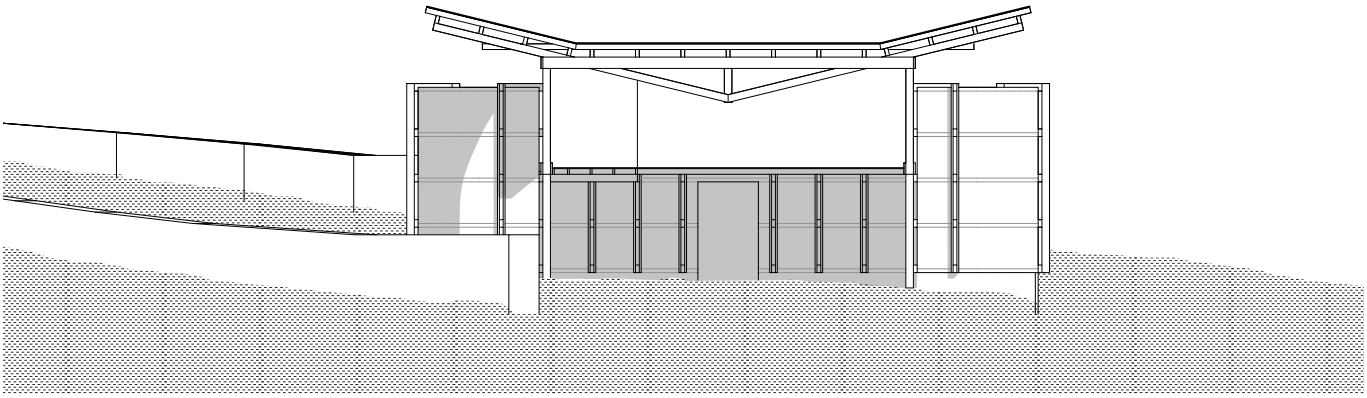
Middle:
elevation South/west
1:400

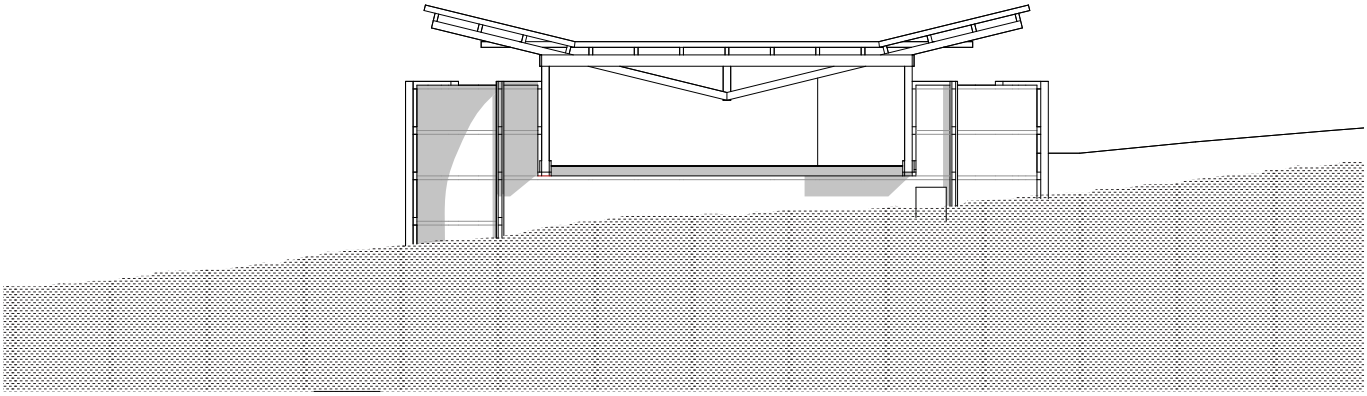
Bottom:
Section AB 1:400

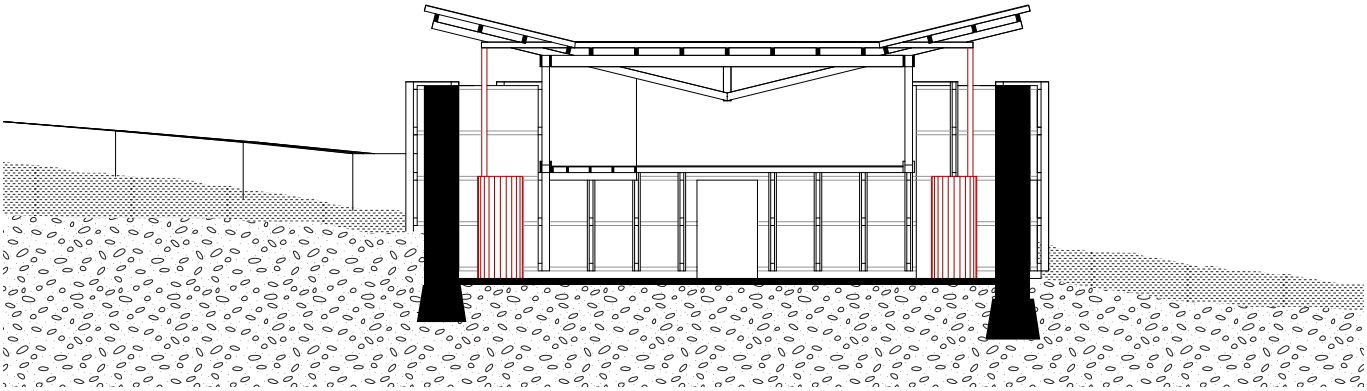
Right page:
elevation South/east
1:200

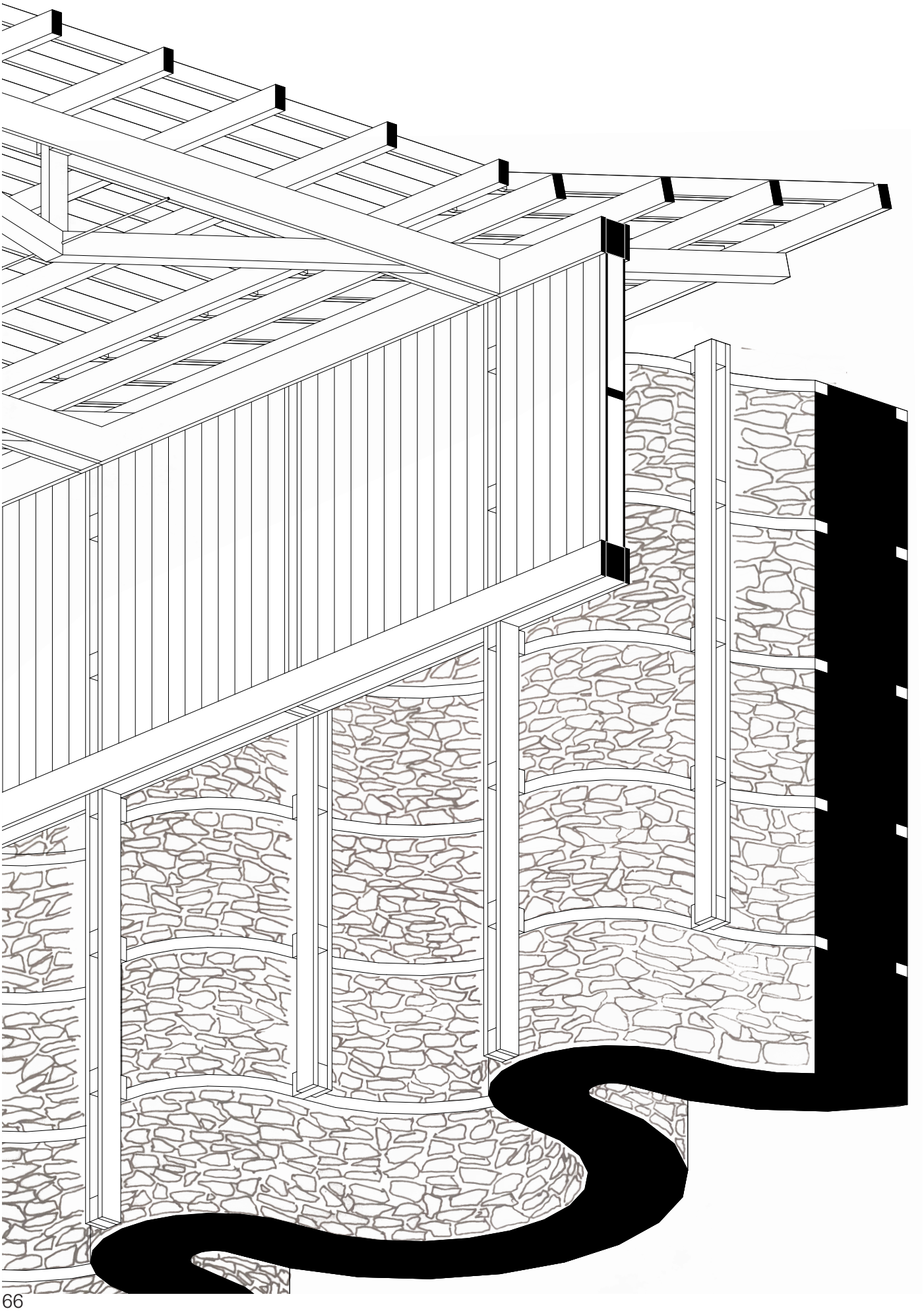
Right page:
elevation North/west
1:200

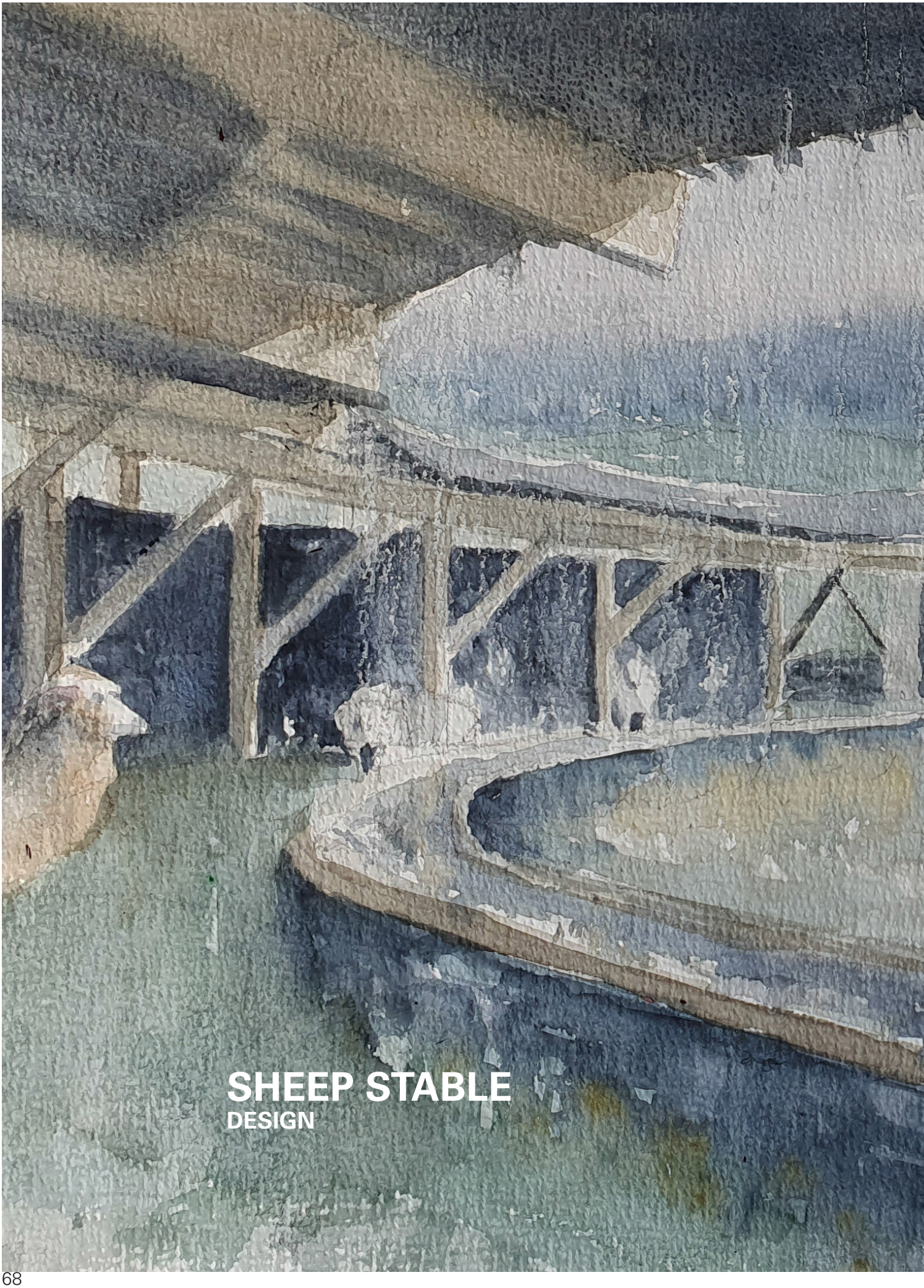
Right page:
section CD 1:200



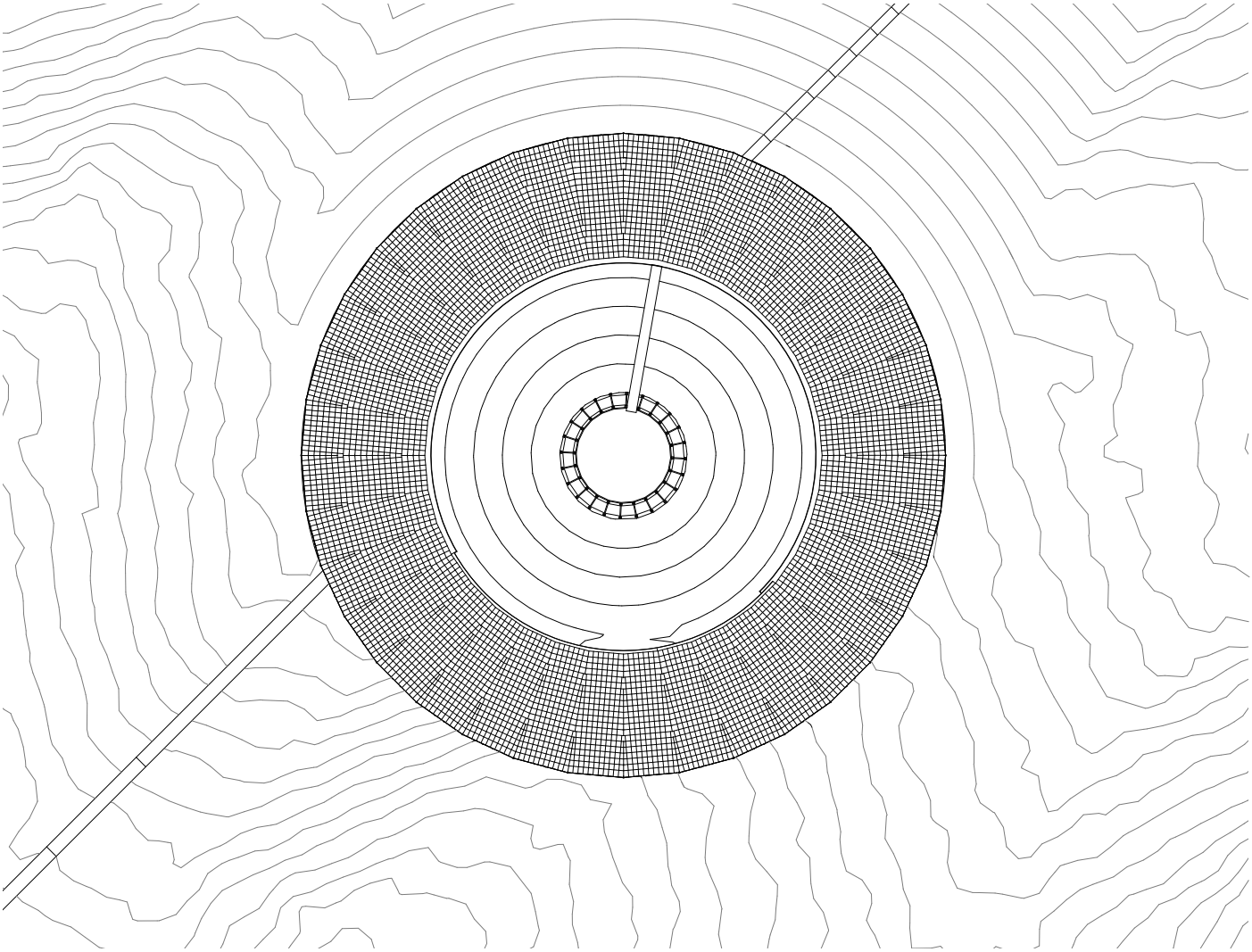


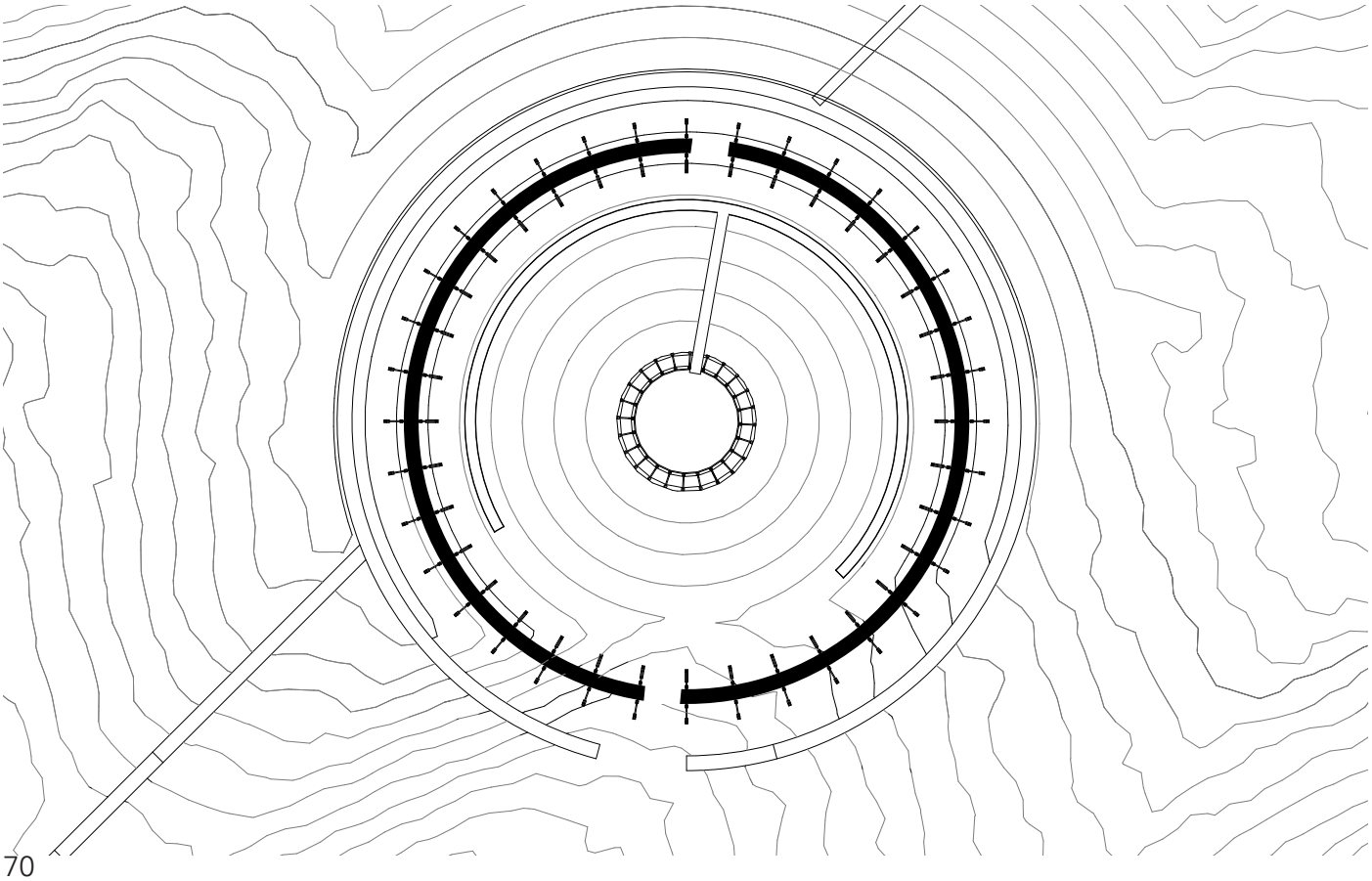






SHEEP STABLE
DESIGN





SHEEP STABLE

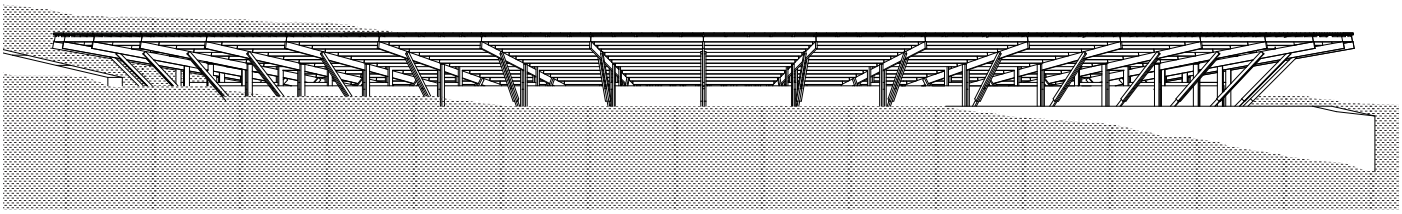
Design

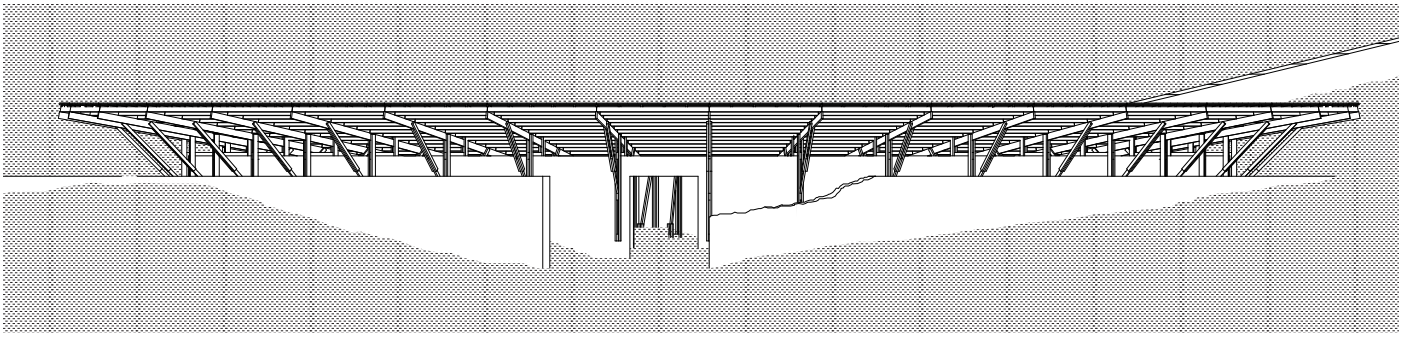
It takes work to maintain a dry grass land. If nothing is done, the forest will slowly grow over, pushing away non wooden species. In the area, three tactics are used to prevent this from happening: cutting or mowing, controlled burning or grazing. Grazing, if done correctly (no overgrazing) is the most effective method. Furthermore it comes with beneficial side effects: spread of seeds and pollen, and manure. Sheep don't need much, but a dry place out of the wind can make them happy. The stable is round, so no matter which wind is blowing they can find a good spot.

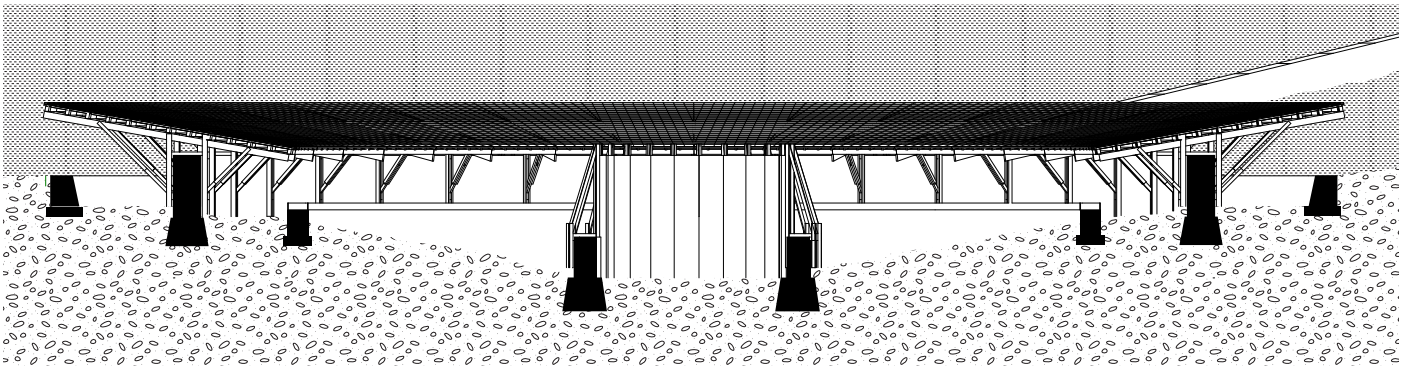
top:
impression of the outer side of the stable. provides a dry place, but within the sun. The inner side also provides shade

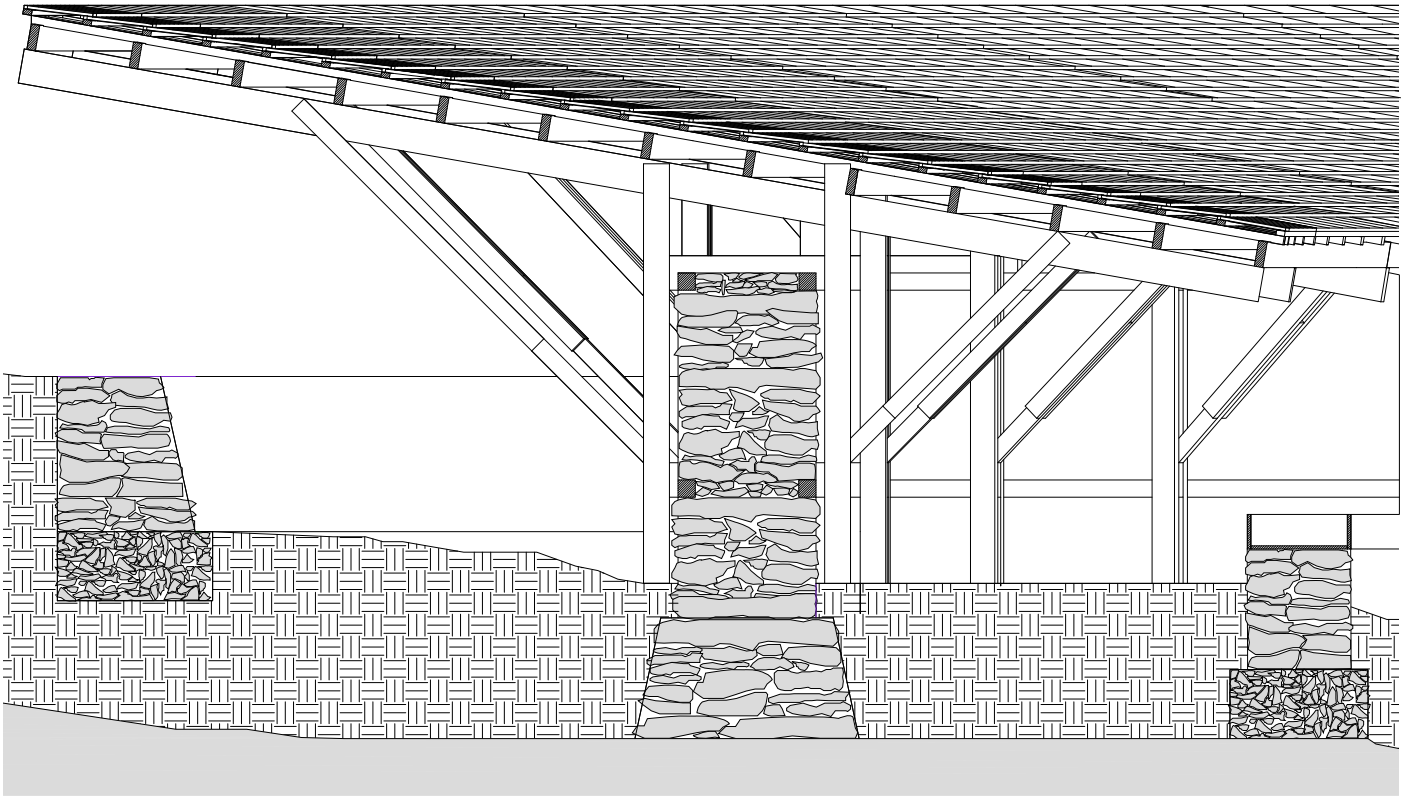
Left page:
roofplan and situation

ground floor plan









The sheepstable has three dry stone walls circeling each other. the outer wall as retaining wall. Only where the ground gets lower, at the entrance, does this wall stick above ground. The middle wall is build up with horizontal and vertical wooden beams that ensure the wall, while carying the roof. The inner wall is a low wall that carries a trough that collects rain water. Remaining water is collected in the middle.

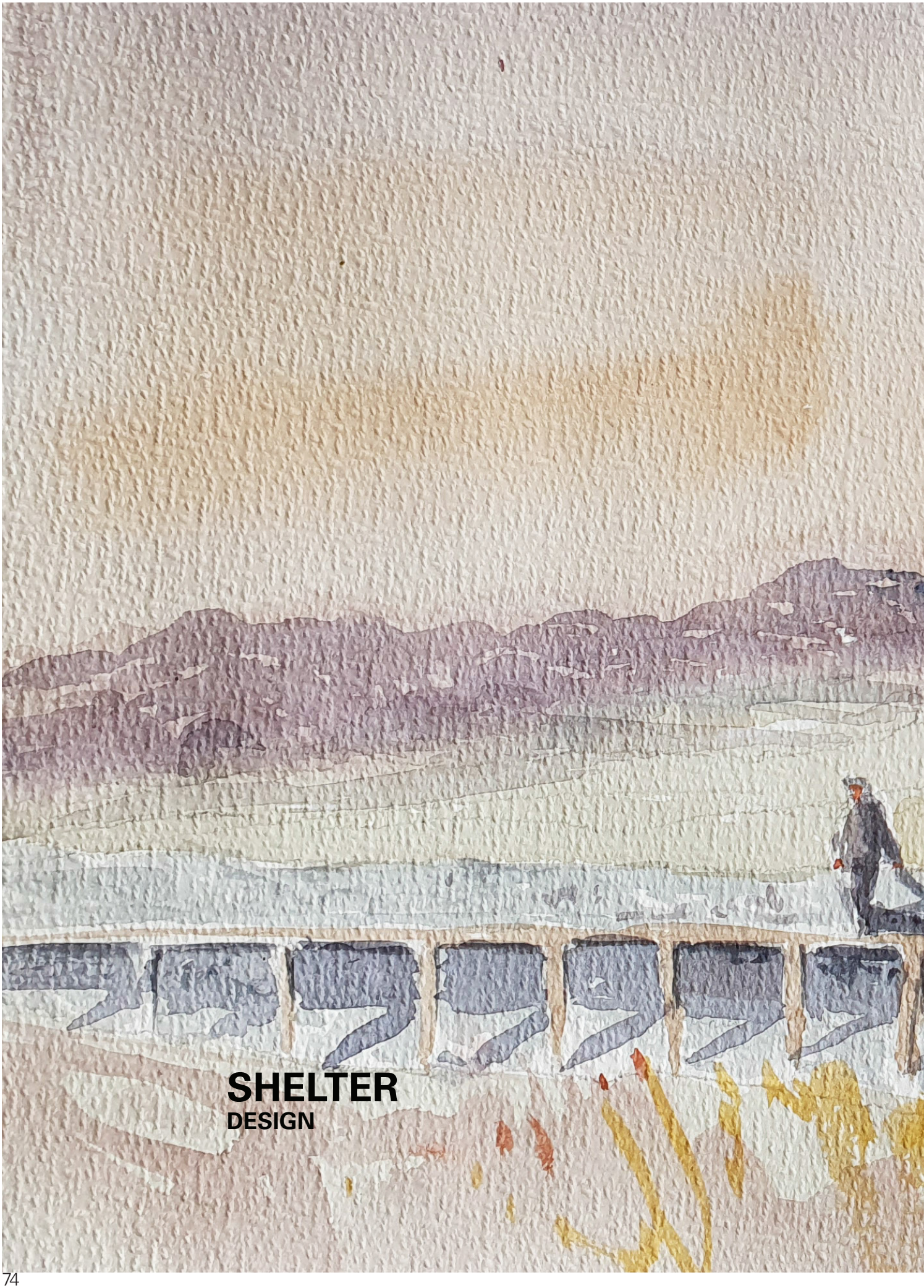
The cantilever roof provides to conditions: the outer ring and the inner ring. Both dry, one can be enjoyed in the sun while the other provides shade.

top:
detailed section of the three dry stone walls and the cantilever roof

Left page:
elevation south/east 1:200

elevation north/east 1:200

section AB, 1:200



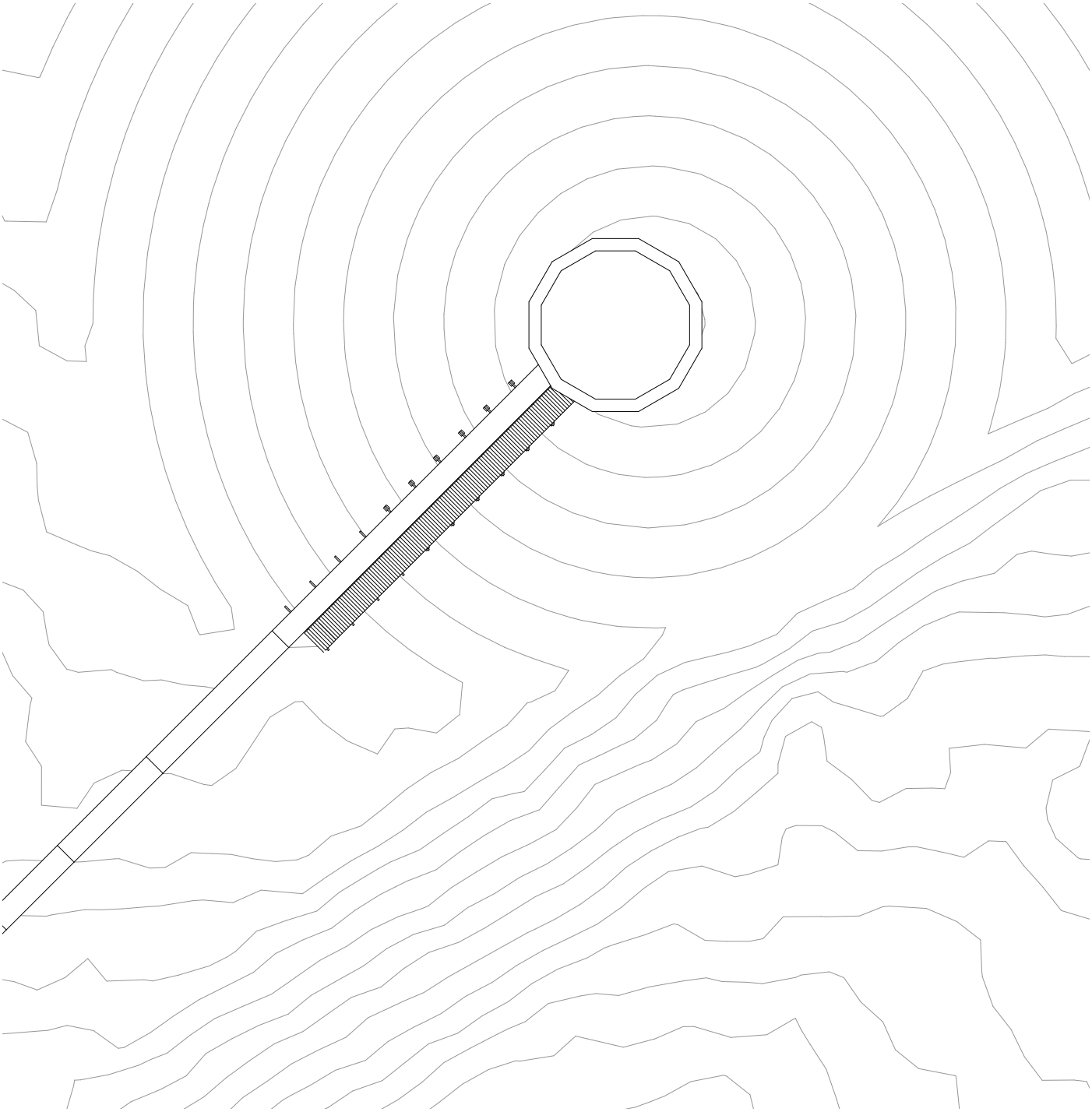
SHELTER
DESIGN

SHELTER
Design

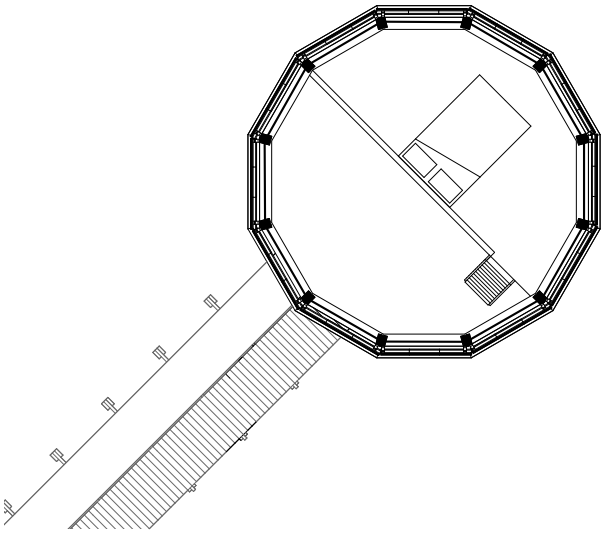
There is also a place for a human provided within this landscape. Not to big offcoarse. The small shelter sits in a newly made doline and sticks its head above the surrounding area to provide an overview of the landscape and the continious project. A extended dry stone wall leads to the entrance level, where a turning staircase on top of the wall leads inside the outer cladding. Behind the door is a small living place and kitchenette, and a steep staircase leading to an entresol with a bed and a place to work. the upper part has single glass windows going all the way around, providing daylight for both floors. The outer facade is a similar system with closed wooden panels or glass panels. he system allows for freedom in the sizes of the panels used.

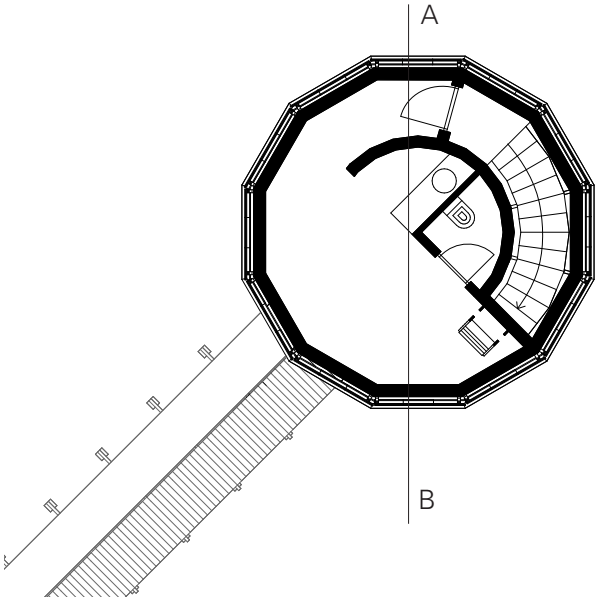
Titel page:
Impression of the shelter from outside, during the end of the day.

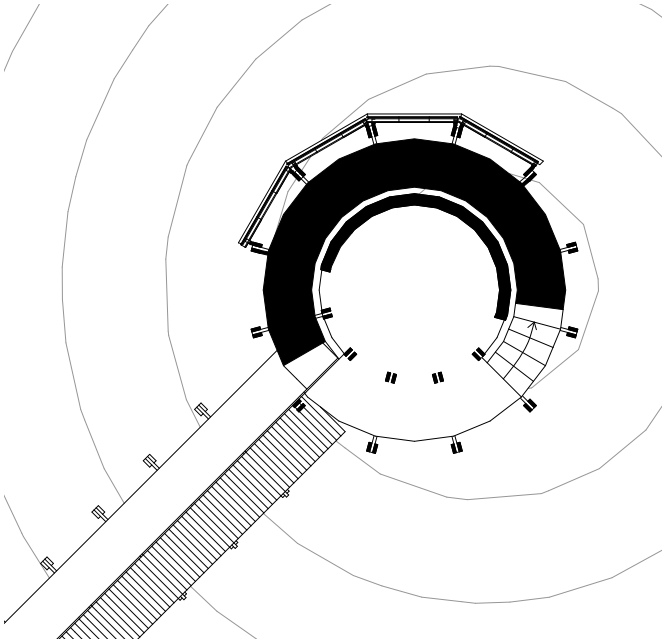
Right page:
Impression of the shelters exterior staircase, which enters the facade from underneath. The entrance level provide a small outside area, shielded from rain. The door is at the top of the staircase



Roofplan and situation,
1:200



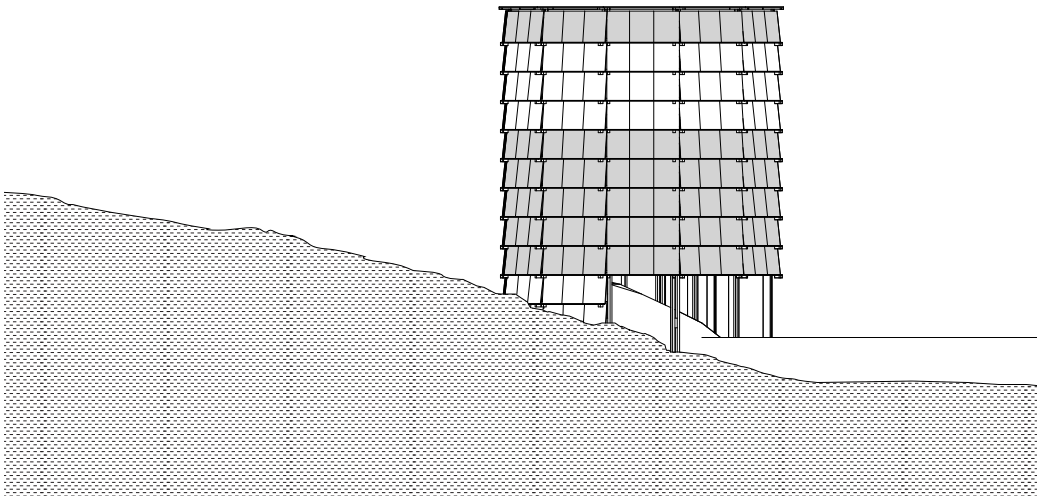


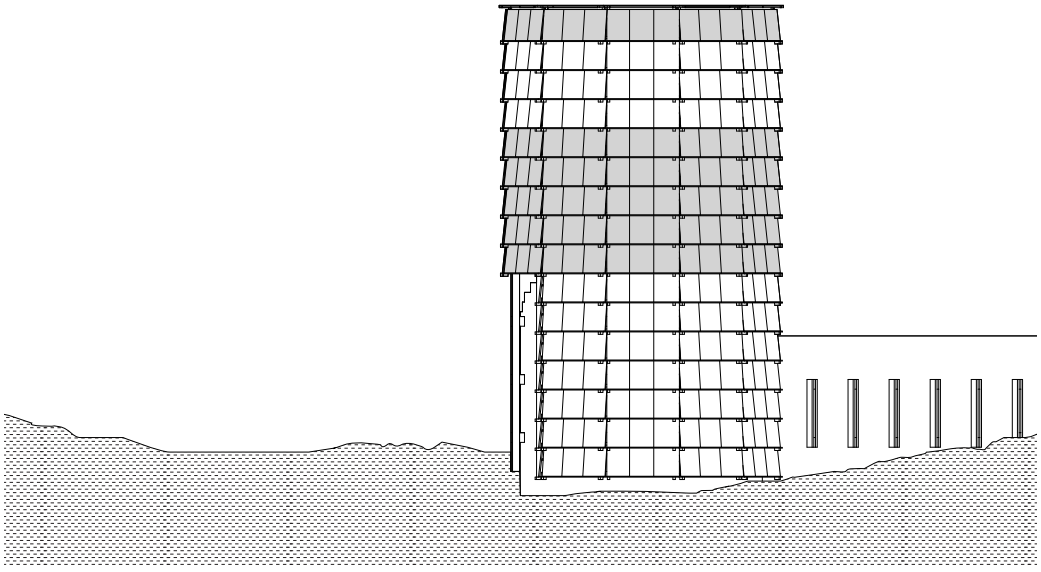


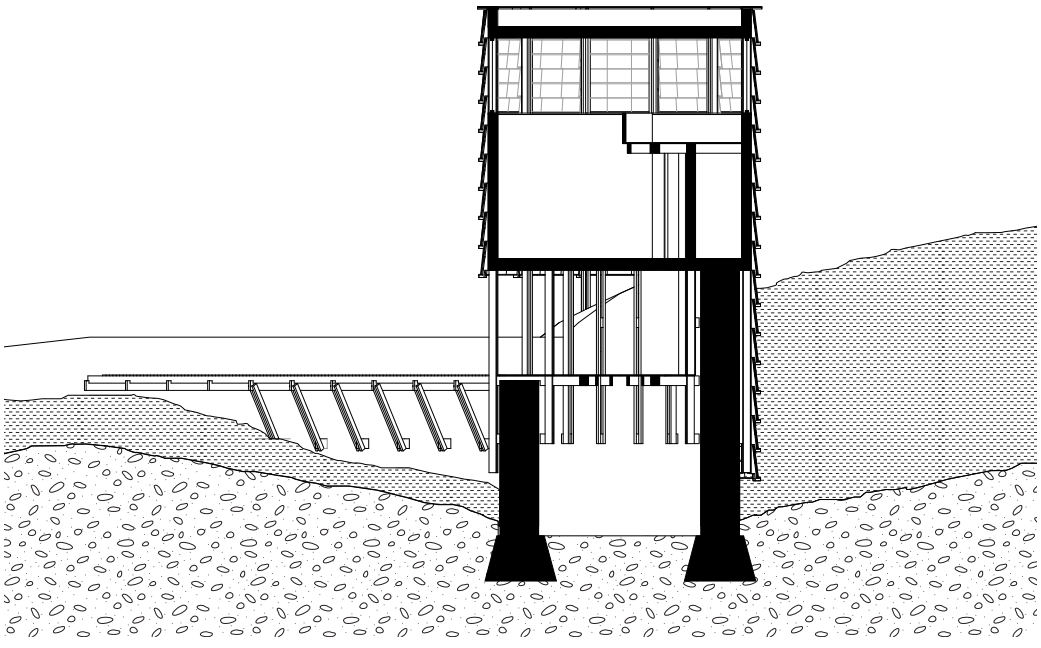
Top:
Plan second floor, 1:100

Middle:
Plan first floor, 1:100

Bottom:
Plan entrance floor 1:100



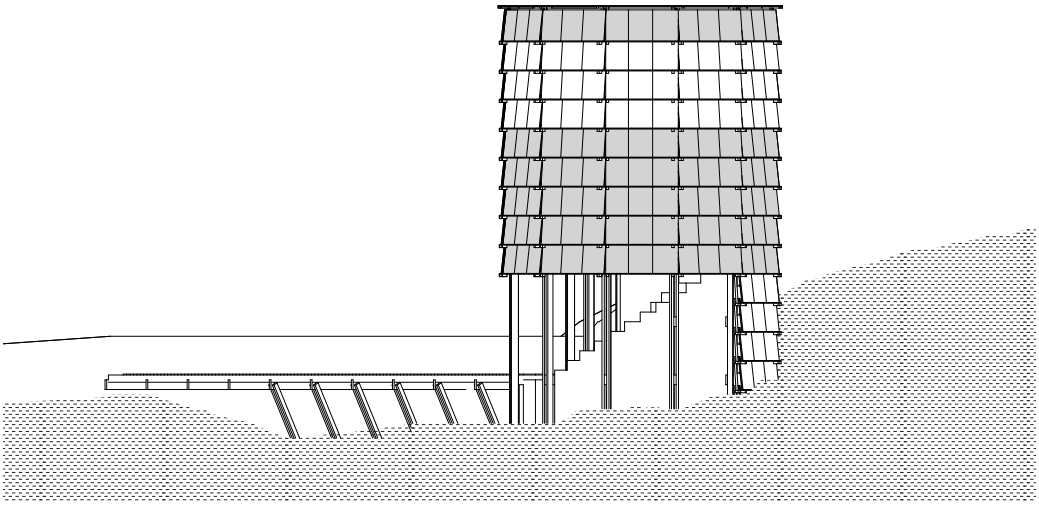


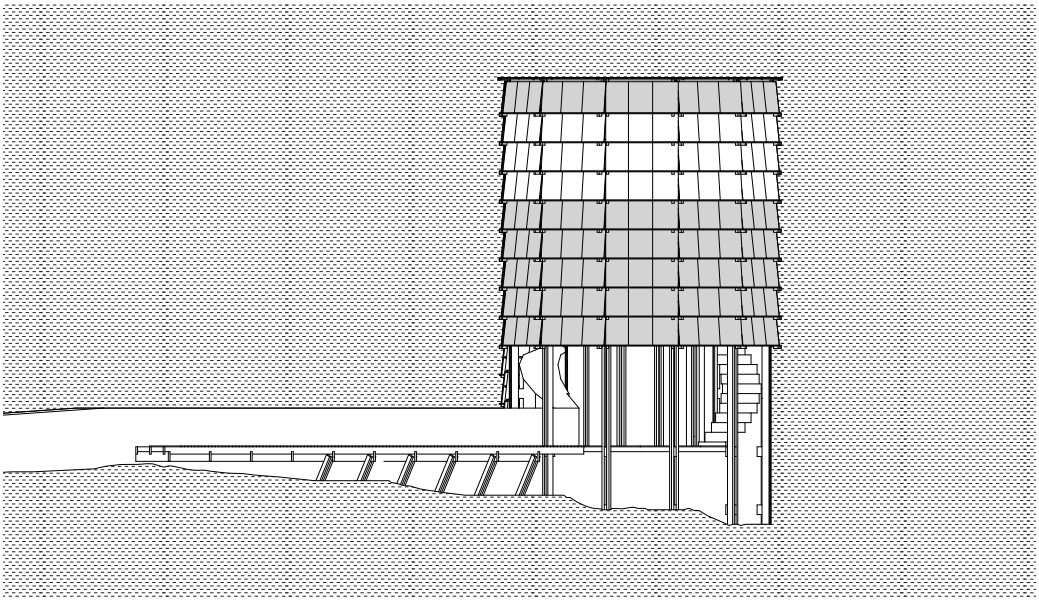


Top:
Elevation south/east,
1:100

middle:
Elevation South/west,
1:100

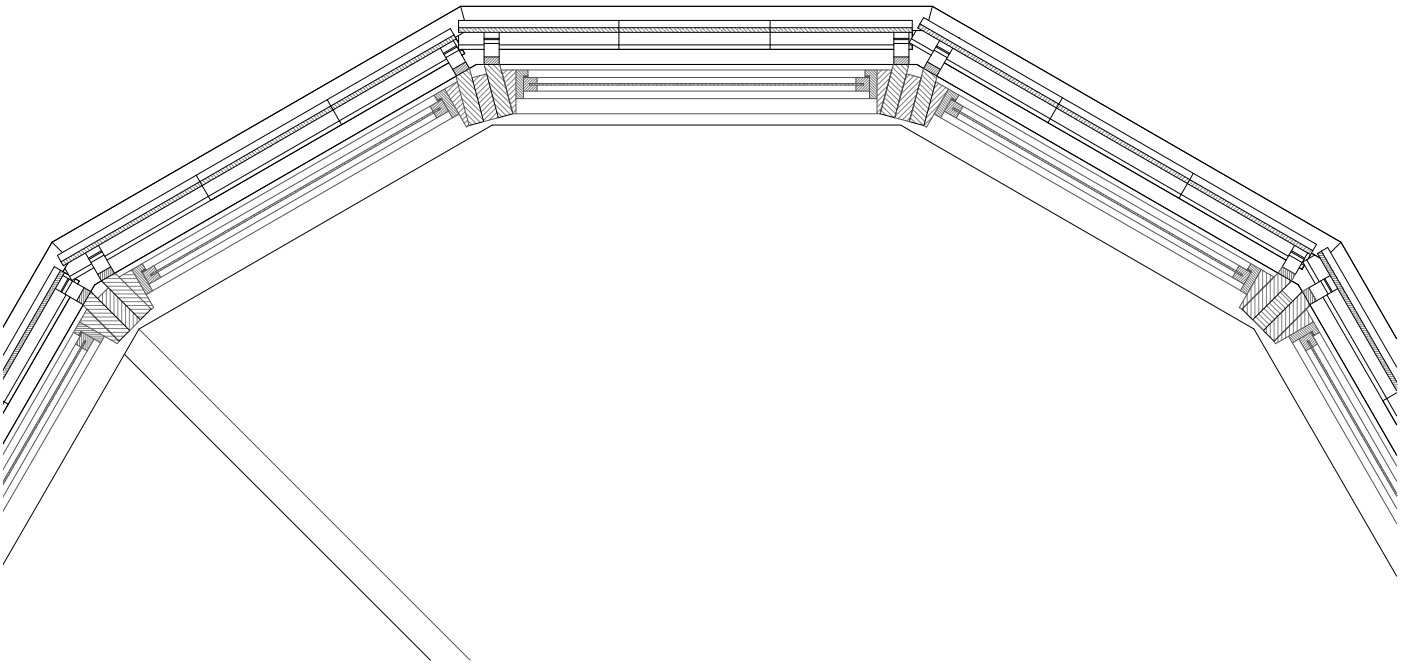
Bottom:
Section AB 1:100





Top:
Elevation North/west,
1:100

Bottom:
Elevation North/east,
1:100



Axometric exploded view from the facade of the shelter. the facade is a system of wooden slats that carry translucent or closed, wooden panels. The system offers more freedom in the size and placement of the panels, so that even parcially broken glass can be used, when found at the caserma.

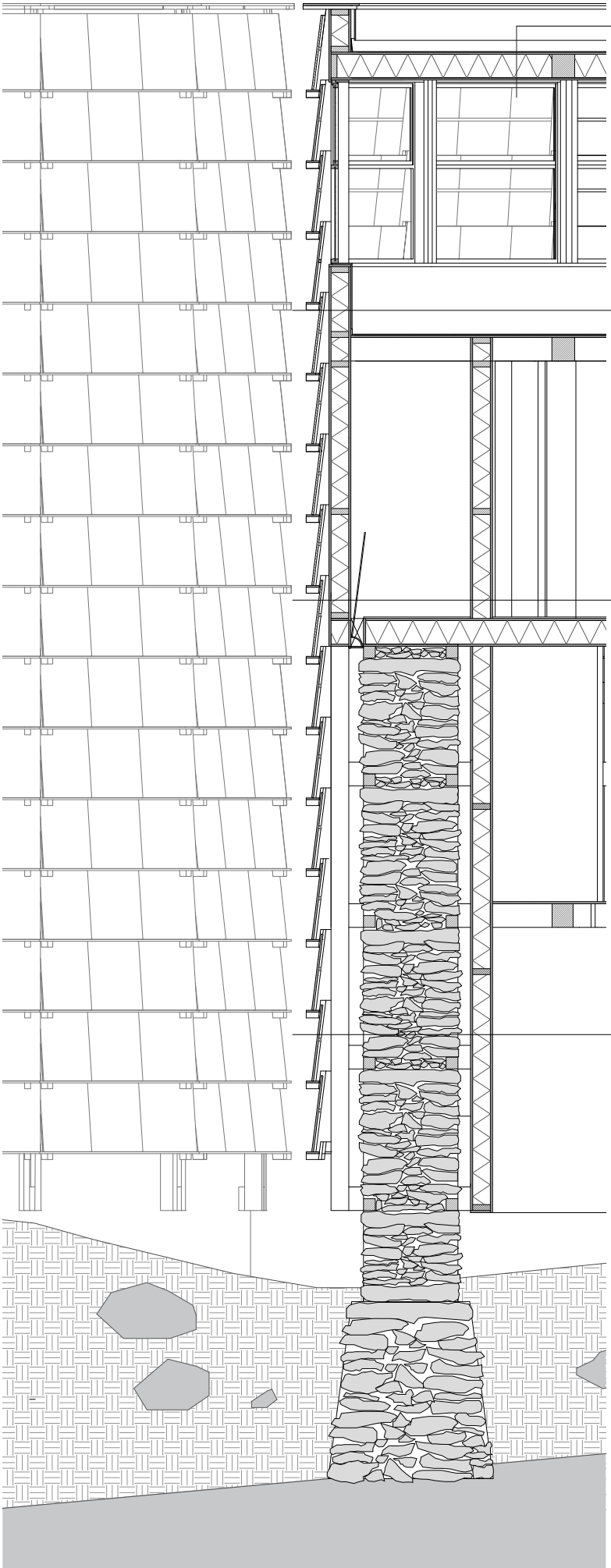
with the glass panels already as the outer layer of the shelter, the windows are made out of single glass frames. Single glass is easier and more sustainable to produce, and provides more options to recycle glass. At the top are windows that can can be opened for ventilation.

The section shows the same facade system, and the round dry stone wall that holds up the shelter. The wall continues down, widening at it foundation, which sits on the solid rock surface.

With the thermal mass of the dry stone wall and the glass facade in front of it, a trombe wall system is made. this is used to heat up the building during the winter. The small openings in the floor can be opened if hot air is needed by using the stick that operates the vault.

horizontal detail glass facade, second floor, 1:20

right page:
Section AB 1:20, showing the trombe wall system



From outside to inside:

roof covering
water retaining layer
wood panel multiplex 18 mm
grassfiber isolation 200 mm (R-value 5 m²K/W)
wooden panel multiplex 18 mm

From outside to inside:

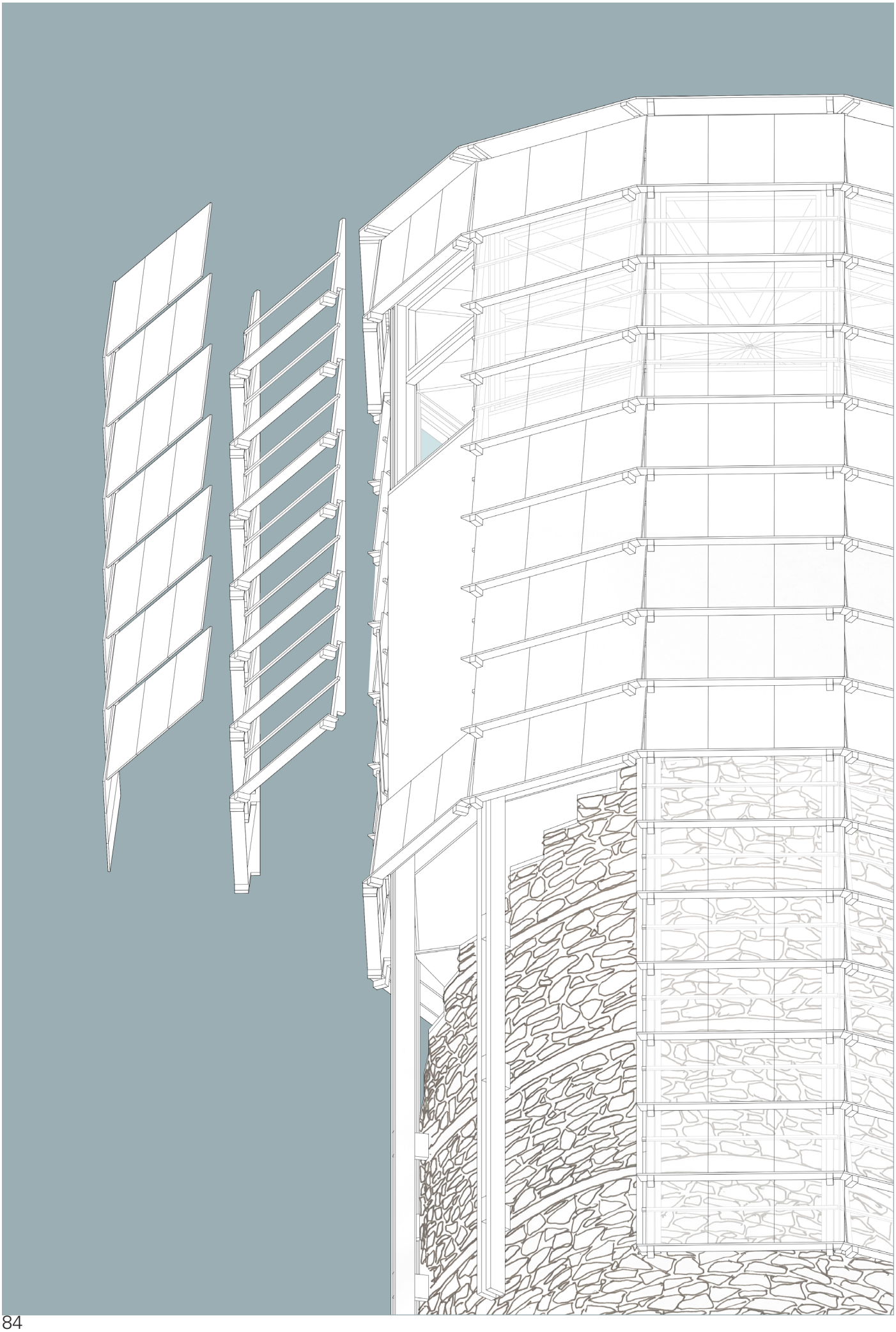
glass panels
wooden support system within cavity
single glass window frame

From outside to inside:

wooden panels
wooden support system within cavity
wood panel multiplex 18 mm
grassfiber isolation 150 mm (R-value 3,75 m²K/W)
wood panel multiplex 18 mm
plaster finishing 12 mm

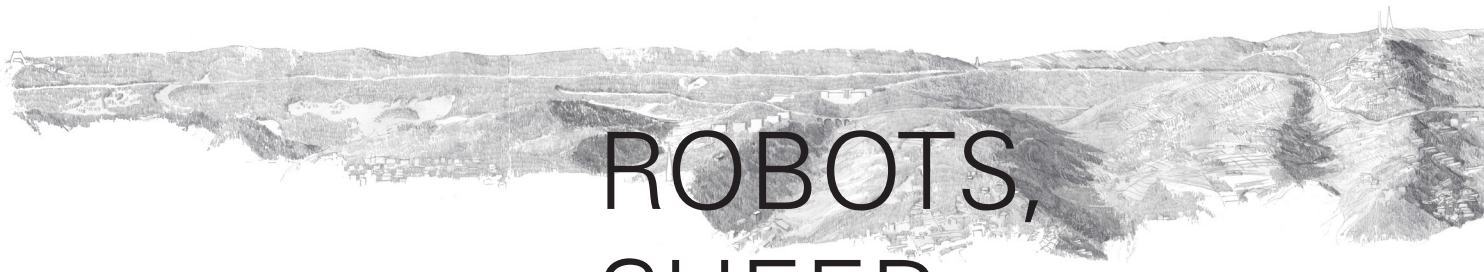
From outside to inside:

glass panels
wooden support system within cavity for trombe wall
dry stone wall 800 mm
wood panel multiplex 18 mm
grassfiber isolation 150 mm (R-value 3,75 m²K/W)
wood panel multiplex 18 mm

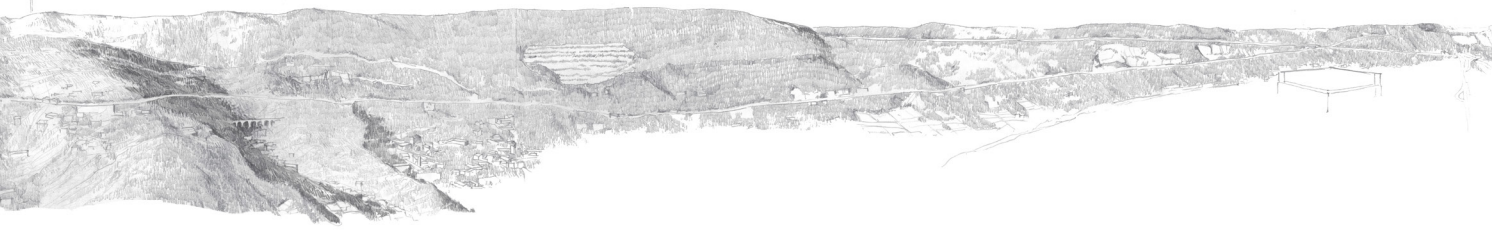


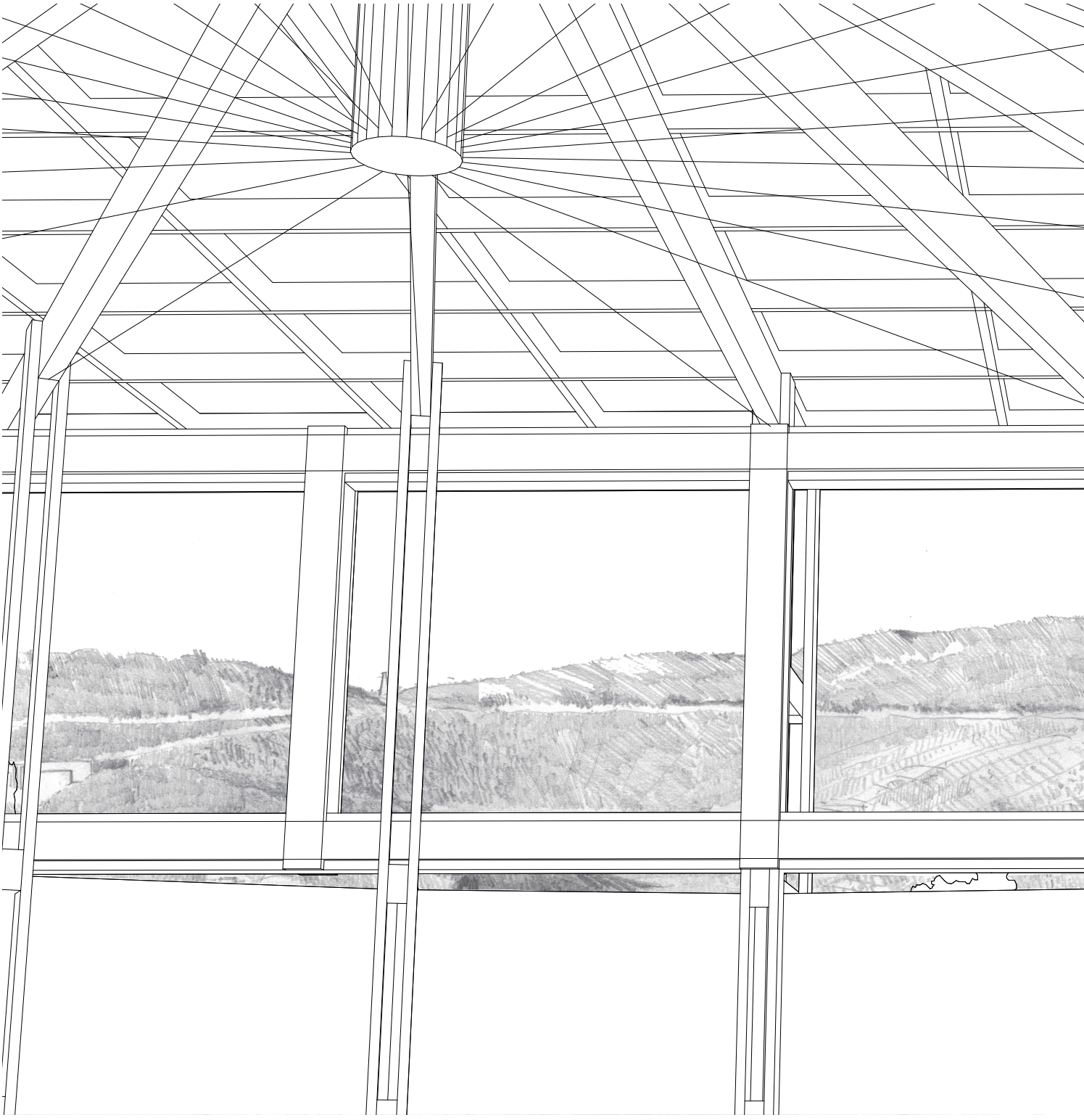
Impression of the shelter's two living floors interior. Only the top has windows, providing light for both floors. Upstairs is a place to sleep or work. Downstairs is a small living space and kitchenette.

Left page: Axometric exploded view from the facade of the shelter.

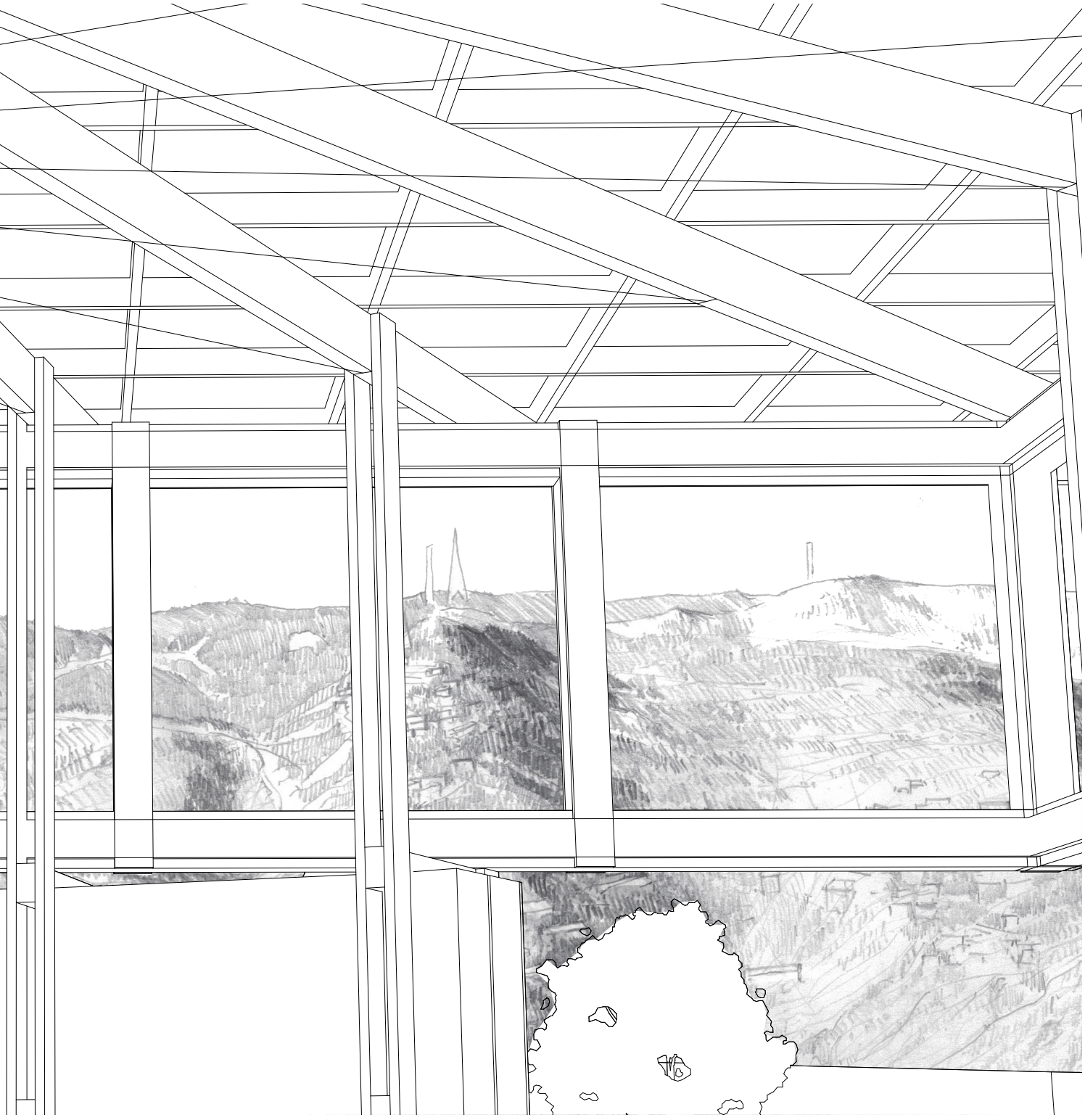


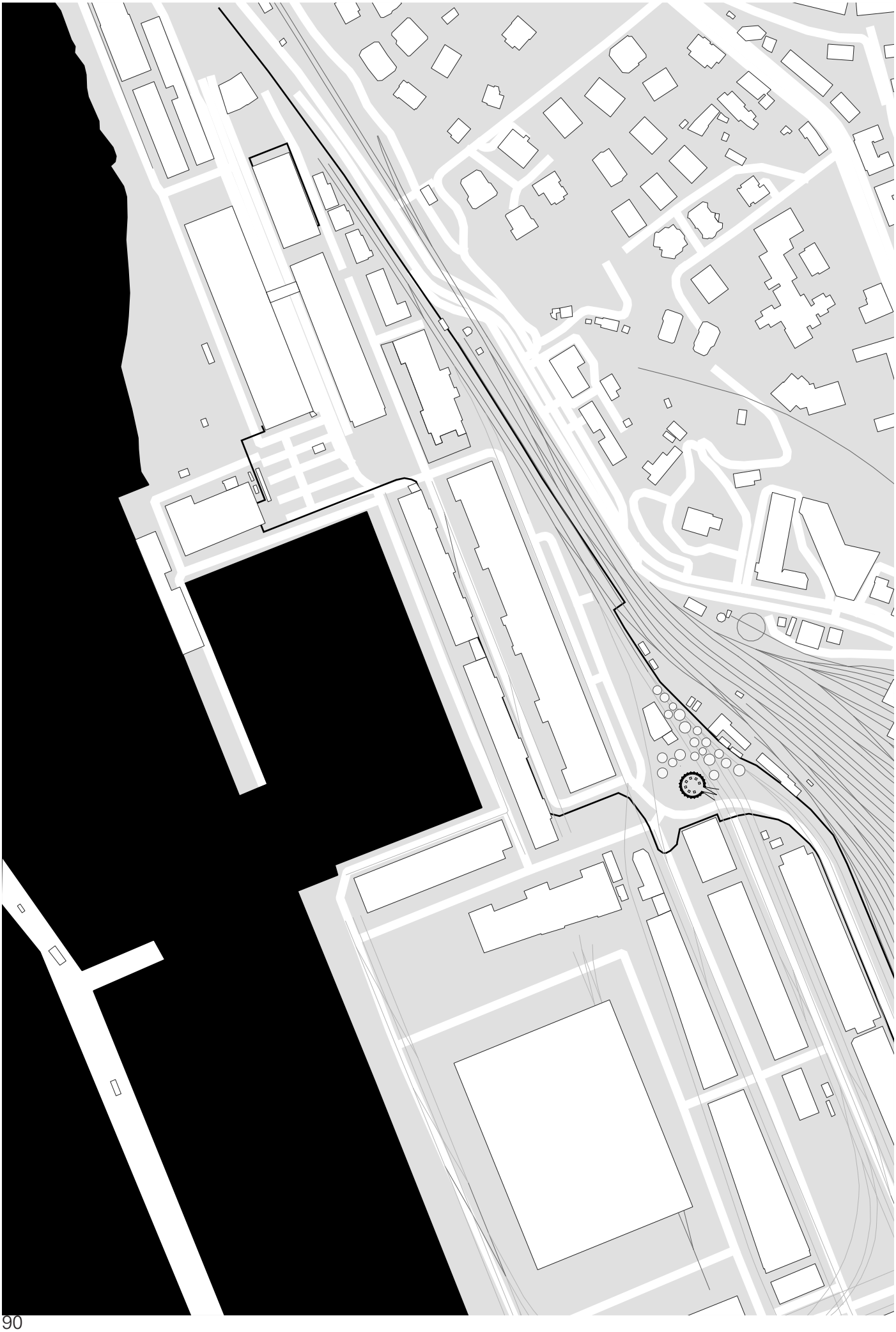
ROBOTS, SHEEP, AND ARCHITECTURE





EPILOGUE
A PAVILION IN THE HARBOR



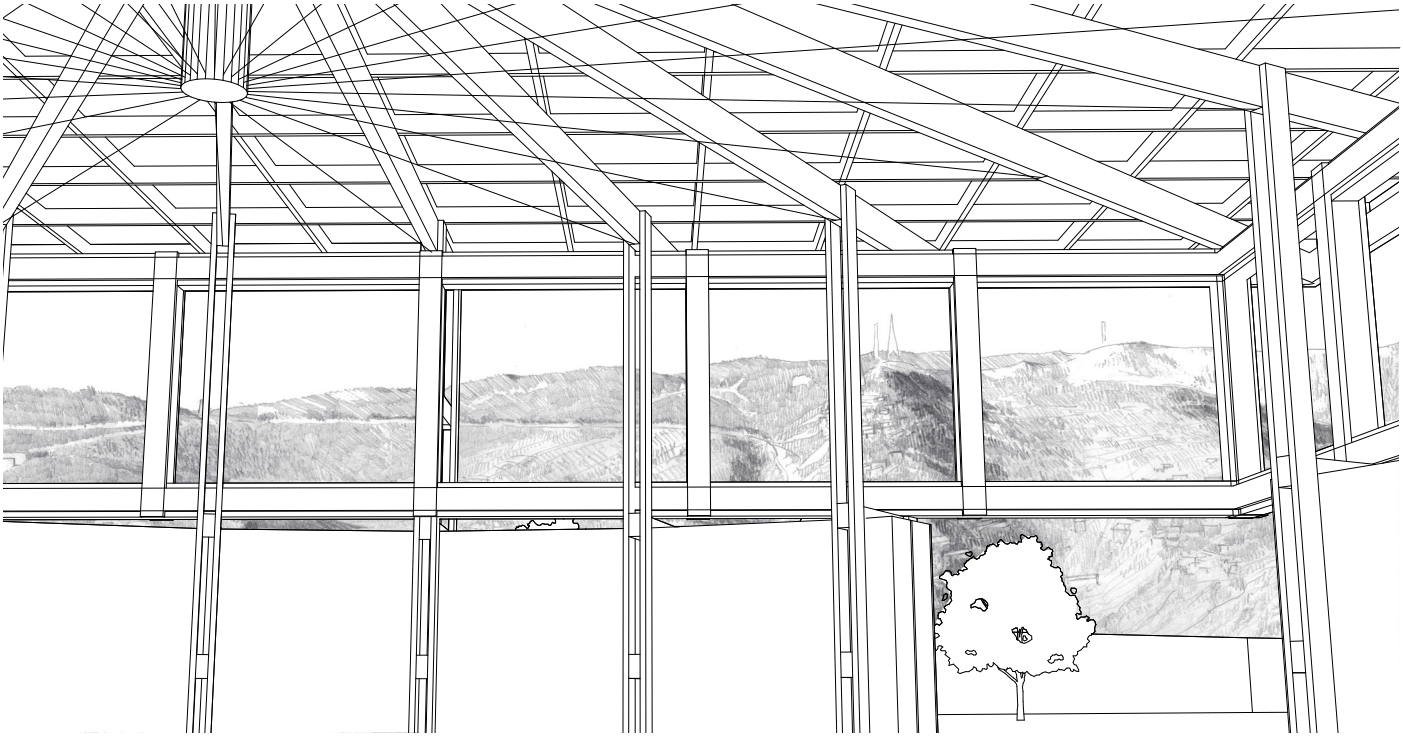


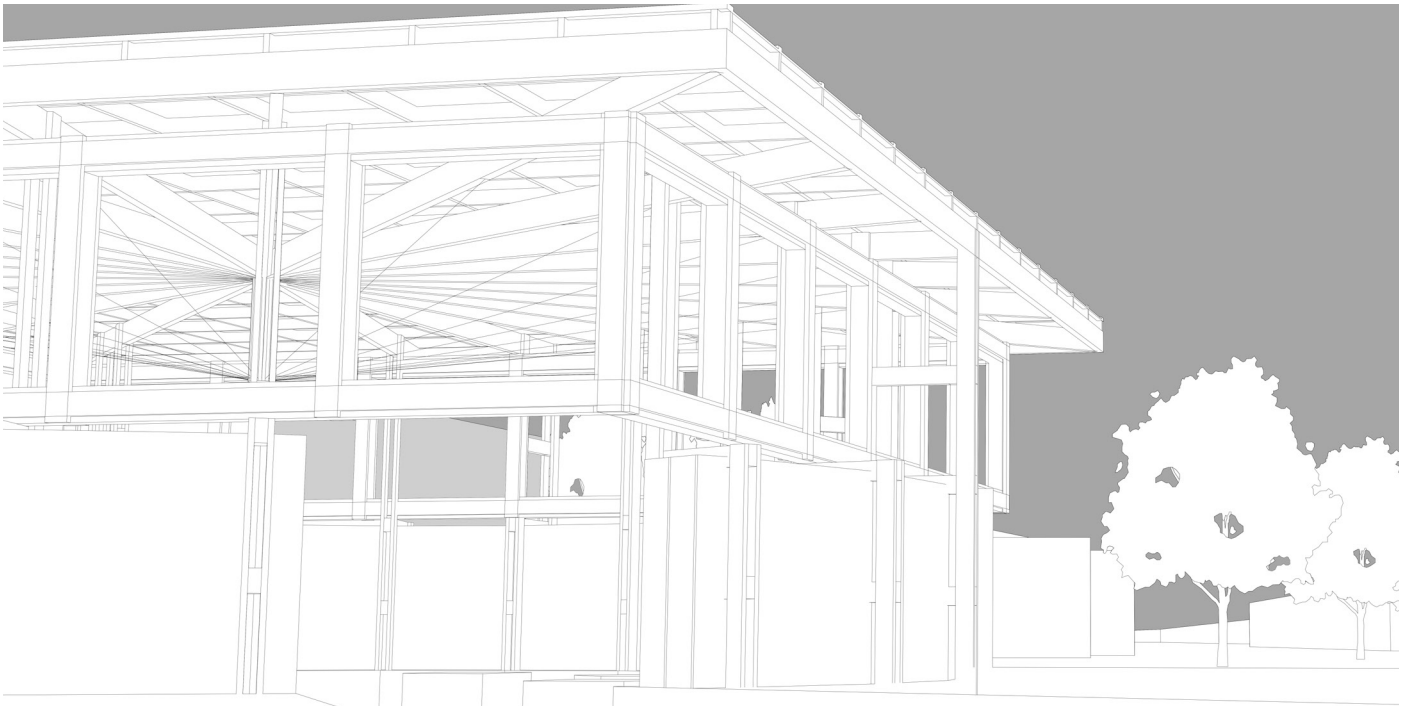
PAVILION
Design

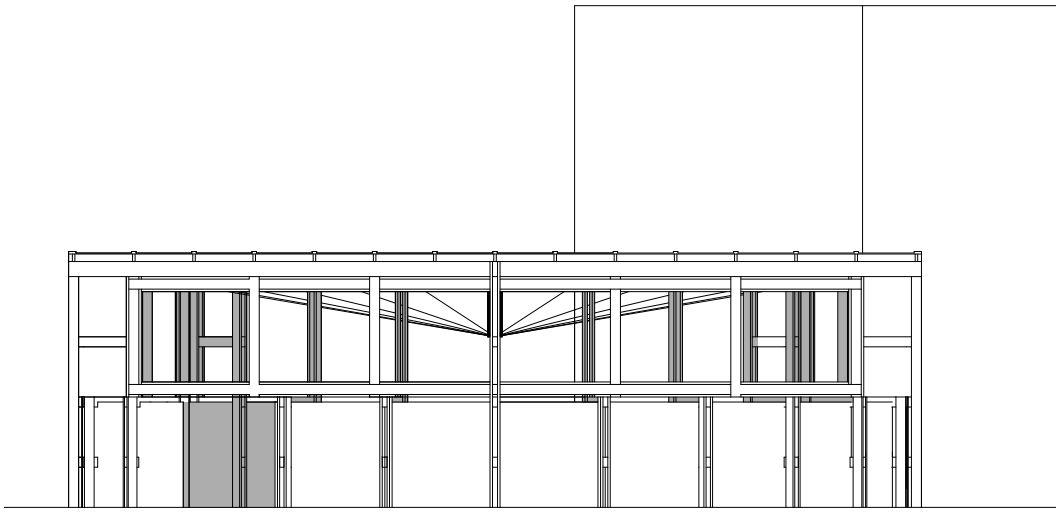
As mentioned earlier, the Karst has been a contested place. Located on the edge of the mediterranean world and the barbaric east, between western democracy and communism, and between Slovenia and italy. Wars have been fought, crimes have been committed, especially between the italians and yugoslavs with the foibe massacres. The Robots will come across other things then limestone. The pavillion slightly lowered into the ground, offers a final resting place for the relics of the past.

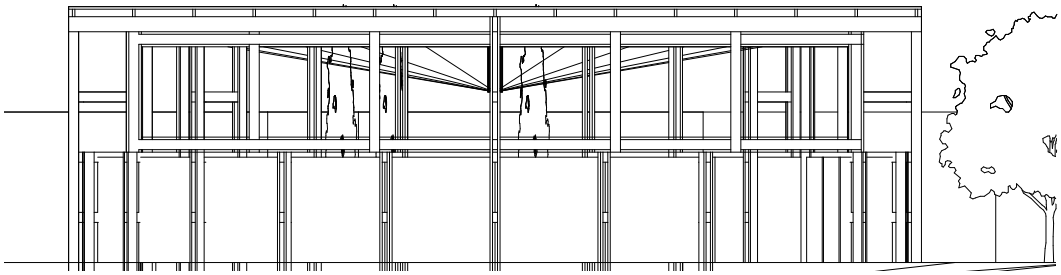
plan and situation of the pavillion, located in the old harbor of Trieste

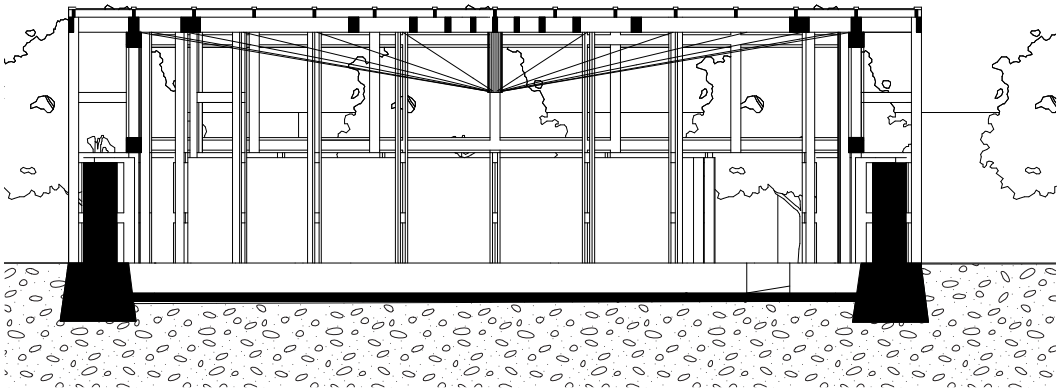
Left page:
Situation of the pavillion in the old harbour, 1:5000











Top:
Elevation east

middle:
Elevation North

Bottom:
section of the pavillion, upon entering you will decend 600mm to the slightly lowered floor.

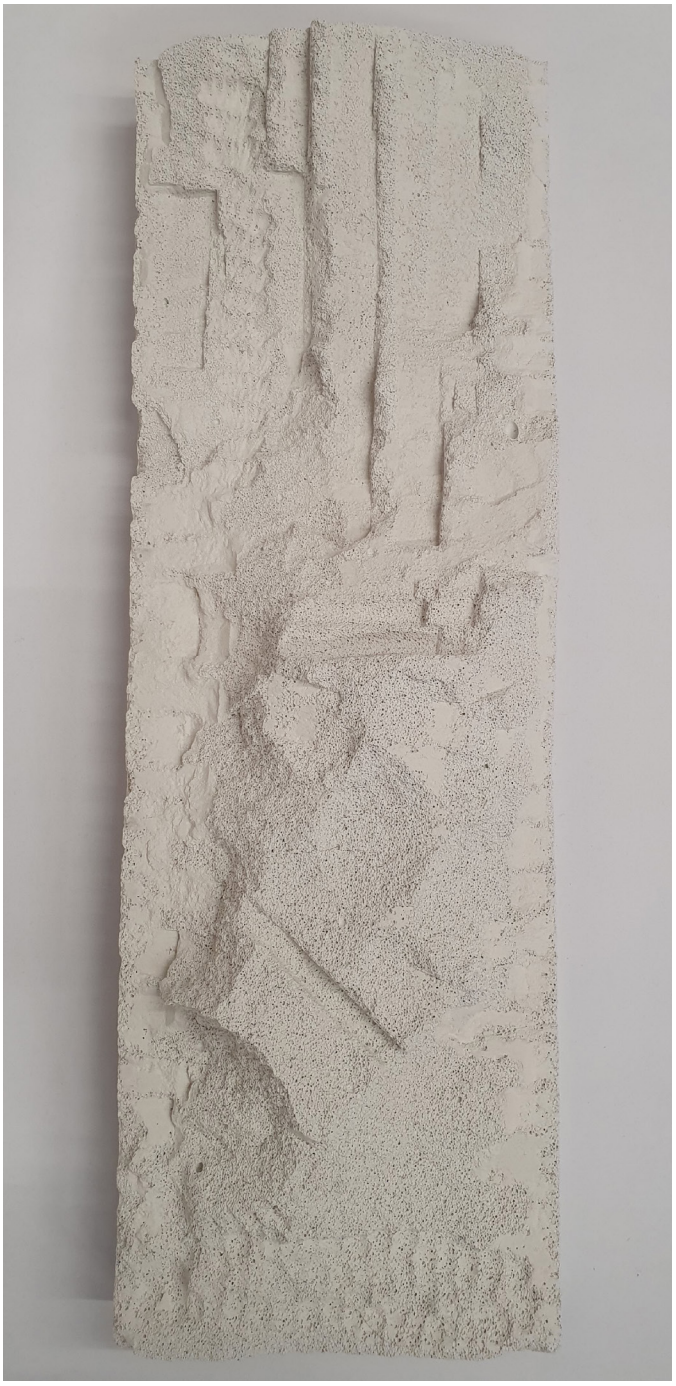
MODUS OPERANDI
DESIGN

SITE
Traces of technique in the landscape

excavation/displacement/erection.
With the models of the first week, I tried to explore how the project would alter the site or territory. The poured model is a 1:2000 model of the practice terrain site, next to the caserma, on the edge of the Karst. The model visualizes the effect of excavating in relationship to the natural sinkholes already present. It further shows a direct relationship between the material excavated and placed back within the digged hole.

The excavation model further explores the used tools and techniques and how they affect the landscape. What kind of traces do they leave behind; to not only think about the material gathered but also about the holes left behind in a direct relationship. For the model i made my own tool, in addition to standardized ones, in order to preserve most of the excavated material.

Right page:
pictures of casted landscape model, representing the location of the caserma. Edited with different cuts and displacement of material

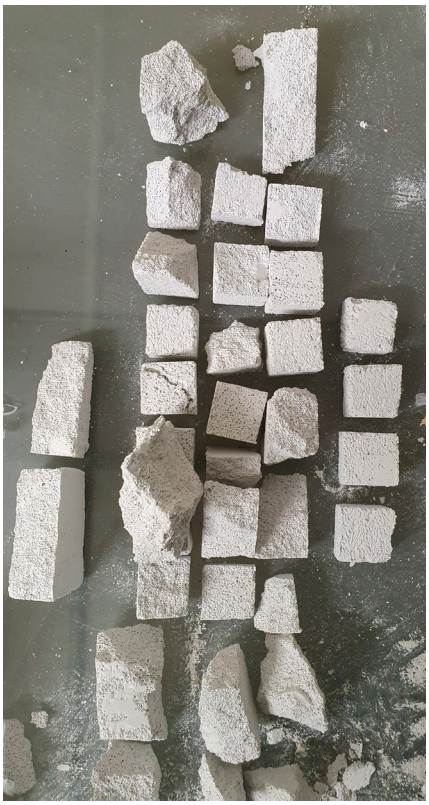


20mm
10mm

ASSEMBLAGE
Material and how to edit

Tension/ friction/ pressure.
With the models of the second week, i wanted to explore the potential of limestone, as well as raw stacking of materials. The models were used to explore the potential of traditional dry stone wall techniques, and how to improve upon them. Through combinations of pressure and tension, or with more precision, using steel rods.

Or should the material be slightly altered for an easier construction. With the models i explored a spectrum of alterations, and how these can be used to assemble the model. Altered in one direction, two or three - when does it become just another brick in the wall.



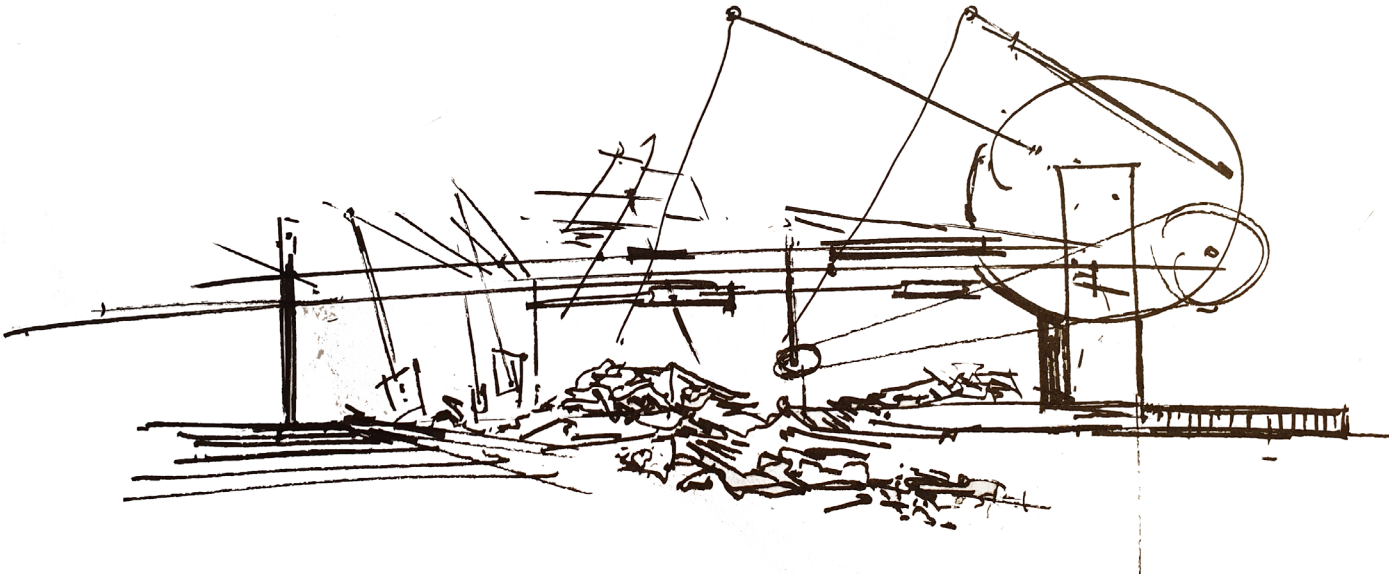
ATMOSPHERE
The machine and the landcape

For the last week of the modus operandi i wanted to make a machine that alters the landscape. A mechanical model that explores the relationship between the territory and the machine. It was interesting to see actual mechanical movements adjusting the ''ground'' underneath, as i tried to simulate this with the excavation model from the first week. But as with all handcraft, i easily became distracted or intensified on specific areas.

The machine is driven by one rotation handle that drives a big wheel directly. A metal rod fixed on the outer diameter of the big wheel drives a slide back and forth along a guiding rail, transferring the rotation into a horizontal motion. A second wheel, connected by two gears, rotates another pole. Differences in the circumference of the pole, with leaning iron rods create an upwards lifting motion that scoops that terrain underneath. The model becomes a mechanical space itself, continuously changing the landscape underneath.

Right page:
sketch of the machine in the landscape, before it was constructed out of wood and metal rods.

close up picture of the tool used by the machine



Pictures of machinal model, that works on the landscape.

Pictures of the functioning of the machine, its motor and mecanics.