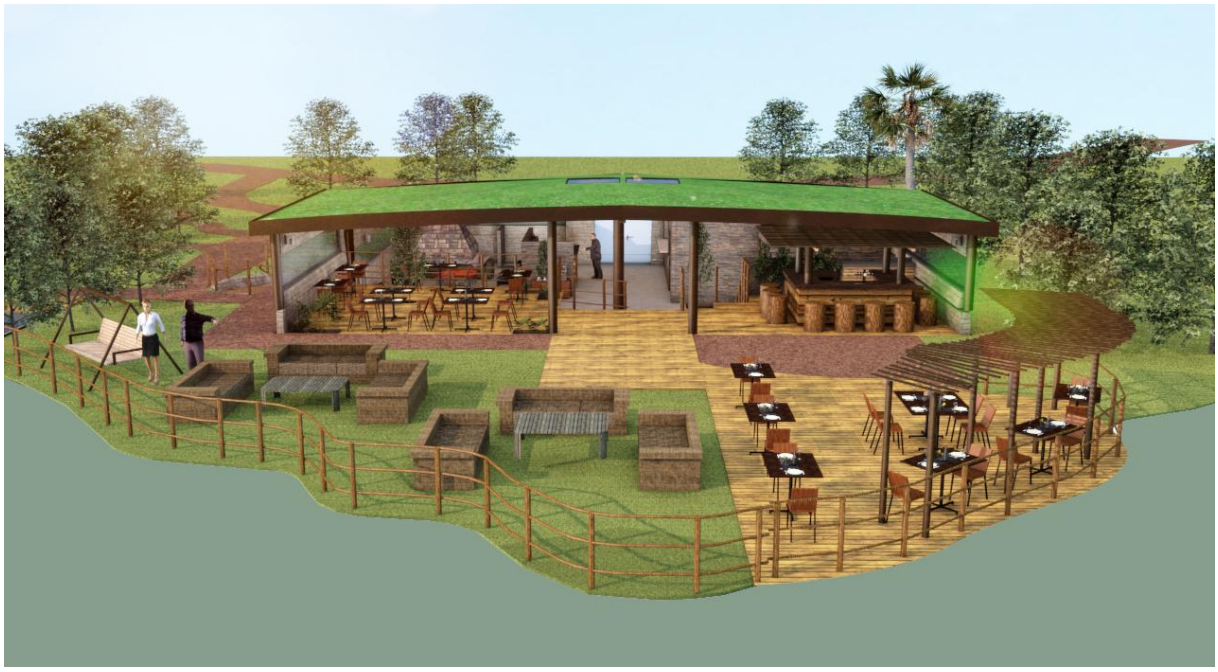
Eco-Green lodge

Design a sustainable wildlife accommodation



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Summary

This graduation assignment shows you how we came to our design from the start, September 2011 (Holland) to the end, January 2012 (South Africa).

When we get our assignment 'design an eco-green wildlife lodge' we didn't even really knew what a lodge was so we did some quick research about it. We saw some examples from all over the world which gave us the first idea of what was meant with the assignment.

The first thing we did was do a lot of research to sustainable materials and building methods. We collected a lot of useful information and with that we could already think about that part of our design. Because we decided to make it a (partly) self sufficient and to use as much sustainable materials as possible we gave ourselves a big challenge.

While we did our research to all the sustainable possibility's our boss found a location for our lodge, later we had actually the choice between two sites in the same reserve. The reserve we are talking about is the *Kariega Game Reserve*, a private game reserve in the Eastern Cape, South Africa. Before we went to the reserve we had an appointment with the owner. We talked about the ideas he had for the site, what it was that he had in mind en what he liked. A couple of days after that appointment he took us to the reserve for a visit at the site so we had a first impression about the environment and the surroundings. After that visit we had a couple more, because it was really important to know about the place where we're designing for.

We started thinking about what we actually want for the rooms and step by step the design changed and changed. Once in a while we talked about our design with our boss and we switched thoughts about what was good/bad or could be better and so, step by step, our design turned into what he is now. After we as good as finished the design of the rooms we went further with the main lodge. We worked the same way as with the rooms; we made something and with a lot of discussions we came to the result which is extensively spoken in this report.

While working on this assignment we found out that way more things are influencing the design than we first thought. Things like the animals walking around, amount of guests in relation to the amount of rangers and a lot more things. With every chat we had with our boss, the owner of the reserve, rangers or other co-workers we received new things to think about and to take with us for our design.

First we made sketches, from that sketches we worked to 2D drawings on the computer and the last step was making it more and more real by drawing the main lodge and the rooms in 3D. Especially because of the last drawings in 3D, we get a nice and clear view of our design and we're actually very proud of the result.

1 Introduction

In front of you, you can see our graduation assignment about the design of an Eco-wildlife lodge. This challenging project in South Africa made us decide going to Port Elizabeth. After going to China for our excursion abroad we found out that we want something more.
Green Leaf Environmental Standard was the company who was interested in students for sustainable building projects, Green Leaf is a company what does certifications for the currently built tourism industry. They check about everything about lights, kitchen, staff etc. to get more sustainable and reduce the costs of running the, for example, hotel. For the company it was challenging to trigger students for designing a new concept what is fully eco so that they can promote it in their industry. For us it was a perfect way to use all our Dutch experience in a new country, a country what got an upcoming economy, but still behind the European standard.
The main subject of the project is make it sustainable and environmental friendly, we can introduce 'new' installations and there are no barriers.

For the whole designing progress we have the opppurtinity to use a piece of land in the Kariega Game Reserve. The reserve got some new land where they actually want to built a new lodge.

In the next pages we will lead you through the assignment step by step, the location, working out our goals and the requirements, the sustainable installations and then further to the final design of our Eco-Wildlife lodge.

Hope you enjoy reading this assignment about the design of an environmental friendly, sustainable lodge.

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3 Schedule of Requirements

Version 2

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Before we can start with our design, it is important to make a list with all the requirements. With all these points listed we can start with the design of conceptual Eco-wildlife - lodge.

Definition of the project

Design a high – rated green wildlife- lodge what is sustainable, partly self sufficient and natural designed. We will mostly use natural materials to connect the nature, building and wildlife, and show the South African building business what is possible with creating a different way of building (new or less used sustainable solutions).

Boundary conditions

In this part we will describe the main requirements of our lodge. Which points and regulations we would integrate in our conceptual design.

- Sustainable
    - Materials
- Self sufficiency
    - Water management
    - Energy management
- LEED (Leadership in Energy and Environmental Design)
- Sorted waste disposal
- Integral design
- Implement in the environment (design)
- Bushy feeling, privacy
- 4 star-rating; hotels and lodges (*South African Star Grading System*)
- Looking less luxurious than it in fact is
- Don't make it a fabulous hotel but a natural designed lodge
- Local materials (preferred)
- Low maintenance level, it should look (almost) the same after a few years
- Back and front of the house always separated, the site must be designed well
- Rooms; outlook from inside to outside important (from bed/bathroom)

Rules and legislation

- South African National Standard (SANS)
    - Environmental management
        - Environmental performance evaluation
            - Guidelines
        - Life cycle assessment
            - Principles and framework
    - Environmental management systems
        - Requirements with guidance for use
        - General guidelines on principles, systems and support techniques
    - Responsible tourism
        - Requirements

Technical aspects

- Self-sufficient
- Natural ventilated
- Totally of grid system
- Low energy equipment (as LED)

Requirements of the design

It is appreciably to make a list of requirements with all participants:

- The project plan is located in the Kariega Game Reserve.
- The site got an outstanding view, next to the Kariega river. The plan is currently partly bushy and untouched.
- It is situated on a slope, part of the mountain.
- Functions in the buildings:
    - Main Lodge
        - Eating (restaurant)
        - Meeting
        - House holding
        - Reception area
        - Lounge
    - Main Lodge
        - Sleeping
        - Chilling
- Size, shape
    - Natural design, with a natural shape
    - Capacity of max. 16 guests (
    - North - east orientated (wind)
    - Designed in the bush, uphill
- Lay-out the building
    - Bedrooms; 7 rooms size +/- $50m^2$
    - honeymoon suite; 1 room size +/- $50 – 60m^2$
        - Place for kingsize bed
        - Luggage place
        - Coffee station
        - Couch/2chairs or both
        - Hang place jackets etc.
        - Small fridge
        - Less lights
    - Bathroom;
        - 2 water basins, mirror
        - Shower
        - Bathtub (only in the honeymoon, the rest eco)
        - Dressing area
        - Toilet, separate/closed in the bathroom
    - Outside
        - Deck
        - Private shower
    - Low roof
    - Main lodge; +/- 300m2
        - Bar counter
        - Library place for a few people (living room feeling with some books)
        - Lounge area
        - Eating areas
            - Inside
            - Outside -> deck
            - Fire place -> kind of a braai experience
        - Entrance
            - Manager

- Reception
- Small shop

- Main lodge; +/- 300m2
  - Office
  - Kitchen
  - Fridge
  - Storage room
  - Public toilet
  - Central outside pool
  - Technical 'Room'
- Back of the house;
  - Laundry room
  - Outside Drying
  - Housekeeping
  - Storage
  - Garbage
  - Water basins
  - Parking places
  - Sleeping facility for staff (max of 15 persons)

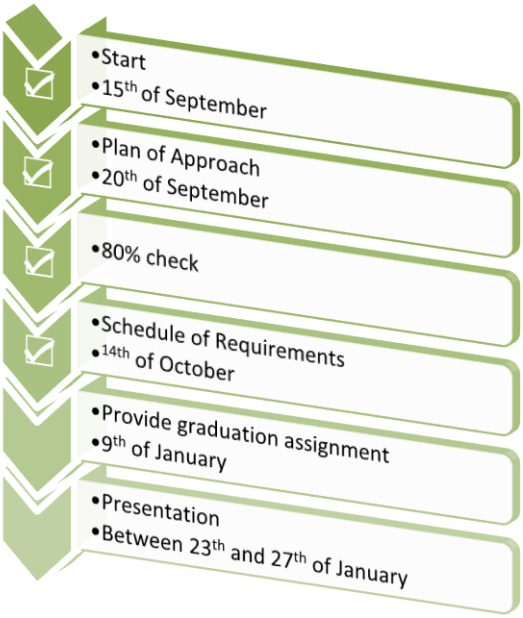
Financial aspects

Owner of Kariega Game Reserve will invest in this property.

Project procedures

We will roughly work on the same researches, especially in the beginning of the assignment. When the research progresses and we could start with our design we will work more separately on our specialization. Kevin more with the architecture of our Lodge and Pim more about the engineering and the building physics but still all the decisions we'll make together.

Time schedule



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4 Location

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Kariega Game Reserve

Green Leaf Environmental Standard (further on called *Green Leaf*) asked us to make a conceptual design of a eco wildlife-lodge. One of the things left was to find a place where the lodge really could be built. *Green Leaf* has a big network of lodges all over the country and they succeed to find a place for which there are real plans to build a new wildlife-lodge; the *Kariega Game Reserve*.

The Kariega Game Reserve is located in the Eastern Cape Province of South Africa, between the Kariega Queen River and the Bushmans River. It is situated at the end of South Africa's famous Garden Route (starting at Cape Town), 14 km's from Kenton-on-Sea and 141 km's from Port Elizabeth. The reserve is 9000 hectares and spans across five different eco-systems (riverine forest, valley bushveld, savannah grasslands, fynbos and acacia woodlands). In the reserve live more than 25 species of game and more than 250 species of birds. In the reserve there are four existing lodges, in different kinds of environments, scattered over the area and a new one is welcome.

Environment

The *Kariega Game Reserve* is a big reserve with 5 different eco-systems and a lot of difference in nature and with that many different views. In the area there are mountains, rivers, open fields, forests and with that a lot of different kind of animals.
For our design we have to look at the nature, because it's important that the building isn't that eye-catching as many architects want their building to be, but it has to be commune with the nature. The place of our lodge is very important for our design because it makes a lot difference if it situated in the forest, near a river, at the face of a mountain or wherever.
The main thing is that we, with building this new lodge, don't bother the nature and all kind of animals that live in the *Kariega Game Reserve*. On the site where they want to built a new lodge there is only nature at the moment. We don't want to bother the nature so it is real art to make a building which the nature can live around.

Our exact location

Our site is located in the Kariega Game Reserve district Harvestvale, the property is bought a few years ago by the owners of the Kariega Game Reserve. The size of the exact location is 55 hectares and is situated on a little hill next to the Bushmans river.
The location got a amazing view over a nice flat area where the animals are living, you can see Giraffes etc. You can see the nice Bushmans river flowing along the hills.
There is a lot vegetation on top of the hill which can be used for integrating the lodge into the bush. Only the location for the rooms and the main lodge should the bush be cutted.
The lodge will be designed on top of the ridge which offers an outstanding view, underneath this ridge there is a steep slope.

The orientation for the plan is north – east, perfect for designing against the wind, most of the time the wind is coming from the west.

There are different ways for our design, we can design the lodge and the rooms on top of the ridge there is a big flat area. If we design the lodge more on the flat area the view will be worse.
When we create the lodge on the edge of the ridge the view would be great, now we can think about designing it on the edge (on the flat area), on stakes or integrated in the mountain.

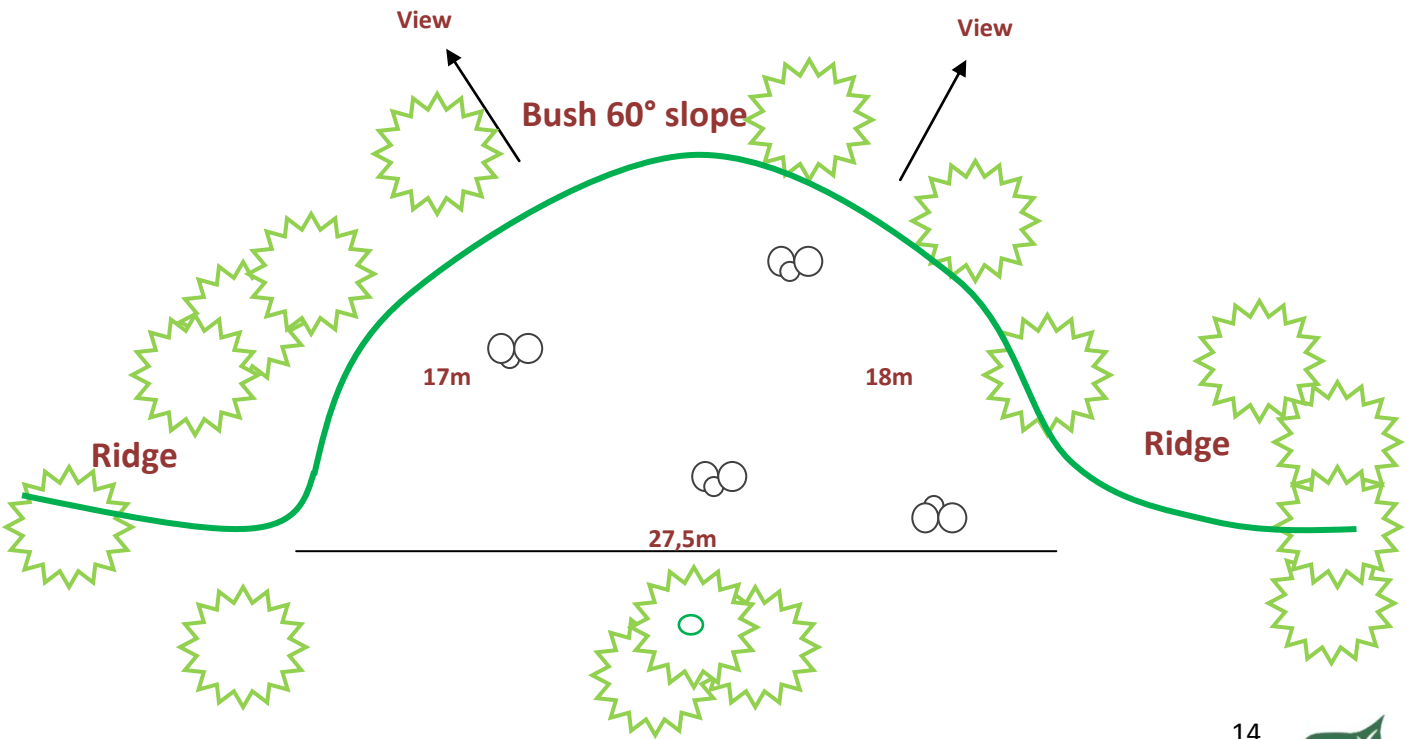
On top of the Harvestveld area there are no big animals as giraffes or elephants the only animal what could walk there are cats, impalas, ostriches etc, but normally they wouldn't be there.
For safety reasons of the lodge we won't need any extra borders.

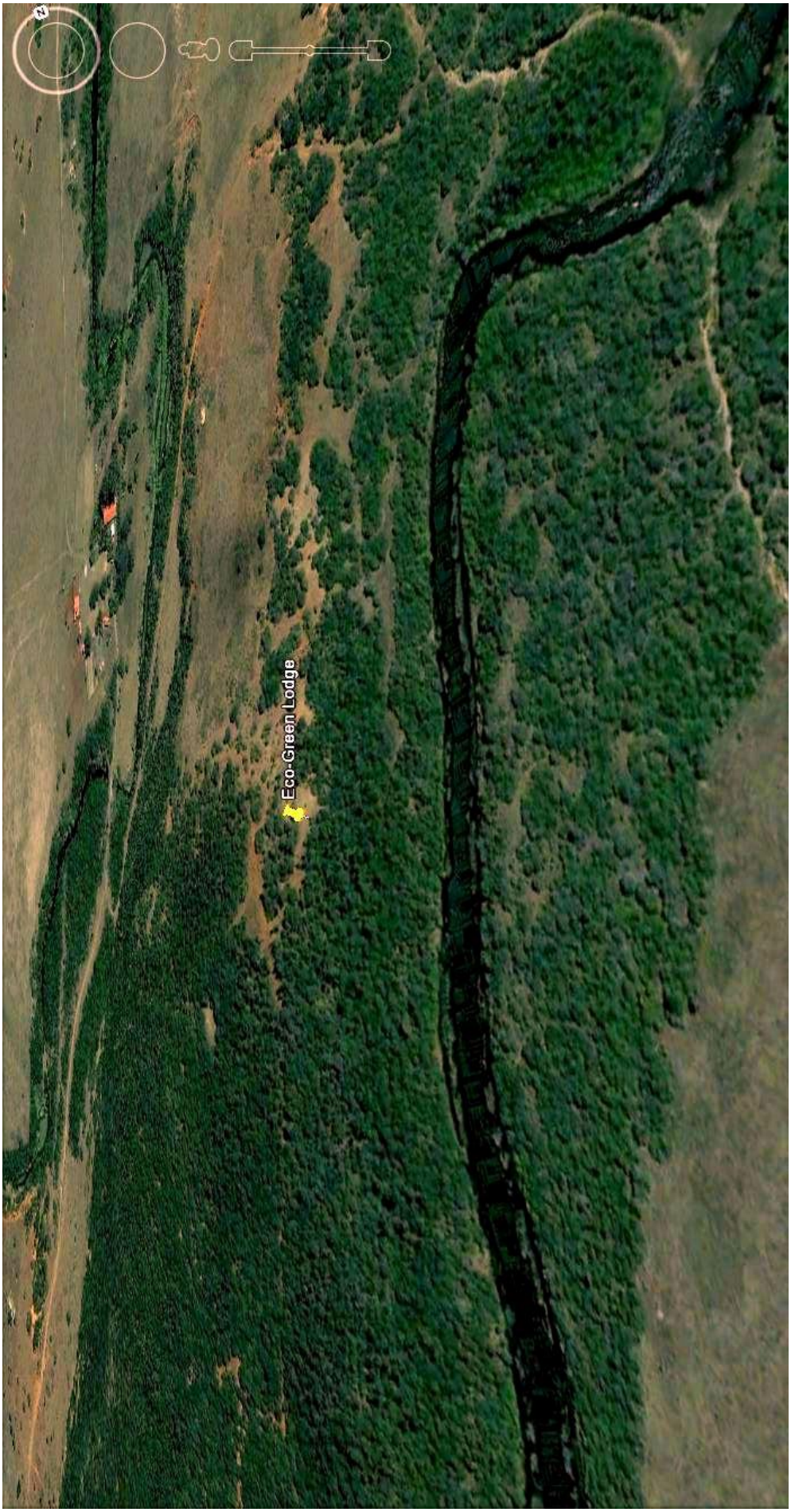
In the next pages you will get a better feeling about the location.

(see inset 4A for more maps/pictures of the location)
(see inset 4B for more info about the other lodges in the reserve)

A open space on top of the ridge, outstanding view, perfect for some facilities of the main lodge.

Sketch measurements of this space:




Eco-Green Lodge

Composition of the soil – landslides

In South Africa we have 73 different Soil forms, defined by the nature of the topsoil; organic, humic, vertic, melanic or othic.
When we did a site visit we researched the ground on the surface level, there were many rocks in the ground but also sand on top. When we were walking more to the back of the surface we saw a natural path from the rain. the soil was more looking like clay (kinda red). Knowing this we had to research about the soil conditions in the area.

In the Grahamstown area (biggest near city with information) there are different vegetations; namely, Eastern Cape thicket, grassy fynbos, semi-arid karoo and sourveld grassland.
The dominant soil type is clay, which is relatively infertile, shifting into acid soils in the surrounding hills - home of the grassy sourveld.

In our design we will assume that the ground is stable for founding on surface level. For exact details of the ground a geodesic have to make samples of the ground on different levels (pressurize the ground).

On our site we can't say we have one sort of soil. The soil is a mix of stone and clay. These two materials variate each other, layer for layer.

Ground temperature

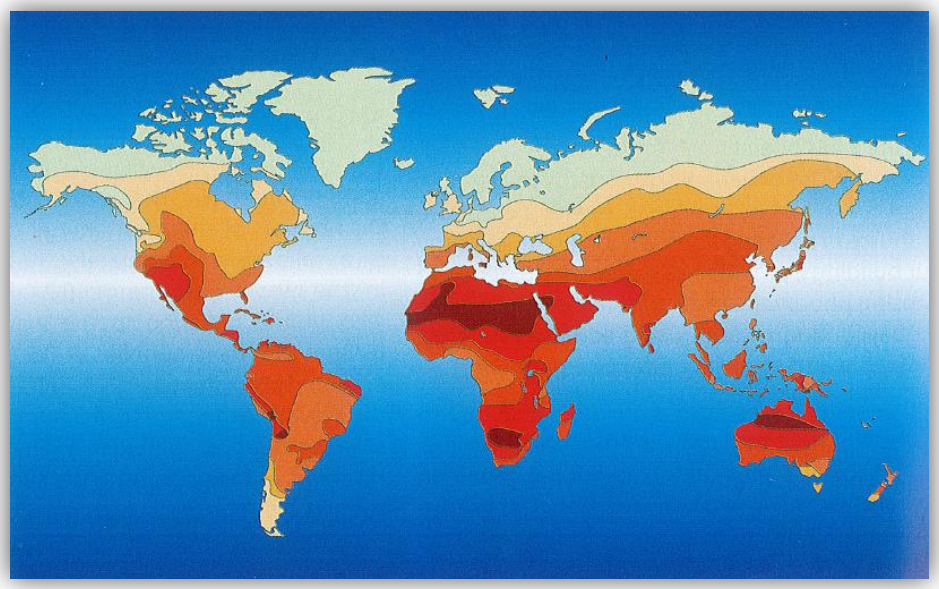
The temperature of the ground is about 18 °C. It is a few degrees below the average temperature during the day but it is nice to work with for a constant room temperature.

Landslides

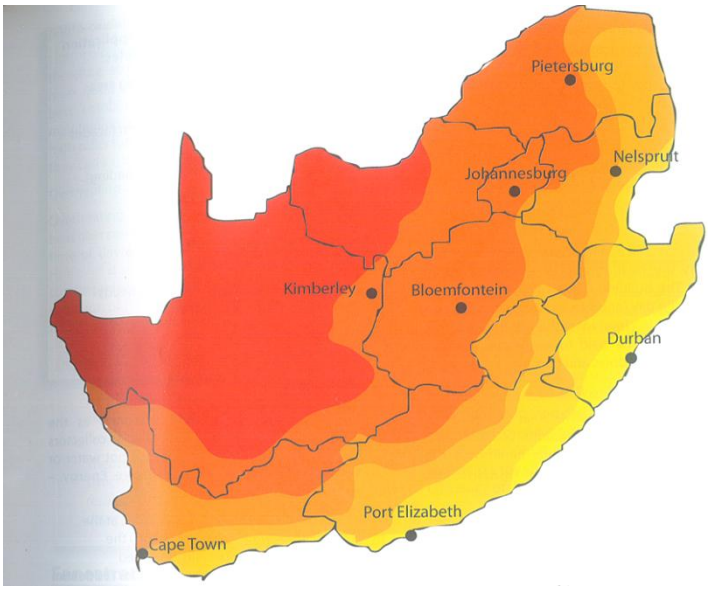
It is not really common but a few times a century there are earthquakes in the area. But the impact is low in the area, with occurrences of earthquakes at no more than scale 5 on Richter. When an earthquake occurs, it may be felt indoors by many people, outdoors by a few people during the day. At night, some people may be awakened.
Earthquakes are not a big issue for designing proposes.

Climate

South Africa got a big diversity in climates. Dry places, windy, warm, sub-tropical it is very divers. The Kariega Game Reserve is located on the road between Port Elizabeth and Grahamstown.
The closest city is Kenton-on-sea which is about 15km from the reserve.
When you see the world and especially Africa in the solar radiation map you will see red marks because of the high solar radiation which is good for Solar systems as Photovoltaic cells and Solar water heating.



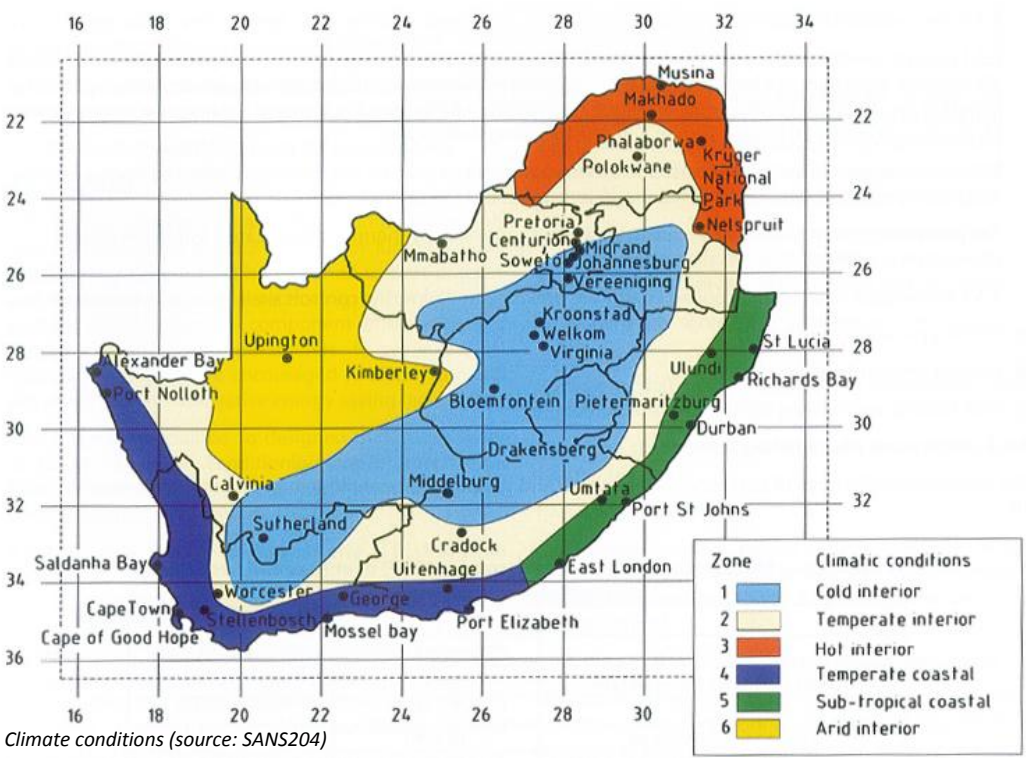
Global annual solar radiation (source: SANS204)



South Africa annual solar radiation (source: SANS204)

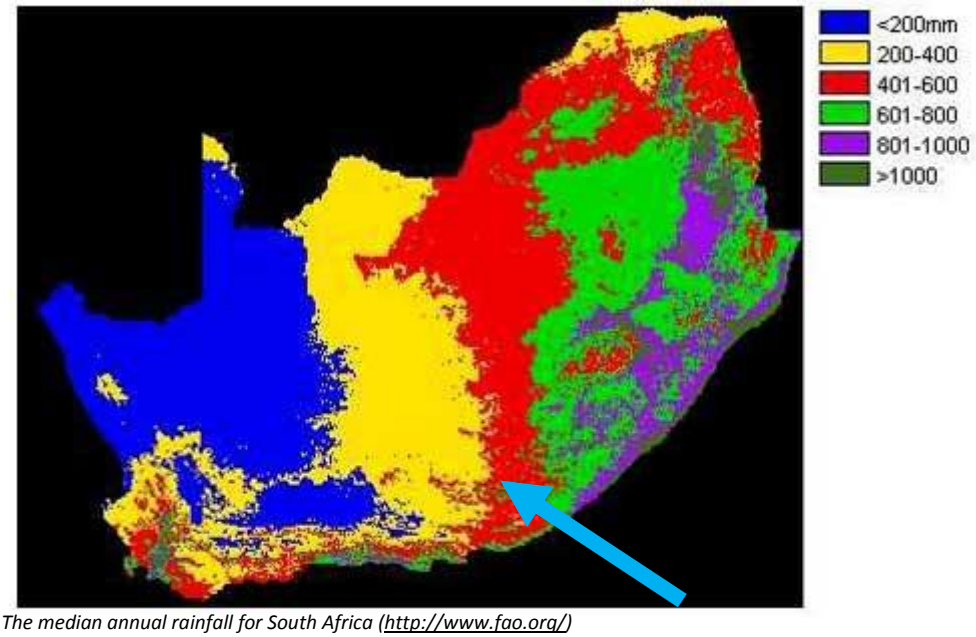
In South Africa the sun radiates 1450 – 1950 KWh/m^2 annum solar power! When seeing the diagram it will be about 1500 KWh/m^2 which is comparing to Holland maximum of 1000 KWh a year (data from TUdelft solar radiation report) 1,5 times more. Using the sun for making electricity will become more valuable. *Nice to know: the Sahara got a average value of 2200 KWh/annum.*

As we have said there are different climates in South Africa. Our region is on the border of temperate-coastal and sub-tropical coastal climate. In fact is it situated in the temperate-coastal zone which means that there are no really cold winters and the summer is fine.
What makes it pleasant in the summer is the low humidity, when it is about 25 °C in the summer it won't feel very hot.



Climate conditions (source: SANS204)

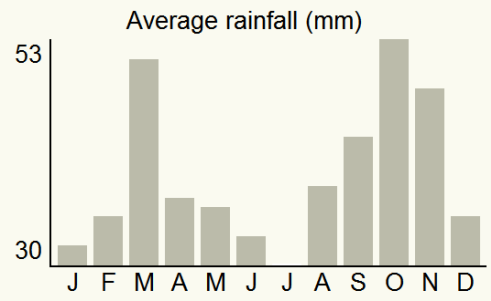
The rainfall in South Africa varies in the whole country. The Kariega is located where the blue arrow is directed to.

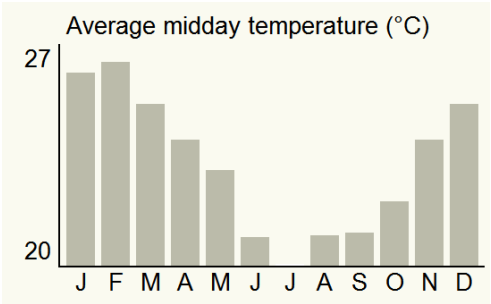


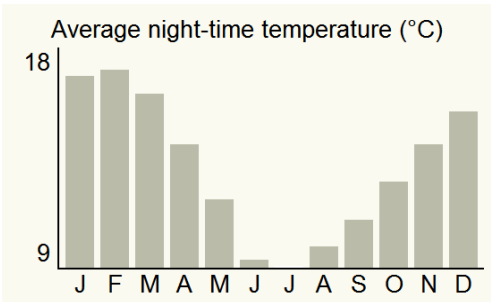
The median annual rainfall for South Africa (http://www.fao.org/)

It is a little bit inland so we will follow the red mark, about 401-600 mm rainfall a year.

The closest city/village from our location is Kenton-on-Sea, we will use this location for the climate parameters.
Kenton-on-Sea normally receives about 471mm of rain per year, with rainfall occurring throughout the year. The chars diagram below shows the average rainfall values for Kenton-on-Sea per month. It receives the lowest rainfall (30mm) in July and the highest (53mm) in October. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Kenton-on-Sea range from 20°C in July to 26,4°C in February. The region is the coldest during July when the mercury drops to 9°C on average during the night. It is important to integrate a heating system in our lodge (can be with traditional wooden fires).







Climate data (http://www.saexplorer.co.za)

Wildlife in the area

There are many animals in the reserve, but is all secured, controlled and fenced around. There are different animals currently in the area: giraffes, ostriches, impale, kudu and other small animals. The ones which could be dangerous are the elephant, rhino. These animals won't walk on paths and will cross the hills through the bush.
If the lodge will be built the reserve remains the same, but when the operators think it is time they can move elephants to this part of the reserve.

There are also monkeys in the reserve, when asking to people working by a lodge they said that the monkeys are not a big problem. The apes are only a bit brutal, so they can steel things by the lodge.

What can we do?
For now we don't have to make borders or other ways to prevent against the possible incoming wildlife. If the animals cause problems we can make natural barriers as sharp rocks all around the buildings, animals won't walk where the ground is different.
For our design proposes, our design of the rooms are located on the ridge of the mountain. Big animals won't walk here. It is only possible that they walk on top of the building because it is a green roof. Big animals won't do this, when it is needed than we will introduce natural barriers.

The main-lodge is also half in the ground, but even half above the ground. The bigger animals will naturally not go here, we saw it in the 'Main-Lodge' also in the reserve. This lodge is open on the widest side of the building and so we asked the manager and he told us that in all the years only some little animals like some monkeys went inside the building.

Eco-Green lodge

Design a sustainable wildlife accommodation

5 Design

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Ideas & vision

The key for the design lies in the nature, we want to keep the impact on the nature as low as possible. We have to hide the buildings as much as possible and stay inside the bush, no obstruction for the wild habitat.

Keeping this in mind we didn't want a high fashioned building, but a more naturally shaped one (especially the main lodge). In the nature are different inhabits and different living areas, for example the ant got a nice place to stay. This was the first idea before the design started.

An important point we had in mind was to hide the building as much as possible in the bush and where it's not possible, make it naturally shaped.

With the anthill in mind we thought of making the roof of de building curved with the flow of the mountain. When we also make the roof the 'same color' as the environment it will be hidden in the nature.

For the rooms we found a Swiss design with buildings in the mountain which inspired us. The building was built inside the mountain and the front view was the only open space, there was the outlook. On our location we have the same situation, the most important thing is the outlook, the experience of being into the wild.

Vals, Switzerland: architects of SeArch and Christian Müller

With the technical design in mind, for all the facilities as heating and cooling, the constant temperature of the earth, hidden in the nature, the experience of the outlook, this integrated mountain building is a perfect start for our design of the rooms.

For the main lodge was this idea more difficult because of the size, when we only have a front view it would be dark in the back, what is fixable with roof lights etc. but we had to find another solution. We tried to put the building half in the ground, so we still work with the constant earth temperature and keep the ridge of the roof low, inside the bush.

We have to keep the lodge as small as possible.

Key terms of the design

As said before is the main key for a good design, integration in the nature, naturally shaped, no obstruction for the nature, and the amazing outlook as base point.
The bush will only be broken down on the location of the rooms and lodges, everything around will keep intact. If it is possible the grasses and plants can be reused for planting on the 'green-roof'.

The experience for guests is the main point. They are only here for a few days and so we have to make their stay unforgettable.

Main lodge
The design has to be spatially designed, for the rooms is that; working with mirrors to get virtually more space. In the main lodge we work with one big open space, every section is connected to each other but still apart of it because of the height differentiations and the walkway between the functions.

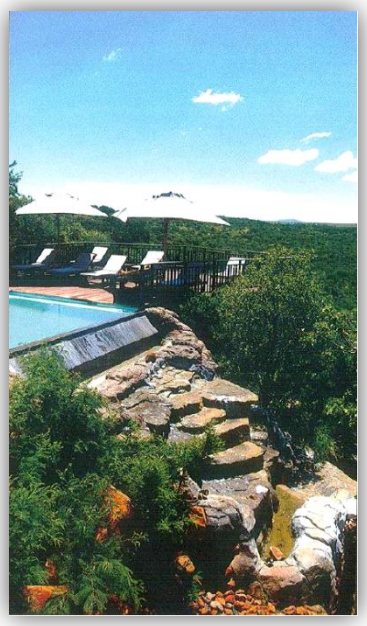
When you arrive at the lodge you won't see the outlook, or only a bit, when entering the main lodge it will lead you to the outside because of the open widely designed walkway. The outside area on the view side is all open with big windows. Inside and outside won't feel different , with the decking inside and the outstanding view you feel like outside in the nature.

There are different functions in the main lodge, we have an inside dining area, bar area and a lounge area. There is also a small place for people who still needs a computer, we didn't want it but for tourism council proposes it is better to have it.
The lounge area is located in the lower area, a warm space with a fireplace built in the floor. This fire is the barrier between the two lounge areas, the people can hear each other but physically have a barrier for a more separate spot. When talking to managers of some lodges we found out that the people wants to stay in touch with each other so they can hear experiences from other guests and share them with each other.

The kitchen area is a closed space, with an open surface in the wall. From here the guest could see the inside of the beautiful kitchen with a nice fireplace in the view. Because all the bigger parts are delivered , stored and prepared in the back of the house the kitchen in the main lodge figures only for preparing the food for breakfast, lunch and dinner. There are no big storages rooms and no big ugly fridges needed. When there is food coming in, the supplier will drive to the back of the house and will never go to the main part of the lodge, this is also for the bar suppliers (drinks etc).

Example: Falcon cooker

The outside area, main lodge



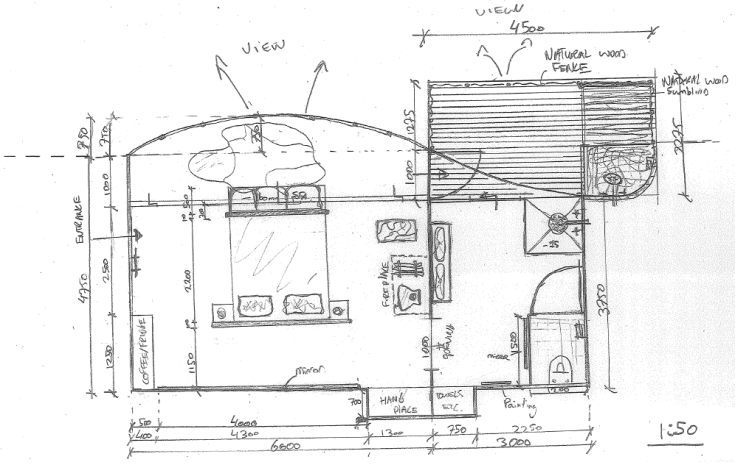
The same path/ walkway from coming in leads you trough the back of the building where you can stay outside. This whole area is open, without obstacles for the outlook.
Outside we have a eating area which generally will be used during breakfast and lunch. In the nighttime when it is getting colder the inside area will be used. The surface of the mountain extends a bit more to the outside what gives a perfectly wide view.
The wind will be forced with some natural wind barriers on the backsides (extra bush, trees, plants).
For the pool area we want to make it on the edge of the ridge, when swimming in the pool you can watch the animals passing below. Underneath this ridge we can make the pumping system, the water will flow down like a waterfall but in this case it is actually for the filtering.

Once in 2 – 3 days there is a outside fire spot, with a braai and bush where is diner after the late afternoon game drive.

Rooms

The idea of these separate buildings is, integrate the building in the mountain for a low natural impact and good thermal performances, enjoying the view is one of the important points.
There are 3 functions in the building, the sleeping area, bathroom area, and the relaxing/outlook area. All these areas in one small building.
The building is in a wide rectangle shape, so you have the biggest view. The shape is formed with 2 rectangles connected inside each other, the widely curved window in the center goes over in the roof and then to the shower in one natural curve.
The bed is located in the middle of the room, with the vista at the foot of the bed. When the weather is bad for being outside there is a couch integrated on the foot of the bed. This will use less space and can give a great experience. There is a step in the building for more height and a better outlook from the bed and the back.
In the bathroom we didn't want to have a bath, because of the high water usage. We want to have a nature experience outside, we designed an outside shower what triggers all you senses in your body, you can hear, smell, see, taste and feel the nature(standing on natural rocks). Also outside we have a wooden deck, as small as possible but useful.

The wide mirror inside the building gives a feeling that you are in a bigger space and a better connection to the outside area.



For more lights we have chosen for solar tubes, these tubes are going through the roof of the building, through the green roof for a natural sunlight from above. When it is night time 'LED'-lights will produce the amount of light needed (dimmable). We also ventilate naturally through these tubes.

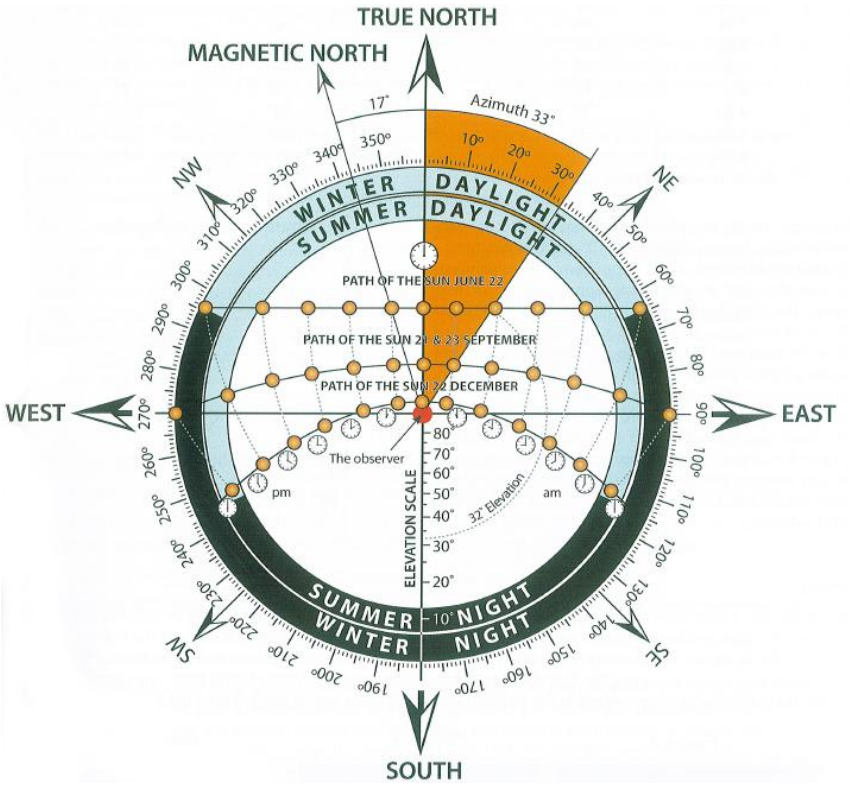
Back of the house facility
In the back of the house are all the facilities for the staff. We didn't designed the building but the functions in this area are:

- Staff sleepover, on a 15 / 10 based system. 15 people at work and 10 are off. People work about 20 days in a row and are 10 days of. Start point is to attract couples, they can sleep together and don't have problems with staying away from each other.
- Laundry place, with outside hang place for drying.
- Storage rooms
- Kitchen equipment, fridges, freezers and a preparing place.
- Technical installations
    - Water management, pumps, filters, tanks, helophyte field
    - Energy management, big solar field, inverter with backup systems.
- Parking cars from guests, guest will drive to entrance and a employee will bring it to the back of the house. Parking staff.
- Car wash place, for game drive vehicles etc.

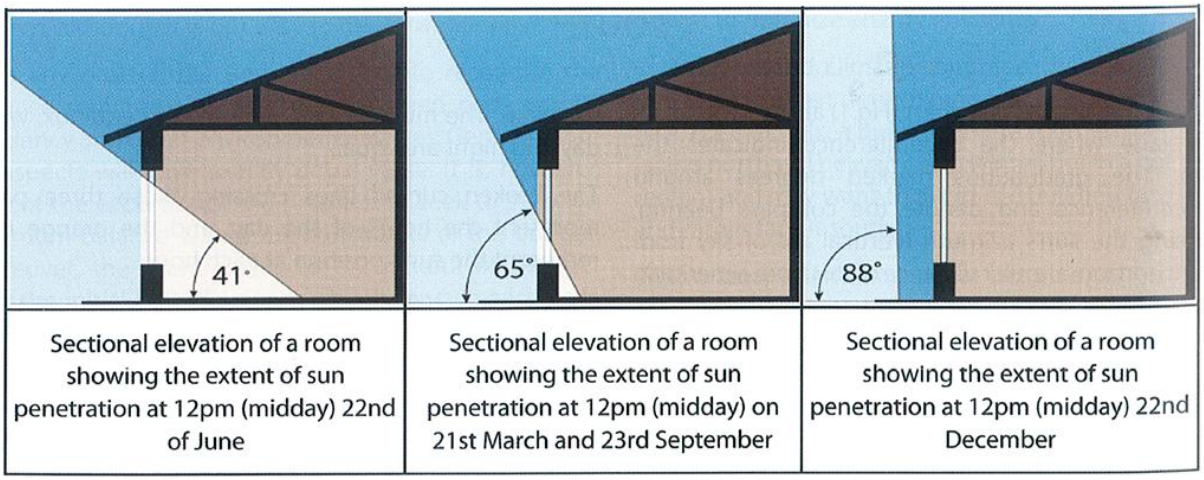
Other design matters

How does the sun moves during the day?
Our lodge is almost perfectly located to the east. The sun comes up on this site what will warm the buildings a bit after a cold night. (nights in South Africa are not warm).
The wind comes most of the time from the west what makes it a perfect spot for the lodge.

Some designing information in South Africa with the sun
The sun is coming up in the east and going down in the west, when the building needs warmth in the morning, the east orientation from our building is perfect. When it's getting later in the afternoon and the outside temperature is high you don't want the sun to shine in the building anymore.

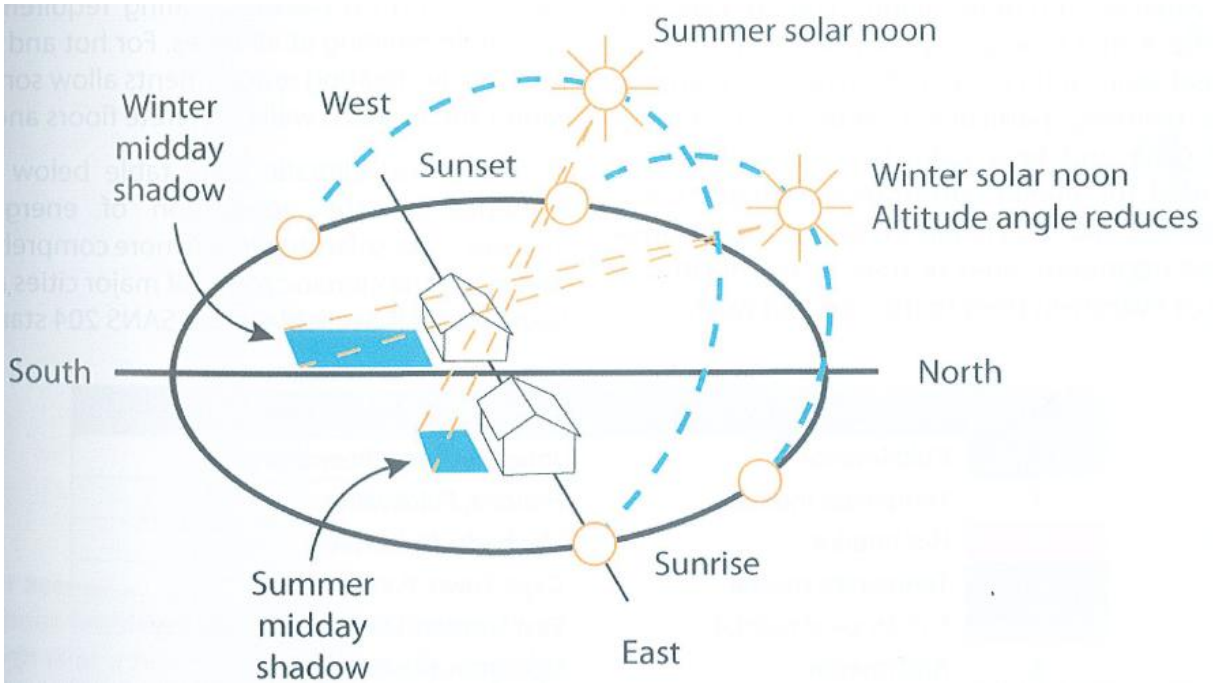


What have we done with this information for our designing proposes?
When the sun is low and coming up, the sun will heat the building a bit for a nice temperature, but when the sun is higher and stronger you won't need the sun anymore. When construct a overhang on the roof you won't get the direct sunlight in the building anymore.



Overhang to stop direct sunlight coming in during the day. SANS204

In South-Africa is an overhang of approximately 300mm required. In our lodge we took this measurement in the overhang, on the view side we took an overhang of 400mm because of the size of glass facade.



Movements of the sun. SANS204

Eco-Green lodge

Design a sustainable wildlife accommodation

6 Building Materials

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6.1 Possible materials

Before describing materials, we want to have it about our assumptions for the design of the lodge. The used materials should be as much as possible renewable and sustainable. The carbon footprint will be as low as possible. Locally found materials are the best to use, they are commonly cheap and not bad for the environment.
The main thing about building materials is that they take energy to make and transport, and some are made from non-renewable resources.
A much used material as cement produces 7 – 8 % of the world wide CO^2 emission. It uses fossil energy for heating the limestone and clay powder to 1500 °C.

In the area and in the reserve there are some local materials available;

- Grade-Stone, in the reserve but also available from built roads etc.
- Wood

It is preferred working with these materials because they are cheap and got a low environmental impact. The body of the design can be built only with these materials but for example in the kitchen you have countertops which can be designed with paper-stone.Stone and concrete are normally good materials for working with earth warmth and retaining winter heat.

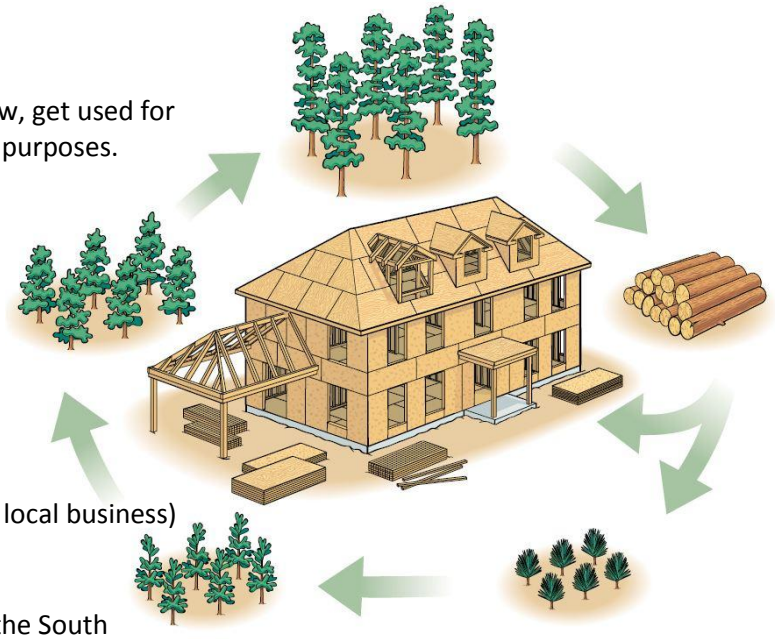
In the next pages we will describe different materials which can be used for the structural design of the lodge:

- Wood
- Bamboo
- Concrete
- Local Rock
- Stone/Bricks/Clay
- Steel

First we describe the different materials we can use for the different parts of our building. Afterwards we put them in a choice-matrix for every purpose and compare them to each-other to make out what's the best choice for that purpose.

6.1.1 Wood

Wood: a natural material we all know, get used for centuries and can be used for many purposes.



In our design wood can be used for:

- Fencing
- Decking
- Furniture
- Structure

Advantages:

- Sustainable
- Local (logistics and good for local business)
- Natural look

Disadvantages:

- Need to be treated against the South African bugs
- Without checking it, it possibly isn't FSC certified wood

6.1.2 Bamboo

Bamboo: also a totally natural material. It's originally from China where they build a lot with it. It is a strong material which can be used for a lot of different purposes.

In our design bamboo can be used for:

- Fencing
- Furniture
- Sunblinds

Advantages:

- Sustainable
- Natural
- Strong

Disadvantages:

- Not local
-

6.1.3 Concrete

Concrete: Concrete is a perfect material when you have a difficult shape, building with concrete is boundless. It also got nice thermal features for storing heat during the day or keep your building cool.

In our design concrete can be used for:

- Foundation
- Walls
- Floors
- Roofs
- Colum's

Advantages:

- Strong
- 'unlimited' lifespan
- Thermal characterics
- Every shape is possible
- Can be fully recycled

Disadvantages:

- Not sustainable
- Portland cement

6.1.4 Local Rocks

Local Rocks: a material that people are using for decades. It is strong and gives that natural look. The materials can be found in the reserve which takes a lot of advantages with it. You can make it how you want it, less rocks and a lot of clay between it or a lot of rocks with less clay.

In our design local rocks can be used for:

- Outer walls
- Inner walls
- Decoration

Advantages:

- Sustainable
- Local
- Cheap

Disadvantages:

- Weight
- Transport
- Shapes

6.1.5 Earth, mud and clay

Earth, mud and clay: all materials we can find in nature and so in the reserve. These materials can be used for different purposes but mostly for joints.

In our design this materials can be used for:

- Outer walls
- Inner walls

Advantages:

- Sustainable
- Local
- Easy to use

Disadvantages:

- Time needed to get strength
- Handwork

6.1.6 Bricks

Bricks: clay, baked in the chosen shape. The bricks have hardly the same shape / weight, so they are easy to make in big amounts, easy to bundle and easy to build with.

In our design bricks can be used for:

- Outer walls
- Inner walls

Advantages:

- Same size of every brick
- Processable
- Local

Disadvantages:

- Not sustainable
-

6.1.7 Steel

Steel: a very strong material which can be used for a lot of purposes because of it's good quality's and possibility's to be casted in almost all imaginable shapes. We don't need a lot of metals but we need it for some purposes so we have to think about it.

In our design wood can be used for:

- Fencing
- Decking
- Furniture
- Structure

Advantages:

- Sustainable (if possible)
- Local

Disadvantages:

- Weight
- Not sustainable

6.2 Floors

In our design we will work with the earth warmth, the material for the floor should work with this type of building. The room is integrated in the building and need enough strength for holding the amount of power from above.

Using the earth warmth it is useful having a material which radiates the heat of the earth gradually. Wood is not the best type for radiation, and it also keeps some warmth during the nighttime. Stony buildings radiate the temperature from the earth which will give a pretty constant temperature during day and night time. During the day the warmth from the sun etc. will get into the structure and it will radiate it back during the nighttime when it is cooler in the room.
Wood is not the best solution for this, because it doesn't radiate well comparing stony materials as rocks and concrete.

	Wood	Bamboo	Concrete	Rocks	Earth Mud Clay	Steel
Maintenance *(10%)*	3	3	5	4	4	4
Life Span *(10%)*	3	3	5	4	3	4
Thermal specs *(15%)*	2	2	4	3	4	1
Transport *(10%)*	4	1	3	4	4	2
Local-friendly produced/managed *(20%)*	4	1	3	4	4	2
Sustainable-environmental friendly *(25%)*	4	4	3	3	3	1
Cost *(10%)*	4	1	3	4	3	2
Total: *(100%)*						

6.3 Walls

The walls are another important part of our design. We want as less walls as possible visible for the visitors and because of the fact we are building the rooms in the mountain we actually only have one wall which is completely visible. From the two outer walls there is only a little part of it visible and the wall in the back is completely hided under de ground.
We can choose between a lot of materials to build this walls but because of the requirements of these walls we have to make a good decision. Important is the feature to radiate the heat of the earth gradually. Wood is not the best type for radiation, and it also keeps some warmth during the nighttime. Stony buildings radiate the temperature from the earth which will give a pretty constant temperature during day and night time. During the day the warmth from the sun etc. will get into the structure and it will radiate it back during the nighttime when it is cooler in the room.
Wood is not the best solution for this, because it doesn't radiate well comparing stony materials as rocks and concrete.

We heat the rooms with fireplaces; one big one in the lounge part of the lodge, one little in the bar area and one in the dining area. The fireplaces are the only warmth sources, the rest of the warmth will be provided by the earth warmth, directed through the floor and walls.
The cooling occurs also in a natural way. The fresh air from outside provides the air inside to cool down. The result isn't like that from an air conditioning but it definitely cools the rooms with a couple degrees which feels comfortable. It isn't actually necessary to cool the rooms down a lot, because the rooms automatically take over the temperature of the soil around the lodge. That soil has an almost stationary temperature, in summer and winter.
The isolation of the building occurs except through the walls (soil) also through the green roof and the HR++ glass in the façade.

	Wood	**Bamboo**	**Concrete**	**Rocks**	**Earth Mud Clay**
Maintenance *(10%)*	3	2	4	4	4
Life Span *(10%)*	3	3	4	4	4
Thermal specs (15%)	3	3	4	4	3
Transport *(10%)*	5	1	3	4	3
Local-friendly produced/managed *(20%)*	4	1	3	5	3
Sustainable-environmental friendly *(25%)*	5	5	2	4	3
Cost *(10%)*	4	1	3	4	3
Total: *(100%)*					

6.4 Roof

There are two different types of roof, one in the main lodge and one in the rooms.
In the rooms we need a slim roof which can hold a lot pressure from the soil from above. The roof in the main lodge is big and got big over spans. FSC-branded laminated beams can work with the big spans and is also sustainable.

	Wood	Concrete	Steel
Maintenance *(10%)*	3	5	3
Life Span *(15%)*	3	4	4
Transport *(10%)*	4	3	2
Local-friendly produced/managed *(20%)*	4	3	2
Sustainable-environmental friendly *(30%)*	5	3	2
Cost *(15%)*	4	3	2
Total: *(100%)*			

6.5 Decks

The decks are actually the floors from outside, but also from the inside connecting the outside and insides decks for an open feeling. They deck need to be reliable and made of a strong material which can resist the weight of the people walking on it, the impact of the weather and all the other things from outside.

For a natural look we could choose from wooden planks or plastic recycled planks. The recycled planks doesn't fit in our design so we choose for the planks.

6.6 Fences

With the decks directly come the fences, for protecting people to fall from the decks and for separate different parts of the garden or rooms in the main lodge. For the fences are also a lot of possibility's for the material which get used, but we are in the nature and we will keep the impact as low as possible so we choose for wooden branches.

6.7 Façade

The façade is the first thing people see when they see a building. It gives the first impression of the building and the choice of the material used for the façade can make a lot of difference in it. There are many ways to cover a building, a lot of building methods and a lot of materials which can be used for it. For example rocks give a total different appearance than steel.

	Wood	**Bamboo**	**Concrete**	**Rocks**	**Earth Mud Clay**	**Steel**
Maintenance *(10%)*	3	2	4	4	3	3
Life Span *(15%)*	3	2	3	4	3	3
Transport *(10%)*	4	1	3	4	3	2
Local-friendly produced/managed *(20%)*	5	1	3	4	3	2
Sustainable-environmental friendly *(30%)*	5	5	3	4	4	2
Cost *(15%)*	4	4	3	5	3	2
Total: *(100%)*	☆			☆		

We want to use 2 natural materials for the façade, you can see it later on in the drawings.

Eco-Green lodge

Design a sustainable wildlife accommodation

7 Aspects of implementation

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The implementation is an important thing in the building process. In this assignment we're designing a wildlife lodge, so we don't really have to take a detailed look at this part of the process but we can already think about some things which make the further process easier.

Logistics
Transport takes a lot of costs with it, so it is important to reduce it as much as possible. Because our site is in a reserve where a lot of materials can be found in the ground in and around the reserve, some of the materials we need can quickly be transported to the site. The materials which can be found in or close to the reserve should be found somewhere else but the closer the better.
The distance is not only an important thing because of the costs and the time it takes to transport that materials to our site.
Our site can be reached by an old road (the old M*ain Road* between Cape Town and Johannesburg years ago) which leads through the reserve and also next to our site. When the lodge definitely gets build they're going to build a road to the site so (small) trucks can reach it.

Connections
Because only small trucks can reach the site and it isn't possible to get a big crane over there. The main lodge is way easier to reach than the rooms so here we can use prefab parts (not to big because of the needed size of the crane). For the rooms it isn't possible to use a crane without harming the bush so we should built it at the site itself, especially for the concrete. First the mountain should get dug out, after that the concrete can be casted and the rest of the building can be build up.

Eco-Green lodge

Design a sustainable wildlife accommodation

8 Technical Installations

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In this paragraph we will introduce you with different types of green buildings and how to built green. For reducing the usage of powers as water, energy, materials and waste we have to look at new solutions to handle with these problems.
South Africa is far away with this way of new building. The certification they get are mostly for being energy sufficient, but where they get it from it is still not clean.

There are a few basic needs for building and living in a building:

- Water
- Heating
    - Sun
    - Electricity
    - Gas
    - Fire
- Electricity
- Waste management
- Building materials

All these points are normally installed in traditional way.
Before we start with designing our wild life lodge, we have to think about what is a lodge in our opinion. What are our basic principles of building an Eco-green Lodge? What are our goals?
To have a view of our thoughts see the diagram below.

8.1 Water management

There is a big water problem in South Africa, so we have to start reducing the usage of drink water and start with using newer developments. It is important to use as less as possible water and get the water from a natural source without hurting the nature. Rain water is something what can be used for the garden, toilets and also for the drinking water, but there are many other ways to get water.

To understand what we will going to research a few start points:

8.1.1 Water management

- Borehole – water
- Hand dug
- Rainwater (roof – ground drainage system)
- If it is possible river water
- One of the systems with a backup system (extra water tank or refill points for a tank truck)
- Use grey water
- Recycle water (all, also toilet with a Helophyte)

The design could work with one or more of the systems together.

On our location there isn't a great demand for water but we really need it. On the moments there is a need for water, there has to be water. For example in the kitchen, when the meals have to be prepared or the dishes has to be done and the times guests want to take a shower. The swimming pool has to get filled once in its entirety and all in due course filled up. In times of dryness this actually will be the first things which get cut down.

The demand for water comes from a couple of needs, in order of demand:

- *Showers*
- *Kitchen*
- *Toilets*
- *Washing machines*
- *Swimming pool*
- *Cleaning*
- *Basins*
- *Bar*

Water management is a very important point, especially because of the location of our lodge. The main thing is that our system can't be connected to the water net so the water needs to get obtained in other ways and will have a big effect on how our system is going to be build up. Because of the way the water gets from the spring into the pipes without any pump, the pressure is limited. However the pressure is high enough to pump the water out of the pipes with enough power.

8.1.2 Water sources

There are 3 possible water sources for the lodge.

- Borehole water
- Rain water
- River water
- Spring water

There is no possibility to connect the water system to an existing waterline.

8.1.3 Borehole water

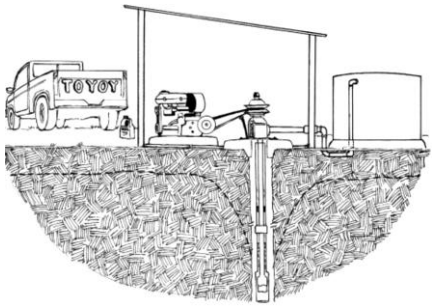
There are different ways to use water from under the ground. The most useful one is borehole water. Water will be pumped up with different possible systems to the needed height of the installation. For the lodge we need a system what is mainly eco-friendly and reliable. *(see inset. 8.A)*

Advantages of boreholes:

- Boreholes can be constructed in a short timeframe
- They are more efficient comparing the hand dug wells
- In hard rock environments boreholes are the only solution.
- The water source is generally reliable

Disadvantages of boreholes:

- The cost are higher than a traditional hand dug well
- Uncased boreholes are liable to collapse in highly weathered formation (the prevent this always case the hole)
- If the water got a high iron level the abstraction screens will clog



8.1.4 Sources for the pumping system

For our lodge it is important to have a system which can be trusted for pumping the water to the surface.

What kinds of systems are there available for our site?

- Hand pumps
- Solar powered pumps
- Wind powered pumps
- Diesel powered pump
- Electric pumps
- Bio petrol pumps
- Spring water

Hand dug:
This is manual pumping; it is nice for an eco-look but not useful for big usages. It will ask too much power for just a little amount of water.

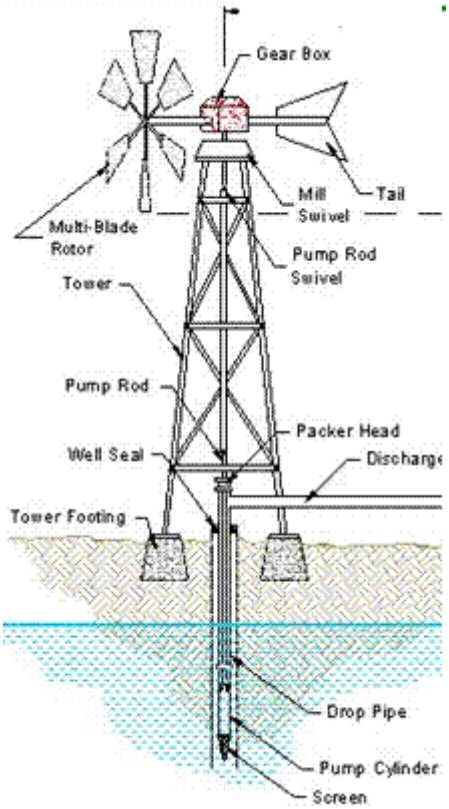
Electric pumps:
An electric engine pumps the water from the borehole to the surface, it is a constant and reliable way of pumping. It will be better when using this pump with a renewable source for the energy as solar energy or wind energy.

Solar powered systems:
This system works with an electric system which is powered by photovoltaic-cells. This system needs a backup for nighttime shifts. There are many sun hours in this area so for the produce of energy it is perfect.

Advantages:
- No cost of energy usage
- Good for the environmental impact with a good backup system

Disadvantages:
- Need a backup system, bad for the environment with the usage of traditional battery-cells.
- Expensive system
- Higher maintenance

Wind powered pumps:
The rotor of the windmill will turn the pump which pumps the water from inside the borehole. This is a commonly used system in South-Africa so it's cheap. For our design it is important to stay low inside the bush and keep the impact of the nature as low as possible. Windmills will block some of the nature and the view. The sound of the mill is also annoying. *(see inset. 8.C)*



Advantages:
- It is cheap
- It is free and sustainable
- The pump can lift water from great depths

Disadvantages:
- You always need wind, when there is not you would use a backup or you're out of battery
- It blocks the view and the nature (birds)
- High maintenance level (rotor, gearbox)

Diesel powered pumps:
Strong and reliable way of pumping, engine is powered by diesel. It doesn't depend on variable sources as sun or wind, but the impact for the environment is really bad. *(see inset. 8.D)*

Biodiesel pumps:
It works the same as normal diesel powered pumps only with minerals of vegetable origin. It is not bad for the environment because the progress is in a natural cycles.

When choosing for a reliable borehole system we can choose for Diesel and Electric based pump, when using Bio-diesel the environmentally impact is low, but when going totally off-grid (solar based the electric system would be better).
On top of the mountain it is not reliable for using a borehole based system, the depth is too deep because we are building on a hill and the required water quality is not that good because of the salt in the river next to it. That makes the price for the water high and makes it worth searching for better sources.

Using an already built spring:
In the area there is a spring available located in the mountains, this spring provides clear fresh water which can be used directly as drink water. The water availability is 'unlimited' and is directly drinkable from the source. Research in the past from the reserve says that with gravity powered pipe will push the water up the hill without a pump.
This was the best way to get a stable pressure of water for the main source water system.

8.1.5 Rainwater Harvesting

It is important using all the free water sources in the area, the rainwater in our project area is clean when we get it from the roof. *(see inset. 8.E)*

Advantages:

- the technology is easily and simply applied
- water is collected at household level so there is ownership of the system
- water is provided at the point where it is needed (near the building)
- the quality of the water is easily maintained
- gutters and storage tanks can be constructed from locally available material

Limitations:

- rain is unpredictable
- in areas where the dry season is long, large storage tanks may be required

We would definitely use rainwater in our area, seeing the climate table and our experience there is enough rain for making rainwater harvesting worth it.

8.1.6. River water

River water can be used for all the water systems, toilets, showers, taps, but always needs to be filtered. If you have a good stable water quality it is worth using river water, but in our area the water from the river is brackish, which means sometimes is fresh and sometimes it's salt. Than the treatment for the water is too difficult and will cost too much money for getting some fresh water. We can decide using the river water for flushing the toilets and irrigate the gardens, but then we would need some expensive pumping from underneath to get the water on top of the hill.

What system are we going to use for the main water source?
After this research about what kind of sources there are, and what the possibilities are with these we have decided to use in cooperation with the Kariega Game Reserve, for using the already built spring in the same area for the main water source. It is gravity powered and its already in use so doesn't bother the environment more.
For the extra water source we will use rainwater harvesting from the roofs and store the water in tanks.
For all the water system we would use water tanks for the peak usage like morning and night times before and after game drives.

8.1.7. Grey water

Grey water is the generic term for water used for personal hygiene, washing of clothes and the dishes. Instead of disposing it in a sewage system it can be recycled and used for garden irrigation. Our goal for our Eco-lodge is using all the available water and where it is possible recycle it, using a grey water system is perfect for us.

For a grey water system you only need separate water pipes from the bath, shower, basins and or washing machine to a tank. Grey water contains chemicals from soaps, detergents and organic materials it can be directly used for irrigating and toilet flushing.

Costs
Costs are associated with:

- filters
- storage chamber
- submersible pump, pipes, sprinkler

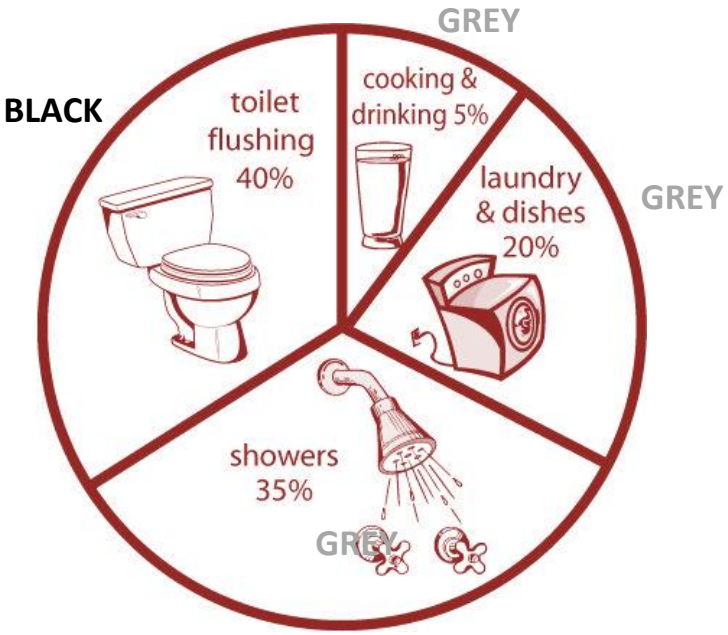
Advantages:

- water that would otherwise be wasted can be used for irrigation
- the consumption of freshwater is reduced

Disadvantages:

- grey water cannot be stored for more than 24 hours when it hasn't been treated

We will describe our Black water system later on.



8.1.8. Water purification systems

For our water management system we need a filter for the grey water storage, normally grey water can be stored for a maximum of 24 hours after that it can't be reused. *(see inset. 8.F)*

What systems are available?

- Sand filter
- Rapid sand filter
- Membrane filter

The sand filter can filter the grey water easily and is environmental friendly instead of the membrane filter which uses a chemical reaction. This ceramic cartridge filter is normally not good for the environment.
When there is not enough space it is sometimes easier for choosing a membrane filter because of the smaller size.
We will keep the water usage as low as possible so we don´t need a rapid filter. We choose the sand filter for our lodge water filtering system; it has a big capacity and is the most ´natural´ filter. There is enough space available on the location so we don´t have a problem about the size of the filter.

8.1.9. Black – water

After all the progresses with the water, and the toilet flushes with grey water we have black – water, this is the water what we don't want and need anymore.

What can we do with this water:

- Store it in a septic tank and empty it once in a while (truck)
- Filter it and use it for irrigation *(see inset. 8.G)*
- Dump it without filtering

Options:
As first dumping is not an option, black water can be really chemical.
Using a septic tank means that you have to store all the black water into a tank and it has to be empty once in a while. It has to be transported which costs money.
For our design our goal is to be self-sufficient in the main needs, so we had to find a solution for cleaning the water and then irrigate it somewhere.
We found out that Wetlands or Helophyte-filters can clean black – water into grey. The costs are high but it got a long life span and you will only have to pay once. It will pay back in years and the environmental impact is very low.
A filter system between the sewerage filters the water from the poo and the papers, this can be used for the biogas system. (see energy management)

What kind of system are we going to use?
We have two water sources, one from a gravity pipe up hill and one from rainwater harvesting. The main water source will come from the rainwater, however during less rain the gravity powered water pipe will fill the tanks back up.
The rainwater in the reserve is filtered with a standard sand filter for stuff pieces of wood or insects and some alleges. Water from the gravity line is also drinkable and connected to the water tanks.
With a pumping system the water will go through a piping system pressurized to all the facilities, first back of the house, main-lodge and then the rooms.
After using the 'white water' for showering, taps, the water will be drained to a 'grey-water tank' this tank will be used for the toilet, irrigating gardens, cleaning cars etc.
The water from the toilet becomes 'black-water' this water will be pumped in a pressurized drain to the back of the house where the helophyte-filter is situated.
Before it goes into the helophyte-filter a big filter system, for the poop and paper works, separates the black-water.
The bigger stuff, the poop, will be collected and used for the biogas installation. This biogas installation produces a gas with green garbage and the 'black stuff'. This gas can be used for the backup system (biogas generator) and the cooker in the main lodge.
The helophyte-filter produces grey water from the black water. If it is needed, the grey water can be added to the grey water tanks by the back of the house. Overcapacity will be irrigated or thrown away in the river.

Water Management by location:
Back of the House
Water from the spring in the mountains can be used for the taps. This water is fresh enough to use as drinking water. Rainwater we collect can be used for a lot of purposes like doing the dishes, showering, washes the linen, cars etc. The (dirty) 'grey' water from these purposes can be used for flushing the toilets. The dirty 'black' water from the toilets gets passed through to the helophyte-filter.
Rooms
Water from the spring in the mountains can be used for the taps. Rainwater we collect can be used for the shower(s) and if there is a shortage of water, it can be filled up with water from the spring which get filtered 'at location' through a sand filter. The waste water from the shower (grey) get cached and used for flushing the toilet. The dirty 'black' water from the toilet gets pumped from a sewerage pump system to the back of the house and from there into the helophyte-filter.
Main lodge
Just as at the back of the house and the rooms, we use the fresh water from the spring for the taps. The rainwater gets used for doing the dishes and for washing the glasses at the bar after it gets filtered through a sand filter. The dirty 'grey' water gets used for flushing the toilet and the 'black' water from the toilets get cached in sewerage and pumped to the helophyte-filter, in the back of the house. (*See the inset 8.H for a sketched scheme)*

8.2 Water heating

The source of water has been researched now it's time to explore the possibilities how we can heat the water for showers, tap water, etc.
In this research we want to have it about these systems for heating the water:

- Sun boiling
  - Ground heating
  - Sun roof boilers
- Electricity heating
- Fire heating (wood)
- Gas heating
- Earth warmth

8.2.1 Types

The sun produces a lot of energy (*see attachment)* which can be used for heating up the water. In our area the sun shines most of the time a year, and a sun boiling system also works when there is no sun. It depends on the size of the boiler and the sun collector what the capacity of the warm water is, a small collector is already fine for a room.
In sustainable way of thinking it is a good solution comparing with the traditional systems as gas, electricity or wood.

Electricity heating:
This system uses a lot of power, which is bad for the environment, we can produce it green but the key is still the less the better. It is fine for a backup in the sun boiling when there is a peak usage of warm water or when the weather is bad for a longer time period.
Fire heating:
People have to keep it running which takes time and more money. With a boiler it will work fine but for a new building it is not recommended.
Gas heating:
Only good with bio-gas, a gas heater is working with non-renewable sources what makes it bad for the environment. With bio-gas the cycles is there, but there is not enough bio-gas available at our site.
Earth warmth:
Earth warmth is good for preheat the water, but not for warming the water to a recommended temperature.

We choose the sun boiling system; this system produces normally enough warm water for the rooms and the main lodge. With an electrical resistant in the tank we can guarantee a perfect temperature.

8.3 Energy management

Electricity is a basic need in this modern world. Everybody got a cell phone or need a light to get in the room. You could think, a lodge situated in a wildlife reserve could also be back to basic with wood etc. But we are designing a 4-star lodge which should have some power, but our goal is a lodge what works without the connection to the energy net.

What kind of solutions do we got for getting the power?
Electricity:

- Solar cells
- Solar cells with backup generators
- Hydro power
- Hyrdo power with backup generator
- Only biogas
- Windmills
- Windmills with backup generator
- All in one – renewable sources
- All in one – renewable sources with backup generator

8.3.1 Photovoltaic-cells

South-Africa got plenty hours of sun, even when it is winter the sun shines most of the time (clear skies). It is useful to change this inexhaustible source into electricity.
A nice statement from a guy called *Ramez Naam;*
The sun strikes every square meter of our planet with more than 1,360 watts of power. Half of that energy is absorbed by the atmosphere or reflected back into space. 700 watts of power, on average, reaches Earth's surface. Summed across the half of the Earth that the sun is shining on, that is 89 petawatts of power. By comparison, all of human civilization uses around 15 terrawatts of power, or one six-thousandth as much. In 14 and a half seconds, the sun provides as much energy to Earth as humanity uses in a day.
The numbers are staggering and surprising. In 88 minutes, the sun provides 470 exajoules of energy, as much energy as humanity consumes in a year. In 112 hours – less than five days – it provides 36 zettajoules of energy – as much energy as is contained in all proven reserves of oil, coal, and natural gas on this planet."
http://blogs.scientificamerican.com/guest-blog/2011/03/16/smaller-cheaper-faster-does-moores-law-apply-to-solar-cells/

How can we convert this energy from the sun into power?
Years of developments has result in the current used Photovoltaic cells, these cells absorbs the power of the sun into a voltage/ watts.

What are the advantages using Photovoltaic cells:

- Long life span (25 – 30 years)
- Good financial rendement
- In time of cloudy days the cells will still functionate (less).
- PV-cells got a very low maintenance level
- No moving parts
- Rain will function as cleaner

What are the disadvantages using PV-cells.

- High purchasing cost
- Long payback period

In normal conditions the connection on the electricity is available, but in our plan the connection to the energy net will cost approximately *2 to 3 million rand (about 200.000 ~ 300.000euro).* That makes it just even more attractive for us using PV-cells.

A PV-cell is located inside a glass object, normally in a big panel on top of the roof in cities, but it is also possible to put them in a field when there is enough space.

There are 3 different panels available. *(see inset. 8.I)*

- Monocrystalline Silicon Cells (155 W p/m^2)
- Polycrystalline Silicon Cells (120 W p/m^2)
- Amorphous thin film (60 W p/m^2)

As you can see does the Monocrystalline produce the most energy. The life durance is at least 25 years but can be more then 50. Polycrystalline got the same life durance but it produces less power as the mono. Amorf cells got a low capacity so you would need more m^2 to reach the required amount of power.
The difference in the cells are in the capacity with warmth, the problem with the mono-cell comparing to the poly-cell is that the mono-cell doesn't work as good as the poly-cell in warmer conditions (with an average of 23/24 Celsius it is equal).
In the green way of thinking, the producer of mono-cells are much more worse than the poly-cells.
The advantage of Amorf cells is that it works with really high temperatures, in places like a desert where you have big lands and high temperatures you should choice that solution.

	Mono-Panel	**Poly-Panel**	**Amorphous-film**
Lifespan	3	3	1
Green (product)	1	2	3
Power (watt/m^2)	3	2	1
Produce in a warm environment	1	2	3
Cost	1	3	2
Total:	**9**	**12**	**9**

8.3.2 Wind Turbines

The basic principle of a windmill is actually very simple, compare it with a dynamo on your bicycle only now the energy from moving air (wind) gets converted to electrical energy instead of that from the spinning cycle wheel. The amount of the energy what the windmill generates, depends on the height, the length of the blades of the rotor, the wind speed and the location of the windmill.

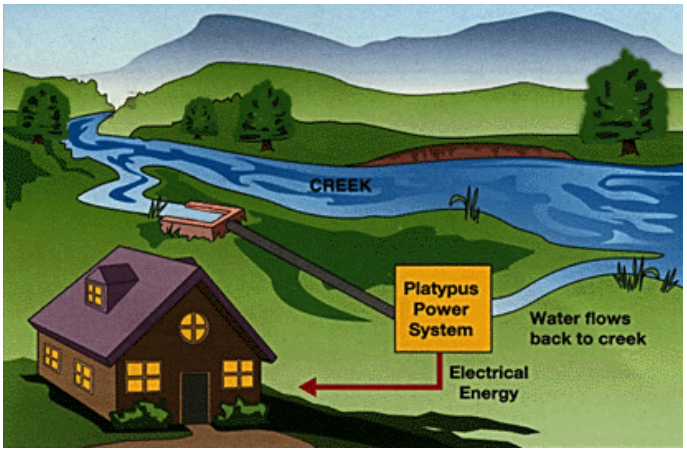
There are a lot of different windmills. Not only because of the different suppliers but first we have to look which kind of windmill would fit in our site. The most important thing, beside of the efficiency of the windmill is that the effect on the view should be as less as possible.

Types
There are actually two kinds of windmills; horizontal en vertical. The horizontal are used the most in open areas and the vertical in urban environment and on roofs. *(see inset. 8.J for windmills & extra info)*
In our case we can use all the different turbines but some of them are less profitable or have other disadvantages. We have to think about things like having (negative) effect on the view, sustainability, making sound, obstruct or hurt the animals etc. We took three different turbines and compared them with each-other on the different points in the following schedule:

	Horizontal Large	Horizontal Small	Vertical	Direction Changing
Life Span	3	3	2	2
Green (product)	1	3	2	1
Performances	3	3	1	2
Capacity	3	2	1	2
Sound	1	3	1	2
Cost	1	2	3	2
Total:	**12**	**16**	**10**	**11**

http://www.clean-energy-ideas.com

8.3.3 Hydro power
In places where a river is located it could be possible to generate energy with the flow of the water. The principle is shown in the picture underneath. Draw off a part of the river en lead this water through a power system. In this system, the movement of the water provides movements of parts of the system what results in new (green) energy.
In the Kariega Game Reserve there are two rivers located, the Kariega River en the Bushmans River. Both rivers got a low current and there is a possibility that the river can get dry within long periods without rain.
So there is energy but the amount of it is to low and to variable for using it. The Busmans River is underneath the hill where our plan is situated, so there are possibilities but the efficiency is too low for using this system.



Hydro power; source wikipedia

8.3.4 Biofuel generator

For producing energy you can choose for a more basic system with generators. The generator can work on normal fossil fuels but in the green way of thinking we have to decide for choosing a bio fuel system on gas or diesel.
The system works the same as a normal diesel generator but it uses a green fuel which is renewable and got a short circuit. (CO2)

You have two types of generators:

- Biogas
- Biodiesel

We are producing biogas with our 'biogas' – system from black water and green garbage, but we also have biodiesel available in the area. All the game cars are driving with this gasoline.
Because we are producing our own gas and the generator is there only for the back-up we want to use our own produced bio-gas. (self-sufficiency).

8.3.5 Inverter

There are three types of inverters. *(see inset 8.L)*

- Multi Function Inverter
- Synchronous Inverter
- Standalone Inverter

The standalone inverter is an totally off-grid system where all the parts are connected like the solar-panels, backup systems, but it will also give the output voltage.

8.3.6 Energy system

Because of the environmental impact on the nature and the view, windmills are not worth using them at our site.
This system will work of grid and will produce all the energy from the power of the sun. In times of high usage and a longer low sun energy time period the backup system will automatically turned on for the required amount of power.

8.3.7 Backup systems

For the backup of the batteries we will use local produced bio-diesel. The vehicles in the reserve all drive with this fuel so this is a perfect solution for the backup of the batteries.

In this sketch for the system we wanted to use a system with a battery backup system, we took it in consideration and said this is not sustainable we have to try find a new solution for powering the building during the nighttime. (see inset 8.M for the old scheme)

When you are looking on the web searching for renewable energy sources the missing link is the storage of energy. 99 of the 100 found fully of grid systems are working with Lithium-cells or other battery types. Using them is very useful but the products holds non environmental friendly products, after a while battery has to be replaced and the battery can't be recycled, or not all the parts.
The sun-cells only works when there is daylight and wind turbines only works with wind.
Energy storage is a crucial functionality to a clean energy future. http://www.greentechmedia.com

8.3.8. What kind of (sustainable) solutions are available? *(see 8.N for a detailed explanation)*

- A compressed air power system
- Pumping water up hill, *solar dam*
- Flow batteries
- NaS batteries
- Flywheel technology

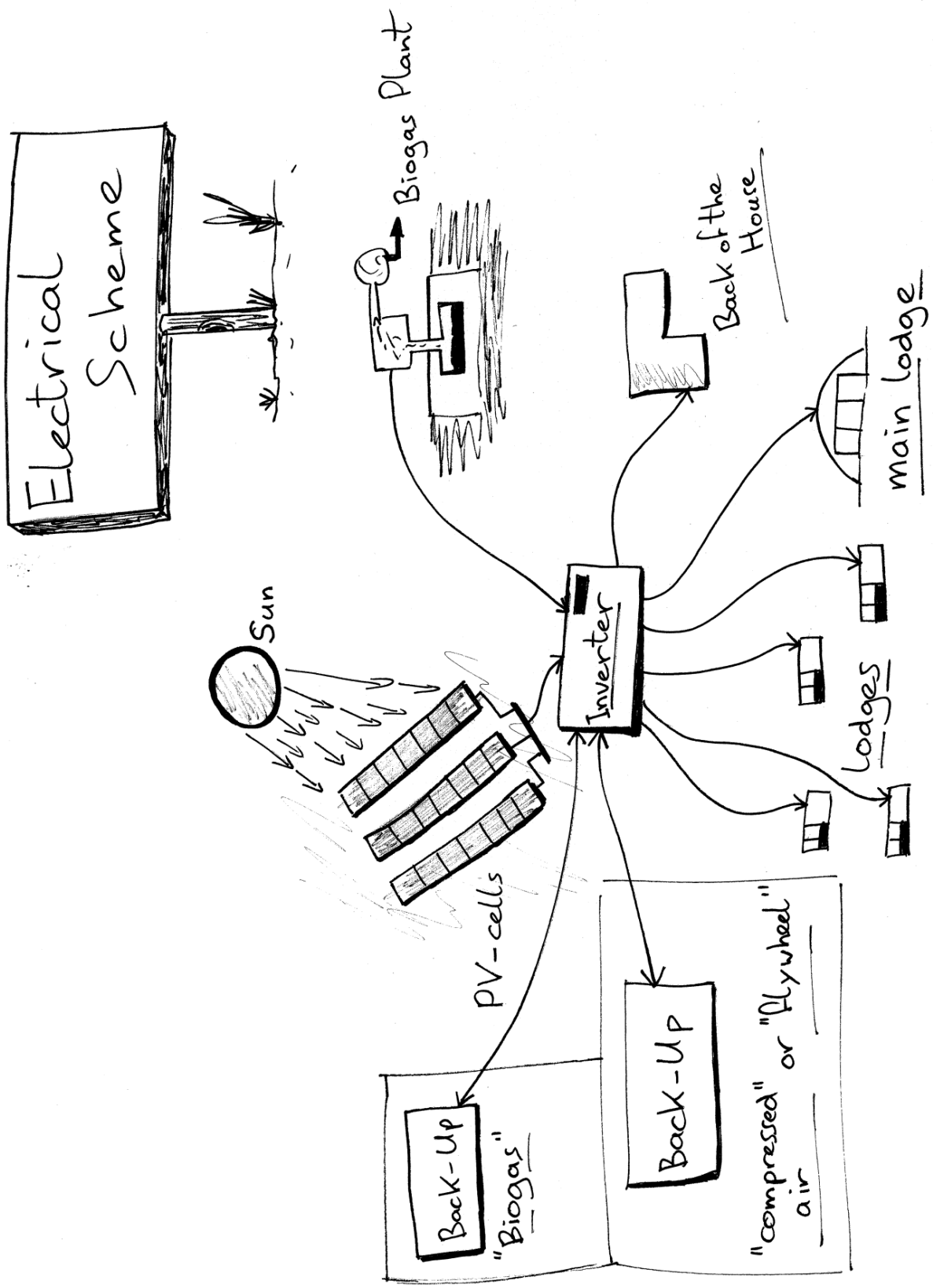
Choice backup system:
We have to think sustainable, we are totally of grid and we only have the power from the sun which is enough for the whole lodge. The only missing link was our backup system, for our sustainable design we have to choose between a solar-dam, air compressed system or the flywheel. All the three are good solutions when you check the specifications, but when you think about the natural impact and the size, the flywheel and the compressed air system will be the best. For our conceptual plan we will introduce the air compressed backup energy storage, the flywheel is expensive and there are no developments going for housing and commercial buildings.
The compressed air energy storage is a nice environmental friendly solution for the backup of energy. Maintenance and the expected life span are good.

8.3.9. Biogas – Green waste management

Biogas is gas resulting from an anaerobic digestion process. A biogas plant can convert animal/human manure and green plants into combustible gas.
Biogas can be used in similar ways to natural gas in stoves, lamps or engines. High methane content is desirable for the energy content of the gas.

The gas which get produced through this system can be used for different purposes. In our case we first use it for the gas cooker. The gas which is left goes to a backup system where we keep the surplus for how long is necessary. When there is shortage of electricity, we can ‘call’ the gas for using it in a biogas generator which use it for making electricity. (see

8.3.10.Scheme energy management



Eco-Green lodge

Design a sustainable wildlife accommodation

9 Afterword

Kevin de Bont **1537813**
Pim de Blois **1534317**

Green Leaf
Environmental Standard

The last four months we lived and worked in South Africa, more than 9000 km's away from Holland. To live there is something totally different, that is what we expected before, but to work there was something we really didn't knew how it should be. We heard things about the contact with the people here and the way the people work (way slower than we're used to in Holland) there but it was totally different than what we heard. We started with some contact through e-mail so we could make a start with our plan of approach. From the day we arrived at our office till the last day, we had more than great support from our boss and colleagues and we went every day without dislike to the office. When we're looking back to our time here in South Africa, we feel great! Not only because of how beautiful the country is, how much you could see here, how many nice people we met but we had the opportunity to work on this fantastic assignment of designing a wildlife lodge in, we think, the most beautiful private game reserve of South Africa.

We will thank Andrew Philips for giving us the opportunity to work at his office, to arrange us a project and help us where possible with getting the best results. We also want to thank Graeme Rushmere (owner of the *Kariega Game Reserve*) for giving us all of the information we need, to make time for us to come and visit him at his office for the questions that we had and for letting us stay 3 days in the *Kariega Game Reserve* to get the real bush feeling, to give us enough time to investigate the site and to let us experience how it is to be a guest in a wildlife lodge.

Eco-Green lodge

Design a sustainable wildlife accommodation

10 Insets

Kevin de Bont **1537813**
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Green Leaf
Environmental Standard

Eco-Green lodge

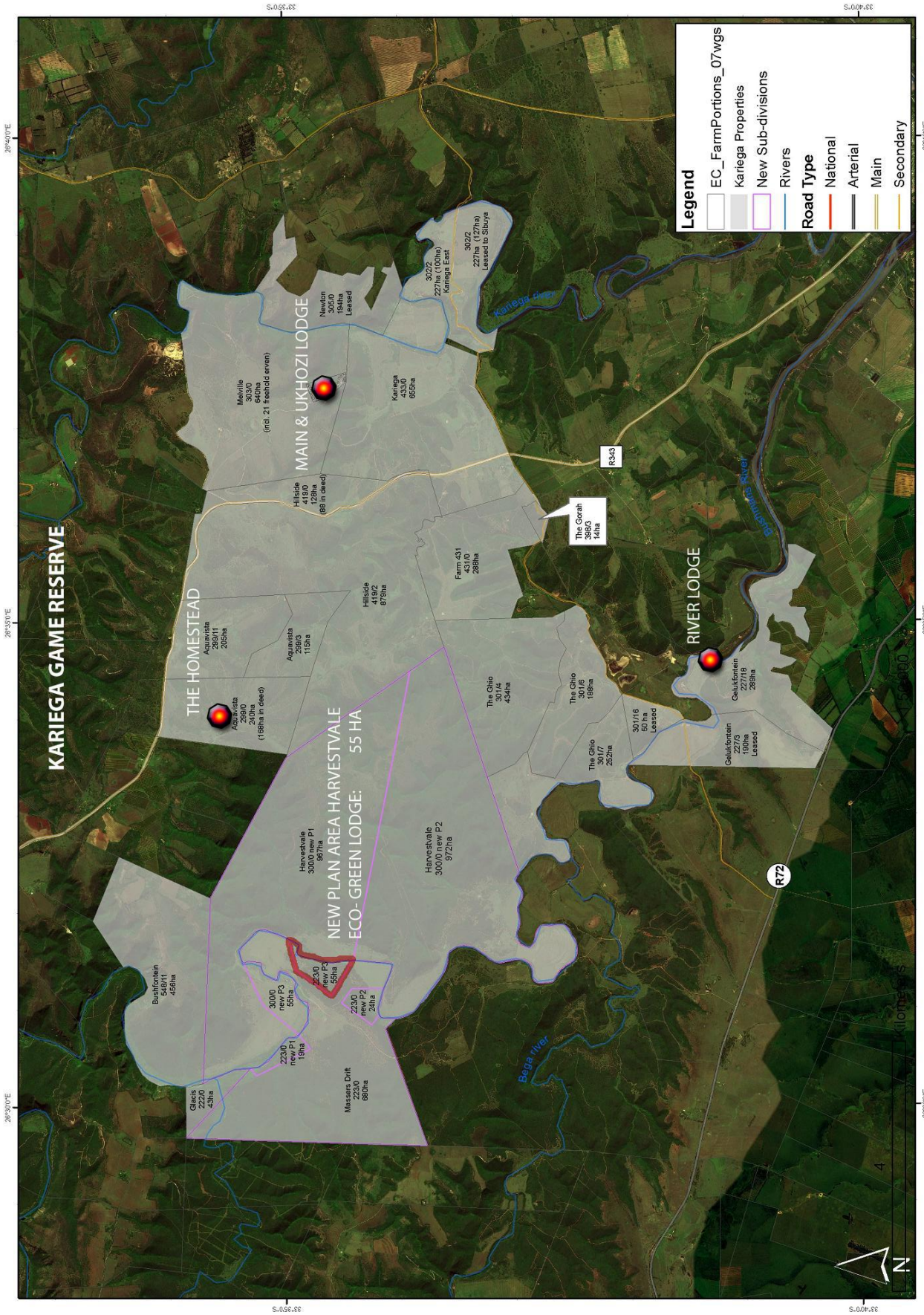
Design a sustainable wildlife accommodation

10.1 Extra info with the report

Kevin de Bont **1537813**
Pim de Blois **1534317**

4A Maps/Photo's Location

The Kariega Game Reserve area 9000ha. This page in A3



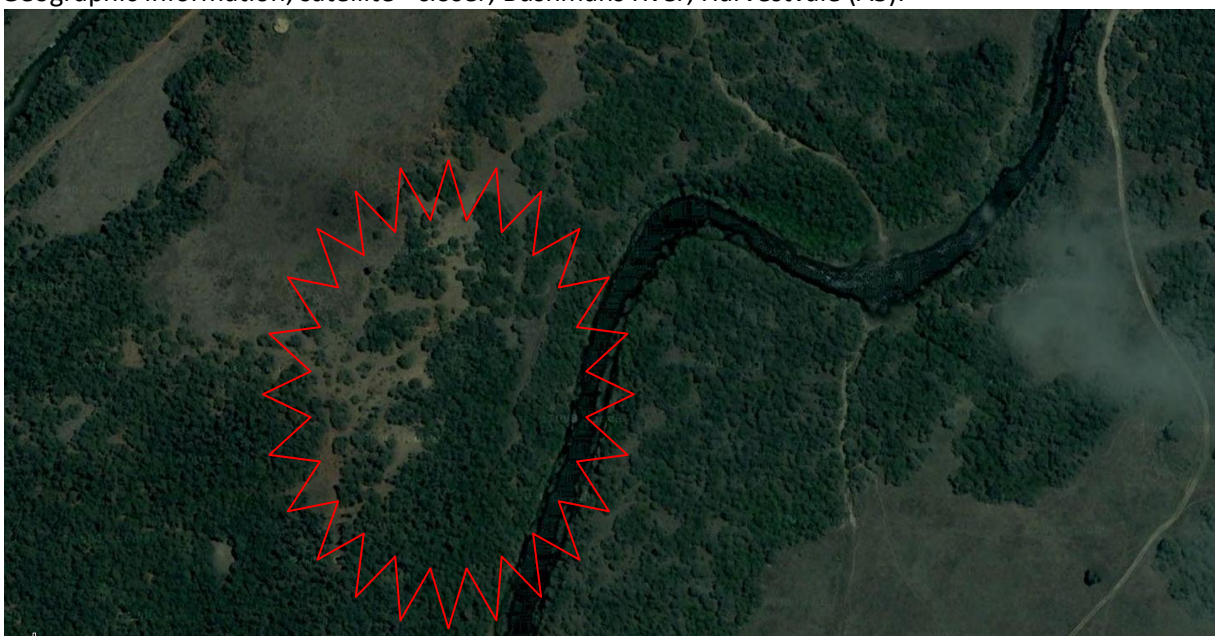
Views from plan site:

When you walk along the ridge there are several places to build some rooms, inside the bush:

The natural paths ‘can’ be used for accessing the rooms, attention: It could be a natural water drain.

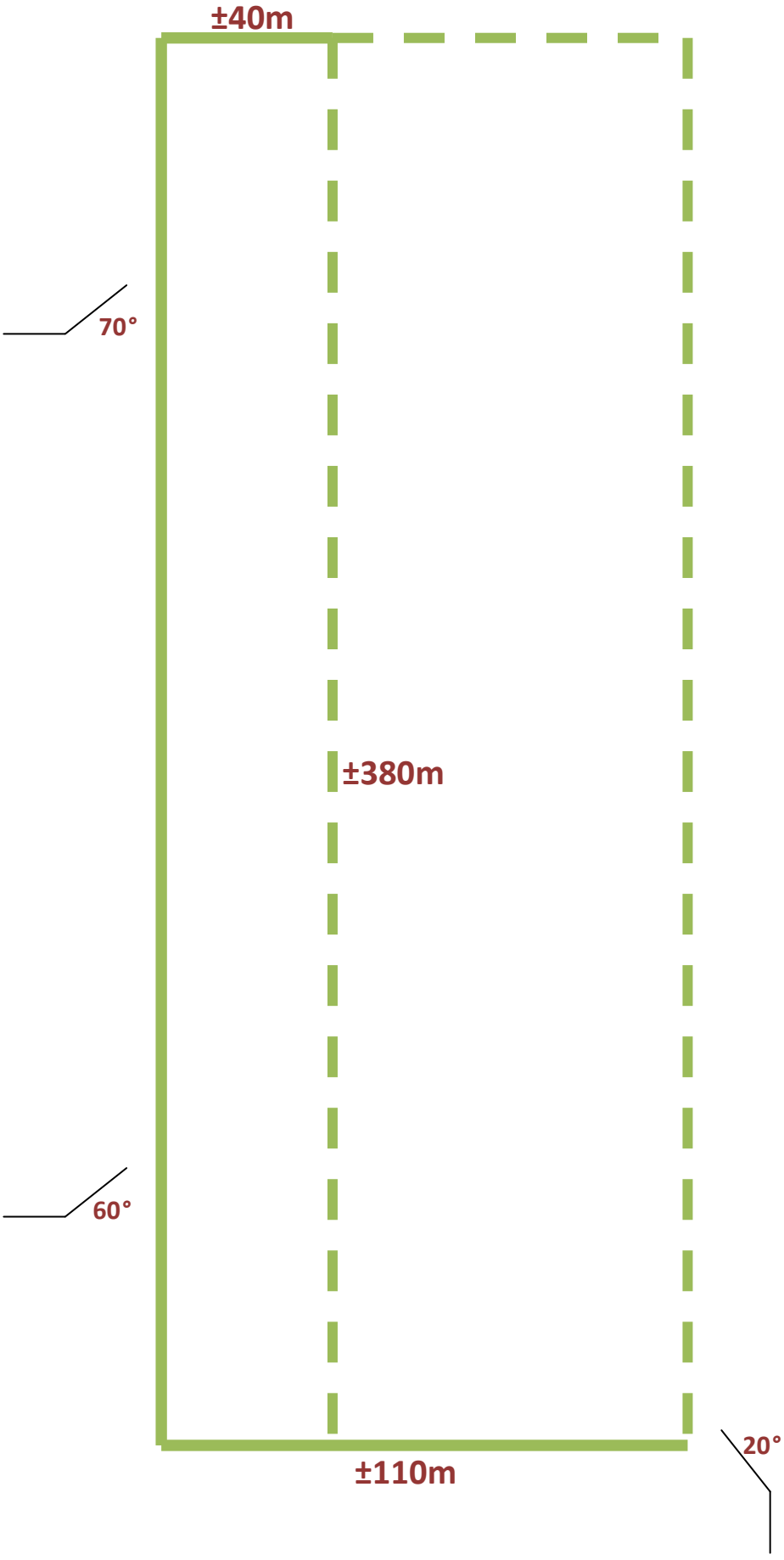
Geographic information, satellite; Bushmans river, Harvestvale (A3):

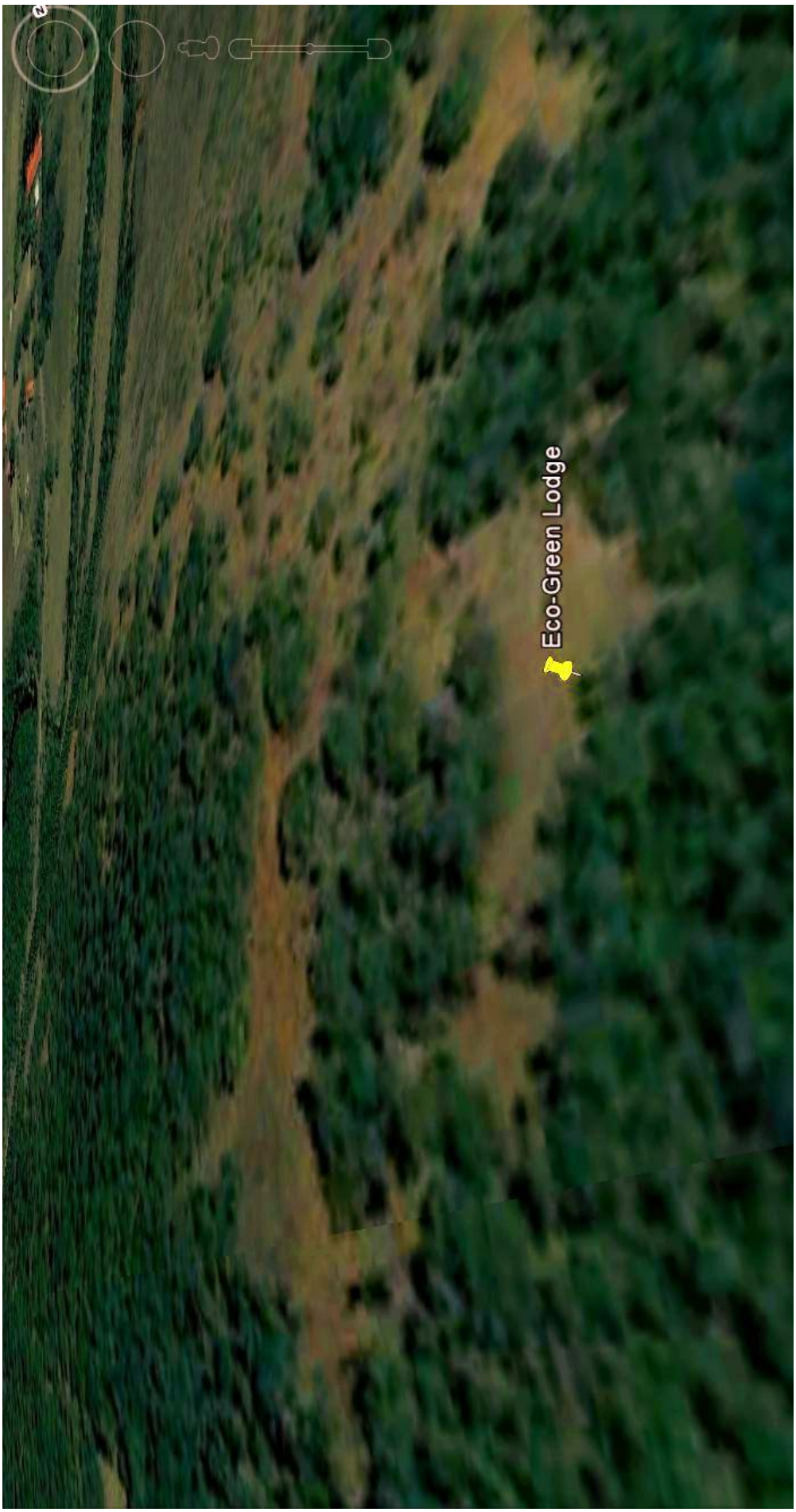
Geographic information, satellite - closer; Bushmans river, Harvestvale (A3):



Geographic information, map & terrain, Bushmans river, Harvestvale (A3):

The exact GPS-coordinates of the plan area are: 33°35’12.47’’ Z – 26°31’27.12’’ O
These measurements are token on site.




Eco-Green Lodge

4B Other buildings in the reserve

On the 9000 hectares of the reserve there are four other lodges established. The lodges are situated on different spots, scattered across the reserve. The common factor of the four lodges: authentic design detail, intimacy with the bush, luxury, world-class service and fine cuisine. Two of the lodges, *Kariega Main Lodge* and *The Homestead* are perfect for groups of friends and families. The other two, *Ukhozi Lodge* and *River Lodge* offer more absolute exclusivity and privacy for couples, children under 12 not allowed. The four lodges in the *Kariega Game Reserve*:

- River Lodge
  This 5-star luxury game lodge, on the banks of the Bushmans River, comprises 10 superbly appointed thatched suites all offering exclusivity, comfort and spectacular views.

- Ukhozi Lodge
  This 4,5-star luxury game lodge also comprises 10 superbly appointed suites, each with their own plunge pool and panoramic views from private viewing decks. The lodge has unique African-style lounges, dining area and an outdoor pool.

- Kariega Main Lodge
  This family friendly 4-star luxury lodge comprises 21 luxurious and spacious log chalets, all with en-suite bedrooms and own viewing decks, some of them even with a private pool. It's situated in the heart of the bushveld and overlooks the Kariega River Valley.

- The Homestead
  This family or group friendly private lodge is situated in a remote part of the reserve and is perfect for groups up to 10 persons, who desire a unique safari experience tailored to their own needs.

6A Wood

In our design wood can be used for different things;

- Fencing
- Decking
- Furniture
- Structure

Wood is a natural source which is not bad for the environment using it. It is preferable using it with a green certification such as the FSC-brand, the global accreditation organisation for green forest certification. Forests are audited once a year. Wood marked “100%” is from well managed forests. Trees and wood from the own area, are also good they are almost free and not really bad for the environment. It is natural grown and when using these trees/bush it is possible to seed some new ones, or you can decide using them and leave the nature as it is. The nature will be grown back again, but not as fast when you seed some.

No hardwoods, no exotics.

For example if you look in neighbor countries, you will see in Zimbabwe a big Tree farm. In this tree farm they grow Rose Gum. This is a fast growing tree which can be used for flooring, decking etc. Very strong material which also can be used for the structure.

When you think about our design, wood is not a good type for radiation of earth warmth when using it for the structural design as the floor, walls or roof.

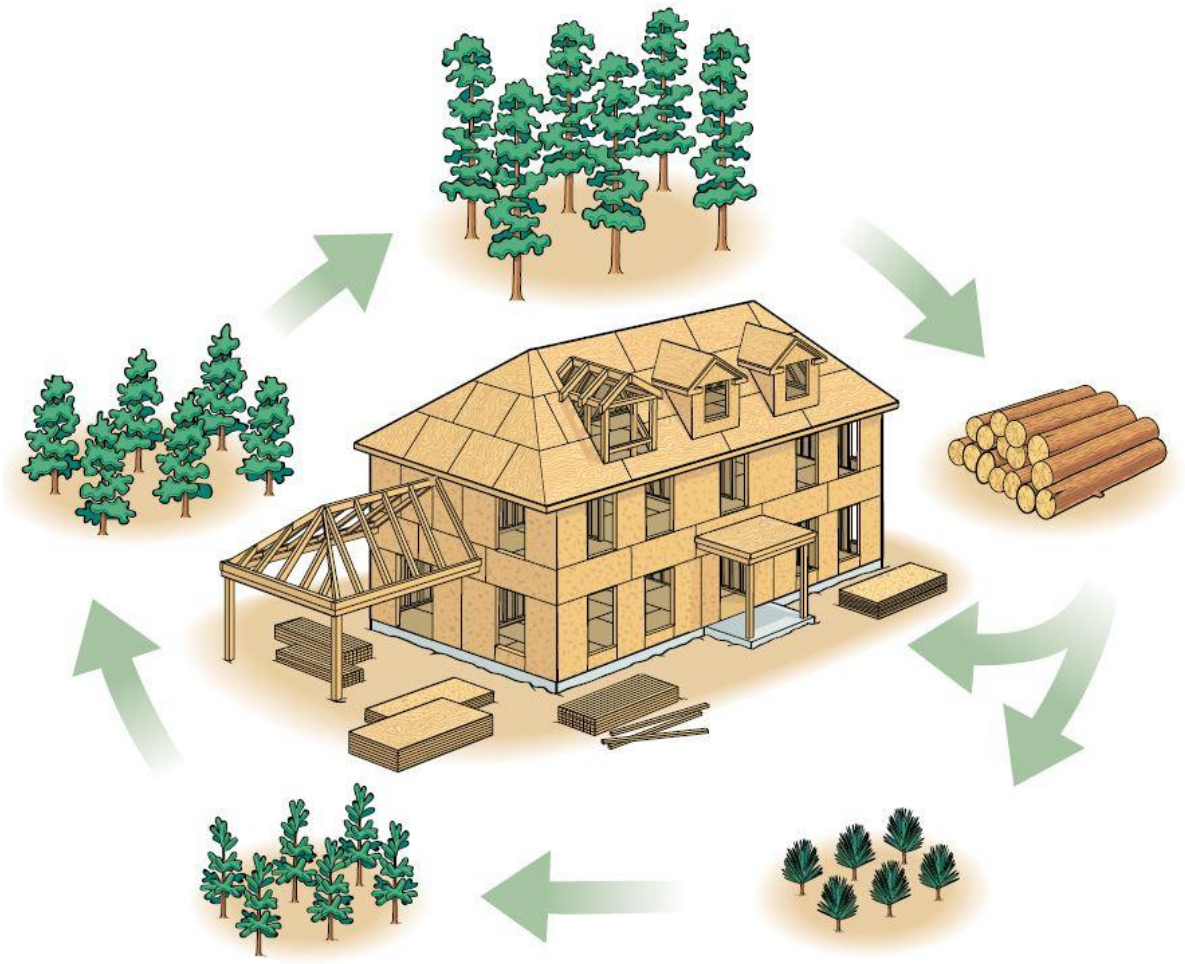
It is a good solution for decking, fencing and sun blinding for the rooms and the main lodge.

Natural wooden fencing

Natural wooden sunblinding

Natural wooden structure

Here in South Africa you also have Red Gum trees, they are also fast growing and strong. In the reserve we have some wood what we can use for fencing and the sun blinding. For the rest it is recommended getting it locally.
When using a wooden structure, the beams have to be treated for South African bugs, without these treatment the wood will break in a short time. The treatment itself is not good for the environment because of the bad gasses.



Best way of building a wooden structure from 'APA The Engineered Wood Association'

An alternative for wood is recycled plastic, this material can be used for the decks or fencing. In the esthetic way of thinking, with the bushy feeling it is not the best solution.

When using wood some recommendations:

- Use local wood from the reserve, without hurting the nature. Plant some new ones instead of the used ones.
- Use wood locally, but only responsible wood.
- Use wood from inside South – Africa which is branded with a FSC-Certification (or like that).
- Try to keep the distance for the transport as short as possible.
- Buy in bulk.

When the distance is too far for transporting it within a short time, or it is not worth it using wood try other solution for example a local rock for the structure.

Recycled plastic deck

6B Bamboo – Grasses

Bamboo is a renewable material, it is a grass, it is strong and it grows really fast comparing to hard wood. It will reach its full height in 2 years and is fully grown (hardness) in 4-5 years, compare it with a hard wood forest that grows in 40-50 years.
The best used type of bamboo is the Mao or the Mosa Bamboo because it grows straight and is very tall.
Because it is a grass it keeps growing every year, new stems will grow every year so the plantation will naturally cycle. You cut the oldest ones, year by year and new ones will follow.
If you think about global warming, and the absorption of CO^2 per hectare, bamboo absorbs more than traditional hard wood forests.
In the carbon footprint, bamboo will have a positive impact on the environment, bamboo absorbs more CO^2 during their growth than is released during the manufacturing process of bamboo boards, flooring etc. *(written by Panda Bamboo)*
There is one manufacture in South Africa who works with bamboo *(Panda Bamboo)* they import the bamboo from China which costs more money and is bad for the environment.

In fact, bamboo is a nice and renewable material when it is produced on a certificated plantation and it is better to have it locally. Tests on the web says that a lot of the bamboo farms are still not sustainable because of the way of producing it. Only certificated plantation are good.
Some of the tests says that production of bamboo flooring has social impacts on labor, requires transit energy, contains little to no recycled material, can negatively impact ecosystems and can have a negative effect on indoor air quality.

We think that bamboo is in a booming progress right now and it will cost a few years to develop a better system, just as the FSC-branded forests.

In this and the next page we will show some pictures which shows what is possible with Bamboo:

Laminated table from Bamboo

Illustrations:

Bamboo structures

Bamboo fencing

Untreated structures or fencing are fine for the environment, but like laminated tables or other furniture the environmental impact currently is not that good. For example when using it for flooring the producing of planks will cost more energy in comparison with of hard wood. *(Bamboo is hollow and thin)*

In the esthetic way of thinking Bamboo in a environment with bush and wild animals untreated bamboo is not the best looking material for the design.

If we consider using bamboo, the bamboo will be imported.
Bamboo is a stable product, strong and durable, but not always sustainable.

6C Concrete

Normal concrete got a high rated footprint, to produce concrete you will need a lot of energy.
Concrete is mainly based on cement, making cement is a high energy intensive process. It is made by burning fossil fuel to heat limestone and clay powder to 1500°C. The CO^2 emission is really high, it is 7 – 8 percent of the total CO^2 emission of the world.
To make concrete with the cement, the cement will be mixed with water and gravel. The water that runoff from concrete mixing has a high alkalinity and can be harmful for the environment.
Positive things of concrete are the concrete is a good insulator and heat sink this is important for our design. Concrete works perfect with temperature changes, it will stabilize the temperature.
Using concrete will give a nice and warm feeling inside, the peoples welfare is almost even important as the sustainability of the product.
The end product is not harmful.

Concrete can be fully recycled. When using recycled concrete the CO^2 emission is lower than using new produced concrete. The only problem is that the costs are higher for the consumer, so for the normal business it is not worth it using recycled concrete in the mixing progress.
Manufactures, fabrics are still busy with new systems which reduces the high CO^2 emission.


Recycling concrete

But still concrete is not the best material in the producing process, however when it is produced the material is durable and 'sustainable' it can be recycled and got a really long life span (50 – 100 years).

If you compare concrete with wood, wood will be much better in the CO^2 emission but not for the heat sink of the building. Compare it with steel, steel got a higher emission than concrete. We think if you look in the future, concrete is a strong, durable and also a bit a sustainable solution as a building material.

If you design it well, the maintenance level of concrete is nothing.
The concrete can be locally produced and is not expensive.

6D Local Rocks

Rocks, as old as the hills but still used in the contemporary architecture. It is a strong material and it gives that natural robustly look. That last thing is exactly what we want in our design so we're definitely going to use rocks in our design. The best thing would be that we can find those kind of rocks nearby the site for our lodge and in fact that is how it is; in the Kariega Game Reserve are enough rocks which we can perfectly use.
Another feature of rocks is that they have the strength to carry the roof of the building and the mud, rocks, clay upon it. For our design that is a very qualifying property.
Local rocks are the most sustainable materials we could use for our

Figure X.1 *Flat rocks used for a fireplace*

Figure X.2 *Rocks used for a wall around the swimming pool*

Figure X.3 *Flat rocks used for a braai*

6E Earth, mud and clay

Earth, mud and clay; all three natural products which can be used for building purposes. If you use these materials correctly, it are extremely strong products. One of the requirements for using these materials is the supply which has to be done onsite but that isn't a problem at all in our case. The most common use these days is called 'rammed earth', where mud is mixed with a bit of *Portland cement*. This type of cement is composed of 90% *Portland Clinker*, max 5% plaster (determines the time of harden) and 5% other materials. The specific gravity of this cement is between 1800 and 2200 kg/m^3.

Figure X.4 *Clay sticked on the wood*

Back in the days, people made walls for their houses out of wood and mud. In the Kariega Game Reserve, there are a couple of old farms (from around 1820) built this way. On the picture below you can see one of those farms or anyway, one of the outer walls of it. When you take a good look you can see how it's built up: the wooden branches and the clay on both sides of them. It keeps the warmth in the colder days inside and in the warmer days outside.
Because of this quality of the material, we can use them very good for our design. We want to work with the heat of the earth and use it, through the warmth-cold-radiation so this would be a really good choice for using this material for parts of our lodge.

Figure X.5 *Old farms with clay-wood walls*

6F Bricks

When using bricks, try to go for locally produced bricks and clay if possible. Mud walls (as discussed above) and bricks are very viable but you have to take a good look on where to build, bear the local mud onsite in mind. The bricks would be very sustainable because of the materials could be used for them. Those materials could be found on the reserve itself so we don't have to transport it to our site.

Figure X.7 *Steel*

6G Steel

Steel is a very strong material which can be used for a lot of purposes. The material can be cast into almost all imaginable shapes and has good quality's.

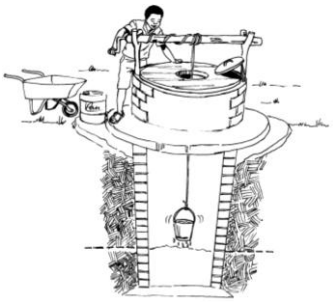
Metals aren't really sustainable so we actually don't want to use them. It isn't easy to avoid using them but we can use them as less as possible. In our rooms we don't need any metals but in our main lodge we can't do without it. We'll need it in the kitchen and for the swimming pool but we aim to use them as less as possible.

Figure X.6 *Steel*

The metals that we use are all made of recycled scrap which is melt down to 'new' steel. In this way we can use steel in a 'reliable' way.

8.A Borehole water

There are different ways to use water from under the ground. The most use full one is a borehole water.



Other one could be a hand dug well, this is a more traditional way and normally works with manpower. This is a big hole which has a minimum diameter of 0,8 meter. With a turning system the bucket can be pulled up and down to bring the water to the surface. This is a nice traditional way to show what is possible with water, but not a good solution for the basic need of water.

For our lodge we need to think about better solutions to get water from inside the ground. Boreholes can reach 'any' depth as recommended for the best water. The diameter of boreholes range from 4 to 12,5 inches (101mm – 308mm). It is important to make the hole deep enough so when the water levels changes in different seasons the pump wouldn't get dry. A ground test is recommended.
The capacity depends on how big the hole is and the power of the pump.

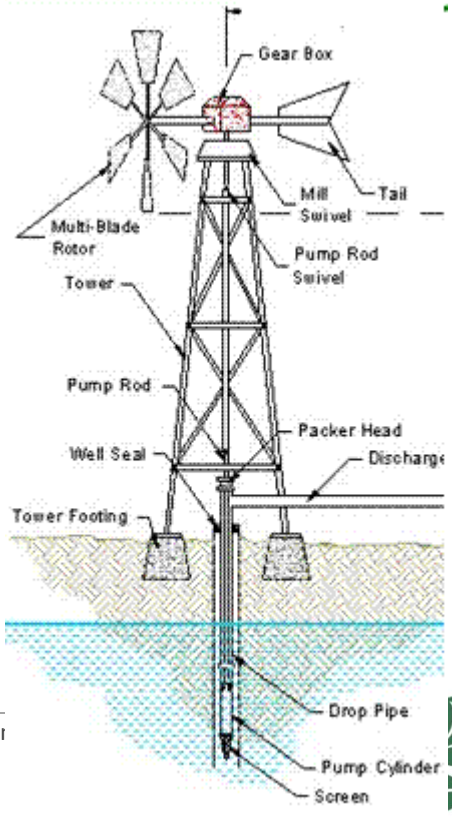
The hole can be pressurized drilled in rock or in soft sentiments with mud rotary drilling. The water will reach the surface with a pumping system or a bailer.
The water quality depends on the inherent properties of the groundwater. But when pumping it, it is recommended to filter and clean it before usage.

8.B Solar powered pumps

This electric pump system will work with photovoltaic cells which will produce the energy during the day for the pump. It is important that the pump can be used 24 hours and 7 days a week so you will need to install a backup system. A battery can figure as backup, charged during the day by the photovoltaic cells. It depends on the needs how big the pump will be and how many square meters you will need.
This is an expensive system, you will need solar panels, batteries, the electric pump and a backup water storage tank.
Solar powered pump are used mainly on private farms and game reserves, as a substitute for diesel pumps. High – cost maintenance and prone to theft.

8.C Wind powered pumps

Wind powered pumps use the energy generated by wind to lift groundwater to the surface. A rotor is mounted on top of a tower, the wind will turn the rotor which through a gearbox drives a reciprocating shaft. The power of the wind could also be used for a air compressor, which can be used for tyres but also for extra power of the rotor.
The wind pump must therefore be placed where there is a clear sweep of wind, it is recommended to install this system where there is sufficient wind. When there is a day without wind or not enough, a water basis should be installed.
These pumps can lift water from great depths. The energy source is free and sustainable.
These pumps got a high cost and breakdowns can be caused in number of ways (rotor, gearbox etc.)
This system had been used a lot in South Africa nowadays.



8.D Diesel powered pumps

Diesel pumps are settled on the surface and turns the pump with V-belts, gearboxes or shafts. It is a strong and reliable way of pumping, it doesn't depend on variable things like sun, wind etc.
This way of pumping is bad for the environment, diesel need to be transported and the exhaust is bad for the air (environment).

Biodiesel pumps
It works the same as normal diesel powered pumps only with minerals of vegetable origin. It is not bad for the environment because it is a circling process.

For using a borehole we should advice an electric based pumping system. The water pump installed on the surface for a good working pump system and easy to maintenance.
It is important to have a big reservoir nearby.
Set off peaks in usage
No continuation of working

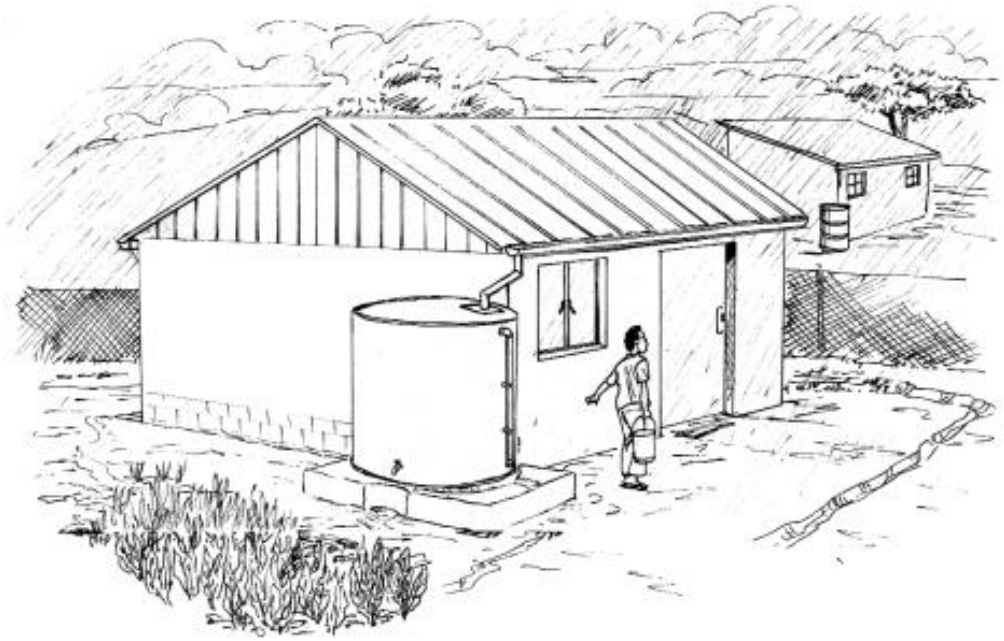
8.E Rainwater Harvesting

Rainwater, it can be used (direct or indirect) for different kind of uses and it´s free, so why would we just let it drain into the ground?
One of the possibilities for getting benefit of rainwater is *rainwater harvesting*. Using this system rainwater is collected from impermeable surfaces and led to storage tanks. These surfaces include roofs and specially prepared ground and rock. There are a couple of ways to do this;

- Rainwater collected from roofs is channeled into storage tanks, via gutters and pipes
- Rainwater gathered from the ground is collected from sloping surfaces which are compacted or covered with tiles, concrete or plastic sheeting and then gets directed to a storage tank
- Rocks can be cleared of vegetation and soil and the rainwater that flows between the bricks/stones can be collected. The water is prevented from running off the rock face by a low wall, which leads to a low point. The water is then led through a filter and then conveyed to storage tanks.

There are a couple of requirements before you can use *rainwater harvesting*:

- The material selected for a roof should be easy to clean and should not pollute the water while being collected. Examples of such material are corrugated iron (with no lead-based paint), tiles (with no lead flashing), plastic, concrete and asphalt.
- When you harvest rainwater from the roof, there must be a good guttering and down pipe system constructed from PVC, fibre cement or aluminium.
- If you want to harvest rainwater with ground or rock face, a collection system is required along a low edge (often a low wall) which must slope to a low point. From here the water is piped to a storage tank. A simple filter is enough to remove dust, droppings etc.
- The design and size of the tank depends on rainfall patterns and the water demand. In South Africa storage of up to nine months might be necessary.



Water Quality

Only rainwater harvested from the roof is recommended for drinking purposes, else it should be treated first. However, this water can be used for washing and watering of plants and animals.
The quality of the rainwater from roofs can be improved by the inclusion of a coarse screen between the guttering and the delivery pipe. When the quality isn't good enough, further improvements can help. A fine screen can be placed between the delivery pipe and the tank, a lid on the tank, a first flush system that sends the initial run off to waste and the use of suitable roofing material are such improvements.
The roofs where we get most of the rainwater from is also a place where a lot of leafs and other stuff from trees falls. Also animals are producing a lot of stuff which can fall on the roofs and can conceal one or more pipes. Because of this problem which can appear, we have to use grids and filters. These filters will purify the water so it can be used for further purposes.
If it has not rained for a long time, the roof must be cleaned before rainwater is collected and the tank, gutters, pipes and screens must all be inspected and cleaned on a regular basis.

Costs

Costs of the improvements are associated with the:

- roof, cleared rock face or prepared ground surface
- guttering system, pipes or collection wall
- filters
- storage tanks

8.F Water purification systems

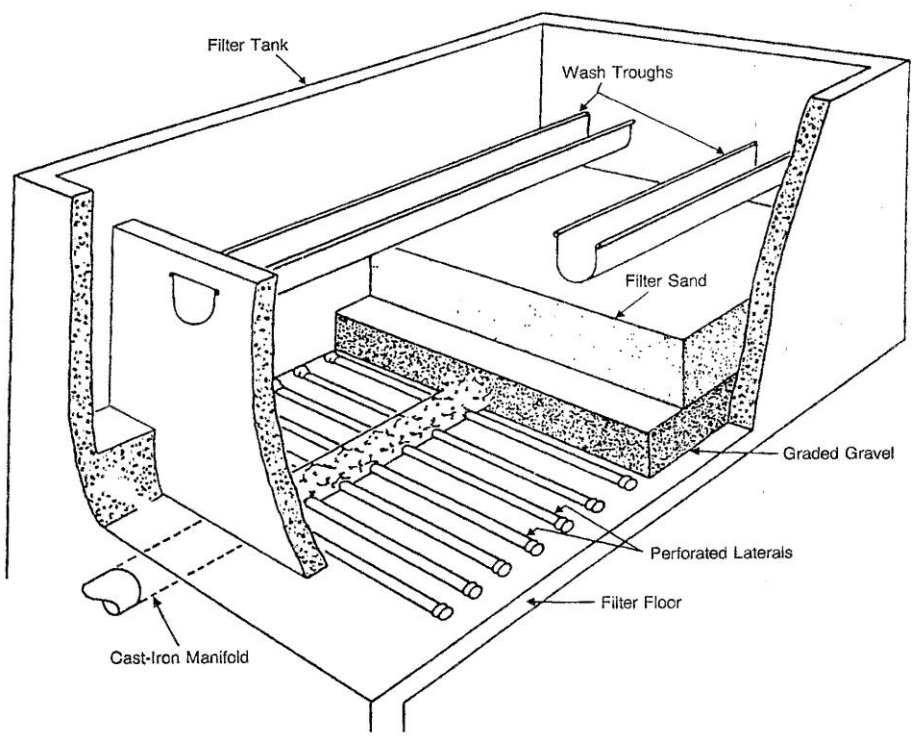
Sand filter

A sand filter based system is a good solution to clean river water.
The capacity of the filter is determined by the surface area of the filter top and not the overall volume of the filter. It may be advantageous to construct 2 smaller sand filter units rather than one large unit so one can be shut down periodically for cleaning and repairs. The process of filtering is slow but it has a good capacity with a big surfaced system. The tanks can vary from 200 liters up to 100.000 liters tanks.

Continuous filtering assists in the development and maintenance of a healthy filter. The filter bed consists of a uniform fine particle sand mixture as specified by a filtering system. For the best result the filter bed is built at least to a depth of 1- to 1,5 meter.

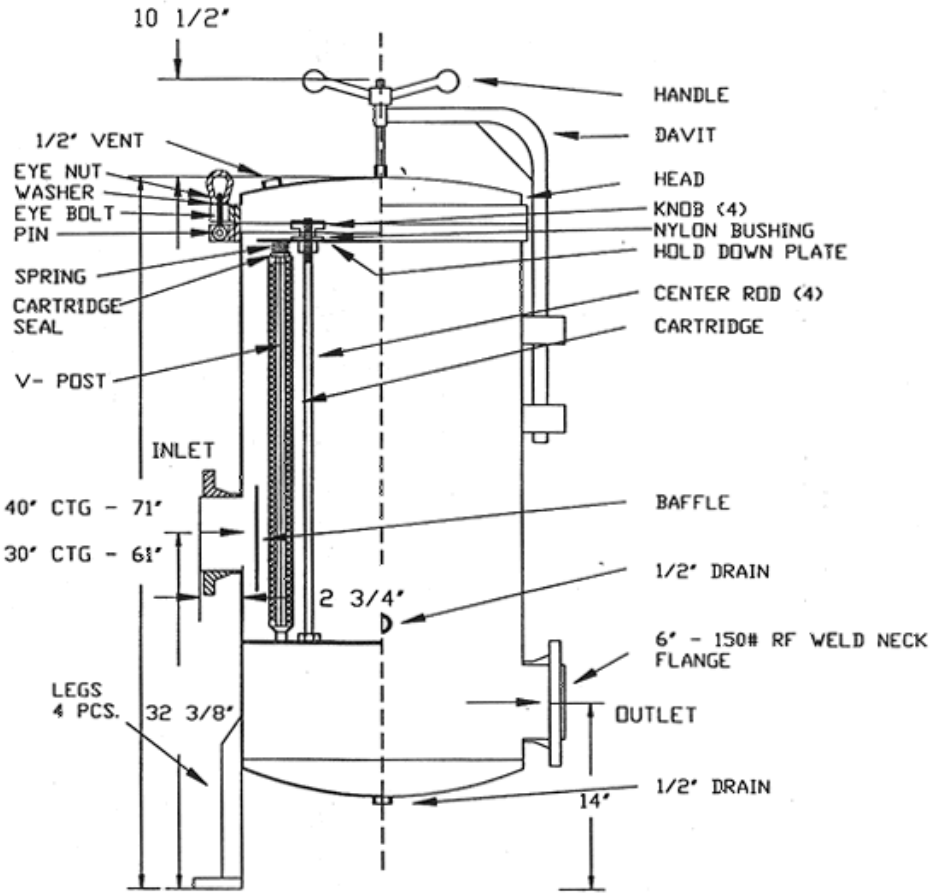
Rapid sand filter

Just like the normal sand filter water moves vertically through sand, on top of the sand there is an often used layer of activated carbon or anthracite coal. The top layer removes organic compounds, which contribute to taste and odor. The space between sand particles is larger than the smallest suspended particles, so simple infiltration is not enough. Most particles pass through surface layers but are trapped in pore spaces or adhere to sand particles. Effective filtration extends into the depth of the filter. Every layer has to filter a part of the water, if the first layer will filter all the particles the system would quickly clog.



Membrane filter

This system is used by a ceramic cartridge filter. The water is pumped into the system which goes through the cartridge for the filtering process. The capacity depends on the size of the unit. It is better to have more than one, you would have a higher capacity and if maintenance is needed the filter can shut down for a short period without losing the application of drinking water.



Membrane filtering system, on the left the inlet and on the bottom at the right side the outlet (size depends on the usage).

We choose for the sand filter for our lodge. It has a big capacity, is the most 'natural' filter and because we have enough free space, we can easily give it a good place. The filters has the best results when they're built 1 to 1,5 meters in the ground so it is also good for the view because it can't be seen from a distance.

8.G Helophyte – filter

Functioning

The functioning of *constructed wetlands* is mainly based on the activities of bacteria in the substrate. Especially around the roots of the reed-plants, large amounts of bacteria develop in a short stretch of time which break down the pollution in the water very effectively. Their growth around the roots is stimulated by the reed-plants, because of the oxygen they derive from the air and transport to the roots like some kind of snorkels. At some distance from the roots, the soil is anaerobic and there live different kind of bacteria which don't need any oxygen.
It's this unique combination of aerobic and anaerobic bacteria living really close to each other that make constructed wetlands so highly efficient in purifying. Beside this role of the plants, they also keep the wetland from clogging by their continuous growth of roots.

In some degree, the plants live on the phosphorus and nitrogen in the waste water, but a considerable part of that will be re-released when the upper parts of the plants die off in winter. Constructed wetlands are, of all small-scale treatment plants, the best in withdrawing nitrogen and phosphorus. Proteins, ammonium and nitrates are for a part converted to the atmospheric and harmless form of nitrogen and phosphorus will be bound to the soil. Because of this binding, we are dealing with an ending process so the soil will eventually be saturated and no longer able to bind phosphorus. The soil has a capacity for around twenty-five years and after this period the system can be refreshed by changing the substrate or sometimes will only the upper part do.

Construction
A *constructed wetland* is in fact a sand filter, planted with reed. Reed has proved to be very resistant against heavy or chemical loads and besides, the roots grow quite deep.

Step by step:
A constructed wetland gets constructed in following order:

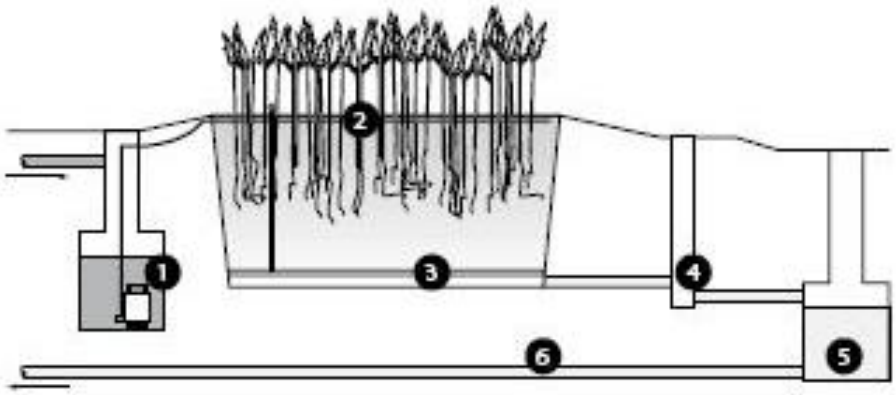
- a surface of several square meters is dug out to around 1,2 meter depth. Per person the needed surface is 4 to 5 square meters. Once dug out, a special membrane is laid out to ensure the water tightness of the system. The next steps are:
- laying of protection cloth
- placing the drainage pipes
- adding of gravel
- spreading of the root cloth
- adding a specially composed mix of fine sand, straw, limestone and iron grit
- making the infiltration system
- covering with gravel
- planted with young reed plants

Maintenance

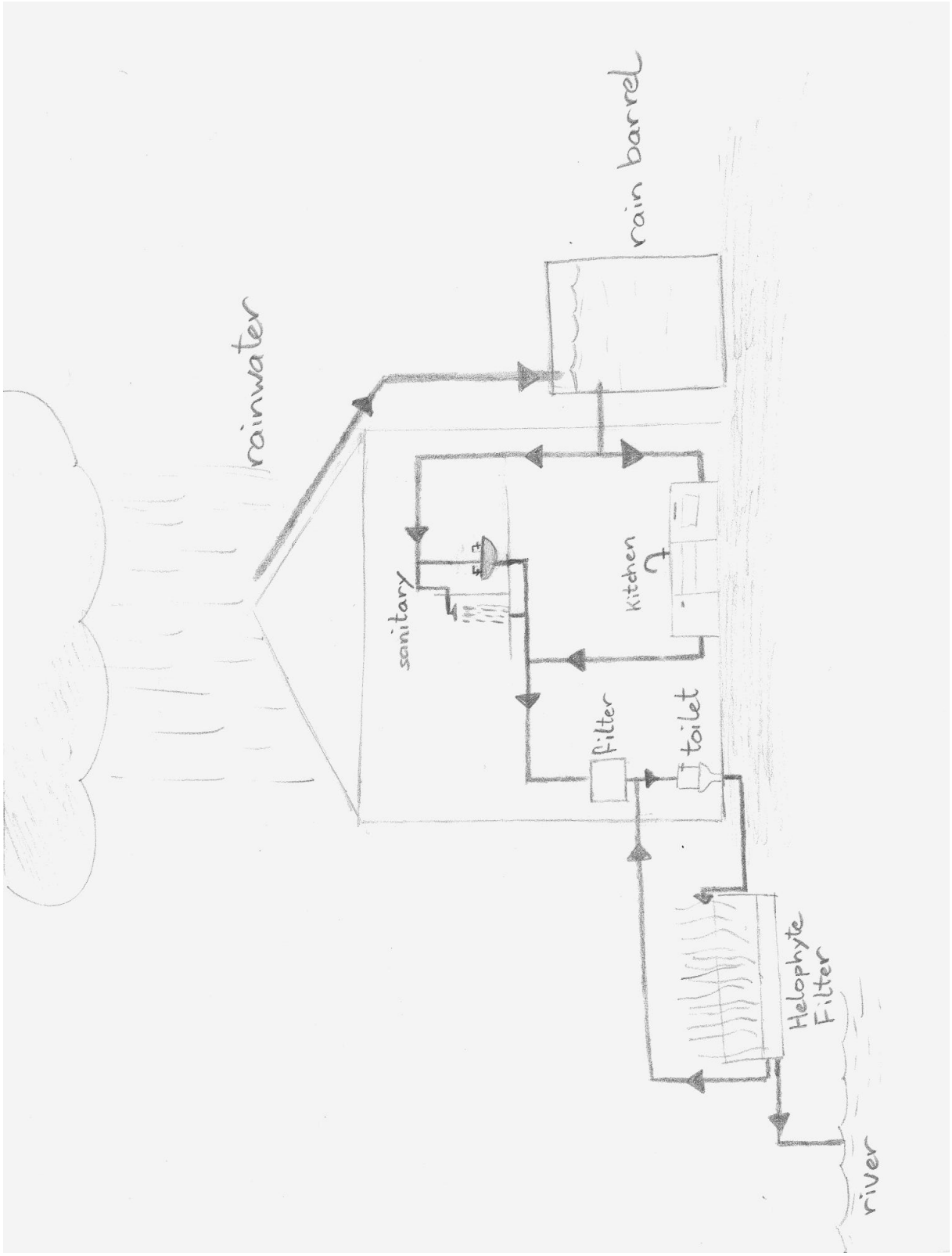
The maintenance of *constructed wetland* is restricted to two kinds of labor; technical and green maintenance. The system only needs a yearly control for checking all the parts of the installation. The green part of the system also needs some maintenance. The first two years some weeding will have to be done, in order to give the young reed-plants a better chance than unwanted weeds like grasses and nettles. After the first two years it meets to mowe the reed two-yearly.

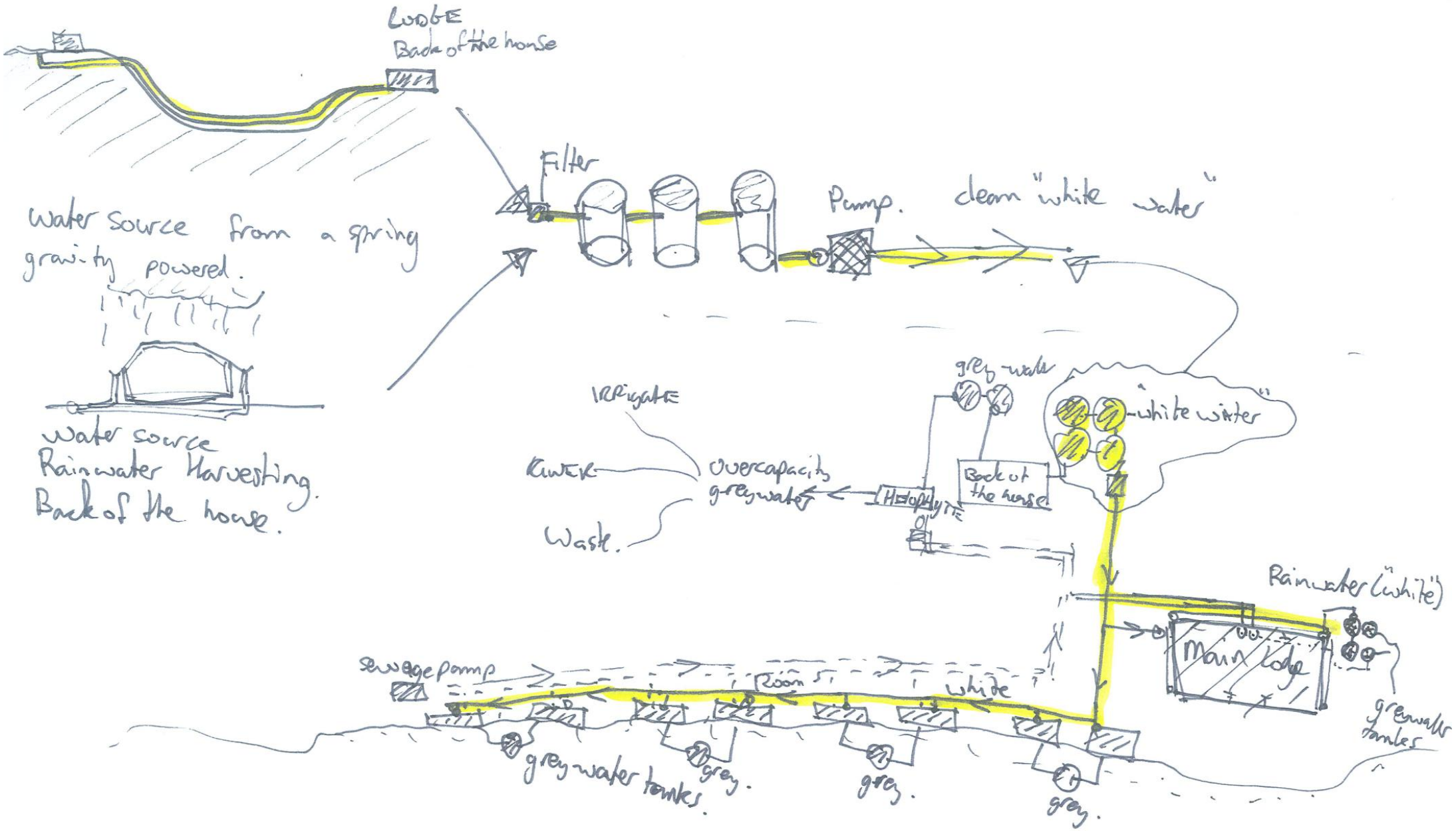
Functioning in short

The filter is composed of a substrate or sand bed (2) in which *helophytes* grow. *Helophytes* are marsh plants, like reed maces, rushes and reed. These plants transport the oxygen to the roots, where large amounts of bacteria settles in the sand bed. These bacteria turn the waste products (1) over into nutrients for the plants and themselves. The filtered water gets leaded through a layer of gravel with drainpipes (3) to a control pit (4) and then further to a reservoir (5) and back to the building for reuse (6). A *constructed wetland* is always approximately 10°C to 15°C and also works in winter.



8.H Sketched water schemes





sketch water management

site plan

8.I Solar panels:

Mono Panels


Mono panels

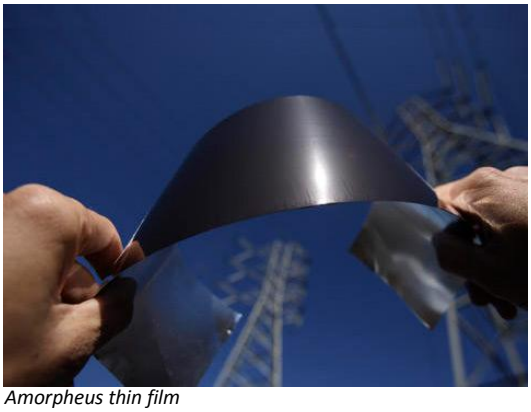
- Mono panels are made up of single-crystal wafer solar cells.
- Single crystal wafer cells are more expensive to make than polycrystalline cells. These wafers are cylindrical ingots so they don't fit a square solar cell module without a lot of wastage so you can normally recognize a mono panel as it will have uncovered gaps at the four corners of the cells.
- These cells are more efficient than poly solar cells and that is why mono panels generally have a higher solar cell efficiency than poly panels.
- Best option if you have a limited space roof.
- Mono panels have much greater embedded energy than poly panels i.e. it takes more energy to make these panels and thus they are less environmentally friendly.
- Good performances in cold conditions.

Poly Panels


Poly panels

- Poly panels are made up of polycrystalline solar cells.
- Polycrystalline solar cells are made from cast square ingots of molten silicon carefully cooled, solidified and cut. These poly cells are less expensive to produce than single crystal silicon cells, but are less efficient. This is why poly panels have a lower solar cell efficiency than mono panels and a lower embedded energy.
- Poly panels tend to be better in higher temperatures than mono panels.
- Marginally less expensive than the mono-panels.

Amorpheus


Amorpheus thin film

- Lowest efficiency.
- Expected lifespan is less than crystalline panels.
- Optimal efficiency in hot weather, less effective in cooler conditions.
- 3-6 month ‘breaking in’ period where long term output is exceeded.
- Requires 2-3 times more panels and surface area for same output as crystalline.
- Ideal for example for example inland Australia, where conditions are hot and vacant space abounds.

8.J Wind turbines

Types

There are actually two kinds of windmills; horizontal en vertical. The horizontal are used the most in open areas and the vertical in urban environment and on roofs.

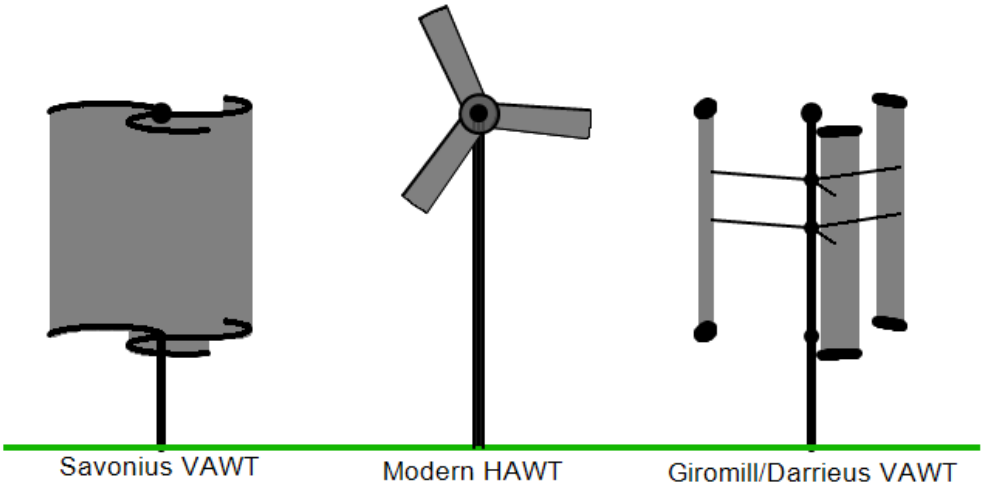


Figure X.1 *the three most used types of wind turbines: Horizontal Axis Wind Turbines (HAWT) and Vertical Axis Wind Turbines (VAWT)*

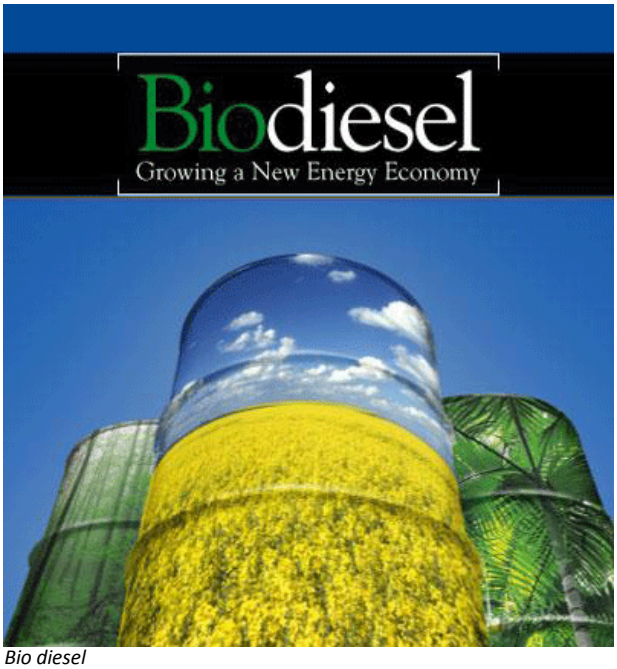
Both types use the wind in slightly different ways; horizontal turbines (the more common design) uses angled propeller type blades to create friction when facing the wind which results in a spinning motion. The vertical turbines use the wind to spin on a centre point on the ground which results in the whole construction spinning around.

The process of electricity production is significantly similar in both designs only the construction makes a difference in the position and design of the blades which are used to create friction with the wind. Compare it with an electric fan but then the other way round.

A good way of thinking about the basics of wind power is by comparing a wind turbine to an electric fan. An electric fan uses electricity to create the blowing motion (wind) and a wind turbine works in the opposite direction, using wind energy to blow the blades which are attached to a generator, creating the electricity.

8.K Biofuel

Biodiesel is available in this section of South Africa so it is useful to use the strong biodiesel for the generator.
There are different types of diesel the B100 is the most natural because it is 100% made from vegetable oil. There is only one problem with the B100 diesel, it will get slushy when the temperature is underneath 0 - Celsius. In fact the temperature at our location will never be underneath that temperature so it is a good solution.
The emissions are fine because it is made from green stuff which is never ending, the CO2 emission will be used for the growth of new plants.
When using a generator most of the energy will get lost of the heat at least 65 % we can decide using this for heating the water.

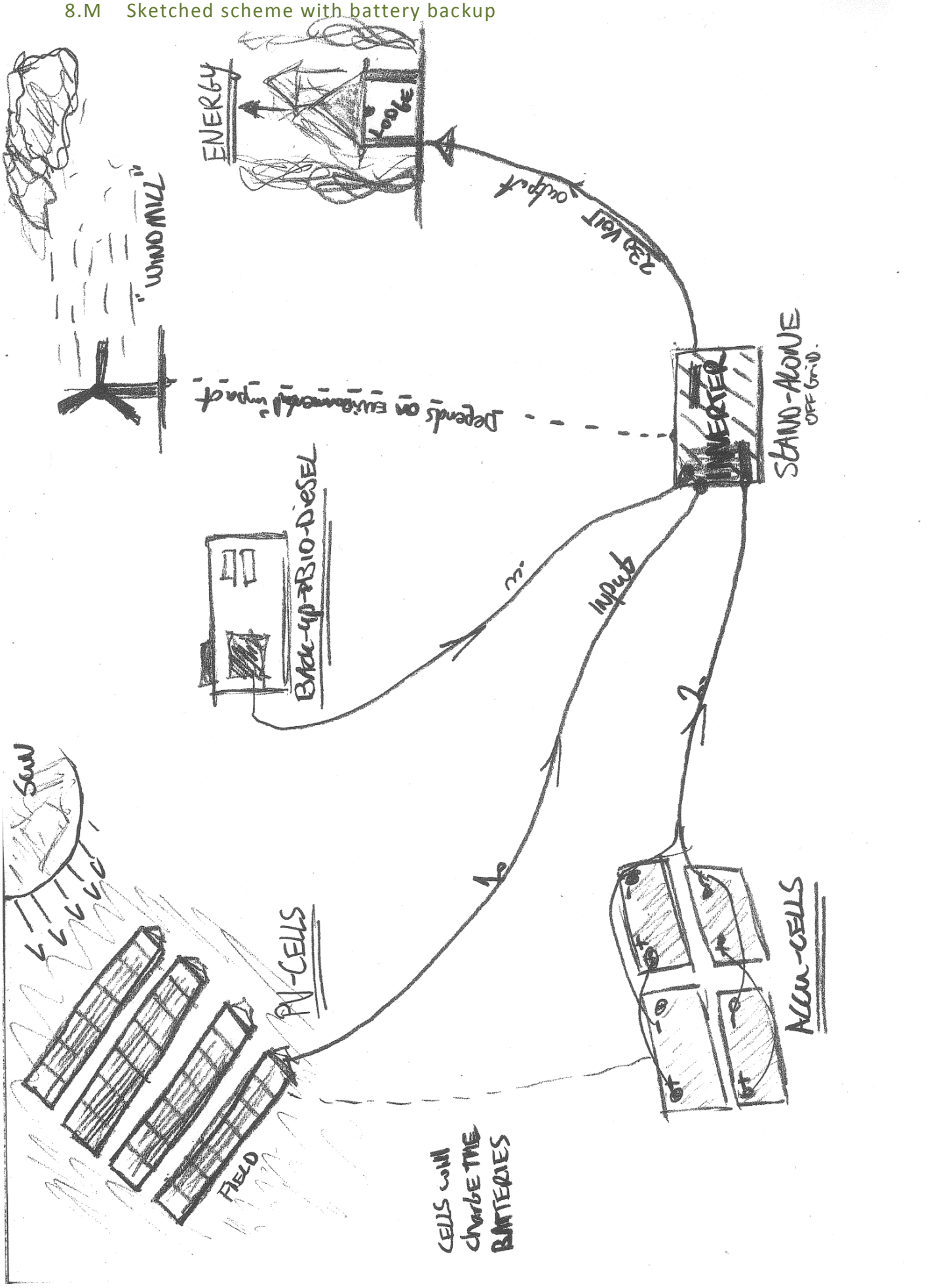


Bio diesel

8.L Inverters

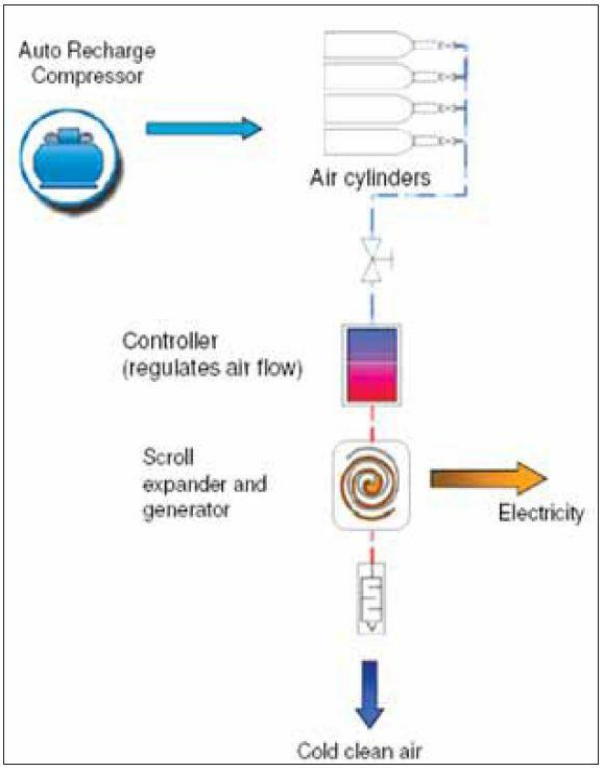
Multi Function Inverter
This inverter is still connected on the utility lines, a set of batteries and if desired a generator. If the utility lines fails the backup will start. It is generally used as a backup system and not as a main system. The utility lines are primary and the battery system is the backup. This system is not recommended in our eco-lodge.
Synchronous Inverter
This is a good solution when you are connected on the utility lines and want sell back excess electricity to the power company. A positive thing is that you won't use a battery system which is good for the environment. The power that the renewable sources produce will be used for all the electrical devices and the over capacity will be given to the grid. The electricity meter will go down, for example if you produce for 500rand and you only use 300rand you will earn 200rand.
Standalone Inverter
With a standalone inverter the house is not connected on the grid anymore, it is totally running with his own power connected to a battery pack. That could be renewable sources, a generator or both. The size of the battery depends on the needs of the lodge, normally the peak usage + 15%.

8.M Sketched scheme with battery backup



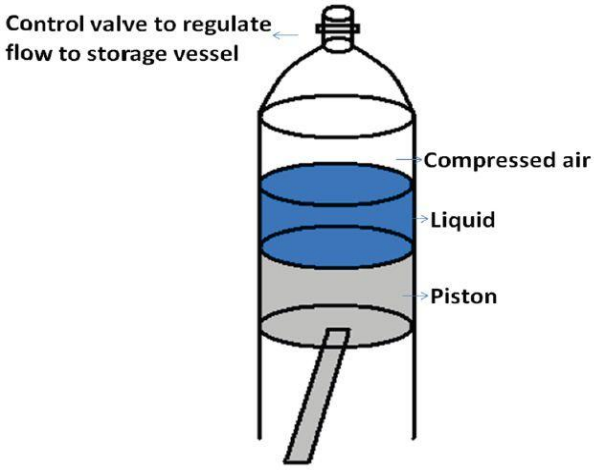
8.N Other backup solutions:

Compressed air power system:
This energy storage system will be working in cooperating of the PV-cells from above. During the day the overcharge will power the compression what fills a aquifer, old underground caves (salt, gas), or on a smaller scale a cylinder or tank.
A air compressed system got a way longer life cycle comparing a more traditional lead acid backup system.
Currently this system is been used on large scale for power plants, however the technology is not standing still and they are making prototypes of systems what can be used for households or commercial buildings.
In the attachments there is a file with the prototype.
The compressed-air energy-storage unit proposed in this work is optimally designed to have maximum efficiency and completely utilize the energy derived from solar-powered PV cells. The proposed prototype is a low-cost, low maintenance, environmentally-friendly system, especially designed to be used in stand-alone off-grid, individual housing units. Assuming isothermal conditions, numerical estimations demonstrate the feasibility of the proposed system; specifically, the prototype is designed to work as a hybrid compressor/motor unit, and if used in conjunction with a small-sized PV panel (10 m2) for 8 hours, is capable of operating any appliance rated at 1200 W for 10 hours. *Compressed-Air Energy Storage Systems for Stand-Alone Off-Grid Photovoltaic Modules: Arizona*



Scheme: Compressed air energy storage

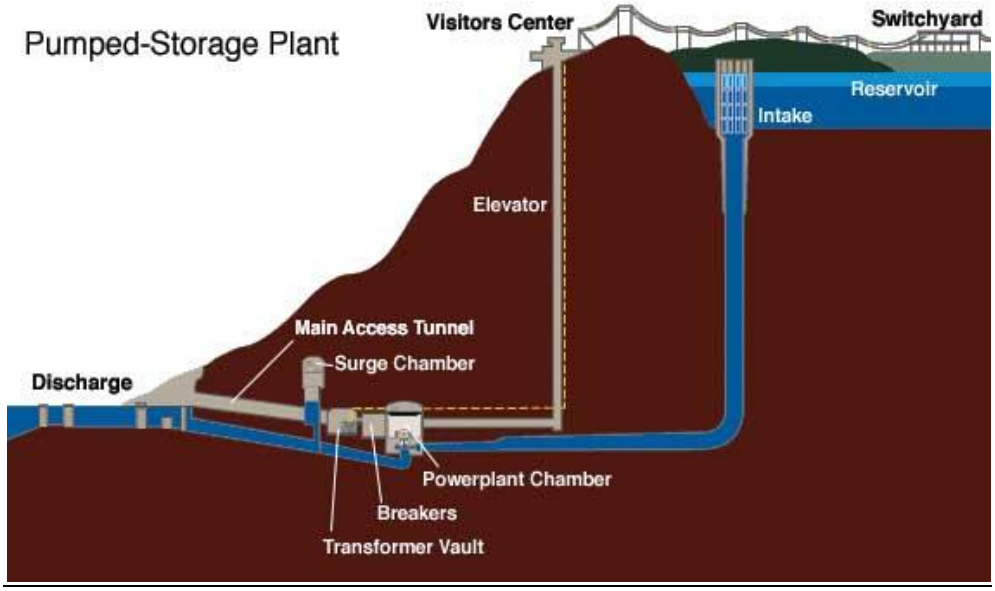
- Type will work with low rpm compressor (60rpm) what is way better for the life span and the maintenance of the system.
- Liquid will keep it constantly filled for better air pressure.



Scheme: Prototype

We advice this conceptual system for our lodge because it is environmental friendly and got the specifications for the backup of the PV-cells during the night. This system is in development now but for our conceptual design it could be a good solution.
For the air storage we can make a hole in the ground like a aquifer or use big steel cylinders/tanks (can also be integrated in the ground, safety).

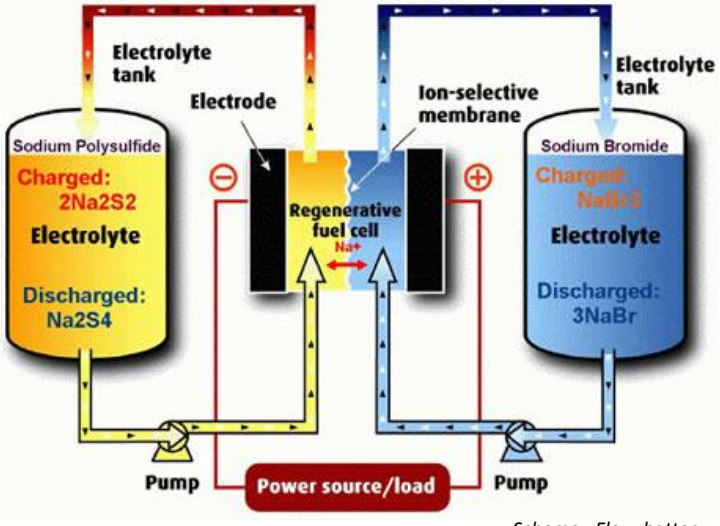
Pumping water uphill, *solar dam:*
This is a nice environmental friendly solution for the storage of power during the day. When using PV-cells the overpower will be used for pumping the water uphill. The amount of power from the PV-cells will be used against the gravity and when the power supply of the cells are going down the current of the waterflow from above will produce enough power for the lodge.
This type of energy storage is not always possible, you would need a good geographic situation for the gravity flow.
In our case, we have mountains where it could be possible. However, when thinking about the natural habitat and the view of this system we don't think it is a nice solution for our lodge for the storage of power. It is also a more expensive system than the others, maintenance level is higher, but it is useful when there is more space and no problems with the view. (there is space but in the natural way of thinking we don't want big water reservoirs/lakes in the area.



Scheme: Hydro power

Flywheel technology:
Flywheel systems are currently used for big power plants for short peak limits 5~30 seconds, developments in the system are producing a better efficient wheel what will store the energy for more than a hour.
For our, small lodge, comparing to power plant the system would probably work. The flywheel can be charged during the day with the photovoltaic cells and during the night the flywheel will provide the energy back to the lodge. It's a clean, powerful and green process. It got a long life span and the maintenance level is almost zero.
The only problem is that it isn't used before, so we will recommend this system for now but it maybe will be used in the future when more improvements are made. For our lodge now it isn't capable.

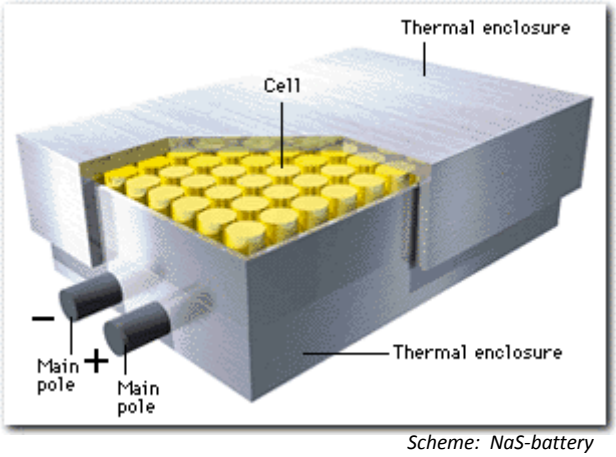
Flow batteries:
Electrolyze process. Big tanks with chemical reaction. High efficiency but not as high as the NaS battery below. It is currently used for power plants, so that the plant produce can work constantly and during the nighttime it will charge the flow battery and during the day it will empty the battery.



Scheme: Flow-battery

It is not a good sustainable product. We won't use it.

NaS batteries:
A battery constructed with sodium (na) and sulfur cells, heating these cells will make them liquid. This type of battery has a high energy density, high efficiency of charge/discharge (89–92%) and long cycle life, and is fabricated from inexpensive materials. However, because of the operating temperatures of 300 to 350 °C and the highly corrosive nature of the sodium polysulfides, such cells are primarily suitable for large-scale non-mobile applications such as grid energy storage. Irrelevant.



Scheme: NaS-battery

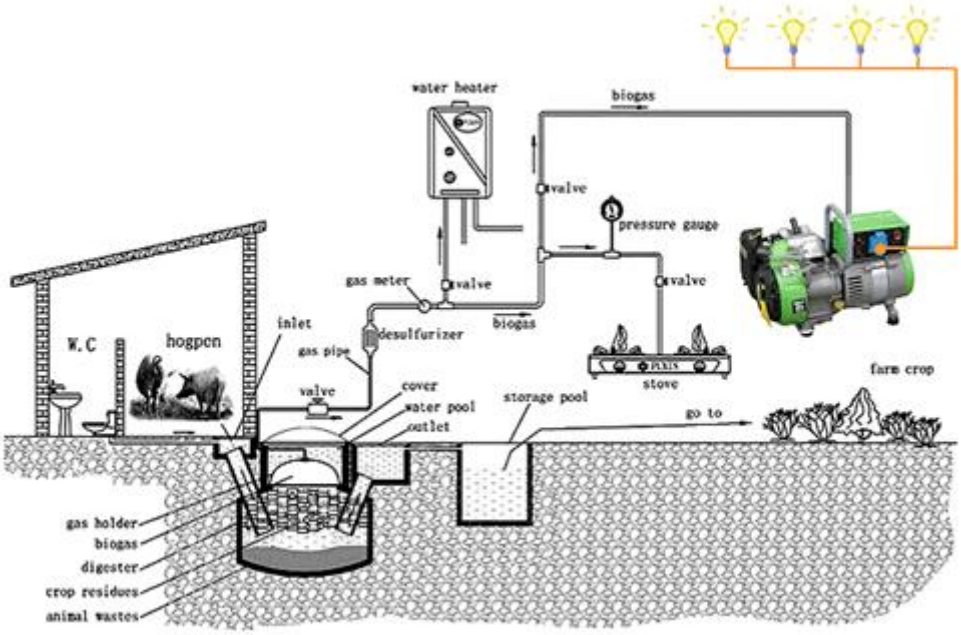
8.O Biogas – Green waste management

Biogas is gas resulting from an anaerobic digestion process. A biogas plant can convert animal/human manure and green plants into combustible gas.
Biogas can be used in similar ways to natural gas in stoves, lamps or engines. High methane content is desirable for the energy content of the gas. The average colorific value of biogas is about 21 – 23,5 MJ/m^3: 1 m^3 of biogas corresponds to 0,5 – 0,61 diesel fuel or about kWh (FNR, 2009).
The yield of a biogas plant depends on a lot of aspects like the type of feedstock, the design, fermentation temperature and retention time. For example: maize silage yields about 8 times more biogas per ton than cow manure.

The gas which get produced through this system can be used for different purposes. In our case we first use it for the AGA. This 'oven' works perfectly on biogas and supplies a lot of heat with this gas. The gas which is left goes to a backup system where we keep the surplus for how long is necessary. When there is shortage of electricity, we can 'call' the gas for using it in a biogas generator which use it for making electricity.

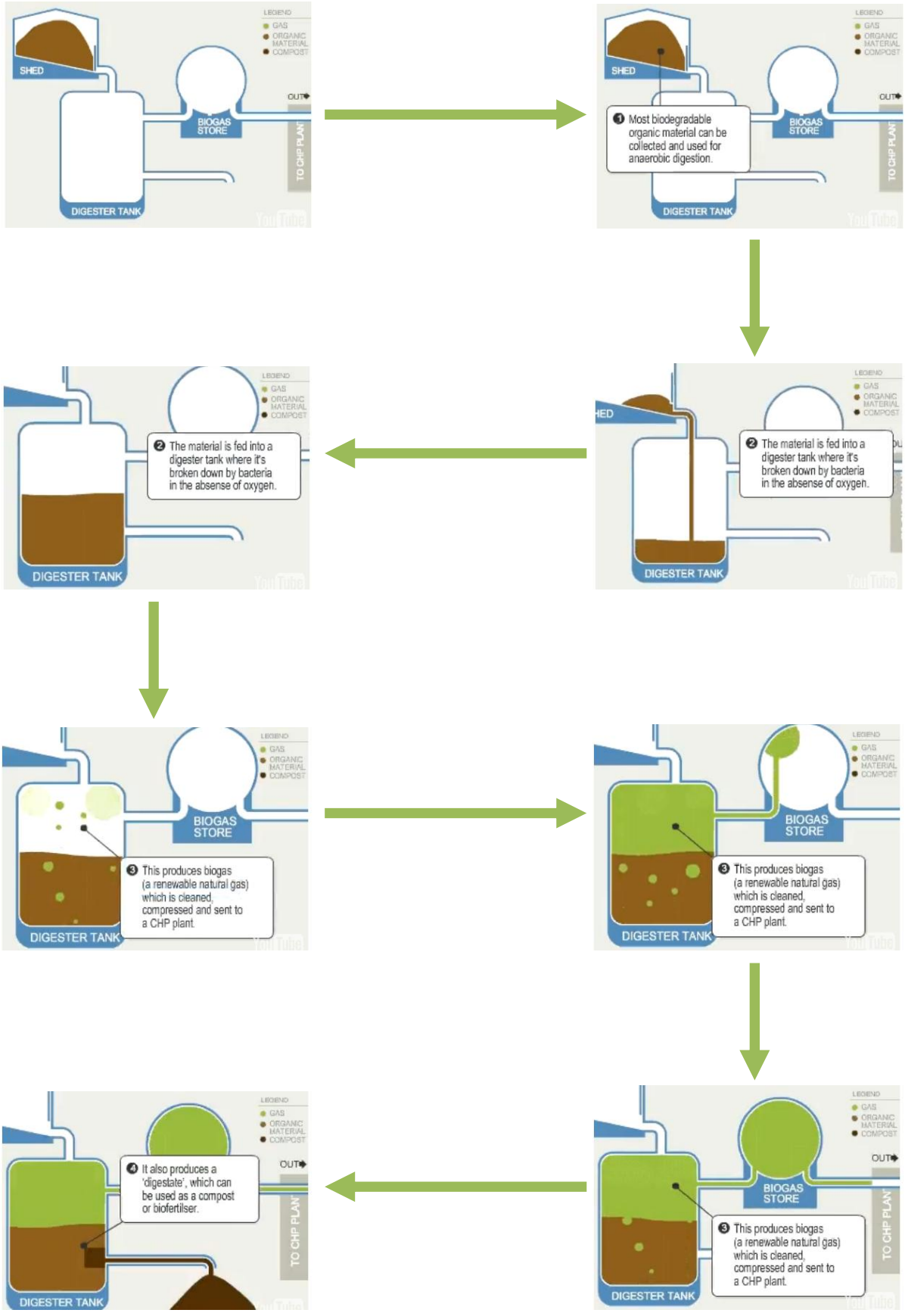
Conversion to electricity
Theoretically, biogas can be converted directly into electricity using a fuel cell. However, clean gas and expensive fuel cells are necessary but this is still a matter for research.

In the pictures underneath you see a schematic of a biogas plant. You can see all the different parts and their connection.



Schematic of a biogas plant used for power generation

Schematic, how the biogas – electricity process works:



Eco-Green lodge

Design a sustainable wildlife accommodation

10.2 Meetings: Kariega Game Reserve

Kevin de Bont **1537813**
Pim de Blois **1534317**

10.1.1Summary meeting 05-10-2011

4-star rating with 5 star quality (smart for the price)

Maximum of 12 rooms (24 person) also for the car

Connection electricity cost 2 – 3 million rand

There is a pump installation but it has to be connected to the lodge (will cost a lot of money)

He wanted to have a tented camp (we don't like that kind of style), with a panorama-deck etc.

5 star location, but 4 star rated (price)

Don't make a fabulous hotel but a natural design

Local materials: grade stone, wood, timber

Wind always from south-east, north orientation required

Lodge = point 1, most important how it's look like

Maintenance= point 2, next, it should look (almost) the same after a few months/years

Cost / materials= point 3

Natural to the environment

In the Kariega Game Reserve you have, a river-lodge, main-lodge so in his opinion the next one should be a tented –lodge. We would say make an eco – lodge

Staff is going to live in a village nearby, villages are far away and not easy to reach. So a sleeping facility is required

On site the big 5 is in the neighborhood but an elephant can't reach the lodge

There is a river nearby but hydro – power isn't possible

It shouldn't be able to see the roof because of the height of the bush

The game drive is underneath the hill, the best principle would be that it couldn't be seen from that road

There is not a high protection required, maybe for some cats

10.1.2Summary daytrip Kariega Game Reserve 11-10-2011

Project plan on a hill, on the cliff east other side more north. (north is the most recommended, east is also good)

Staff 25 people a facility for 15 people somewhere in the back of the house

Electricity, fridge, freezer as small as possible, uses a lot of energy

- PV-cells, space for a field in the back
- Wind enough, only thing is the nature feeling and with a windmill above the trees will change this feeling
- Back – up system with bio diesel etc -> available

Water

- Natural source available, has to connect, no pumping system needed only the power of the gravity
- Water heating, on currently built lodges there they use a geyser -> a sun boiling system is recommended
- Sewage water is a problem, normally they will make a septic tank which cost a lot of money en have a transport cost. -> we can introduce the helofytenfilter

Heating and cooling of the building

- Wooden fires
- Air-conditioning for cooling could also be used for heating (prefer not)

No ventilation system needed, all natural

Lay-out: pool, deck, lodge, 12 rooms, library, lounge, bar (list of req.)

4 star rating

Transport etc from the back of the house -> it is not recommended that the visitors can see this

Leave all the bush as much as possible, cut only some of them where the rooms and the lodge will be built

Lanes etc. keep it gravel or stone no expensive timberworks, deck -> timber

10.1.3 Summary daytrip River Lodge, Kariega Game Reserve 14-10-2011

Meeting with the manager of the whole Kariega Game Reserve and the assistant-manager of the River Lodge

Discussed some operational problems

- Kitchen size and lay-out
- Toilets designed next to the dining area
- WIFI – Discussion (4star rating) prefer not, go somewhere else
- 1 television place needed (4star rating) prefer not

Advices:

- totally of grid system
- solar powered, on a field
- wind is a discussion point
- no air-condition
    - do something with earth-warmth
    - integrated building etc
- rain-water -> sanitairy water (drink/shower etc)
- Grey-water -> toilets etc
- Toilets etc -> helofytenfilter
- Helofytenfilter -> toilets / surplus -> river
- Back-up sanitairy water -> spring connection with gravity power from uphill.
- Sunboiling warm water
- Kitchen stove AGA
- Room heating -> wood/fire/heater
- LED – LIGHTS
    - Moving sensors
    - Time sensors
- Waste – worm farm
- Rest garbage separate

25 people working, ‘weekly’ shifts 15 at work 10 off -> place for stay over somewhere in the back of the house

Natural stone

10.1.4Summary meeting 17-10-2011 at Kariega office

Kariega office-> 8 rooms financial statement

Management together with the homestead (eco + homestead)

Visit Ukhozi-lodge for general lay-out vision

Room lay-out

- Approx. 50m^2
- Space for King size bed
- Coffee station
- Luggage room/place
- Bathroom
- 2 water basins , mirror
    - Shower
    - Maybe bathtub, in the eco thinking preferable not
    - Dressing area
- Place for couch/2 chairs or both -> depends on size room
- Hang place, jackets etc
- Small fridge
- Less lights → LED + Candles + fires
- Outlook from inside to outside is the most important -> view from, bed , bathroom

Outside deck, designed well -> no obstruction for the view from inside

Outside shower!! Important, privacy

Low roof, stay in the bush, catch the water

Roof=functional not architectural in this case, make it green (paint/plants)

Distance between rooms / lodge big enough for bushy feeling -> more or less one level, people hate walking up and down to the main lodge

Main-lodge lay-out

- Central pool
- 2 fire places during the night, 1 is possible but for a good warmth is 2 smaller ones preferable
- Bar counter area with drink storage
- Library place for a few people (living room feeling with some books)
- Lounge area
- Eating areas
    - Inside
    - Outside -> deck
    - Fire place -> (kind of a braai experience)
- Entrance:
    - manager
    - Reception
    - Small shop
- Office
- Outside deck

- Play with the space maybe some steps

Back of the house

- Laundry room
- Fridge coolers
- Kitchen
- Storage room

Everything self-sufficient

Eco-Green lodge

Design a sustainable wildlife accommodation

10.3 Quotation of Sources

Kevin de Bont **1537813**
Pim de Blois **1534317**

Green Leaf
Environmental Standard

Sources

- SANS – 204
- *Introductory Guide to Appropriate Solutions for Water Supply and Sanitation* Richard Holden and Tania Swanepoel, 2004
- *HOW SUSTAINABLE IS CONCRETE?* Leslie Struble and Jonathan Godfrey University of Illinois at Urbana-Champaign, USA
- Steel Takes LEED® with Recycled Content (September 2011)
- The Technical, Geographical and Economic Feasibility for Solar Energy to Supply the Energy Needs of the United States. (pdf)
- Investigation on Storage Technologies for Intermittent Renewable Energies: Evaluation and recommended R&D strategy (pdf)

Websites

- http://www.sustainablehomedesign.co.za/ (general site of sustainable home design South Africa)
- http://www.enterprise.mtu.edu/att/projects.html
- http://doultonusa.com/ (membrane filtering system)
- http://www.oasisdesign.net/ (sand filtering system)
- http://solar.rain-barrel.net/alternative-energy-inverter/ (inverter)
- *http://www.clean-energy-ideas.com (wind turbines)*
- http://www.bamboofencer.com/About-Bamboo/Bamboo-Sustainability (bamboo test)
- http://ellemackenna.hubpages.com/hub/Is_Bamboo_a_Sustainable_Building_Material (bamboo test)
- www.pandabamboo.co.za/ -(bamboo manafucture SA)
- Energy management:
    - http://www.ledverlichtingwinkels.nl/rendement-van-led-lampen.htm
    - http://www.greentechmedia.com/articles/read/epri-on-renewable-energy-compressed-air-energy-storage/
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    - http://www.rural-energy.eu/nl/oplossingen/de-toekomst-van-landelijke-energie-in-europa
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    - http://home.earthlink.net/~fradella/homepage.htm
    - Wikipedia: air compressed system, flywheel & waterpump energy storage*(solar dam)*
    - https://energypedia.info/index.php/Portal:Biogas
    - http://www.greenpower.cn/en/index-home.htm
    - http://www.howstuffworks.com

Figures:
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http://www.consenergybiotek.com/biodisel.html (biodiesel)
http://en.wikipedia.org/wiki/File:HAWT_and_VAWTs_in_operation_medium.gif (windmills)
livingoffgrid.org (circel with percentages grey water)
http://media-cdn.tripadvisor.com/media/photo-s/01/06/8d/4e/crossing-a-clay-bricks.jpg
www.greenpower.cn (biogas plant schematic)
http://en.wikipedia.org/wiki/Compressed-air_energy_storage (compressed air)
http://en.wikipedia.org/wiki/Pumped-storage_hydroelectricity (solar dam)

Eco-Green lodge

Design a sustainable wildlife accommodation

11 Drawings

Kevin de Bont **1537813**
Pim de Blois **1534317**

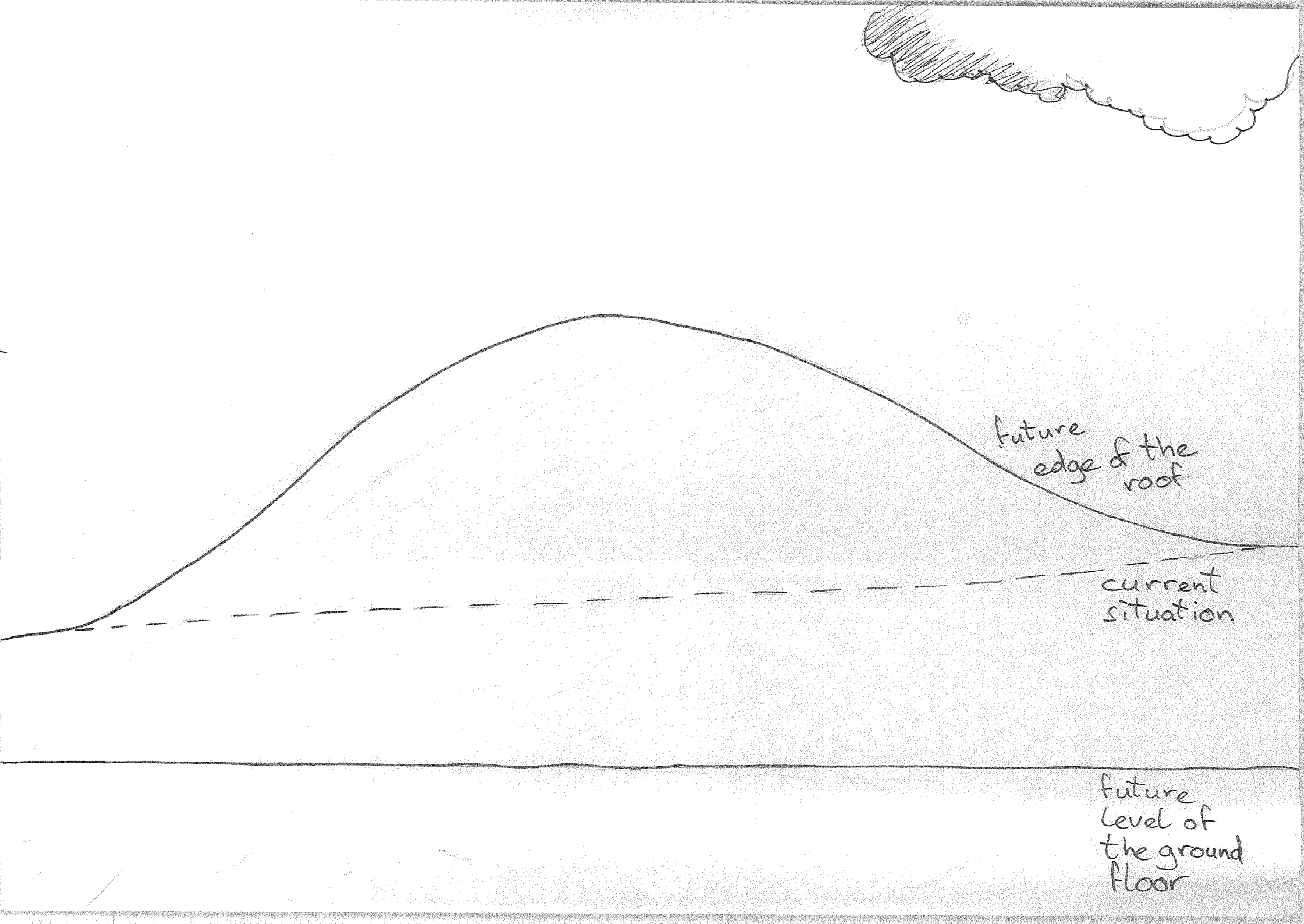
Green Leaf
Environmental Standard

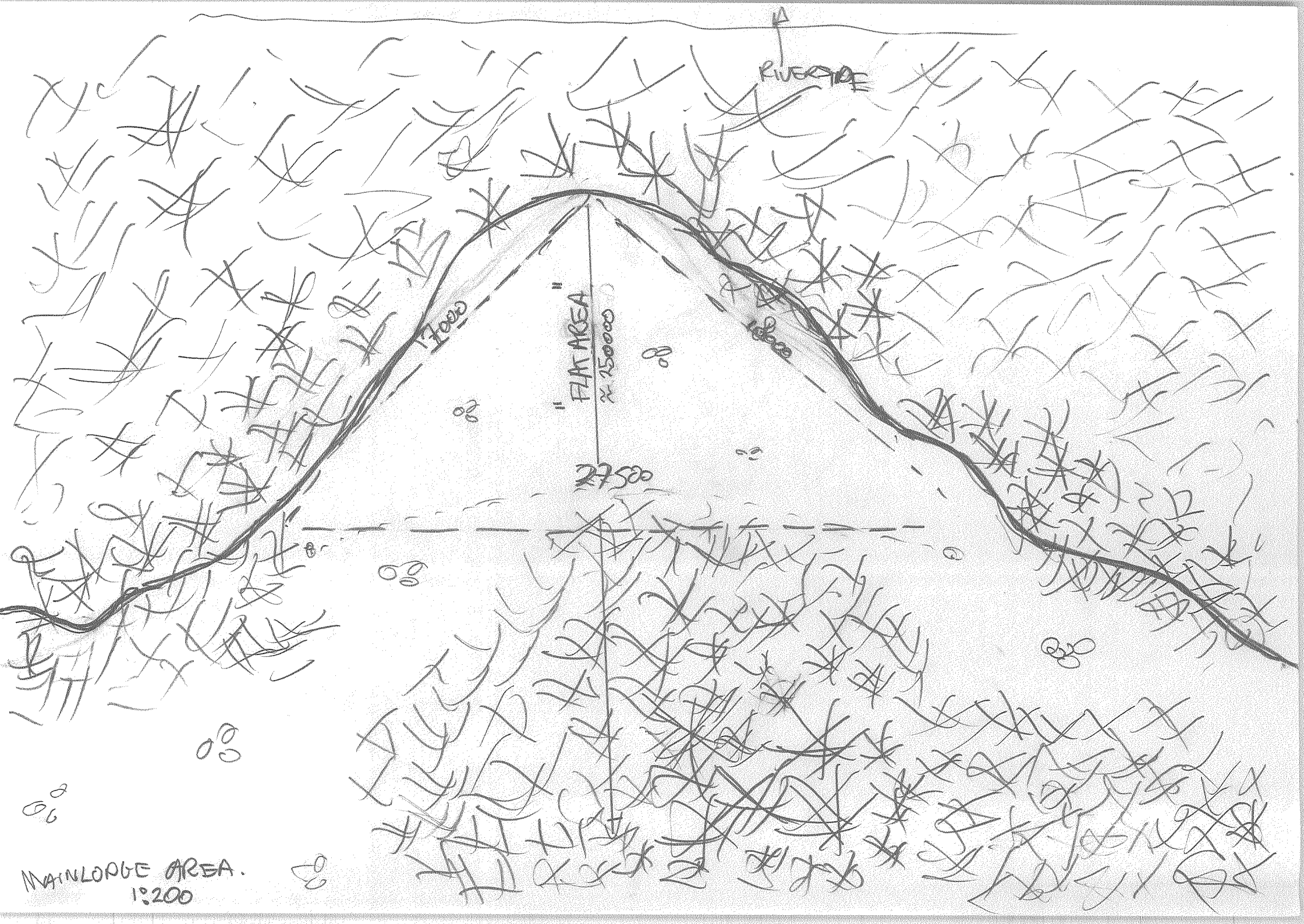
11.1 Main Lodge

11.2.1 Sketches
11.2.2 Site Plan
11.2.3 Floor Plan (1:100)
11.2.4 Floor Plan with site (1:200)
11.2.5 North & South View
11.2.6 West & East View
11.2.7 Roof Plan
11.2.8 Section AA'
11.2.9 Section BB'
11.2.10 Section CC'
11.2.11 Construction
11.2.12 3D – outside entrance
11.2.13 3D – outside view
11.2.14 3D – outside front view
11.2.15 3D – inside entrance view
11.2.16 3D – inside lounge view
11.2.17 3D – inside deck view
11.2.18 3D – inside close-up dining
11.2.19 3D – inside view
11.2.20 3D – total top view, without roof

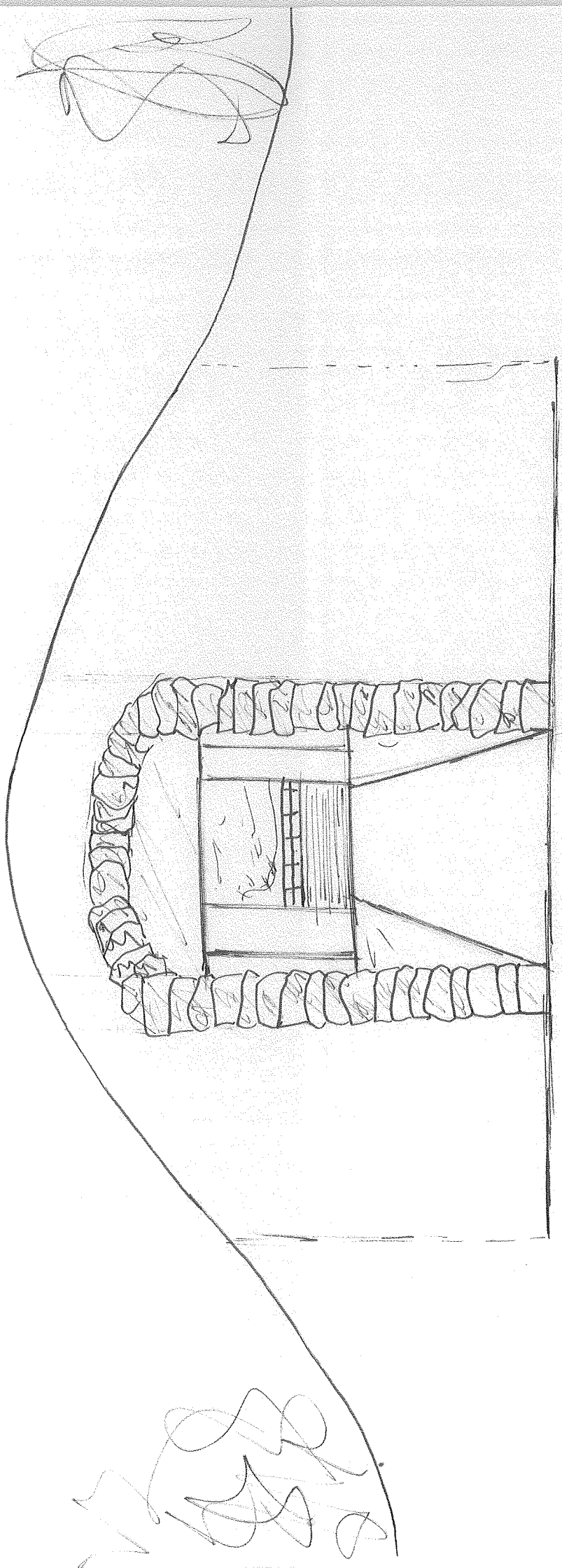
11.2 Rooms

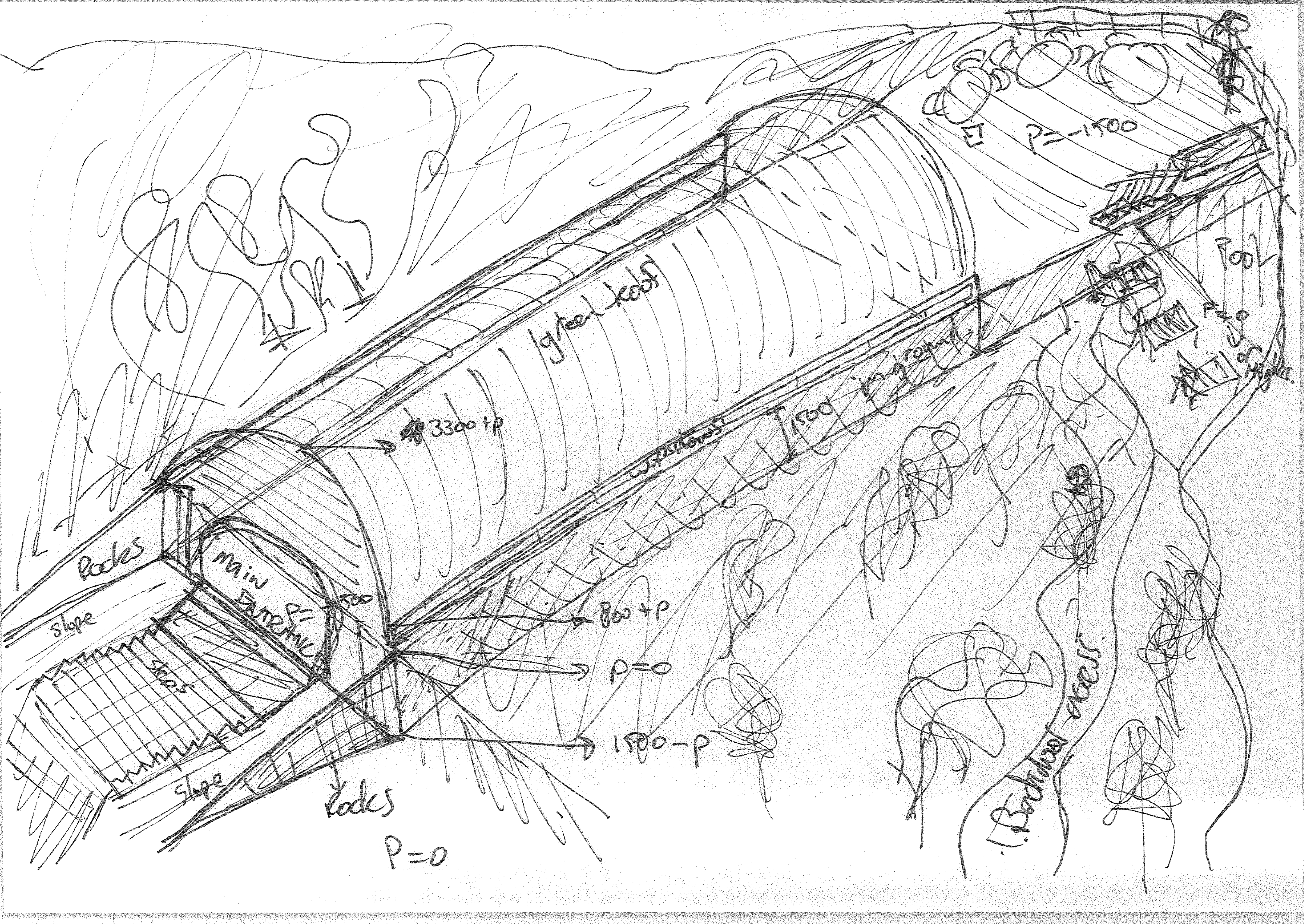
11.3.1 Sketches
11.3.2 Floor Plan
11.3.3 Front View
11.3.4 Side View
11.3.5 Top Plan
11.3.6 Section AA'
11.3.7 Section BB'
11.3.8 Presentation Drawing
11.3.9 Presentation Drawing with site
11.3.10 '3D'
11.3.11 3D inside view
11.3.12 3D outside view
11.3.13 3D outside view

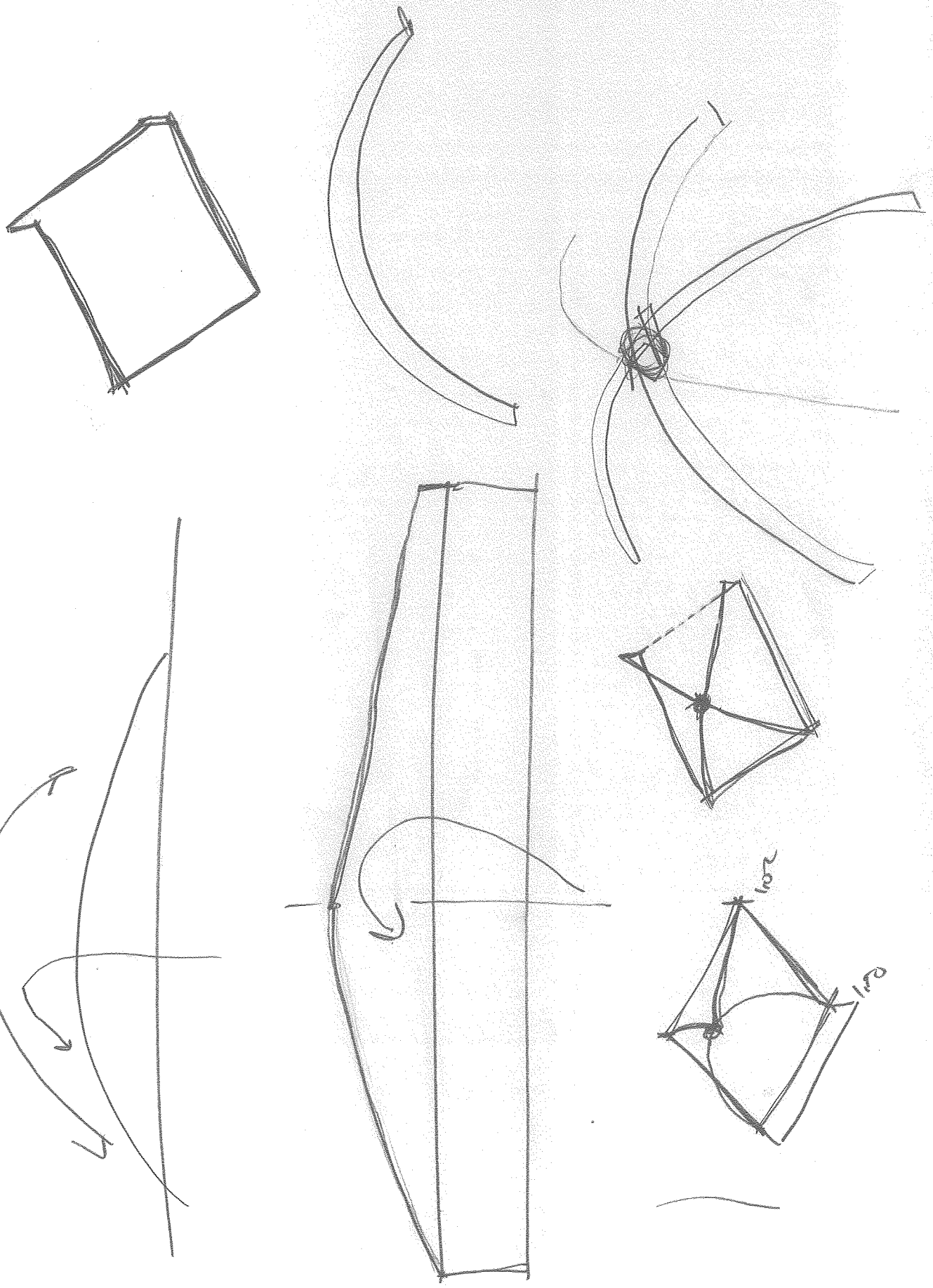

future edge of the roof
current situation
future level of the ground floor

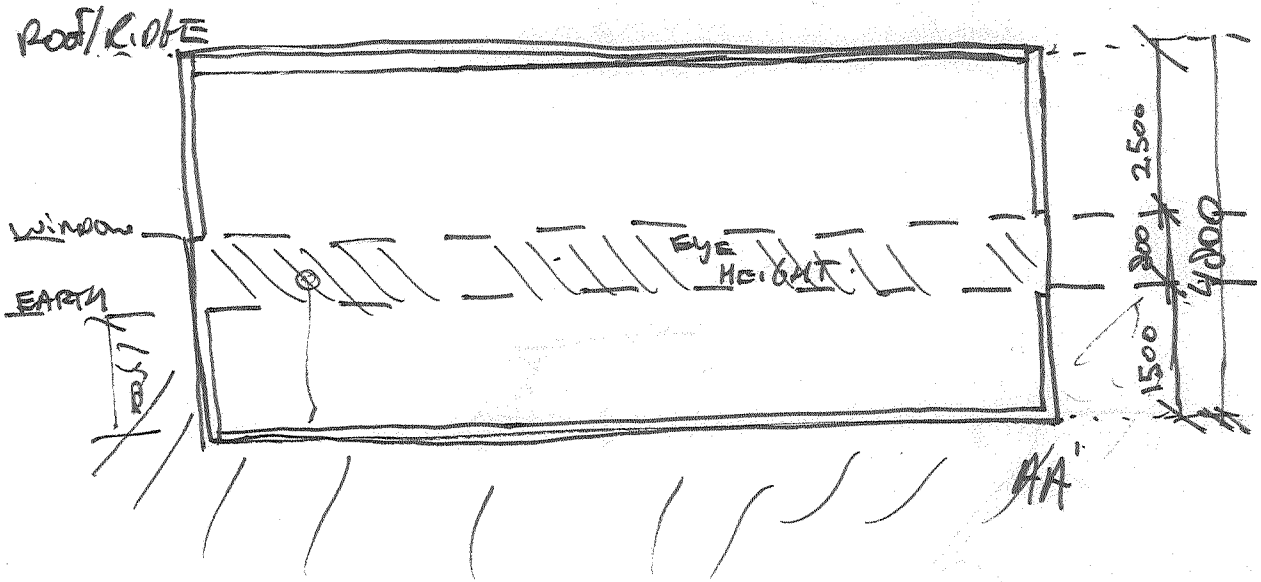


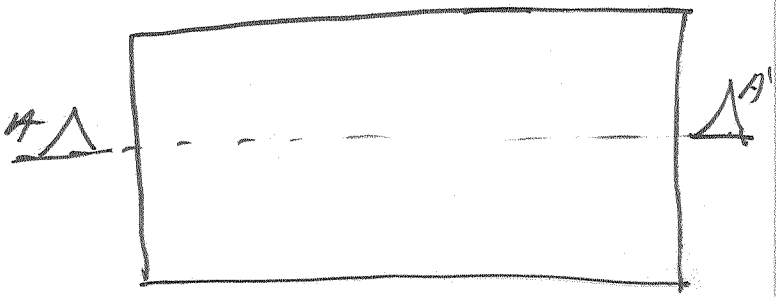
MAINLODGE AREA.
1:200

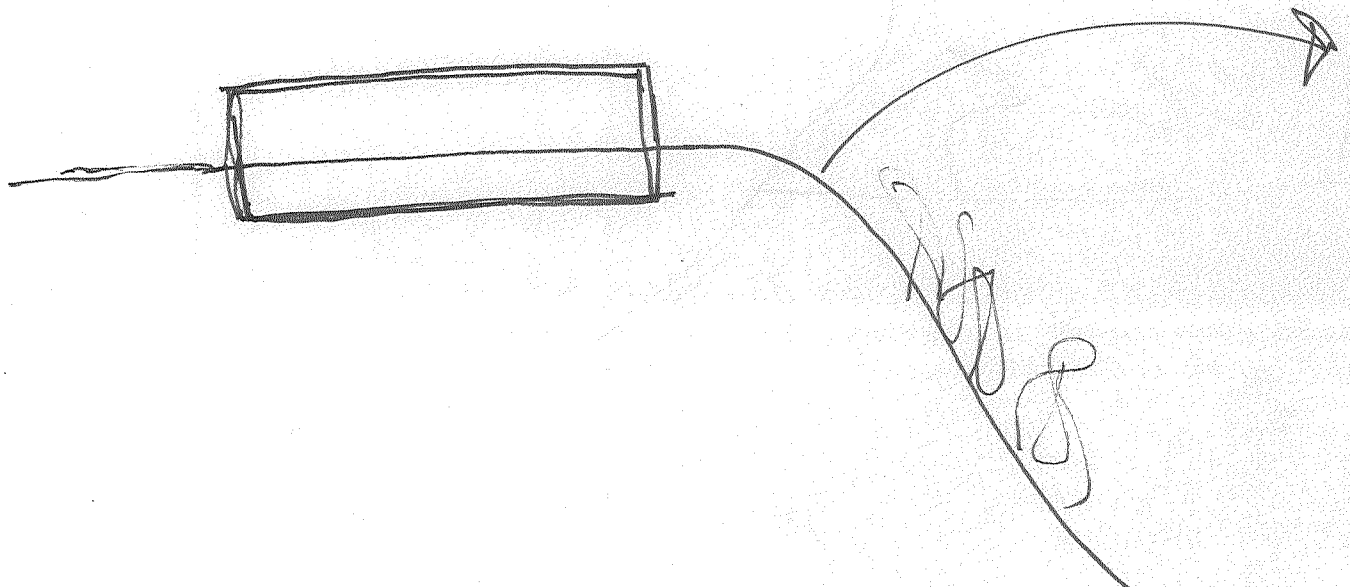



green roof
3300 + p
windows
1500 in ground.
P=-1500
Pool
P=0
or higher.
Rocks
main entrance
P=-1
500
800 + p
p=0
1500 - p
slope
steps
slope
Rocks
P=0
Boardwalk access.

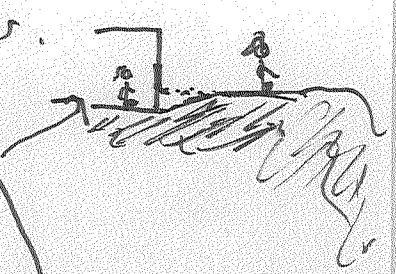






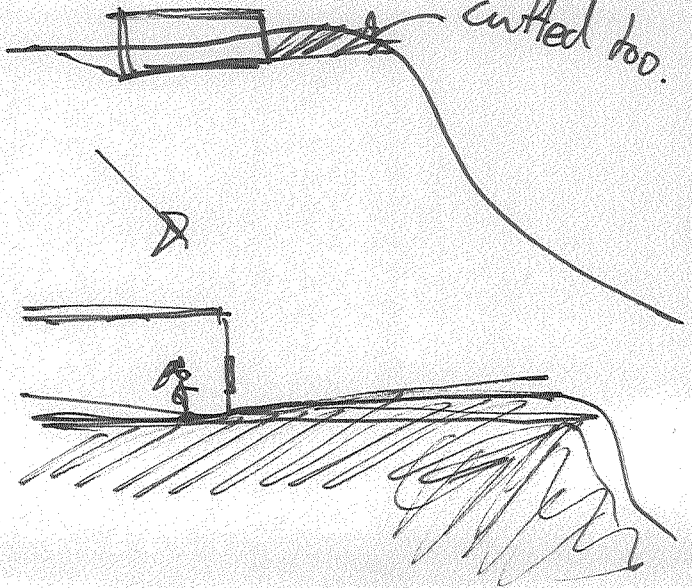


1. outside higher.

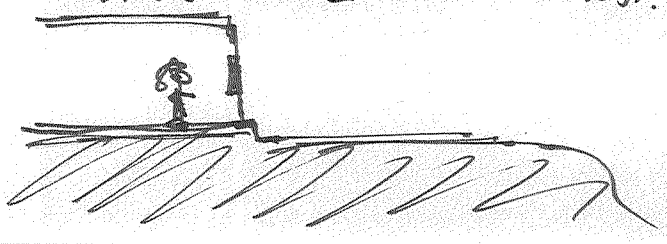


2. one-line outside

dug cutted too.



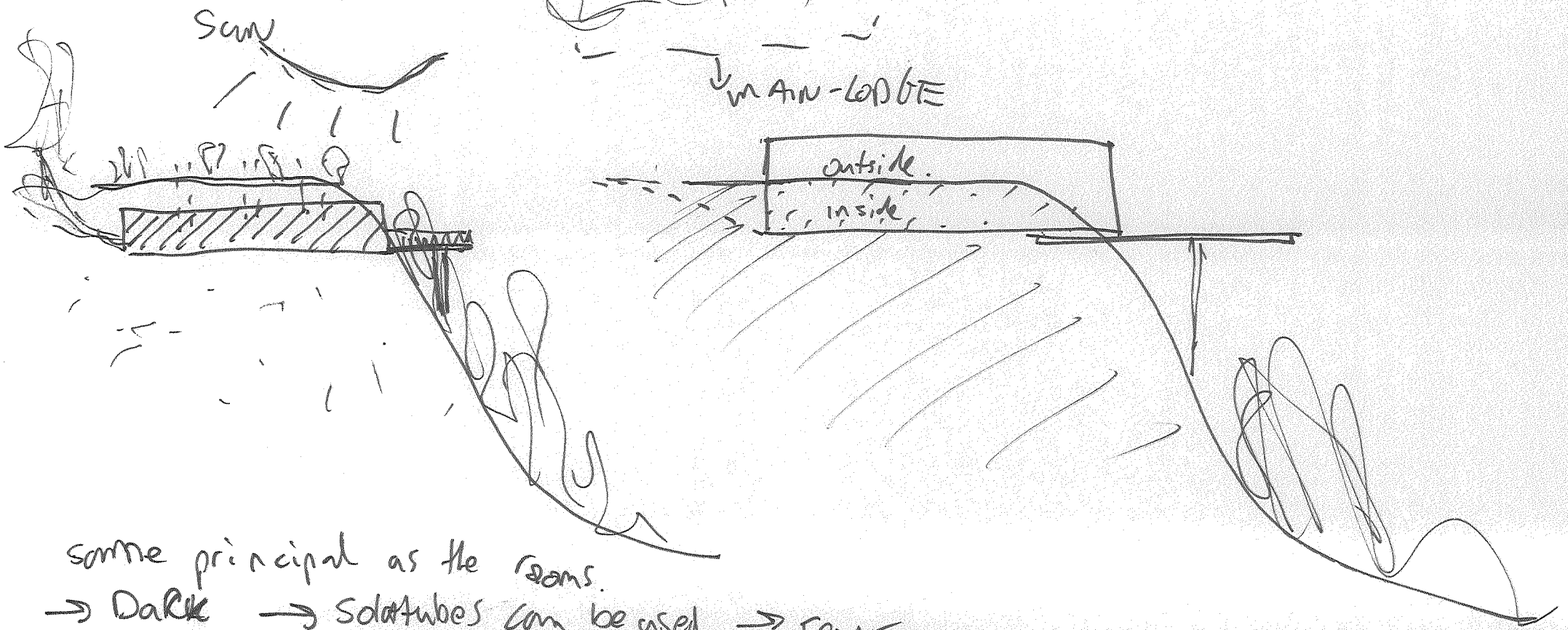
3. outside - lower (or 2 steps).



Rooms

- NO - A/c
- In context with Rooms
  → integrated in mountain
- big sized

main - AREA
top plan.



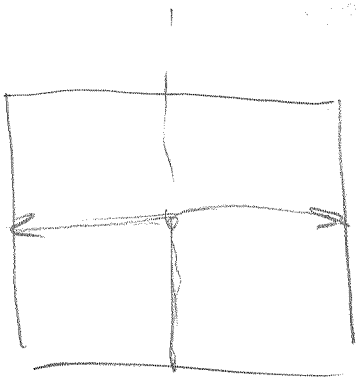
Sun

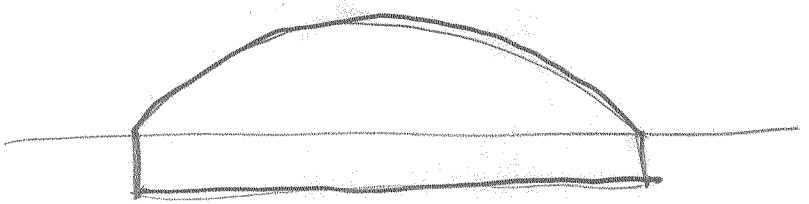
↓ MAIN - LOBBE

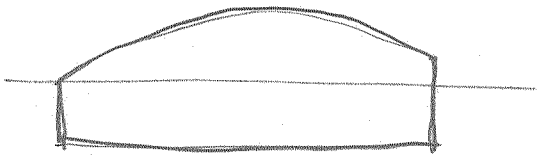
outside.

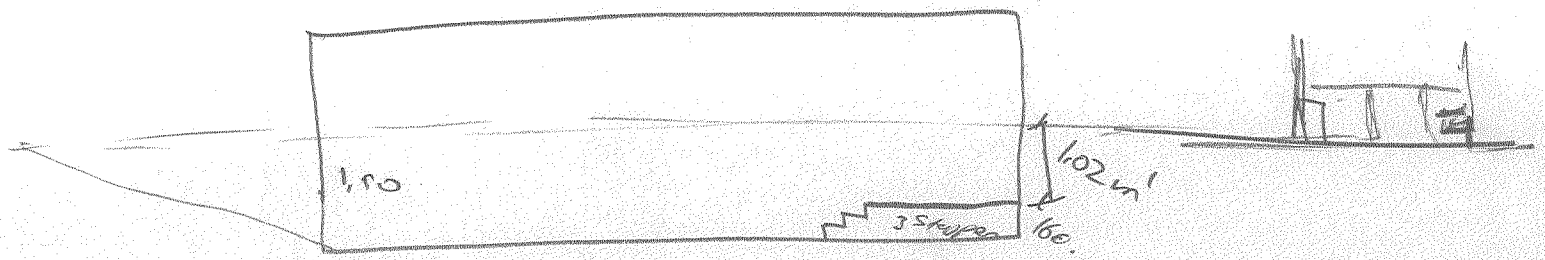
inside

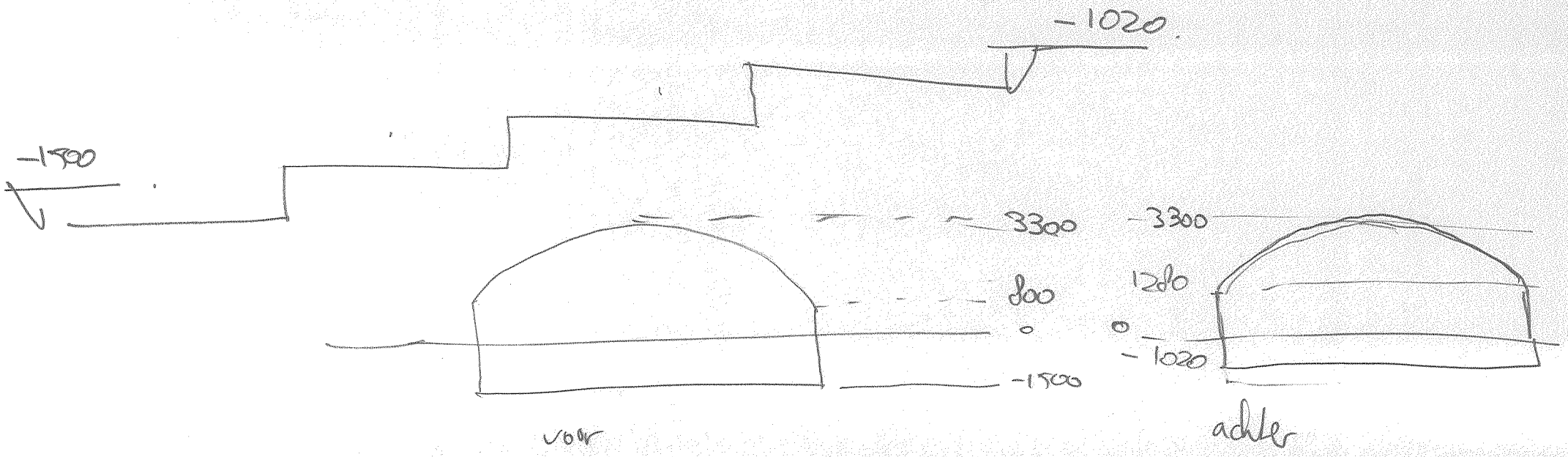
same principal as the rooms.
→ DARK → Solartubes can be used → FRONTVIEW.

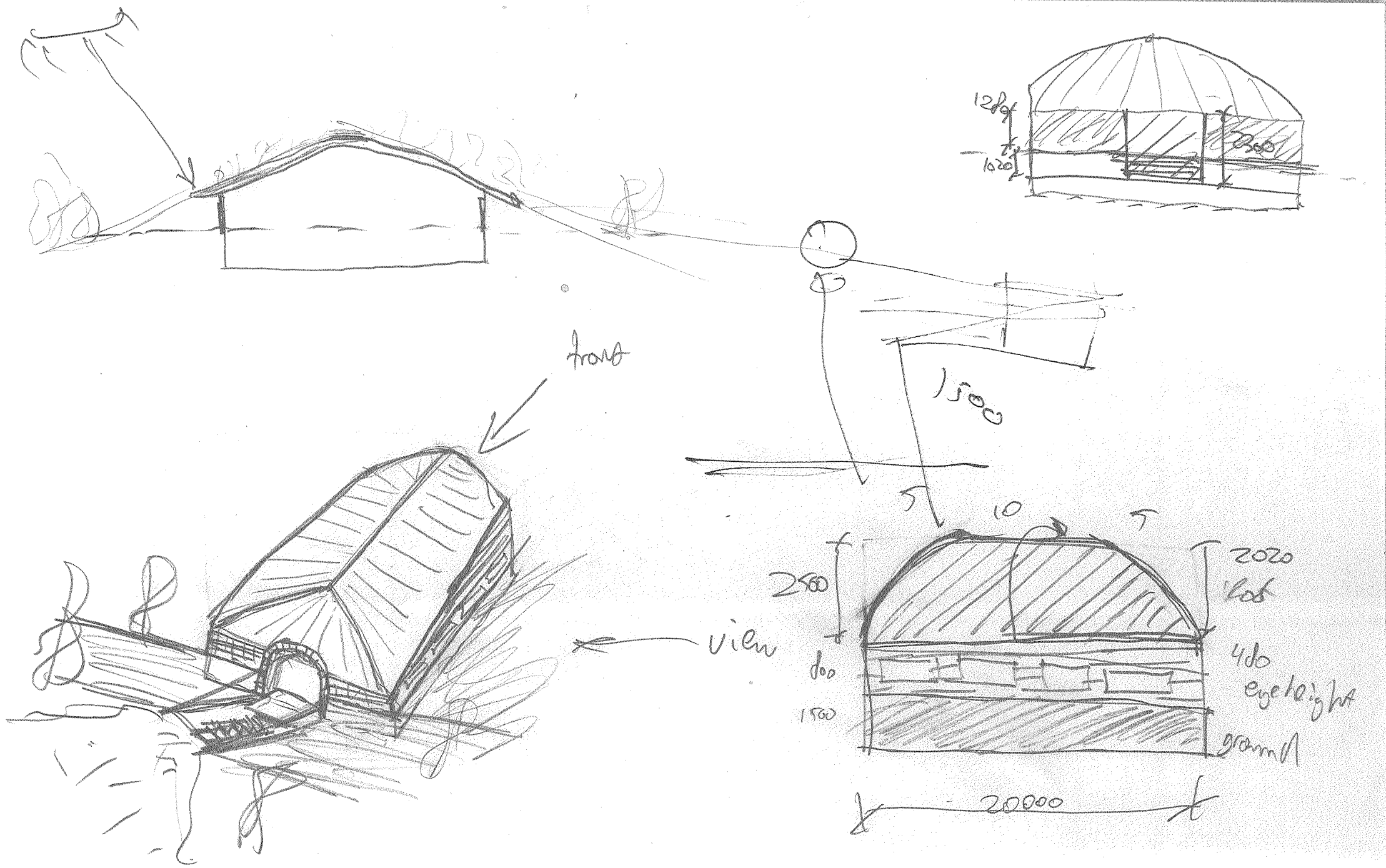


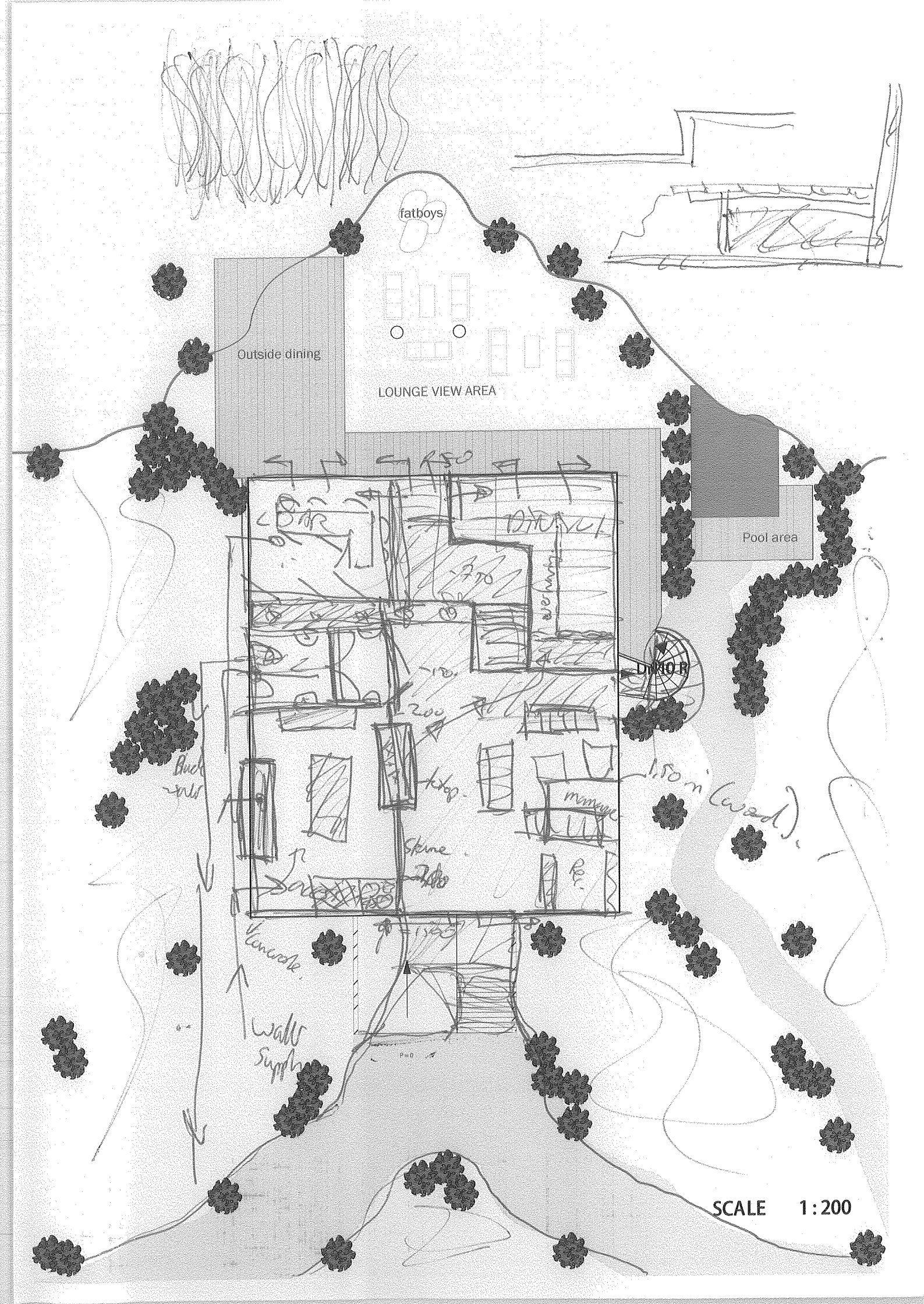


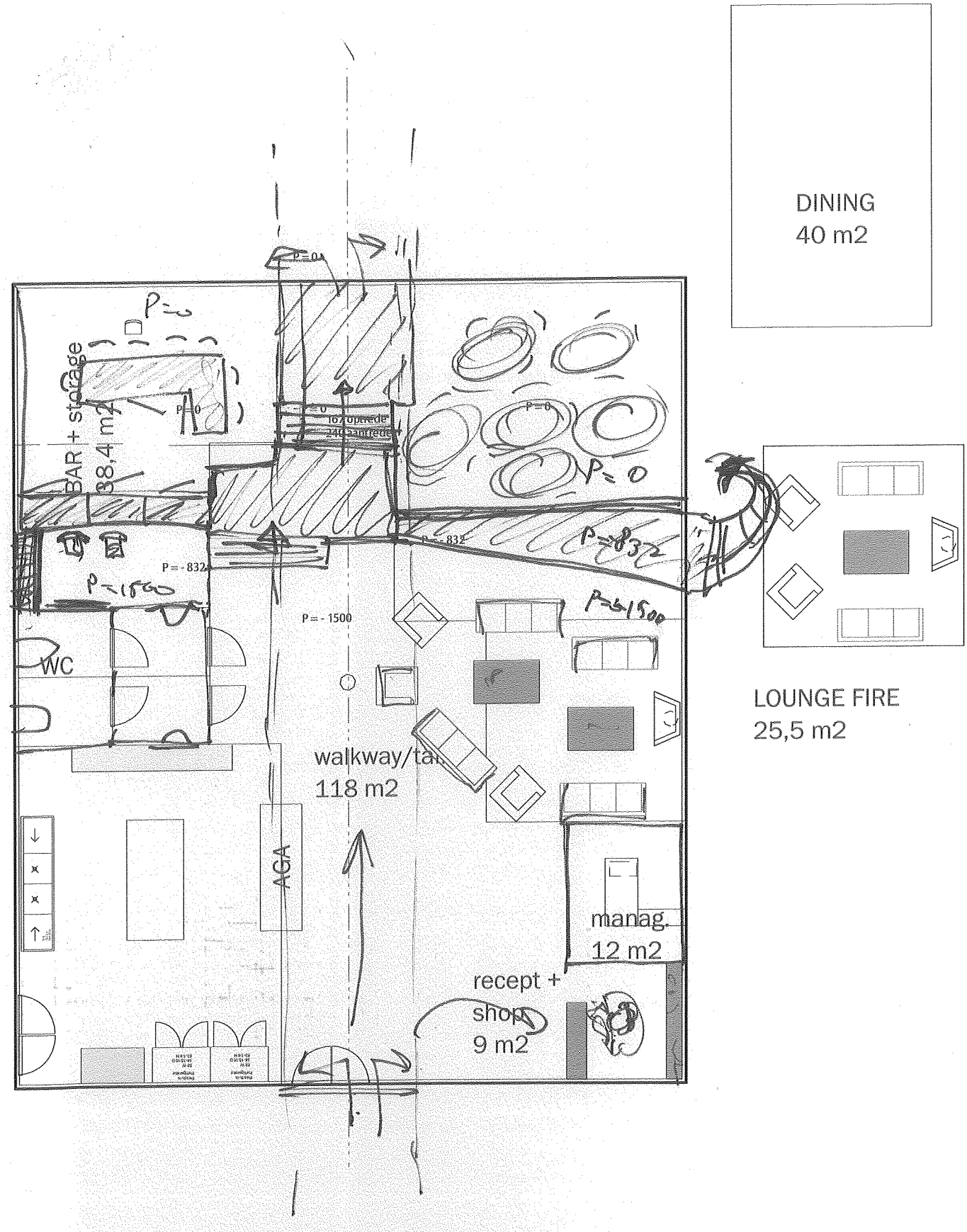


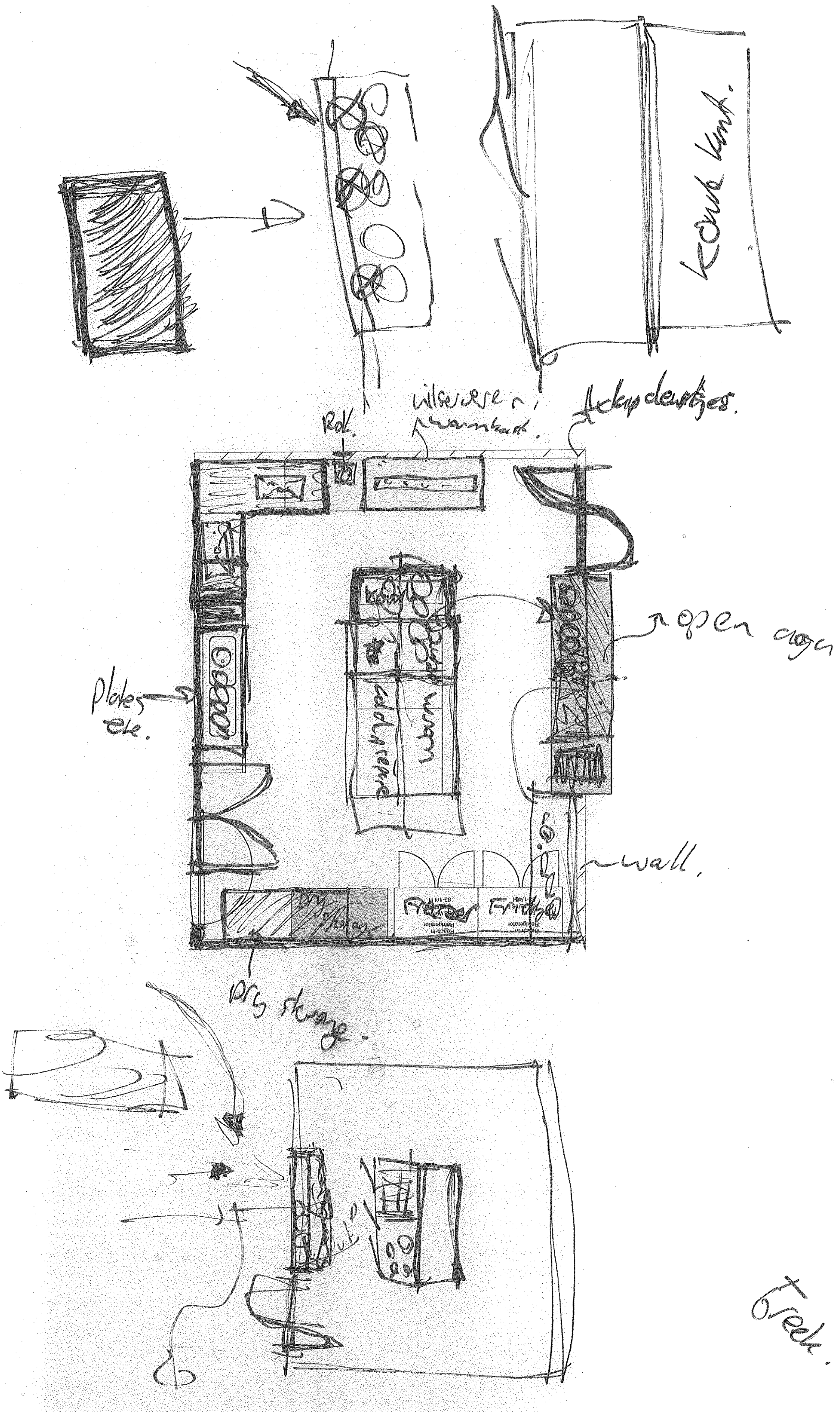

1,50
3 stuks
16e.
102 cm

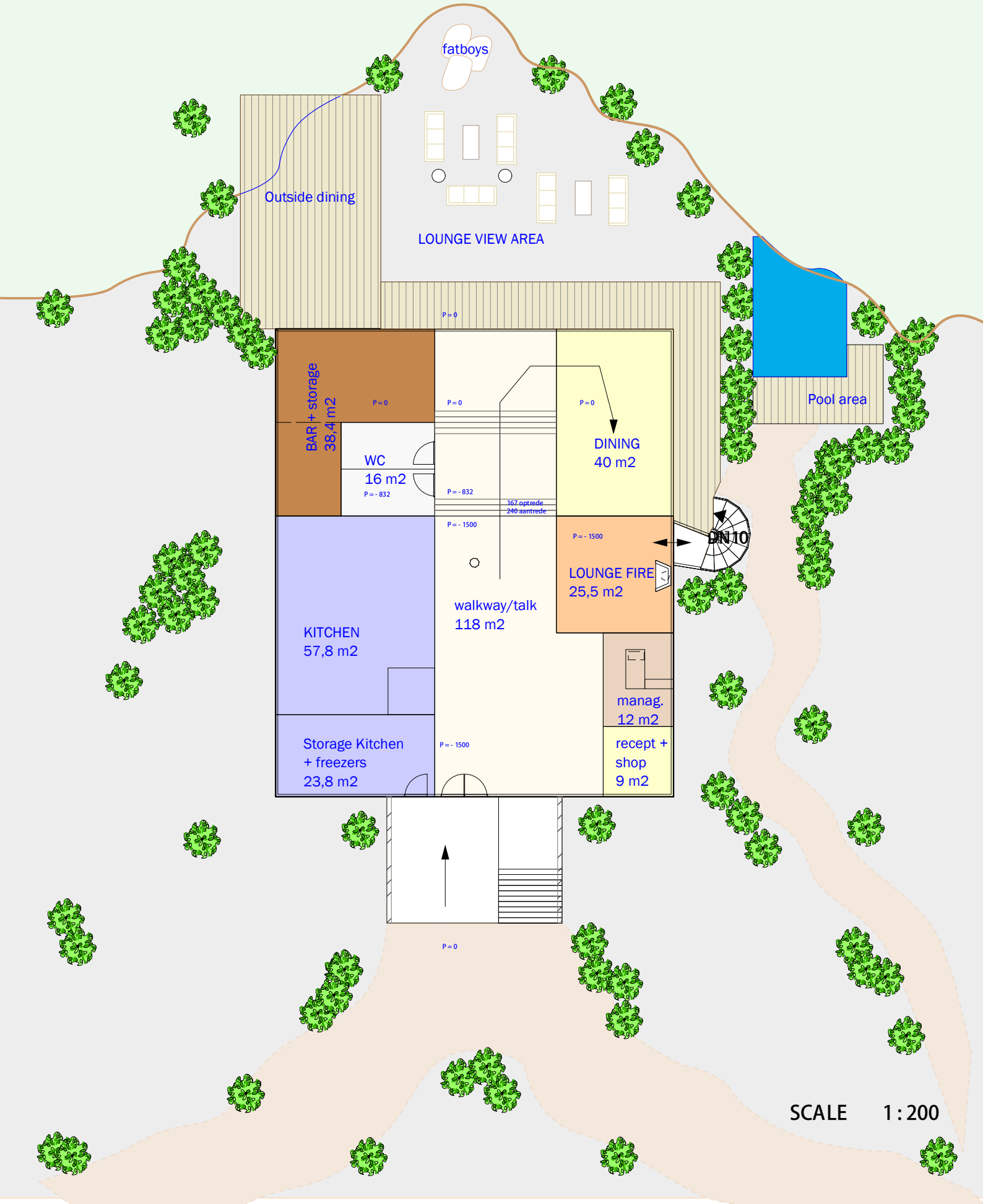

-1020
-1500
3300
800
0
-1500
-3300
1200
0
-1020
voor
achter

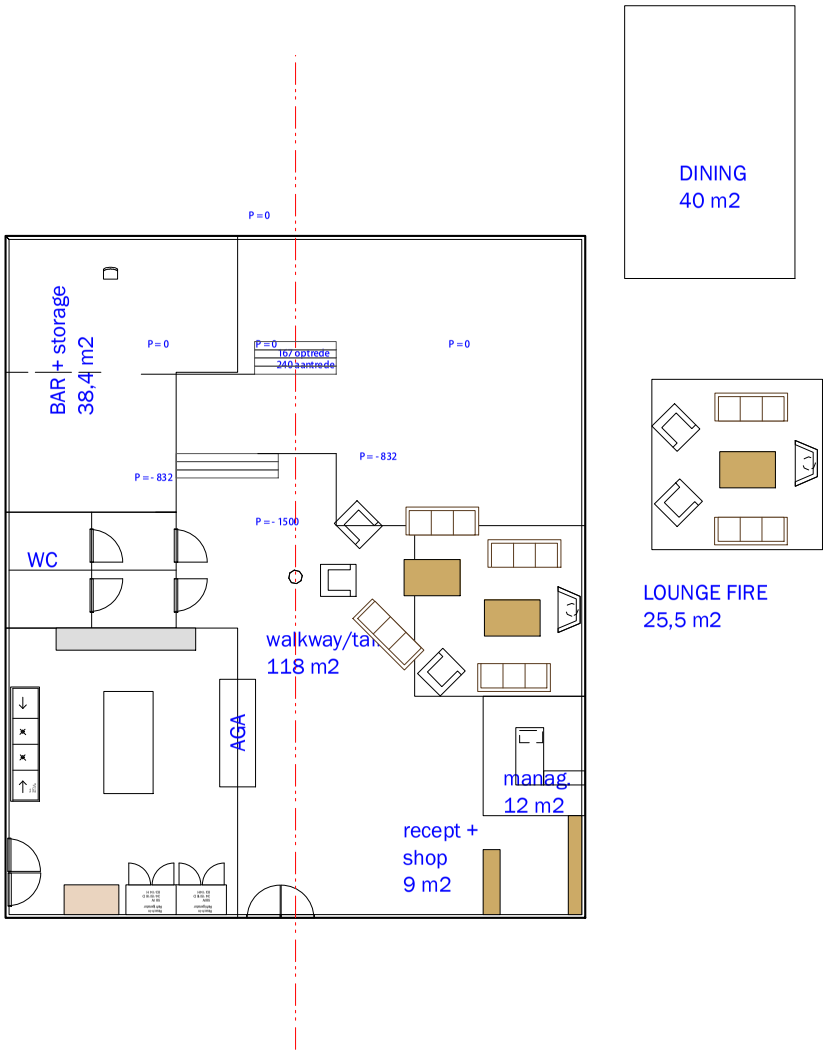

1280
1020
front
1500
5
10
5
2020
roof
2500
400
eye height
1500
ground
20000
view

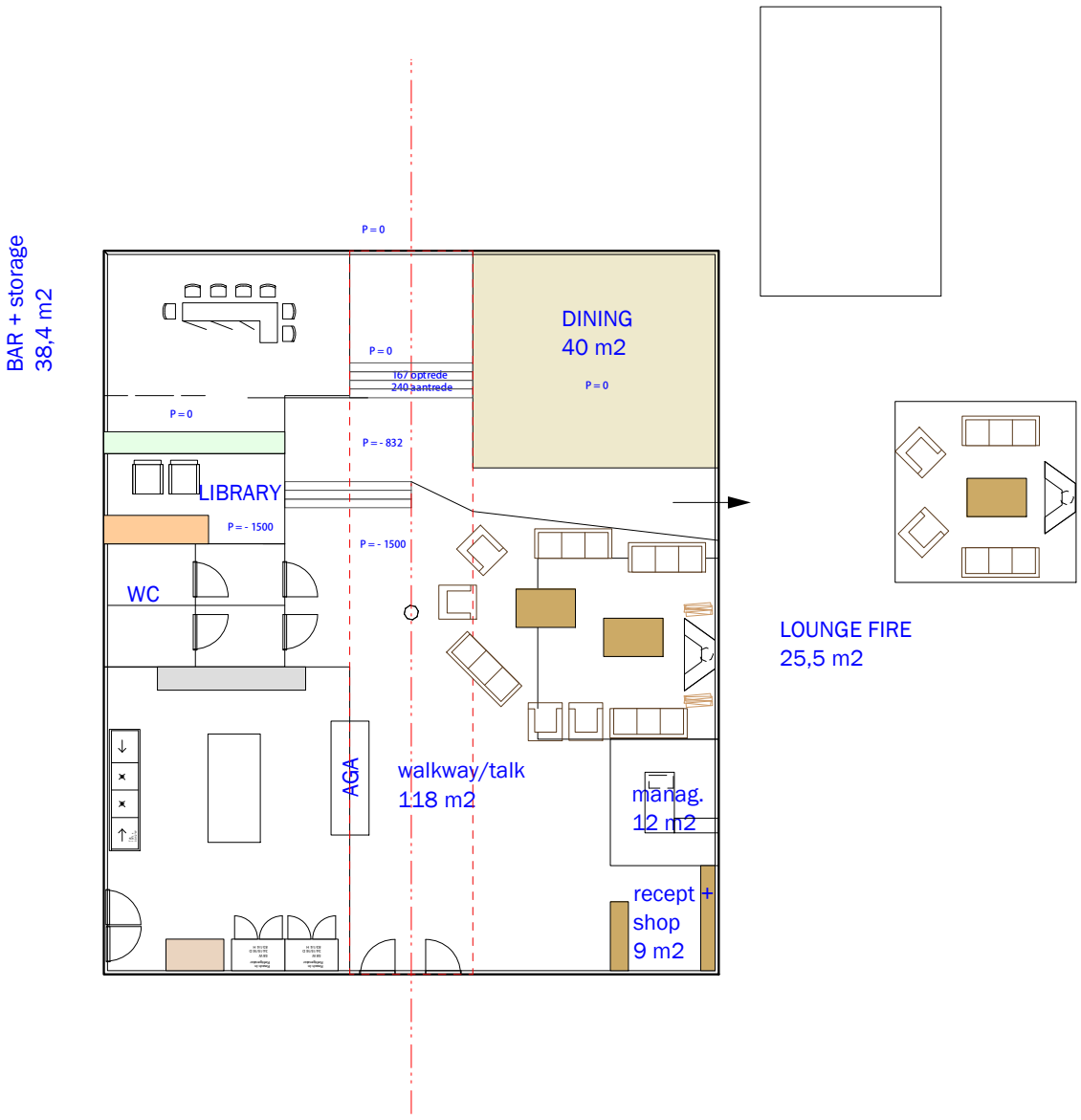

fatboys
Outside dining
LOUNGE VIEW AREA
Pool area
SCALE 1:200

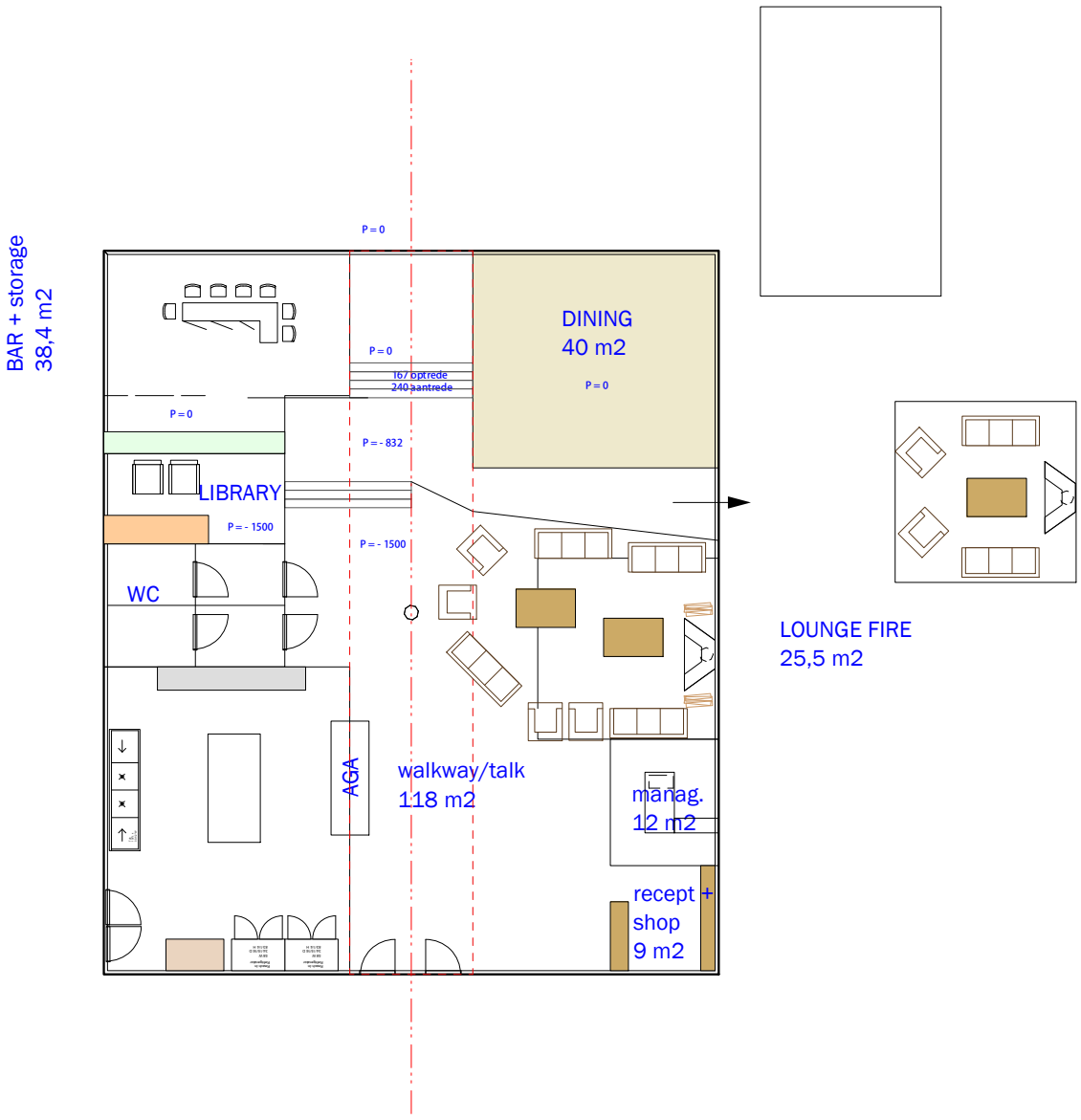

DINING
40 m2
BAR + storage
38,4 m2
WC
walkway/tar
118 m2
AGA
managg.
12 m2
recept +
shop
9 m2
LOUNGE FIRE
25,5 m2

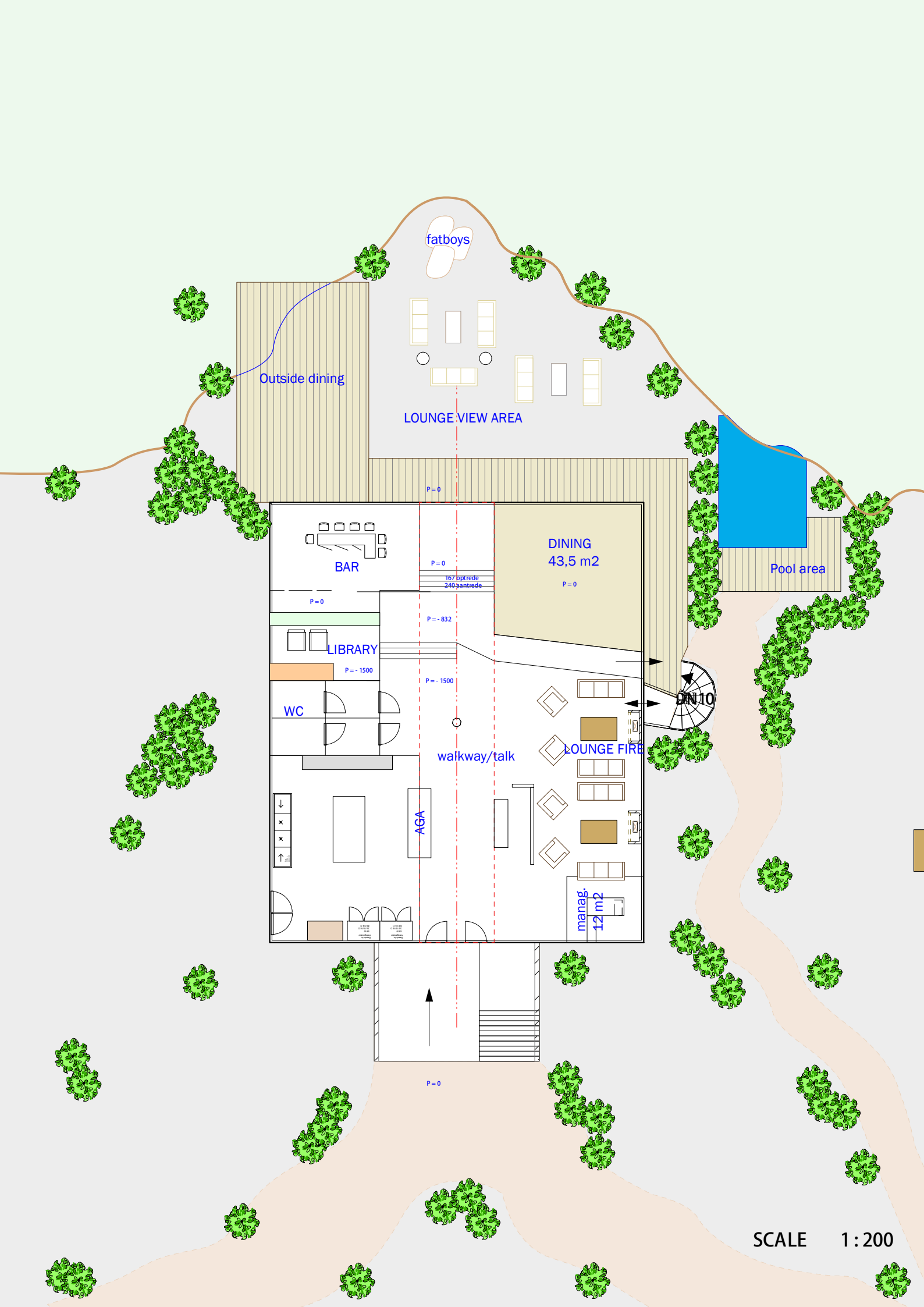

koude kant.
Rok.
open ovgn.
plates etc.
wall.
Dry storage.
Reach-In Refrigerator
83-1/4 H
Freezer
Fridge
warm

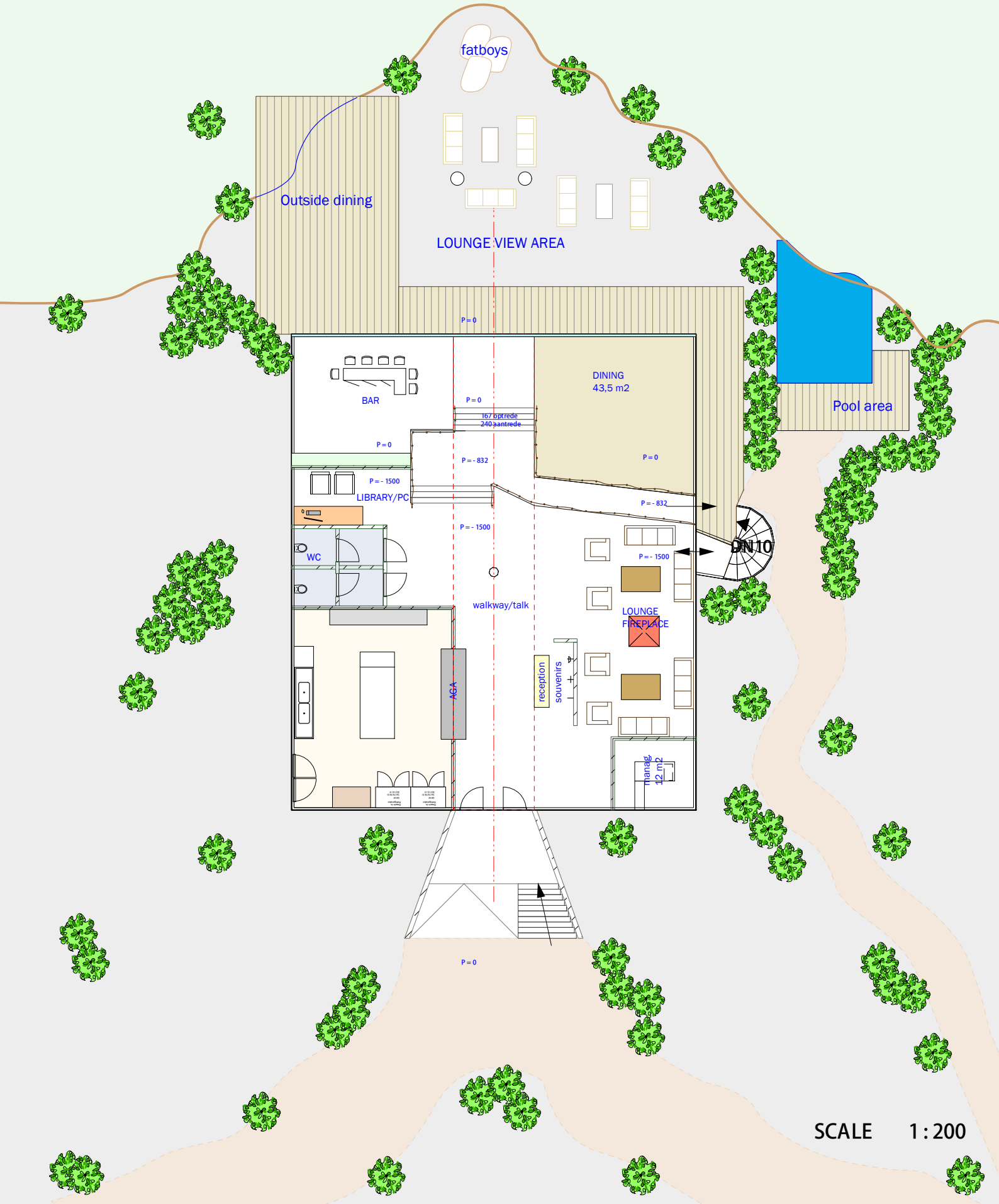

fatboys
Outside dining
LOUNGE VIEW AREA
Pool area
BAR + storage
38,4 m2
WC
16 m2
DINING
40 m2
LOUNGE FIRE
25,5 m2
DN 10
walkway/talk
118 m2
KITCHEN
57,8 m2
manag.
12 m2
Storage Kitchen
+ freezers
23,8 m2
recept +
shop
9 m2
SCALE 1:200

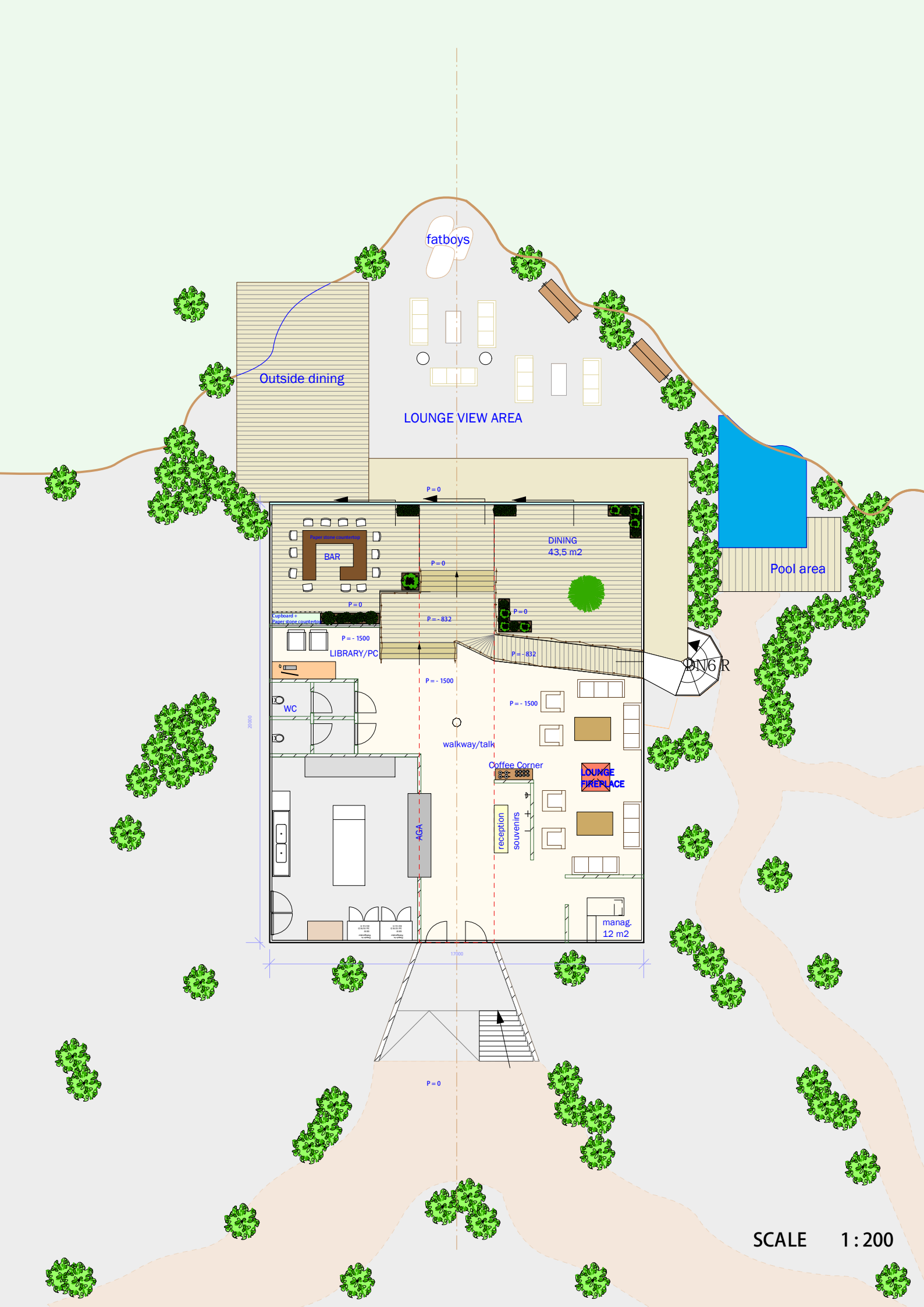

DINING
40 m2
P = 0
BAR + storage
38,4 m2
P = 0
P = 0
167 optrede
240 aantrede
P = 0
P = - 832
P = - 832
P = - 1500
WC
walkway/ta
118 m2
AGA
manag.
12 m2
recept +
shop
9 m2
LOUNGE FIRE
25,5 m2

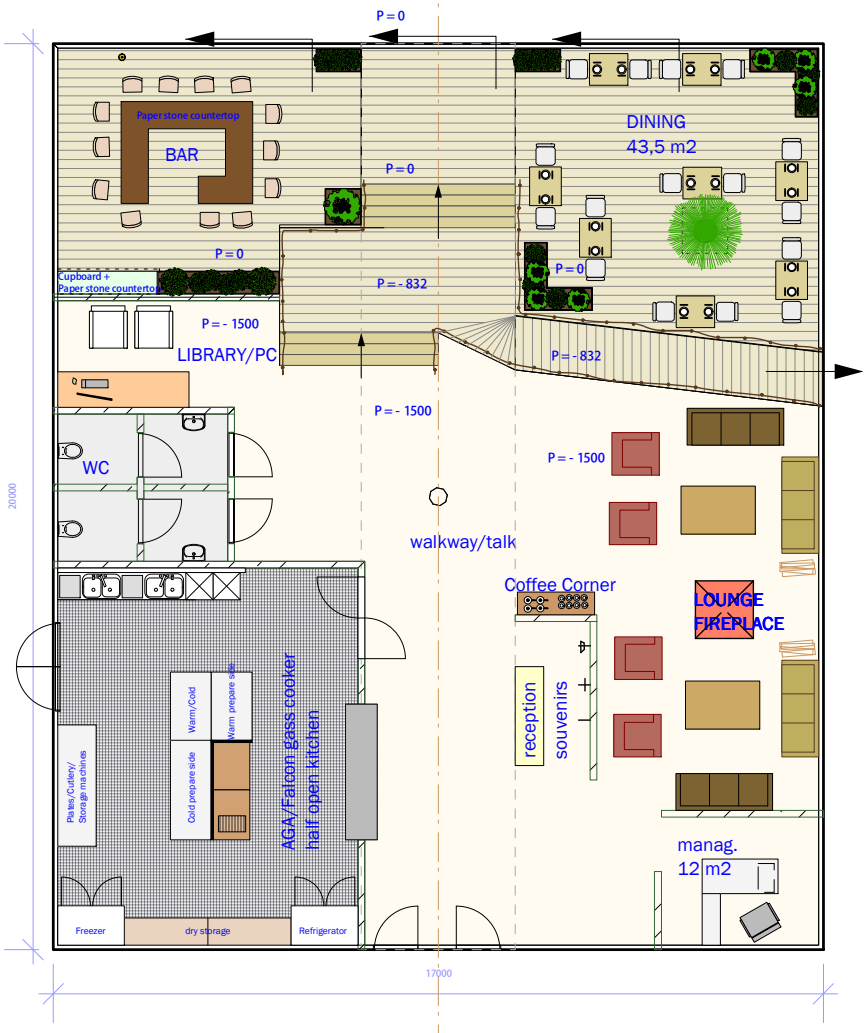

BAR + storage
38,4 m2
P = 0
DINING
40 m2
P = 0
P = 0
167 optrede
240 aantrede
P = 0
P = - 832
LIBRARY
P = - 1500
P = - 1500
WC
LOUNGE FIRE
25,5 m2
AGA
walkway/talk
118 m2
manag.
12 m2
recept +
shop
9 m2


BAR + storage
38,4 m2
P = 0
DINING
40 m2
P = 0
P = 0
167 optrede
240 aantrede
P = 0
P = - 832
LIBRARY
P = - 1500
P = - 1500
WC
LOUNGE FIRE
25,5 m2
AGA
walkway/talk
118 m2
manag.
12 m2
recept +
shop
9 m2


fatboys
Outside dining
LOUNGE VIEW AREA
P = 0
BAR
P = 0
167 optrede
240 aantrede
DINING
43,5 m2
P = 0
Pool area
P = 0
P = - 832
LIBRARY
P = - 1500
P = - 1500
WC
walkway/talk
DN10
LOUNGE FIRE
AGA
manag.
12 m2
P = 0
SCALE 1 : 200


fatboys
Outside dining
LOUNGE VIEW AREA
P = 0
BAR
DINING
43,5 m2
Pool area
P = 0
167 optrede
240 aantrede
P = 0
P = - 832
P = - 1500
LIBRARY/PC
P = - 832
P = - 1500
WC
DN10
P = - 1500
walkway/talk
LOUNGE
FIREPLACE
AGA
reception
souvenirs
manag.
12 m2
P = 0
SCALE 1 : 200


fatboys
Outside dining
LOUNGE VIEW AREA
Pool area
DINING
43,5 m2
BAR
LIBRARY/PC
WC
walkway/talk
Coffee Corner
LOUNGE
FIREPLACE
AGA
reception
souvenirs
manag.
12 m2
DN6 R
P = 0
P = - 832
P = - 1500
SCALE 1 : 200


P = 0
Paper stone countertop
BAR
DINING
43,5 m2
P = 0
P = 0
Cupboard +
Paper stone countertop
P = - 832
P = 0
P = - 1500
LIBRARY/PC
P = - 832
P = - 1500
WC
P = - 1500
walkway/talk
Coffee Corner
LOUNGE
FIREPLACE
reception
souvenirs
Warm/Cold
Warm prepare side
Cold prepare side
Plates/Cutlery/
Storage machines
AGA/Falcon gass cooker
half open kitchen
manag.
12 m2
Freezer
dry storage
Refrigerator
20000
17000

LOUNGE VIEW AREA

Outside dining

BAR

Sliced tree countertop

P = 0

P = 0

Cupboard + countertop

P = - 832

integrated pots for plants

DINING
43,5 m2

P = 0

P = - 1500

LIBRARY/PC

P = - 832

Pool area

P = - 1500

WC

20000

walkway/talk

Coffee Corner

LOUNGE FIREPLACE

reception

souvenirs

Warm/Cold

Warm prepare side

Cold prepare side

Plates/Cutlery/ Storage machines

AGA/Falcon gass cooker

half open kitchen

manag.
12 m2

Freezer

dry storage

Refrigerator

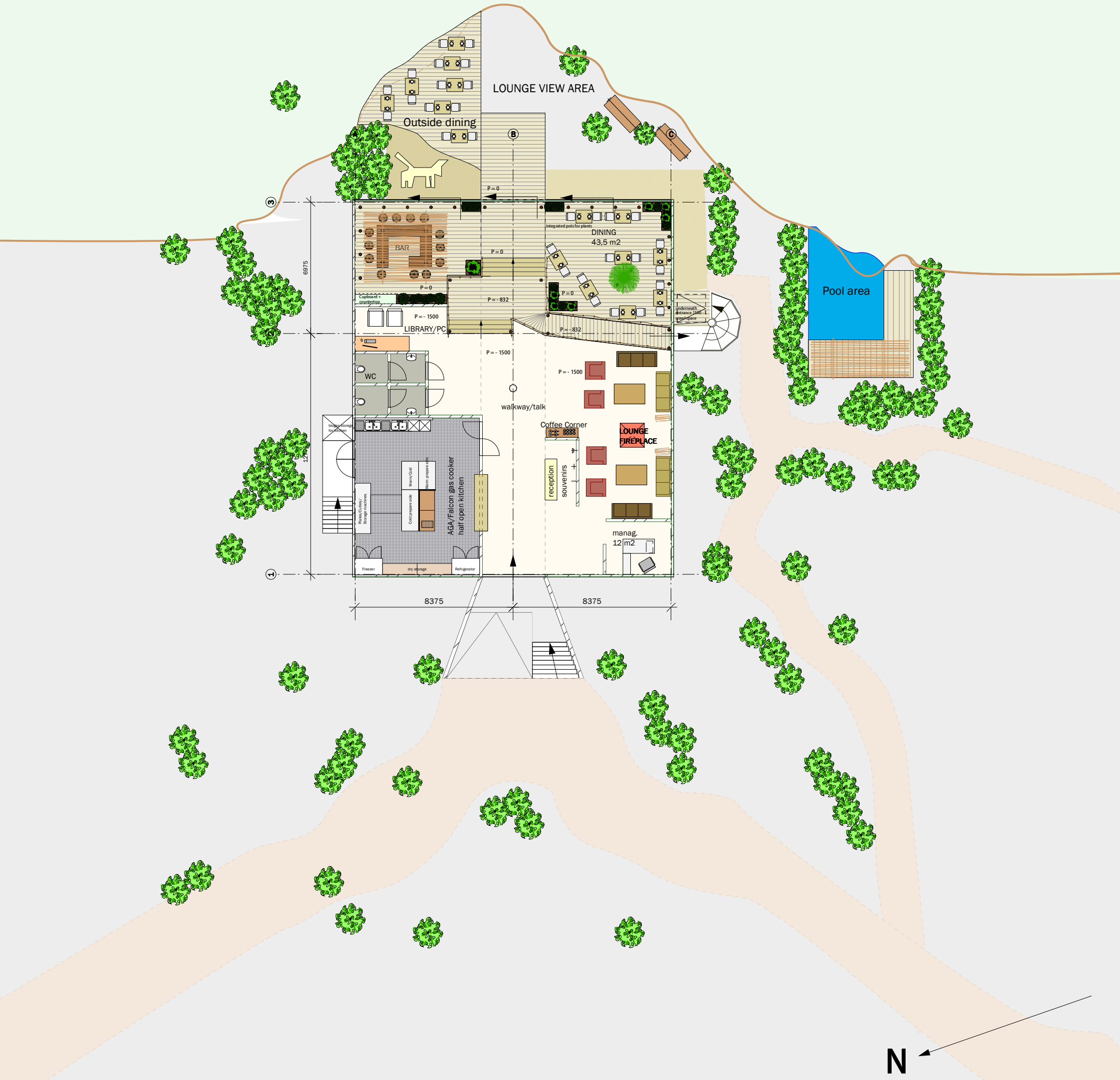
P = 0

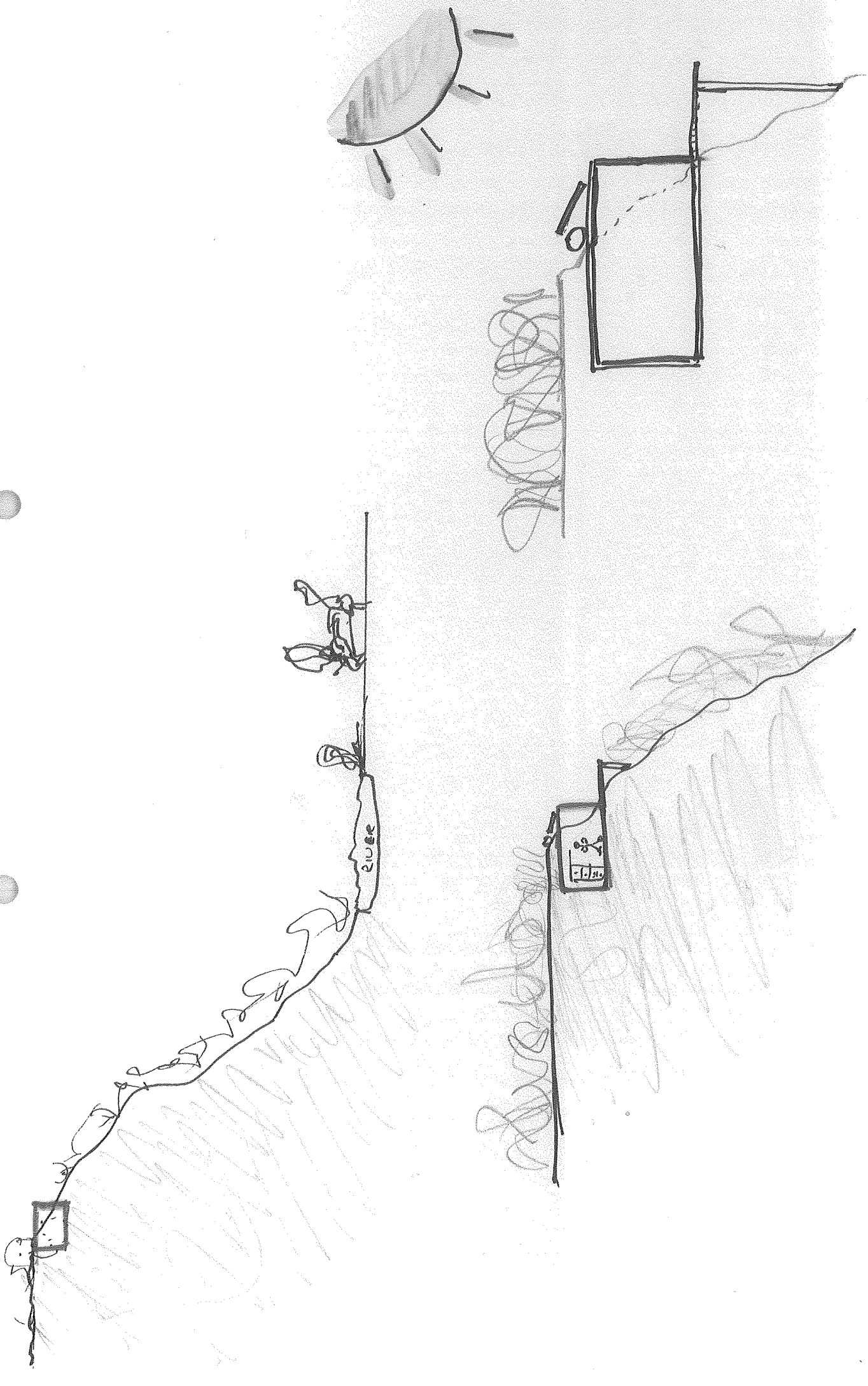
6800

3400

6800

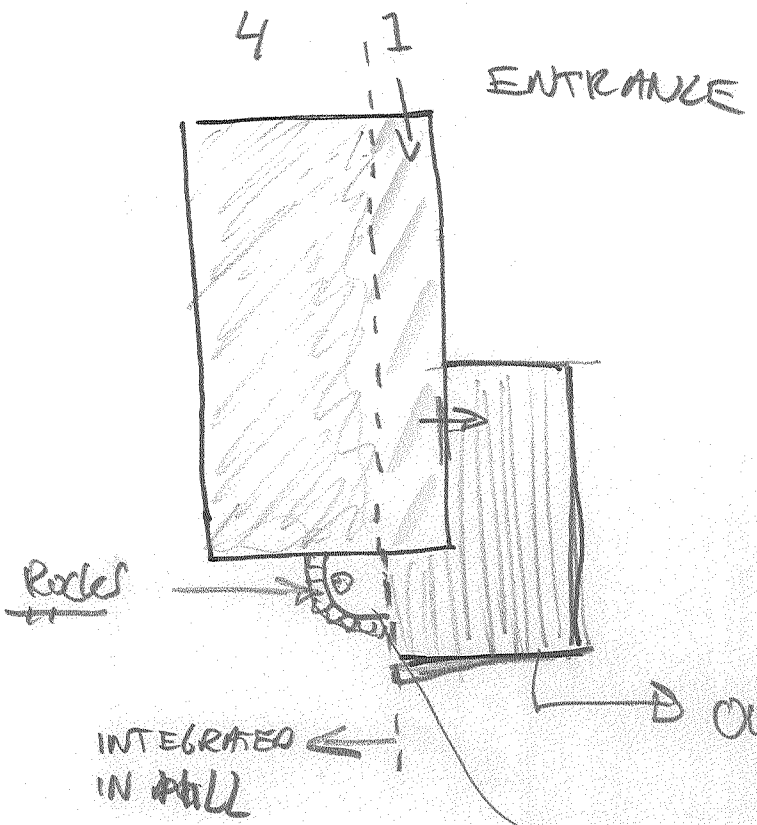
17000

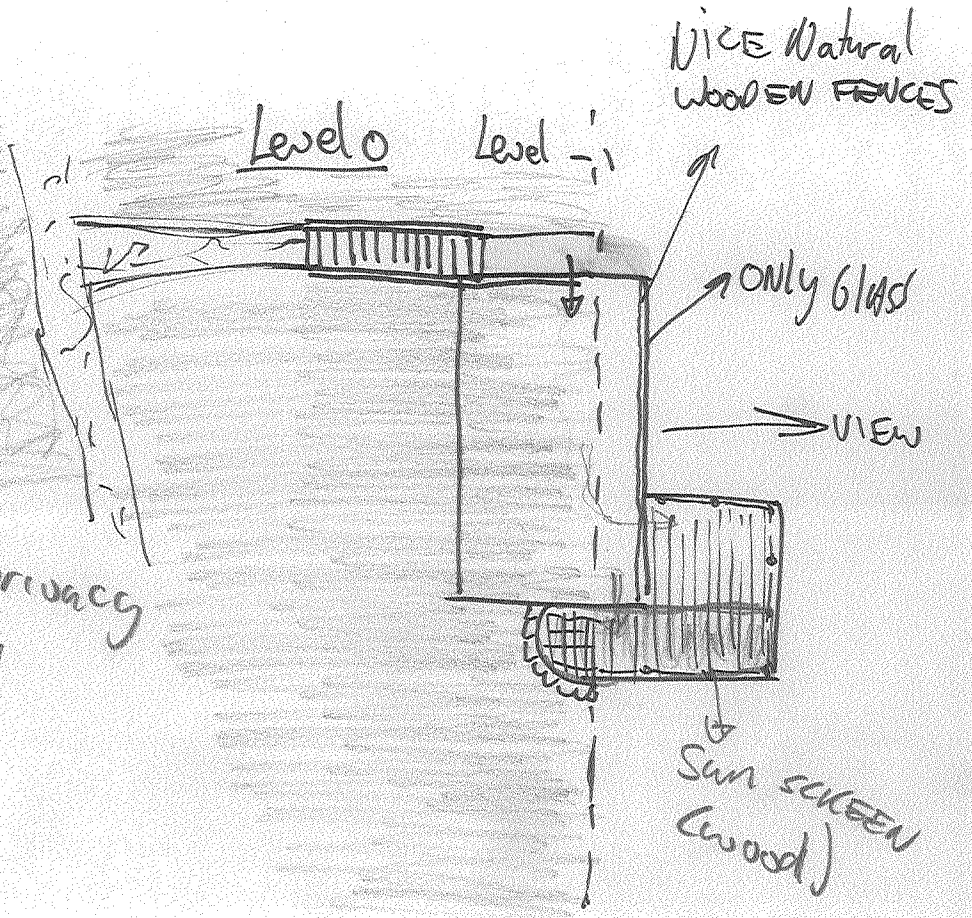

LOUNGE VIEW AREA
Outside dining
B
C
P = 0
integrated pots for plants
DINING
43,5 m2
BAR
P = 0
P = 0
P = - 832
Cupboard + countertop
P = - 1500
LIBRARY/PC
underneath entrance 1500 - 1 grave space
P = - 832
P = - 1500
WC
P = - 1500
walkway/talk
Coffee Corner
LOUNGE FIREPLACE
biogas storage for kitchen
Warm/Cold
Warm prepare side
Cold prepare side
Plates/Cutlery/ Storage machines
AGA/Falcon gas cooker half open kitchen
reception
souvenirs
manag.
12 m2
Freezer
dry storage
Refrigerator
6975
12500
8375
8375
Pool area
N
Siteplan Main-lodge
SCALE: 1 : 200
Drawn by: Kevin de Bont & Pim de Blois

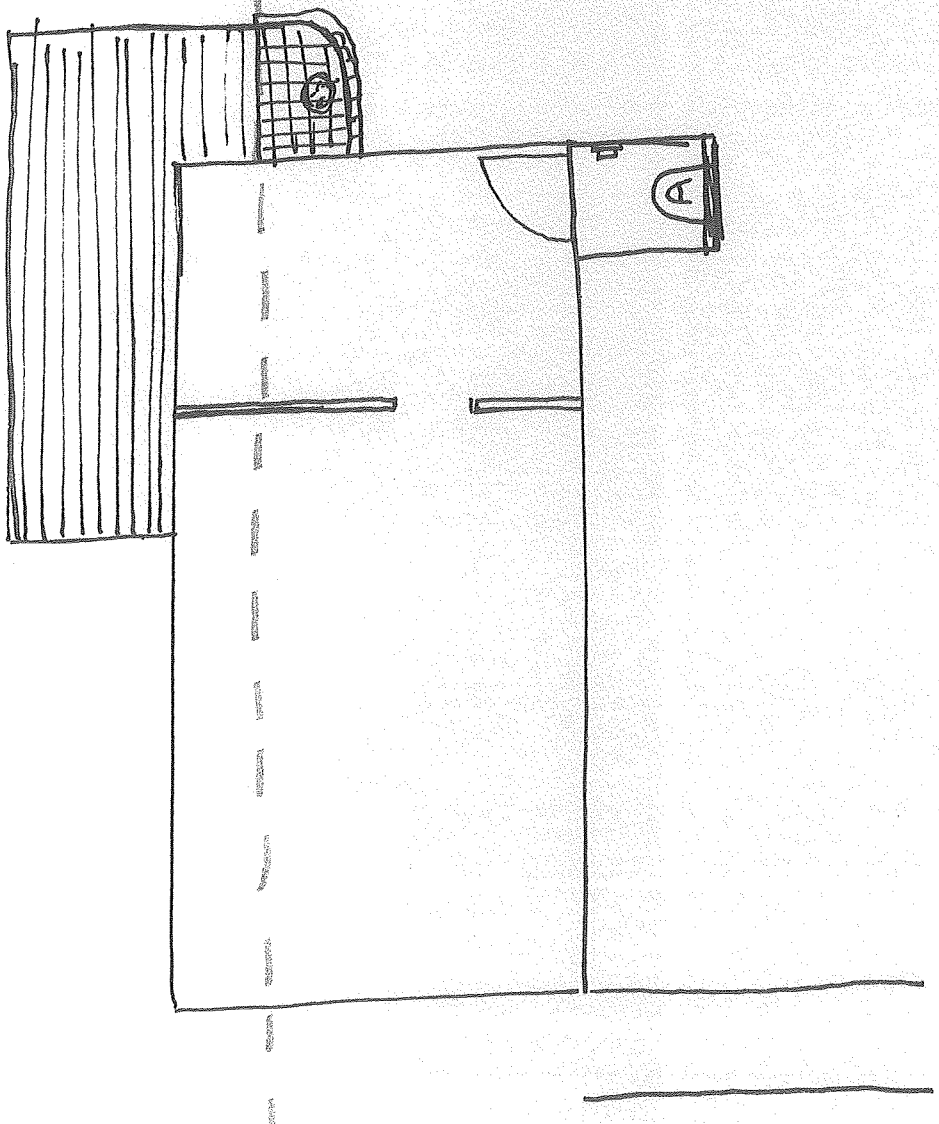


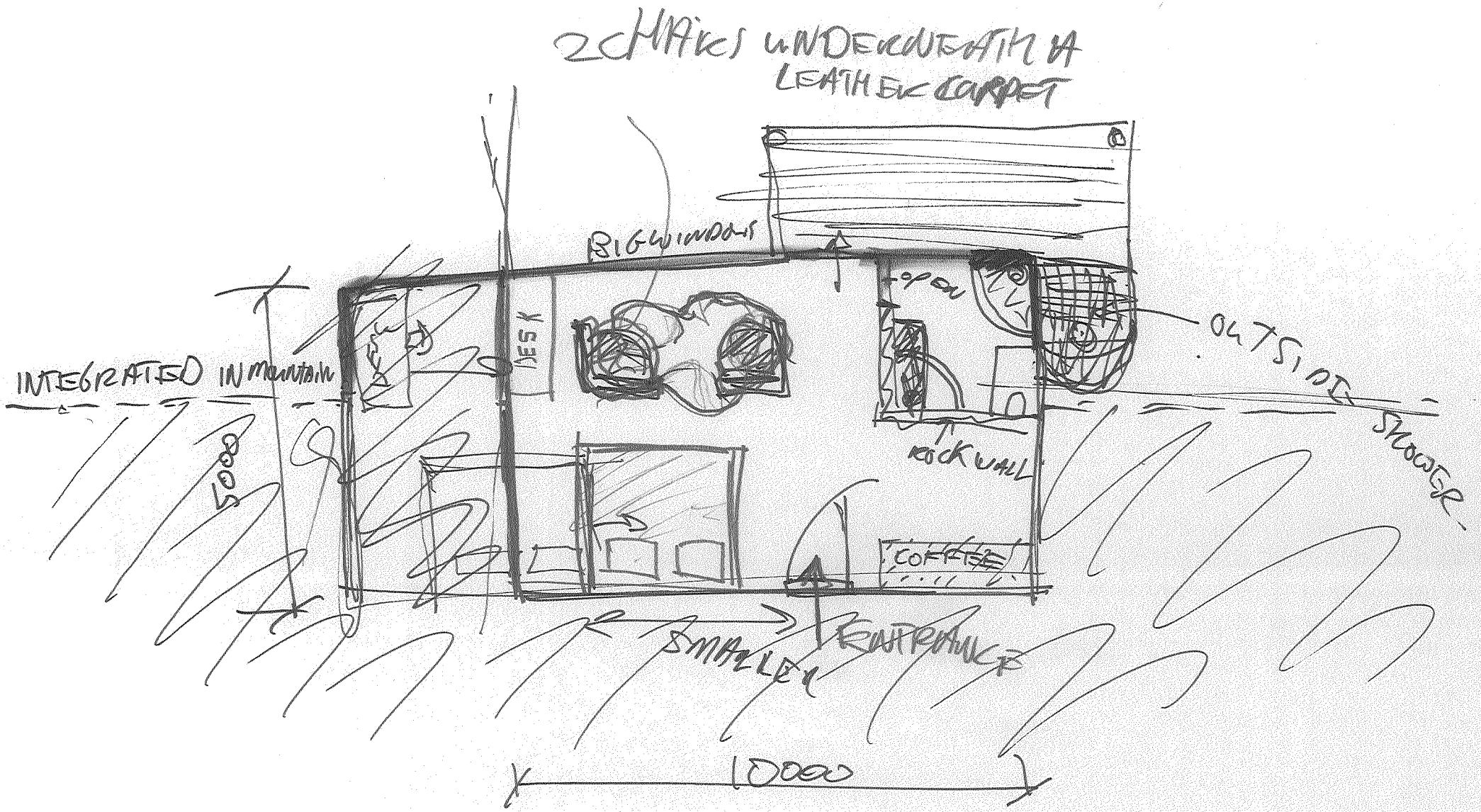
Top plan → ≈ 50m²

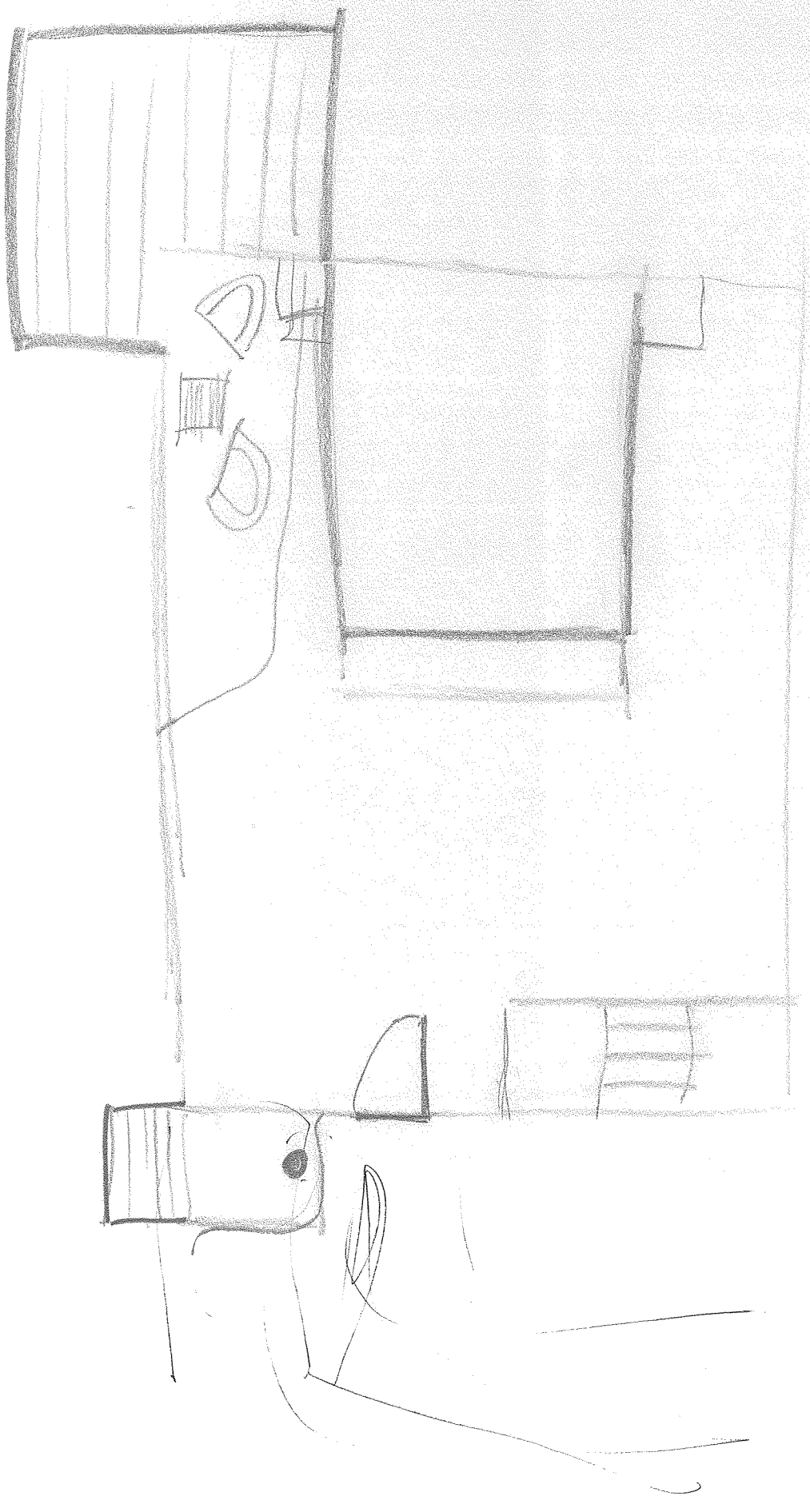
= Not integrated in the Hill.
Space for sumboiling system.
→ eco-lodge can be seen. preferable not.

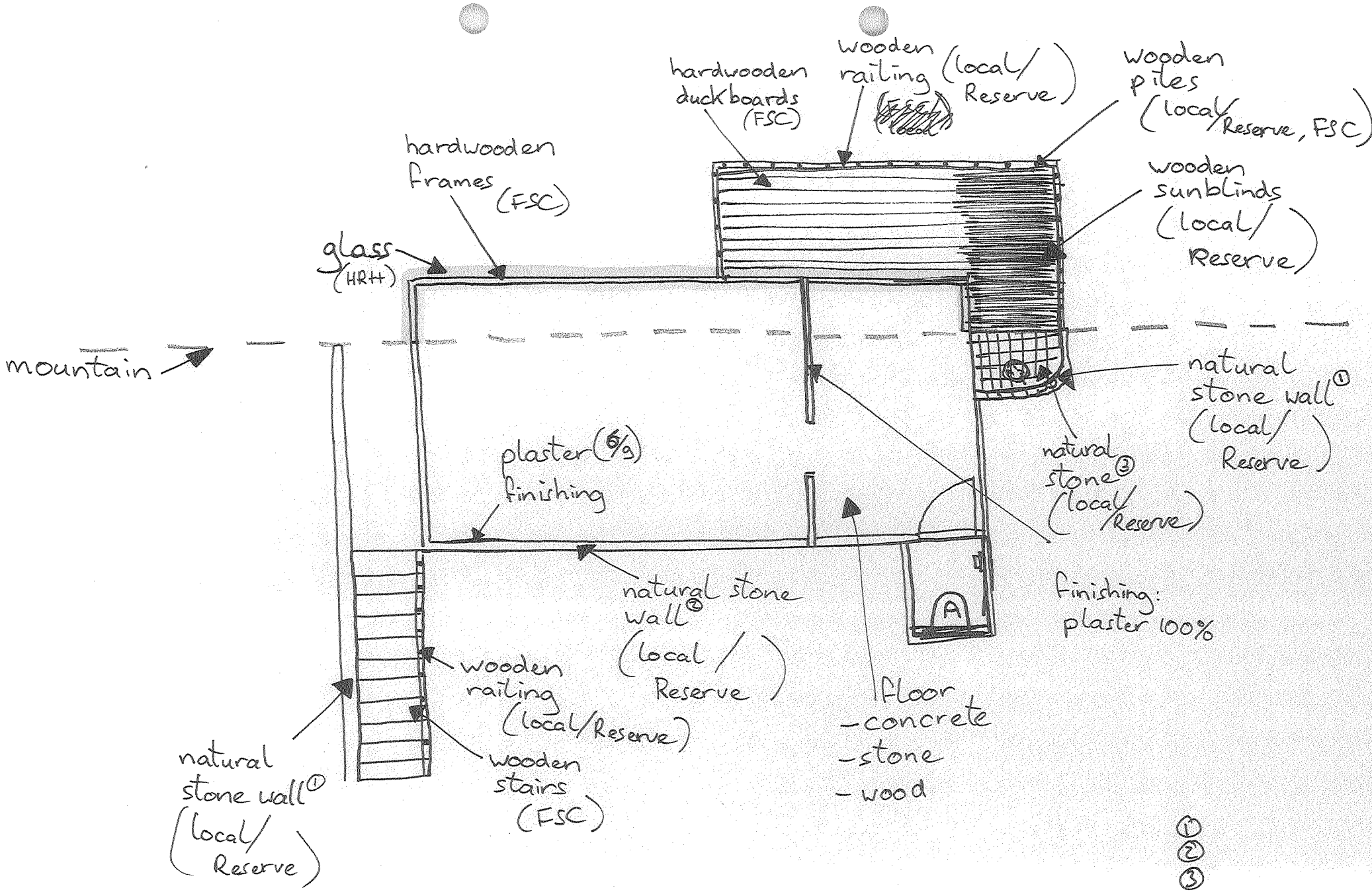


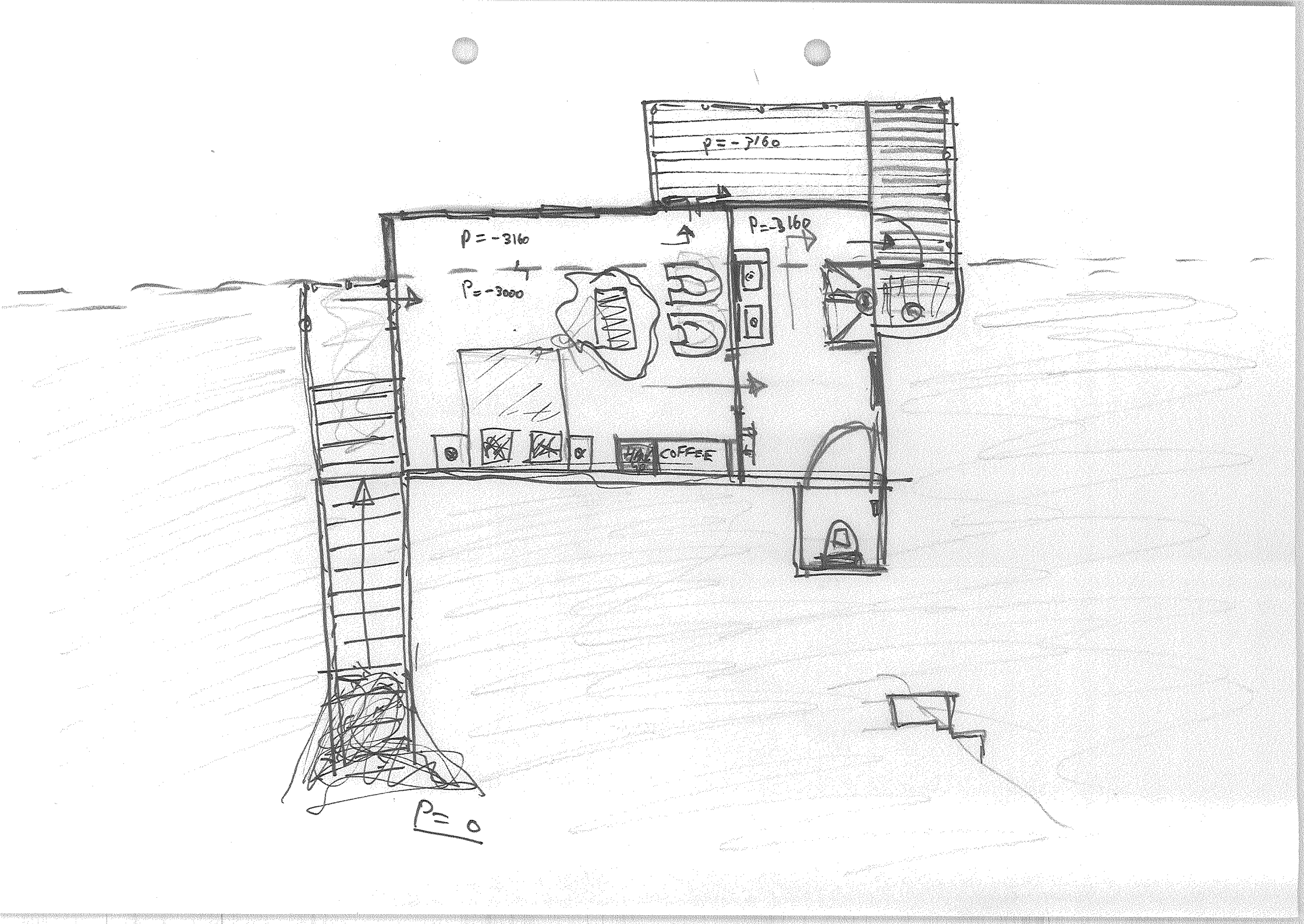


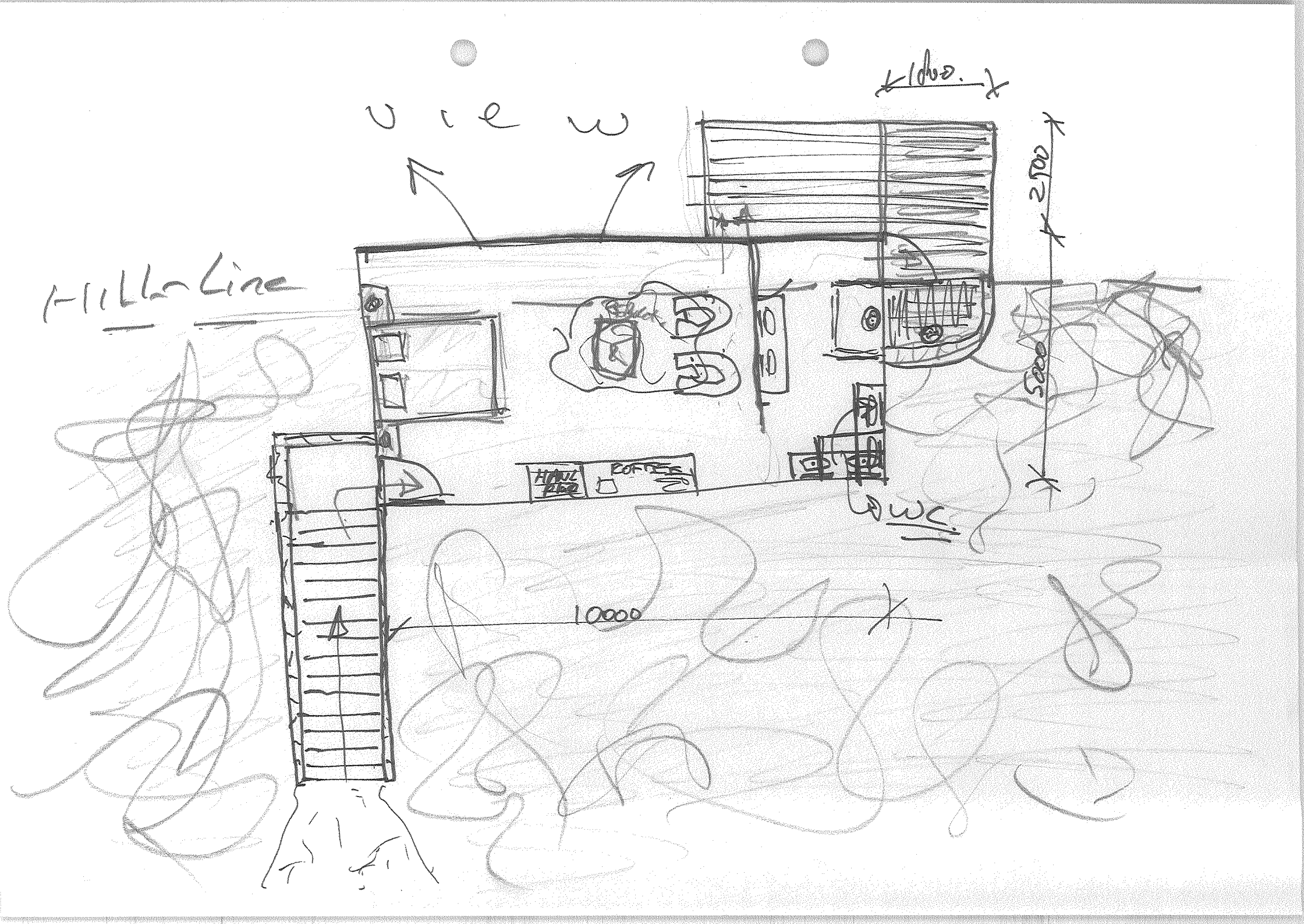


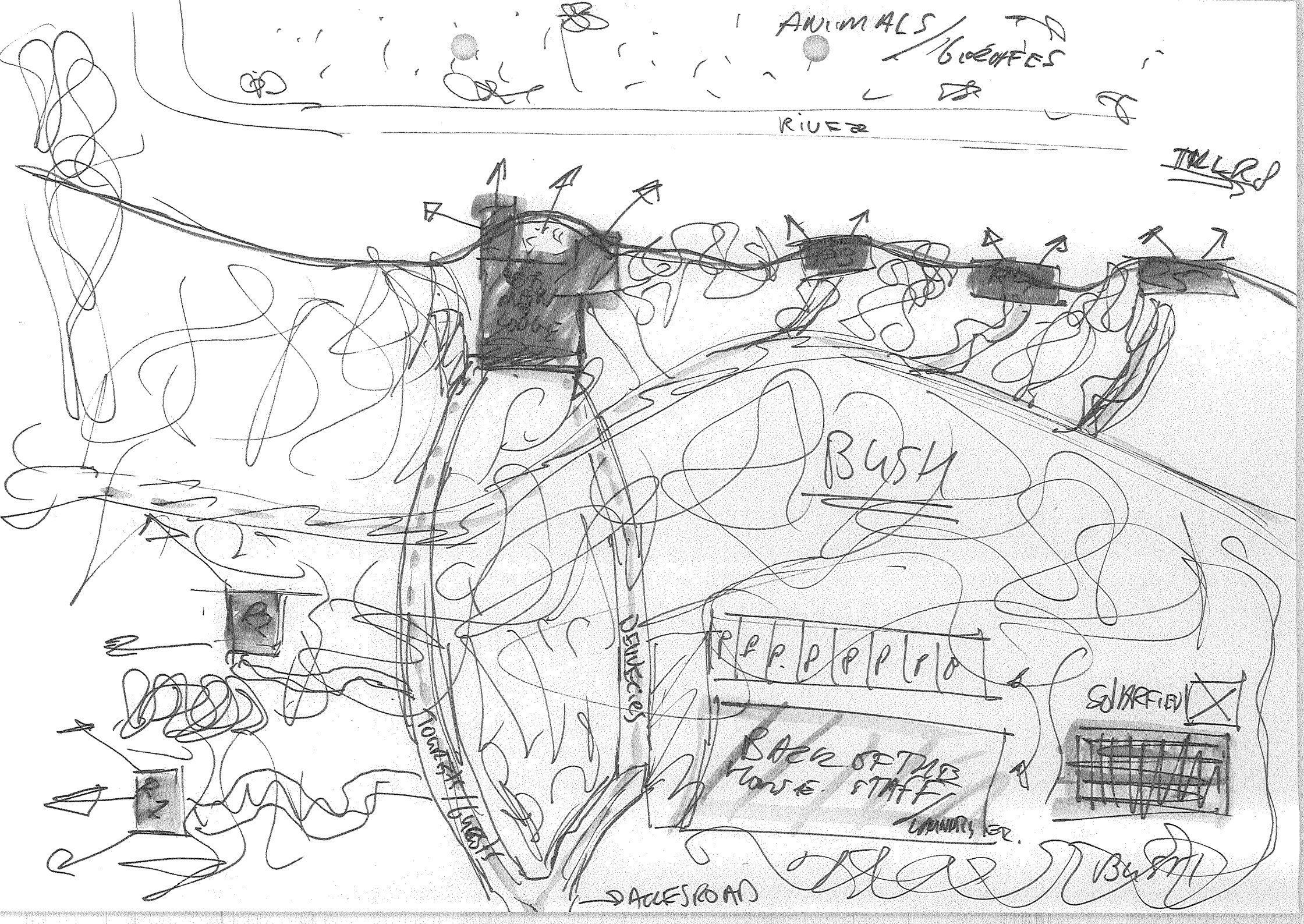

2 CHAIRS UNDERNEATH IN LEATHER CARPET
BIG WINDOWS
OPEN
DESK
INTEGRATED IN MOUNTAIN
LOOP
OUTSIDE SHOWER
ROCK WALL
COFFEE
SMALLER
FIREPLACE
10000

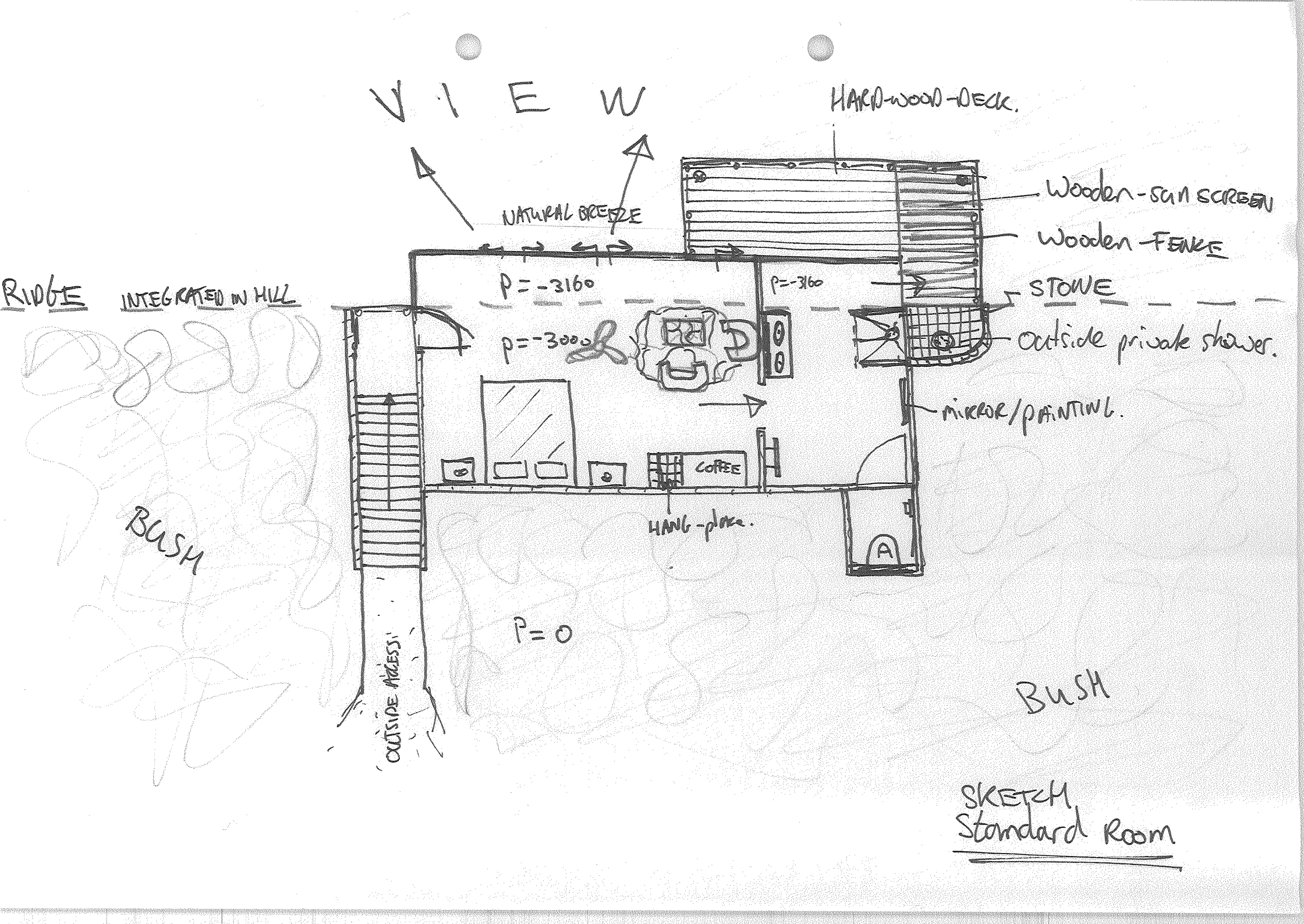


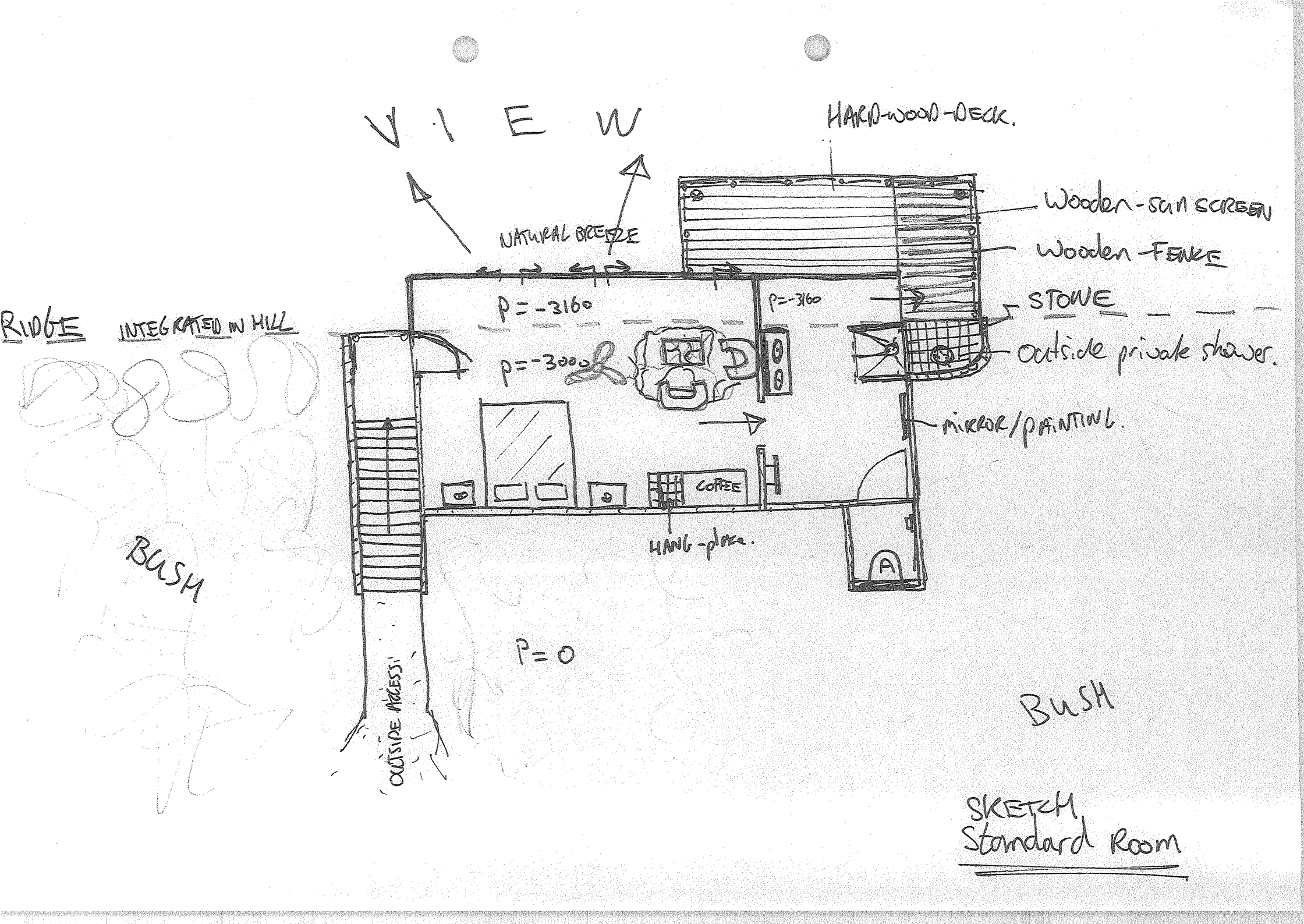

hardwooden duckboards (FSC)
wooden railing (local/ Reserve)
wooden piles (local/Reserve, FSC)
hardwooden frames (FSC)
wooden sunblinds (local/ Reserve)
glass (HR++)
mountain
natural stone wall① (local/ Reserve)
plaster (6/9) finishing
natural stone③ (local/Reserve)
natural stone wall② (local/ Reserve)
Finishing: plaster 100%
wooden railing (local/Reserve)
wooden stairs (FSC)
natural stone wall① (local/ Reserve)
floor -concrete -stone -wood
① ② ③

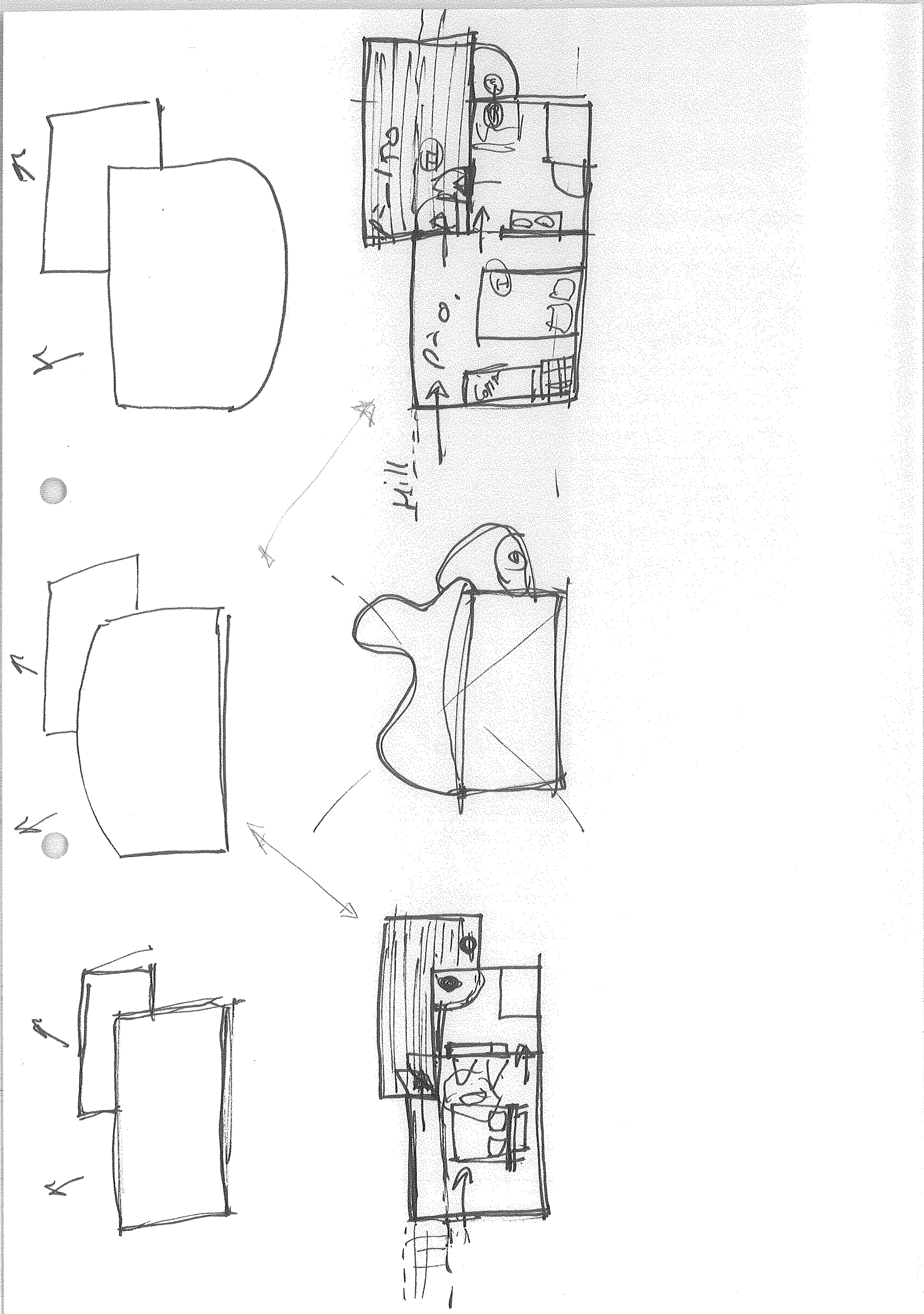

p = -3160
p = -3160
p = -3160
p = -3000
COFFEE
p = 0


view
1000
Hill Line
2500
5000
10
10
WC
10000

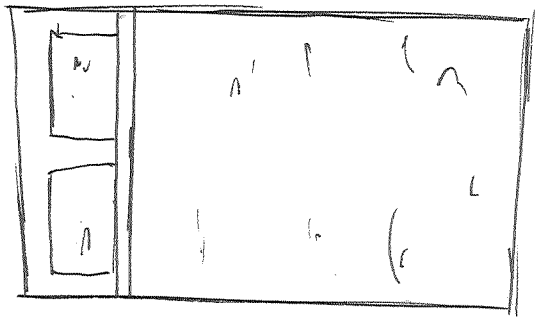

ANIMALS / GIRAFFES
RIVER
BUSH
BACK OF THE HOUSE STAFF
ACCESS ROAD


VIEW
HARD-WOOD-DECK.
NATURAL BREEZE
Wooden-sun screen
Wooden-FENCE
STONE
outside private shower.
RIDGE
INTEGRATED IN HILL
P=-3160
P=-3160
P=-3000
BED
COFFEE
mirror/painting.
HANG-place.
BUSH
P=0
OUTSIDE ACCESS
BUSH
SKETCH
Standard Room

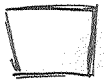

VIEW
HARD-WOOD-DECK.
Wooden-sun screen
Wooden-FENCE
STOWE
outside private shower.
MIRROR/PAINTING.
NATURAL BREEZE
P=-3160
P=-3160
P=-3000
COFFEE
HANG-place.
A
P=0
OUTSIDE ACCESS
RIDGE
INTEGRATED IN HILL
BUSH
BUSH
SKETCH
Standard Room



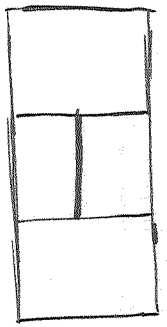
What do we need ?



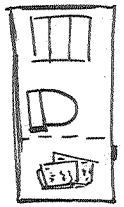
bed (2p)



bedside table 2x

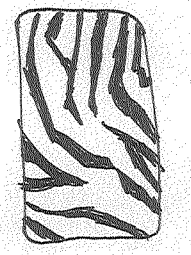


luggage place/
hang place jackets etc.

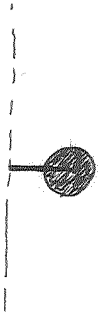


coffee station/
fridge within

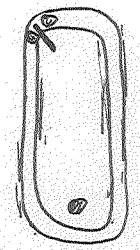
chair
2x



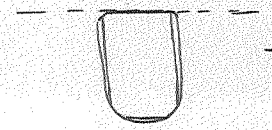
hassock



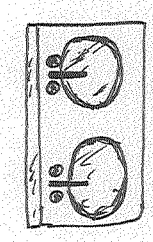
shower
(in/outside)



bathtub
(only in honeymoon)

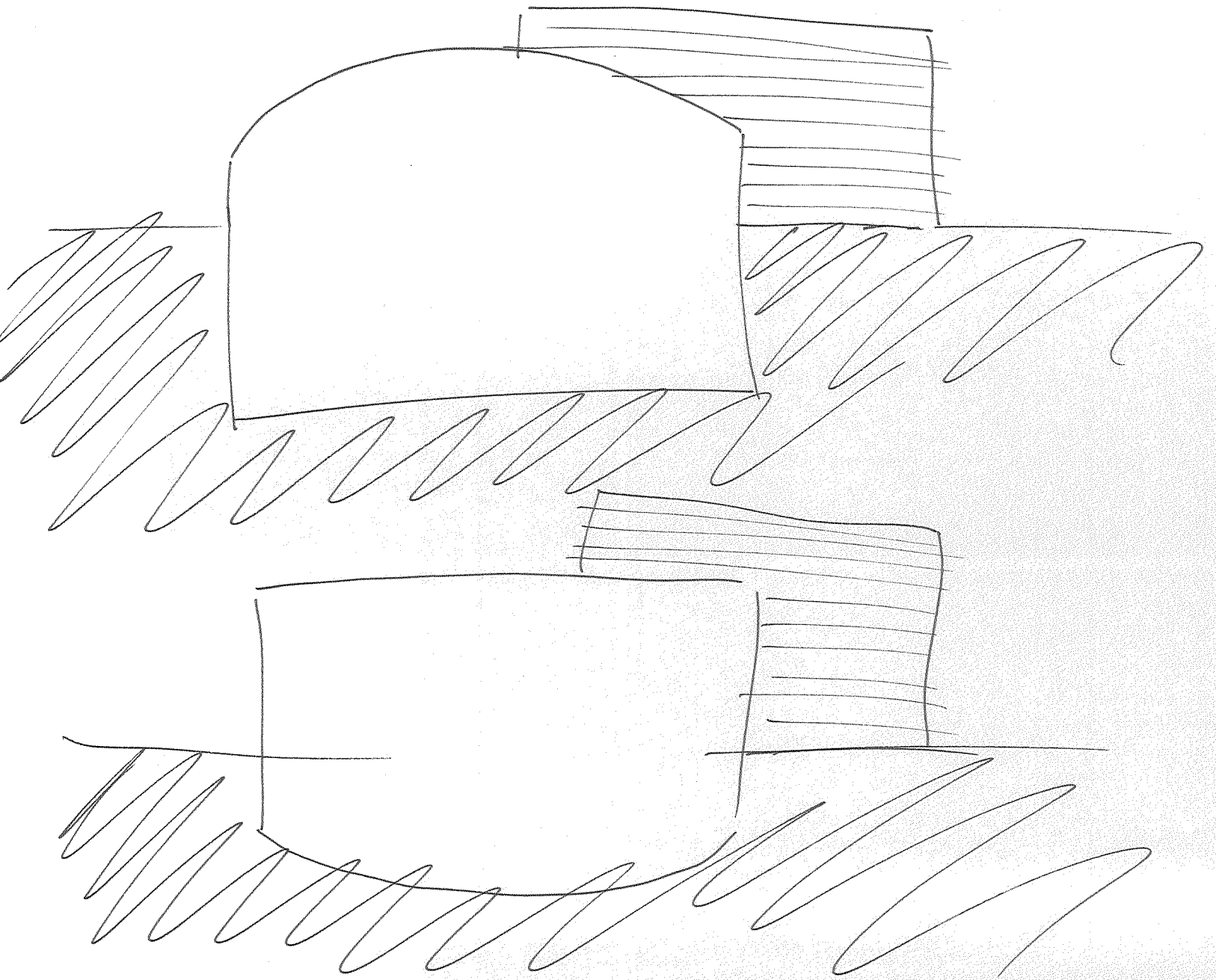


toilet



2 water basins
+ mirror

lamp



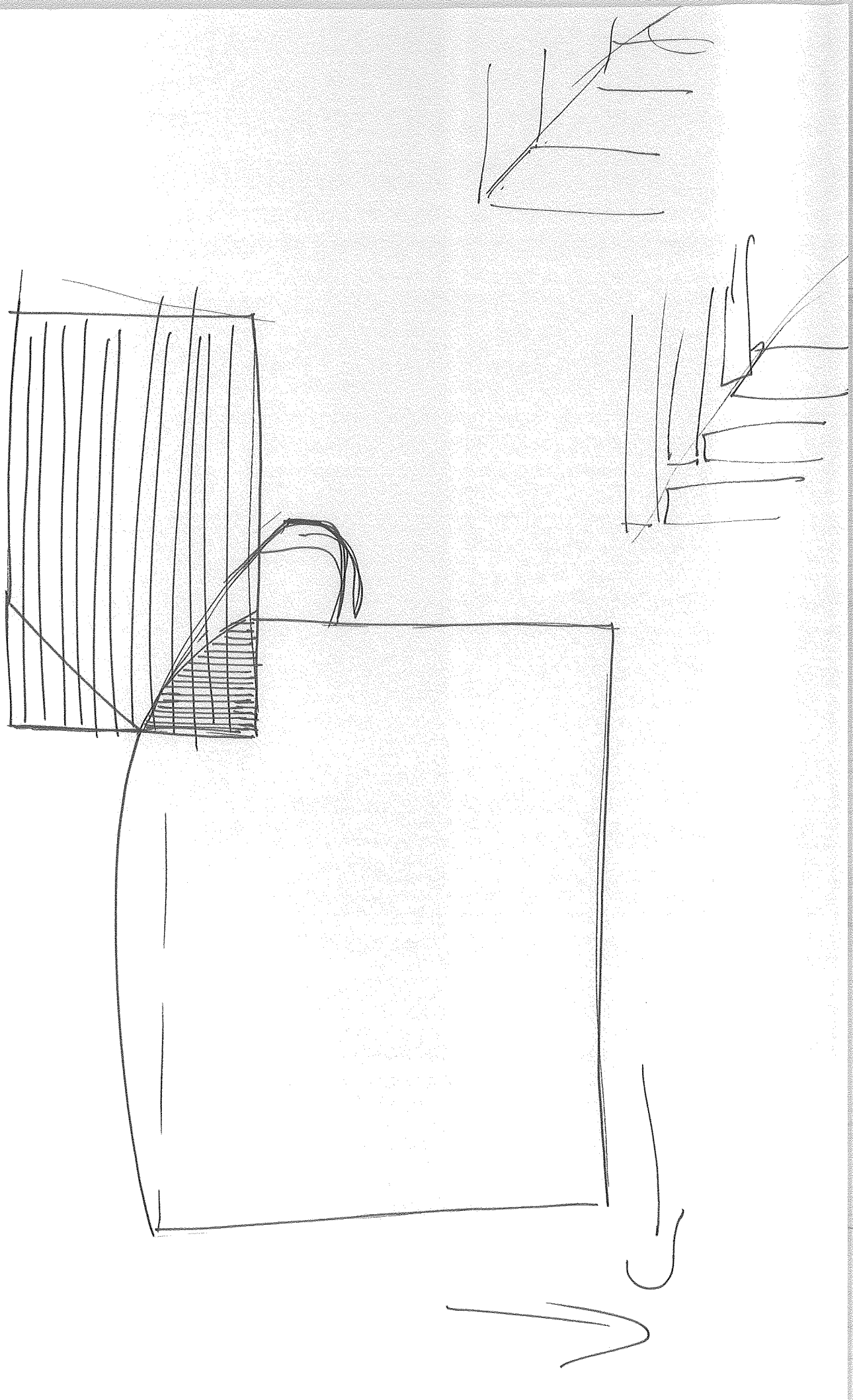
+ view

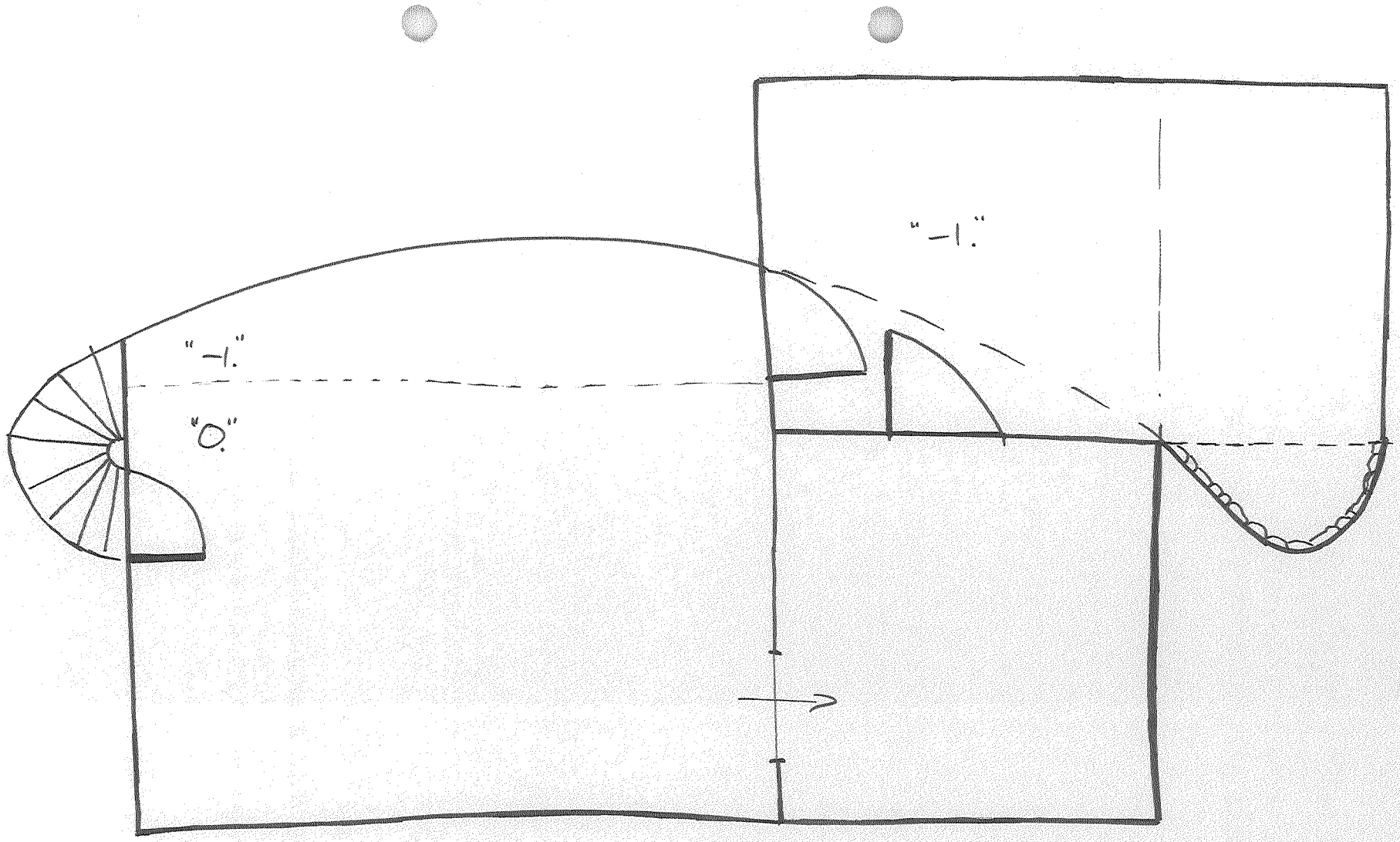
- lastig met wanden

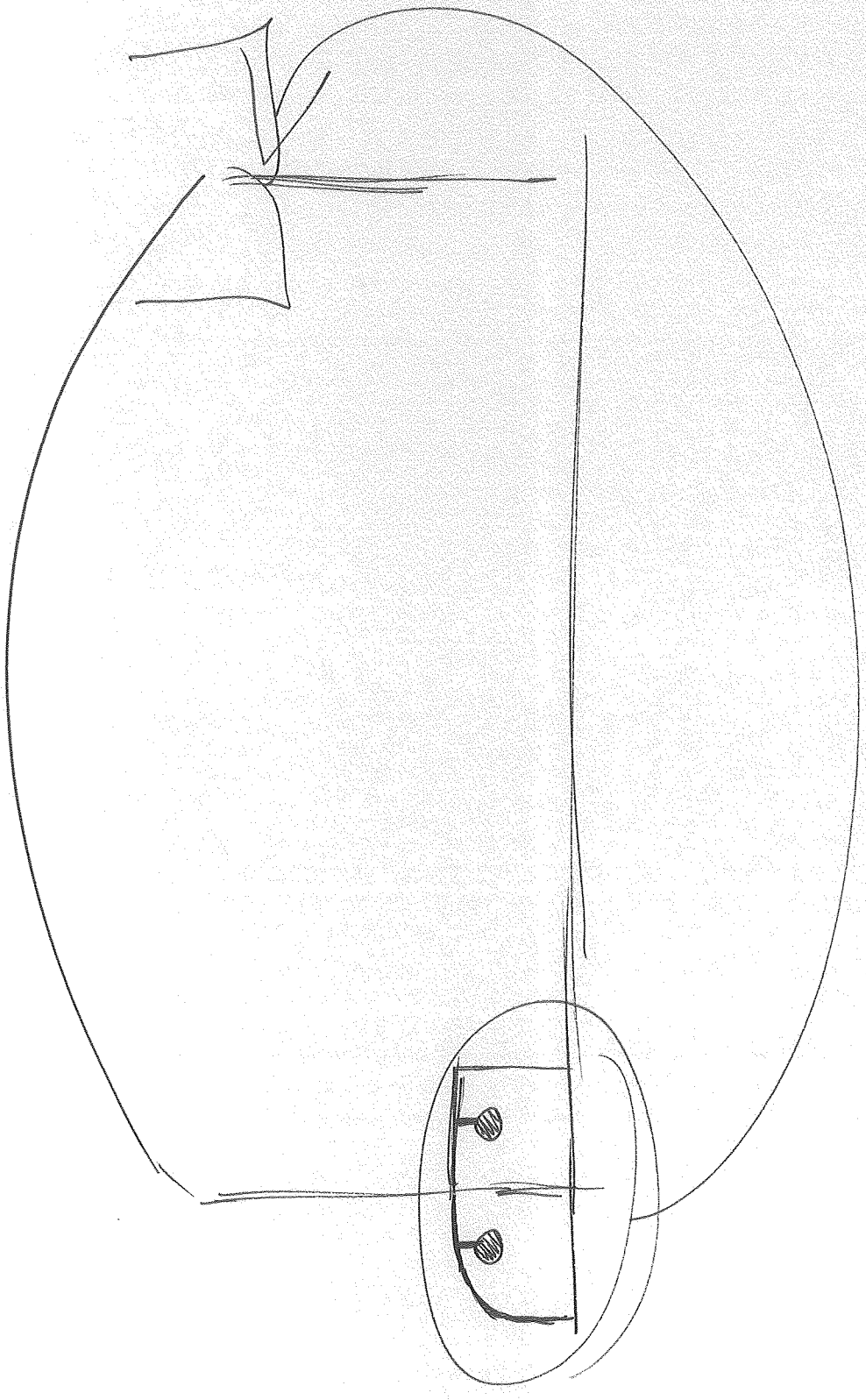
+ wanden makkelijk

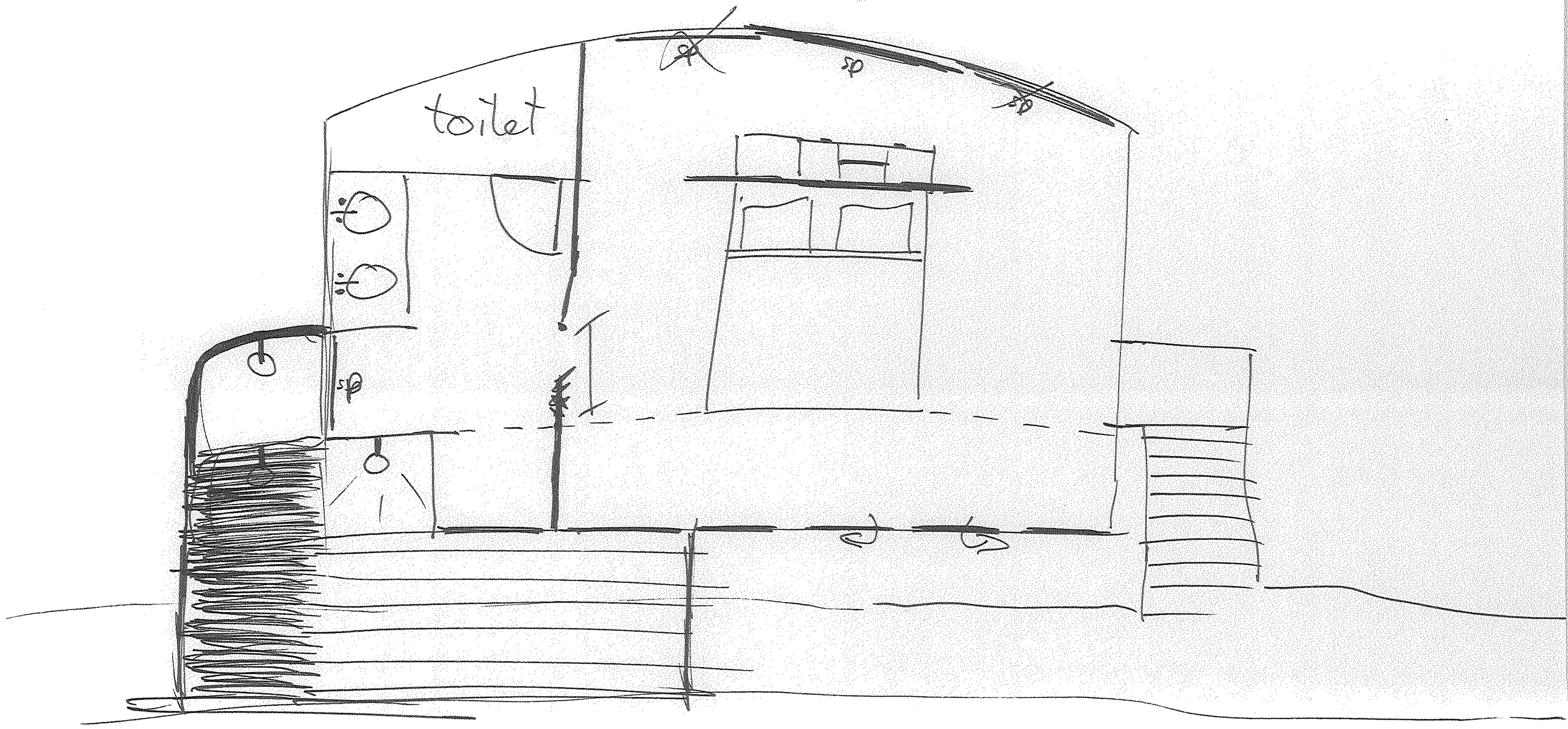
- minder "speels"

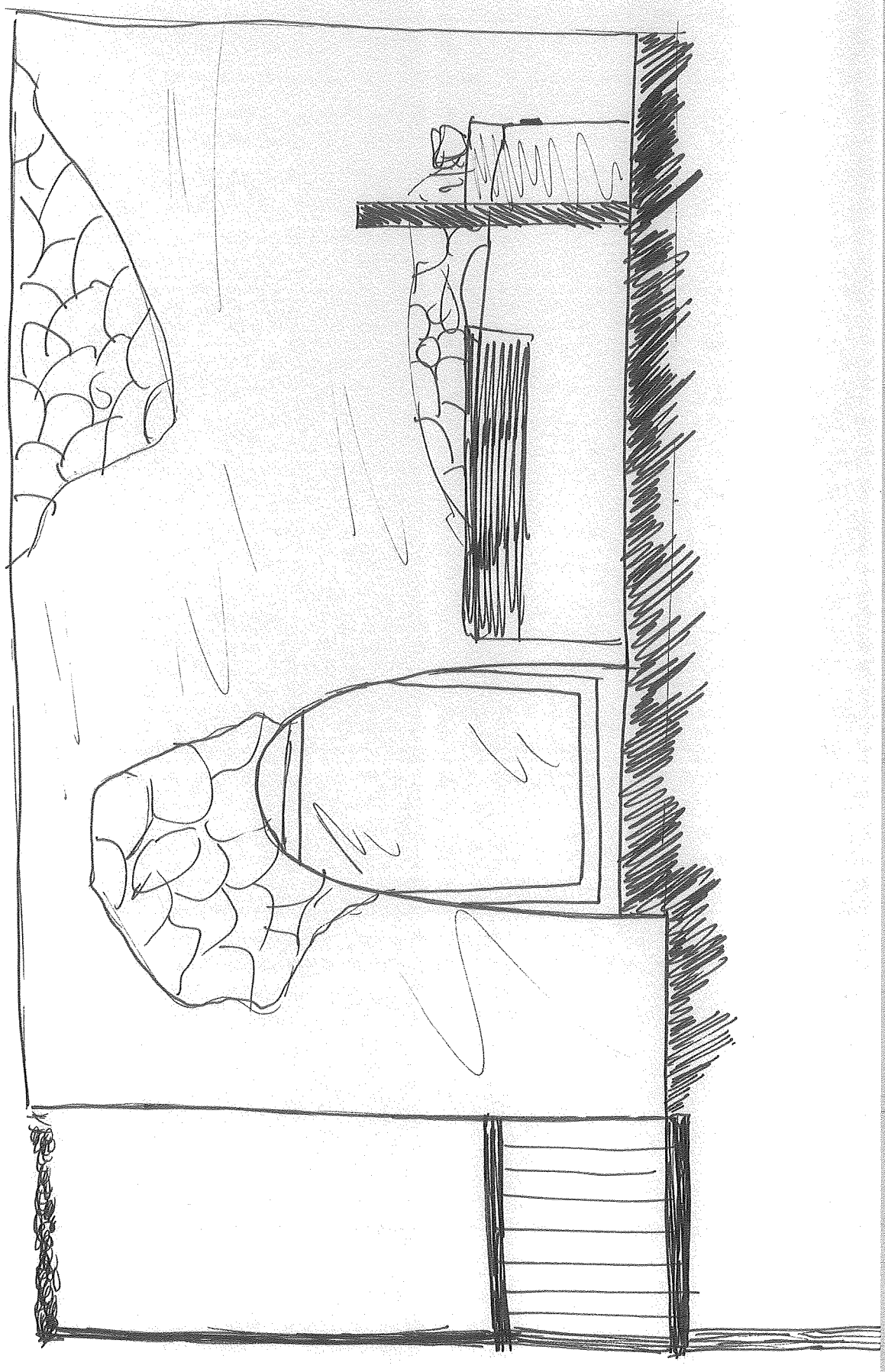
± strakker

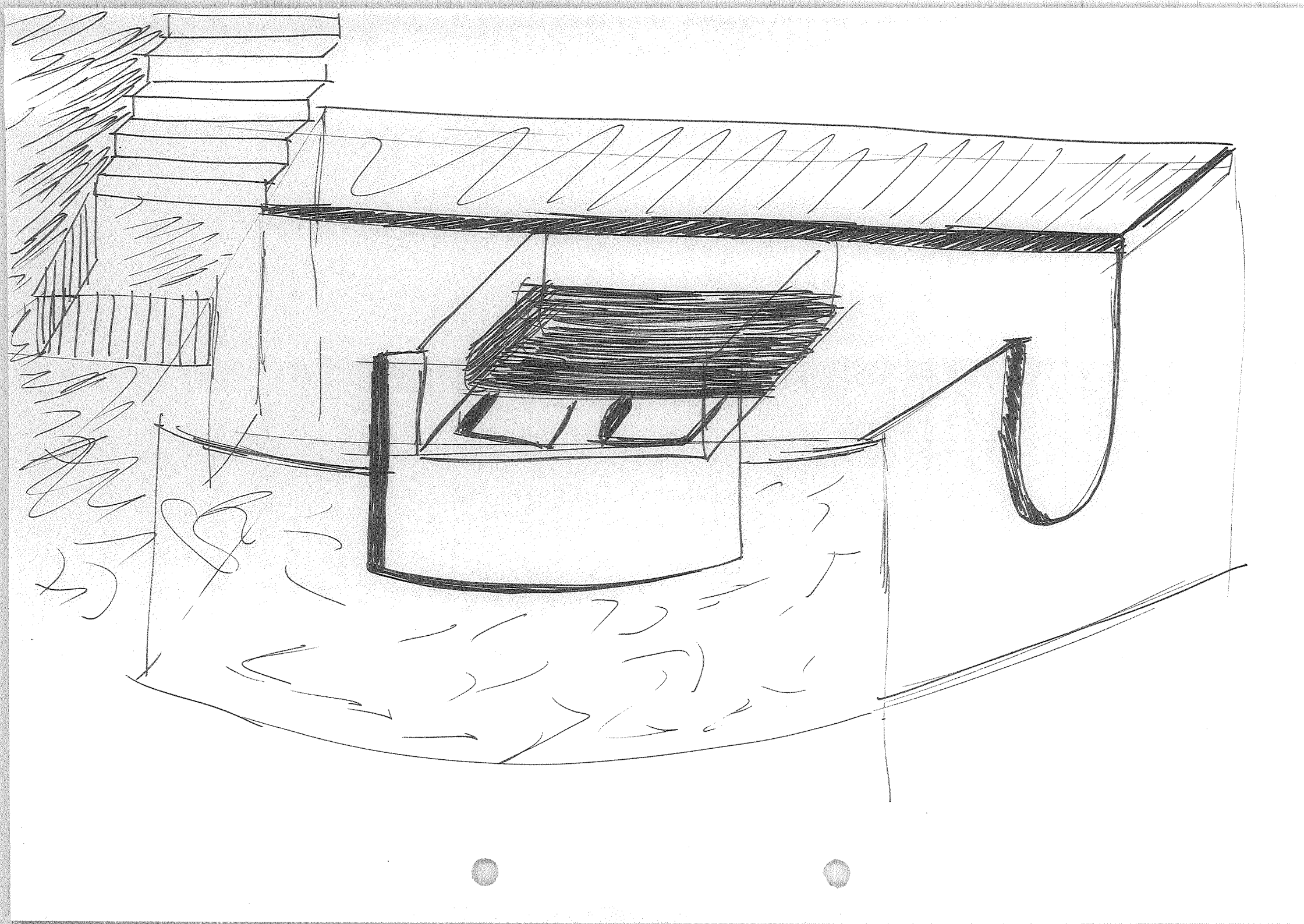


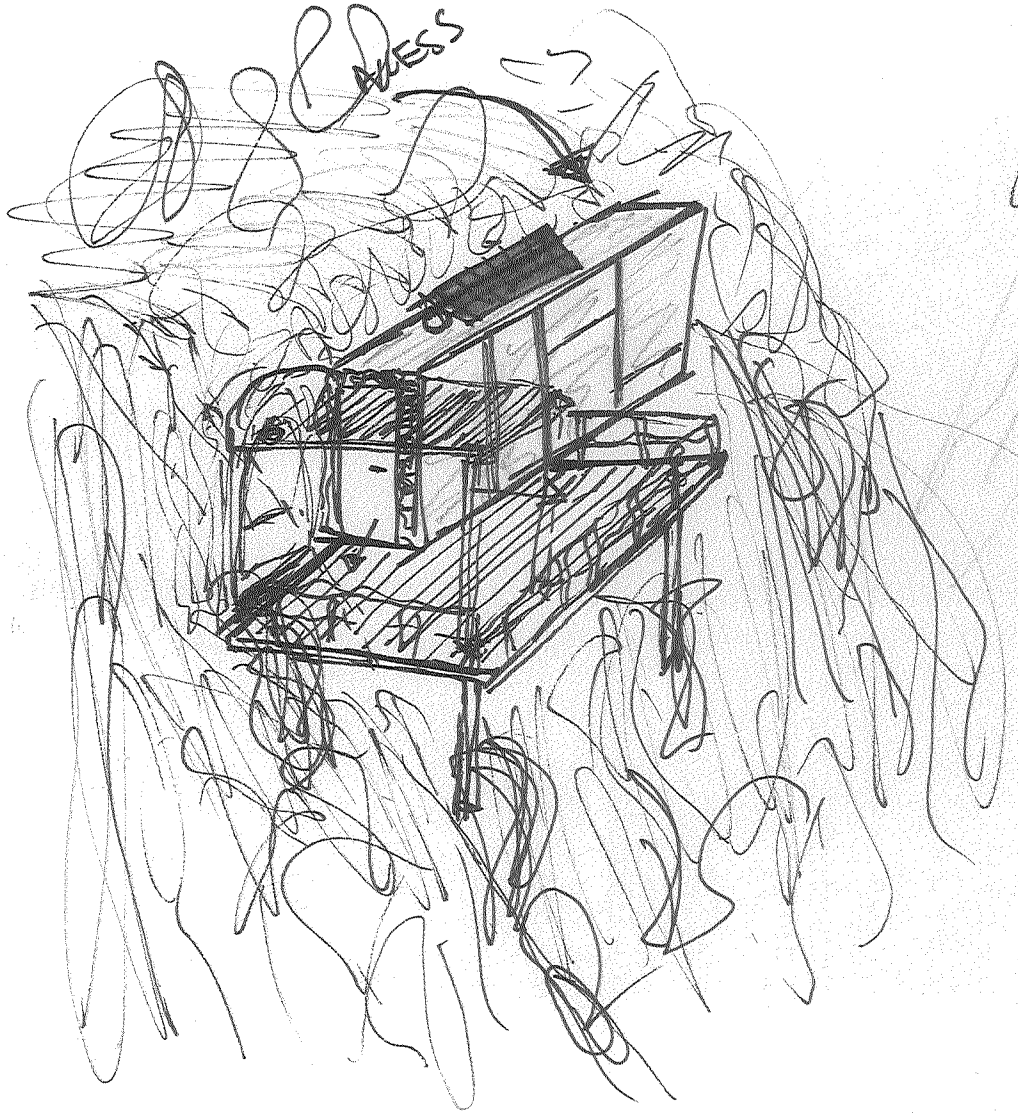

"-1."
"0."
"-1."

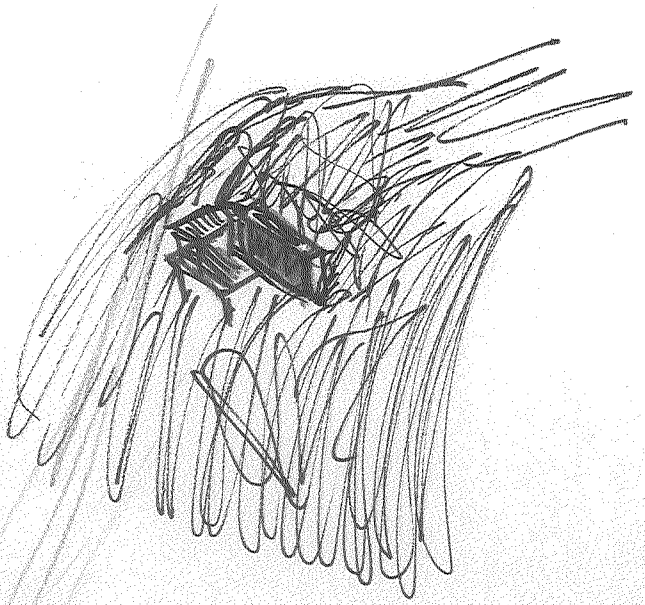


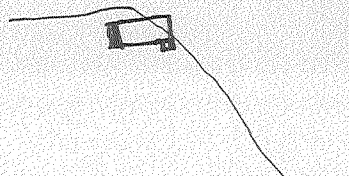

toilet

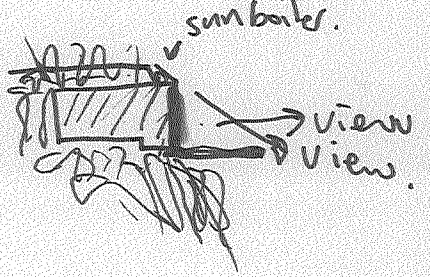


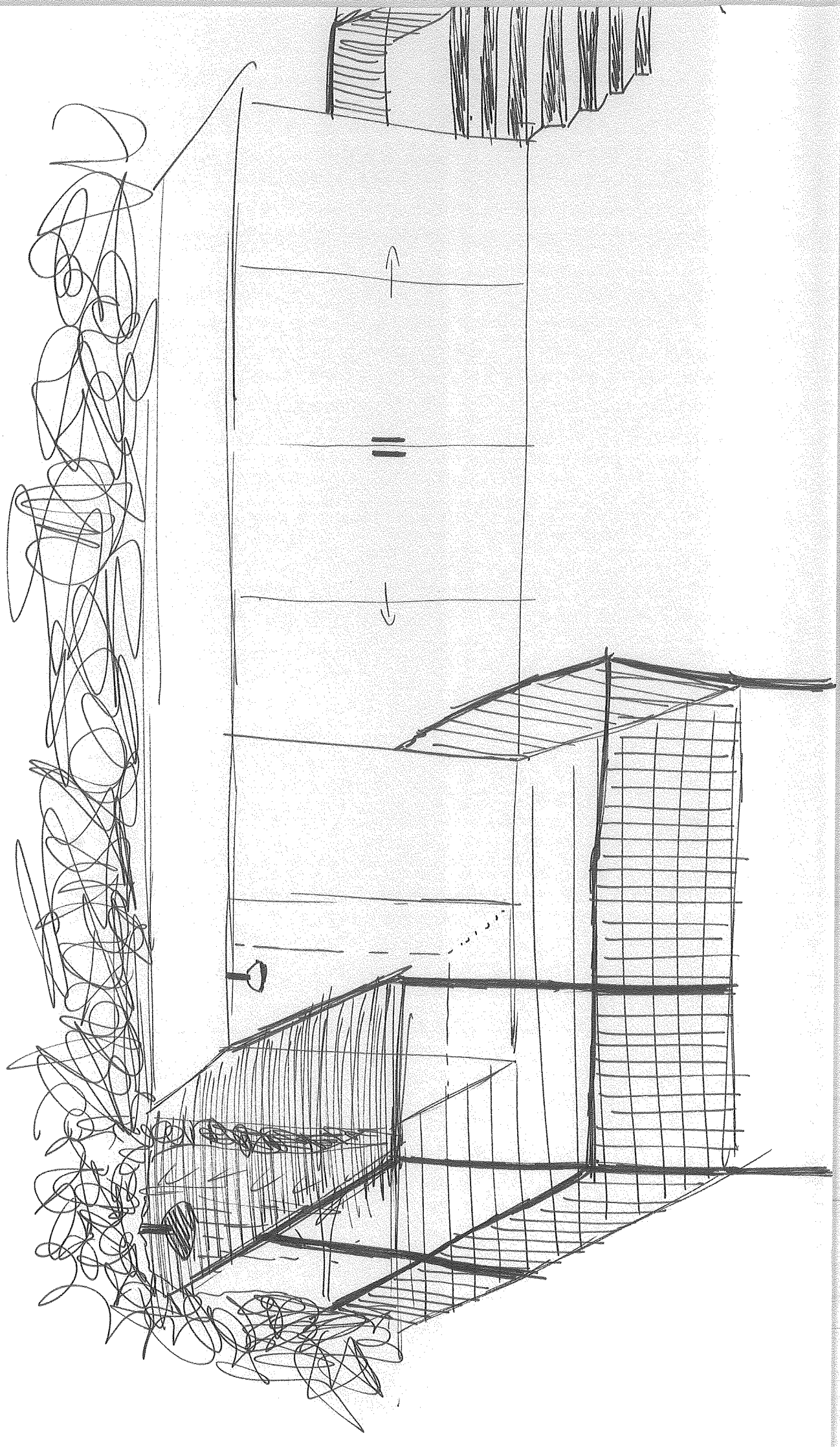


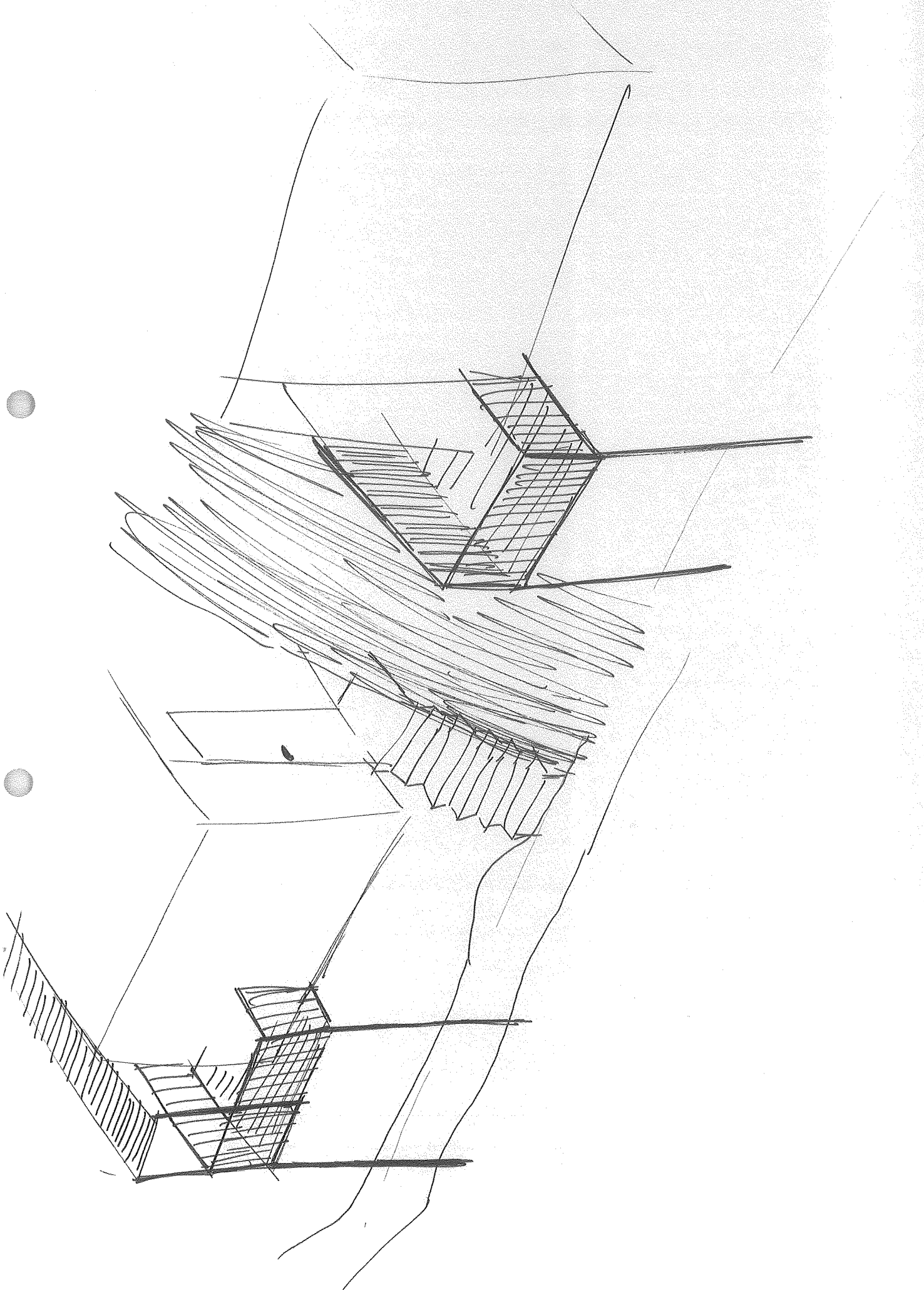


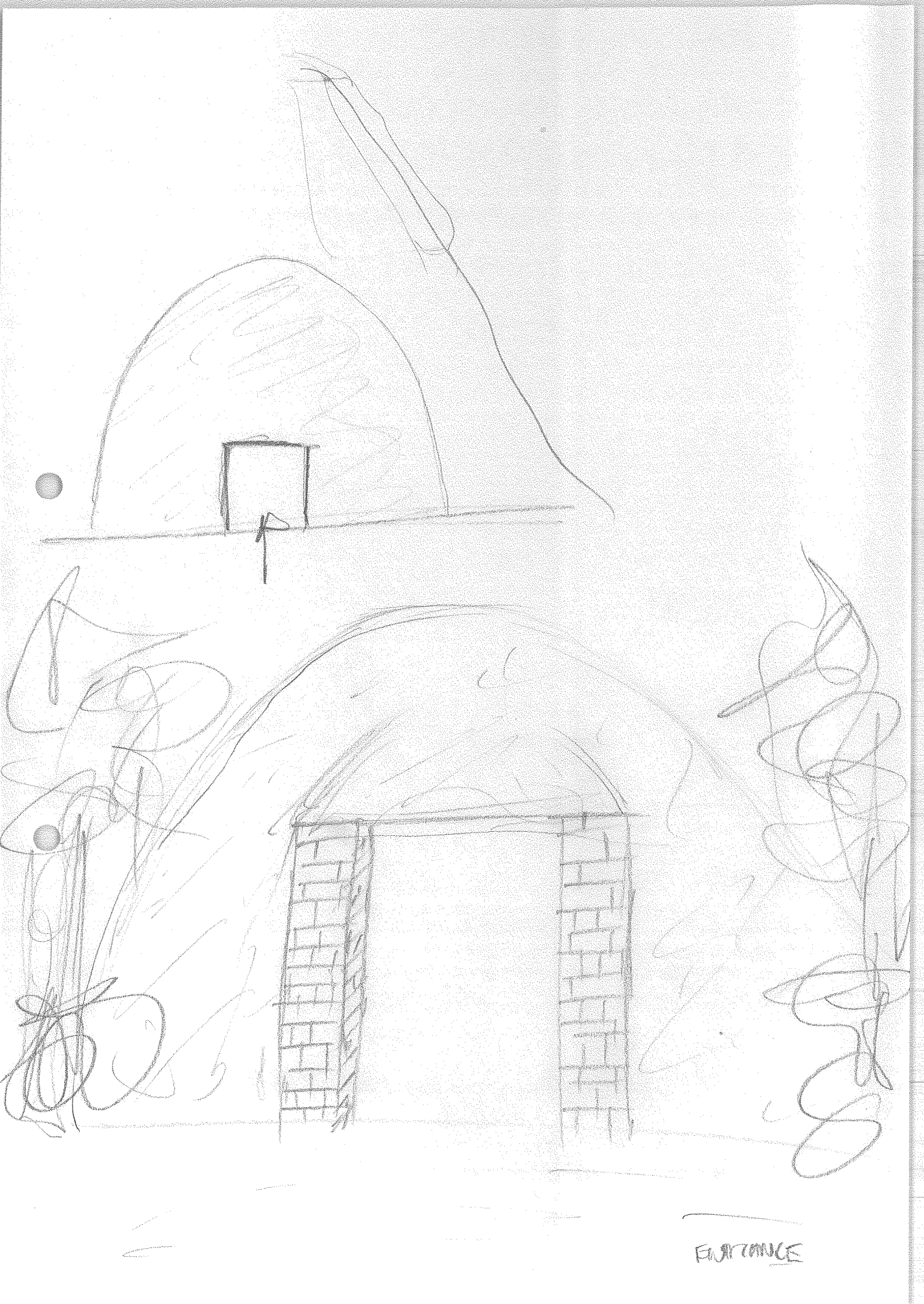


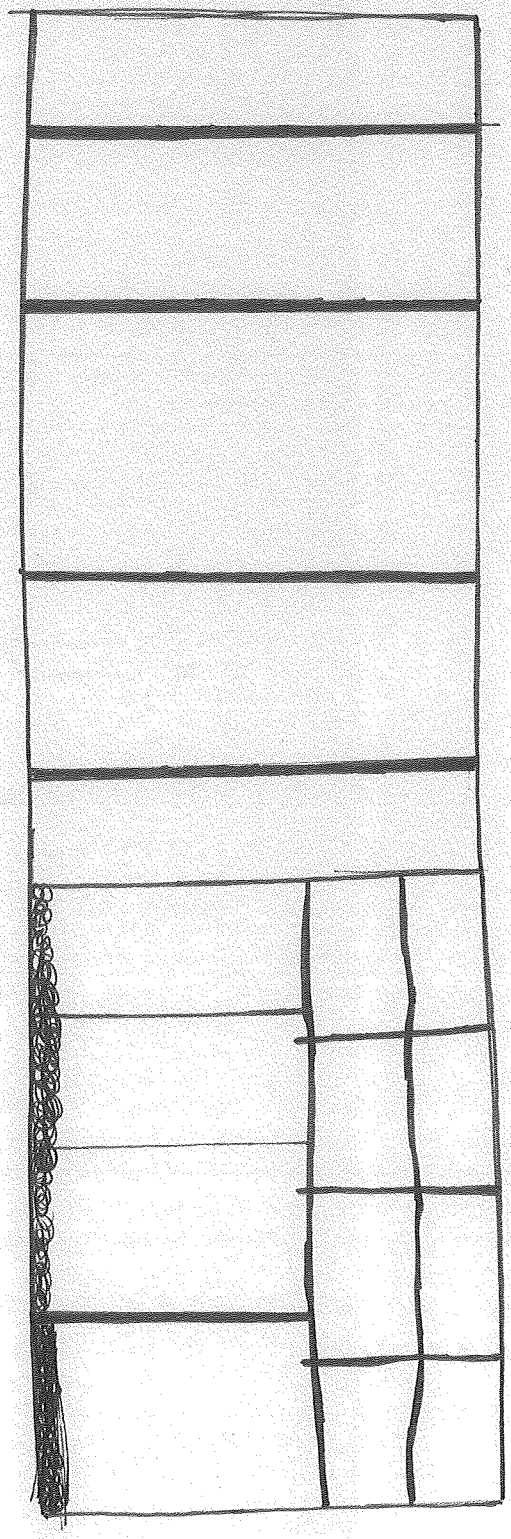



sunbather.
view
view.





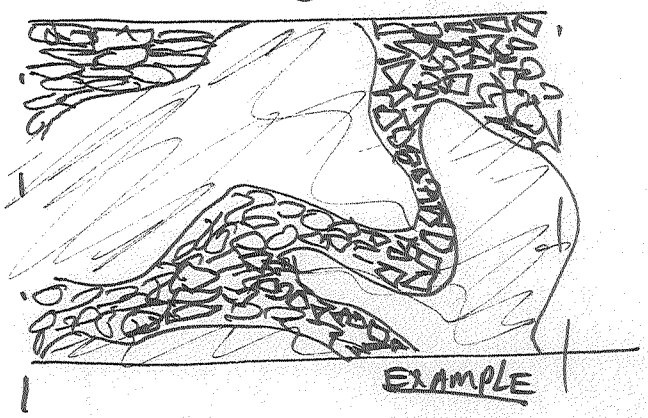

ENTRANCE



WALLS MADE FROM HARD ROCK.

INSIDE RELIEFED PLASTER

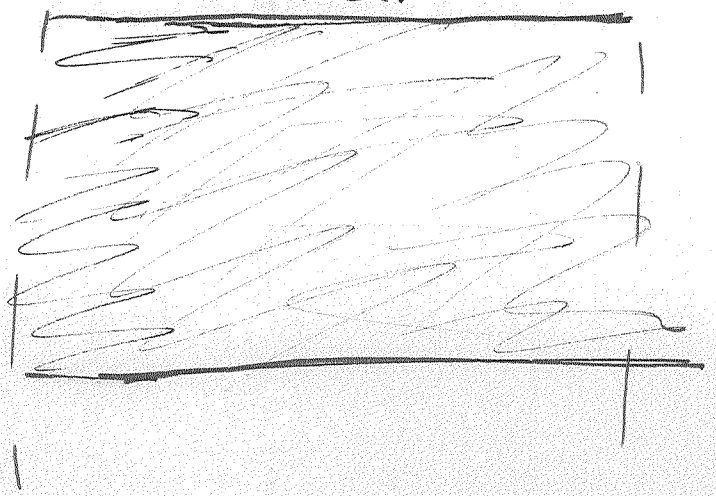
1/3 Rock 2/3 Plaster.



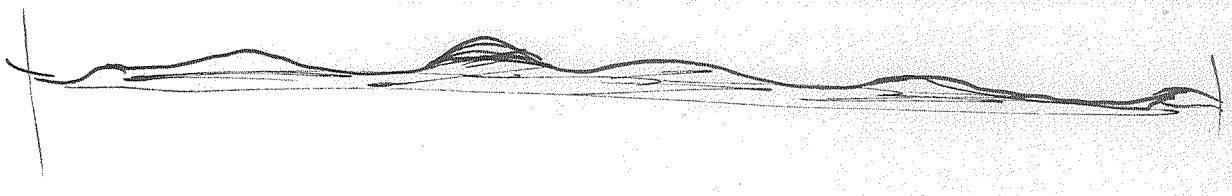
INSIDE WALL CBETWEEN BATHROOM → BEDROOM

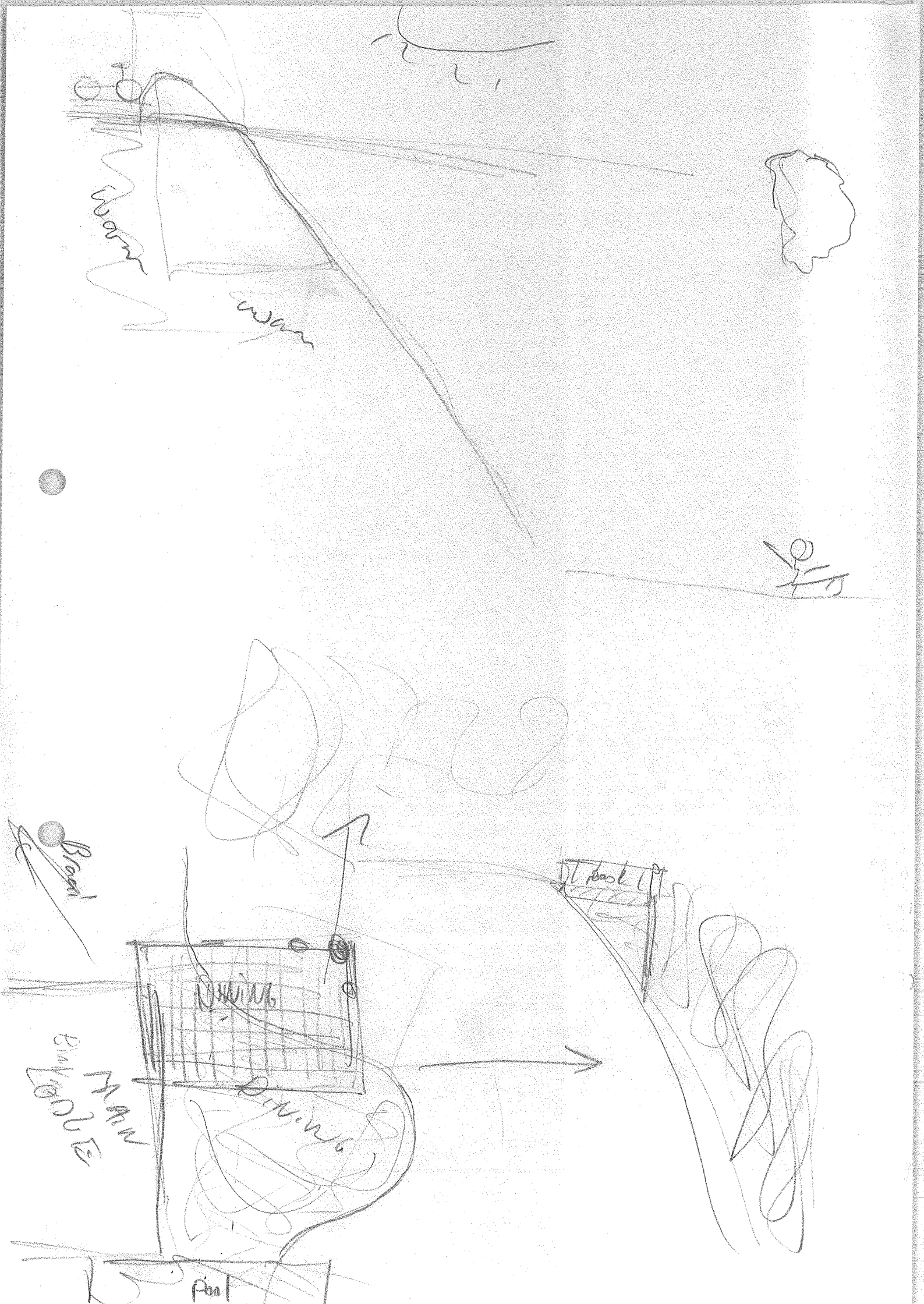
RELIEFED PLASTER

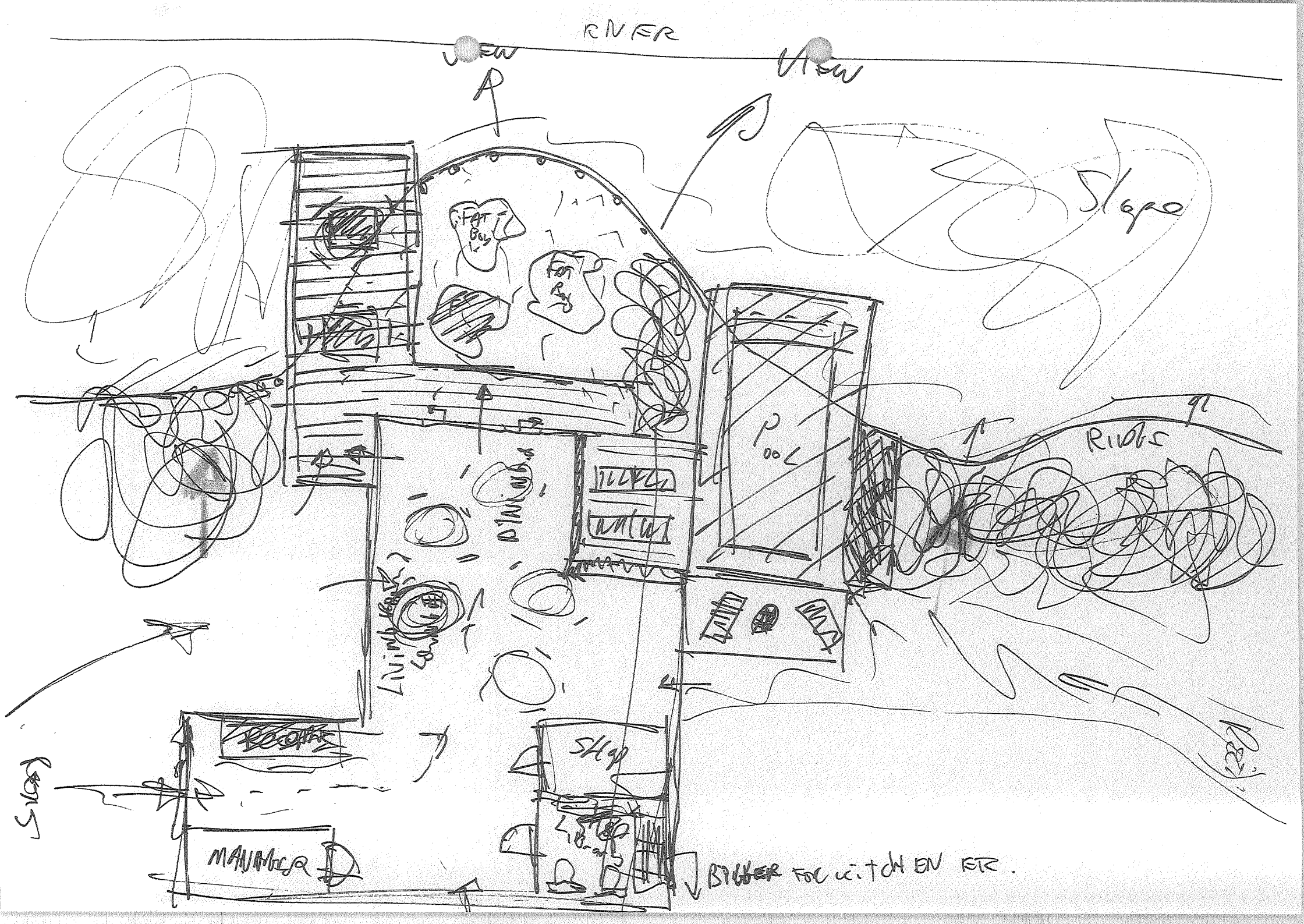
1/1 Plaster.

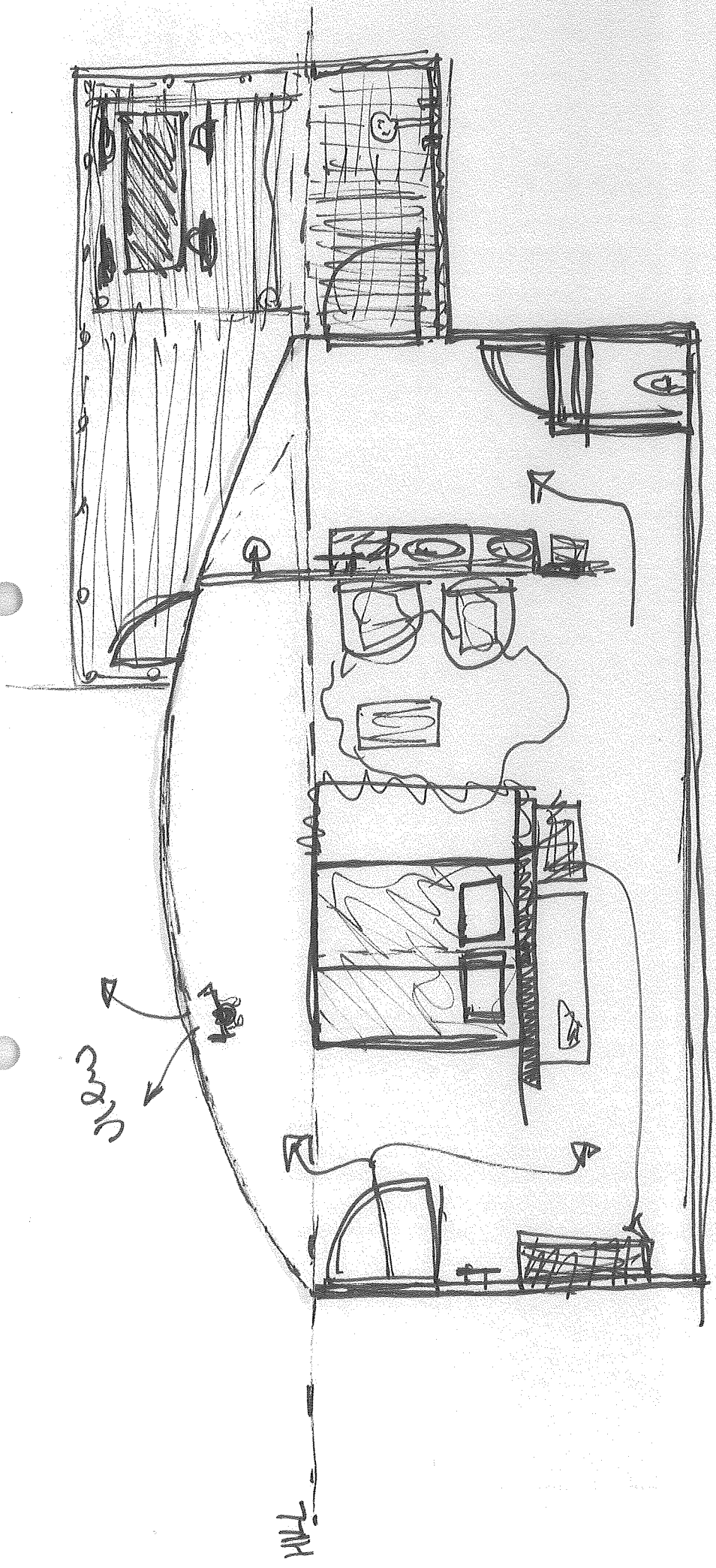


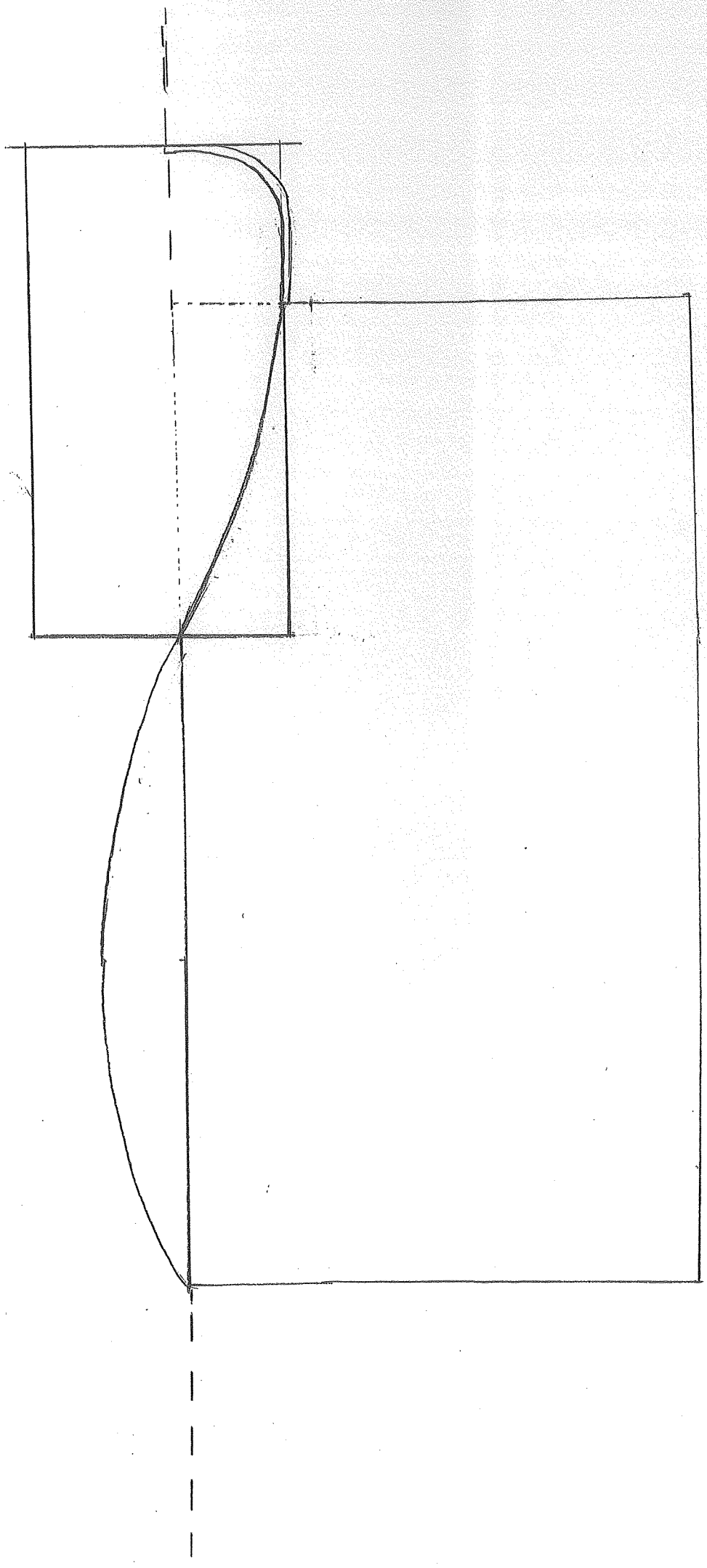
PLASTERWORK

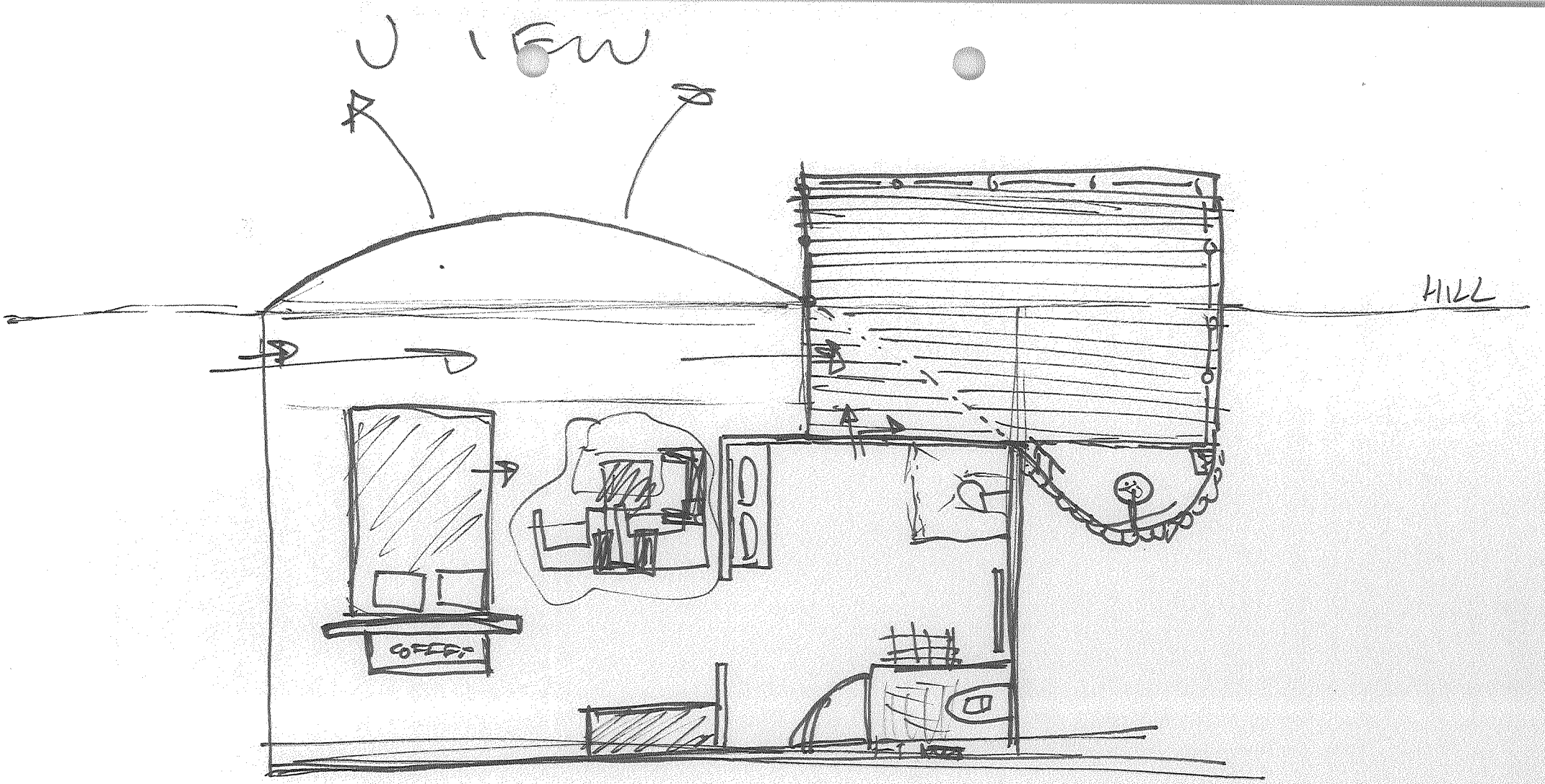


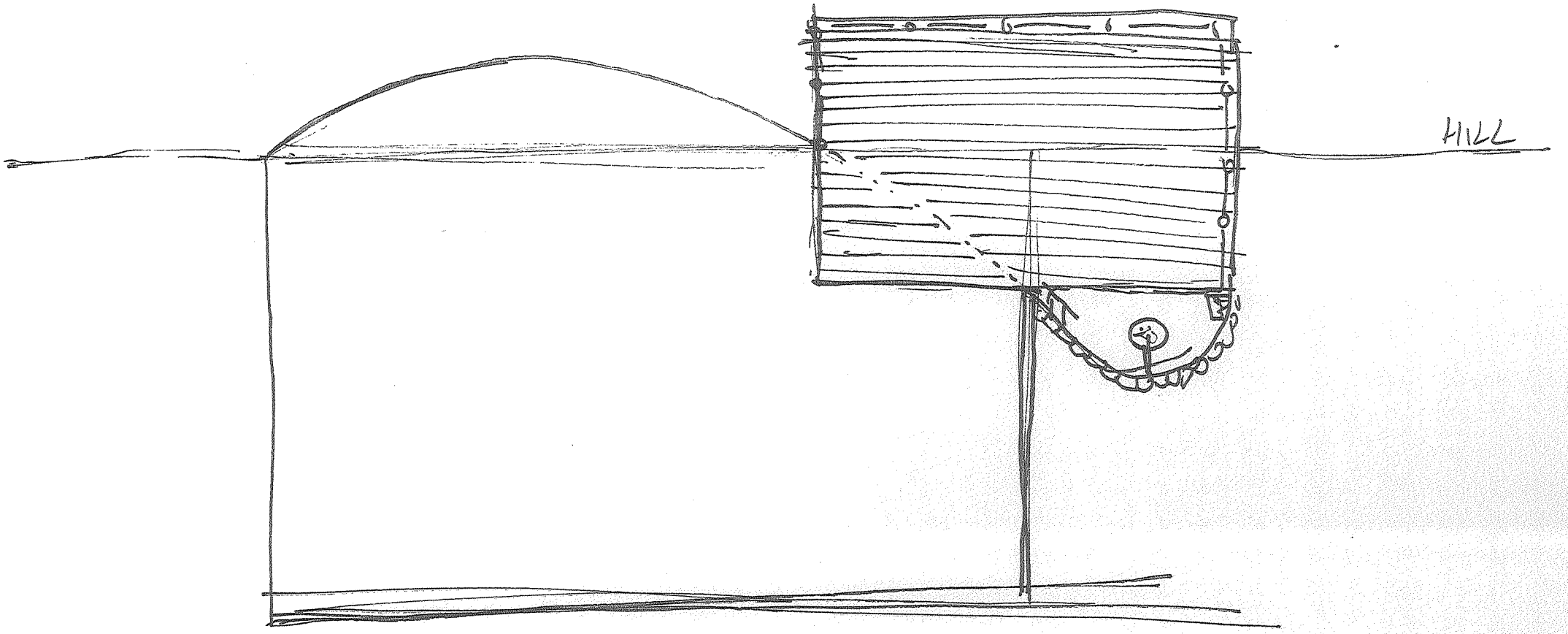

Warm
Warm
Brain
Diving
Diving
Pool

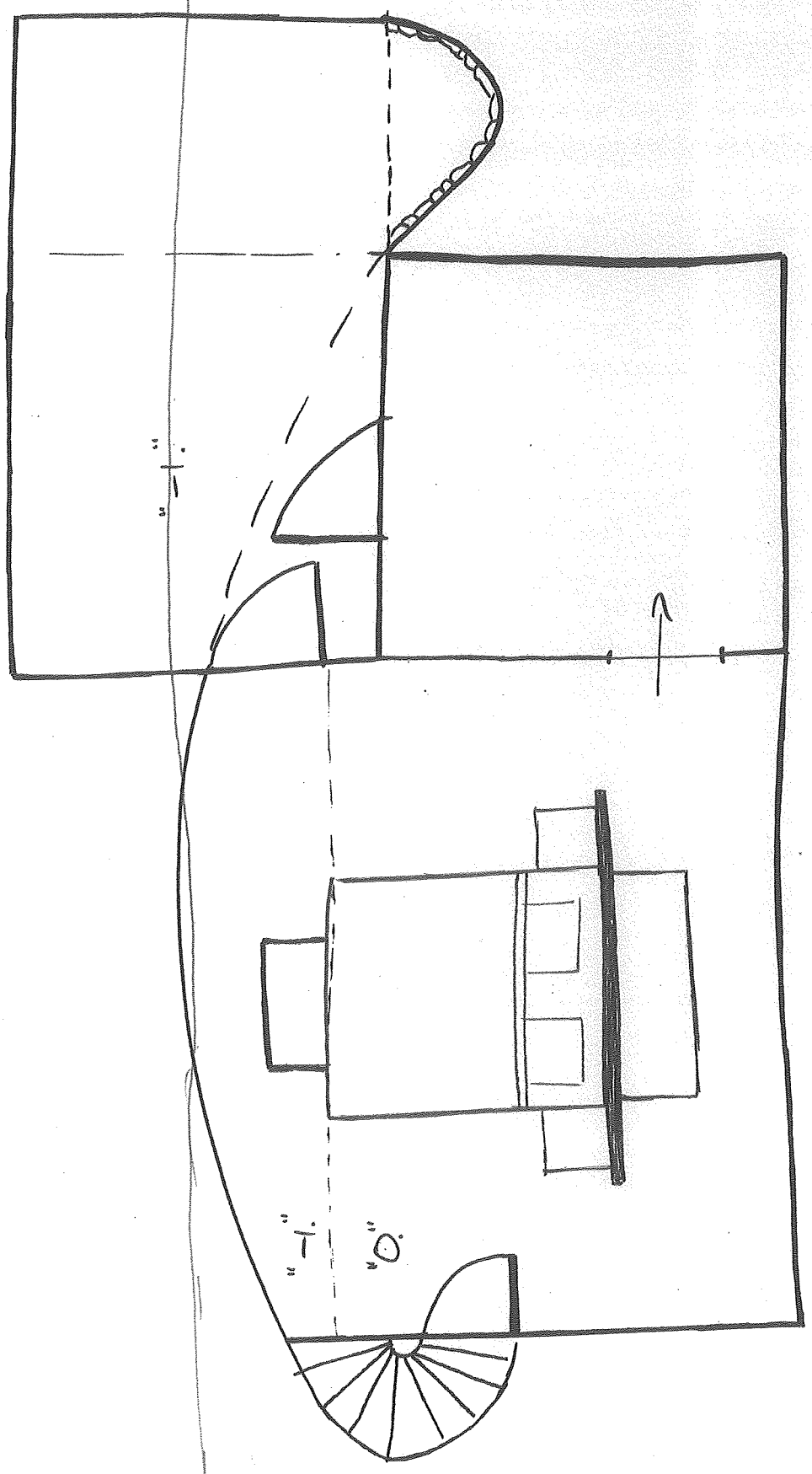

RIVER
VIEW
VIEW
Slope
Fat Boy
Fat Boy
POOL
RIVER
DINING
LIVING
RECEPTION
SHOP
MANAGER
SLOPE
BIGGER FOR KITCHEN ETC.

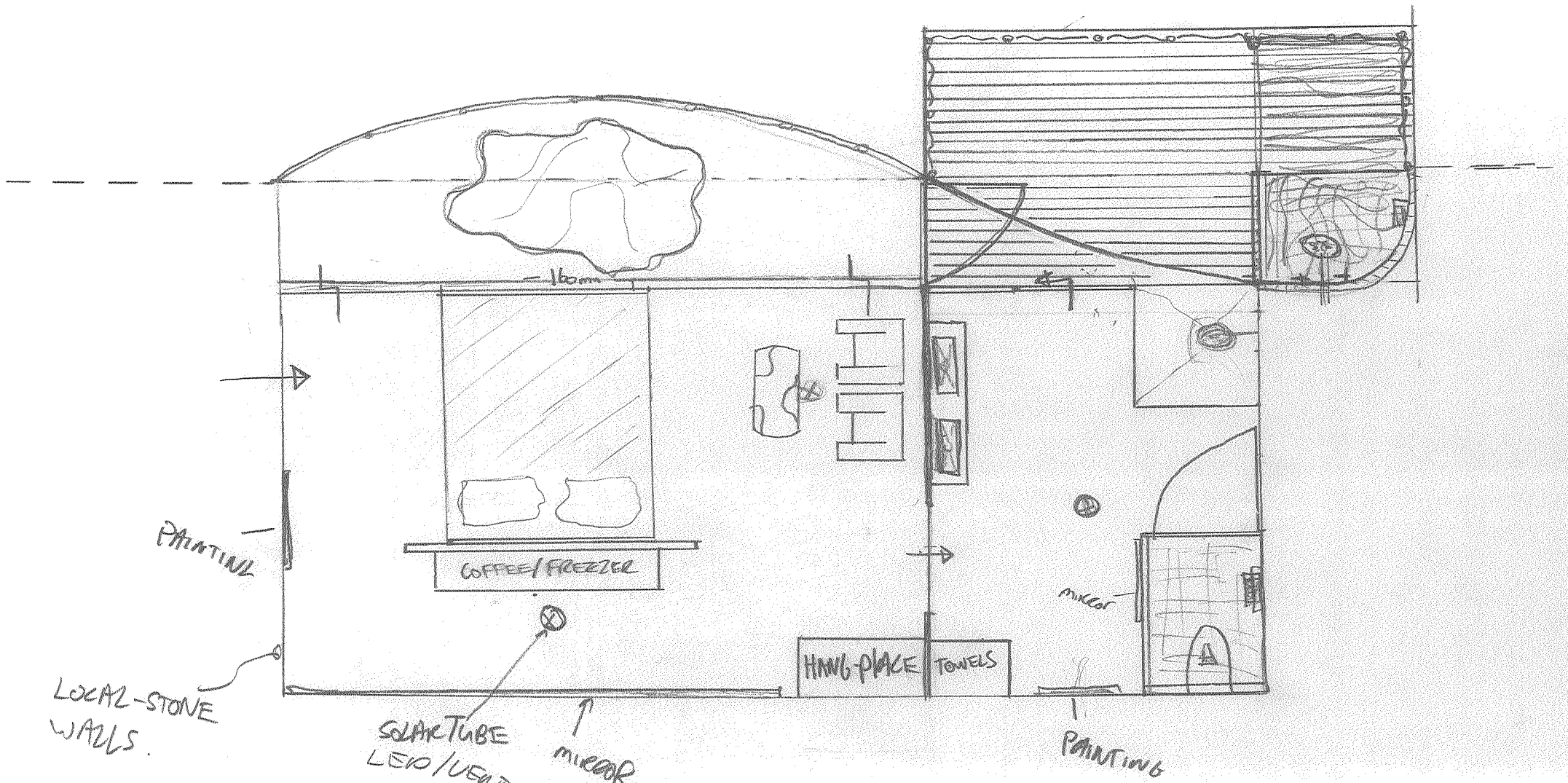




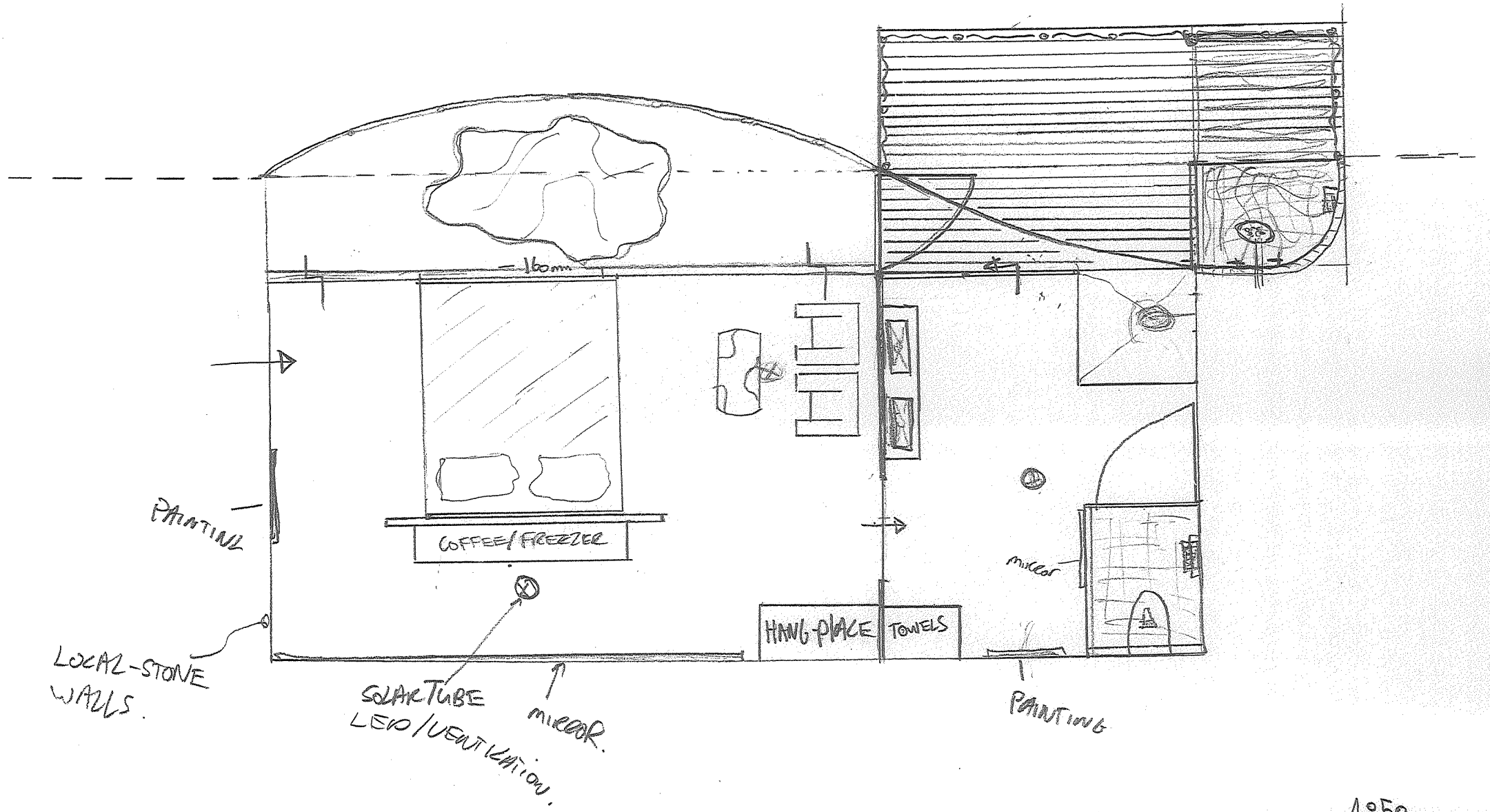

VIEW
HILL


HILL

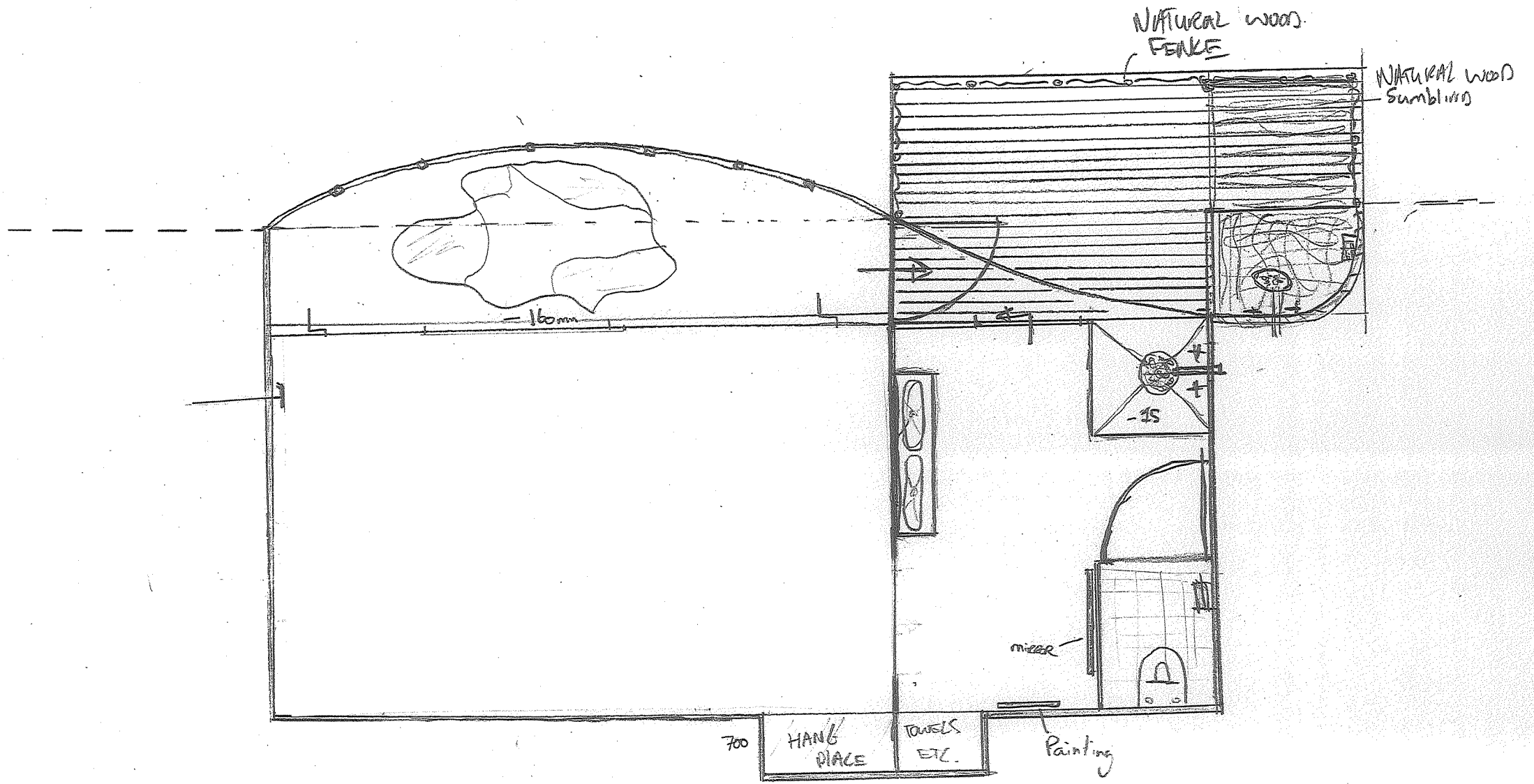


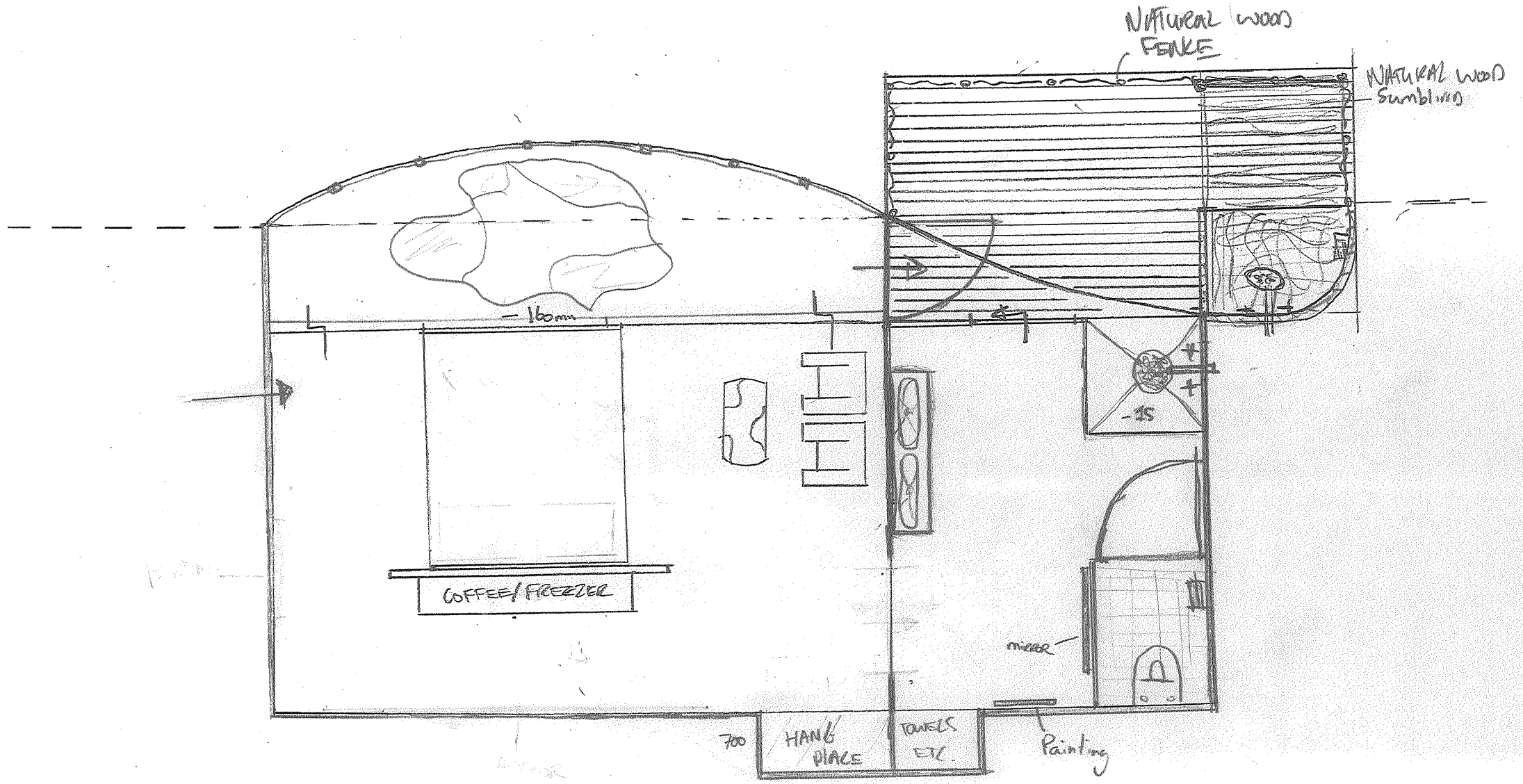

160mm
PAINTING
COFFEE/FREEZER
HANG-PLACE
TOWELS
MIRROR
LOCAL-STONE WALLS.
SOLAR TUBE LED/VENTILATION.
MIRROR.
PAINTINGS

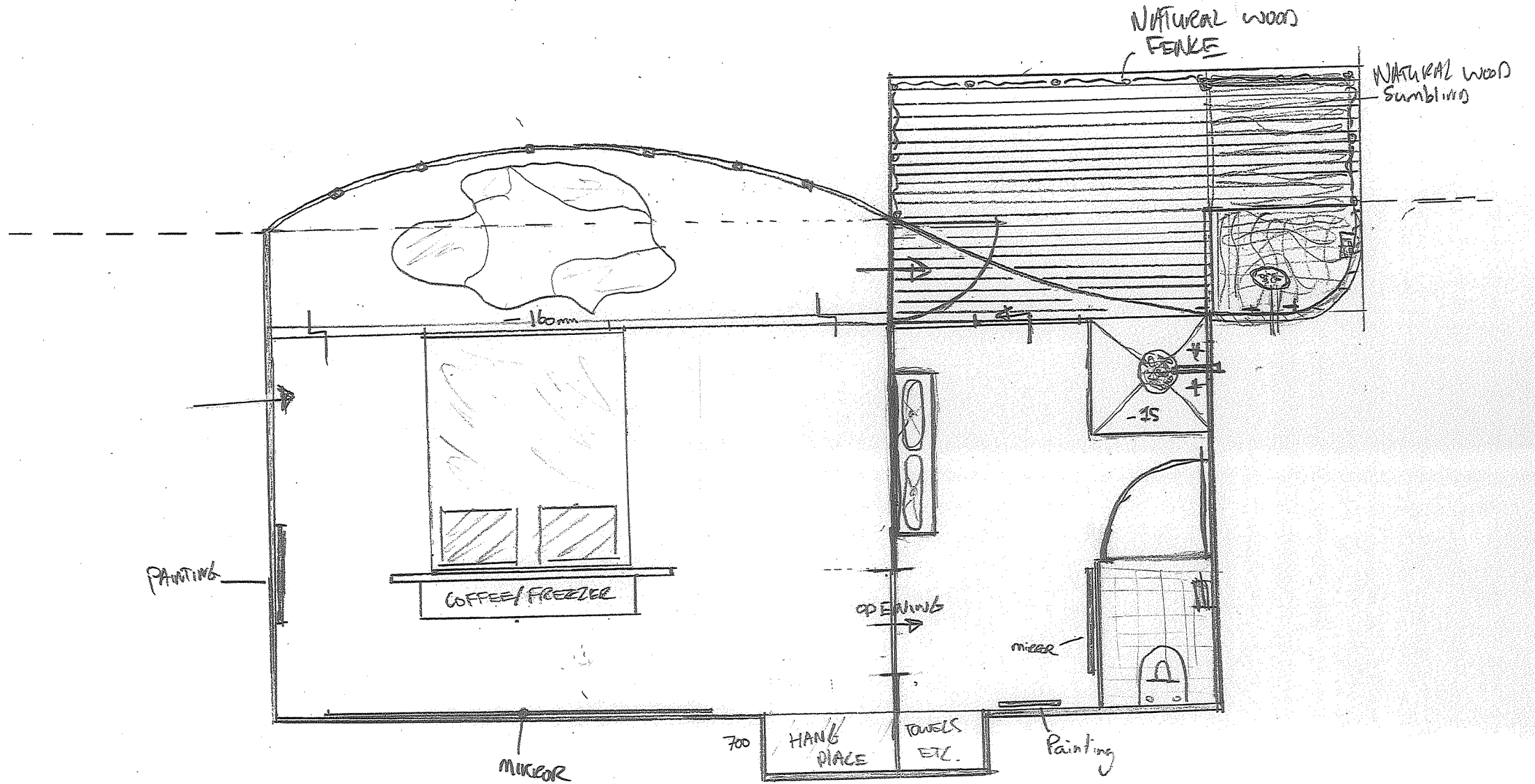
1:50

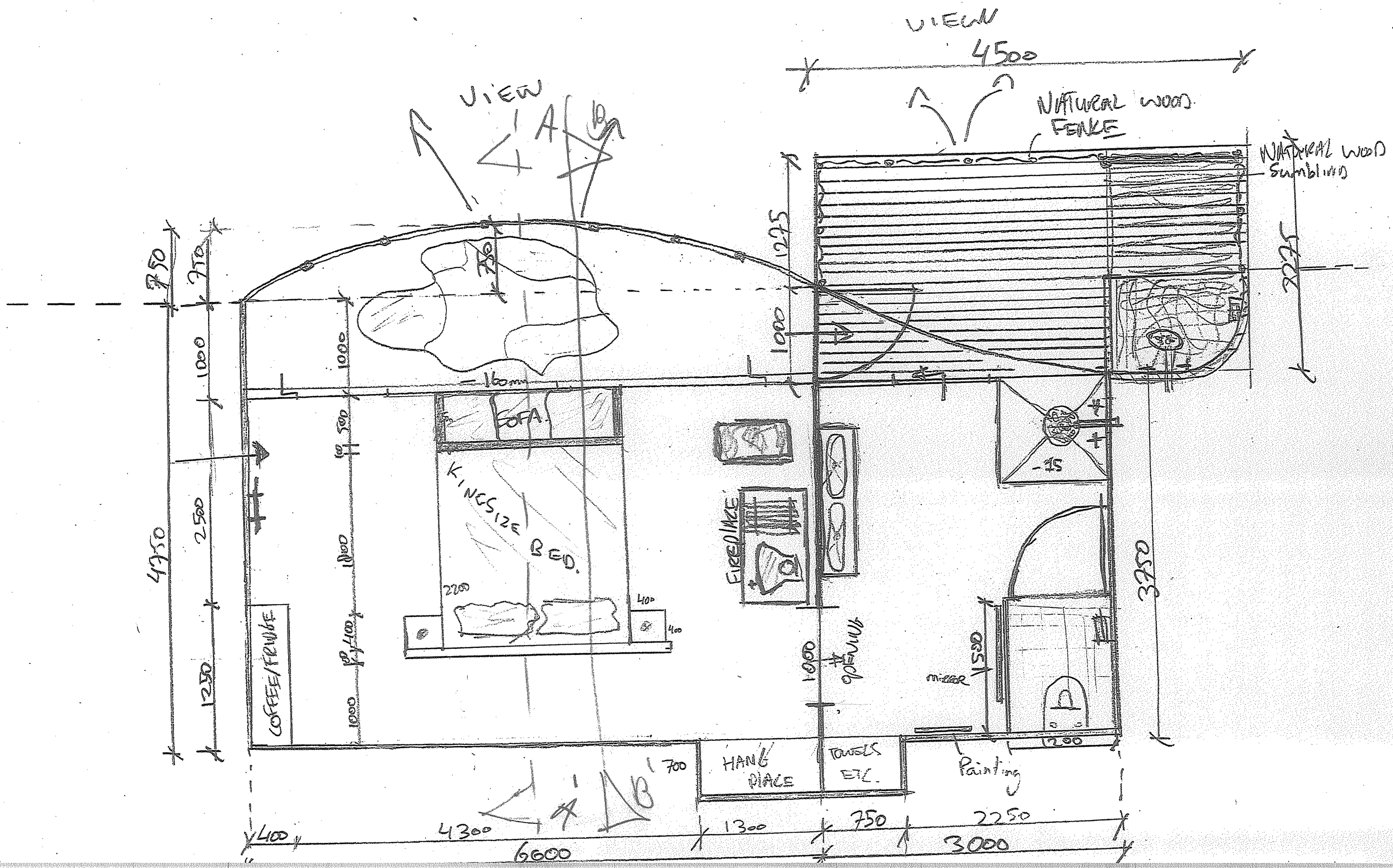

160mm
PAINTING
COFFEE/FREEZER
HANG-PLACE
TOWELS
mirror
LOCAL-STONE WALLS.
SOLAR TUBE LED/VENTILATION.
MIRROR.
PAINTING

1:50

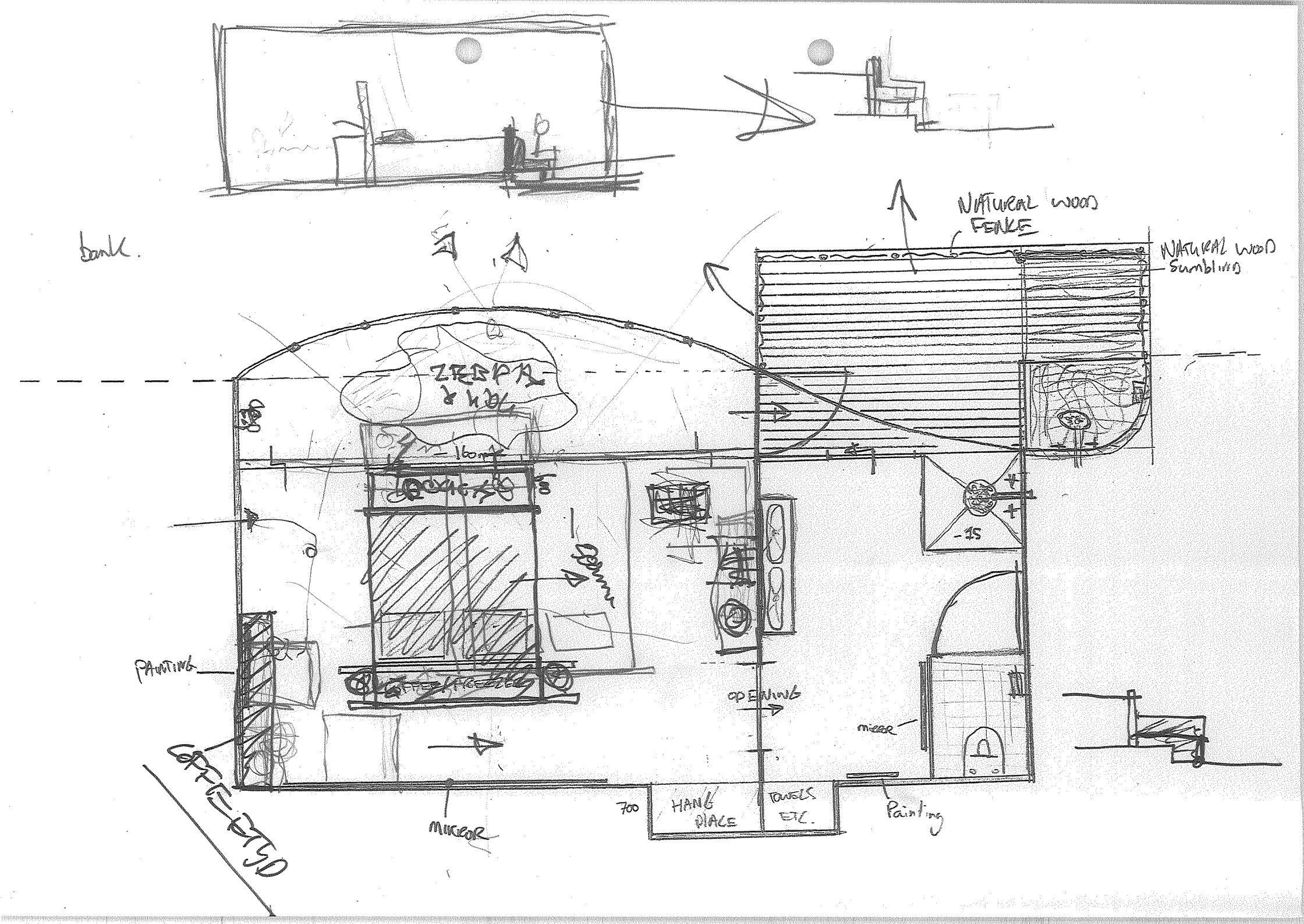

NATURAL WOOD FENCE
NATURAL WOOD SUNBLIND
160mm
-15
mirror
700
HANG PLACE
TOWELS ETC.
Painting

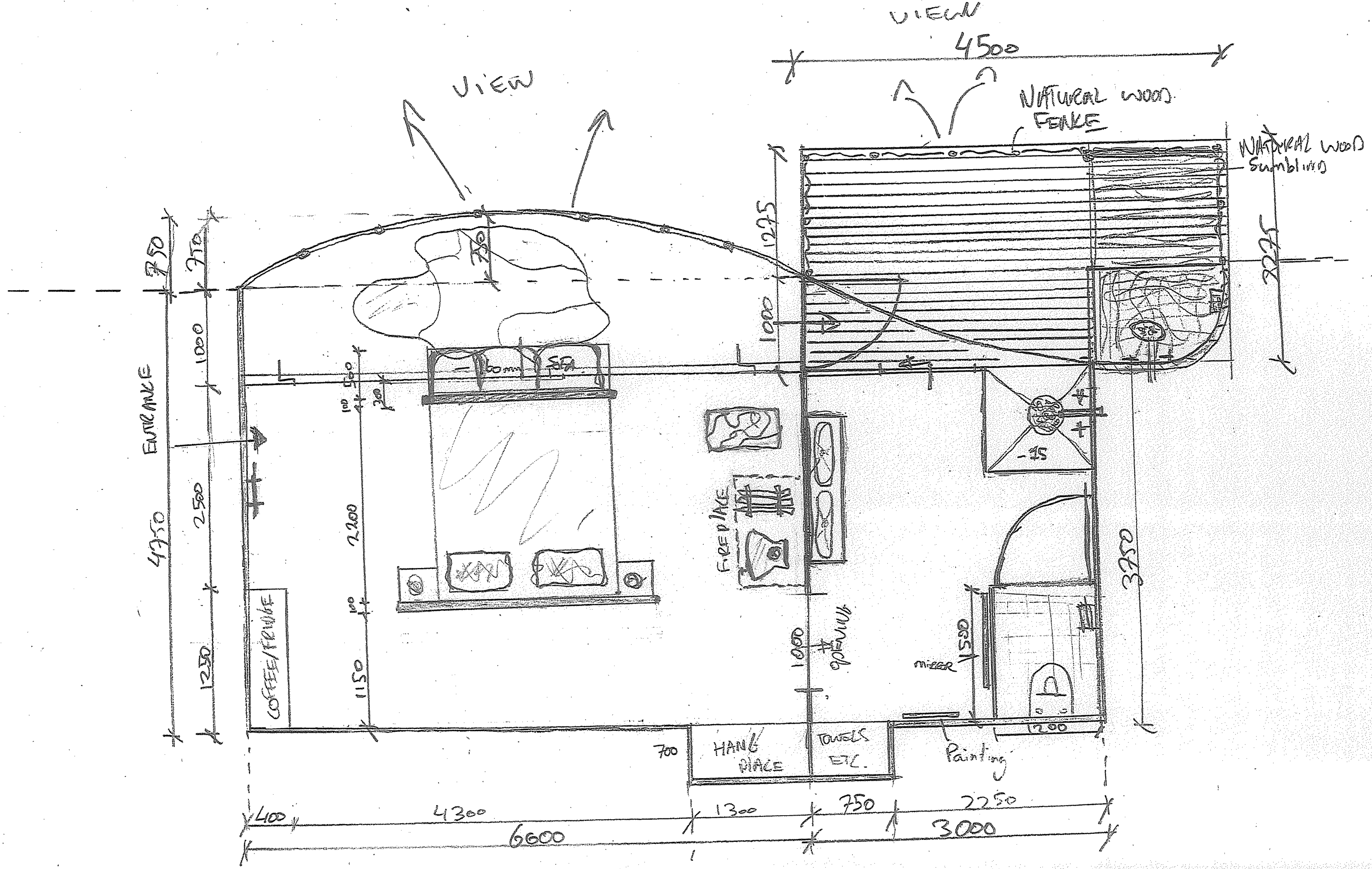

NATURAL WOOD FENCE
NATURAL WOOD SUNBLIND
160mm
COFFEE/FREEZER
MIRROR
700
HANG PLACE
TOWELS ETC.
Painting

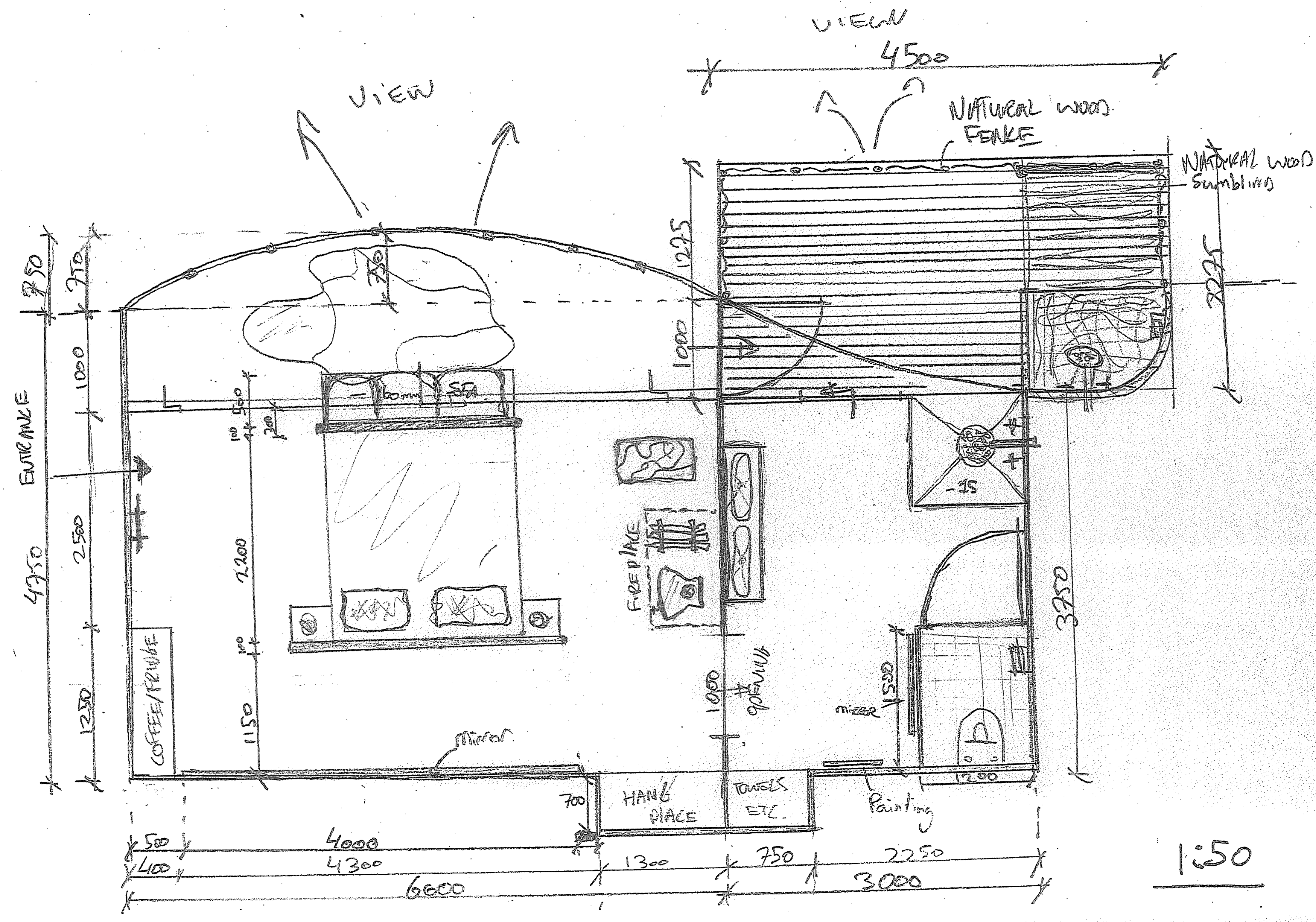

NATURAL WOOD FENCE
NATURAL WOOD SUNBLIND
160mm
-15
PAINTING
COFFEE/FREEZER
OPENING
MIRROR
700
HANG PLACE
TOWELS ETC.
MIRROR
Painting

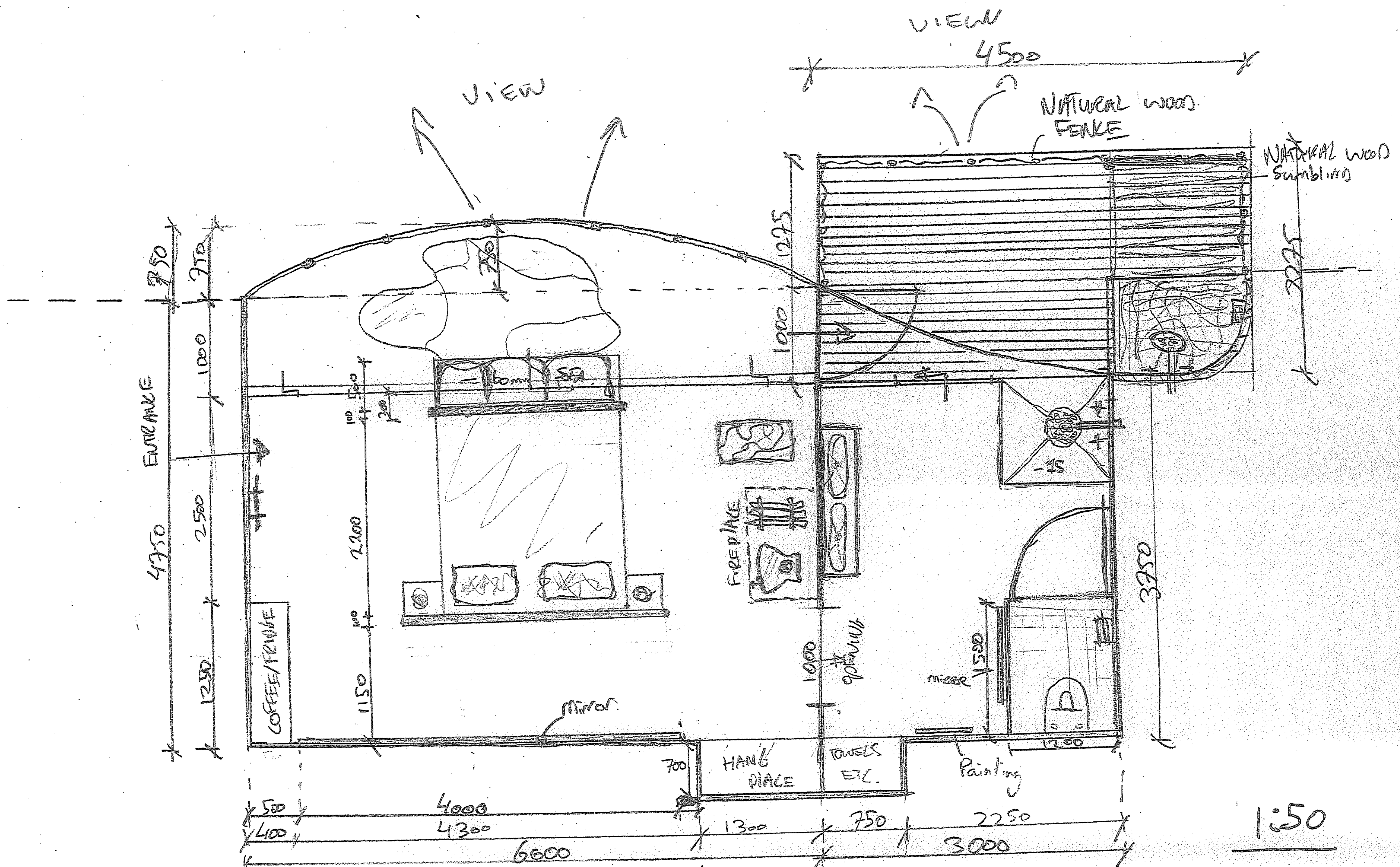


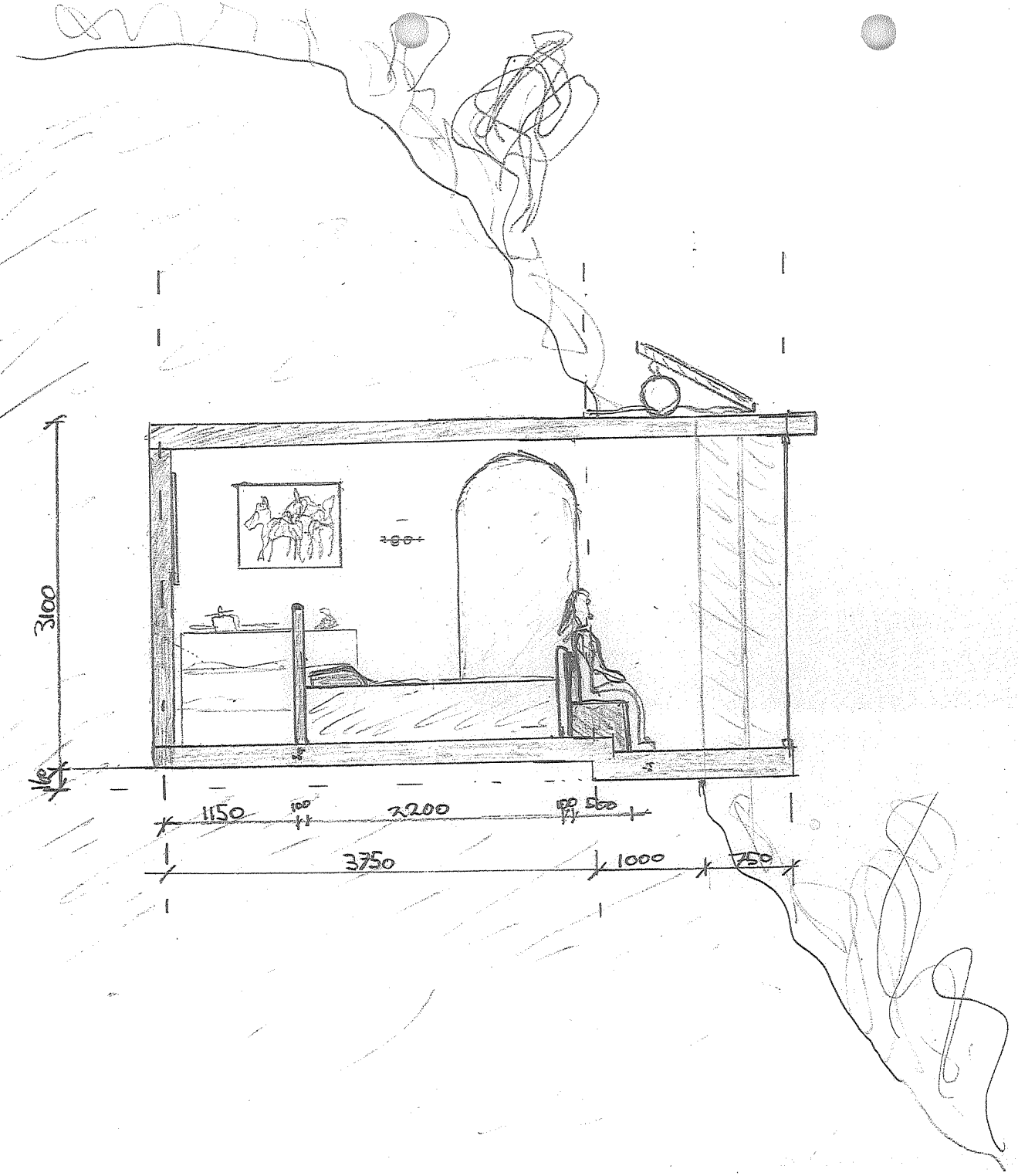
VIEW
4500
NATURAL WOOD FENCE
NATURAL WOOD SUNBLIND
VIEW
A
B
950
770
1225
2225
1000
SOFA
KINGSIZE BED.
FIREPLACE
OPENING
COFFEE/FRIDGE
MIRROR
3250
1500
1200
HANG PLACE
TOWELS ETC.
Painting
4950
2500
1250
400
4300
1300
750
2250
6600
3000


bank.
NATURAL WOOD FENCE
NATURAL WOOD SUNBLIND
ZEBRA
160mm
PAINTING
OPENING
MIRROR
700
HANG PLACE
TOWELS ETC.
Painting
-15

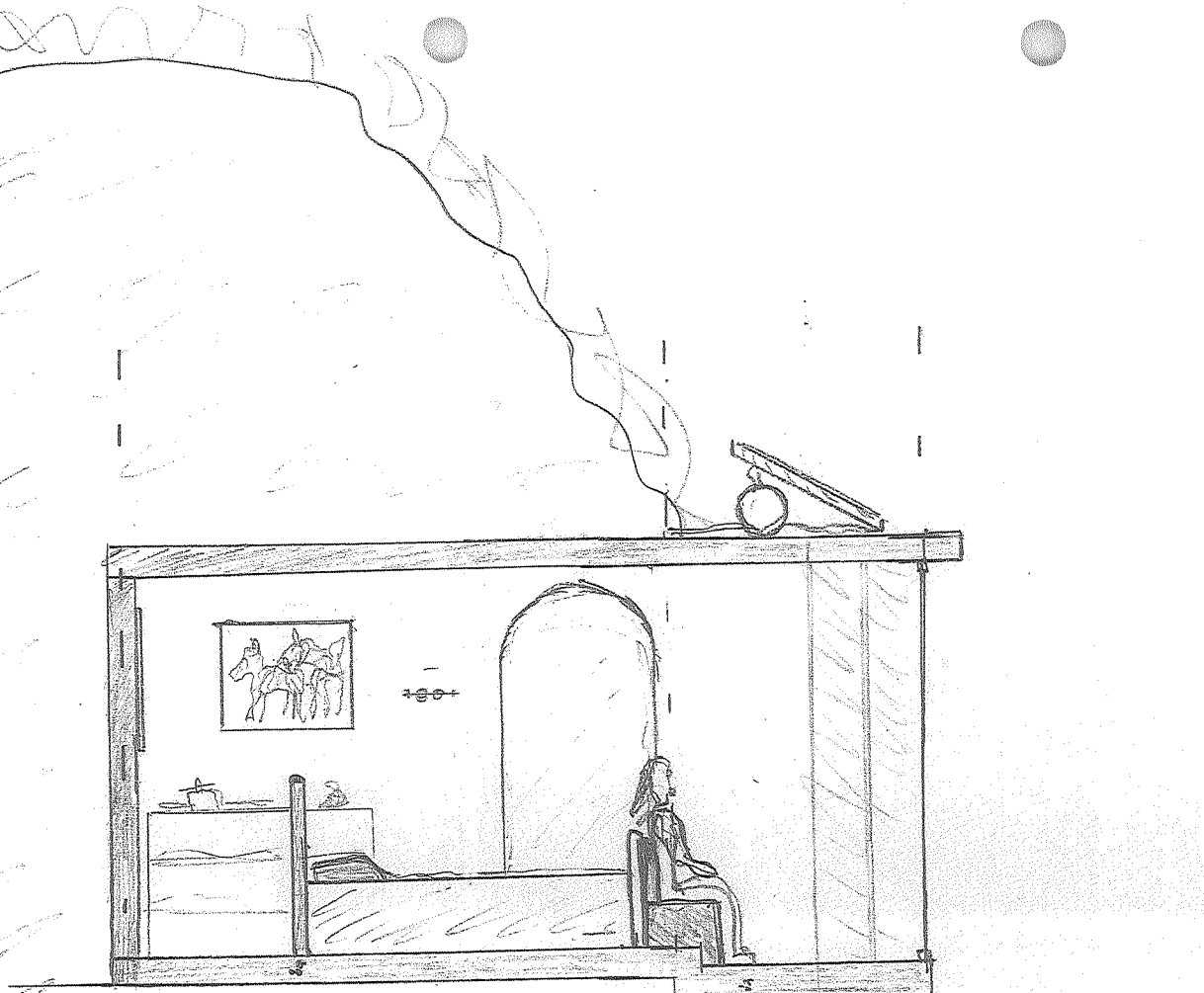

VIEW
4500
VIEW
NATURAL WOOD FENCE
NATURAL WOOD SUMBLIND
1225
1000
3225
750
710
1000
2500
4750
1250
ENTRANCE
COFFEE/FRIDGE
2200
1150
FIREPLACE
1000
OPENING
-15
3350
1500
MIRROR
1200
700
HANG PLACE
TOWELS ETC.
Painting
400
4300
1300
750
2250
6600
3000


VIEW
4500
VIEW
NATURAL WOOD FENCE
NATURAL WOOD SUMBLIND
1225
2225
250
250
1000
2500
4750
1250
ENTRANCE
COFFEE/FRIDGE
2200
1150
FIREPLACE
OPENING
1000
3250
MIRROR
1500
1200
Painting
Mirror
HANG PLACE
TOWELS ETC.
700
500
4000
400
4300
1300
750
2250
3000
6000
1:50

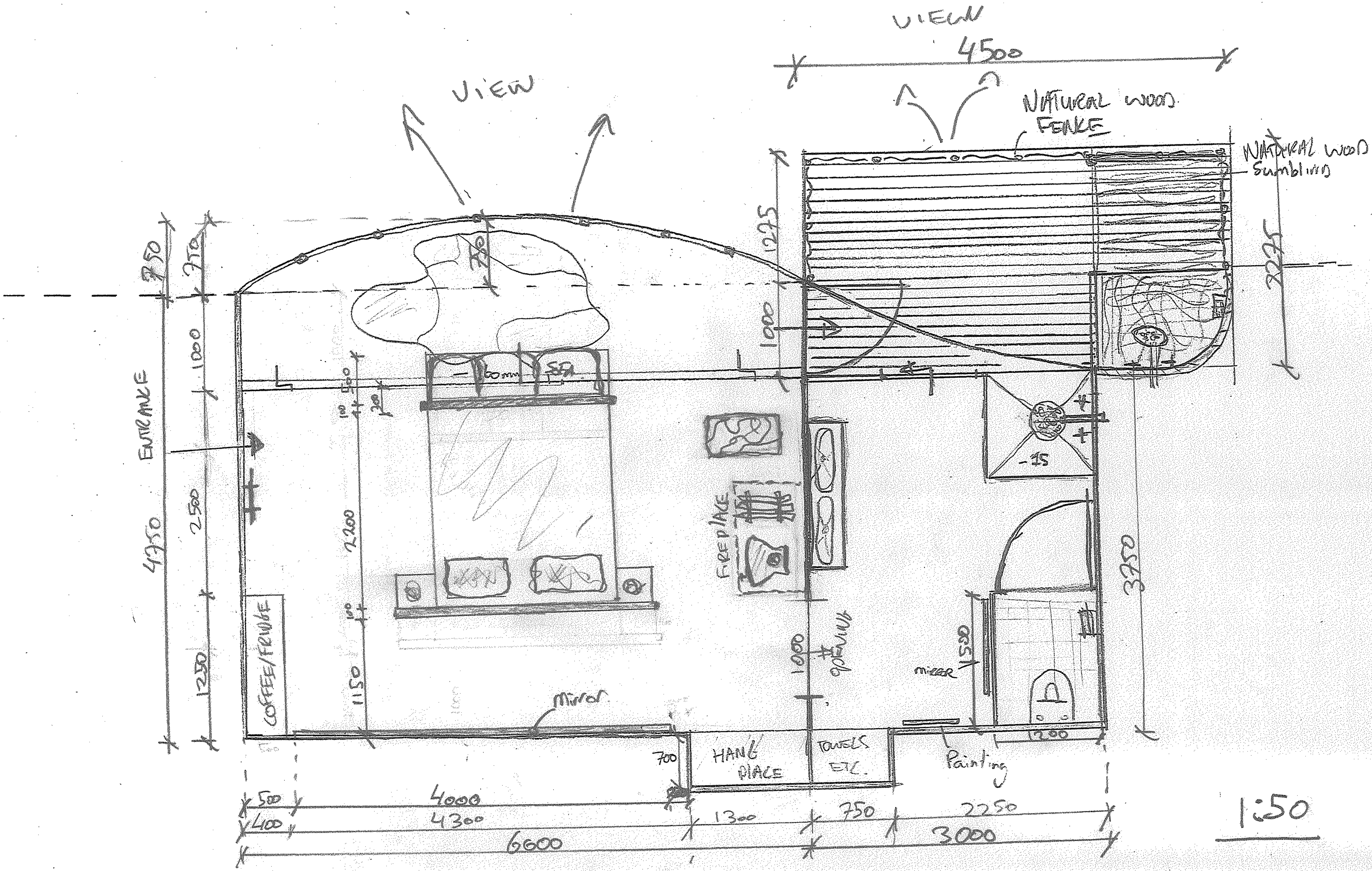

VIEW
4500
NATURAL WOOD FENCE
NATURAL WOOD Sunblind
VIEW
750
750
1225
1000
2225
ENTRANCE
4750
1000
2500
1250
SEA
60mm
500
100
200
2200
100
1150
FIRE PLACE
-15
OPENING
1000
1500
MIRROR
3750
COFFEE/FRIDGE
Mirror
700
HANG PLACE
TOWELS ETC.
Painting
200
500
4000
400
4300
1300
750
2250
6600
3000
1:50



SECTION A-A'
1:50

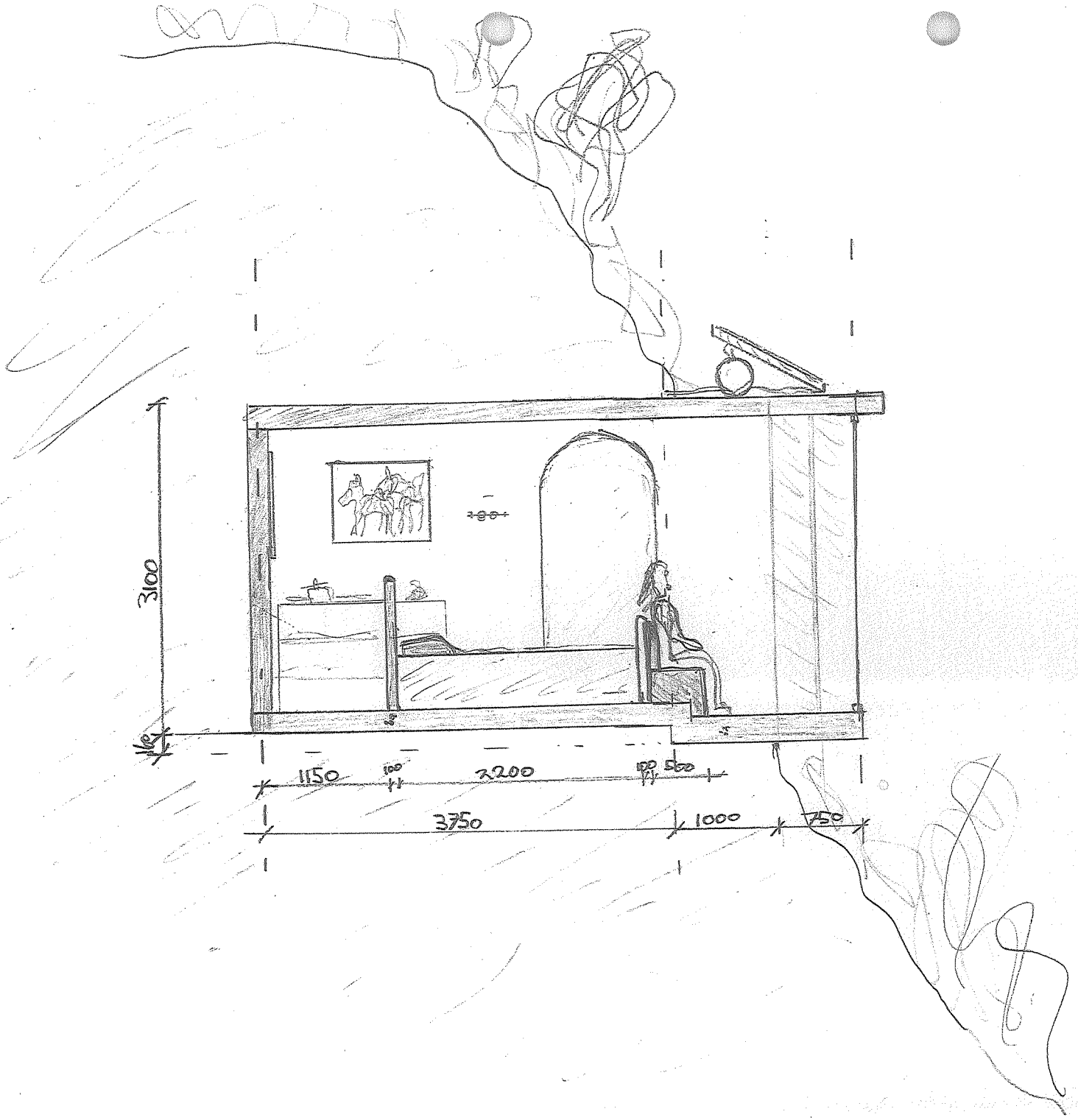


SECTION A-A'
1:50

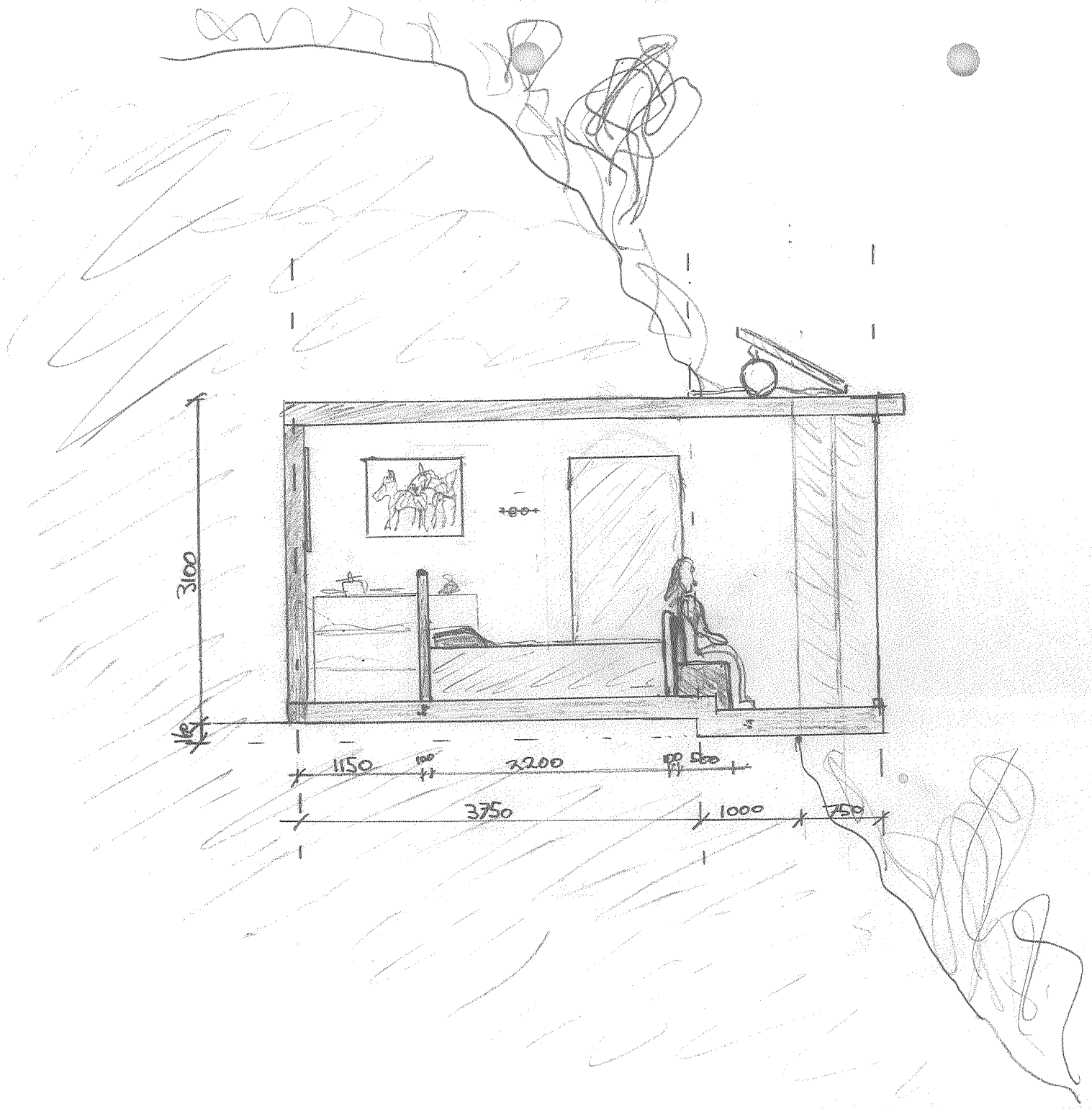


VIEW
4500
VIEW
NATURAL WOOD FENCE
NATURAL WOOD Sunblind
ENTRANCE
COFFEE/FRIDGE
FIREPLACE
OPENING
mirror
mirror
HANG PLACE
TOWELS ETC.
Painting
-15
4750
2500
1250
1000
750
2200
1150
1000
1225
3225
3350
1500
4000
4300
6600
1300
750
2250
3000
500
400
700

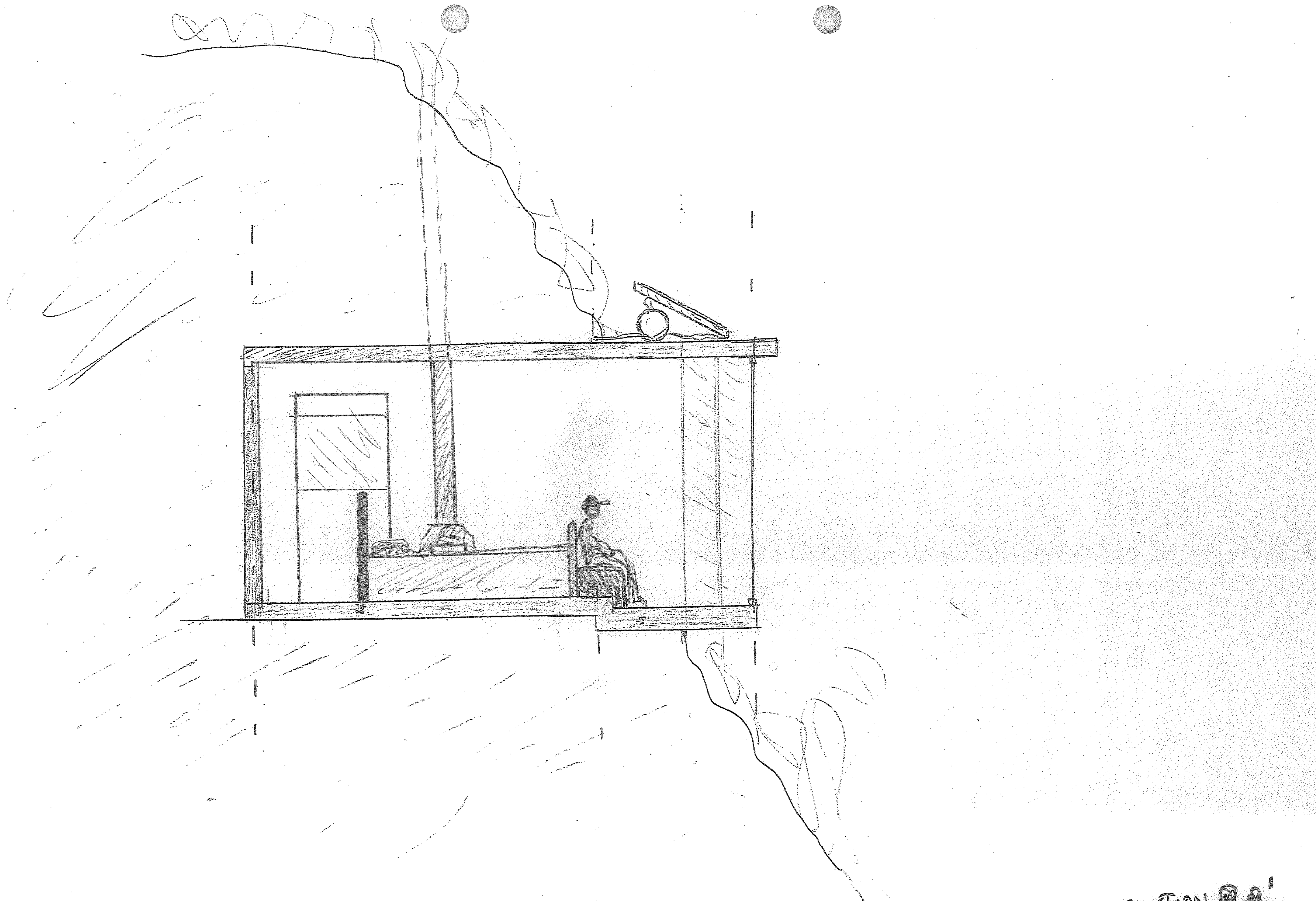
1:50



SECTION A-A'
1:50

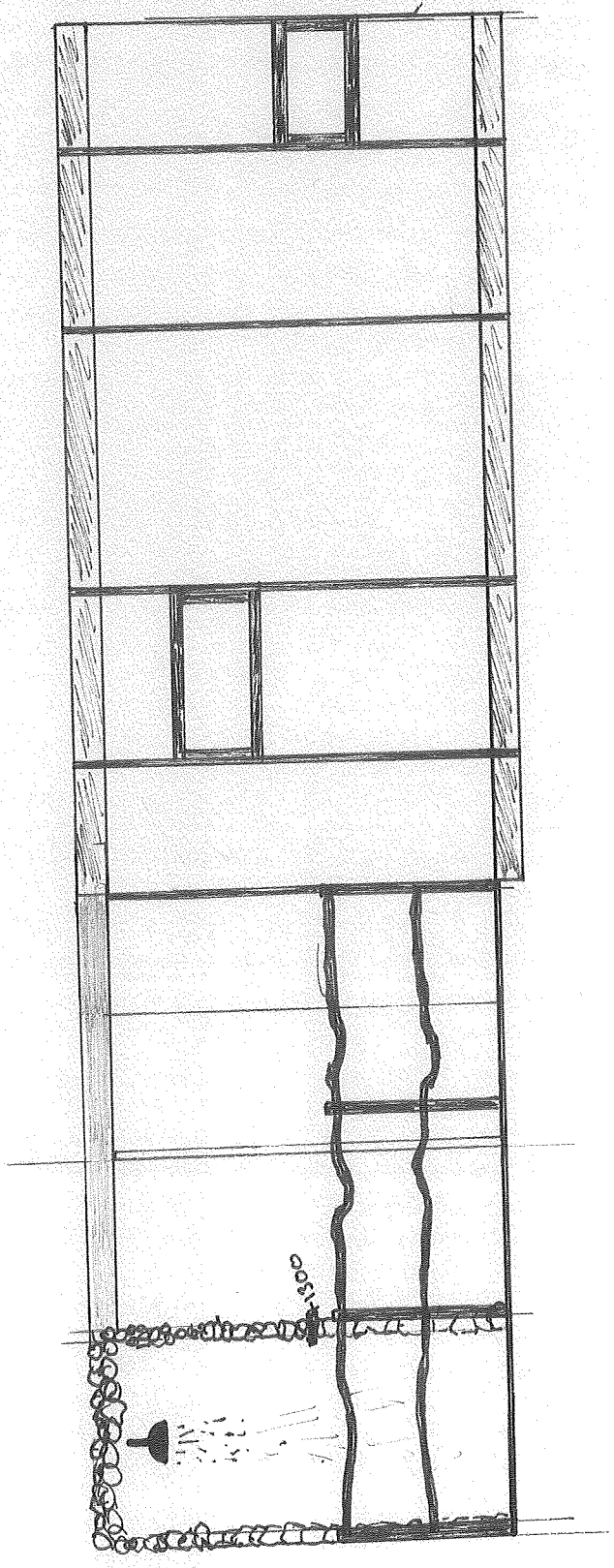


SECTION A-A'
1:50



SECTION B-B'

Front View



Eco-Green lodge

Design a sustainable wildlife accommodation

11 Drawings

Kevin de Bont **1537813**
Pim de Blois **1534317**

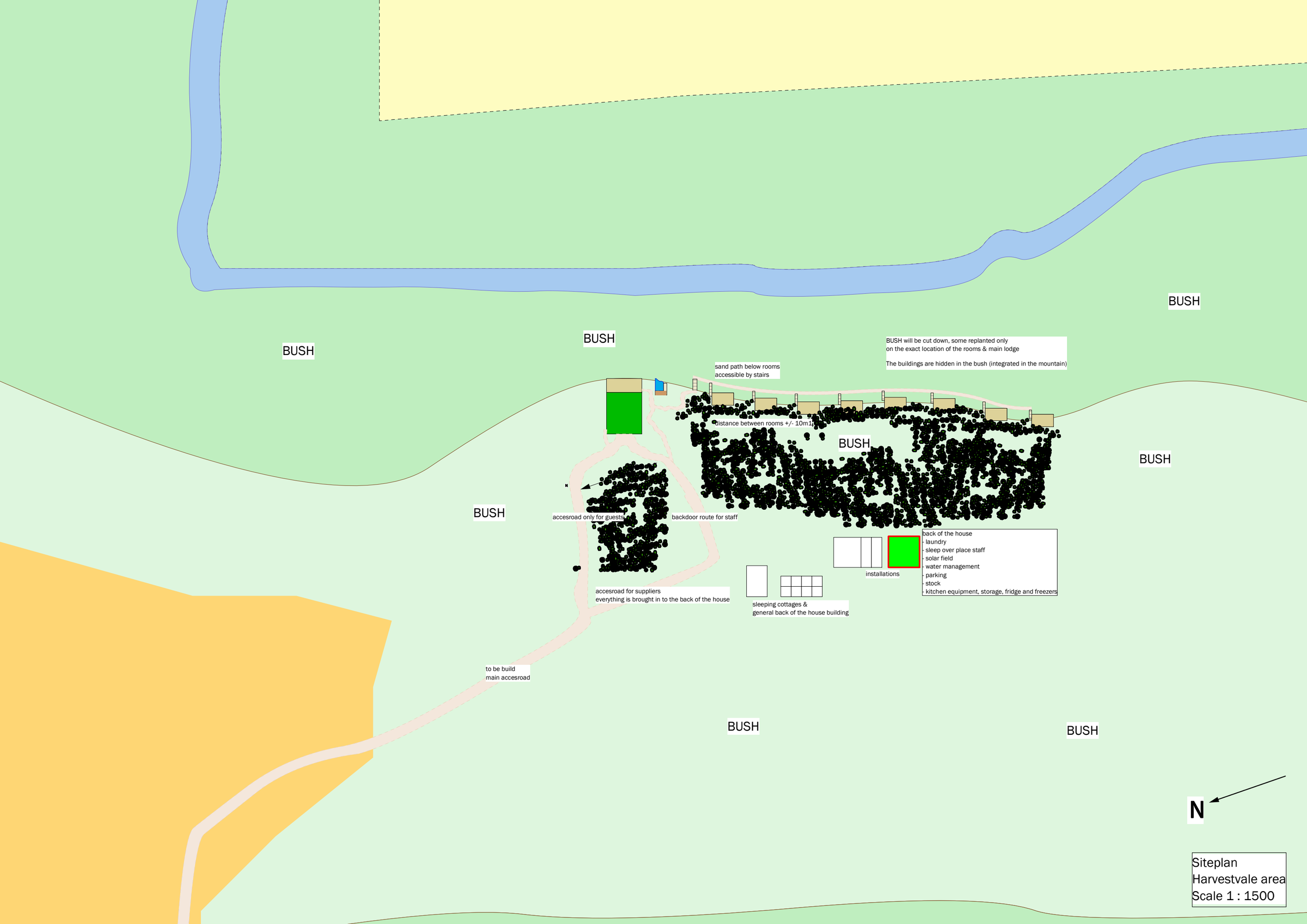
Green Leaf
Environmental Standard

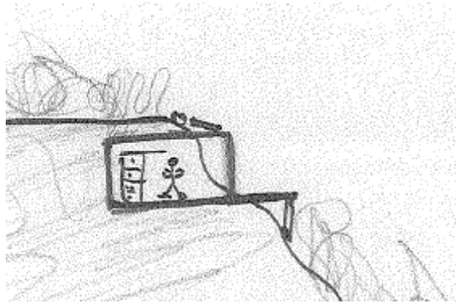
11.1 Main Lodge

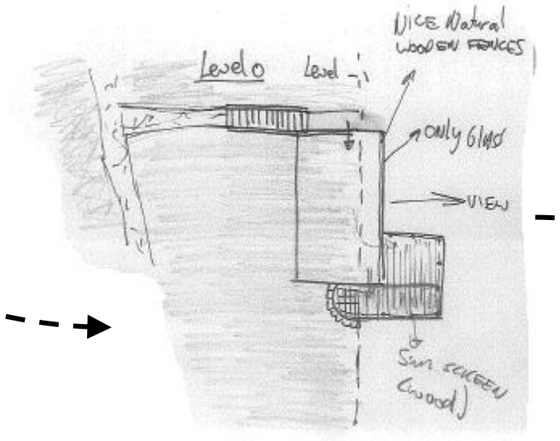
11.2.1 Sketches
11.2.2 Site Plan
11.2.3 Floor Plan (1:100)
11.2.4 Floor Plan with site (1:200)
11.2.5 North & South View
11.2.6 West & East View
11.2.7 Roof Plan
11.2.8 Section AA'
11.2.9 Section BB'
11.2.10 Section CC'
11.2.11 Construction
11.2.12 3D – outside entrance
11.2.13 3D – outside view
11.2.14 3D – outside front view
11.2.15 3D – inside entrance view
11.2.16 3D – inside lounge view
11.2.17 3D – inside deck view
11.2.18 3D – inside close-up dining
11.2.19 3D – inside view
11.2.20 3D – total top view, without roof

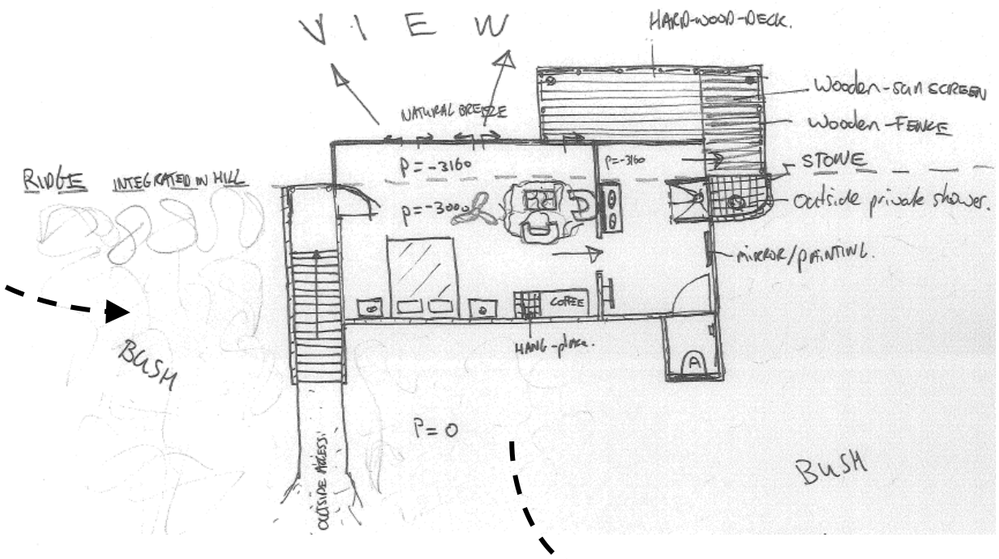
11.2 Rooms

11.3.1 Sketches
11.3.2 Floor Plan
11.3.3 Front View
11.3.4 Side View
11.3.5 Top Plan
11.3.6 Section AA'
11.3.7 Section BB'
11.3.8 Presentation Drawing
11.3.9 Presentation Drawing with site
11.3.10 '3D'
11.3.11 3D inside view
11.3.12 3D outside view
11.3.13 3D outside view

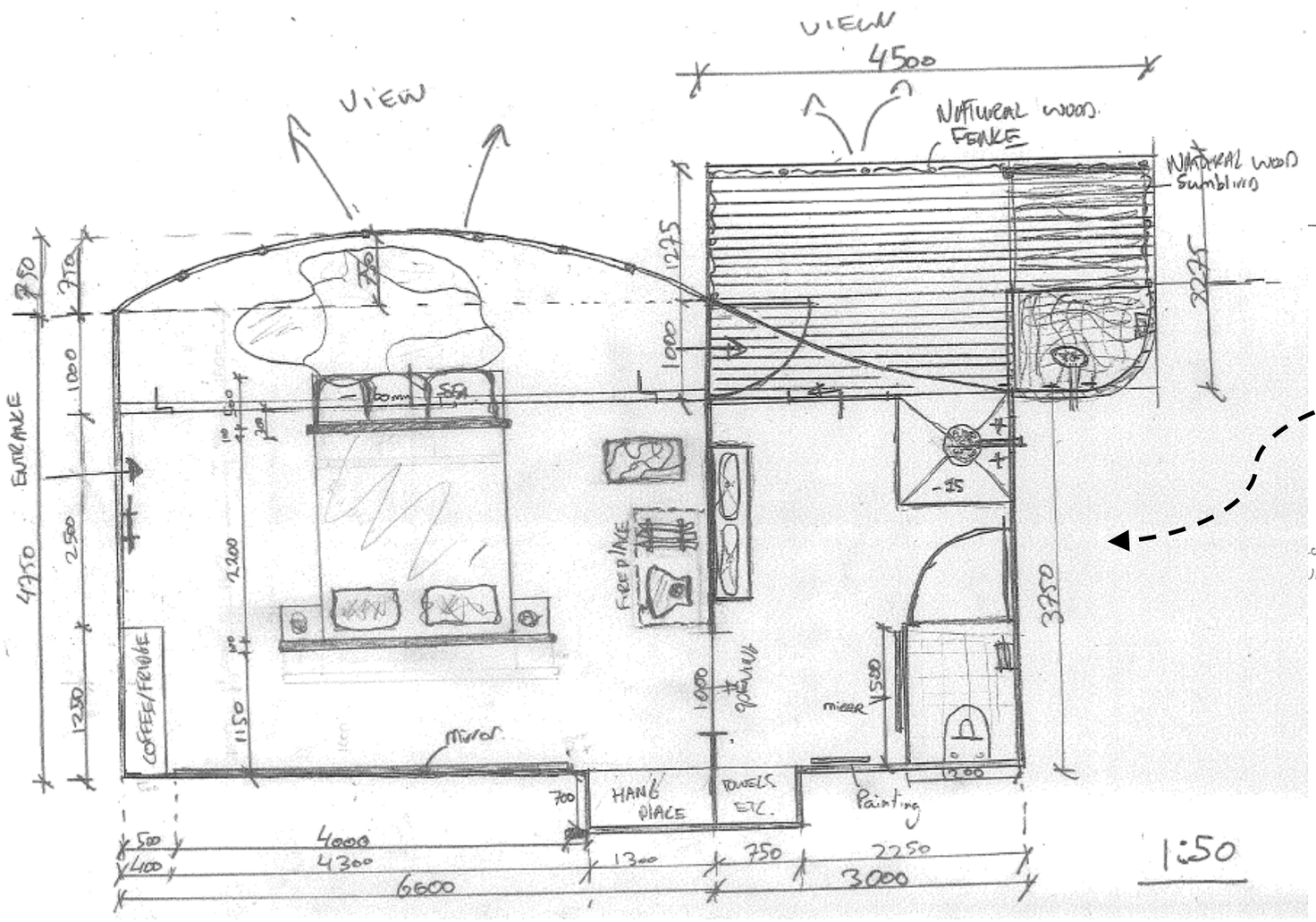

BUSH
BUSH
BUSH
BUSH will be cut down, some replanted only
on the exact location of the rooms & main lodge
The buildings are hidden in the bush (integrated in the mountain)
sand path below rooms
accessible by stairs
distance between rooms +/- 10m1
BUSH
BUSH
BUSH
N
accesroad only for guests
backdoor route for staff
back of the house
- laundry
- sleep over place staff
- solar field
- water management
- parking
- stock
- kitchen equipment, storage, fridge and freezers
installations
accesroad for suppliers
everything is brought in to the back of the house
sleeping cottages &
general back of the house building
to be build
main accesroad
BUSH
BUSH
N
Siteplan
Harvestvale area
Scale 1 : 1500

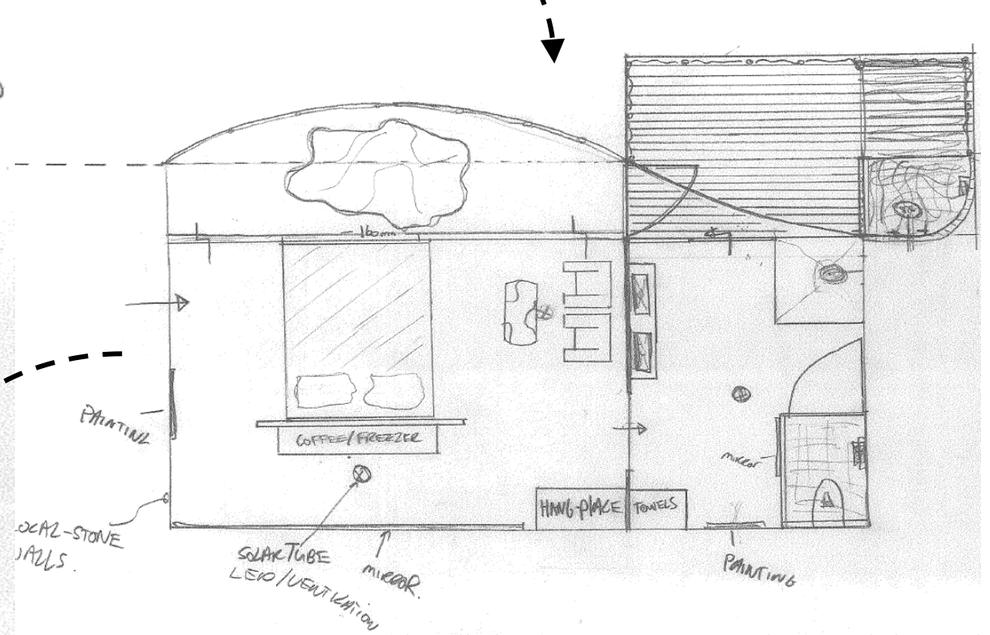


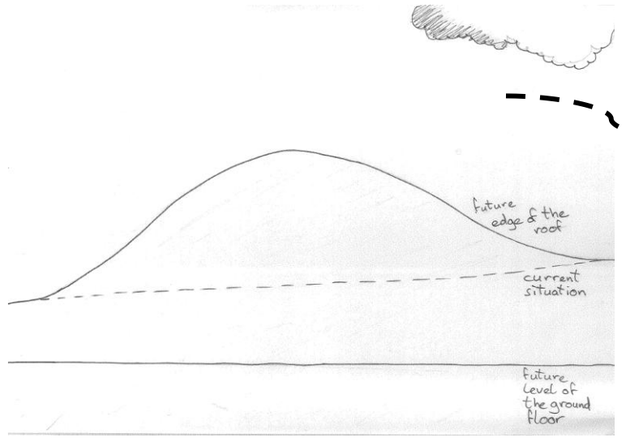

Level 0
Level -1
VICE Natural WOODEN FENCES
ONLY GLASS
VIEW
Sun screen (wood)

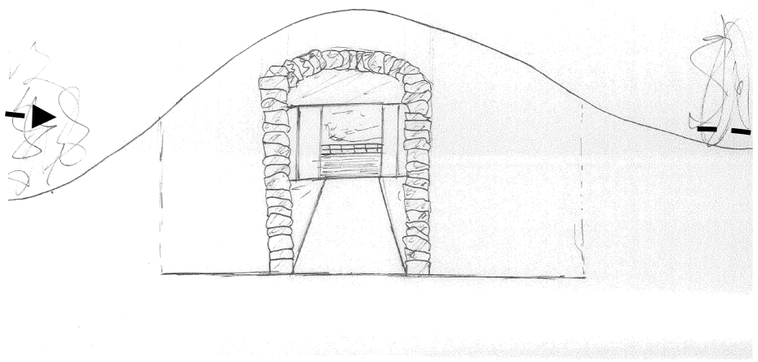

V I E W
HARD-WOOD-DECK.
NATURAL BREEZE
Wooden-sun screen
Wooden-FENCE
STOVE
outside private shower.
mirror/painting.
RIDGE
INTEGRATED IN HILL
P=-3160
P=-300
P=0
COFFEE
HANG-place.
BUSH
BUSH

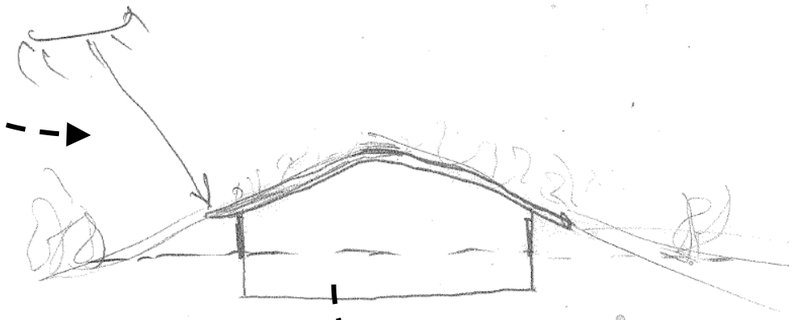
Rooms


VIEW
4500
VIEW
NATURAL WOOD FENCE
NATURAL WOOD SUNBLINDS
ENTRANCE
COFFEE/FRIDGE
FIREPLACE
mirror
HANG PLACE
TOWELS ETC.
Painting
1:50

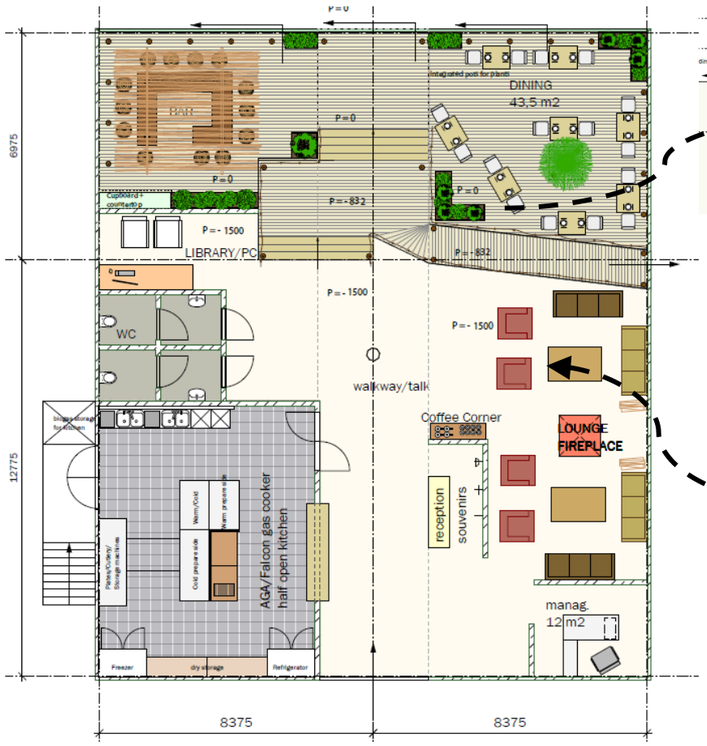

PAINTING
COFFEE/FREEZER
HANG PLACE
TOWELS
mirror
PAINTING
SOLAR TUBE
LED/VENTILATION
MIRROR

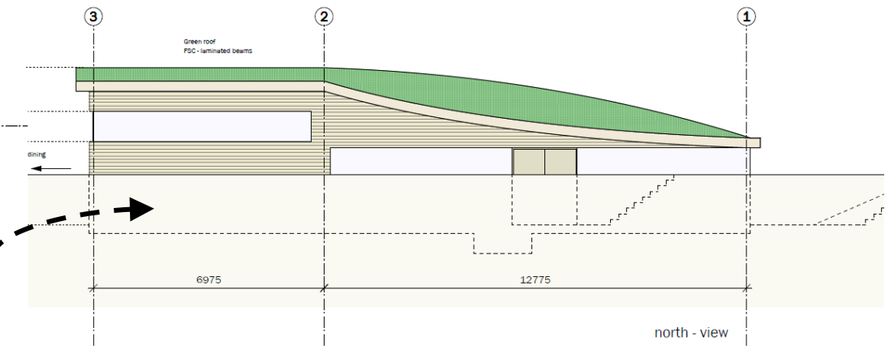

future edge of the roof
current situation
future level of the ground floor

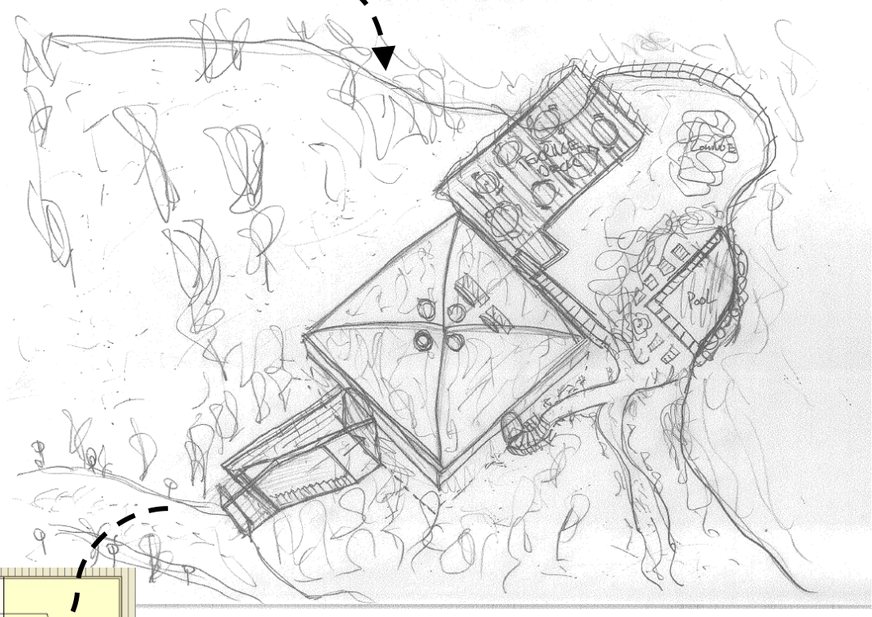


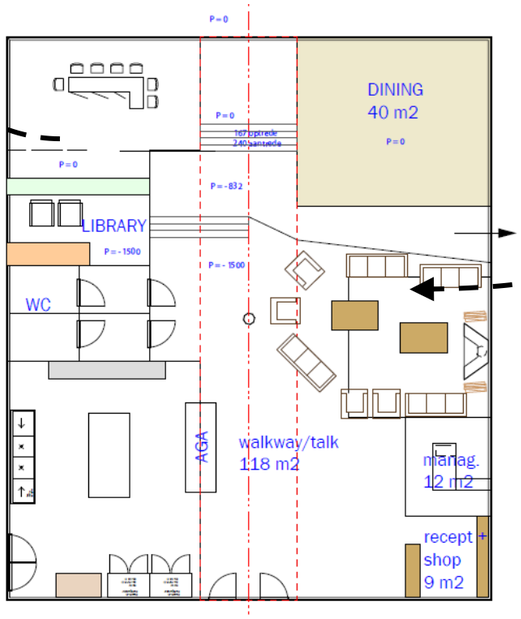


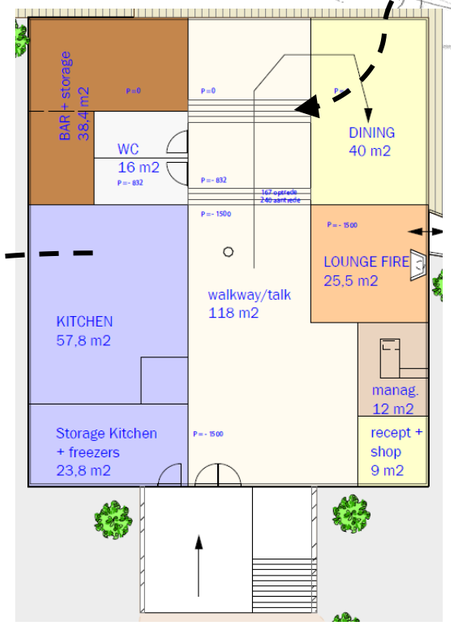
Main Lodge

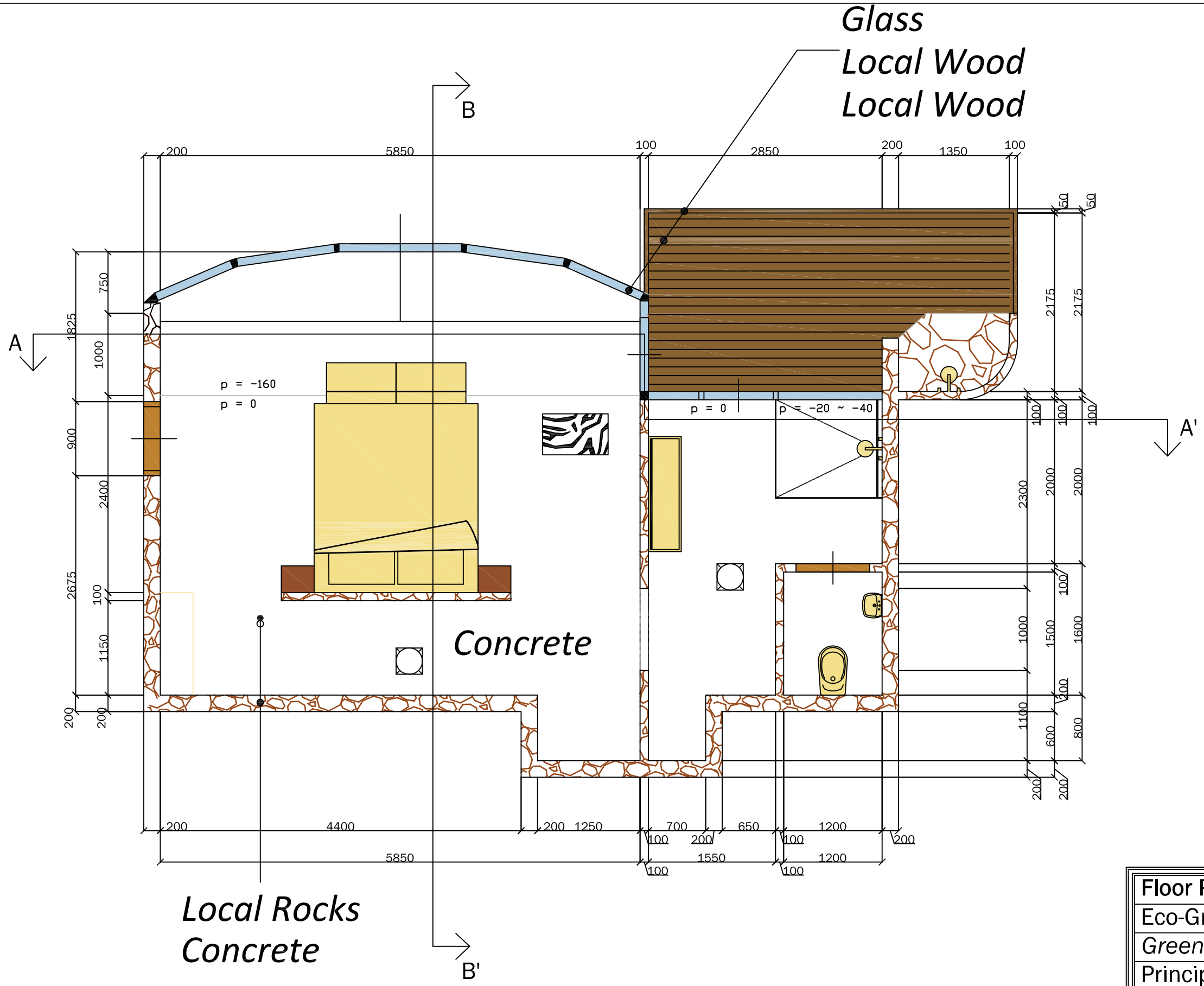

DINING
43,5 m2
LIBRARY/PC
WC
walkway/talk
Coffee Corner
LOUNGE FIREPLACE
reception souvenirs
manag. 12 m2
AGA/Falcon gas cooker half open kitchen
Freezer
dry storage
Refrigerator
6975
12775
8375
8375


Green roof
FSC - laminated beams
dining
6975
12775
north - view


Pool

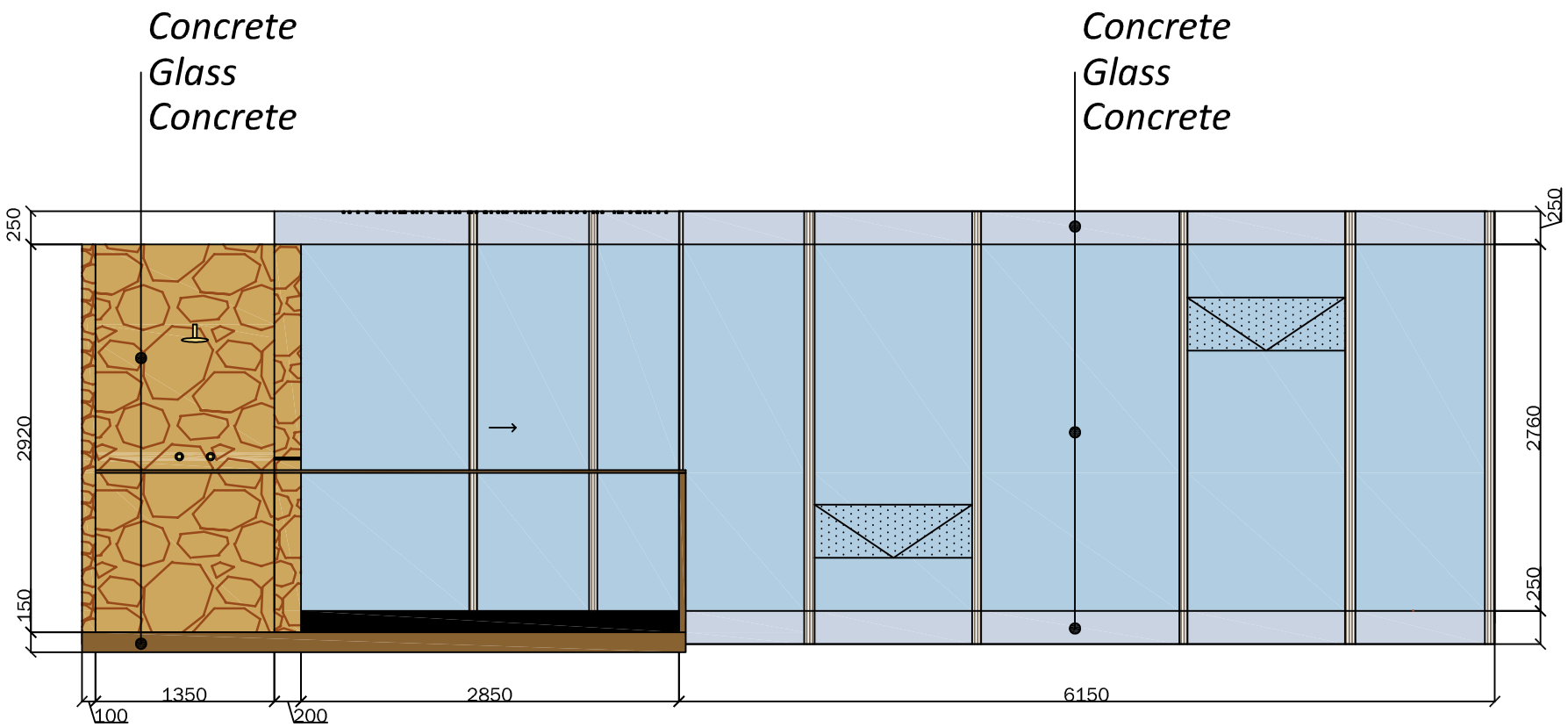

DINING
40 m2
LIBRARY
WC
AGA
walkway/talk
118 m2
manag.
12 m2
recept +
shop
9 m2

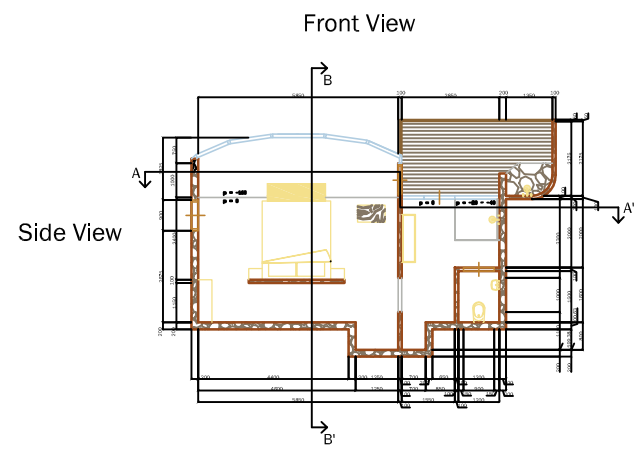

BAR + storage
38,4 m2
WC
16 m2
DINING
40 m2
LOUNGE FIRE
25,5 m2
KITCHEN
57,8 m2
walkway/talk
118 m2
manag.
12 m2
Storage Kitchen
+ freezers
23,8 m2
recept +
shop
9 m2



Floor Plan Rooms	
Eco-Green Lodge	
Green Leaf Environmental Standard	
Principal: Kariega Game Reserve	
Kevin de Bont	Pim de Blois
1537813	1534317
scale 1:50	december 2011

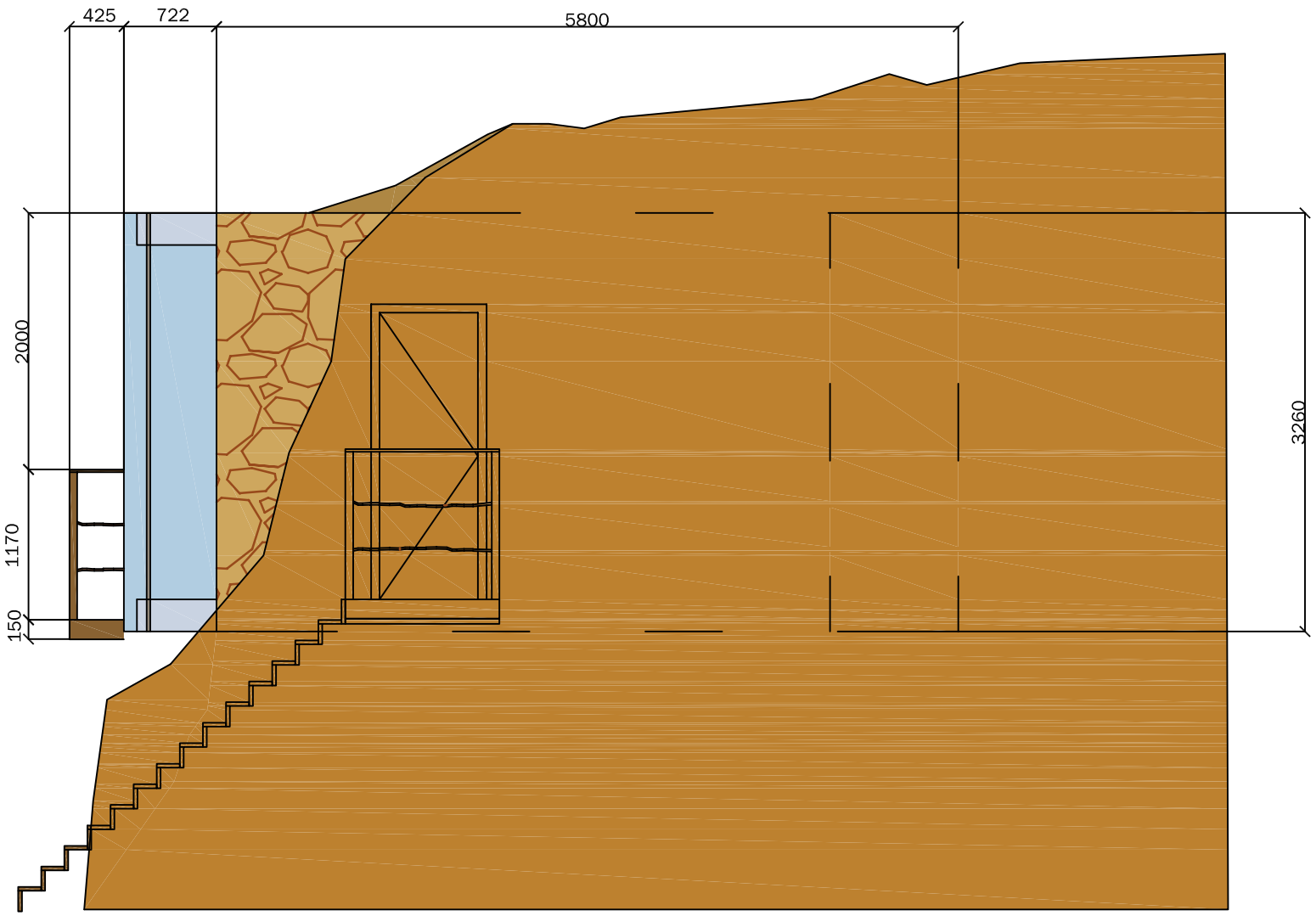
Green Leaf



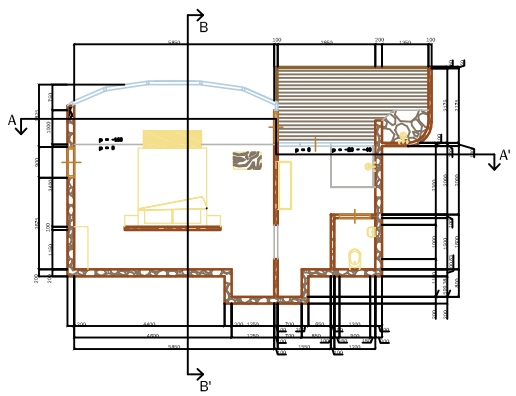


Front View	
Eco-Green Lodge	
Green Leaf Environmental Standard	
Principal: Kariega Game Reserve	
Kevin de Bont	Pim de Blois
1537813	1534317
scale 1:50	december 2011

Green Leaf



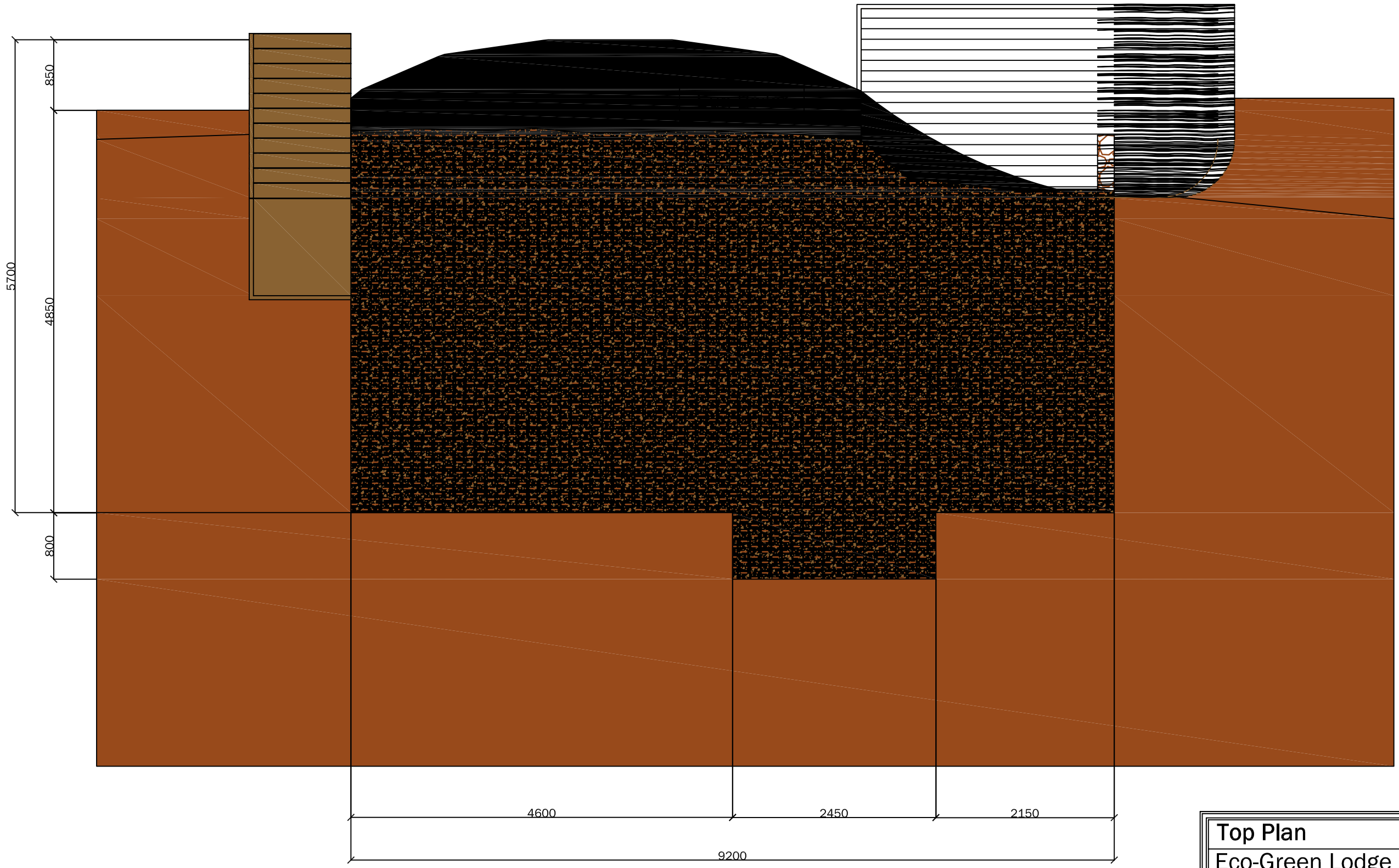
Front View



Side View

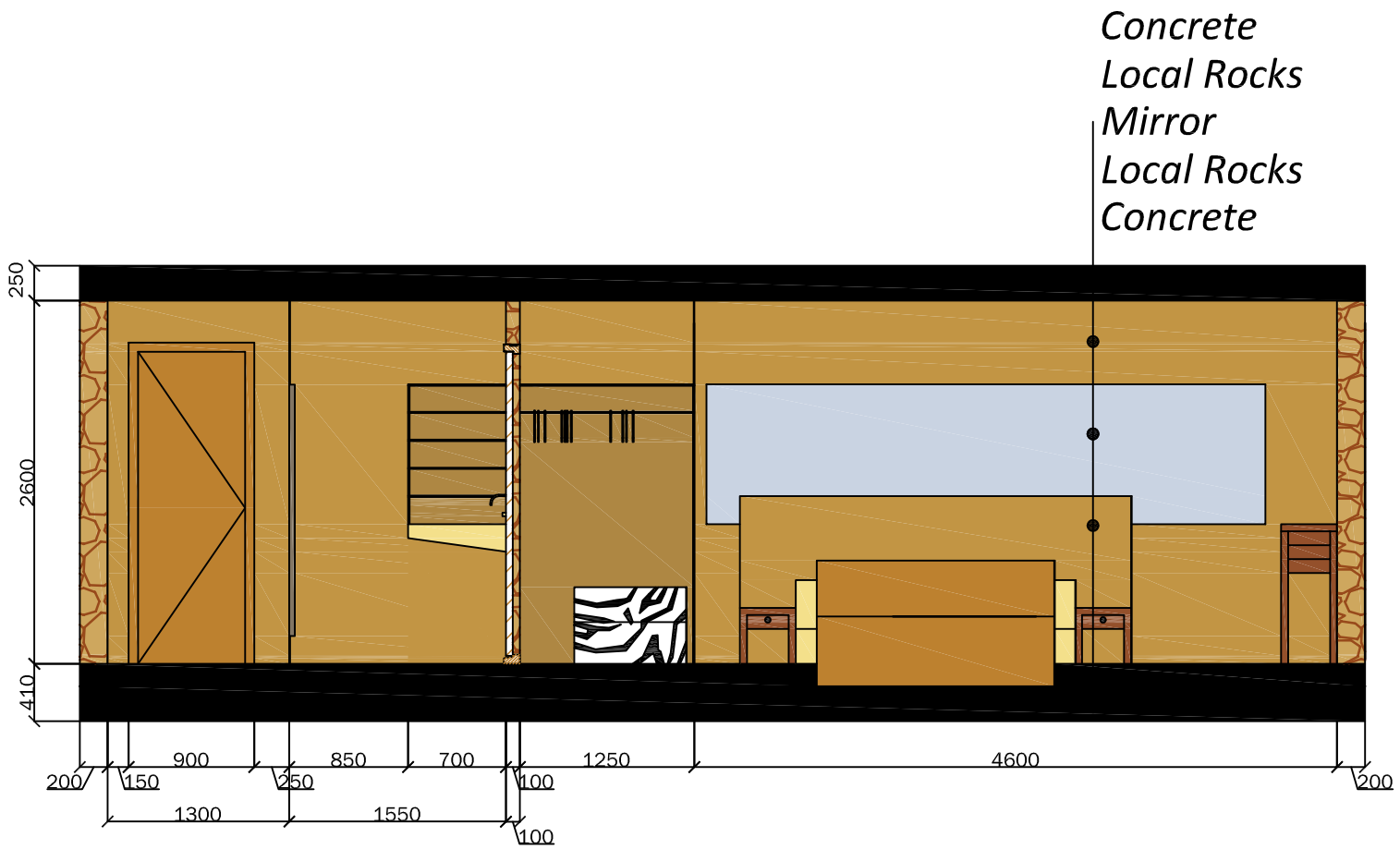
Side View	
Eco-Green Lodge	
Green Leaf Environmental Standard	
Principal: Kariega Game Reserve	
Kevin de Bont	Pim de Blois
1537813	1534317
scale 1:50	december 2011

Green Leaf



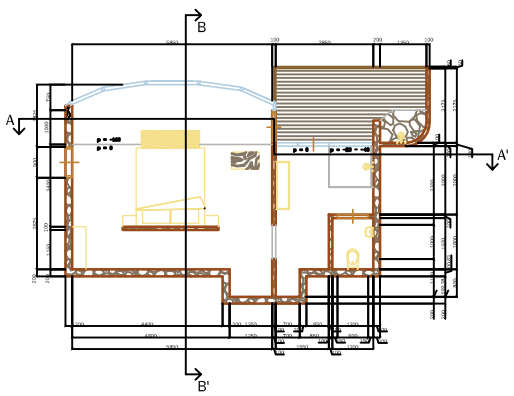
Top Plan	
Eco-Green Lodge	
Green Leaf Environmental Standard	
Principal: Kariega Game Reserve	
Kevin de Bont	Pim de Blois
1537813	1534317
scale 1:50	december 2011

Green Leaf



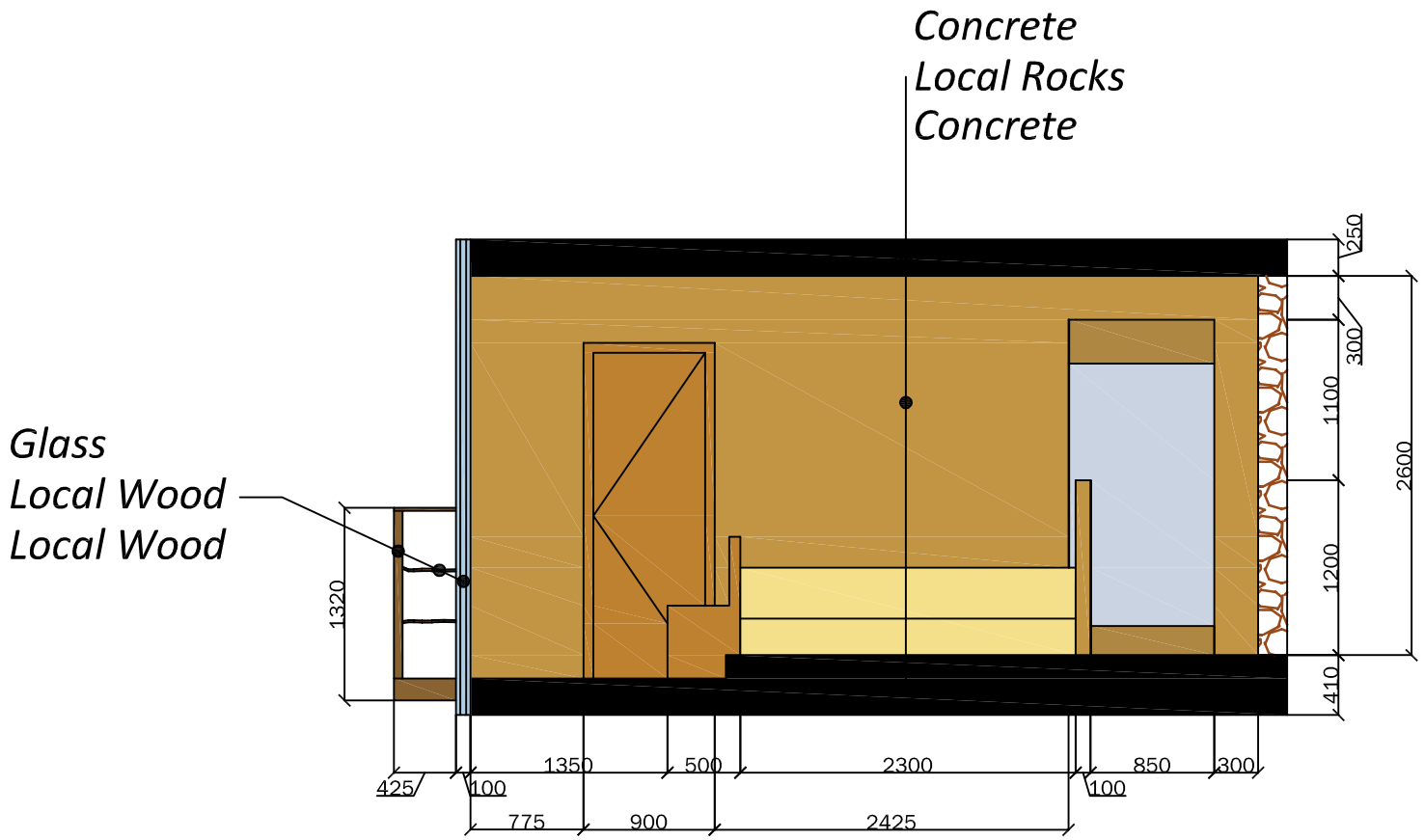
Front View

Side View



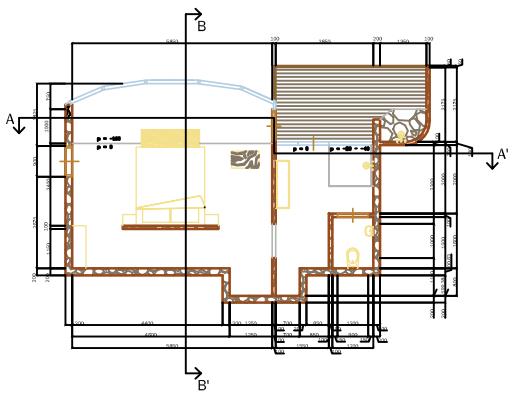
Section AA'	
Eco-Green Lodge	
Green Leaf Environmental Standard	
Principal: Kariega Game Reserve	
Kevin de Bont	Pim de Blois
1537813	1534317
scale 1:50	december 2011

Green Leaf



Front View

Side View

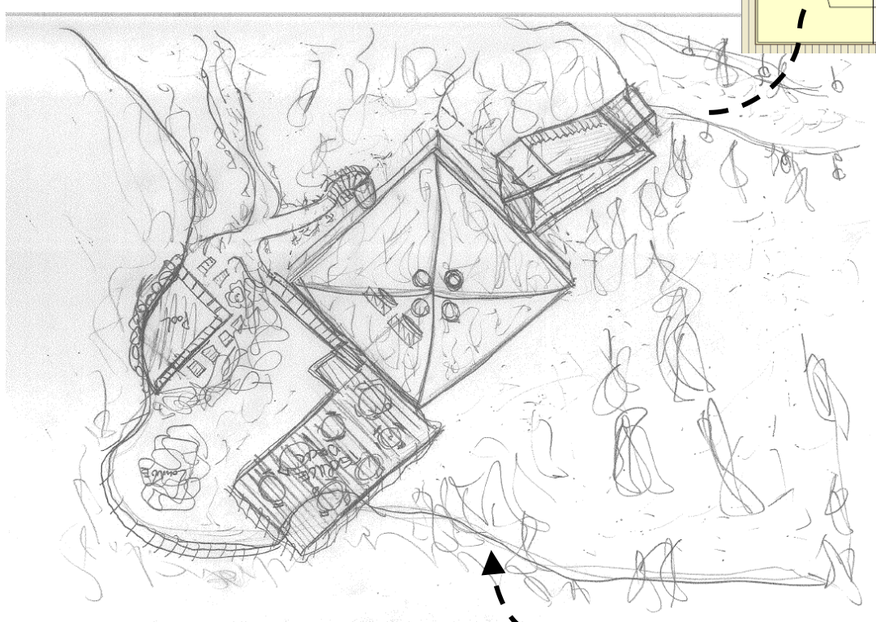


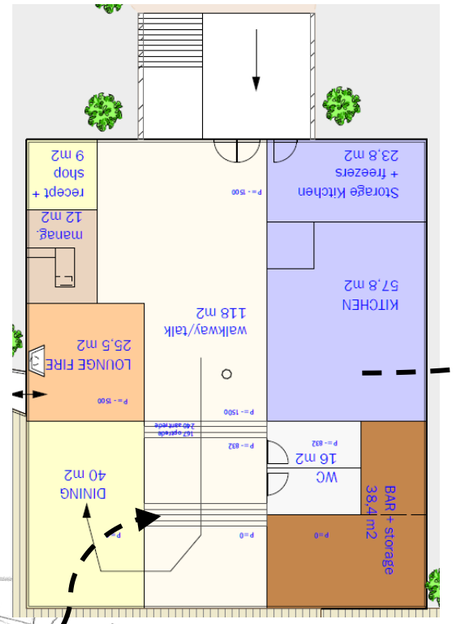
Section BB'	
Eco-Green Lodge	
Green Leaf Environmental Standard	
Principal: Kariega Game Reserve	
Kevin de Bont	Pim de Blois
1537813	1534317
scale 1:50	december 2011

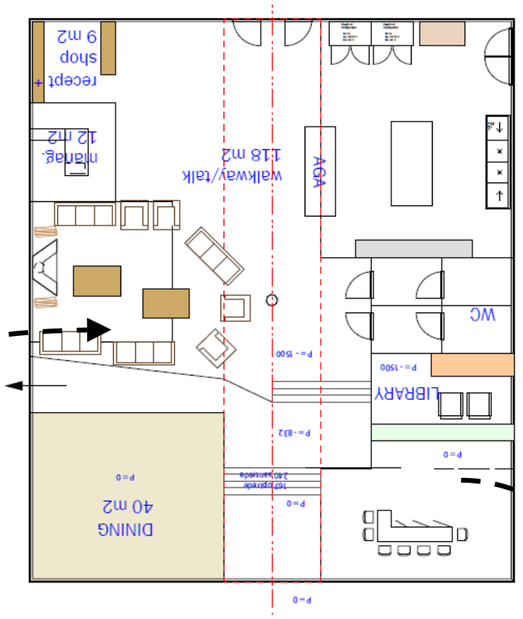
Green Leaf


4.50m
0.75m
1.00m
0.50m
2.60m
2.20m
0.10m
1.25m
1.15m
1.27m
2.27m
2.25m
1.50m
Terrace
Outside Shower
P = -160
P = 0
P = -160
P = 0
P = -20 ~ -40
Bathroom
Toilet
Mirror
Living / Sleeping Room
Coffee Table
Mirror
Hang Place
Towels etc
4.70m
1.29m
0.75m
0.86m
1.20m
2m
4m

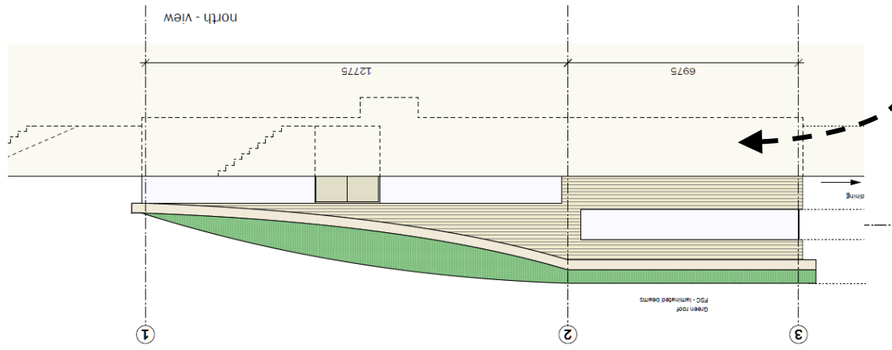

Towels etc
Hang Place
Mirror
Coffee Table
Toilet
Mirror
Bathroom
Living / Sleeping Room
P = -20 ~ -40
P = 0
P = -160
P = 0
P = -160
Outside Shower
Terrace
6m
12m

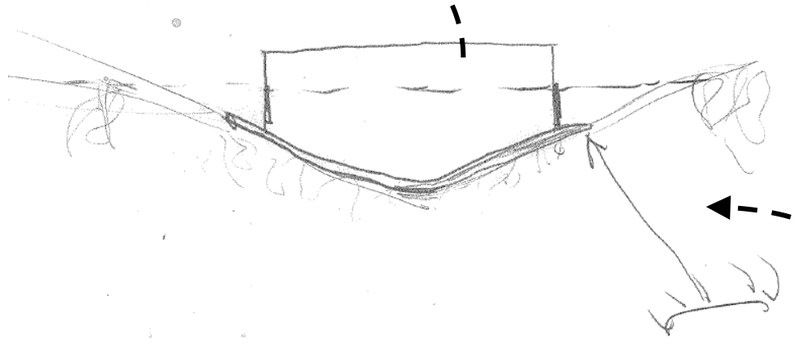


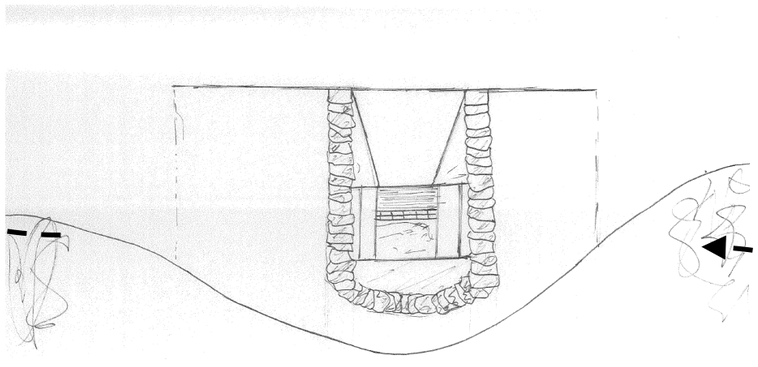

Storage Kitchen
+ tweezers
23.8 m2
recept +
shop
9 m2
manag.
12 m2
KITCHEN
57.8 m2
walkway/talk
118 m2
LOUNGE FIRE
25.5 m2
DINING
40 m2
WC
16 m2
BAR + storage
38.4 m2

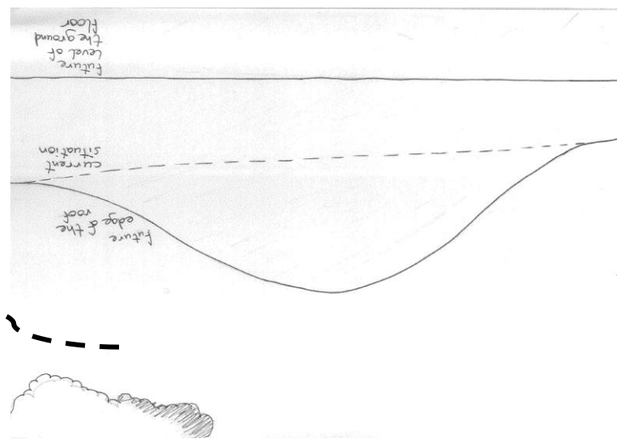

recept +
shop
9 m2
manag.
12 m2
walkway/talk
118 m2
AGA
WC
LIBRARY
DINING
40 m2


8375
8375
manag.
12 m2
AGA/Falcon gas cooker
half open kitchen
reception
souvenirs
coffee corner
LOUNGE
FIREPLACE
walkway/talk
WC
LIBRARY/PC
DINING
43.5 m2
12775
6975


north - view
12775
6975
1
2
3






future level of the ground floor
current situation
future edge of the road

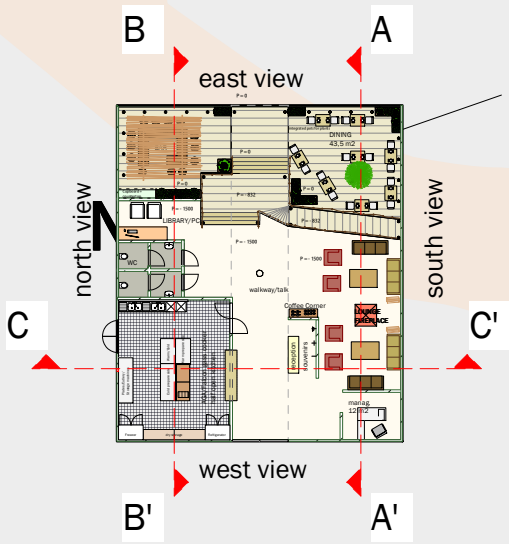
Plan view

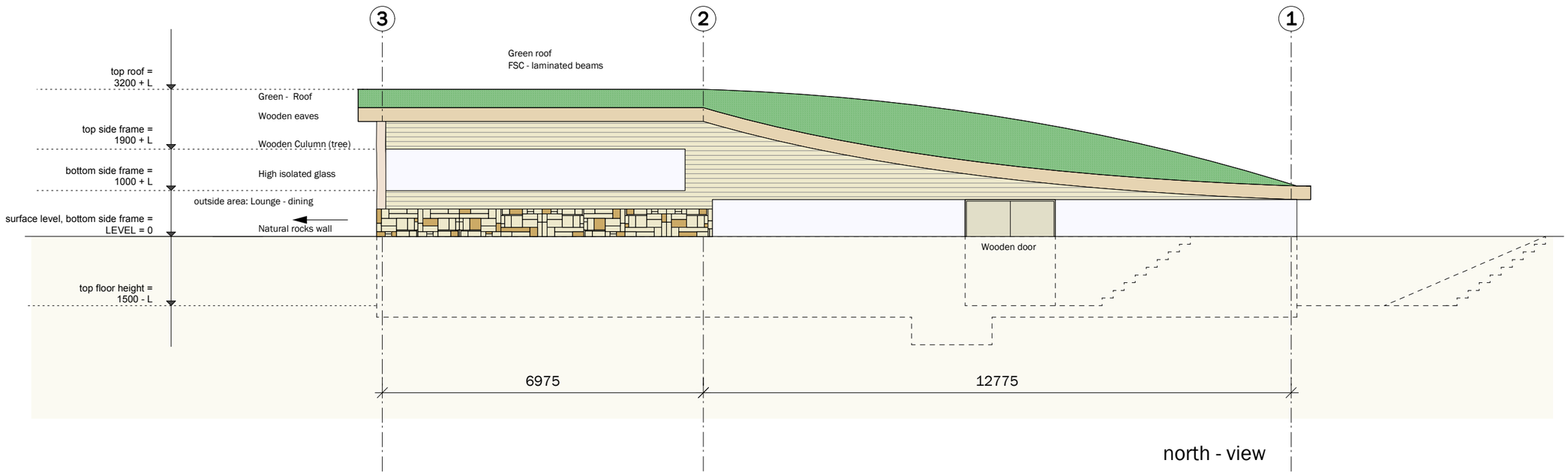
SCALE: 1 : 100

Drawn by: Kevin de Bont & Pim de Blois

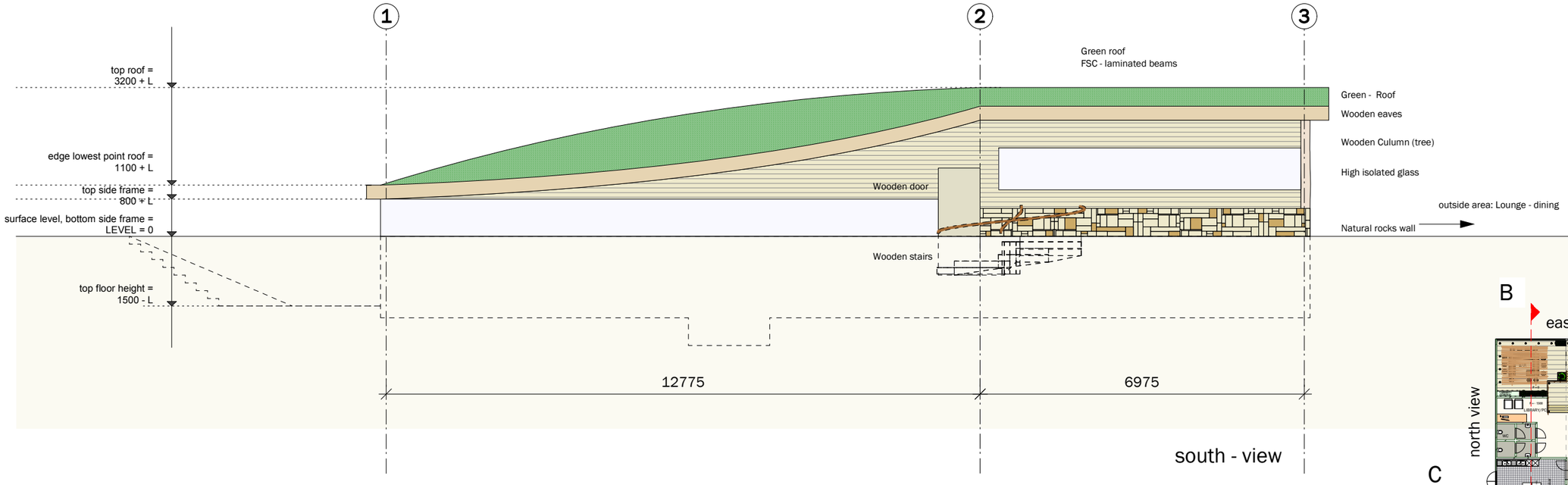
OUTSIDE DINING
35,4 m2
LOUNGE VIEW AREA
WALKWAY
35,8 m2
DINING
42,1 m2
integrated pots for plants
Sliced tree countertop
BAR
31,3 m2
Cupboard + countertop
LIBRARY/PC
11,5 m2
WC
GENERAL AREA
91,8 m2
Coffee Corner
LOUNGE FIREPLACE
35,2 m2
KITCHEN
55,2 m2
AGA/Falcon gas cooker half open kitchen
reception souvenirs
MANAGER
9,8 m2
Installations Control room
dry storage
Freezer
Refrigerator
underneath entrance 1500 - grass/pace
DINING & BONFIRE
P = 0
P = - 832
P = - 1500
6975
8375
8375

Siteplan Main-lodge
SCALE: 1 : 200
Drawn by: Kevin de Bont & Pim de Blois

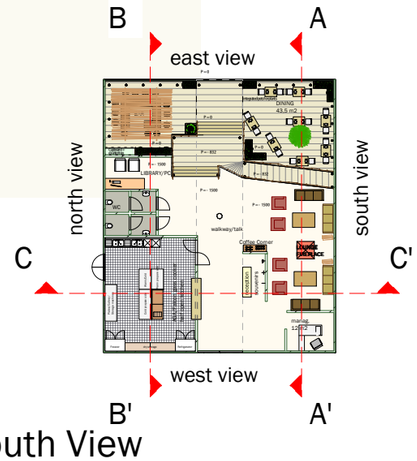




north - view



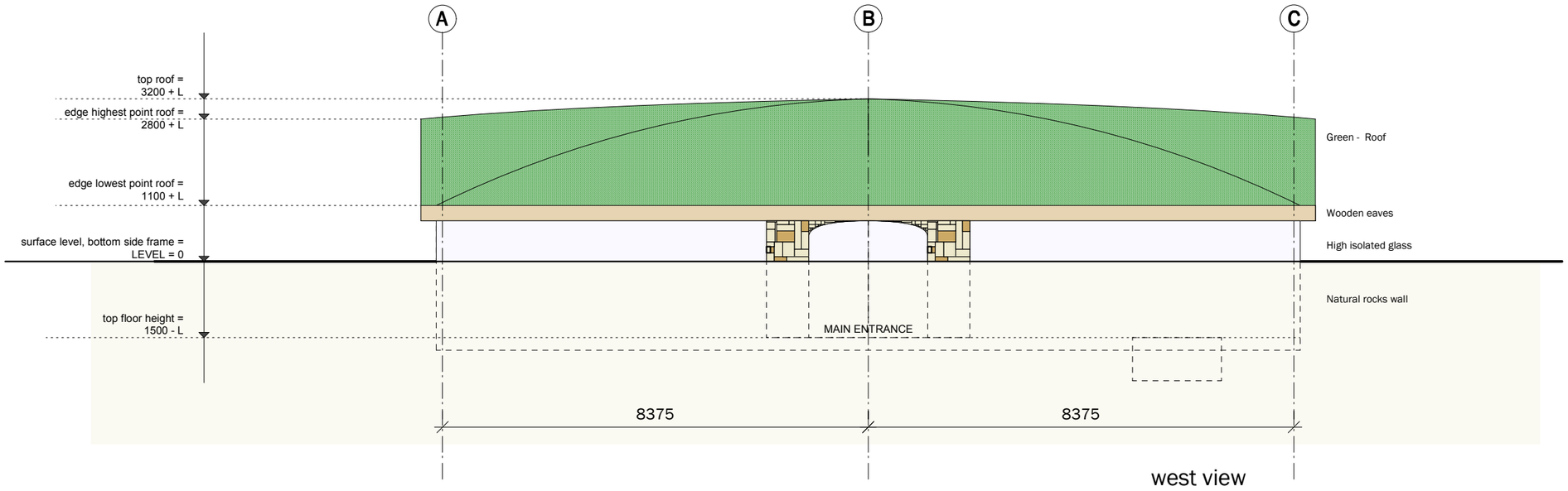
south - view



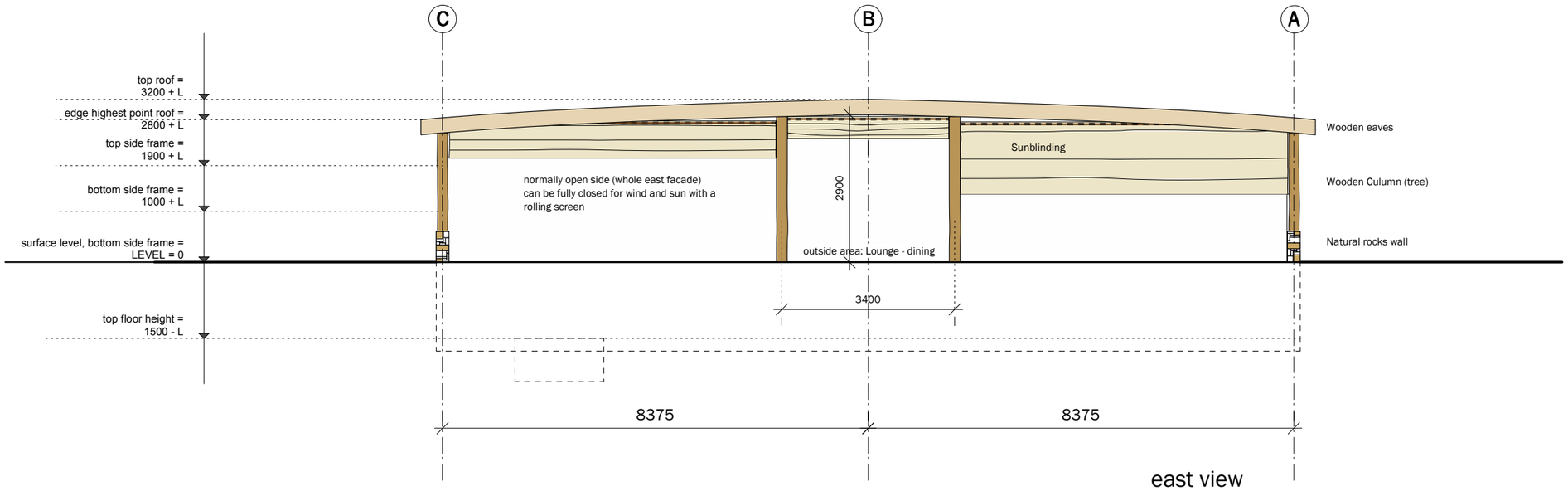
North & South View

SCALE: 1 : 100

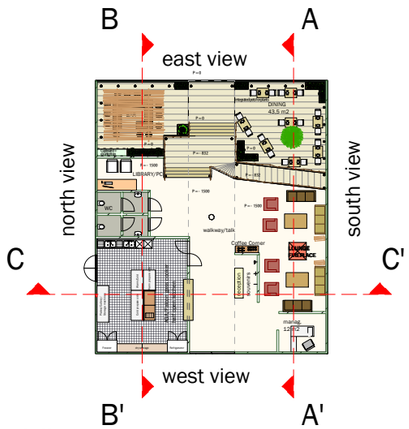
Drawn by: Kevin de Bont & Pim de Blois



west view



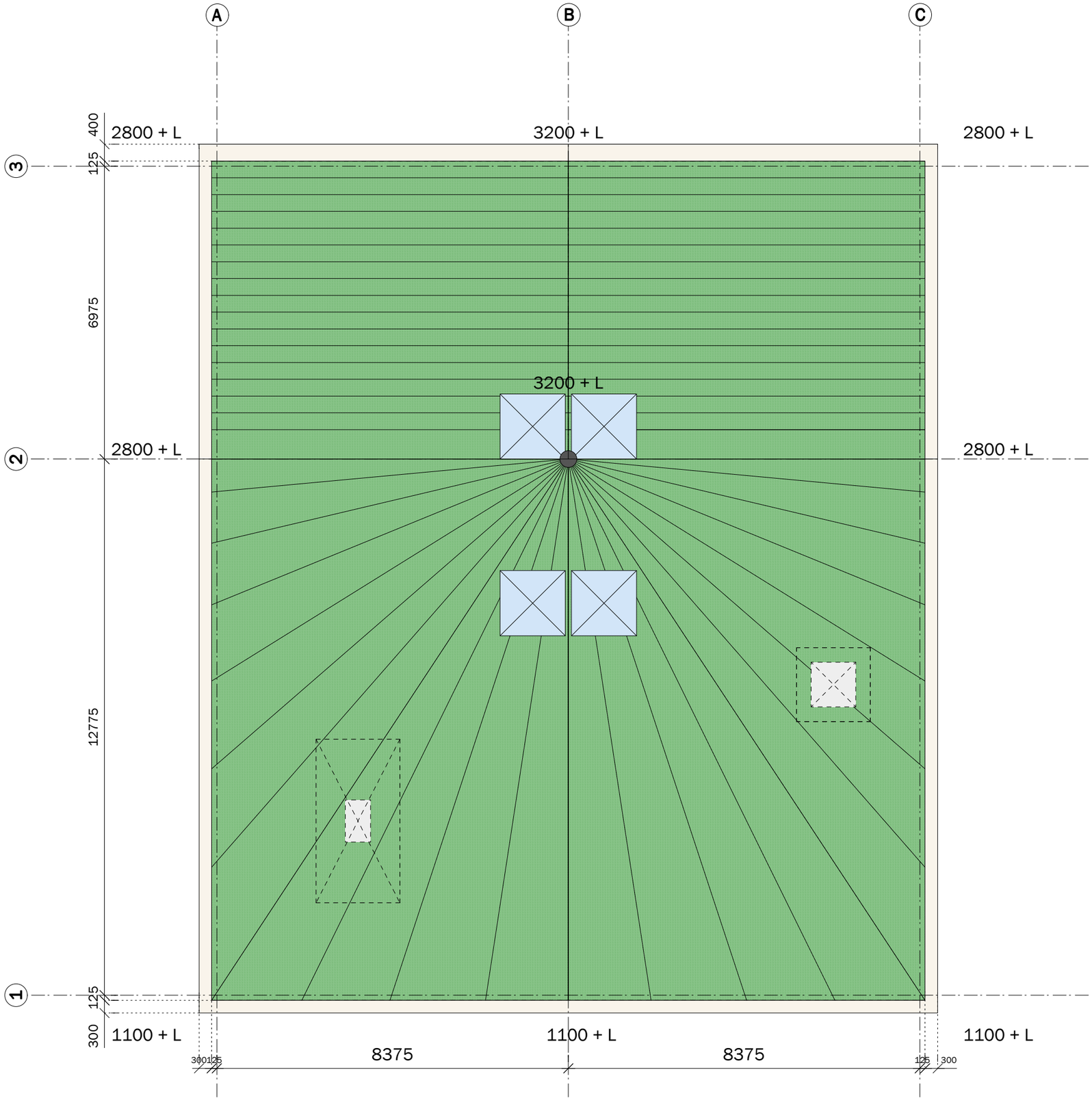
east view

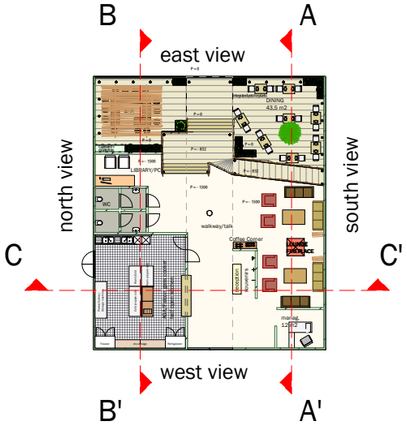


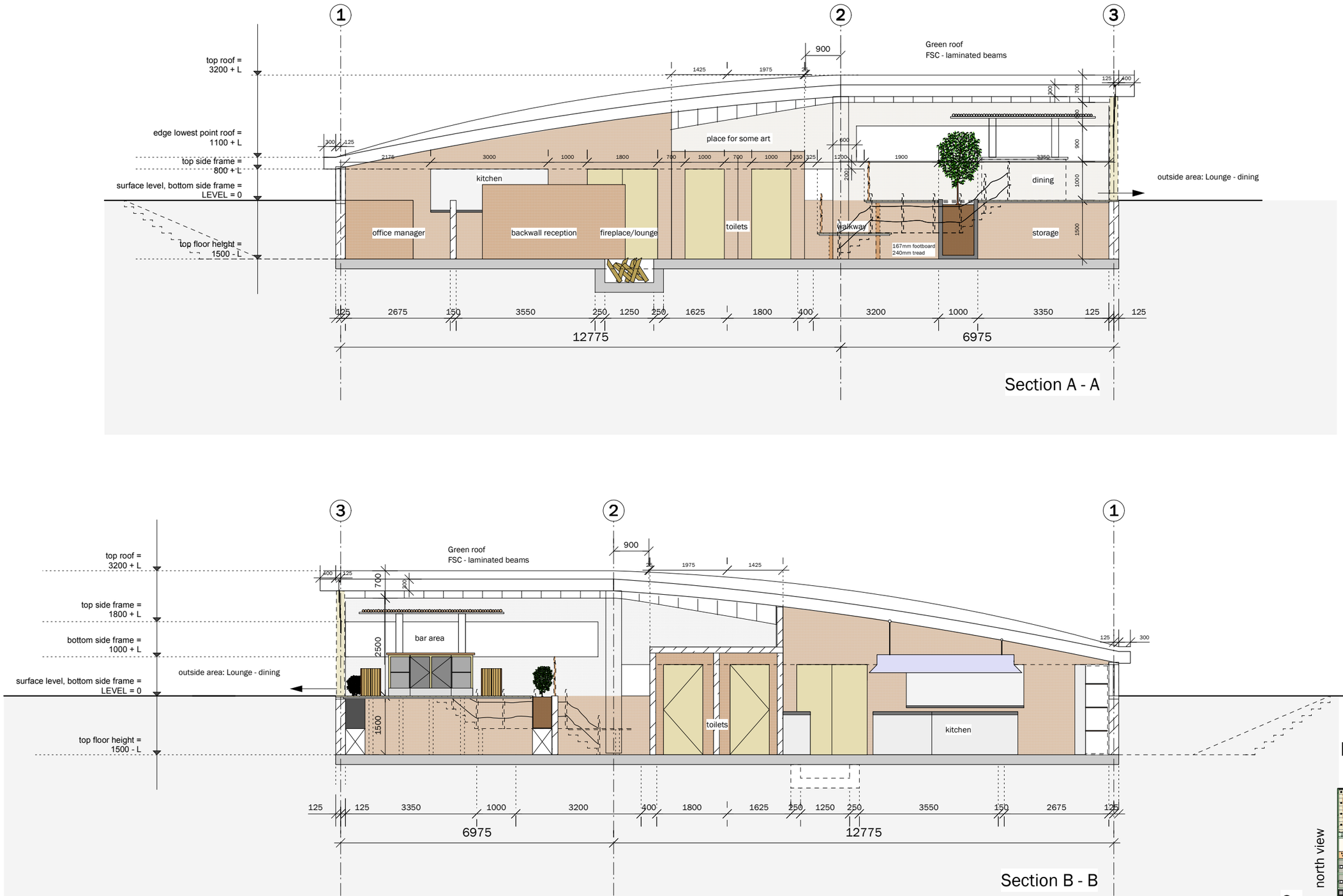
West & East View

SCALE: 1 : 100

Drawn by: Kevin de Bont & Pim de Blois


A
B
C
3
2
1
400
125
6975
12775
300
125
300
2800 + L
3200 + L
2800 + L
3200 + L
2800 + L
2800 + L
1100 + L
1100 + L
1100 + L
300
125
8375
8375
125
300

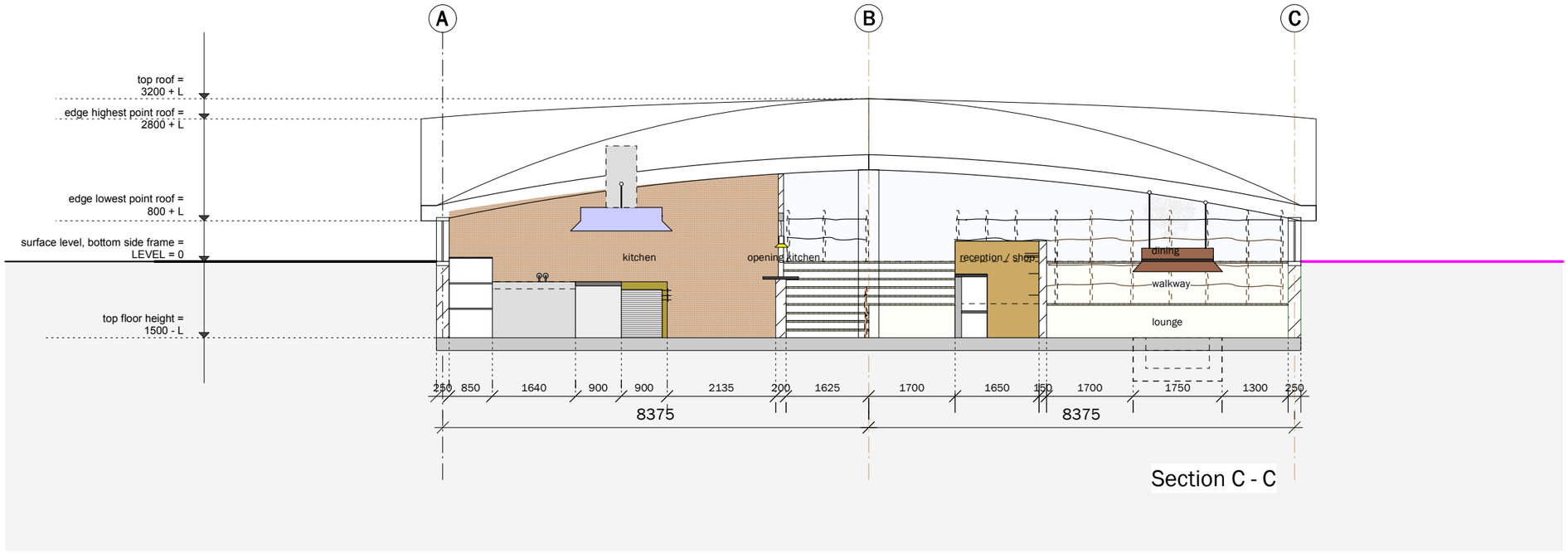

B
A
east view
north view
south view
C
C'
west view
B'
A'



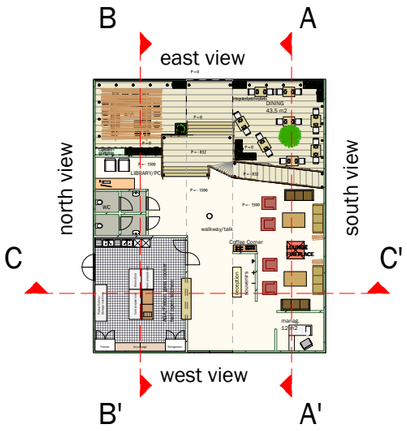
Sections

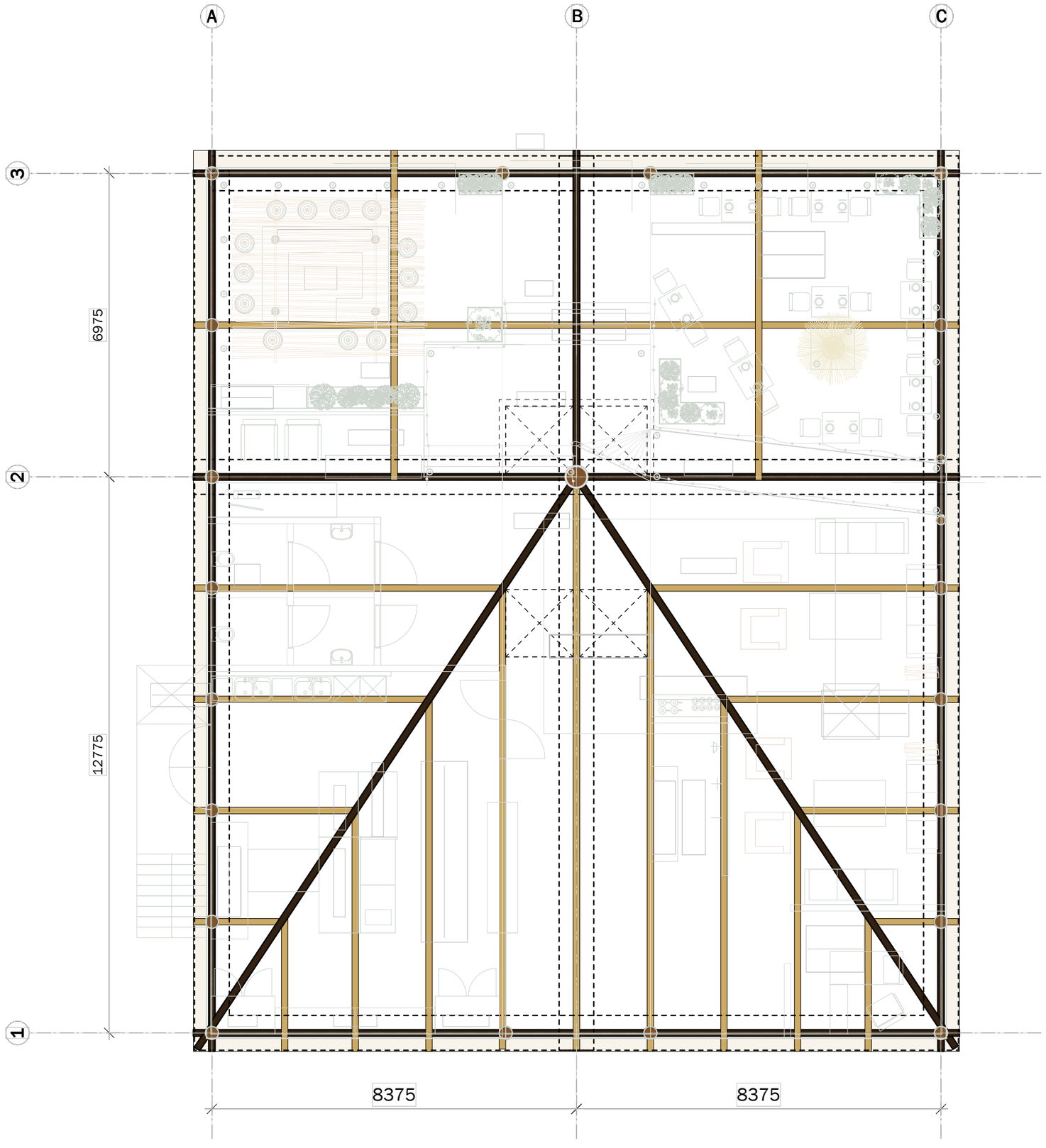
SCALE: 1 : 100

Drawn by: Kevin de Bont & Pim de Blois


A
B
C
top roof =
3200 + L
edge highest point roof =
2800 + L
edge lowest point roof =
800 + L
surface level, bottom side frame =
LEVEL = 0
top floor height =
1500 - L
kitchen
opening kitchen
reception / shop
dining
walkway
lounge
250
850
1640
900
900
2135
200
1625
1700
1650
150
1700
1750
1300
250
8375
8375

Section C - C


B
A
east view
north view
south view
C
C'
west view
B'
A'



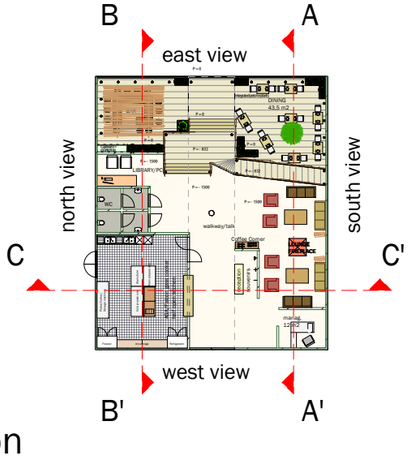
Structure:
Wooden columns +/- 300mm
Laminated beams on top for the roofstructure
Center Culumn is bigger and from concrete for a better stability
All wood got an environmental friendly anti termite treatment

Main-beams

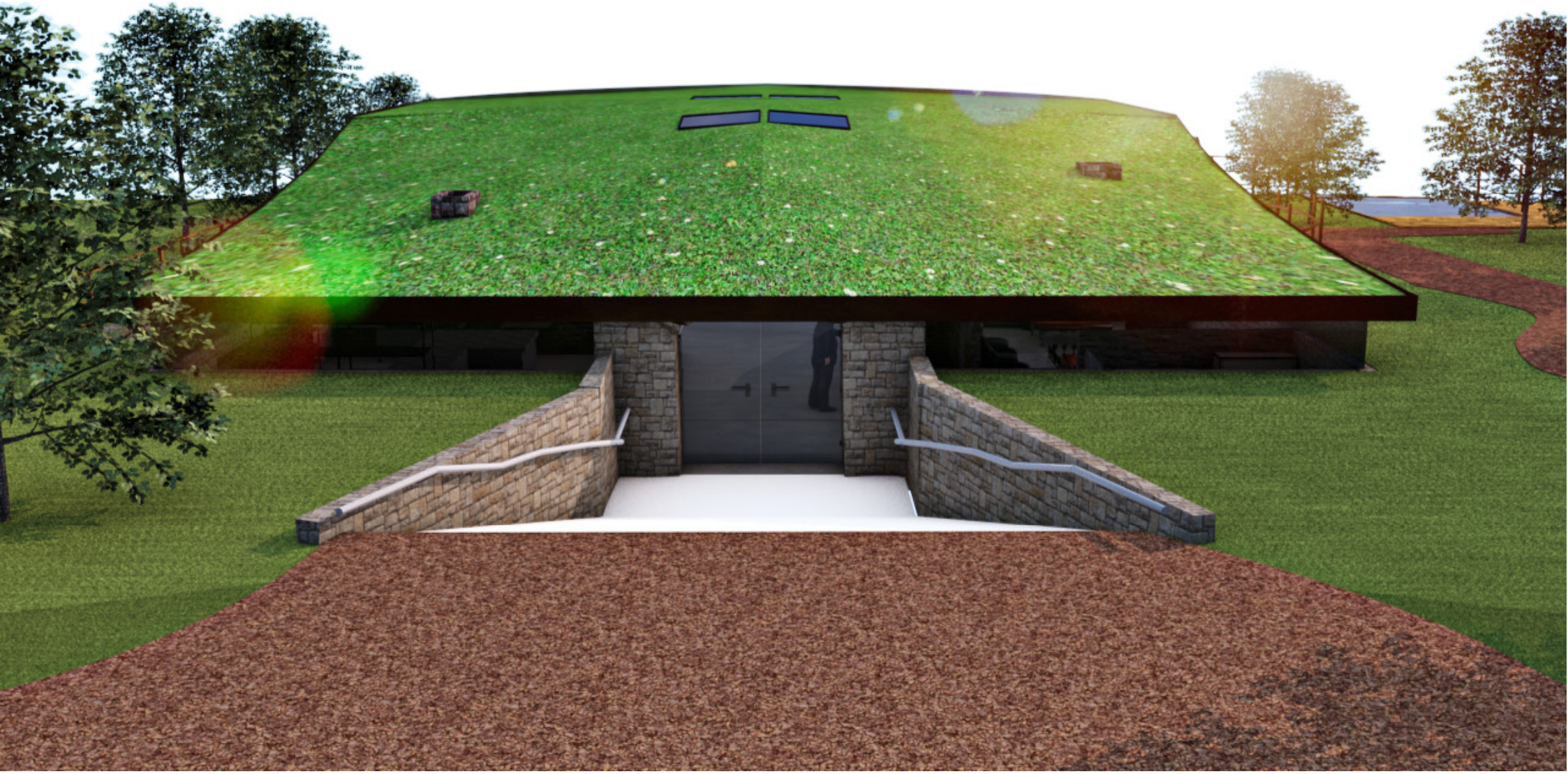
Sub-beams

Culumns

Foundation



Construction
SCALE: 1 : 100
Drawn by: Kevin de Bont & Pim de Blois



MOODBOARD