

# Wildfire resilient village of the future

The independent and responsible rebuilding of Kalemler village

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P5: Architectural Engineering Graduation Studio  
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Technical University of Delft

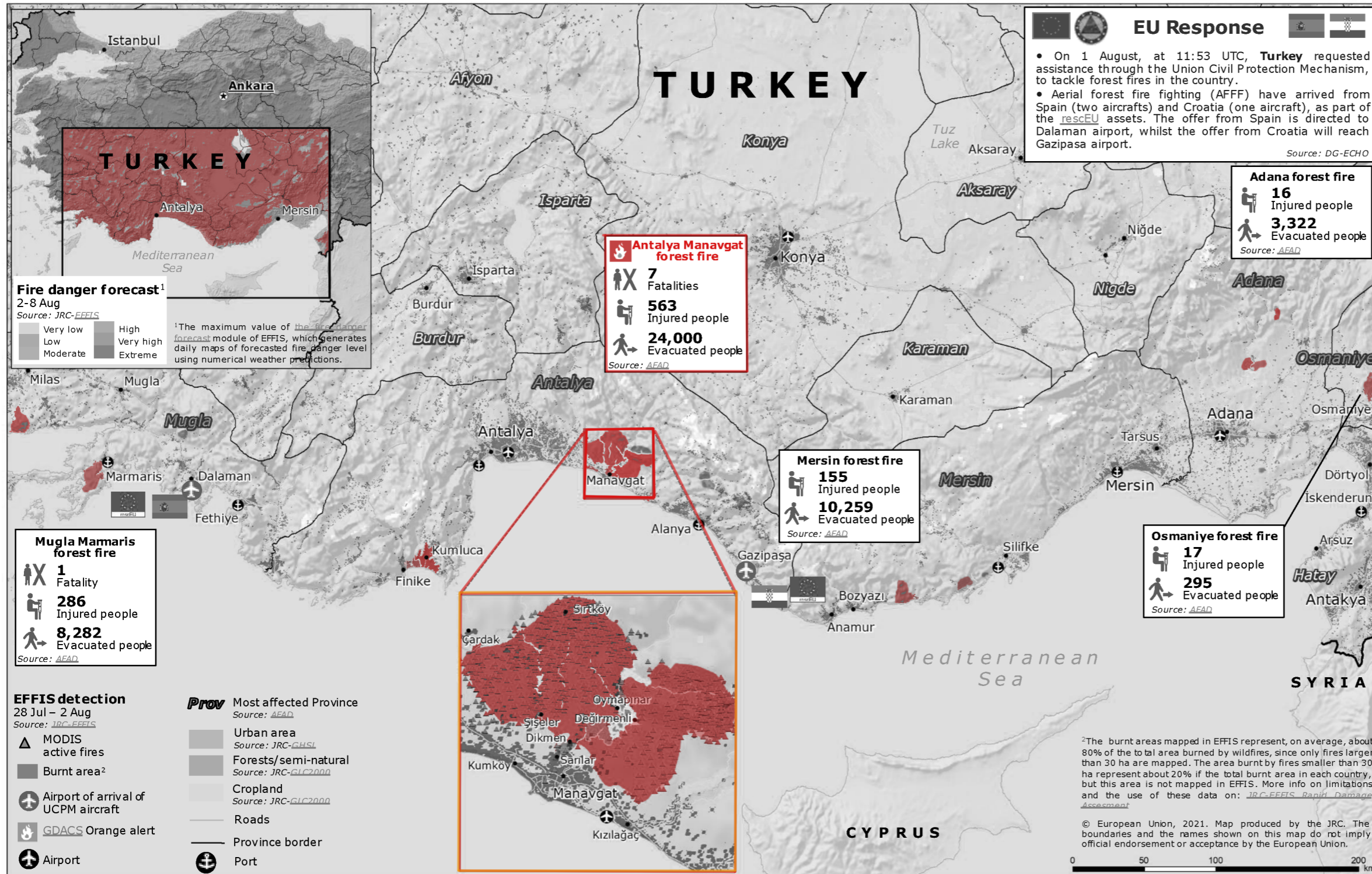
Introduction

Research

Design project

## Introduction

# Turkey | Forest fires and UCPM activation



## Summer 2021: Wildfire disasters in Turkey

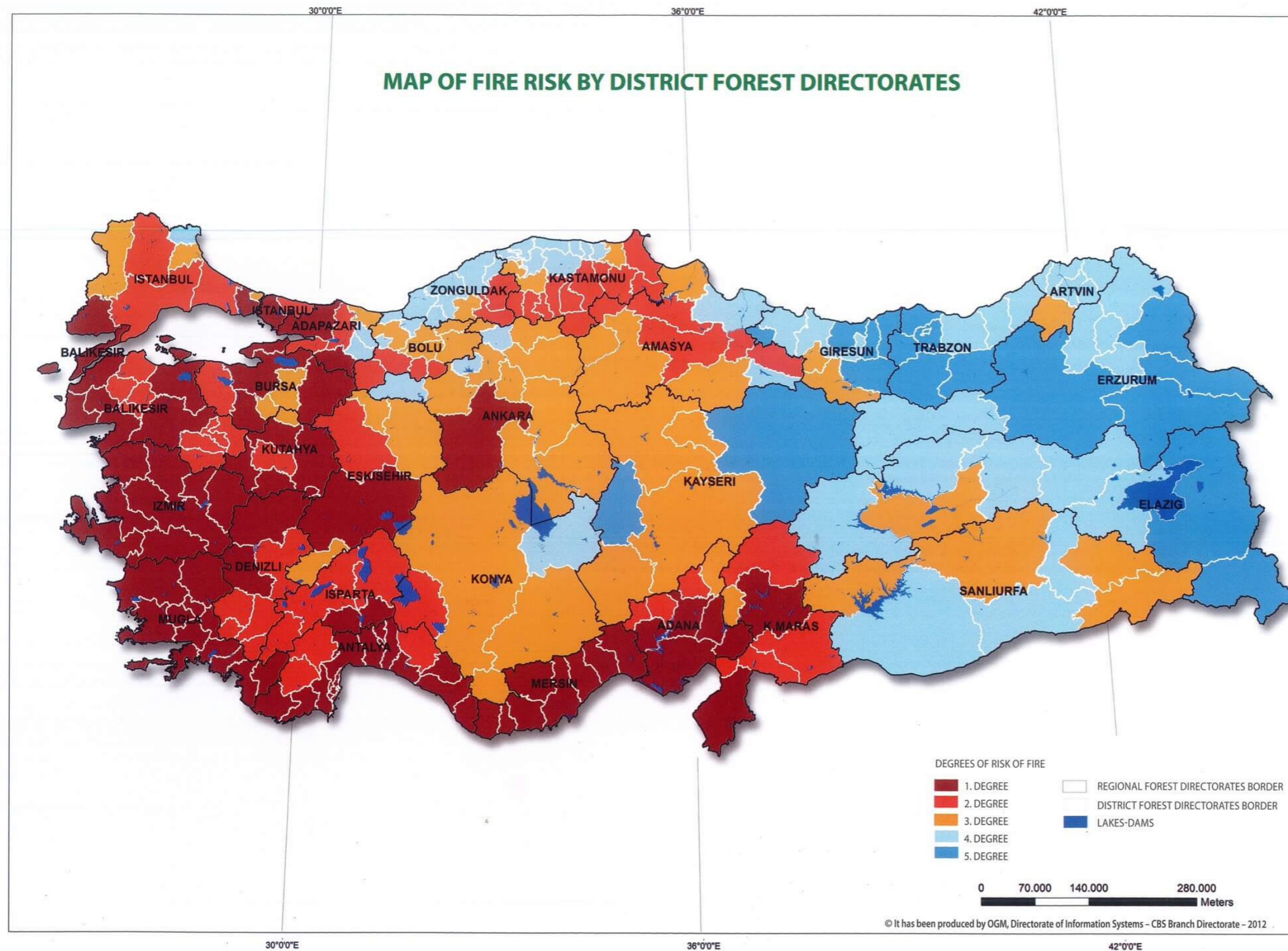
270 wildfires

Most extreme in: Manavgat, Antalya

Map of Wildfires in Manavgat and Mugla, own modifications.  
(From: ERC, 2022. <https://erccportal.jrc.ec.europa.eu/ECHO-Products/Maps#/maps/3782>)

## Riskiest wildfire areas

Mediterranean region of Turkey



Map of wildfire risk areas in Turkey  
(From: IAWFOnline, 2021. <https://www.iawfonline.org/article/fire-globe-wildfire-in-turkey/> )



**District Manavgat  
59 villages destroyed**

*Help came too late  
or not at all...*

*Firefighters prioritised touristic cities*



*Villagers battled on their own*

*Water & power cuts*



**Villagers lost their:**

*Loved ones*

*Houses*

*Barns*

*Income sources:  
agriculture & livestock*



**Fire smoke**  
caught on satellites

(Own modifications, from Google Images Databank, 2022)



“The fire scared everybody”

(From: Antalya Ekspres, 2022. Arazide çıkan yangın korkuttu. <http://antalyaekspres.com.tr/gundem/haber/arazide-cikan-yanin-korkuttu/869052>)

## Not the last time: climate change

Wildfires will occur more often.

(From: KNMI, 2021. <https://www.knmi.nl/kennis-en-datacentrum/uitleg/bosbranden>)

*First fire of 2022 already happened in Antalya*



**How will these destroyed villages be re-  
built?**  
What is their future?

Research



## **Problem statement (1):**

- 1. No involvement of wildfire resiliency strategies in current rebuilding plans**

### **Government:**

Mass-build, no involvement of locals, low quality materials & surprise costs

### **Locals:**

Go back to old habits

### **Worldwide research:**

No scale of villages in wildfire resilient rebuilding





(From Google Images Databank, 2022)

### **Built since last summer:**

Few poor quality housing, no wildfire resiliency



**Problem statement (2):**

**2. Local earth construction practices almost disappeared overtime**

Turkish villagers: *self-made earth houses*

Change 20th century: *brick & concrete*

Knowledge → outdated





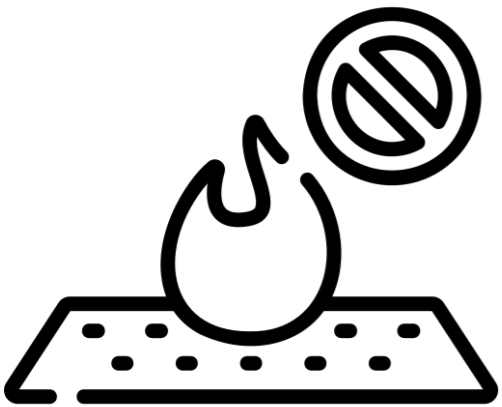
Directly available



Free when excavated on own properties



Positive effect on mental & physical human health



Non-combustible (does not burn)



Natural thermal mass



Natural sound insulation

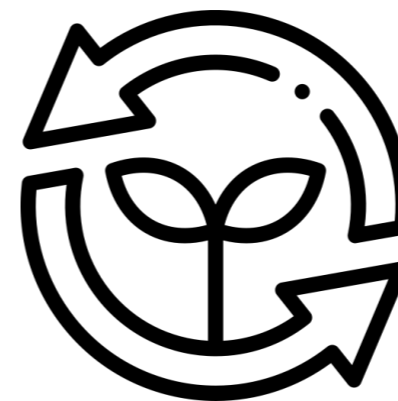
**Opportunity:**  
Reintroduce earth construction methods in an innovative way



No transportation costs



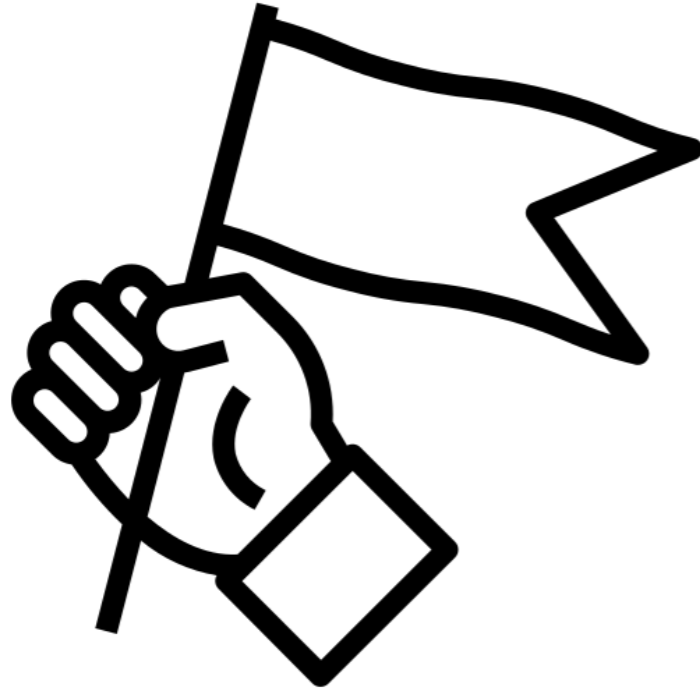
No construction waste



Endless recyclability

**How can destroyed villages in wildfire risk areas be rebuilt in a new wildfire resilient way, involving local building skills and knowledge in the Mediterranean region of Turkey?**  
*-Overall Design Question*

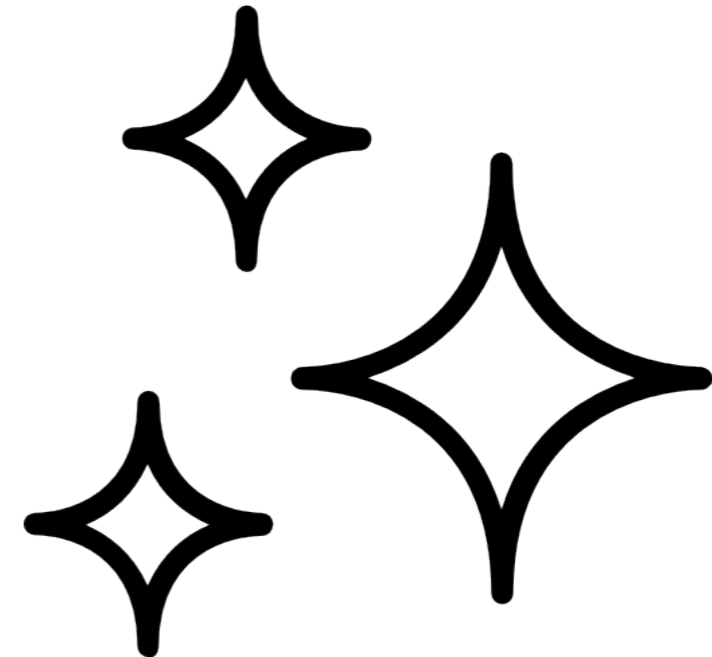
# Objectives



**Wildfire victims move forward independently from the government**



**Rebuild their houses themselves in a responsible & wildfire resilient way**



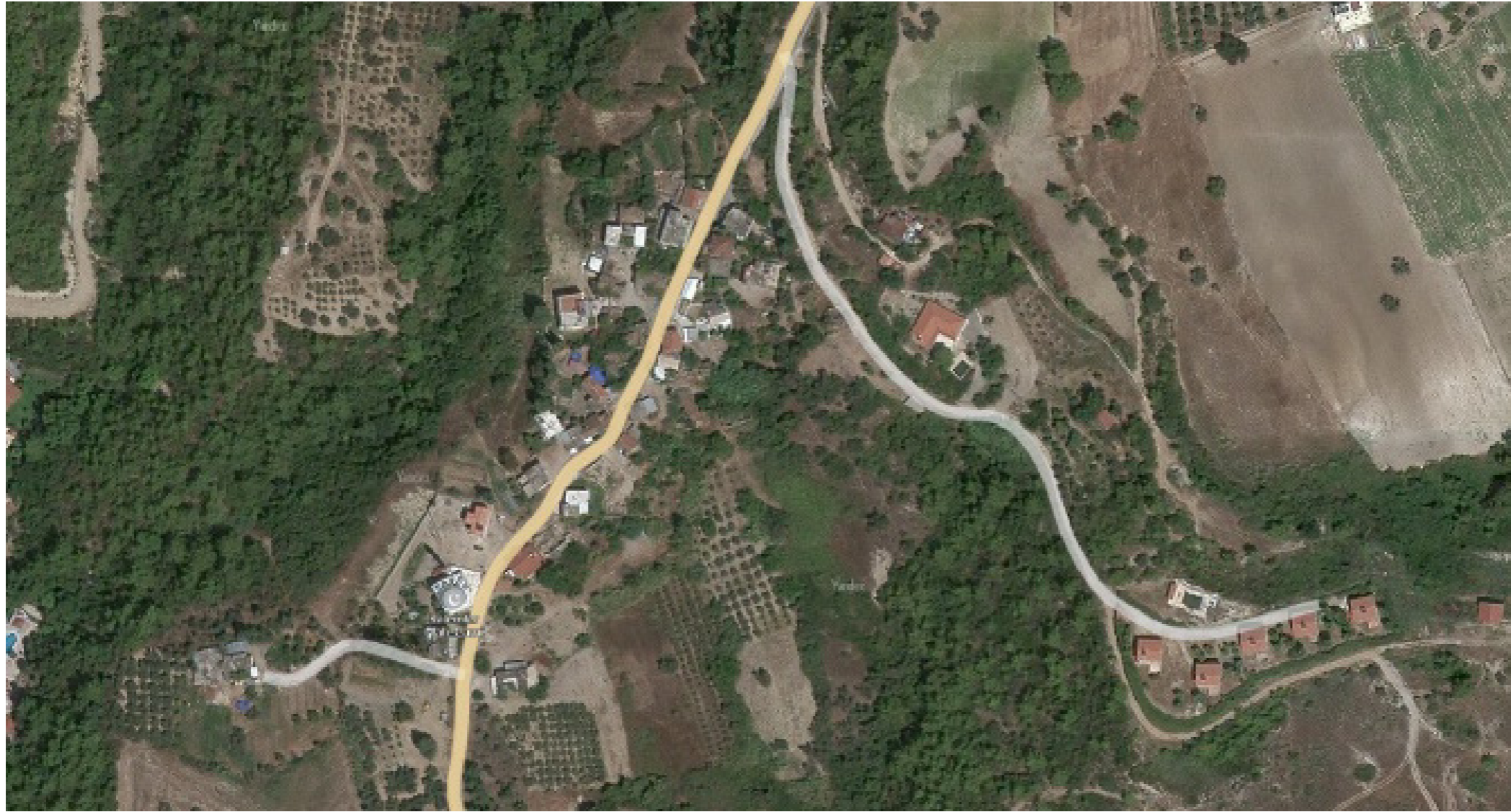
**Survive future wildfires disasters with minimum damage**

Harvest materials and sources at hand

Involve locals

Innovate local self-building knowledge & skills

Long-term sustainable building knowledge



Village scale (from Yandex Maps Databank, 2021)



National scale  
(Own modifications, from Google Earth Databank, 2021)



Provincial scale  
(Own modifications, from Google Earth Databank, 2021)

## Design & Research village: KALEMLER

### Most damaged village

Representative for others:  
*Community, settlement in landscape,  
on mountain slope & nearby touristic  
cities*



Kalemler after wildfires  
(from Ankageo Cesium Api Databank, 2021)

# Wildfire resilient village rebuilding strategy scales:

1. Community

2. Village

3. Building typology

4. Construction

5. Landscape

**How could innovation of vernacular façade earth construction methods contribute to a wildfire resilient rebuilding strategy for burned down villages in the Mediterranean region of Turkey?**  
*-Thematic research question*

## Architectural ethnographic research



### Field trip:

Interviewed:  
*local villagers*  
*local imam*  
*architects*  
*building constructors*  
*contractors*  
*politicians*

### Learned:

1. local historic earth construction methods (mud bricks)

2. presence of earth construction skills and knowledge

*Building houses = 'common knowledge'*

& the potential to reintroduce earth construction to self-builders

(Images blurred after presentation for privacy)



## Geobased local mining

### Learned:

1. Regional landscape

2. Local soil type

*Loam: sand, silt, clay, gravel*

4. Consistency test

*All field tests passed = local earth suitable*

## Litarature research

Comparison matrix  
5 earth construction methods:

Mudbrick  
Compressed earth block  
Light earth  
Cob

### **Rammed earth**

*Proposed earth construction method to introduce as local building method*

*Popular among interviewed villagers*

*Chemically: contains more earth particles per cubic meter due to ramming proces -> more dense building envelope against fire embers*



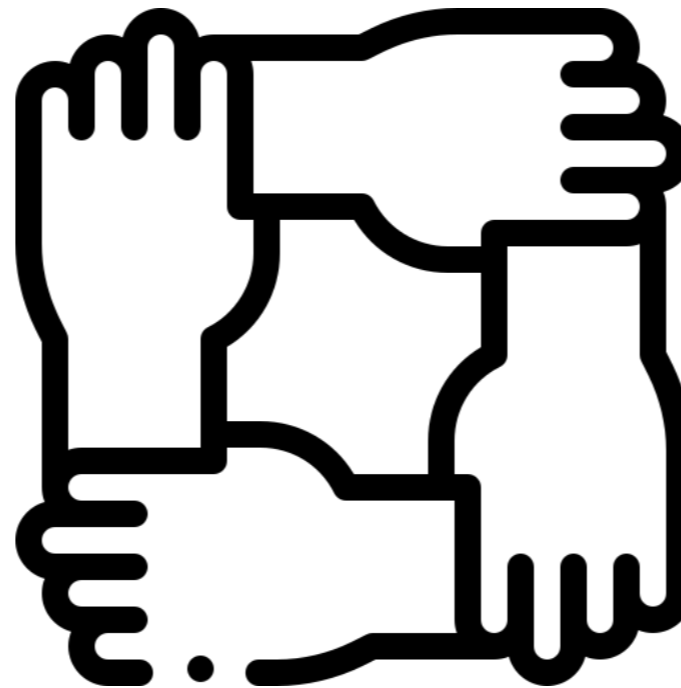
## Conclusion & implementation

The innovation of vernacular façade earth construction contributes to the wildfire resilient rebuilding strategy on 2/5 scales from the total strategy:



### 1. Construction detail

- Rammed earth construction
- Does not burn
- Does not require combustible straw on site
- Can be made with relatively cheap tools
- Easy repair method after surface damage



### 2. Community

- Very easy to learn
- Locals learn sustainable knowledge on innovated earth construction methods
- Continue their lives after wildfires in responsible and quick way
- Causes community bonding among neighbours - *increases chance of success in future plans*
- Revitalization process after wildfire trauma: good sleep in earth houses

Design project

## Situation Before Wildfire '21:

Kalemler:  
-24 houses  
-mosque  
-cemetery  
-barns

Chaotic mix of building  
materials  
(stone, wood, concrete,  
brick, steel, earth...)

*Difficult to focus on  
rebuilding*





(from local vilager, Öz, 2021)



(from local vilager, Öz, 2021)



(from local vilager, Öz, 2021)



(from local vilager, Öz, 2021)



(from local vilager, Öz, 2021)



## Situation After Wildfire '21:

*Almost tabula rasa*

Kalemler:  
-5 houses  
-mosque  
-cemetery

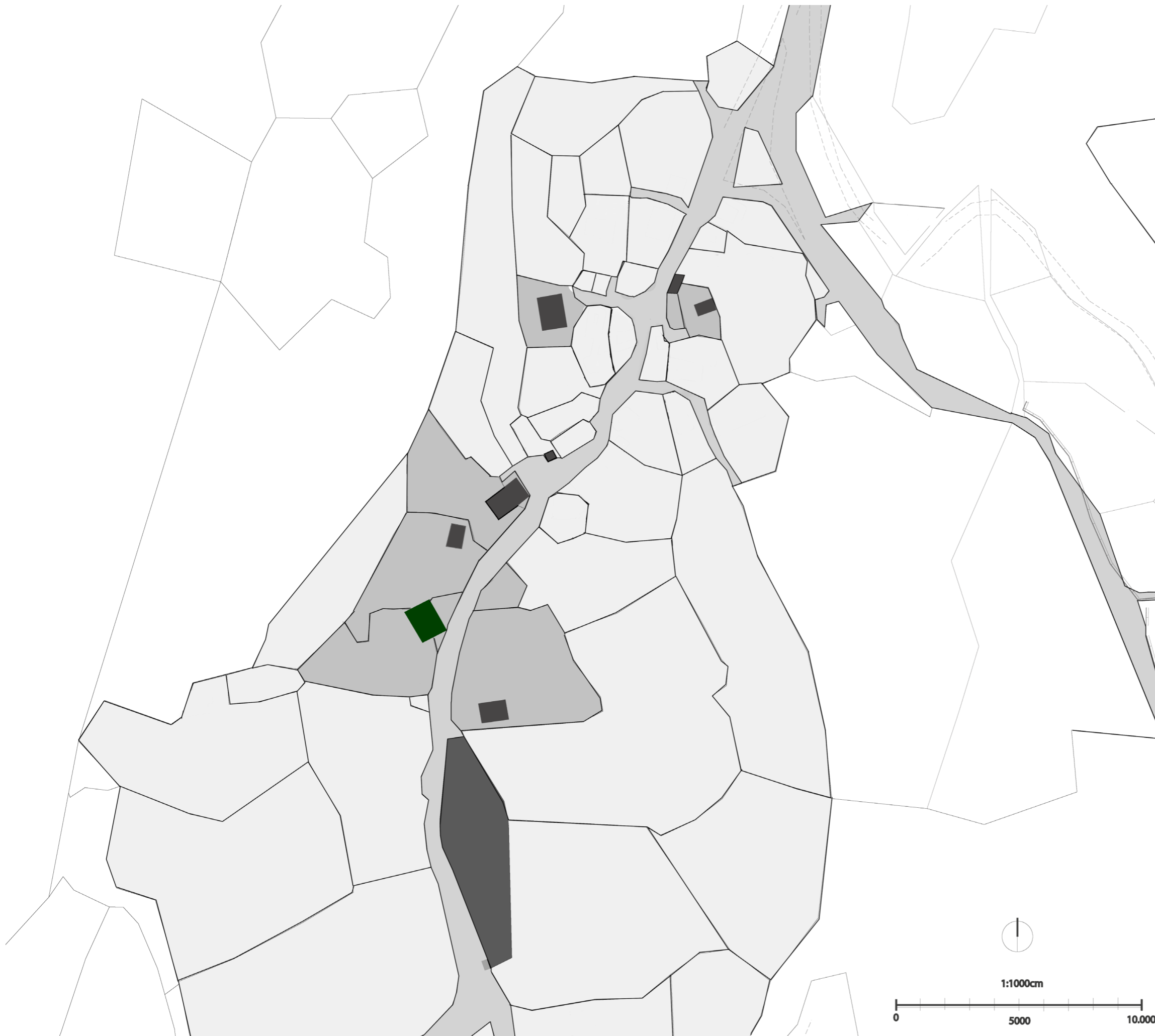


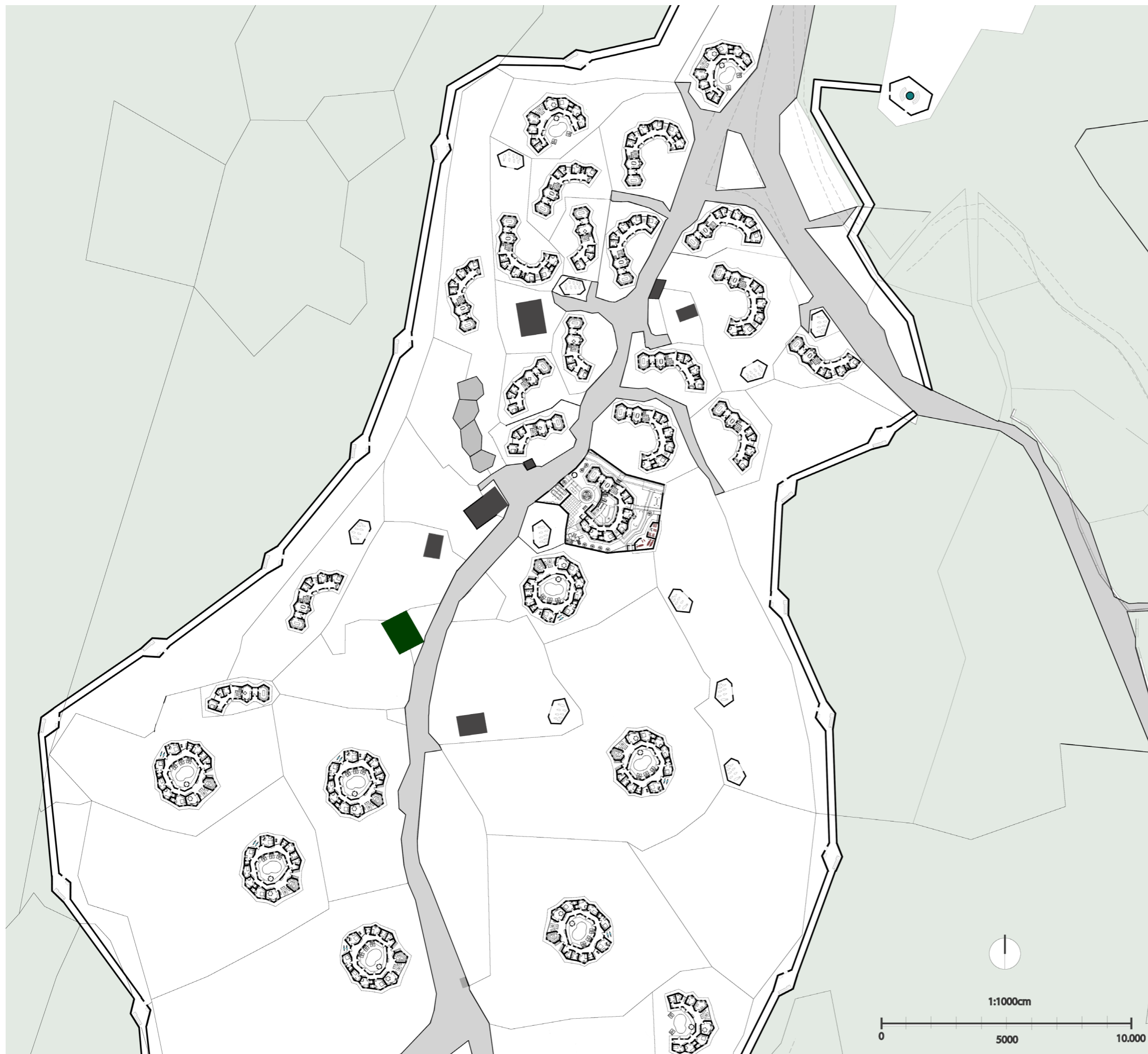
**Design |** situation after

**Village strategy:**

**Dark gray:**  
'The survivors'

**Light gray:**  
(Re)building space





## **Village strategy: Masterplan future**

Fusion village:  
traditional meets innovation

- Respect 'the survivors'
- Learn from them
- Build around them

## **Community centre**

### **28 New wildfire resilient houses:**

18 village houses (12m)  
10 holiday houses (3-12m)

### **Exterior walls**

### **Infrastructure points**

### **Watertower**



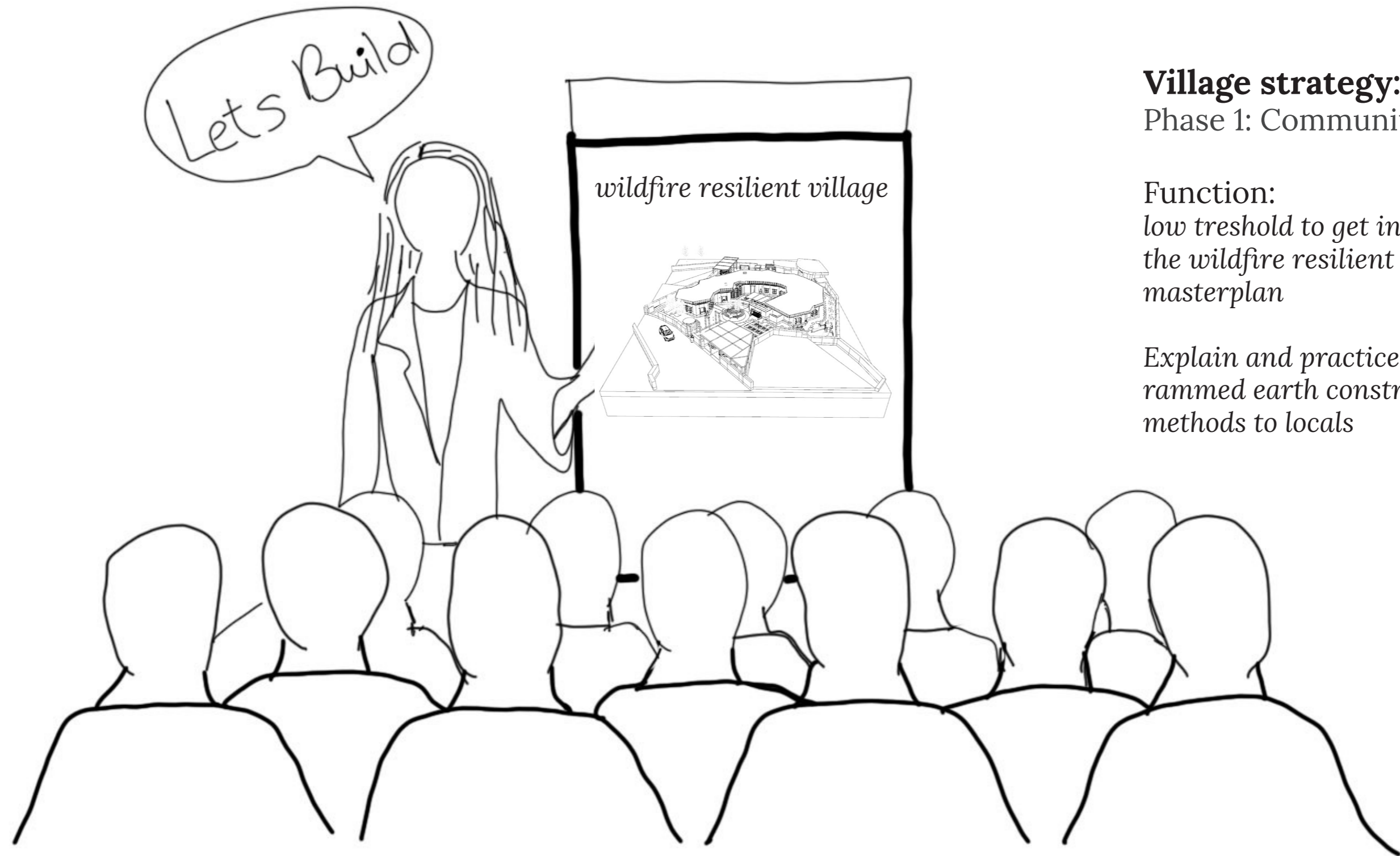
**Village strategy:**

Phase 1

**Community Centre:**

initiated: architect  
financed: municipality  
built: local building  
constructor

*Centered in village:  
equal distance to every villager*



**Village strategy:**  
Phase 1: Community Centre

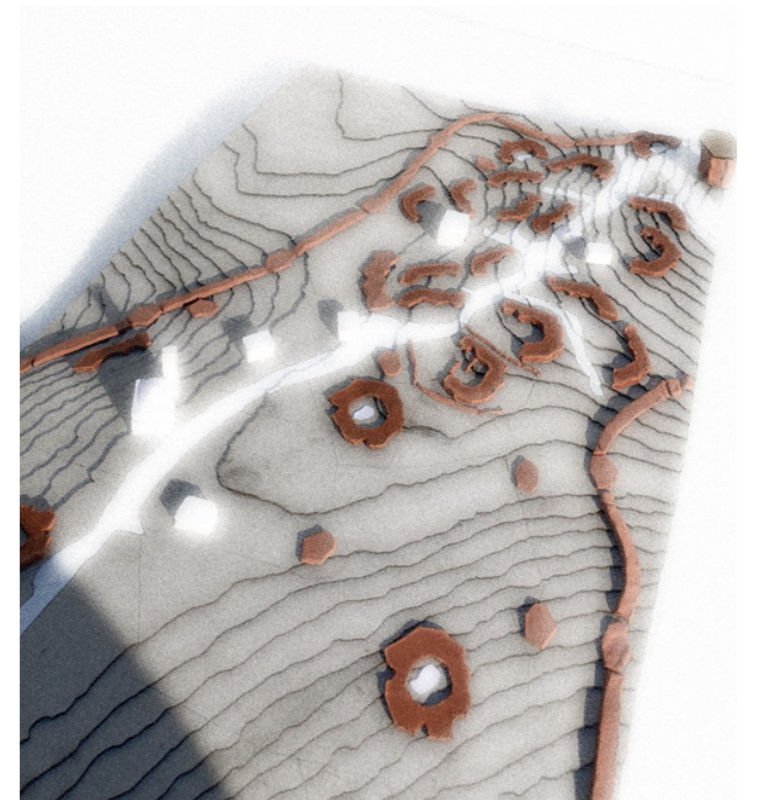
**Function:**  
*low treshold to get in touch with  
the wildfire resilient village  
masterplan*

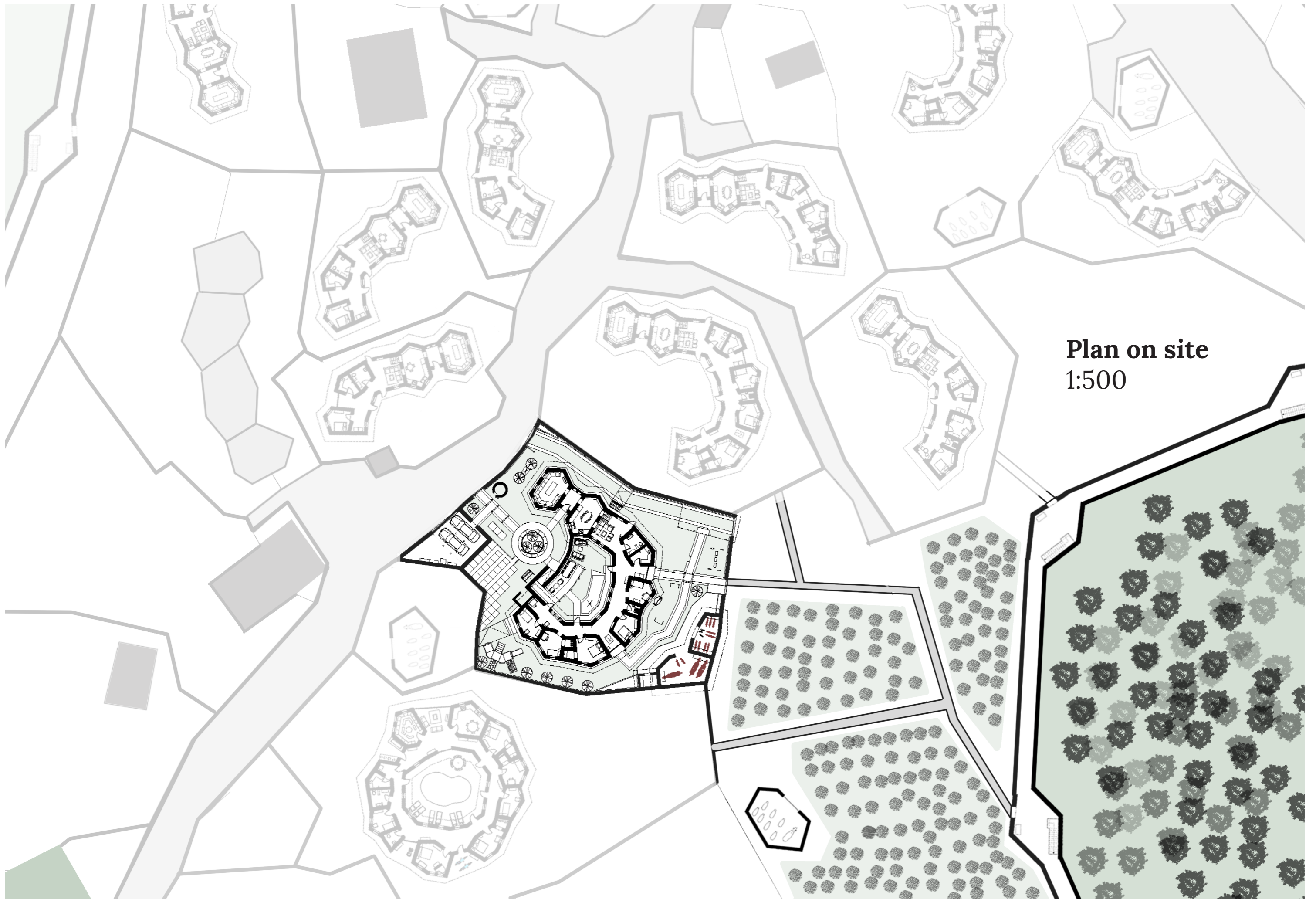
*Explain and practice  
rammed earth construction  
methods to locals*

**Village strategy:**  
Phase 2

**Wildfire resilient houses**  
18 houses:

6 (start) typology's





**Plan on site**  
1:500

# Wildfire resilient village house





# Wildfire resilient village house of the future

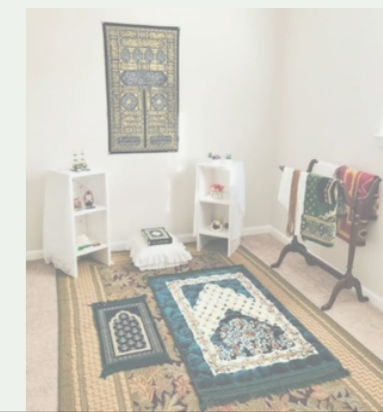


hammam



sedir space

prayer space

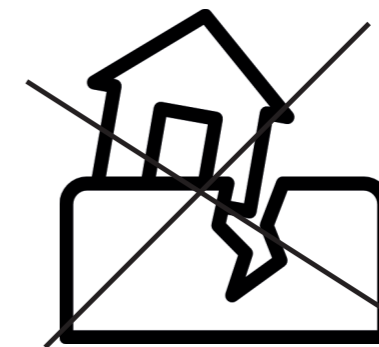


## Building typology strategy

Voronoi-principle  
6 corners

Shape:

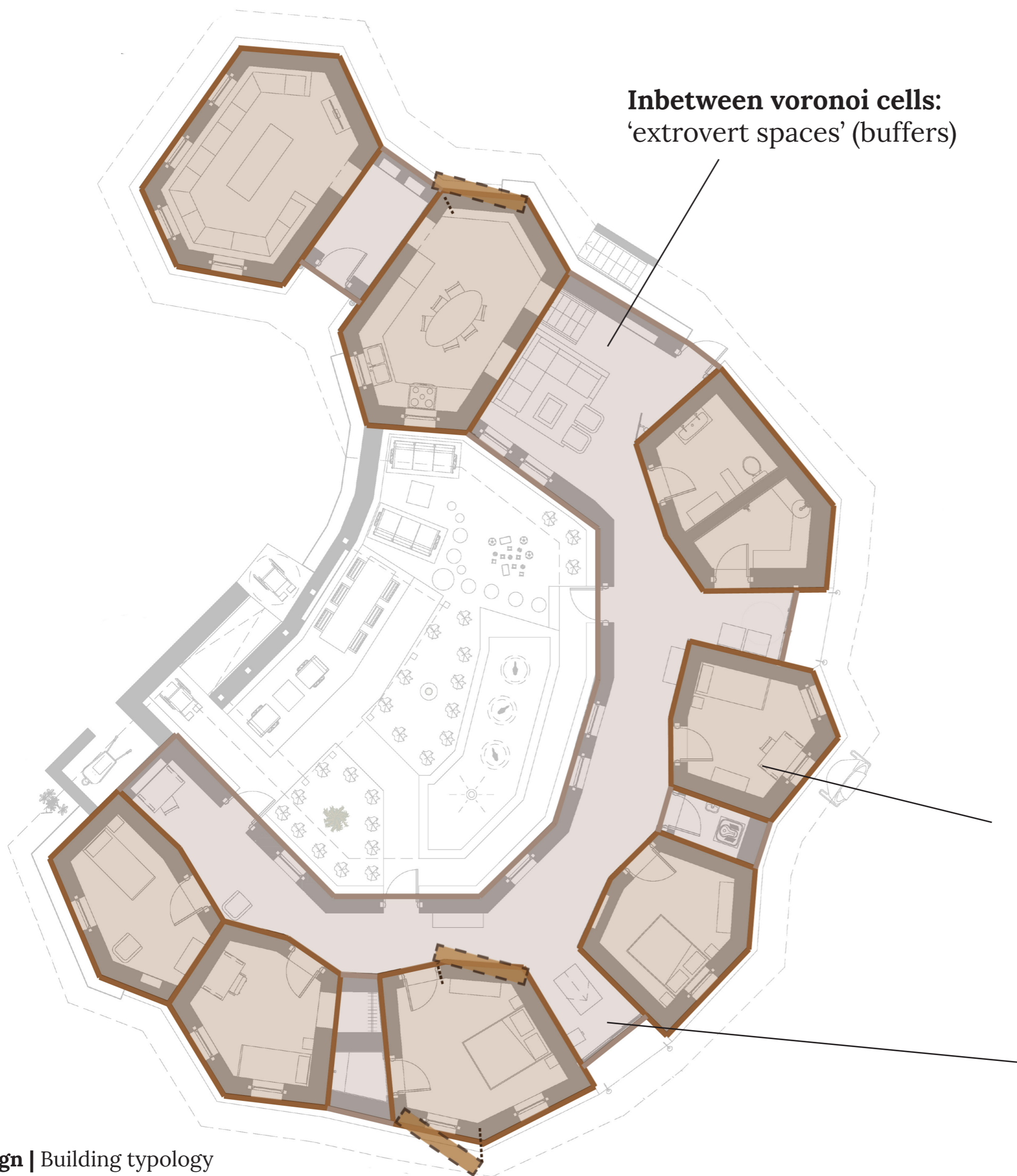
- cancels out lateral seismic forces (*earthquake area*)
- suits the organic vibe of village
- gives space for self builders
- accepts 'mistakes'
- follows daily life & practices



**Voronoi-cells:**  
'introvert rooms'

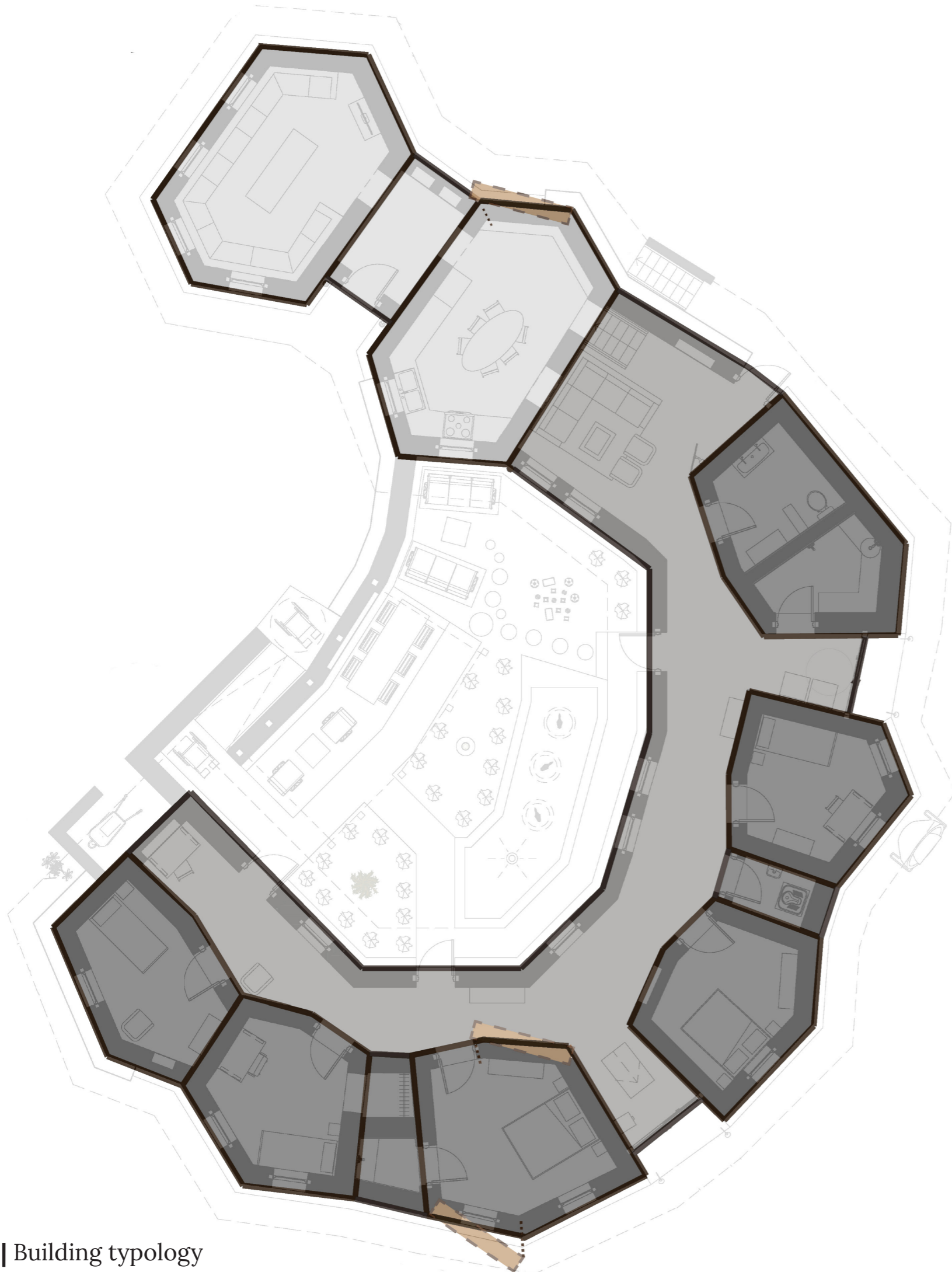
**Buffer zones:**  
deal with imperfections  
during construction

**Inbetween voronoi cells:**  
'extrovert spaces' (buffers)

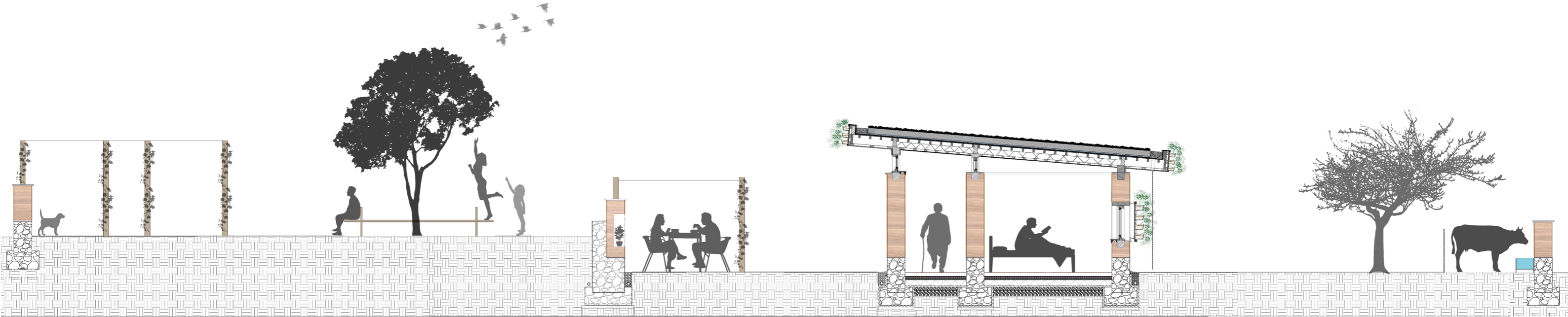


## Building typology strategy

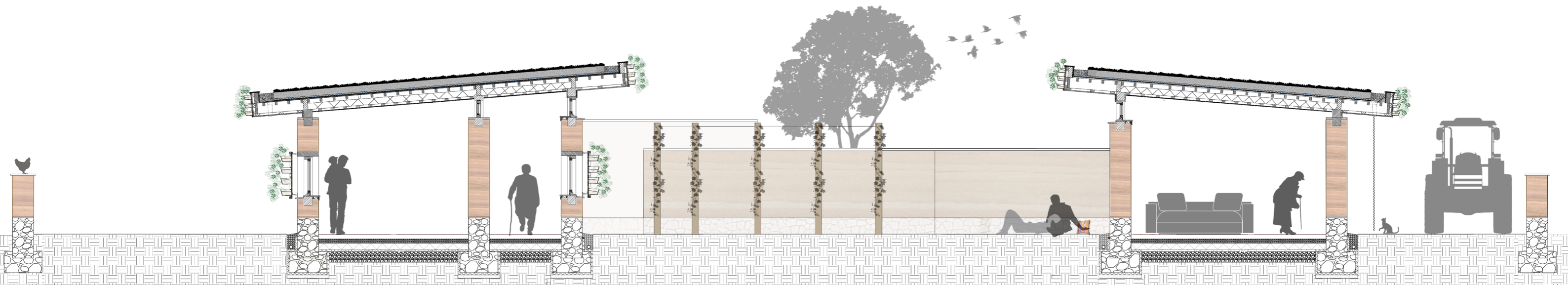
Privacy gradient:  
the deeper, the more private



**cross-cut west-east 1:50** (scaled to fit presentation)

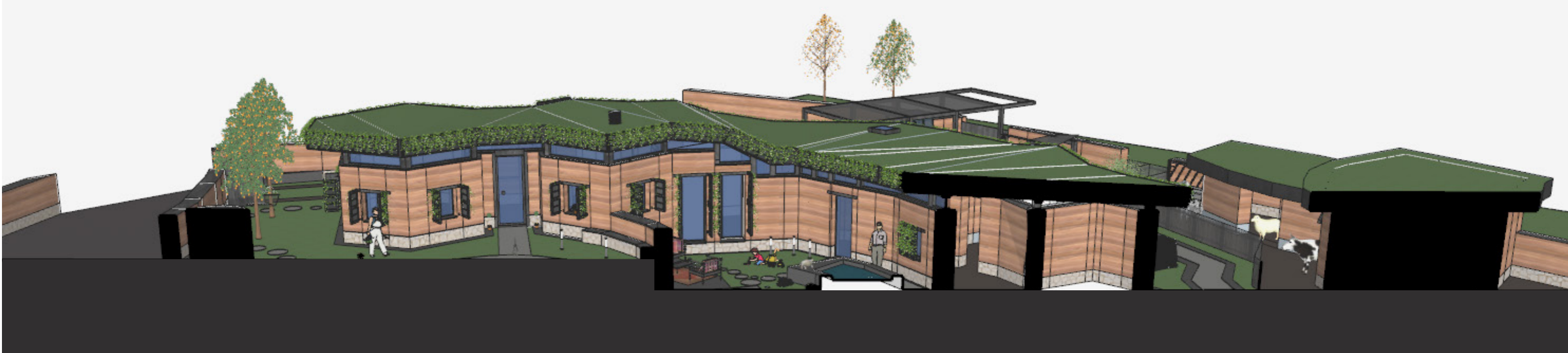


**cross-cut north-south 1:50** (scaled to fit presentation)





**cross-cut north-south 1:100** (scaled to fit presentation)



**cross-cut west-east 1:100** (scaled to fit presentation)



clay board



rammed earth



earth wool



rubble stone masonry



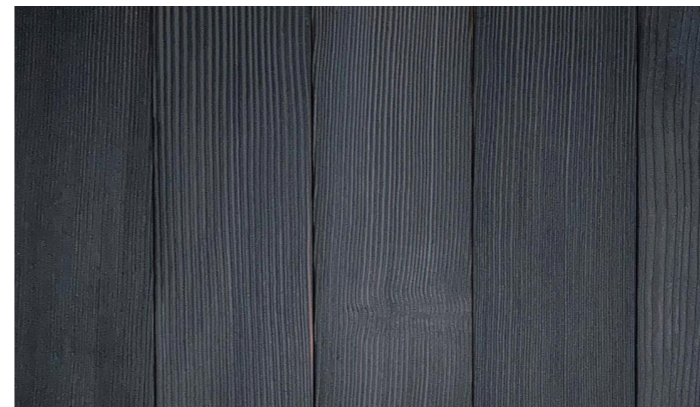
hemp insulation



earth: loam



sheep felt



burned pine timber

**To Harvest:**  
Fire resilient building  
materials  
(*Non-combustible*)

# Harvest map

## Material sources



(Own modifications, from Google Earth Databank, 2022)



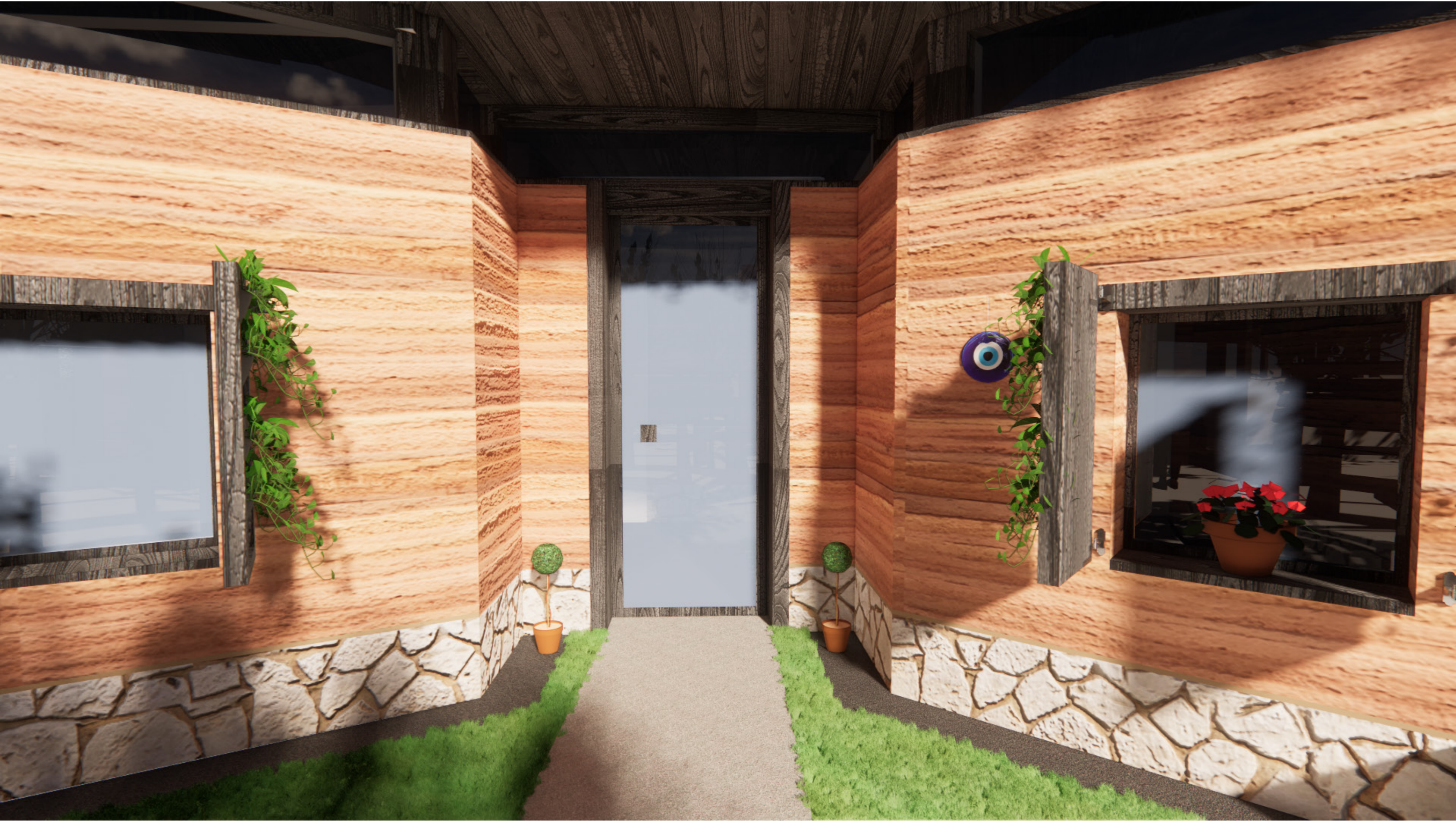
















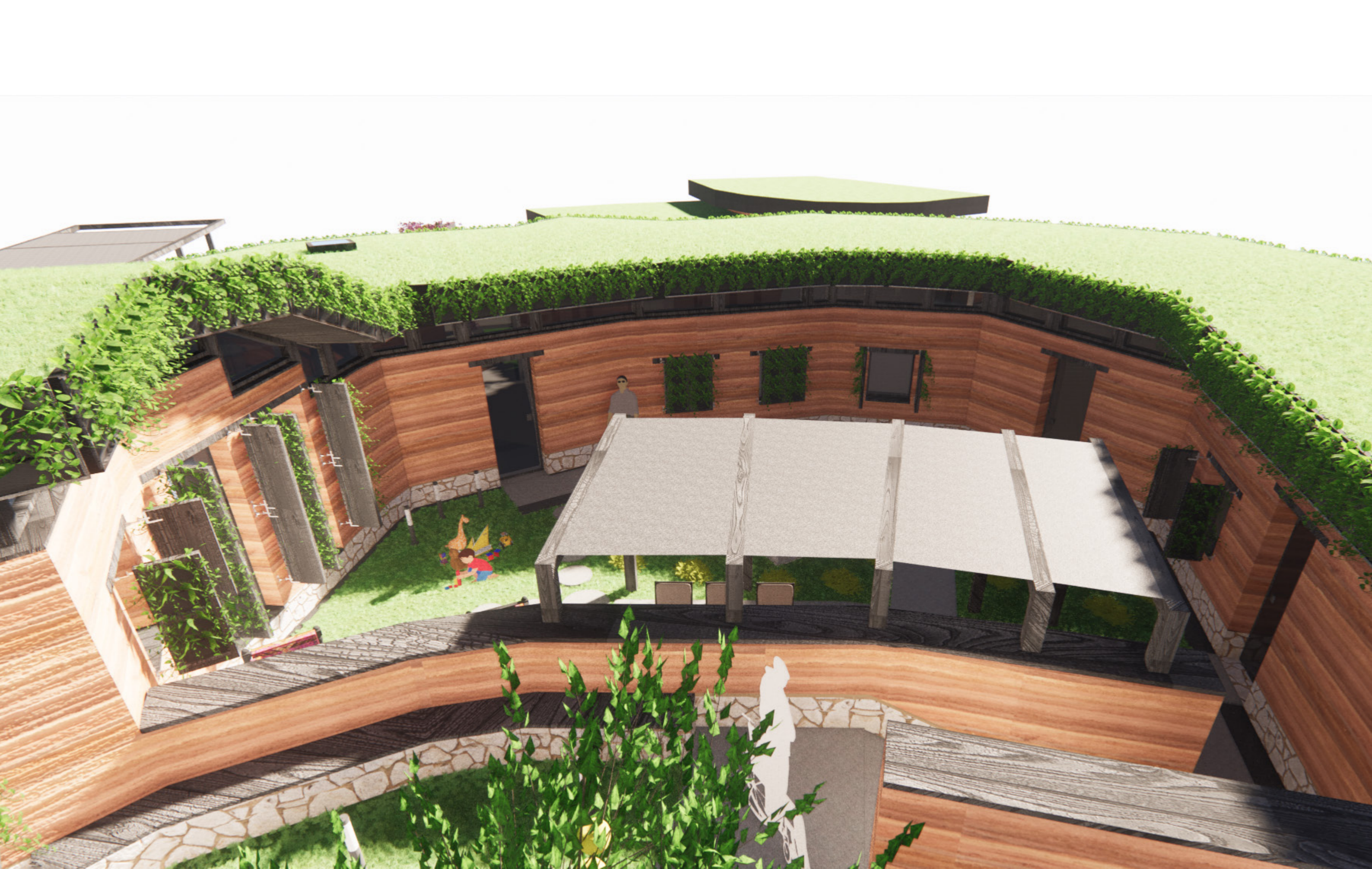




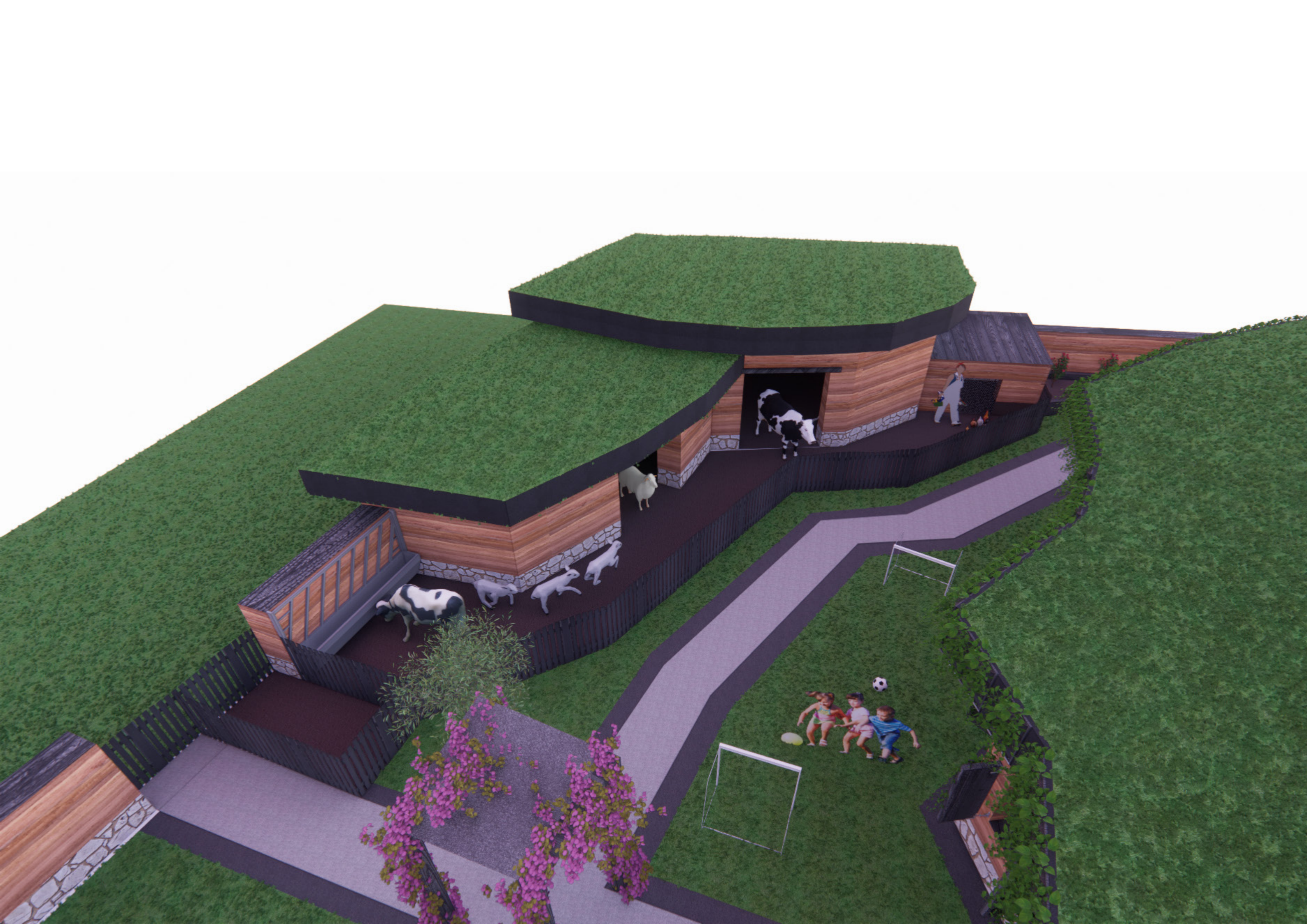








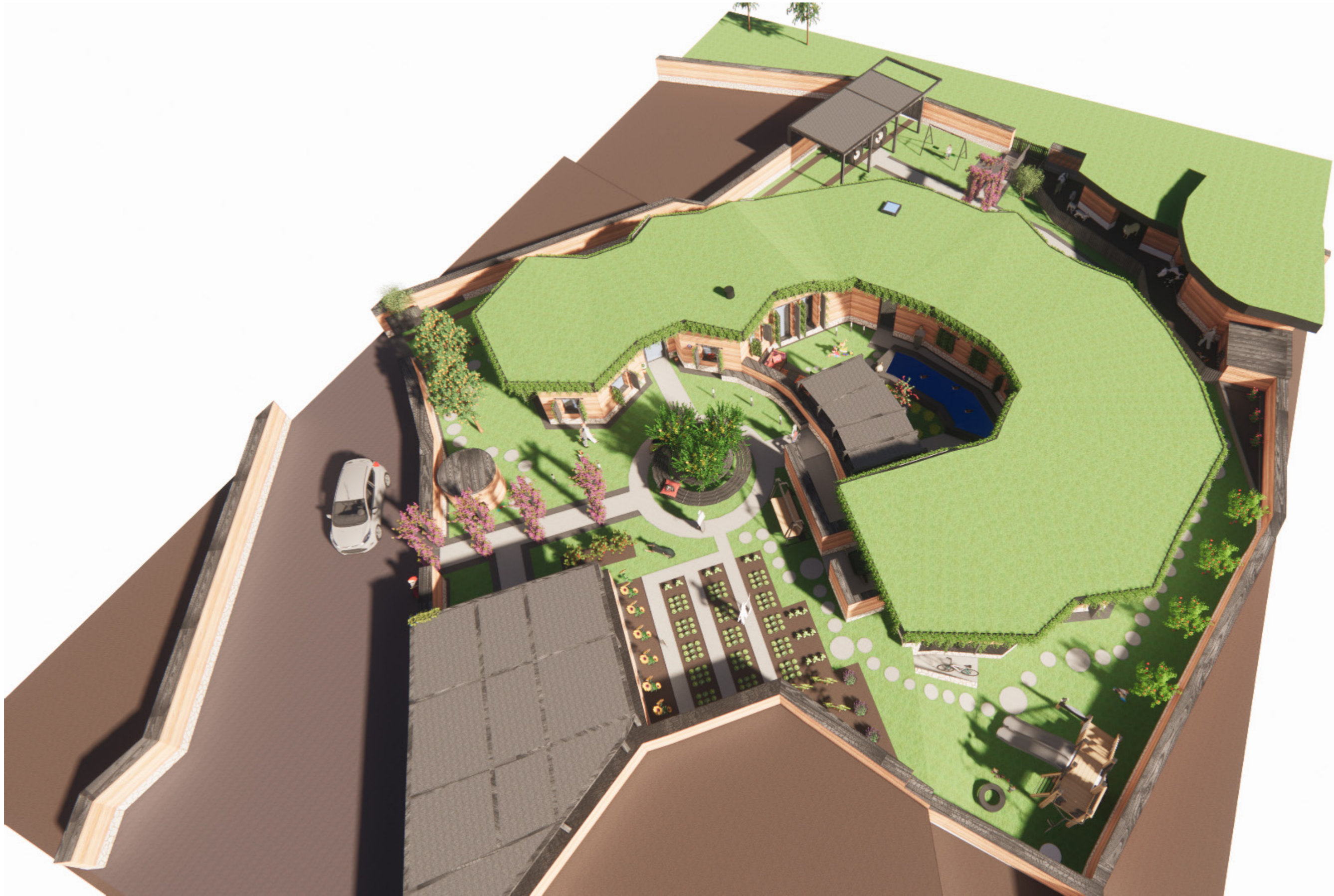






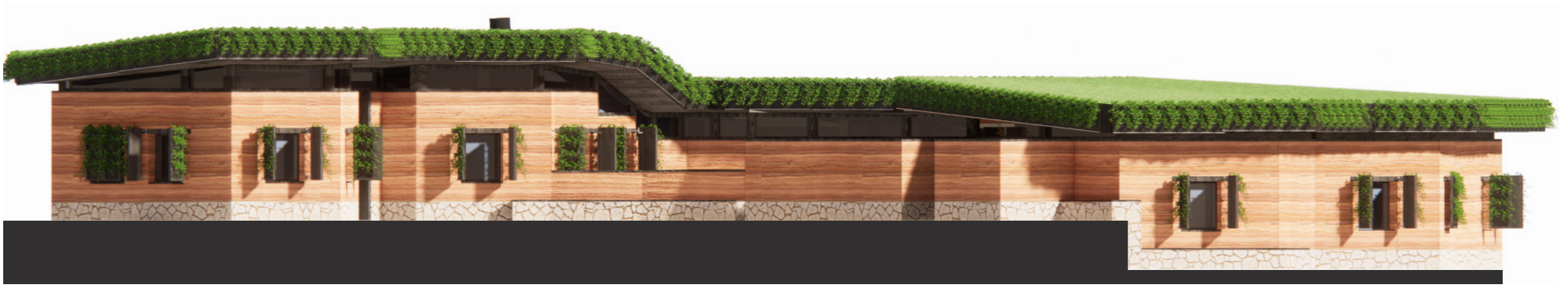








east façade 1:50



west façade 1:50



south façade 1:50

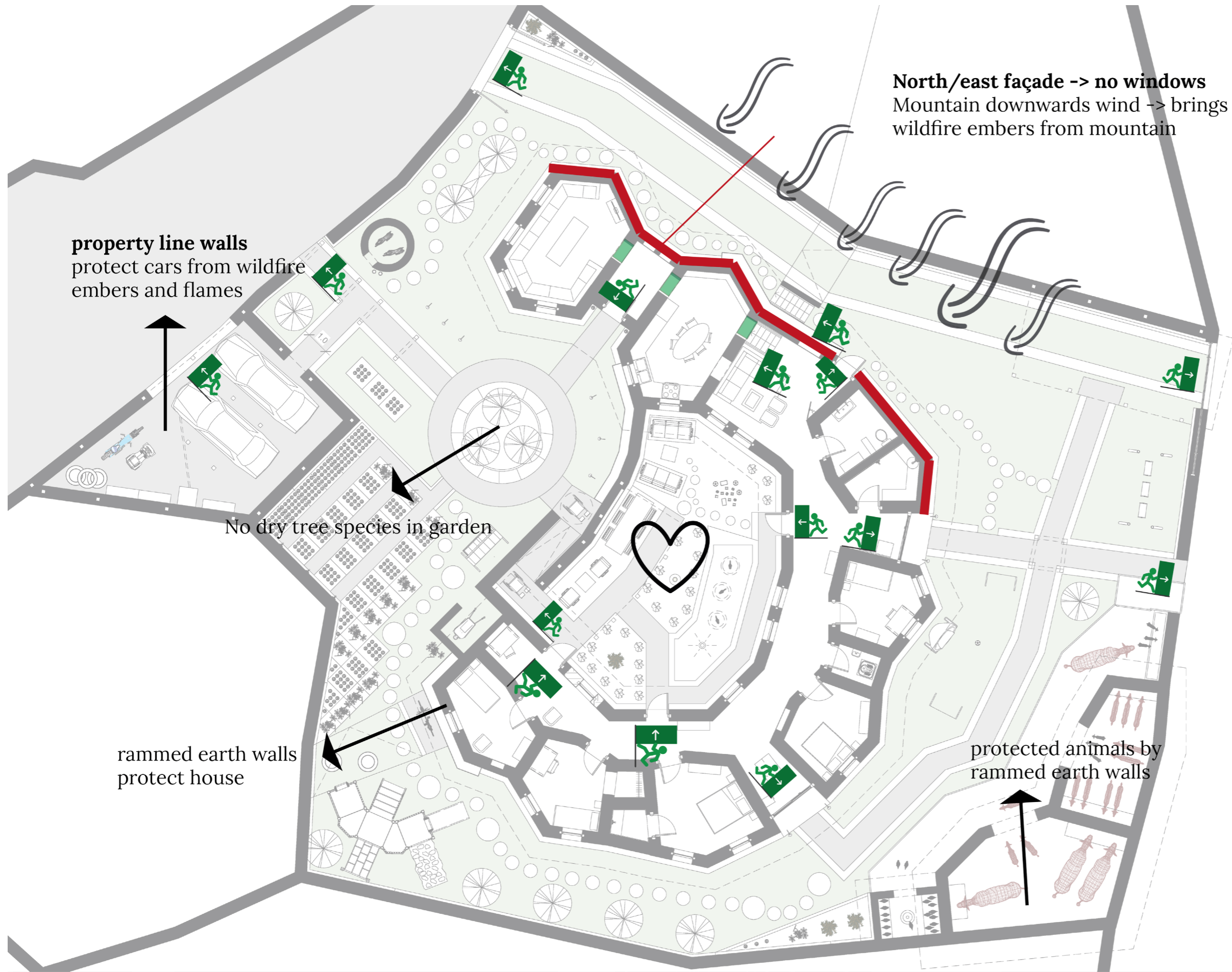


north façade 1:50

# Wildfire design strategy

Wildfire diagram legend:

- Escape
- Safe space in courtyard
- Escape routes





## Landscaping

### Wet tree species (High moist content)

- Apple tree
- Orange tree
- Olive tree
- Lemon tree

Fits local climate








**Paths:**  
pebbles  
stone

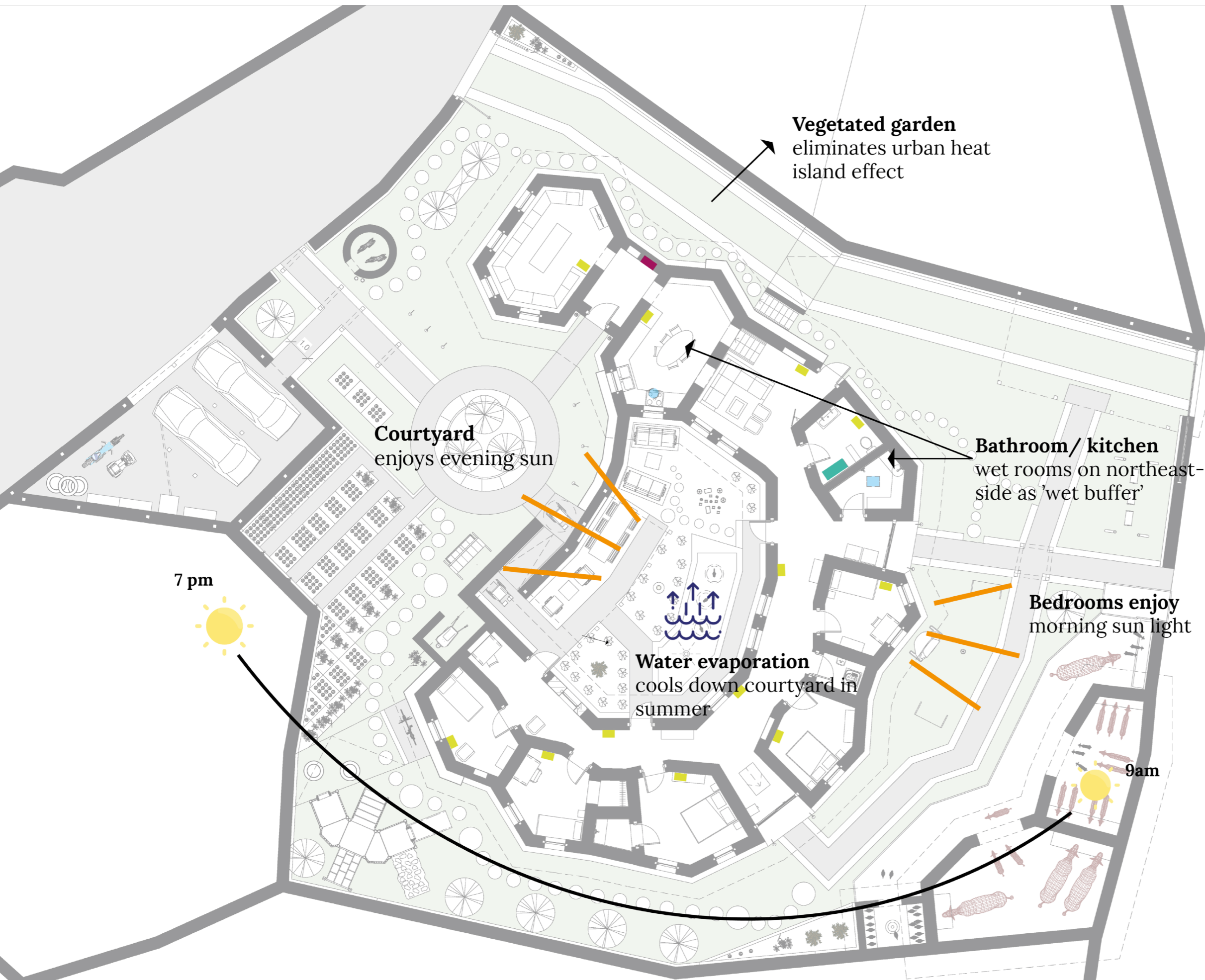


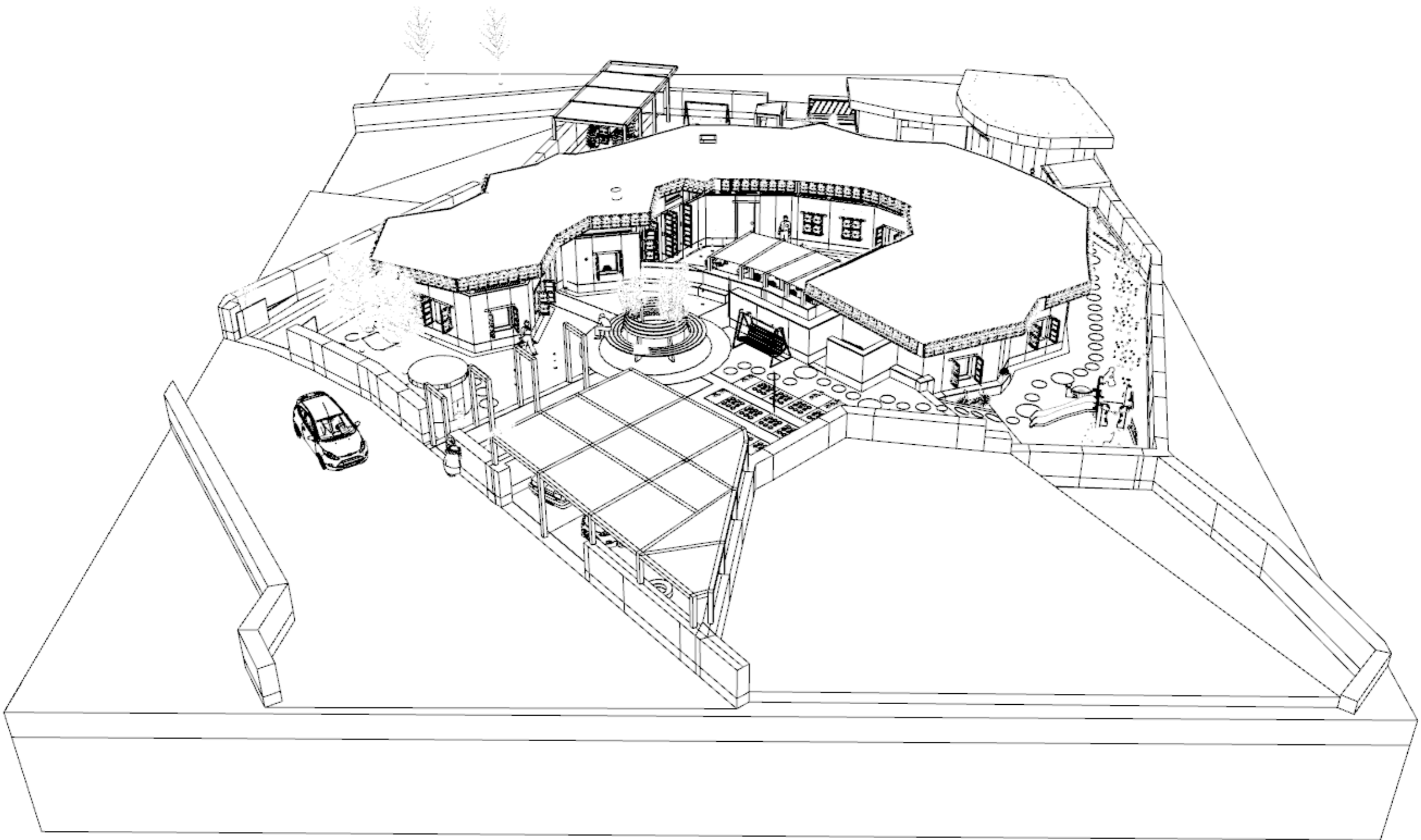
(from Google Images Databank, 2022)

# Climate design strategy

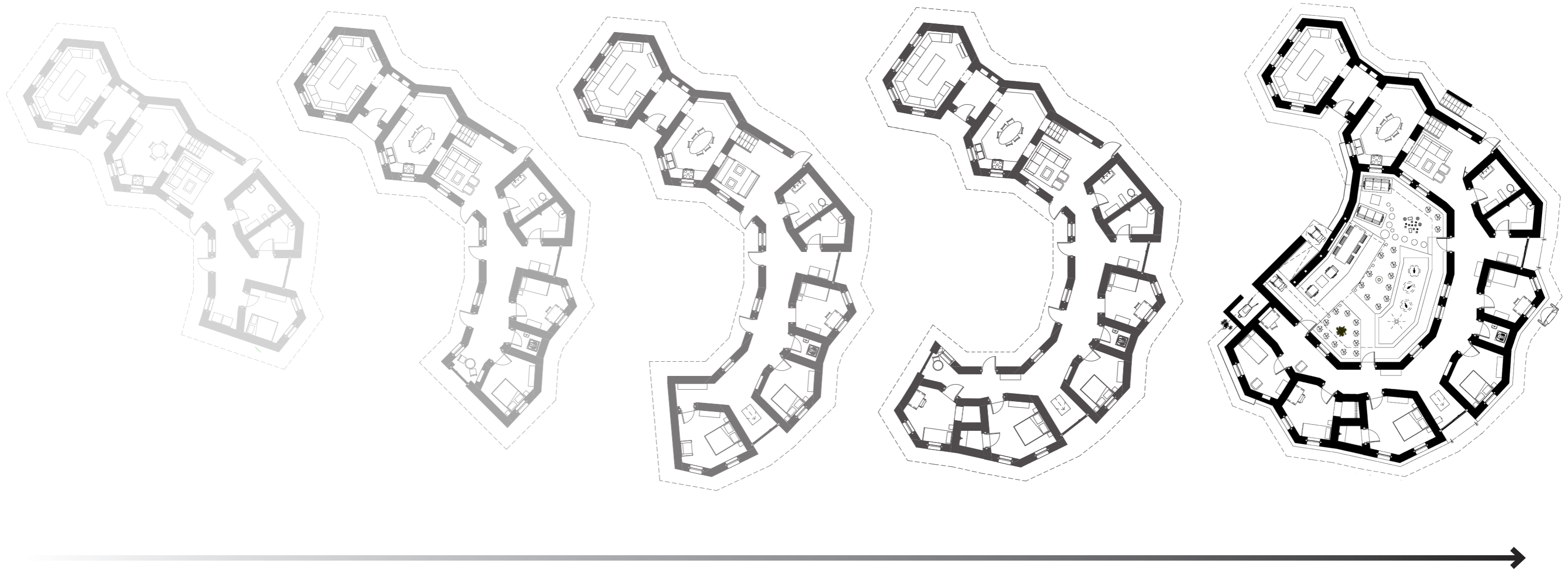
Practical diagram legend:

-  fuse box
-  heatpump-boiler
-  electric heaters
-  cooking shaft
-  hamam roof window

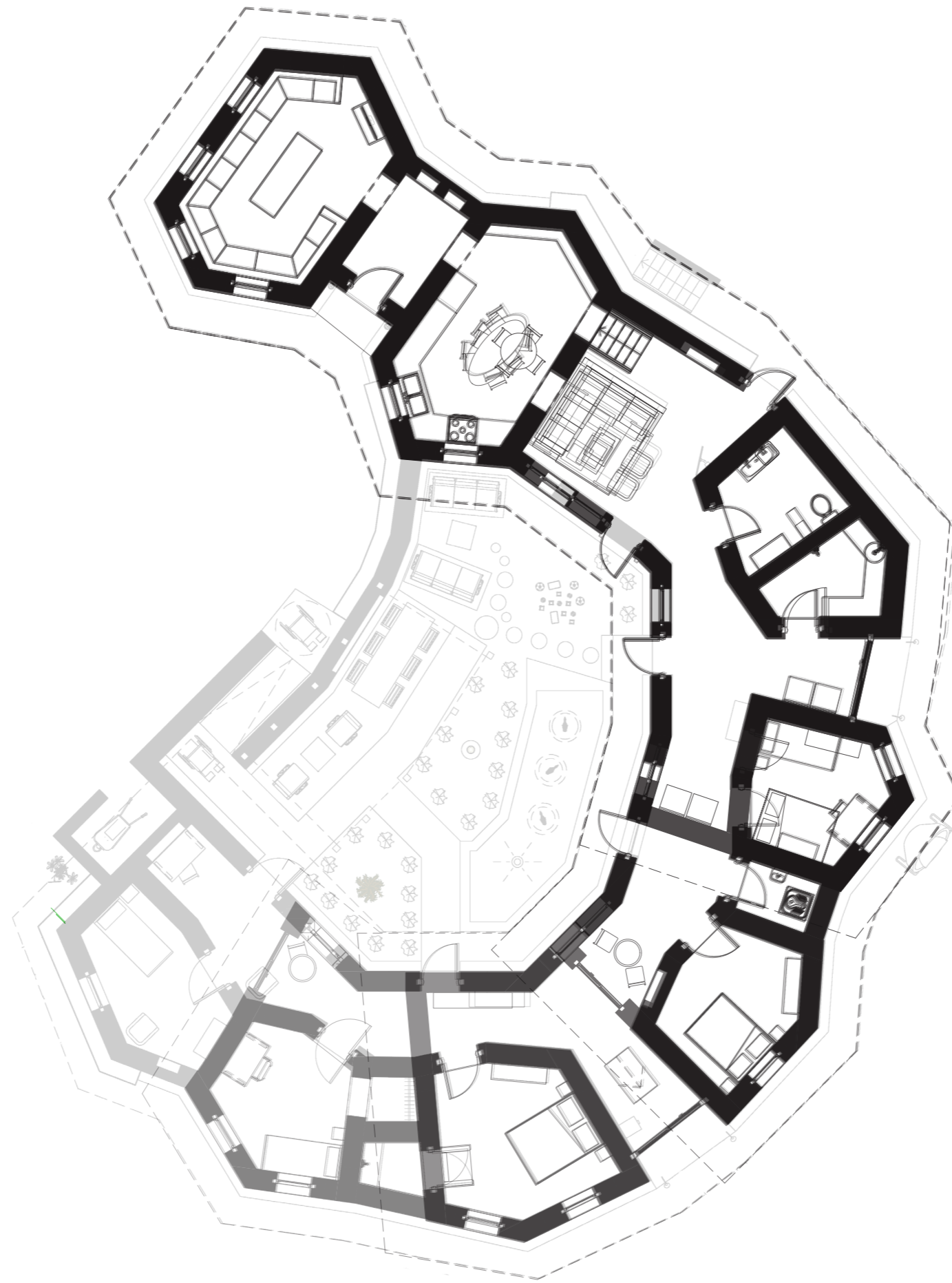




# Building typology strategy: House can grow according to household needs



**Building typology strategy:**  
House can grow according to household needs





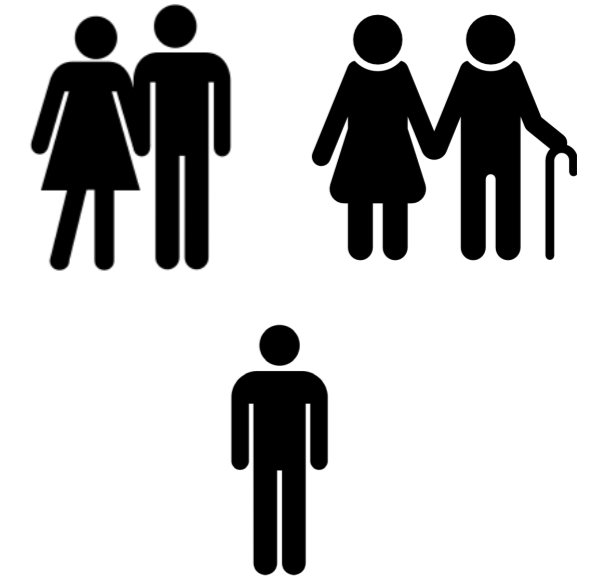
## Village strategy:

Phase 2

### Typology 1: S-house

(starter)

Users: 1-2 person household



#### Rooms:

Sedir living room

Entree with fuse box and  
built-in closet in wall

Kitchen with dining room

Private living space

Bathroom: separate toilet and  
hammam

1 bedroom



## Village strategy:

Phase 2

## Typology 2: W-house (Wheelchair)

Users: 1-2 person household



Wheelchair - proof

### Rooms:

Sedir living room

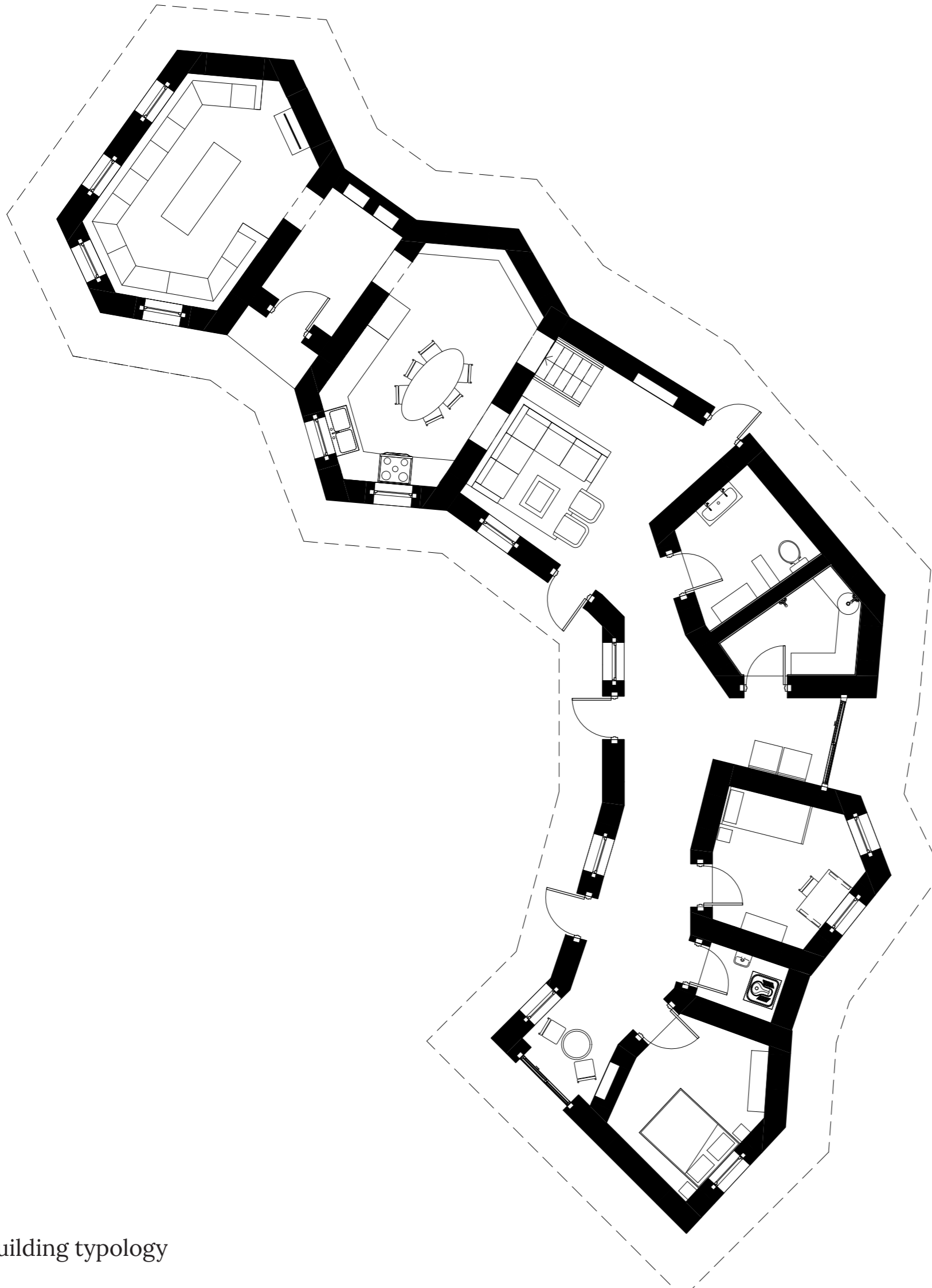
Entree with fuse box and  
built-in closet in wall

Kitchen with dining room

Private living space

Bathroom: separate toilet and  
hammam

1 bedroom

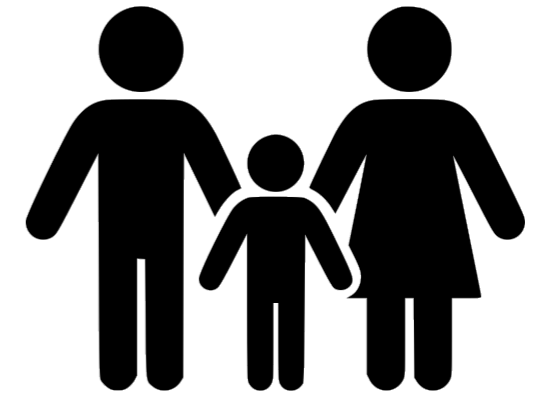


## Village strategy:

Phase 2

## Typology 3: M-house (medial)

Users: 2-3 person household



### Rooms:

Sedir living room

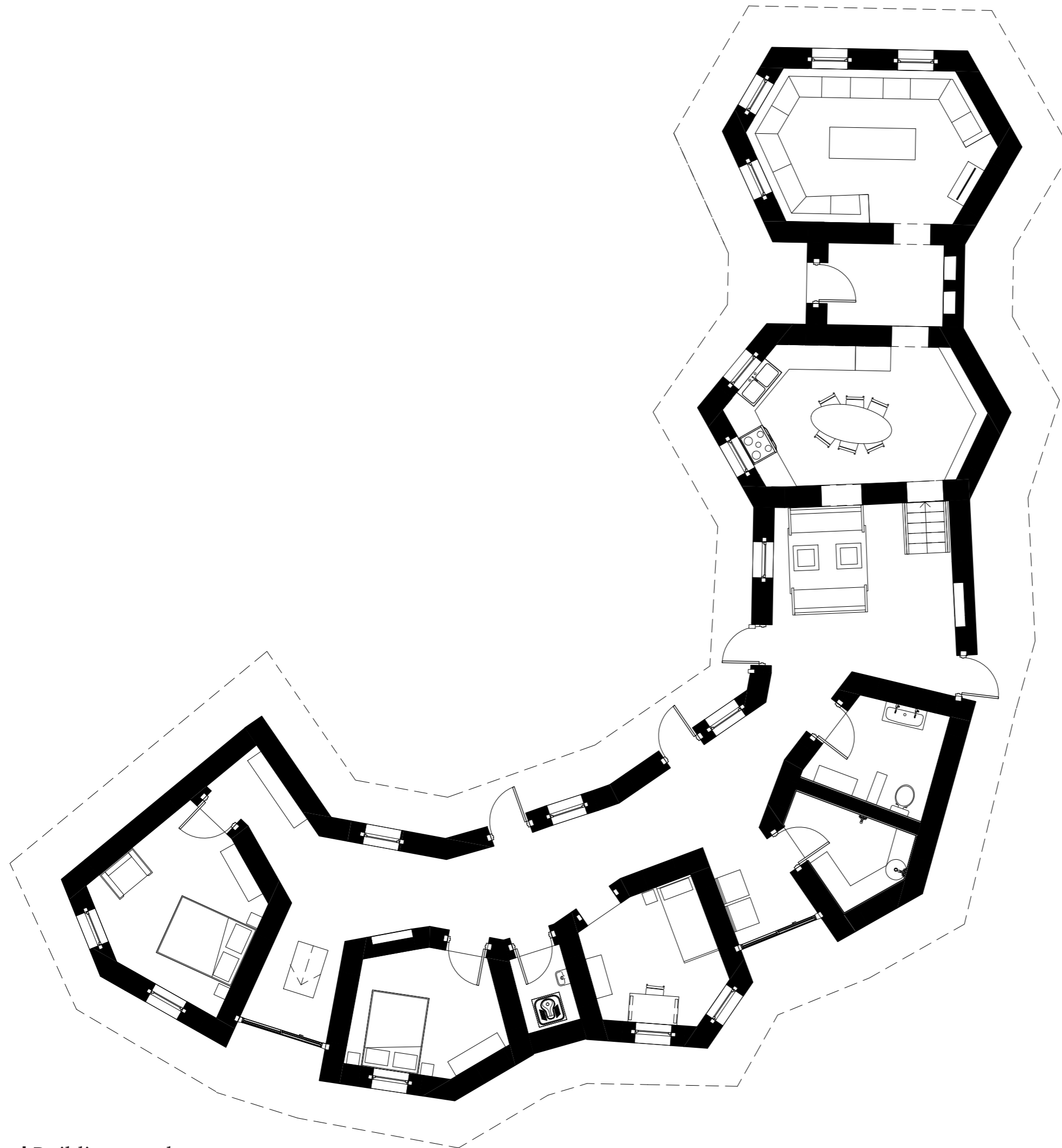
Entree with fuse box and  
built-in closet in wall

Kitchen with dining room

Private living space

Bathroom: separate toilet and  
hammam

2 bedrooms



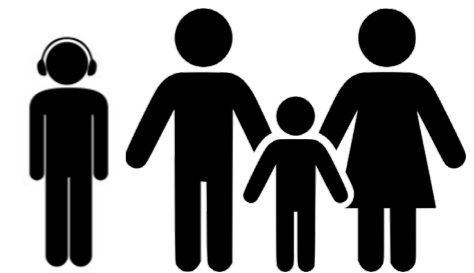
## Village strategy:

Phase 2

## Typology 4: F-house

(family)

Users: 4 person household



### Rooms:

Sedir living room

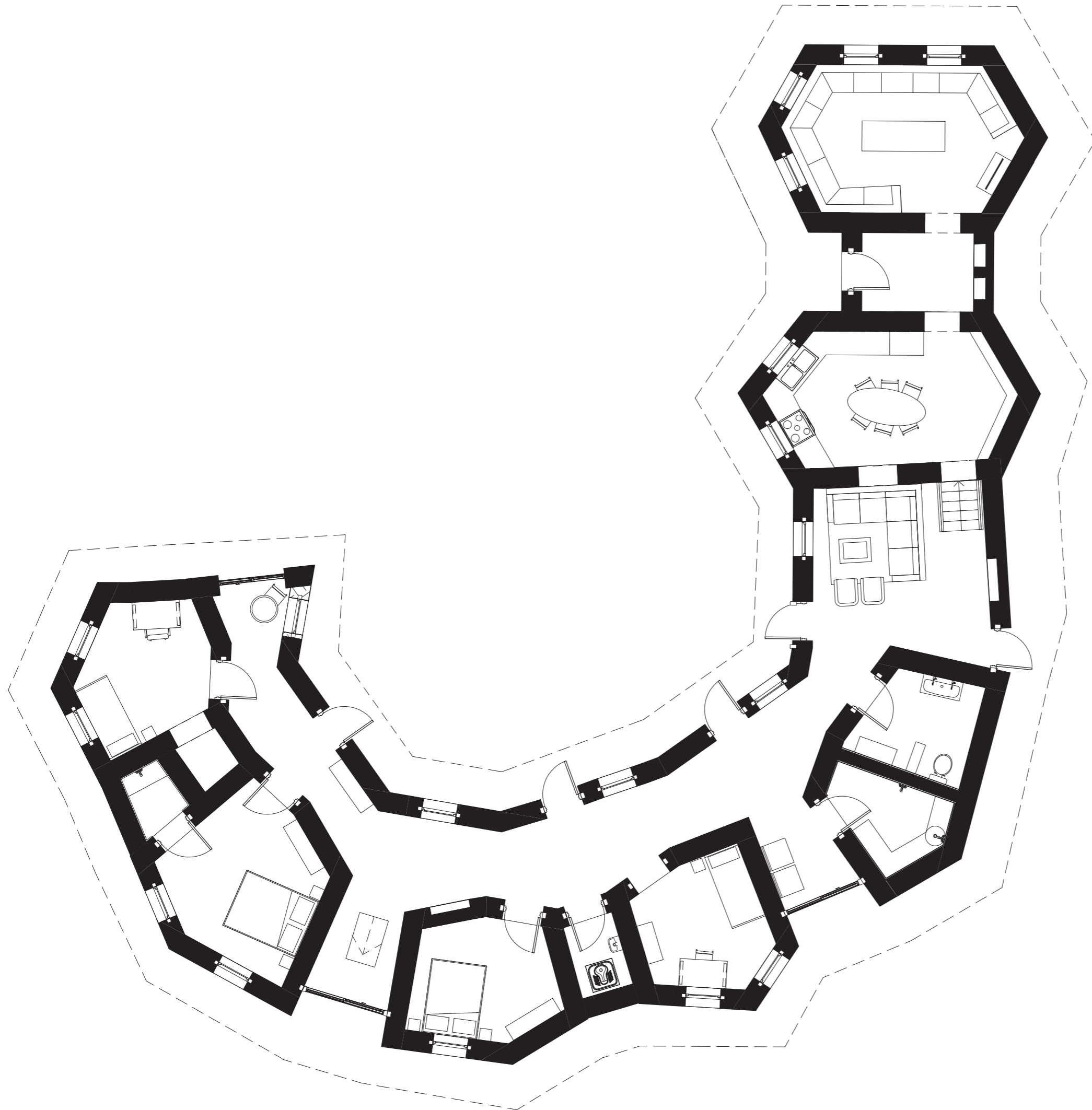
Entree with fuse box and  
built-in closet in wall

Kitchen with dining room

Private living space

Bathroom: separate toilet and  
hammam

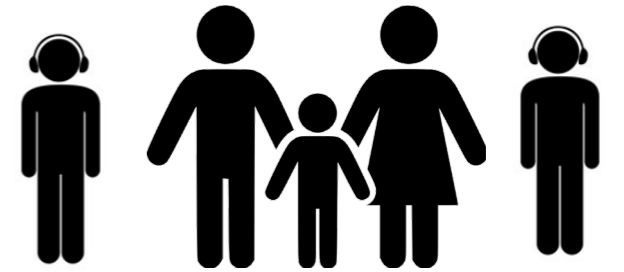
3 bedrooms



**Village strategy:**  
Phase 2

**Typology 5:** GF-house  
(growing family)

Users: 5 person household



**Rooms:**

Sedir living room

Entree with fuse box and  
built-in closet in wall

Kitchen with dining room

Private living space

Bathroom: separate toilet and  
hammam

4 bedrooms

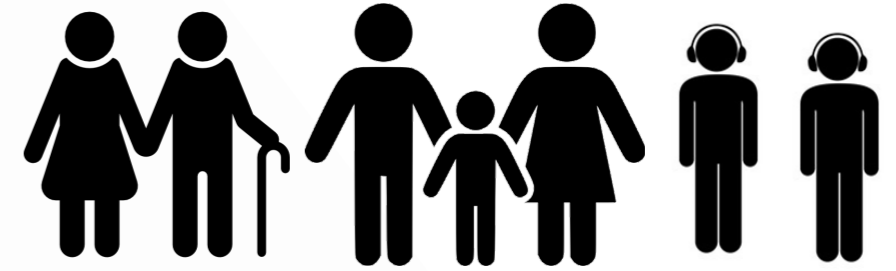


**Village strategy:**

Phase 2

**Typology 6: X-house**  
(final)

Users: 6-7 person household



**Rooms:**

Sedir living room

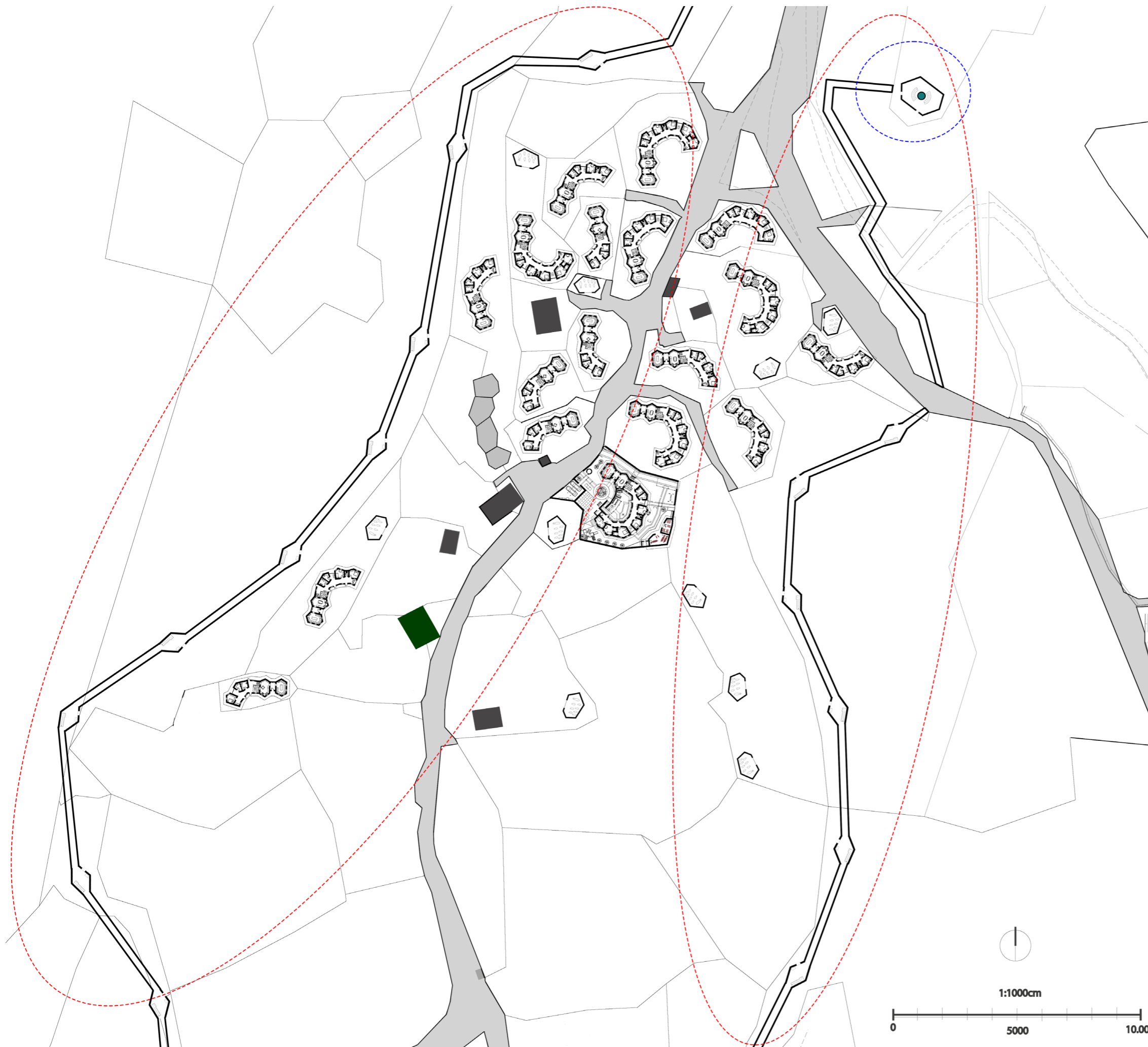
Entree with fuse box and  
built-in closet in wall

Kitchen with dining room

Private living space

Bathroom: separate toilet and  
hammam

5 bedrooms

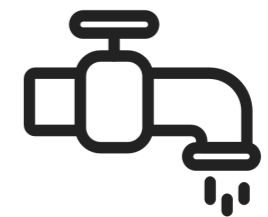


**Village strategy:**  
Phase 3

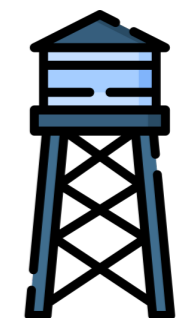
**Exterior walls**  
Walk/escape route  
Keeps flames away  
Energy: PV  
Community storage



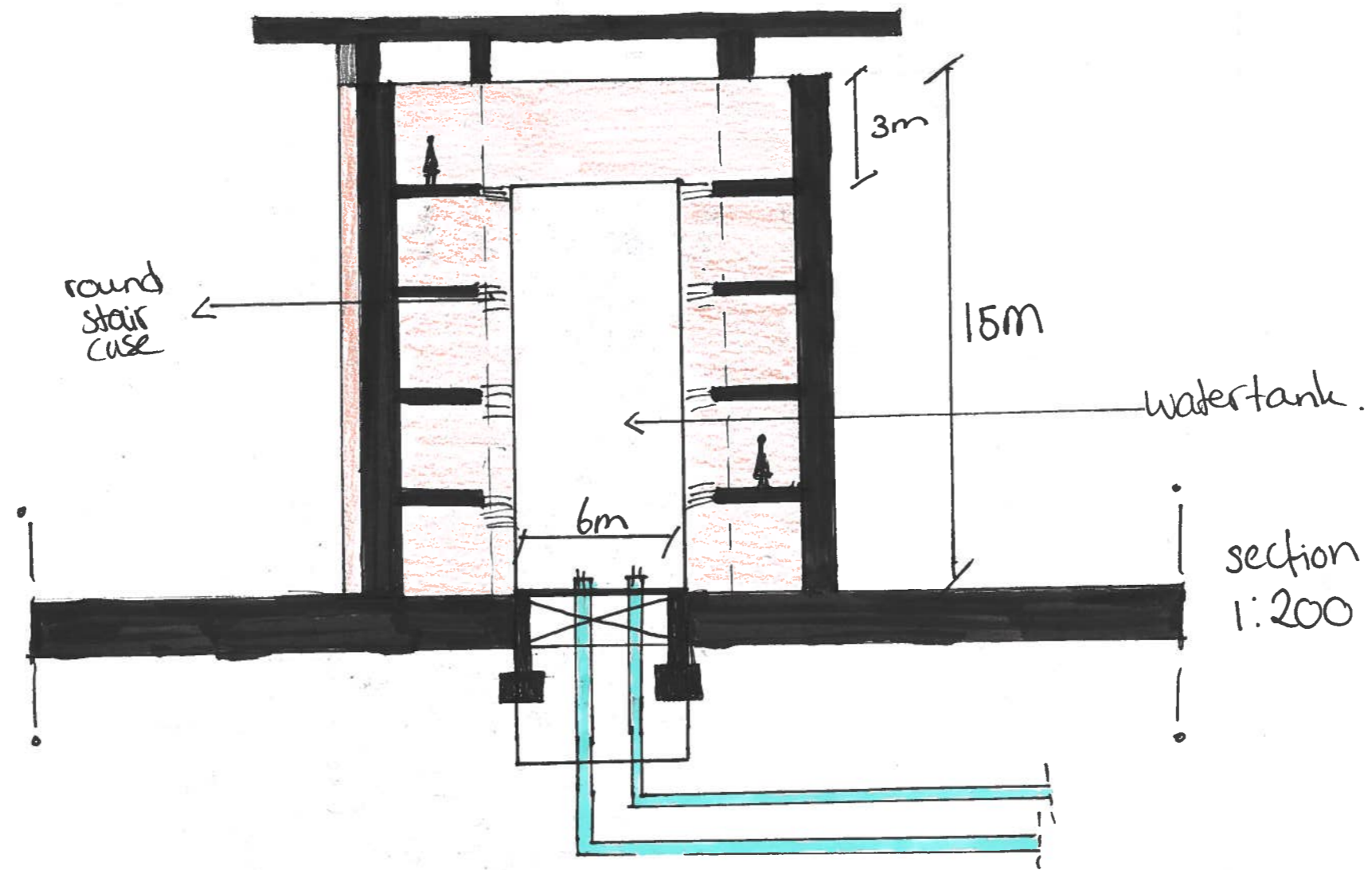
**Infrastructure points**  
15  
Water connections  
Energy: PV



**Watertower**  
Lookout point  
Landmark  
-> attention to village







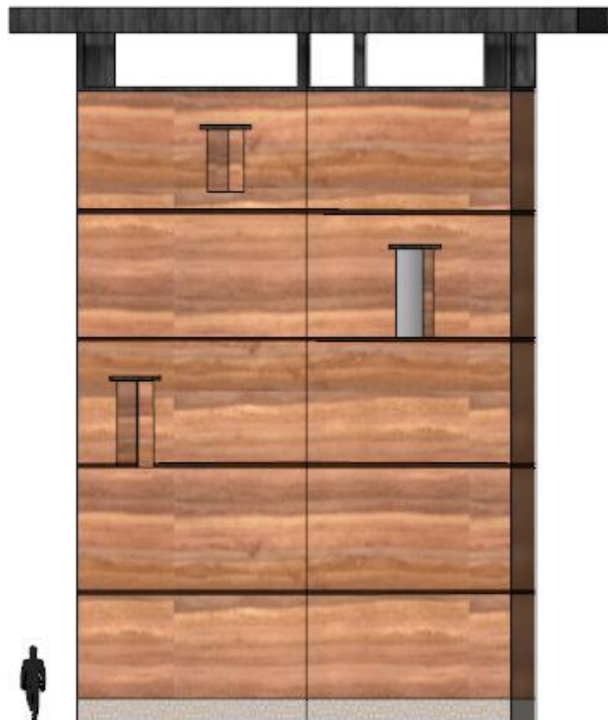
section 1:200



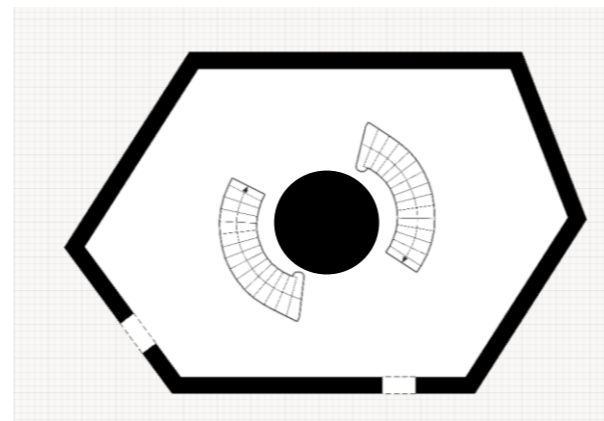
south façade 1:200



north façade 1:200



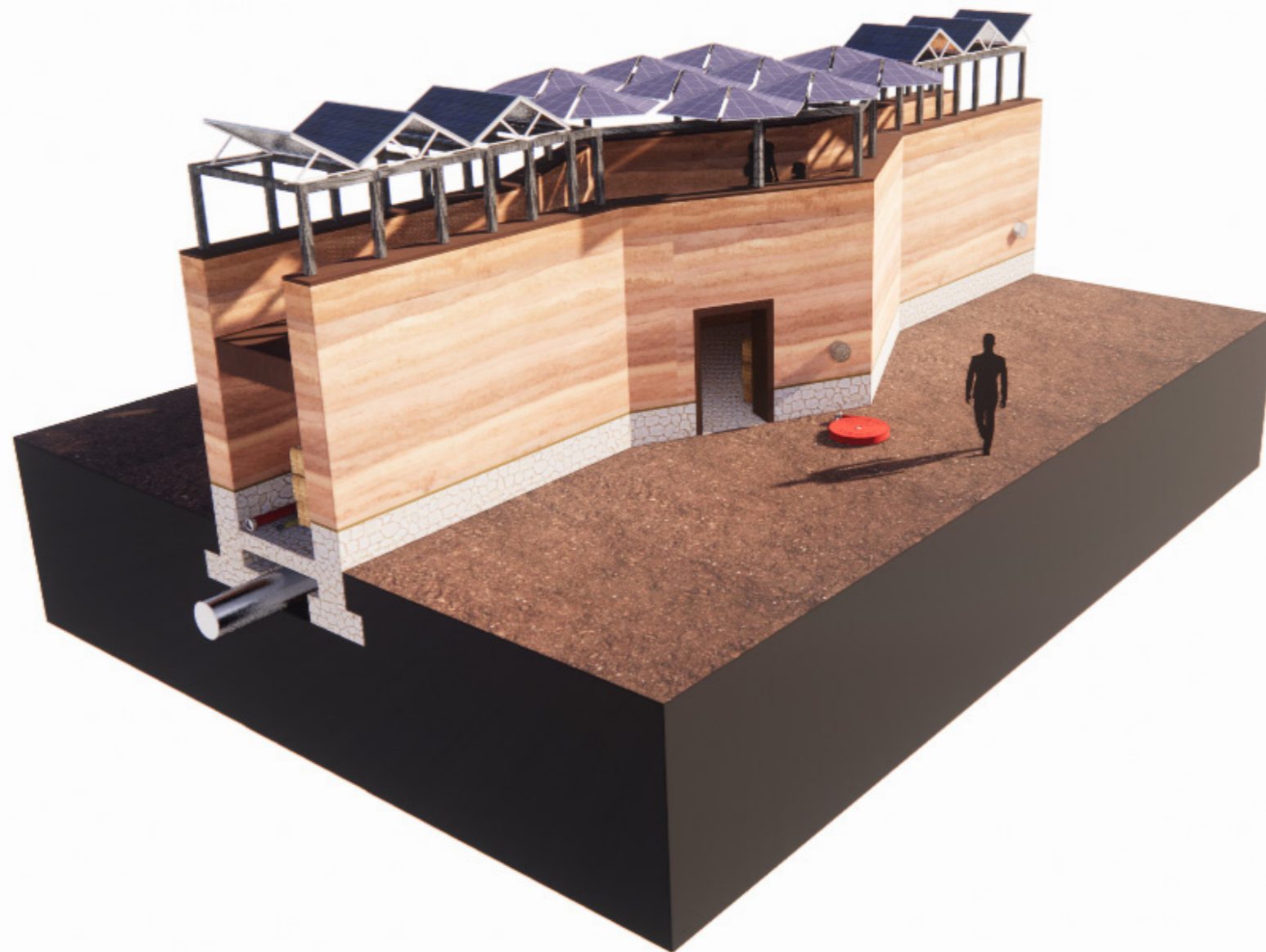
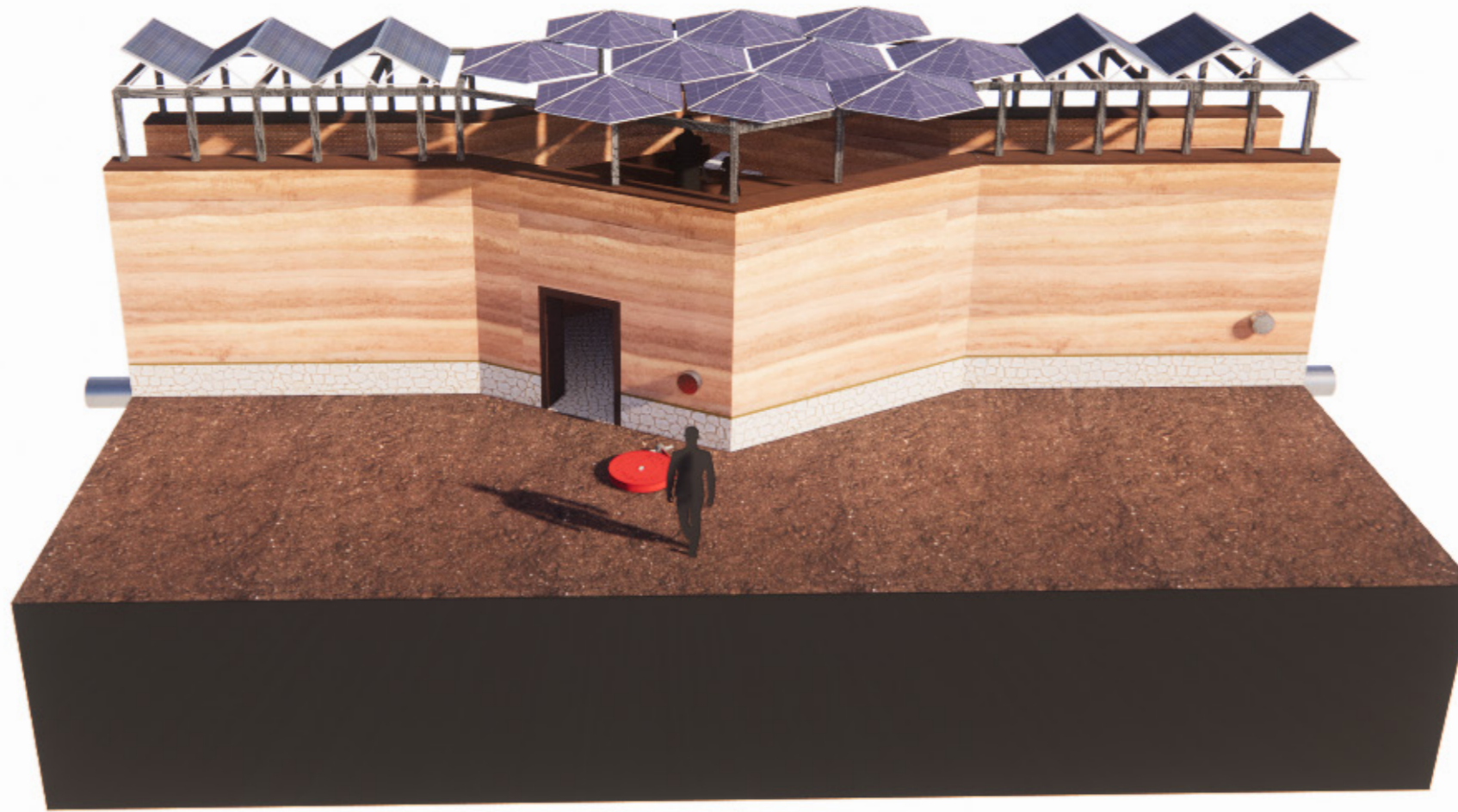
east façade 1:200

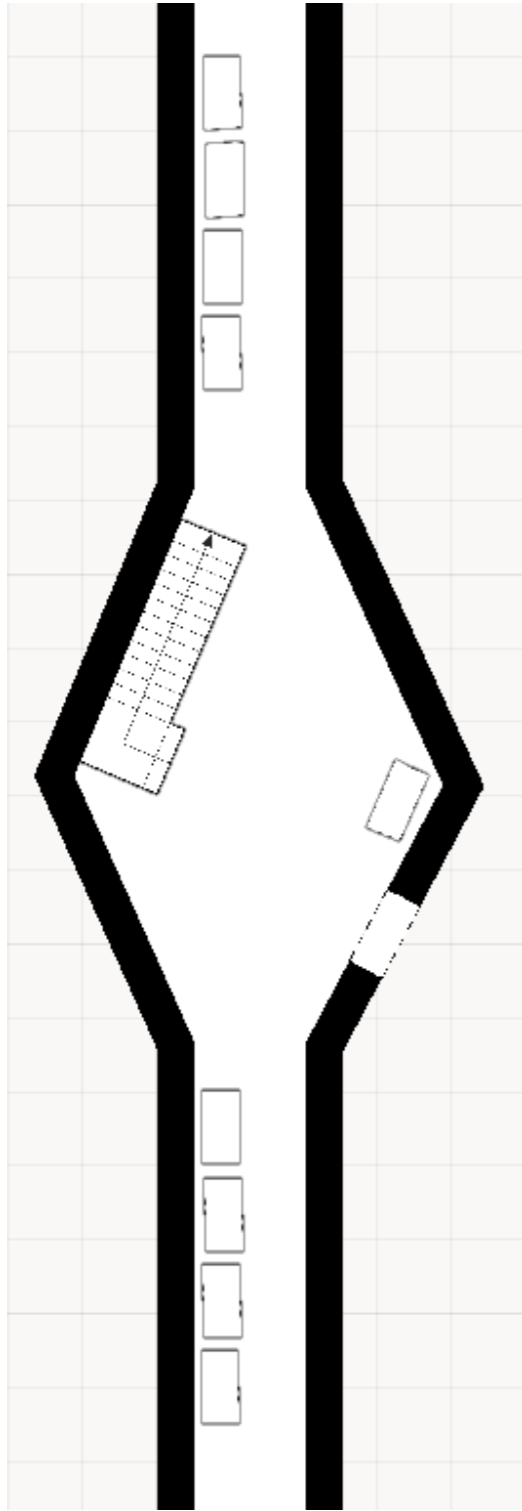


floor plan gf 1:200

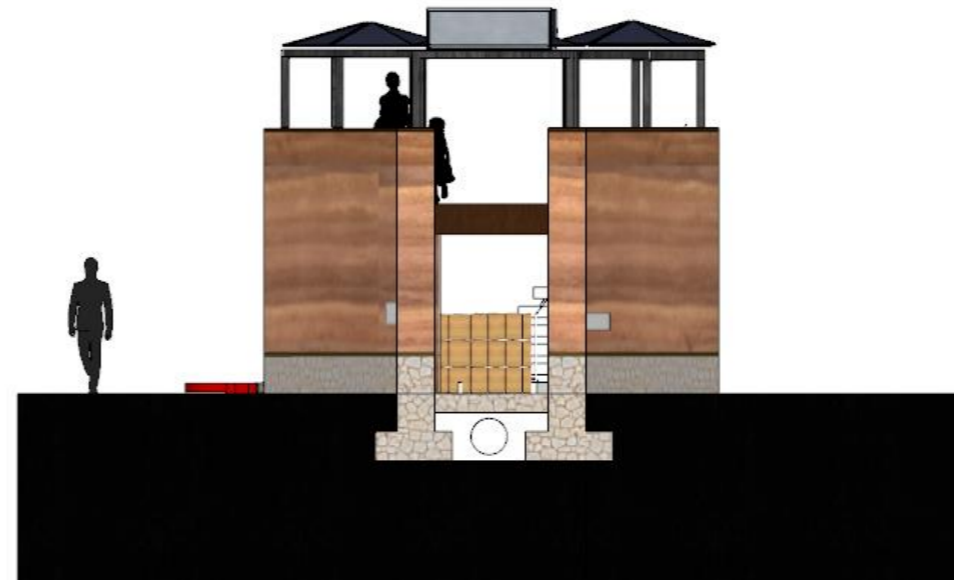
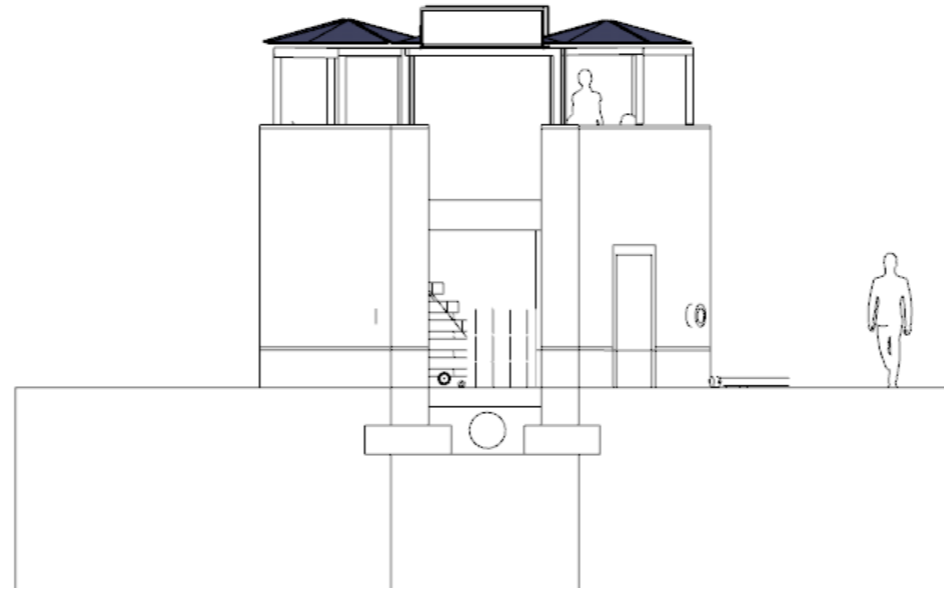


west façade 1:200





1:100 floor plan gf



Longitudonal section  
1:100



sections 2x  
1:100

# Water distribution & collection system

- distribution: underground water pipes (use of gravity downwards hill)
- collection: watertower roof & extra collection points in mountains

**Water collection = 12.480.000 L / year**

1 roof = +- 400 m<sup>2</sup>

400 x 30 (houses and community centre)= 12.000m<sup>2</sup> roof surface

1.040 l/m<sup>2</sup> rain/year in Antalya

12.000m<sup>2</sup> x 1.040l = 12.480.000L water to catch & safe in tanks

**Solar energy collection = 236.800kwh / year**

1 panel = 370kwh (maximum sun hours in Antalya, also winter)

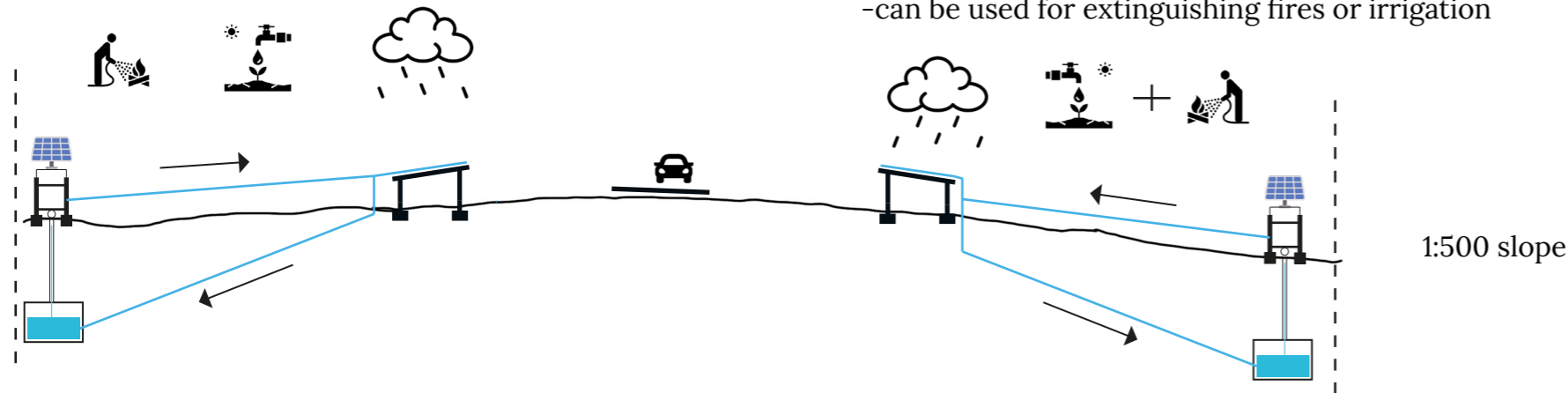
370 x 640 panels = 236.800 kwh

1 family uses 2.479kwh / year ( 30 families = 74.370 kwh)

236.800 - 74.370 = 162.430 kwh for the watersystem and village battery

## Greenroof

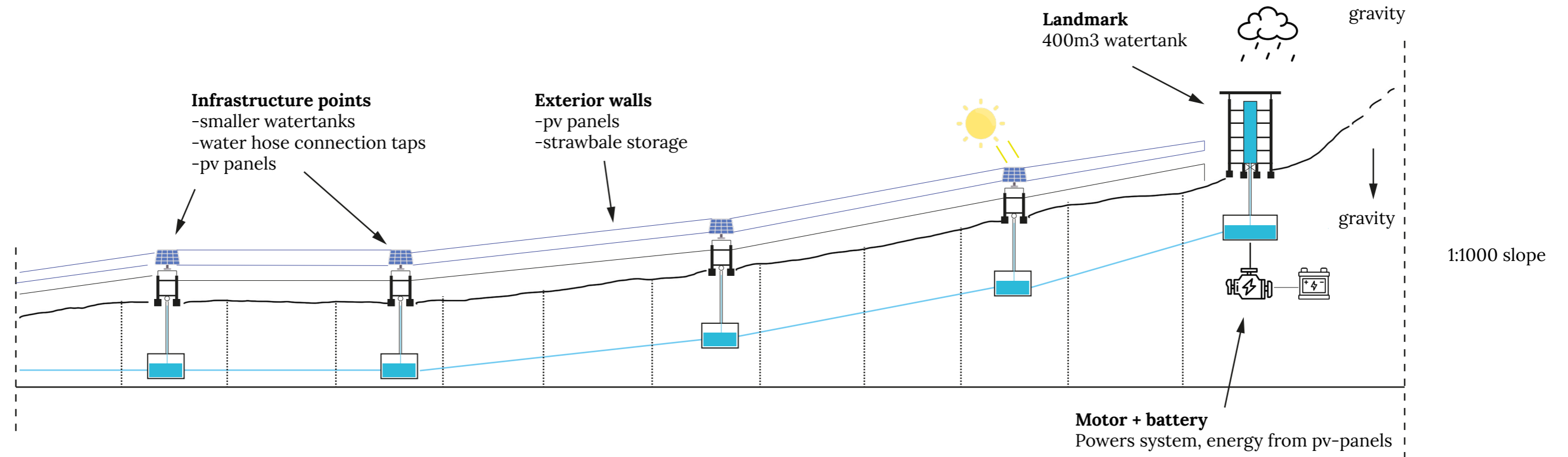
- catches rainwater
- rainwater goes to infrastructurepoint-watertank
- can be used for extinguishing fires or irrigation



## Reservoir

375.000 liters water for Kalemler village  
= 20 fire extinguishing helicopters available for whole antalya province

**Landmark**  
400m<sup>3</sup> watertank



## Watertower large watertank:

- always full, only use for wildfire scenario
- when full, excess to smaller watertanks



## Infrastructure point, small watertank:

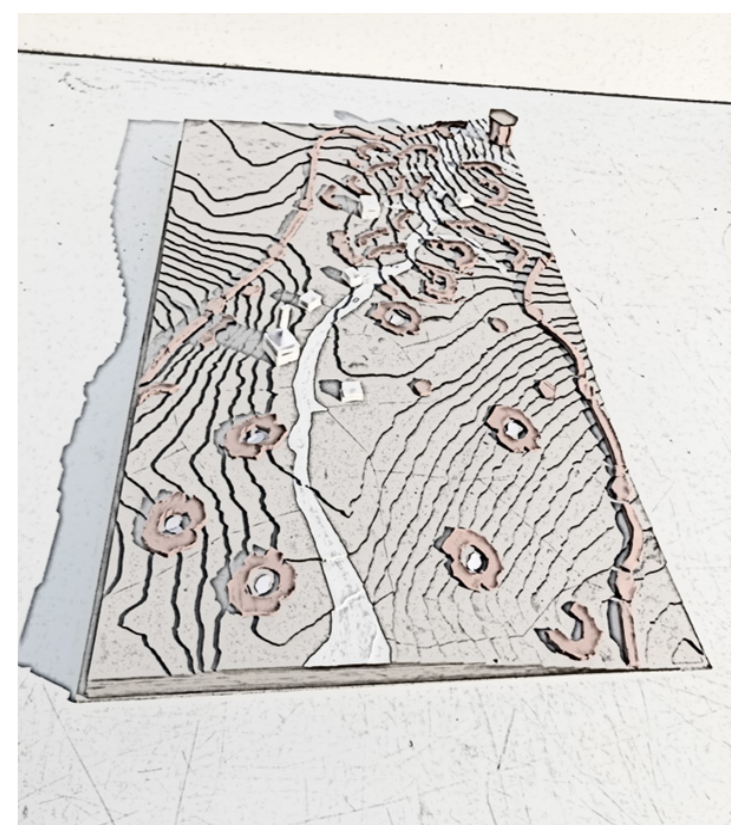
- can be used for irrigation / flushing toilets / water for animals



**Village strategy:**  
Phase 4

**Wildfire resilient  
holiday houses**  
10 houses:  
2 typology's

contribution to disaster  
scenario: *water from pools  
useable for extinguishing*

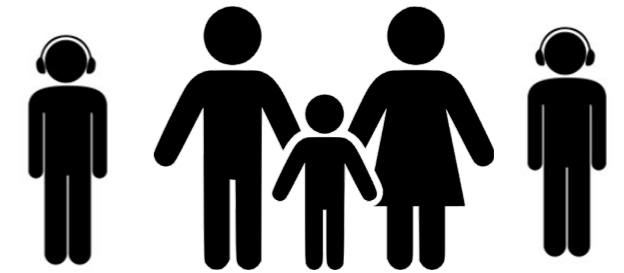


## Village strategy:

Phase 4

## Typology 7: H-house (holiday)

Users: 5 person household



### Rooms:

Sedir living room

Entree with fuse box and  
built-in closet in wall

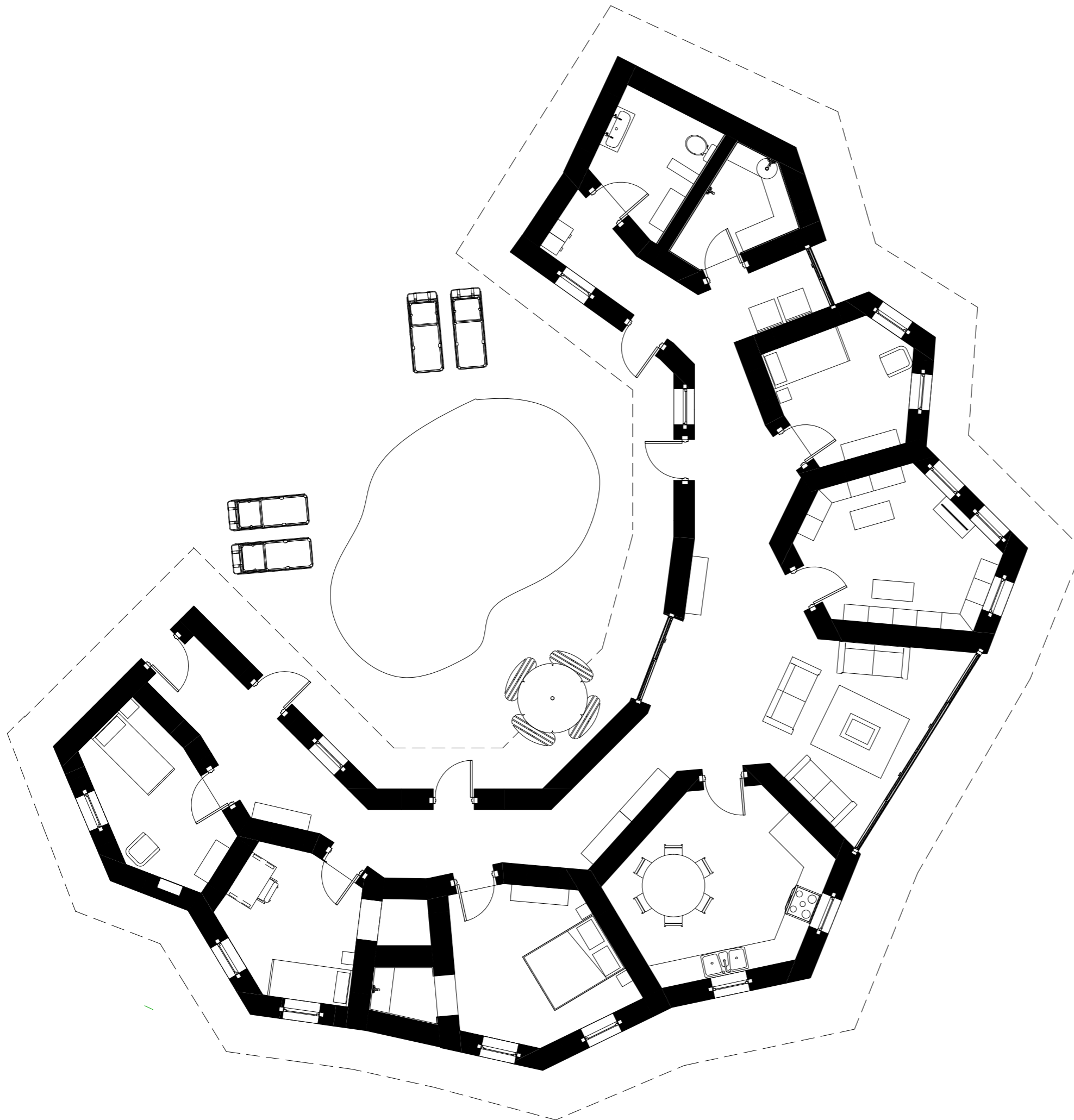
Kitchen with dining room

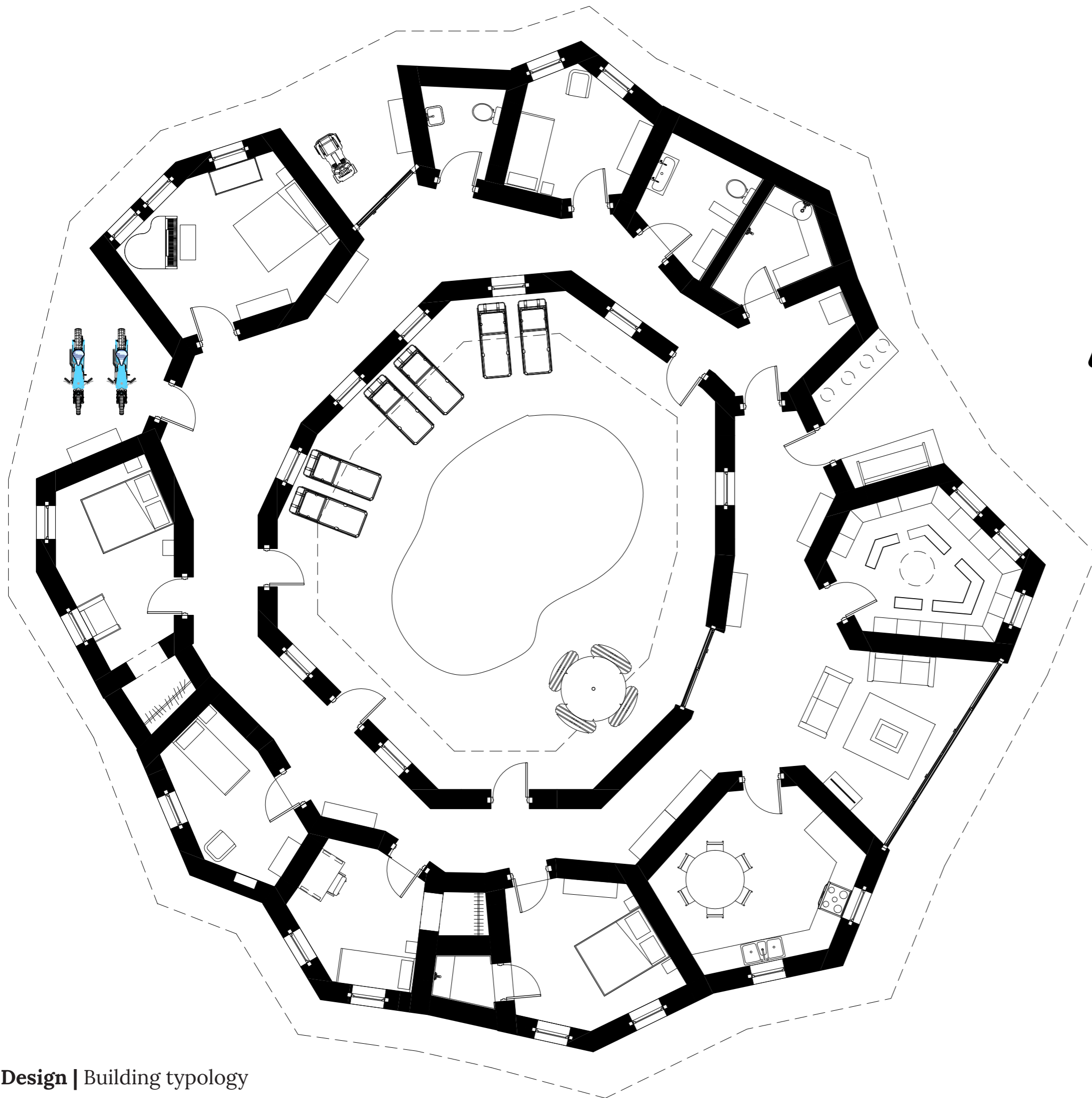
Private living space

Bathroom: separate toilet and  
hammam

4 bedrooms

Pool





## Village strategy:

Phase 4

## Typology 8: L-house (large)

Users: 6-8 person household



### Rooms:

Sedir living room

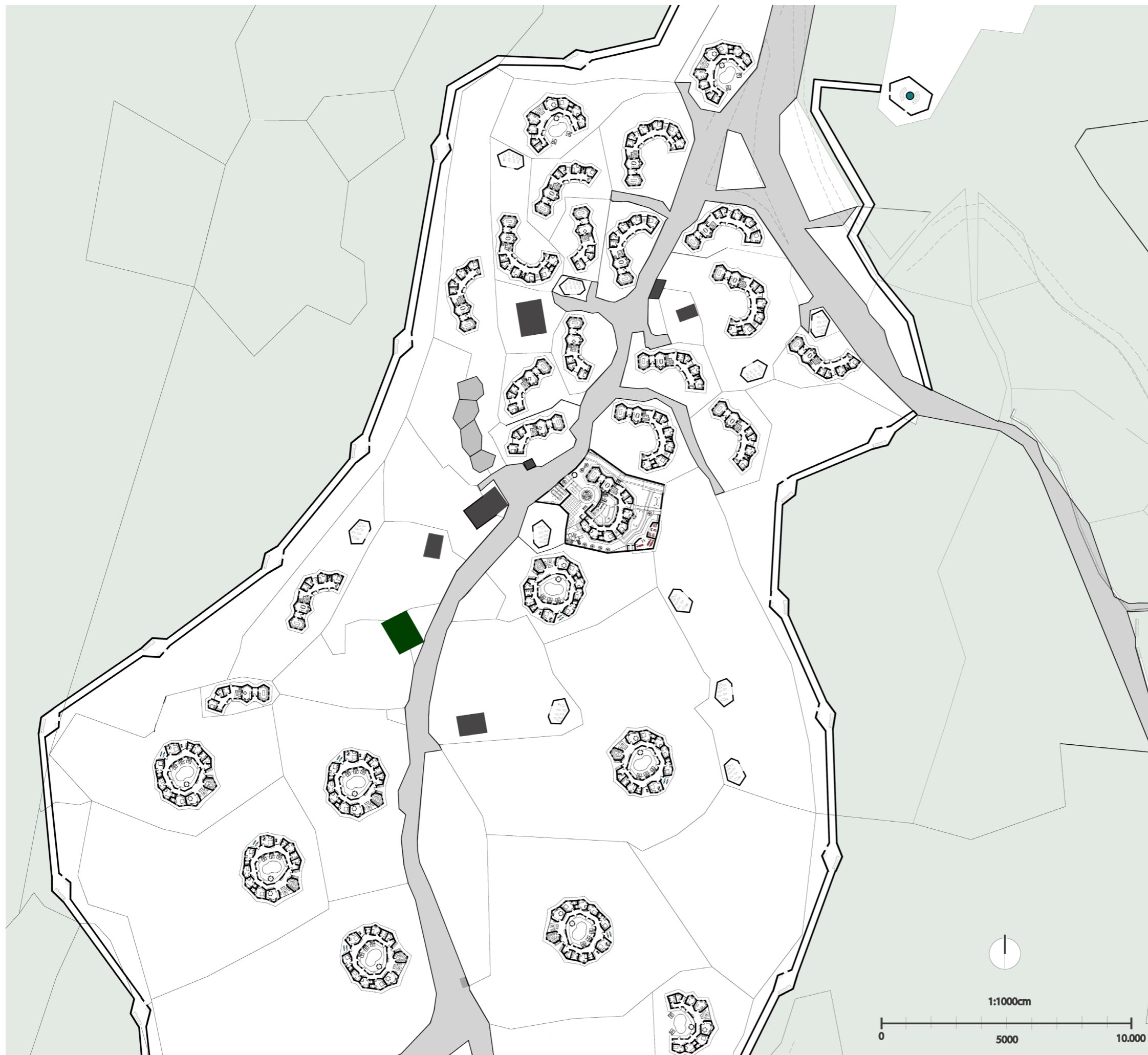
Kitchen with dining room

Private living space

Bathroom: separate toilet and  
hammam

6 bedrooms

Pool

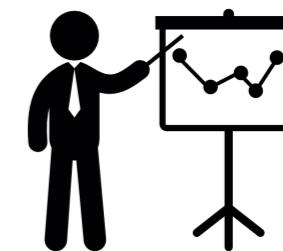


**Village strategy:**  
all 4 phases finished

**community centre**  
function transition into:



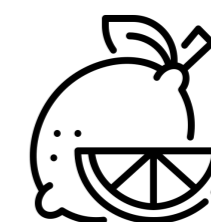
building material storage



exposition space



rammed earth workshop  
space for schools and tourists

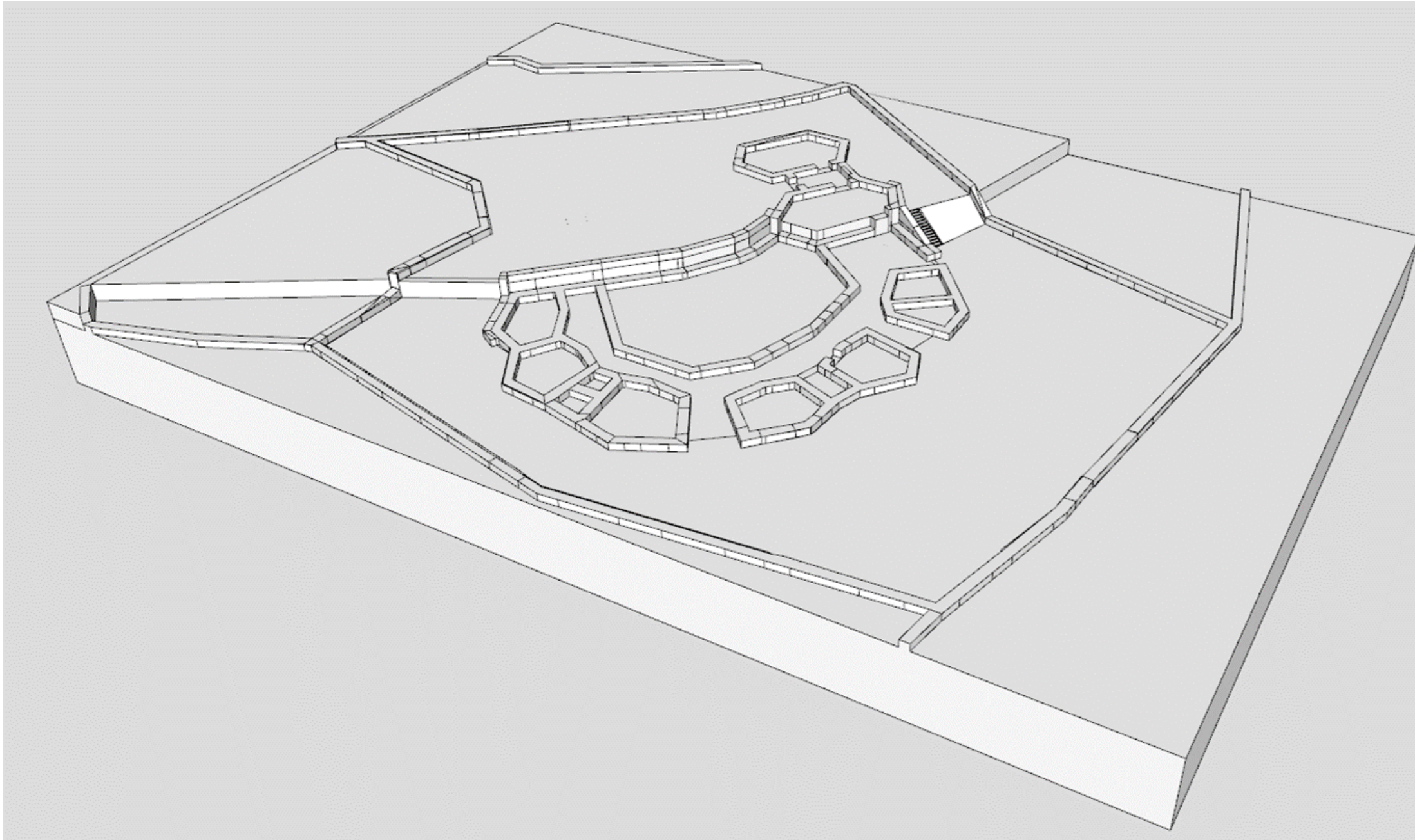


shop for locally harvested  
fruits and veggies

## Support structure construction: step 1

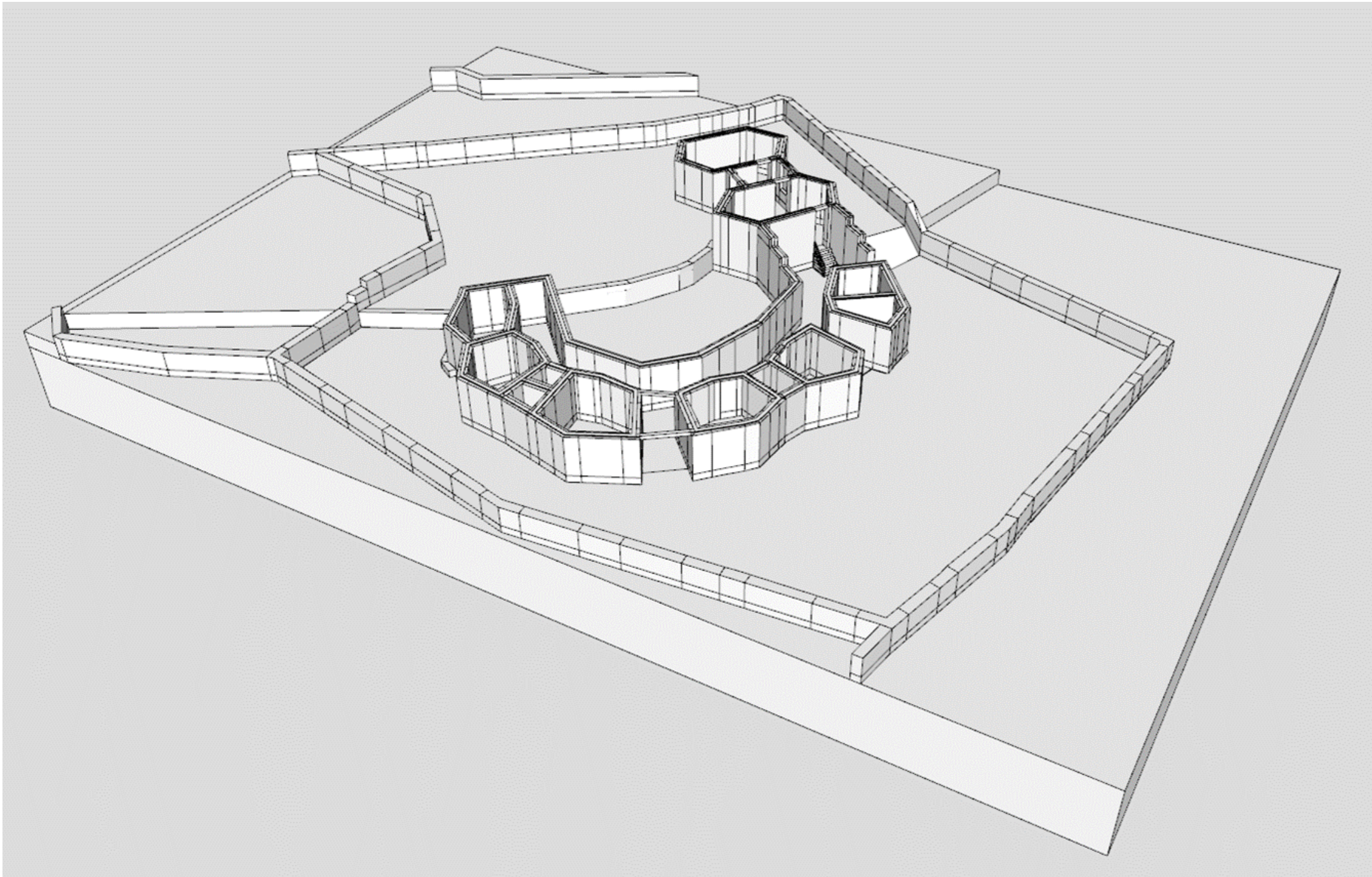
Retaining walls  
Footing  
Foundation wall

*Rubble Stone*



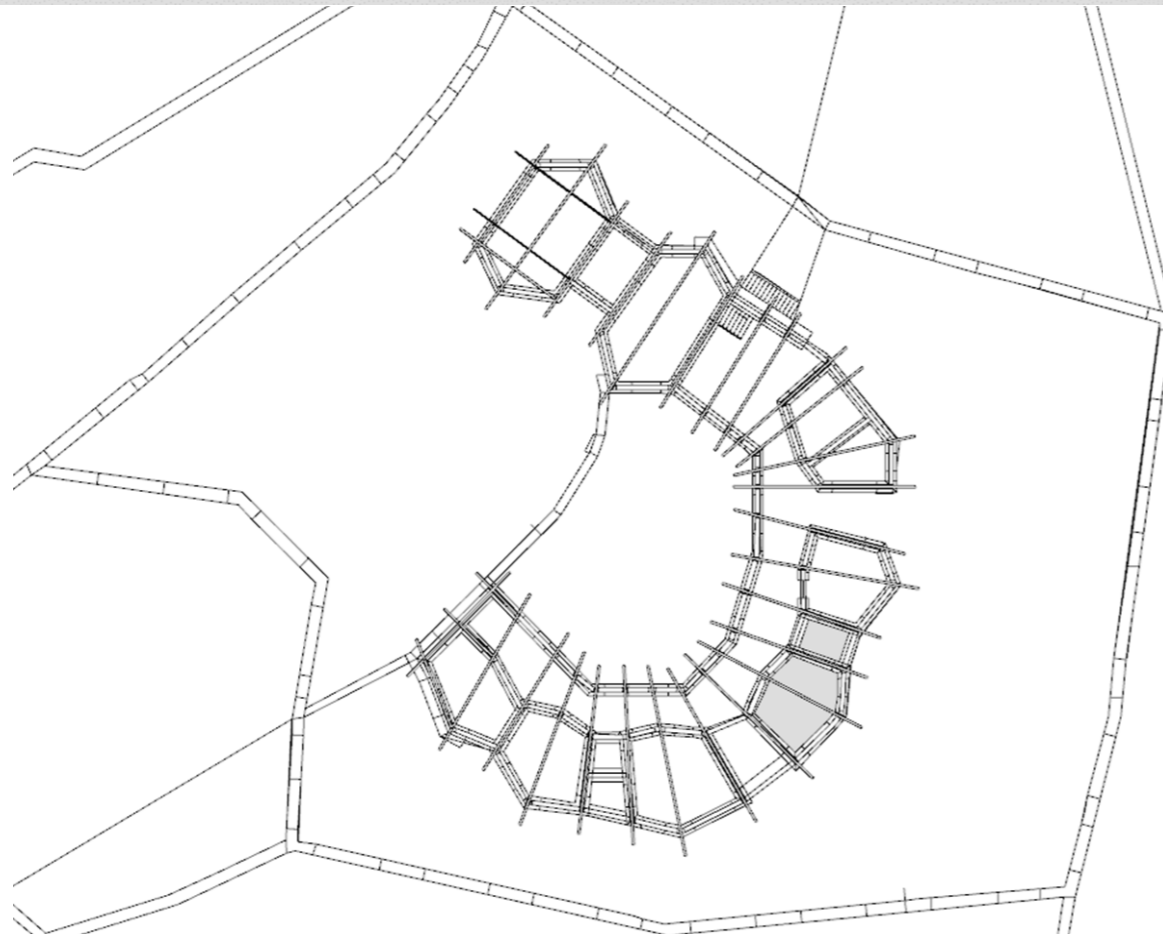
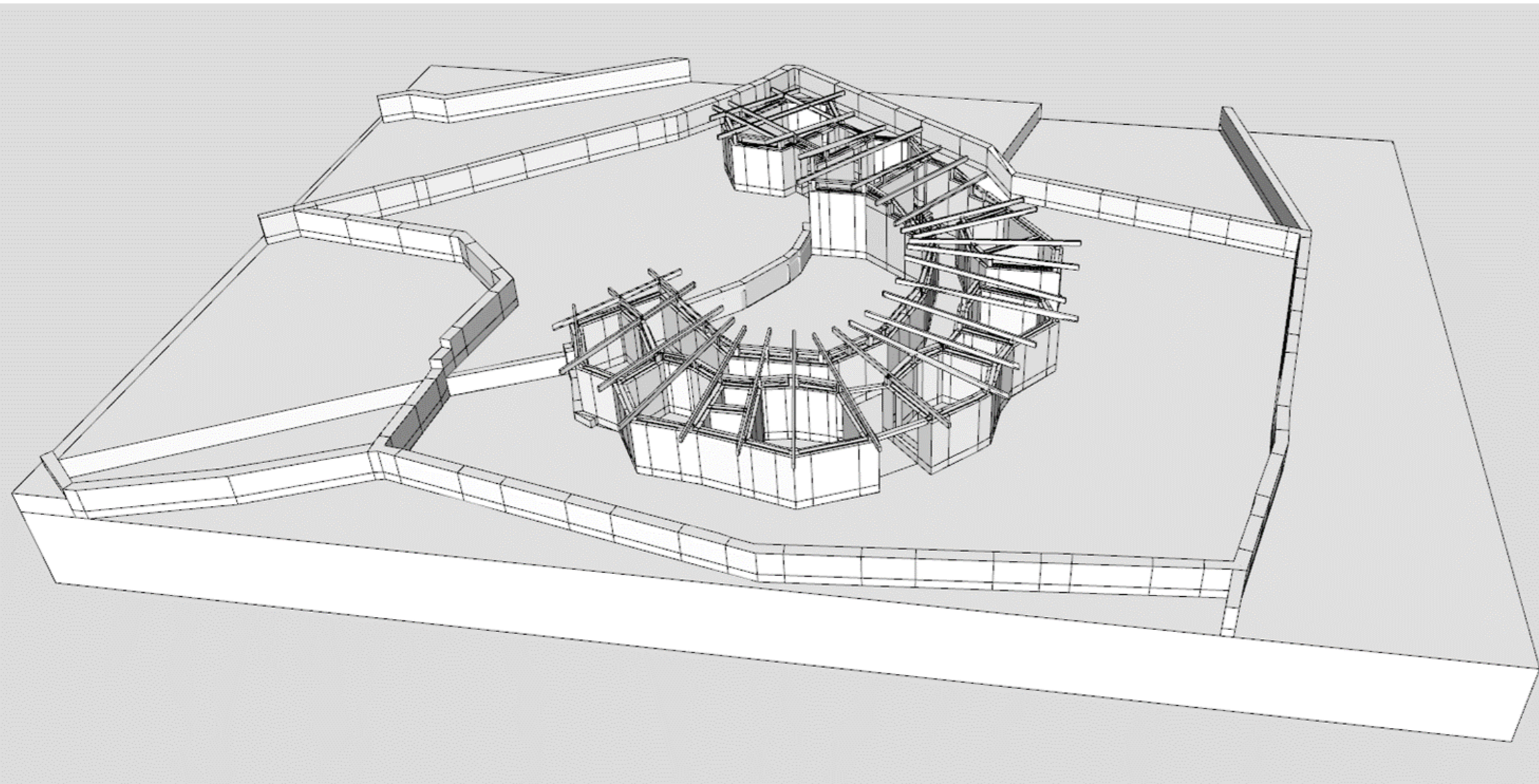
## Support structure construction: step 2

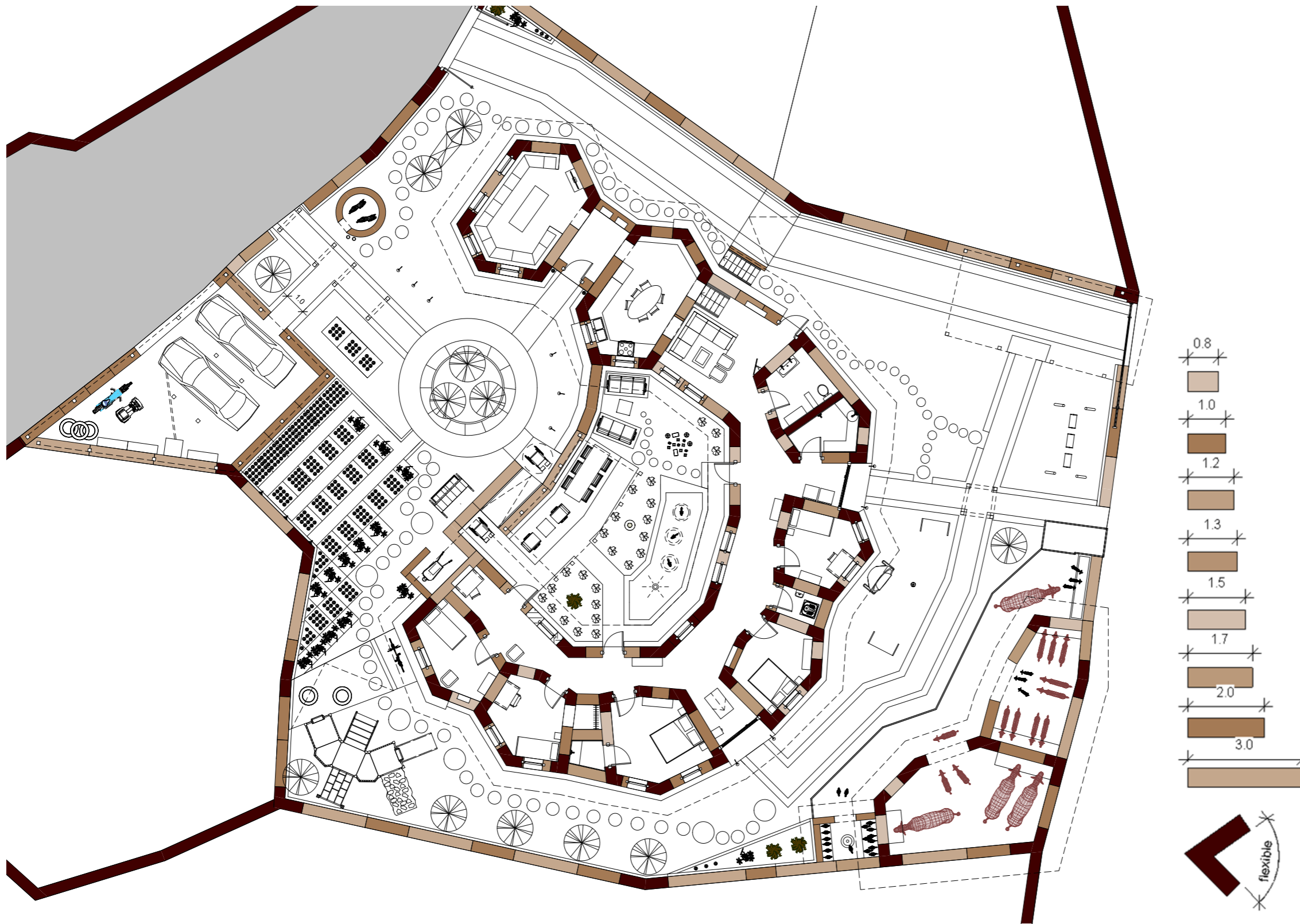
**Rammed earth walls**  
Timber ringbeams



## Support structure construction: step 3

**Roof:**  
timber columns and beams

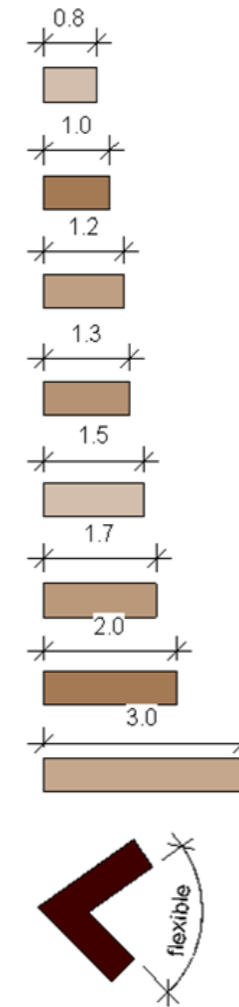




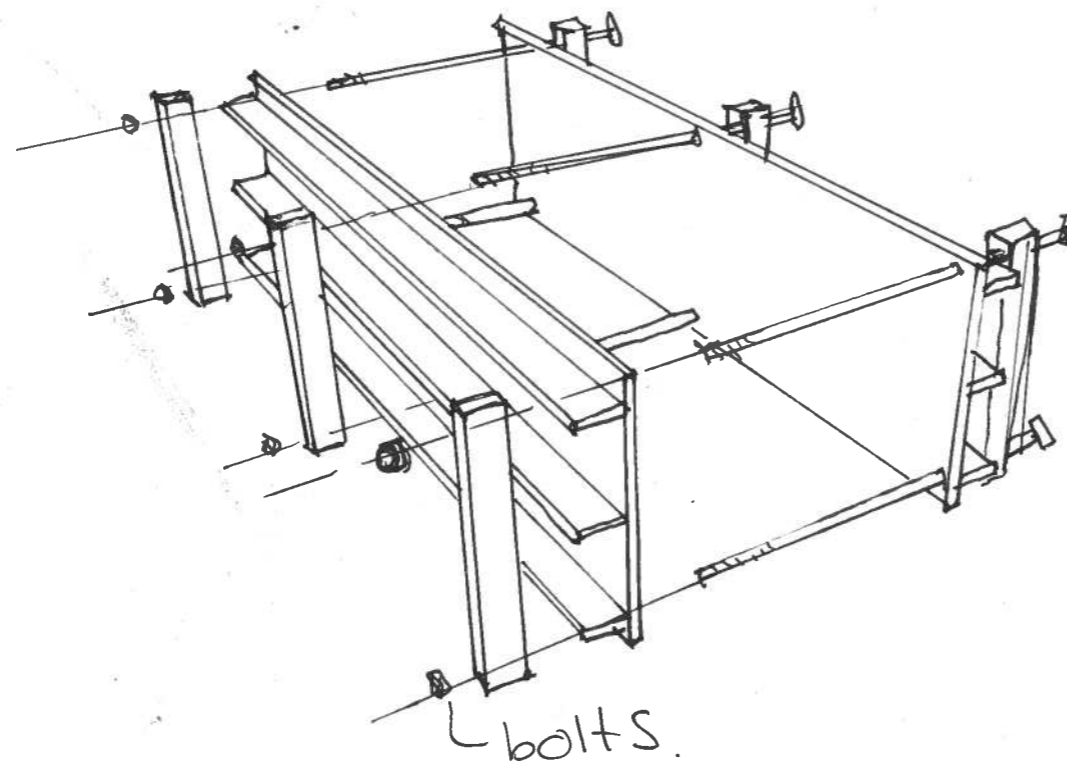
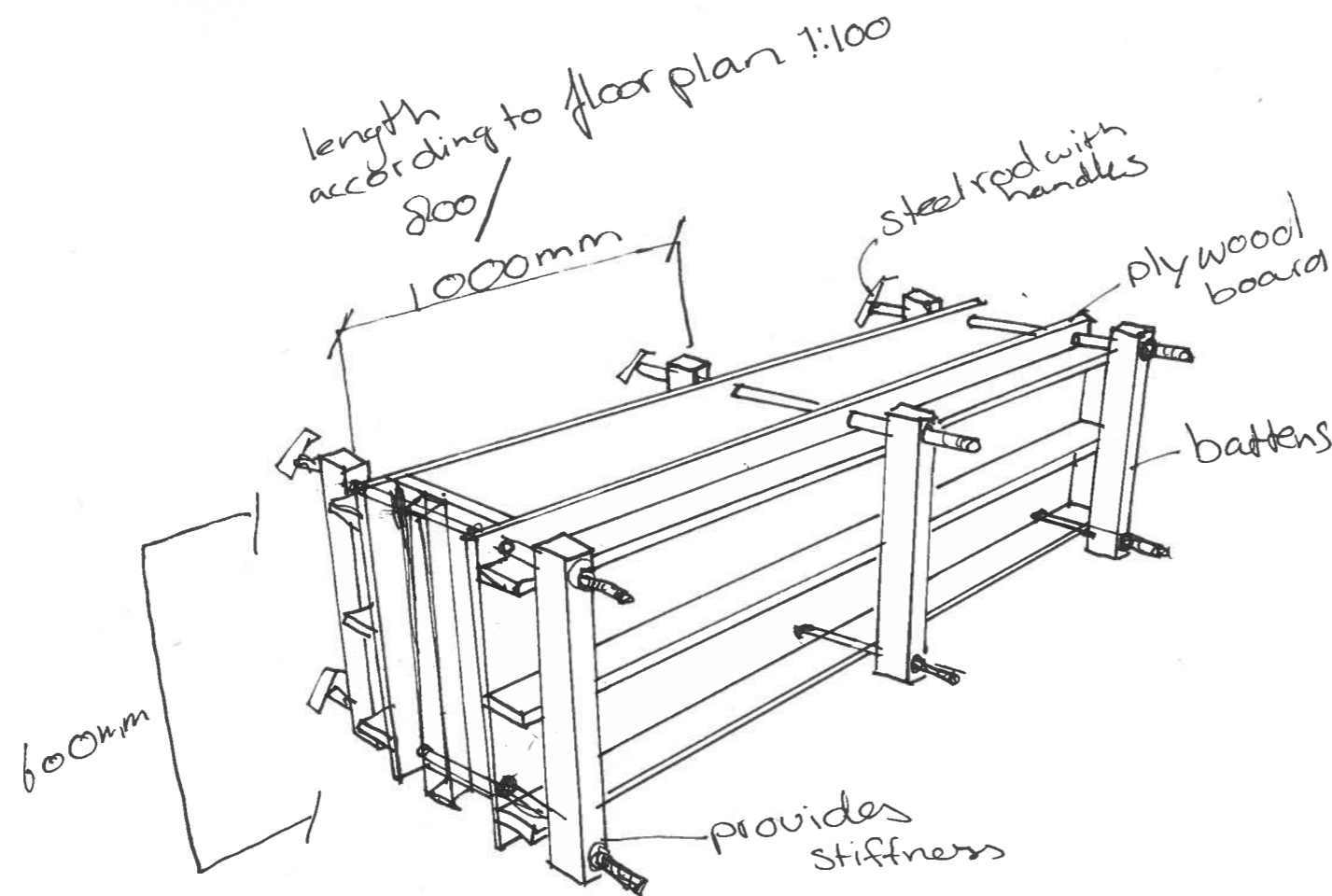
**Support structure construction:**

**Easing the building process**

- Fixed rammed earth formwork sizes
- Flexible corner formworks

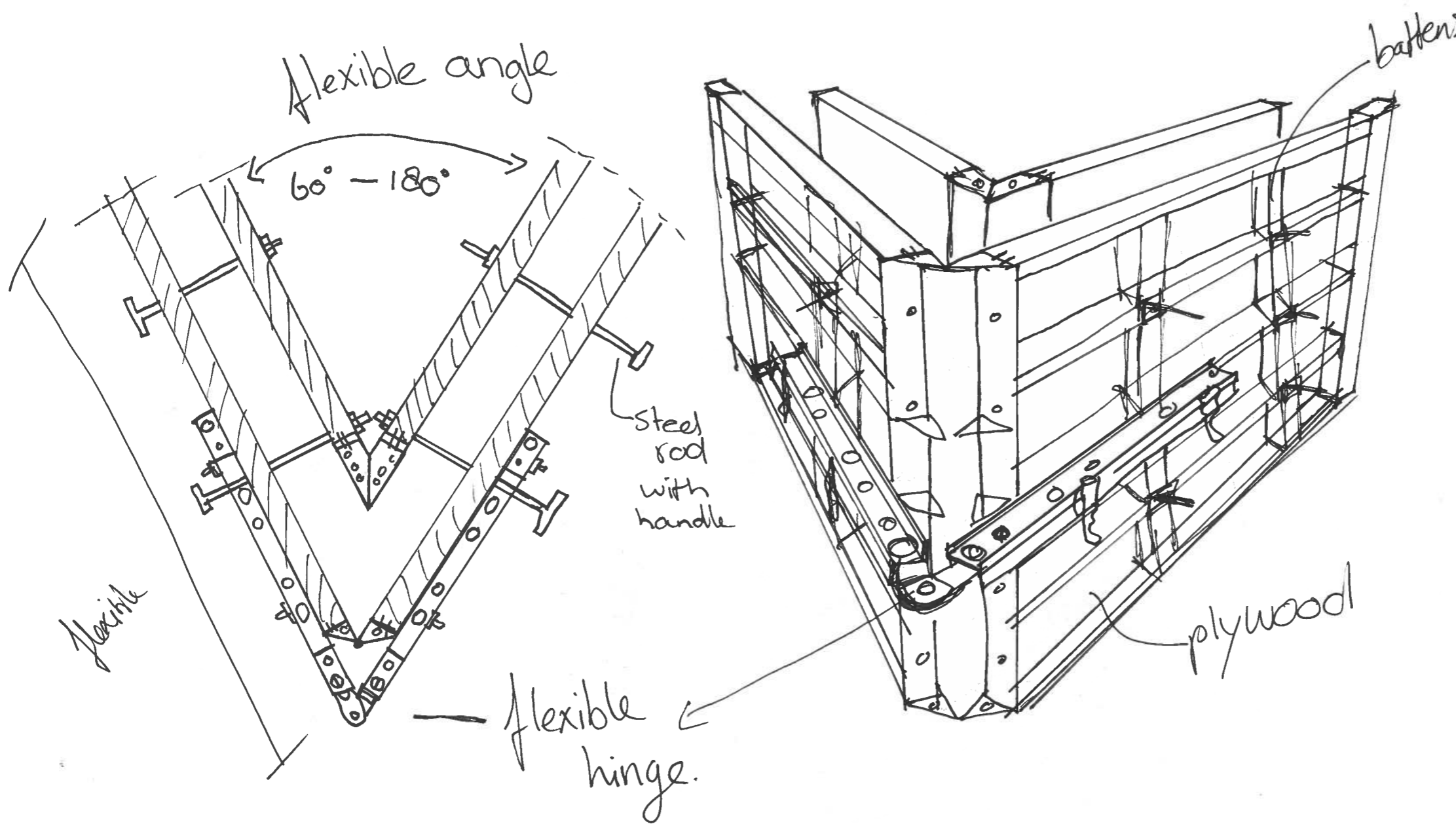


## Support structure construction: Building the Formwork



### 'Climbing formwork'

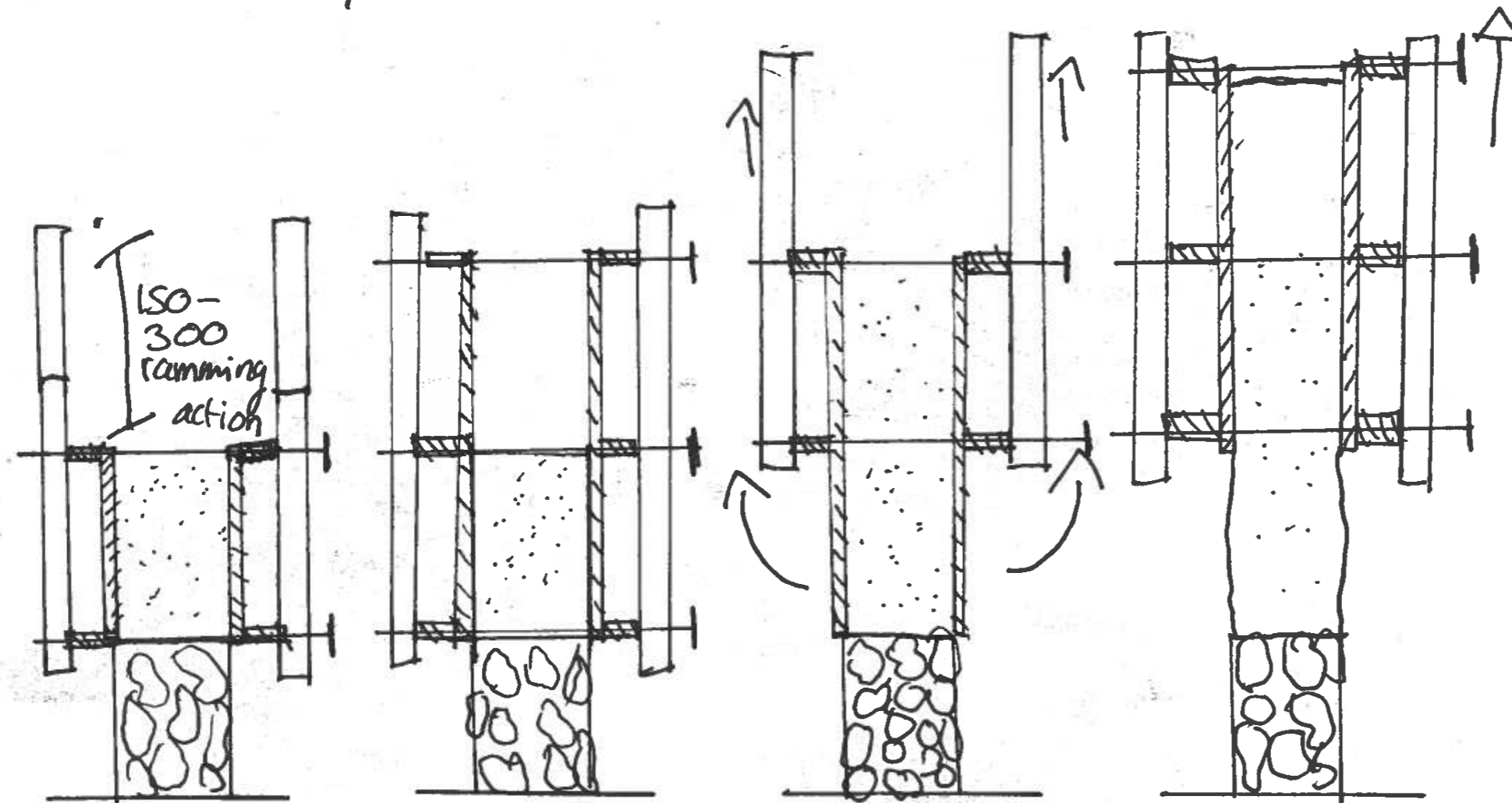
- Primary face:  
2 faces of plywood, 300mm, oiled surface
- Battens:  
Reinforced with wooden strips horizontal and vertical (Acts as stiffeners on the plywood, holds everything together. (horizontal forces due to ramming))
- Side face:  
Plywood, reinforced vertical



**Support structure construction**  
**Building the Formwork**

- Flexible corner formwork**
- Hinges
  - 60-179 corners

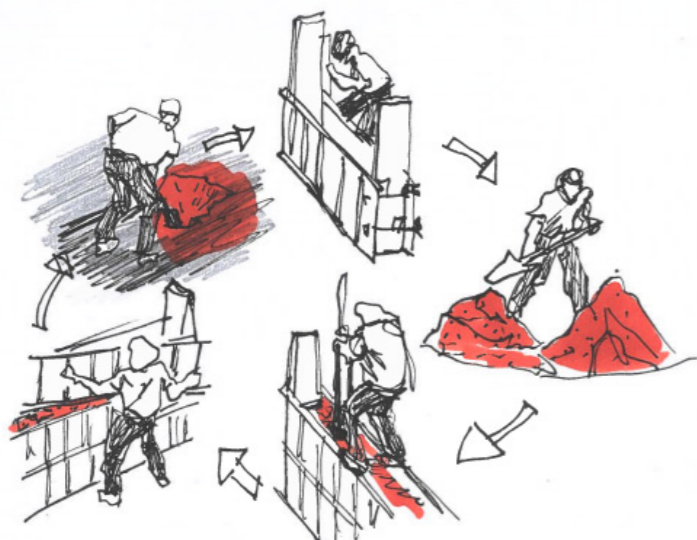
# Vertically movable formwork.



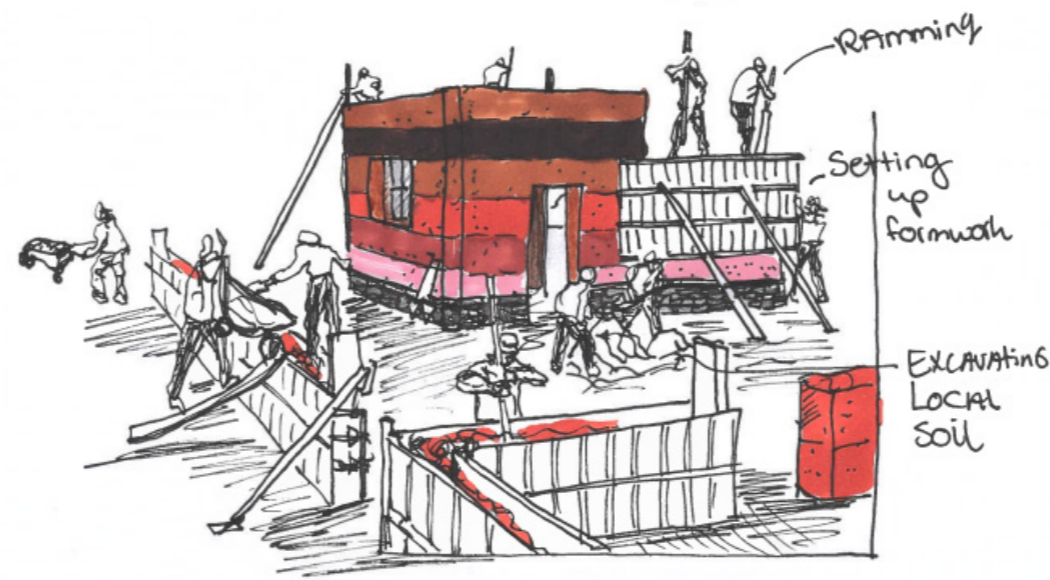
## Support structure construction: Building the Formwork

### 'Climbing formwork'

- Metal rods:  
Handle on on 1 side  
(Take out the metal rods and move the formwork up vertically till you have built the whole wall.)
- Fill the small holes caused by the rods with same earth mixture  
You can also push tubes in these holes for electricity / plumbing.

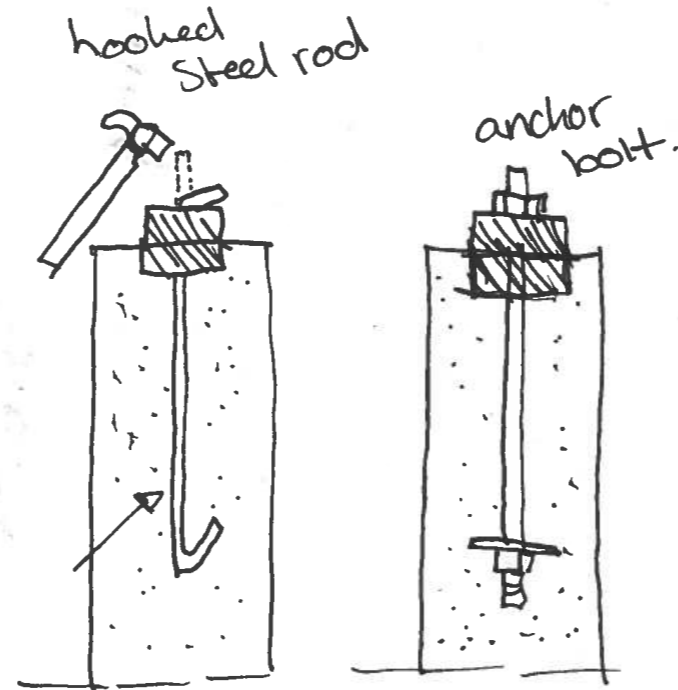
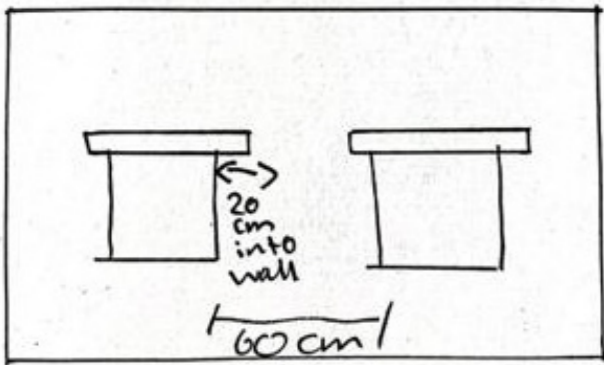
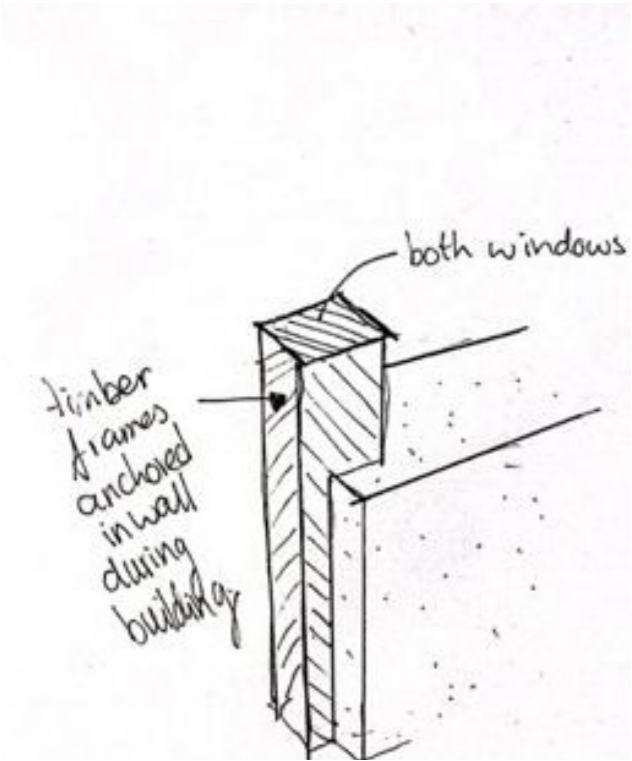


(Own drawing, based on Keable & Keable (2011, p.7))

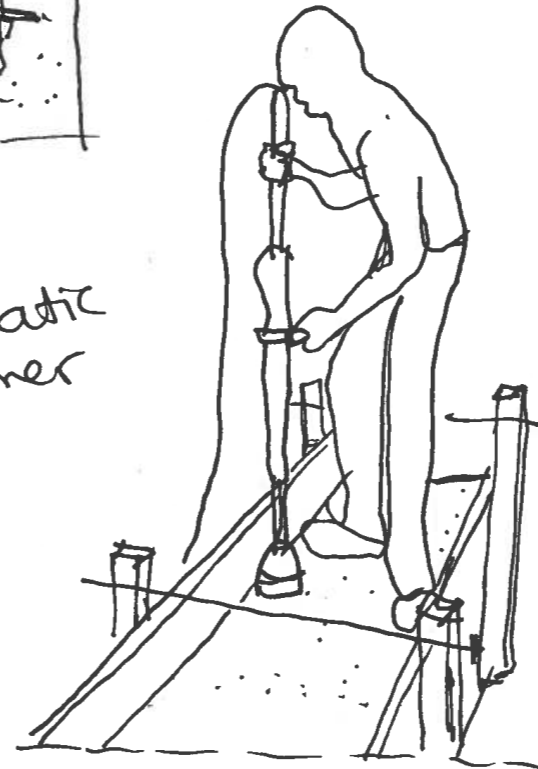


(Own drawing, based on Keable & Keable (2011, p.7))

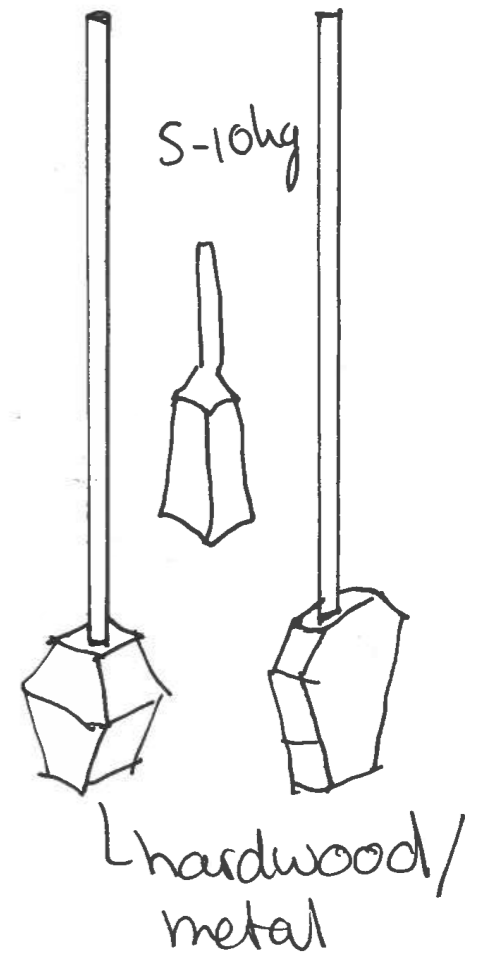
# Building tools & tips for self-builders



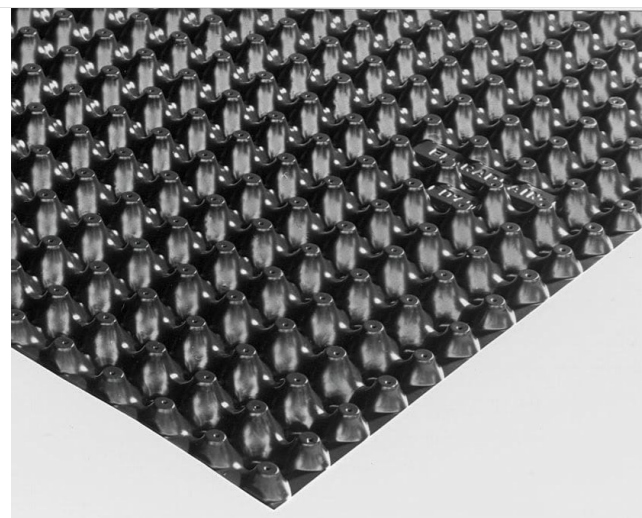
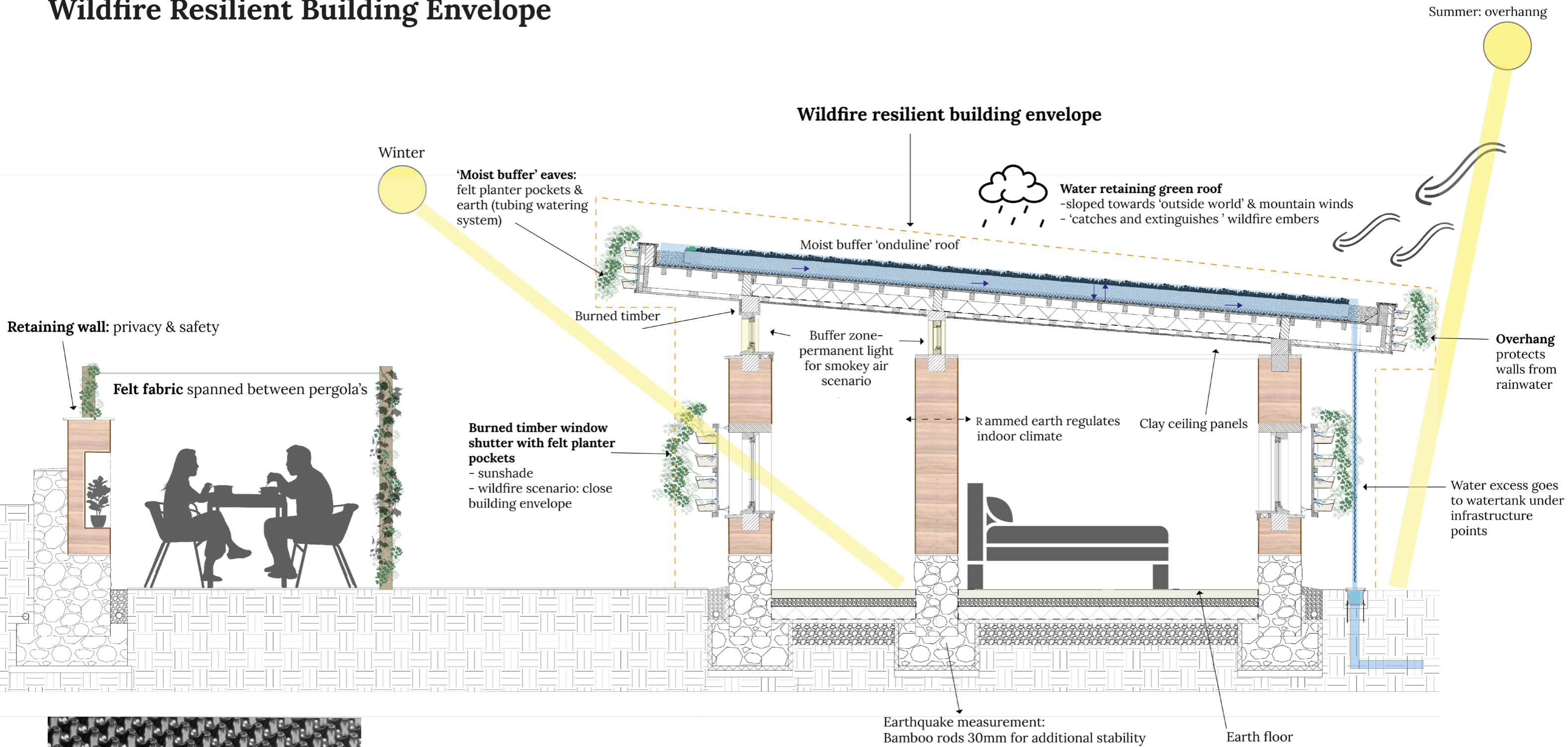
pneumatic  
rammer



manual rammers



# Wildfire Resilient Building Envelope

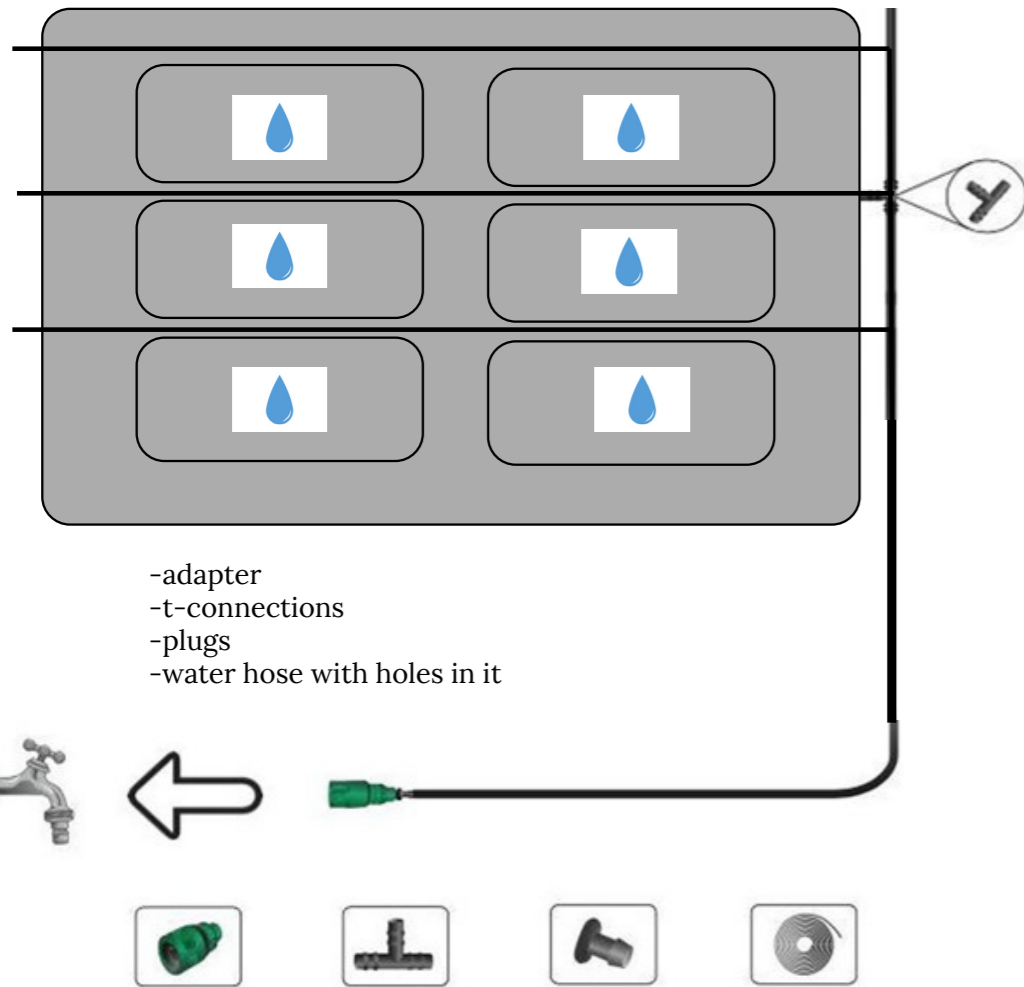


**Purpose roof:**  
Catch rainwater  
Hold rainwater (moist buffer)  
Evaporate rainwater (cooling & wildfire resilient buffer)

**Eaves in wildfire scenario:**  
Turn on water tap on maximum level: the eaves will work like water extinguishers, water will drip down and protect façade

(from Google Images Databank, 2022)

### drip irrigation system

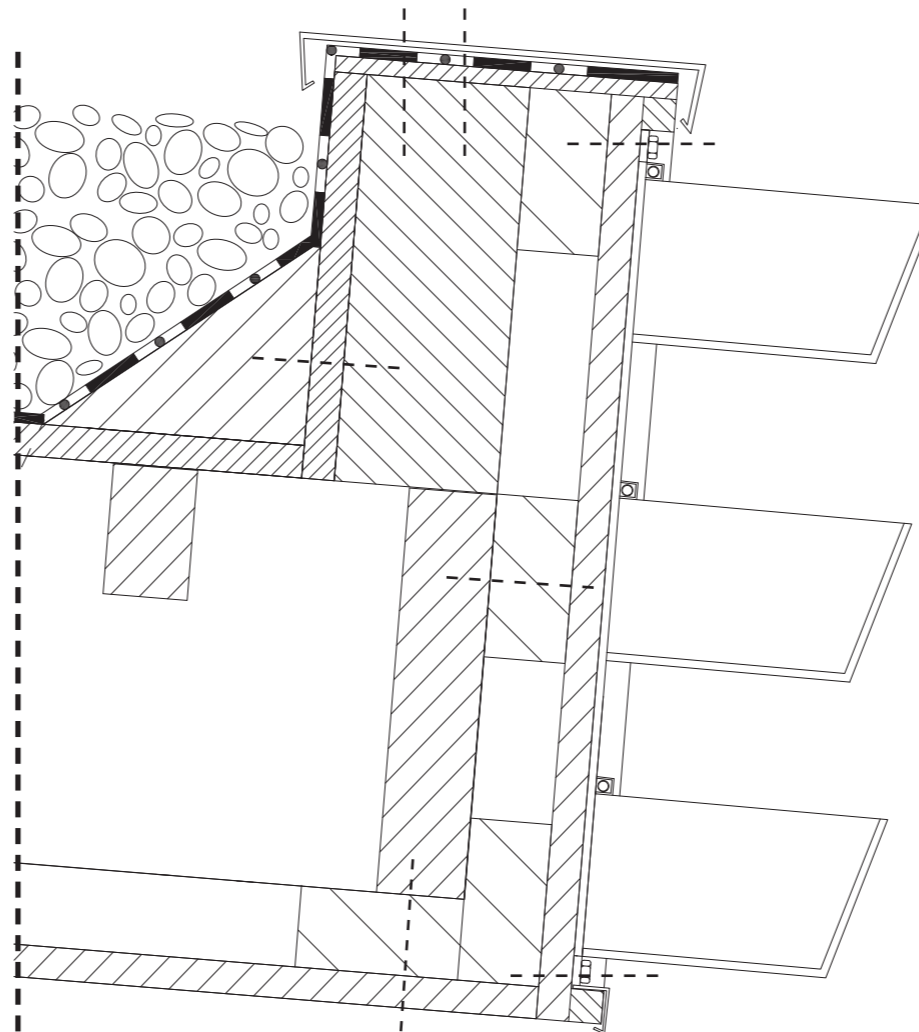


(Own modifications, from Google Images Databank, 2022)



(from Google Images Data-bank, 2022)

### 1:5 vertical detail: Felt planter pocket eave



Wool felt is non-combustible. Burning wool requires more oxygen than is available in the air. The flash point of wool is 580 degrees Celsius. No chemical treatment needed to prevent fire.

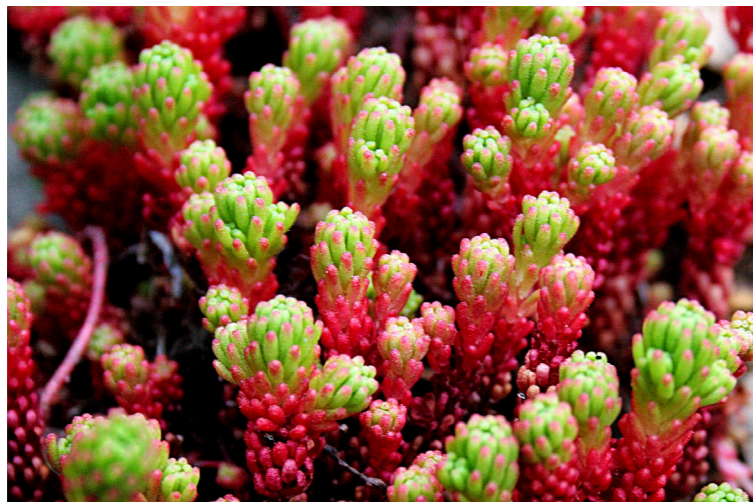
- Catch and hold rainwater (moist buffer)
- Elastic bands to hold waterhose
- Watertube with holes above planter pockets

Wool felt absorbs up to 30% of its own weight in moisture. Because wool fibres have a closed structure, the felt also releases the moisture without mould.

(from: De vilt mannen, 2015. <https://www.deviltmannen.nl/over-vilt/>)

## Plants in eaves & on roof

Wet plants (*high moist content*)



Sedum Lydium



Sedum sexangulare



Sedum spurium



Opuntia



Dianthus gratianopolitanus



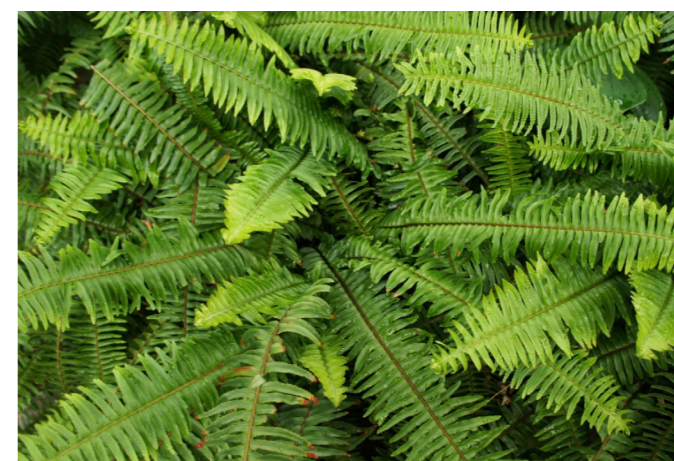
Sedum Album



Hedera Helix

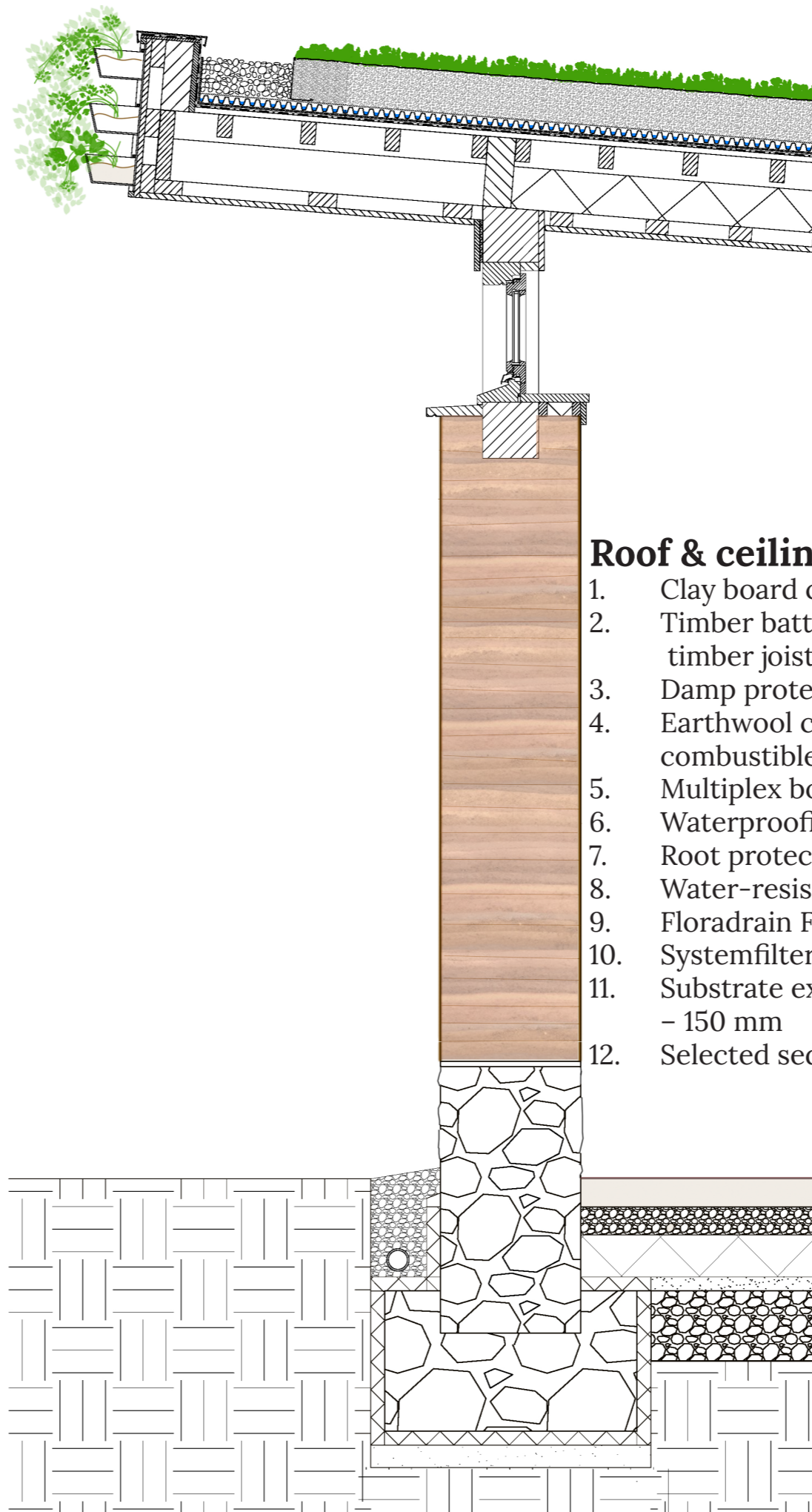
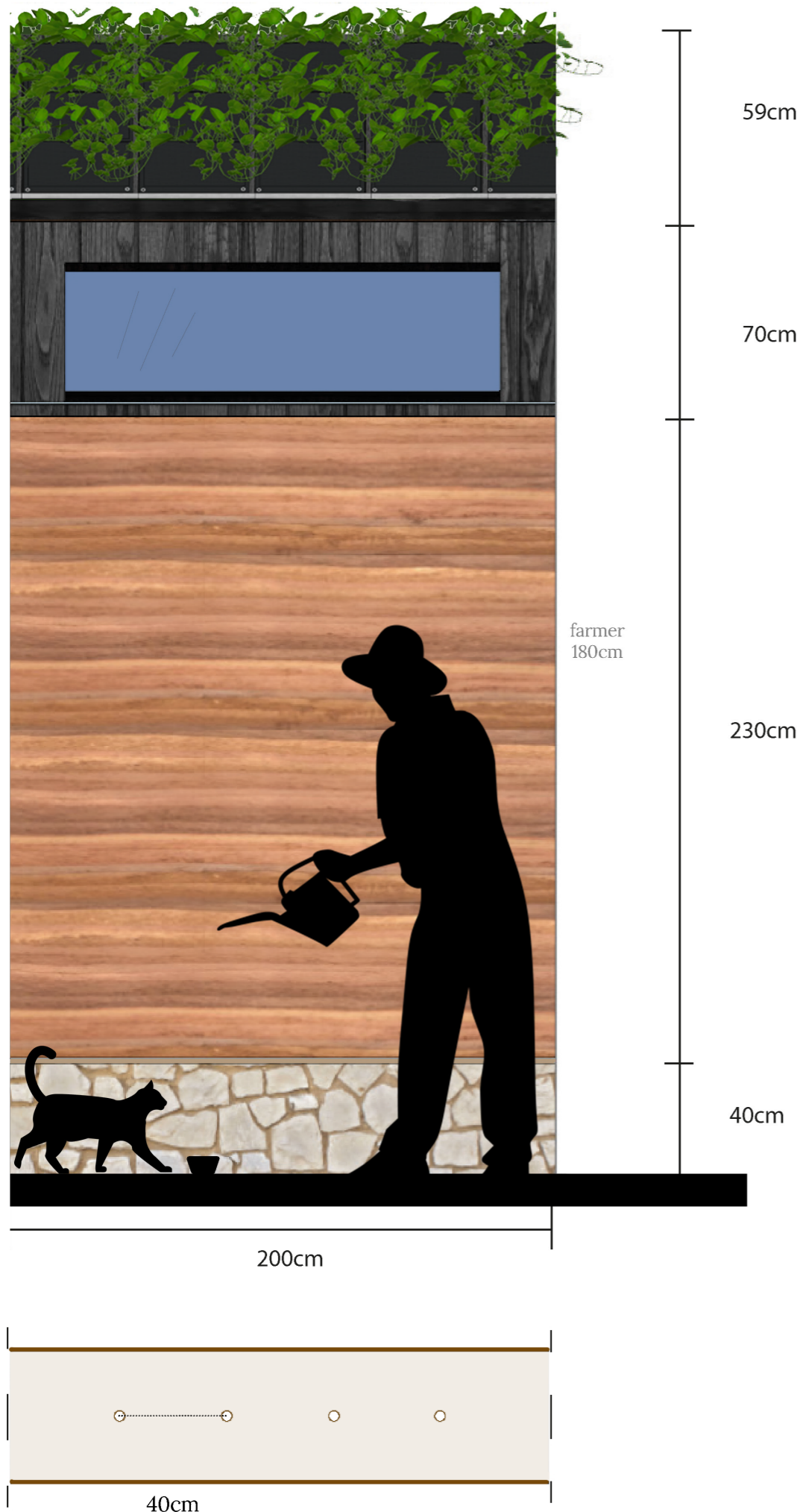


Satin Pothos



Kimberly Queen Fern

(from Google Images Databank, 2022)



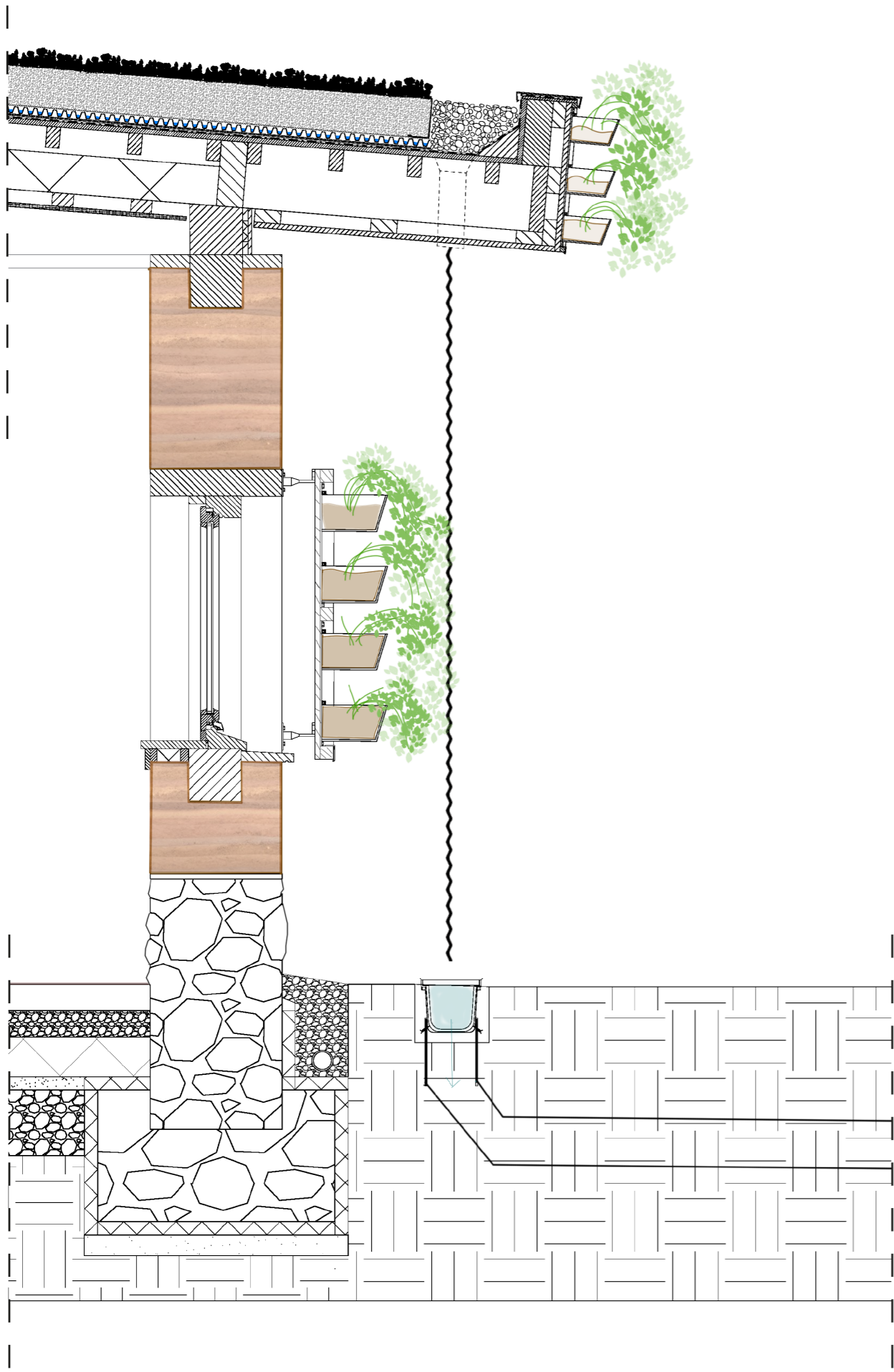
### 1:20 Details

From outside protected against wildfire embers by a non-combustible moist buffer

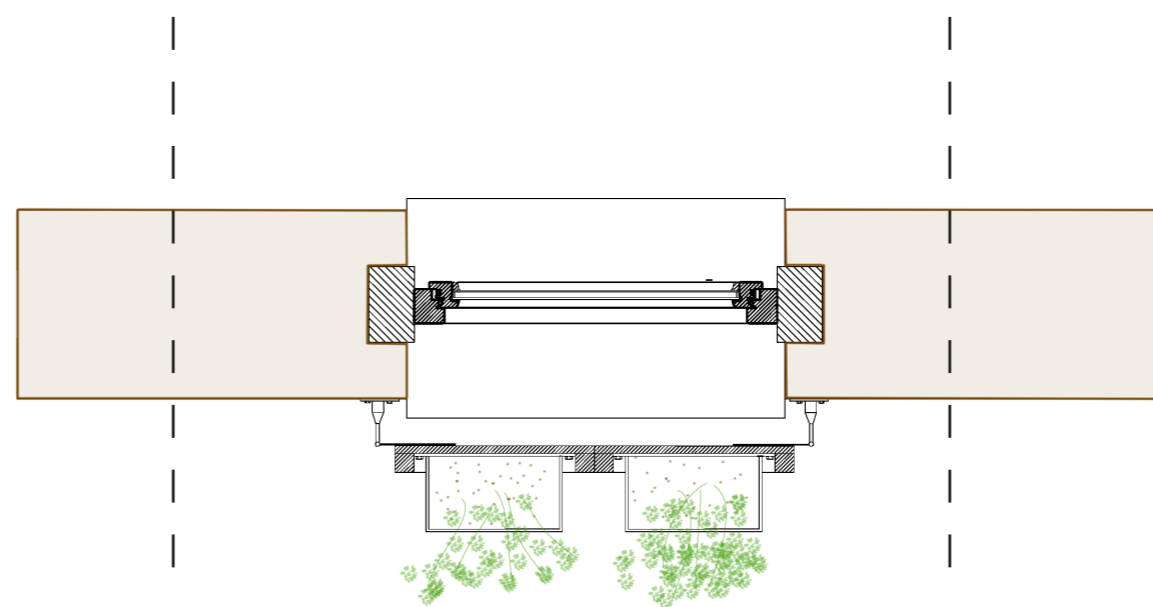
From inside protected against wildfire embers (accidentally entered through forgotten windows) by non-combustible clay ceiling boards and earthwool insulation

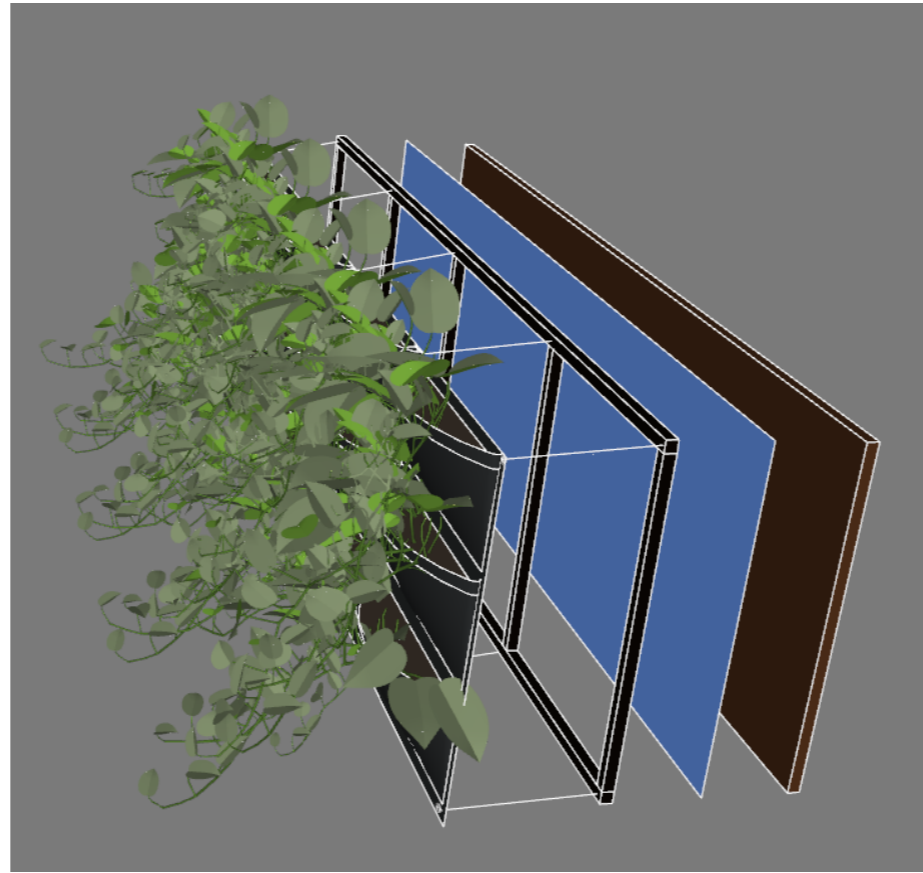
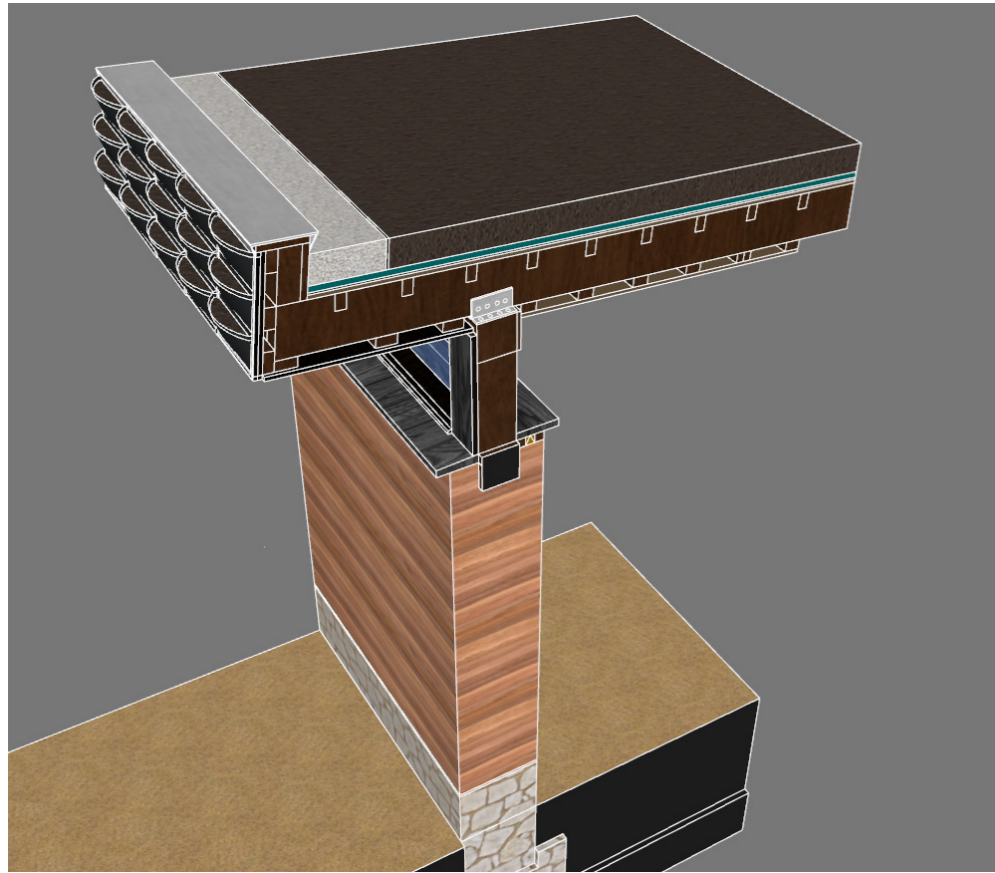
#### Roof & ceiling structure:

1. Clay board ceiling - 20 mm (Non-flammable )
2. Timber battens 50x80mm , timber beam 250x100mm  
timber joists 50x80mm
3. Damp protection foil - 2 mm
4. Earthwool ceiling insulation RC-3.5 - 150mm (Non-combustible)
5. Multiplex boards - 20 mm
6. Waterproofing foil Bituline by Onduline - 2mm
7. Root protection foil WSF 40 - 2 mm
8. Water-resistant protection mat SSM-45 - 2mm
9. Floradrain FD 25-E - 30 mm
10. Systemfilter SF - 1mm
11. Substrate extensive (earth) (Non-combustible) - 150 mm
12. Selected sedum plants & grasses



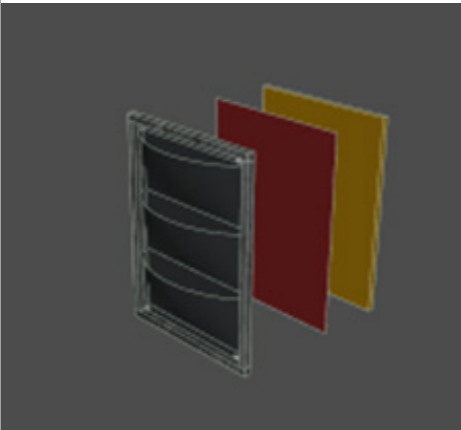
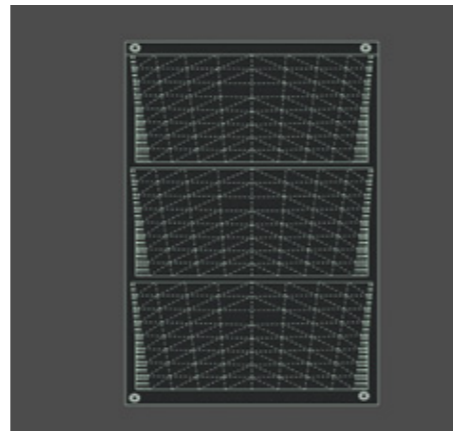
1:20 details:  
vertical,  
horizontal,  
façade





## Building technology: building guidelines

**Pockets**  
handmade by locals (sewed)  
sizes: 40x20cm





## Building technology: building guidelines

### Stabilise

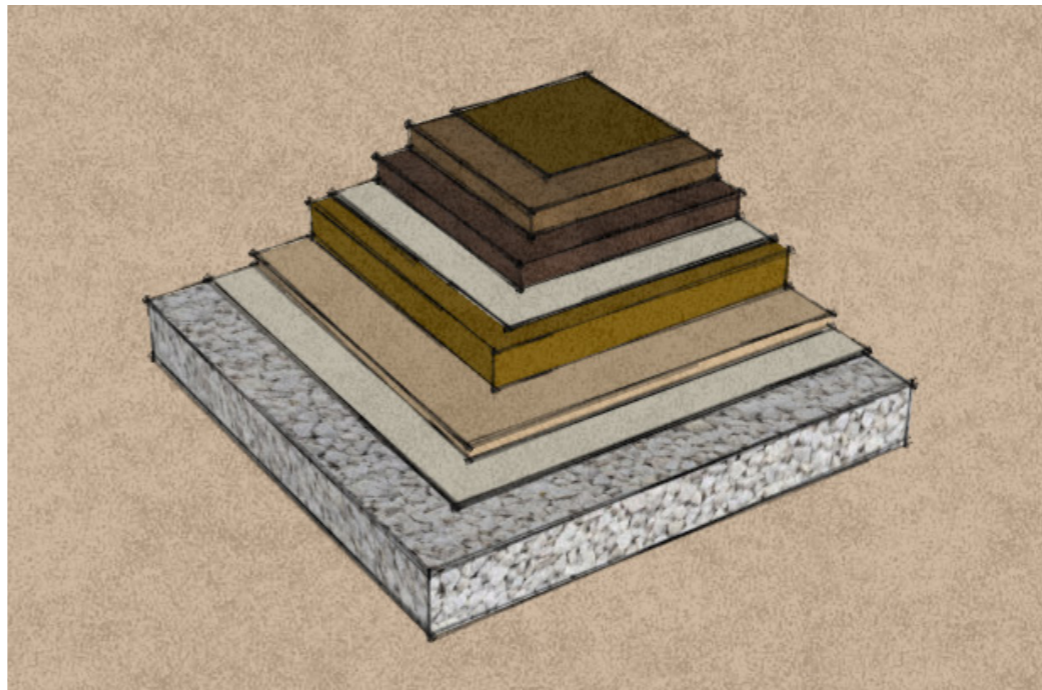
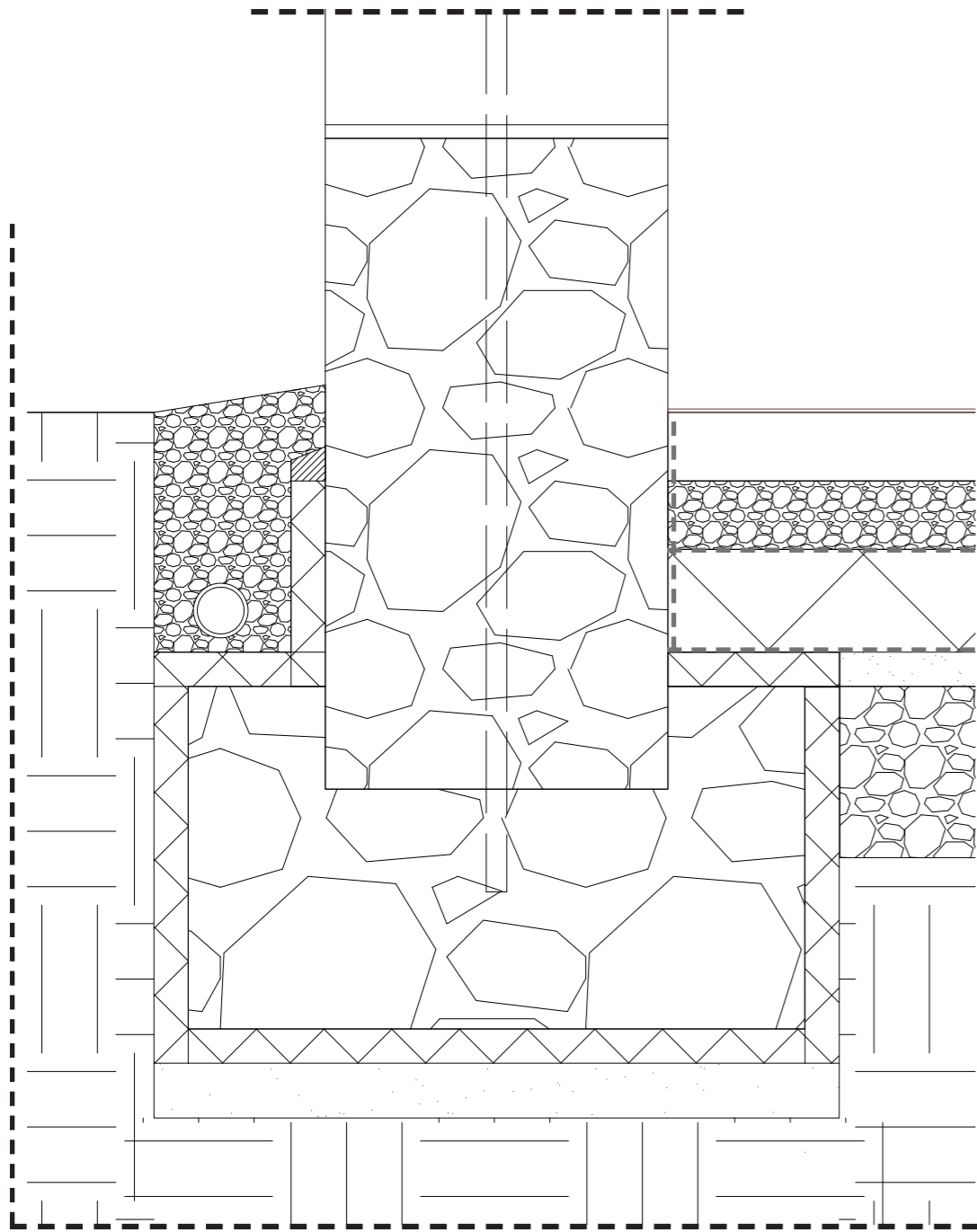
Rammed earth mixture with lime- 10%  
*Increases moisture resistance and  
compressive strength*

Dry density 1700-2100 kg/m<sup>3</sup>  
30% gravel  
45% sand  
13% silt  
12% clay

### Structural performance:

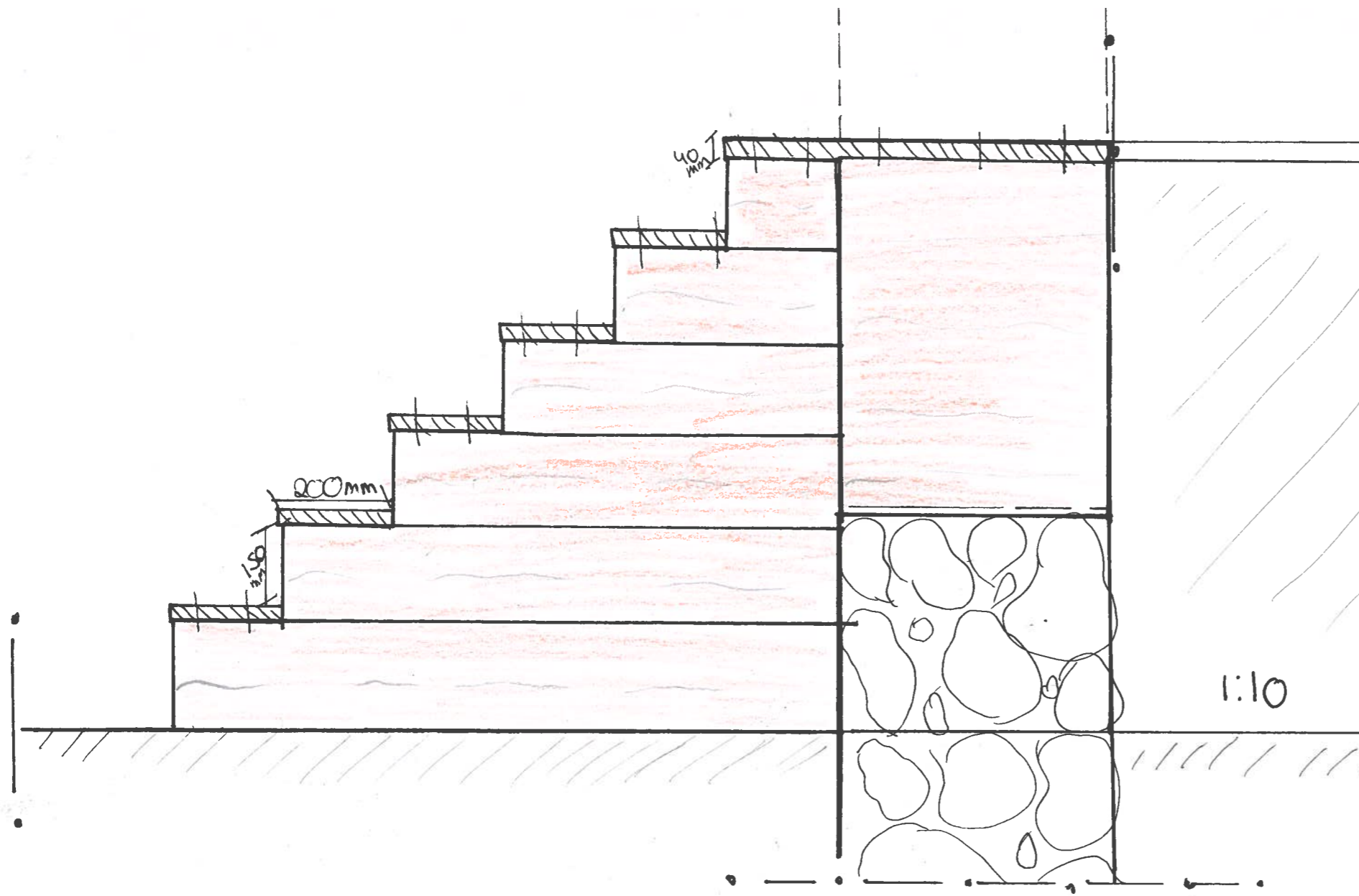
Earth increased in strength overtime  
Compressive strength 18mpa

(Birznieks, 2013. Designing and Building with Compressed Earth.  
from: <http://resolver.tudelft.nl/uuid:9e28a7a6-34b0-461b-b898-a9081b51c015>)

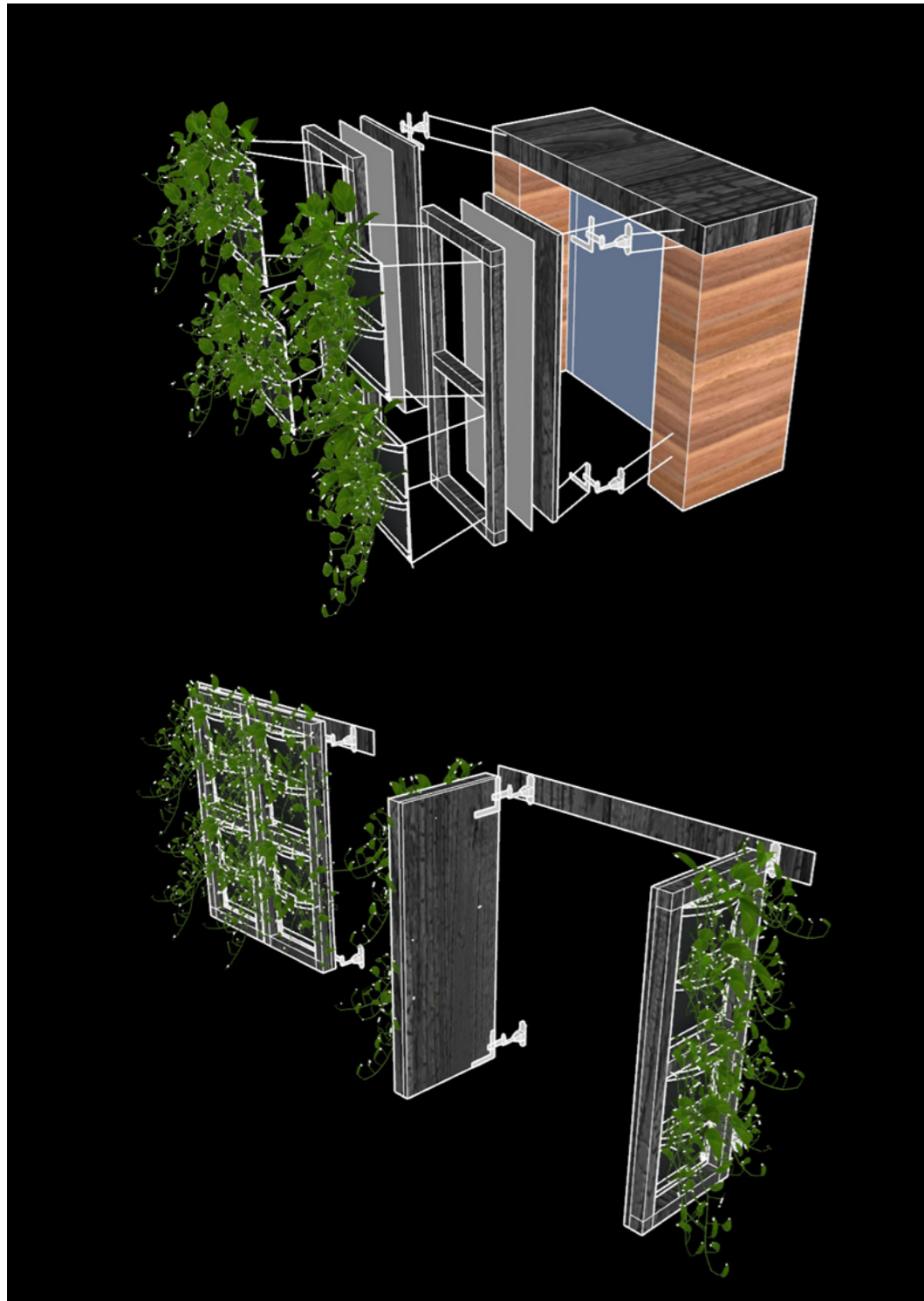


**1:10 vertical detail**  
**Footing and foundation**  
**Floor:**  
 3 layers Linseed oil: finishing & hardening wax  
 Poured adobe mixture – 10 cm  
 Rammed earth with gravel – 10 cm  
 Damp resistant foil – 1 mm  
 Hemp insulation – 15 cm  
 Sand – 5 cm  
 Water resistant foil – 1mm  
 Pebbles – 25 cm

**Foundation & plinth**  
 40cms above ground level, 40 cms in ground  
 Footing at each side at least 10 cm wider than foundation and plinth  
 Lime: more resistant against moist and rain

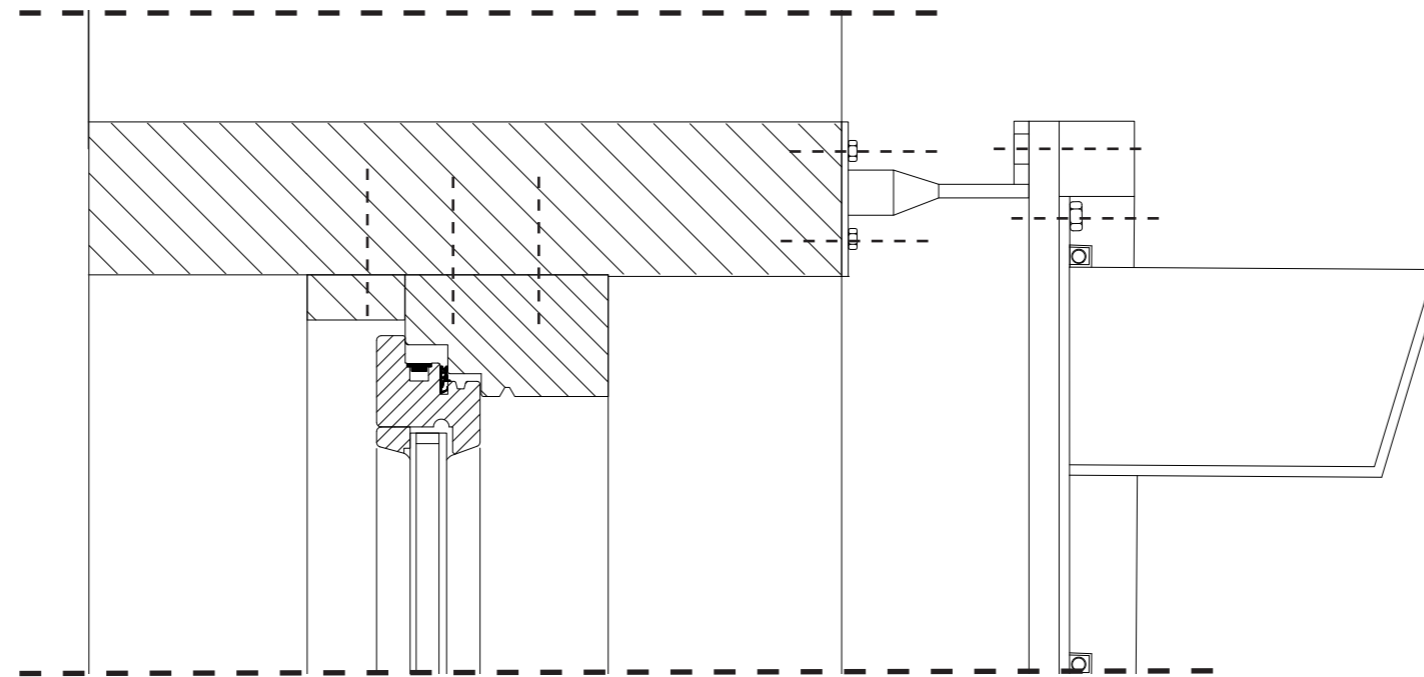


**1:10 vertical detail  
Stairs on 1m slope  
(kitchen to sitting area)**

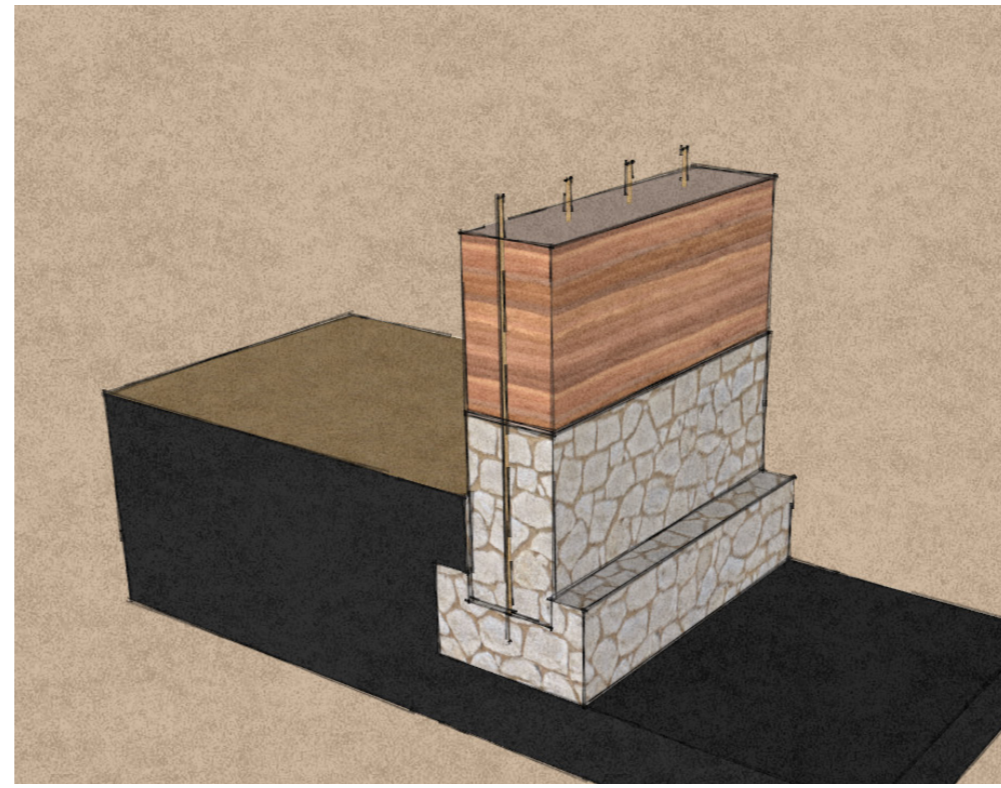
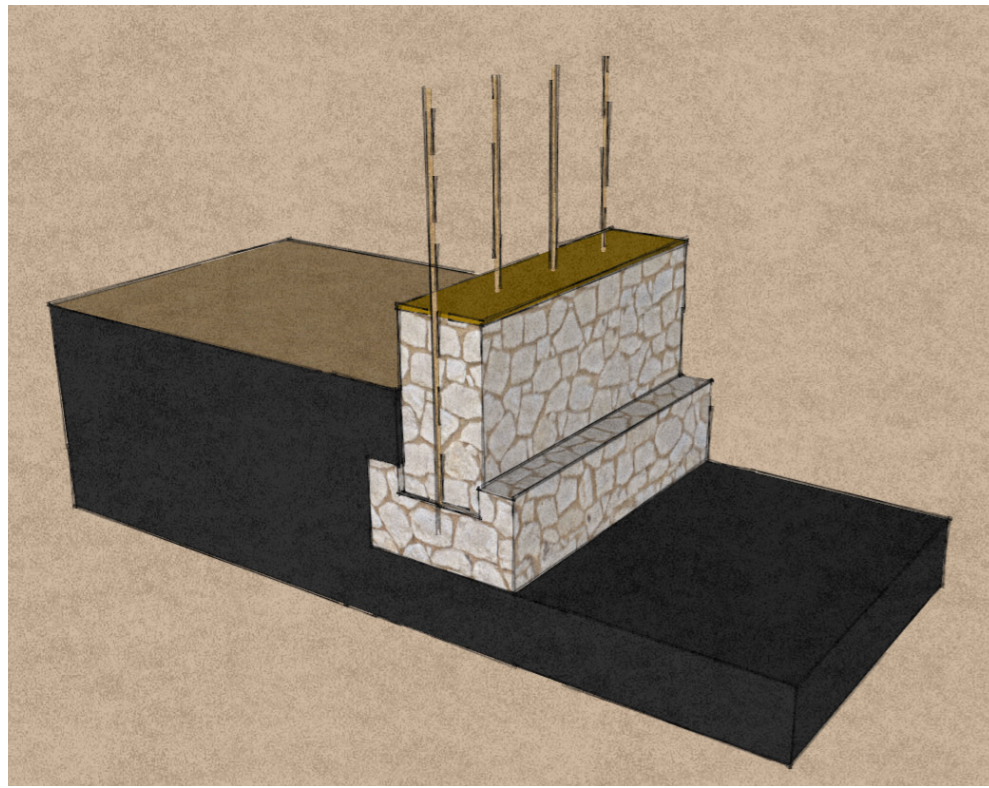


**Building technology:  
building guidelines**

Window shutters



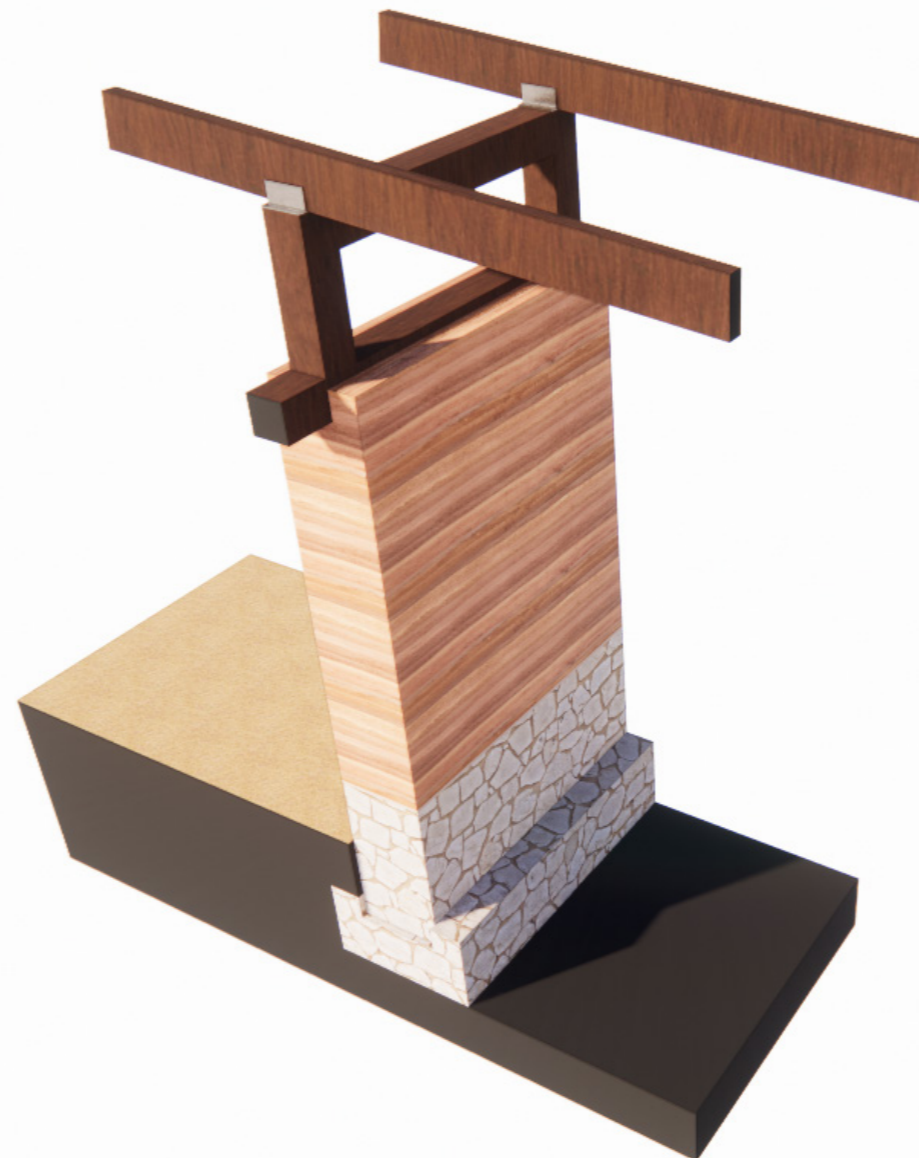
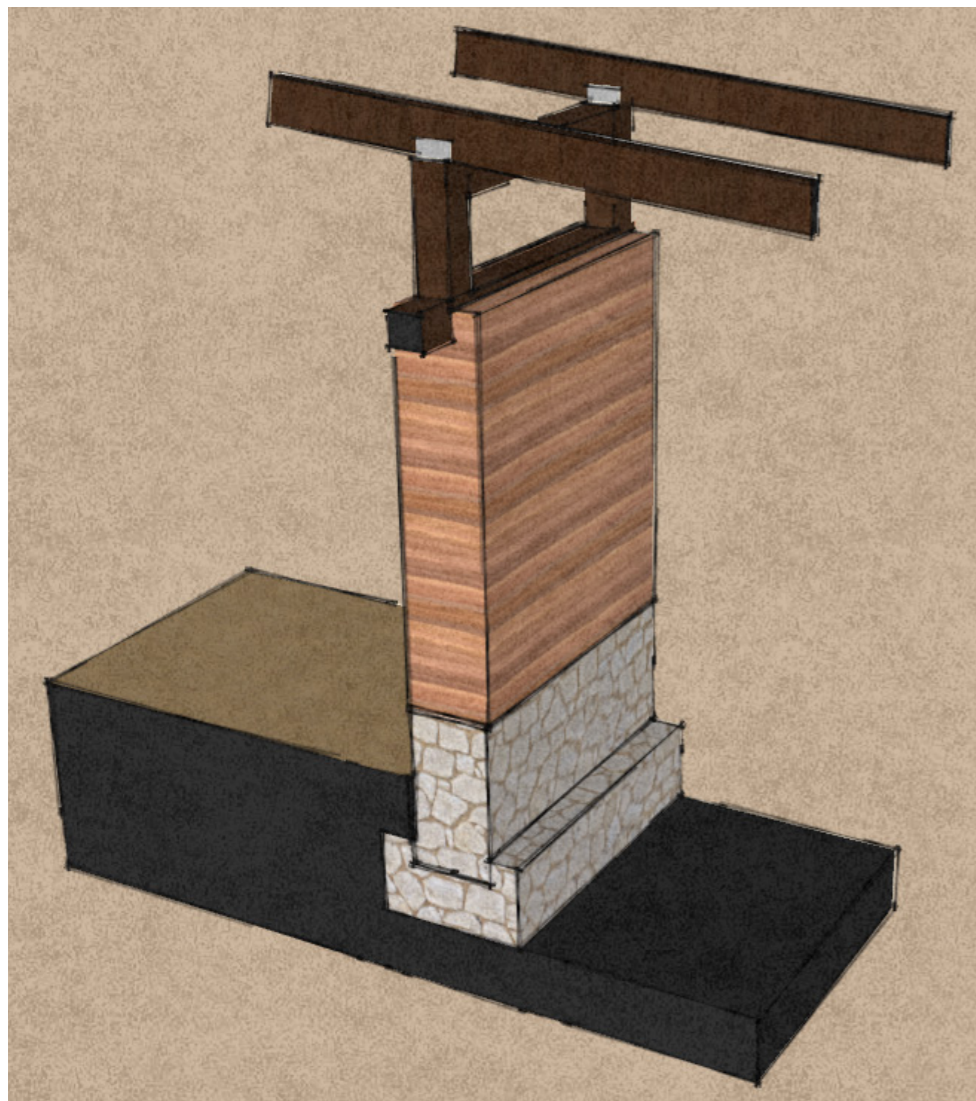
**1:5 vertical detail  
window in wall, lintel  
and window shutter**



## Support structure construction Building construction guidelines

### Support structure

- Rubble stone masonry footing and foundation base (bigger stones in footing, on site chopping sizes between 5cm-30cm)
- Rammed earth walls 50 cm
- Timber ring beam 200x200 mm
- Timber columns 200x200
- Timber main roof beams 250x100mm  
(1/20 x 5)  
(25/3 x 10)



### Walls:

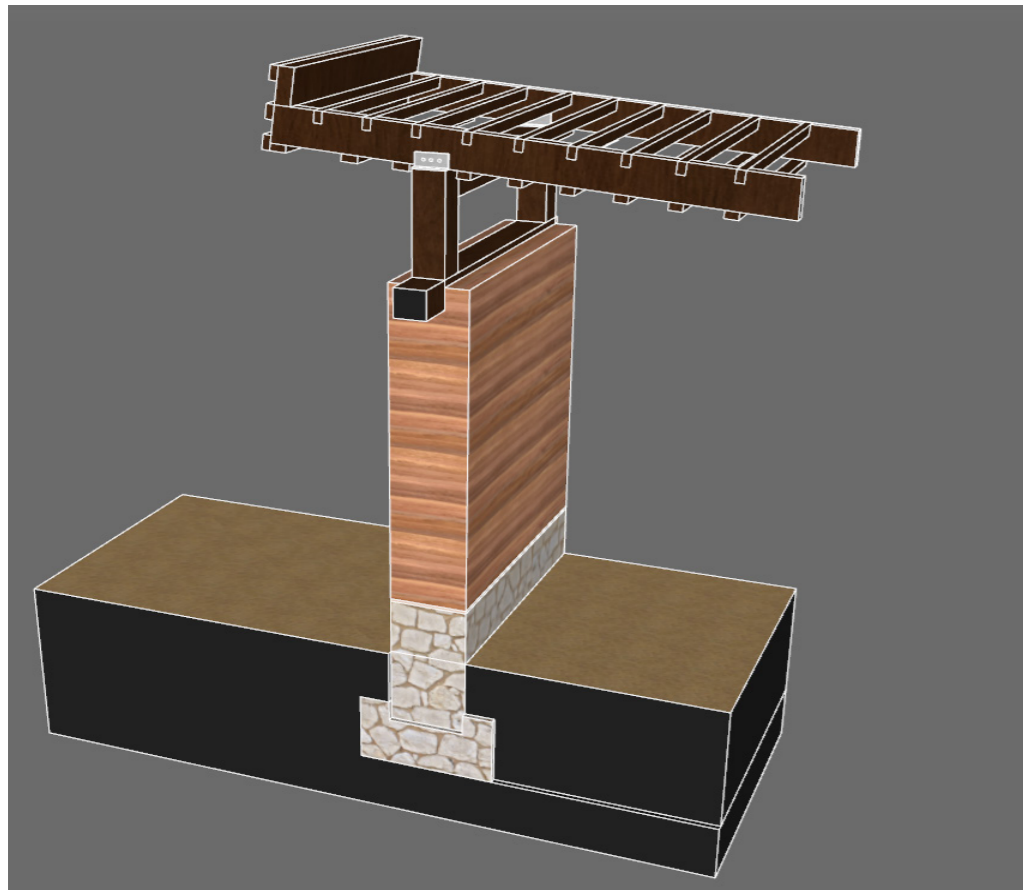
stable, stiff and load-bearing on their own, work like vertical stability surfaces

### Disc construction:

discs provide sufficient stability

### Roof:

small span (~2m) and secondary head and mid joists



## Support structure construction Building construction guidelines

### Connections

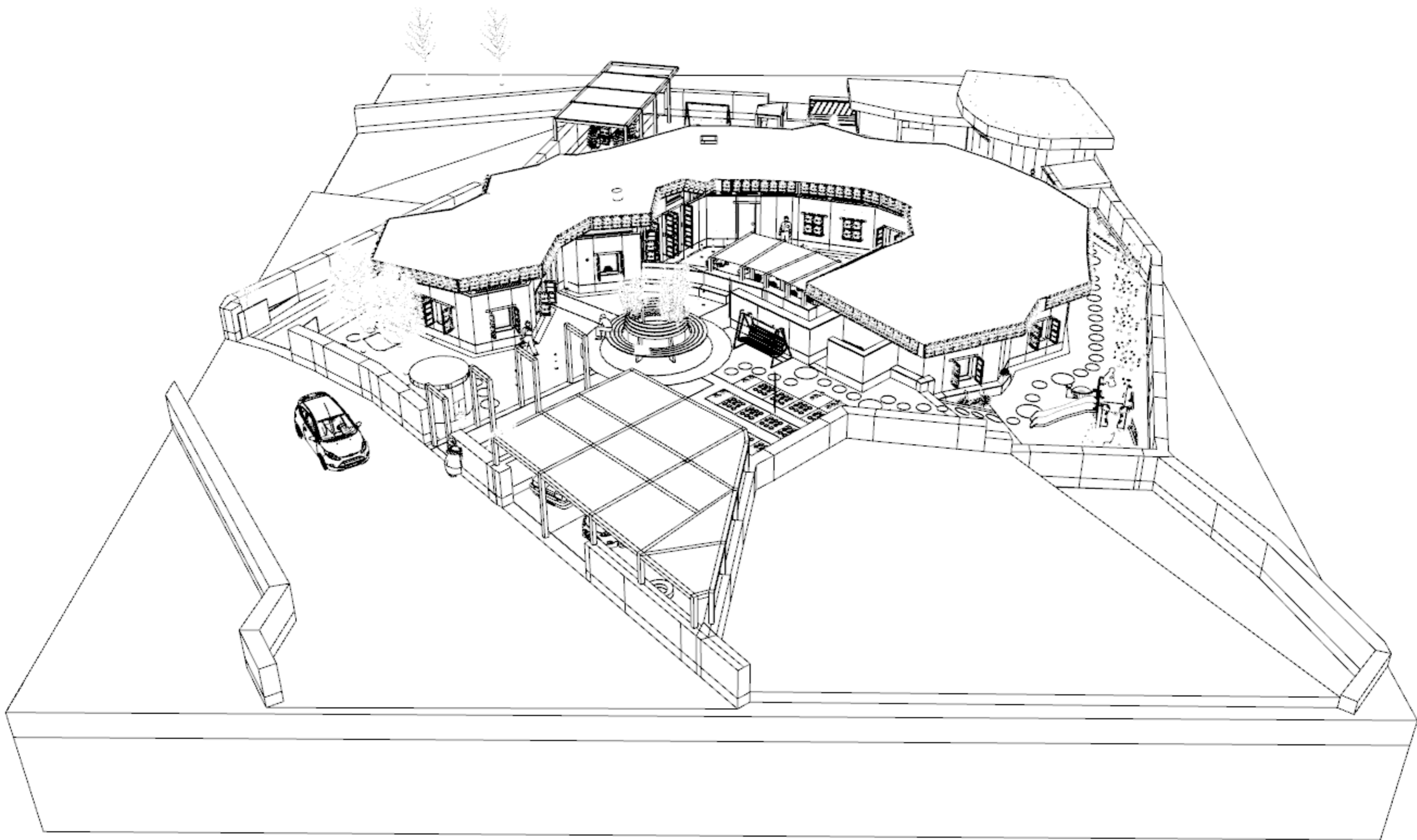
- Rubble stone masonry foundation base & RE-walls: earth-lime mortar
- Mortar rubble stone masonry: earth-lime mortar
- Connection ring beam and RE-Walls: RET-joints by anchors bolts
- Connection timber columns and main roof beams: slotted holes (flexible bolt placement)
- Connection timber main roof beams and secondary beams: invisible joints 'blind joist connection'

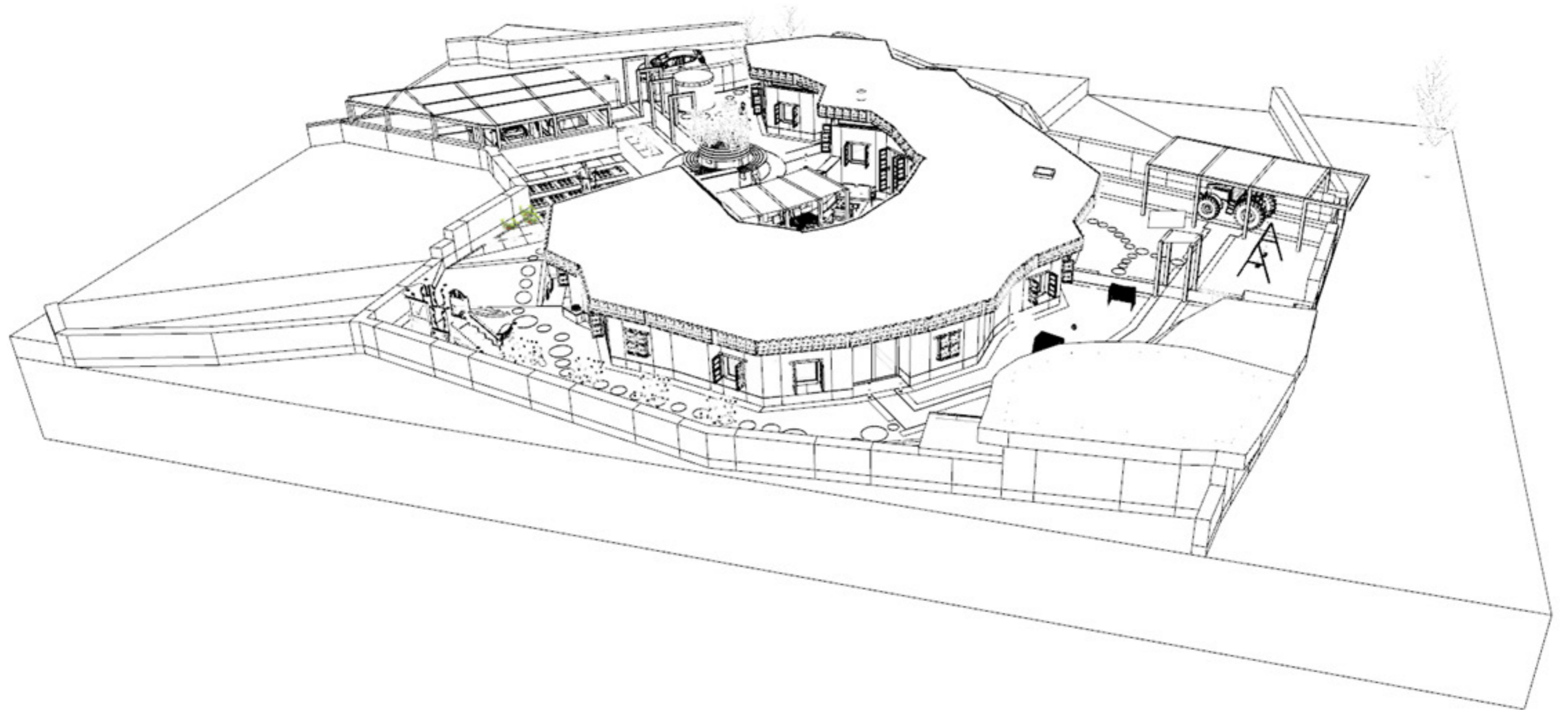


All support structure timber & inside timber element:

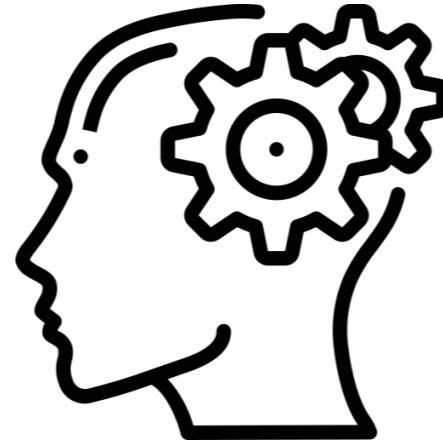
1. primer
2. fire resistant coat
3. protective topcoat

1. Structural system: 50cm massive RE-walls will withstand earthquakes
2. No cement, it makes it less resistant against compressive forces.
3. Bamboo rod of 3 cm every 40 cm for additional stability
4. Height < 8 x thickness.
5. Horizontal distance between openings in walls at least 1 m
6. Lintels 20 cm in the walls
7. Ring beam that holds the top of all the walls together

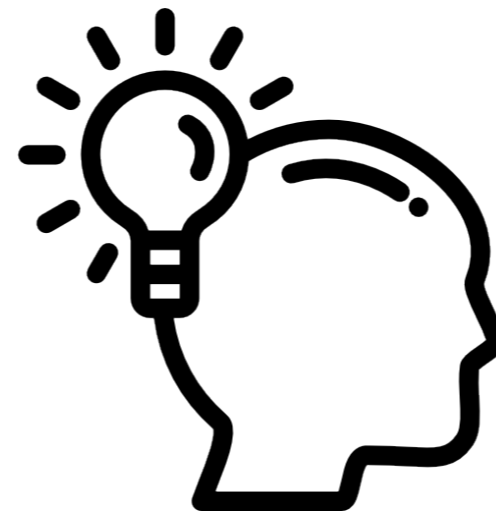




## Architectonic and social relevance



Get local municipality and architects to stop what they are doing now and encourage them to think wildfire resilient in different scales.



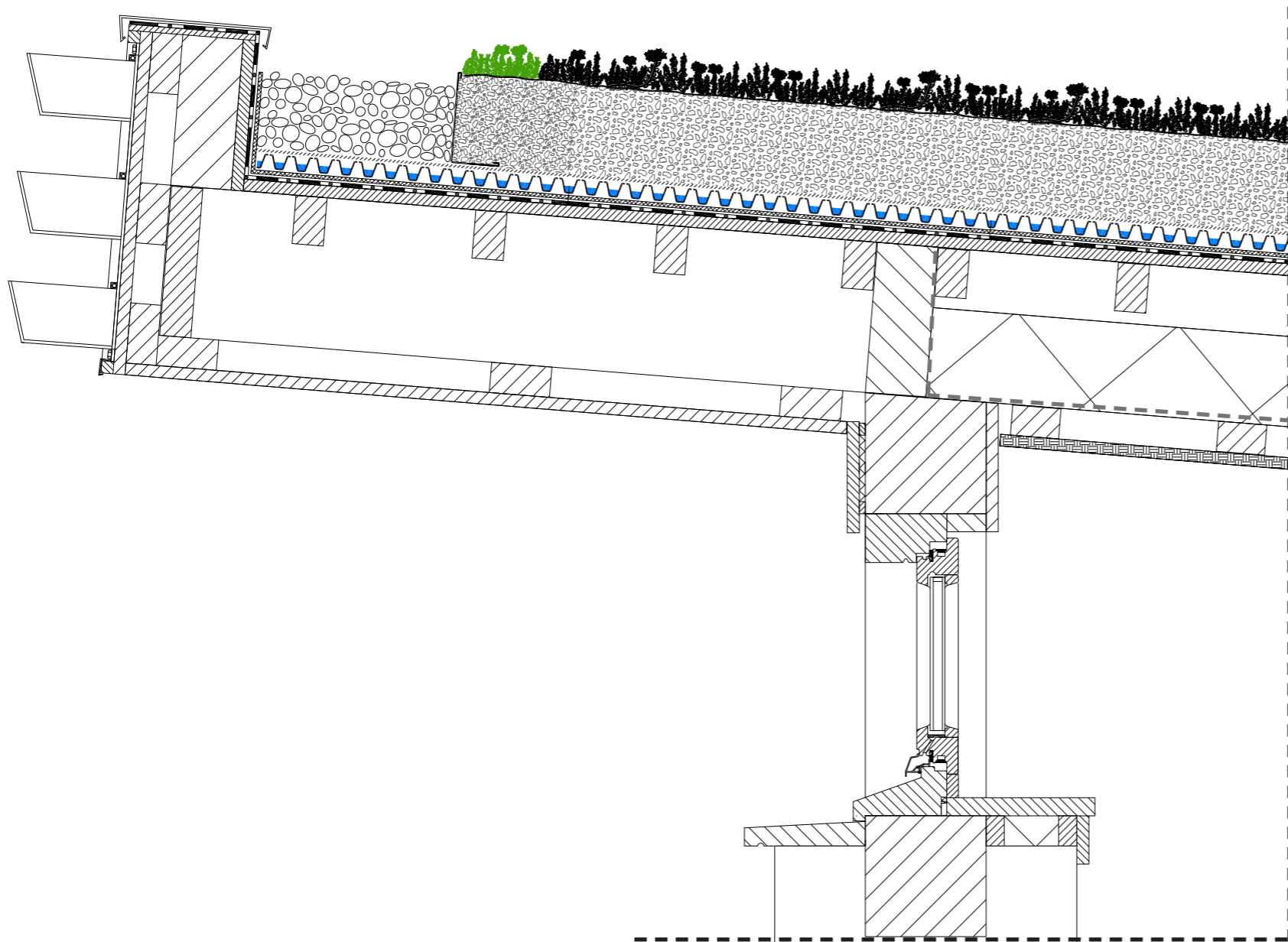
*Wildfire resilient community:*

- able to (re)build their houses with sustainable building knowledge and skills.
- with materials that prevent damage in terms of a little / no demolition caused by wildfires.
- they can continue their daily lives or pick it up immediately after a forest fire happens.
- in case of unforeseen destruction, they can easily repair the damage themselves.

**Start rebuilding Kalemler!**

**Healthy & safe rammed earth houses for now and future generations**

**Thank you!**  
**Questions?**



**1:10 vertical detail**

**'front eave' fragment**

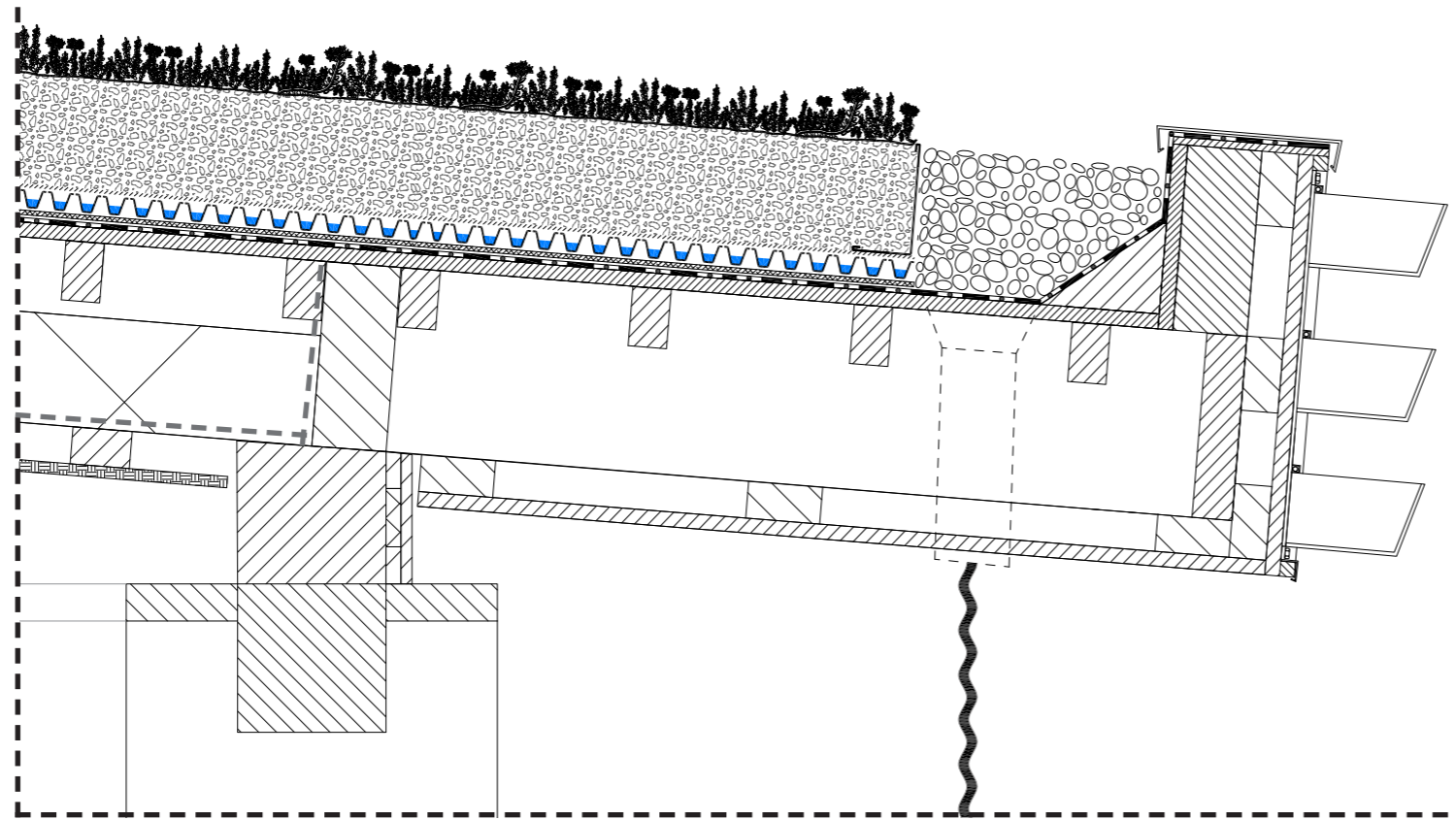
Multiplex board – 20mm

Water-resistant foil – 1 mm

Timber framework 20x20mm

5mm Felt earth pockets , screwed to framework

Root-wrapped plants with felt to put in  
pockets, roots grow into this layer



**1:10 vertical detail**

**'back eave' fragment**

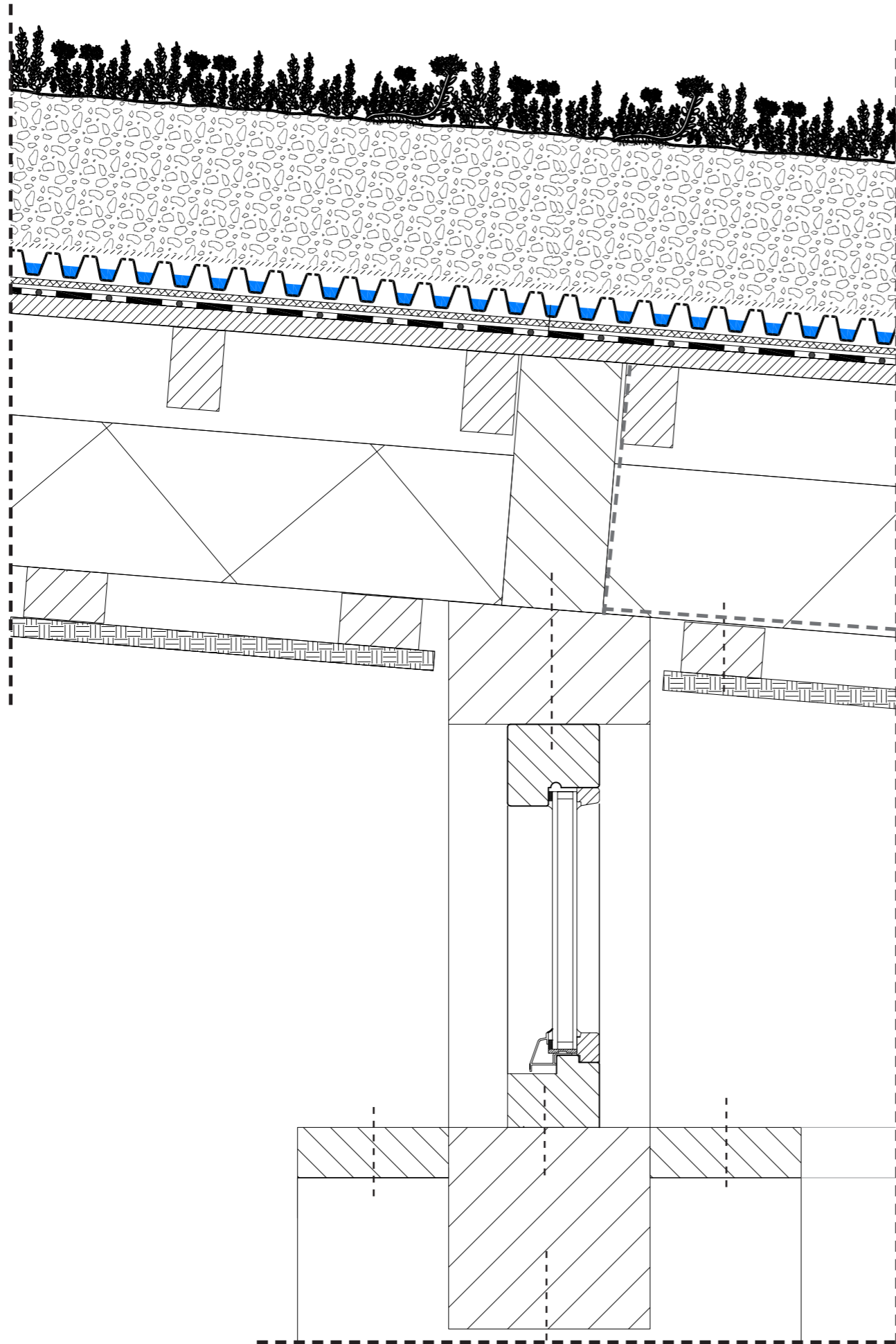
Multiplex board – 20mm

Water-resistant foil – 1 mm

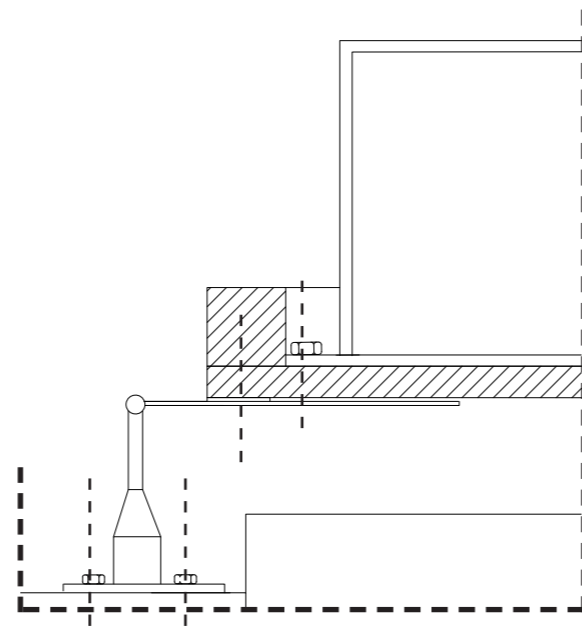
Timber framework 20x20mm

5mm Felt earth pockets , screwed to framework

Root-wrapped plants with felt to put in pockets, roots grow into this layer



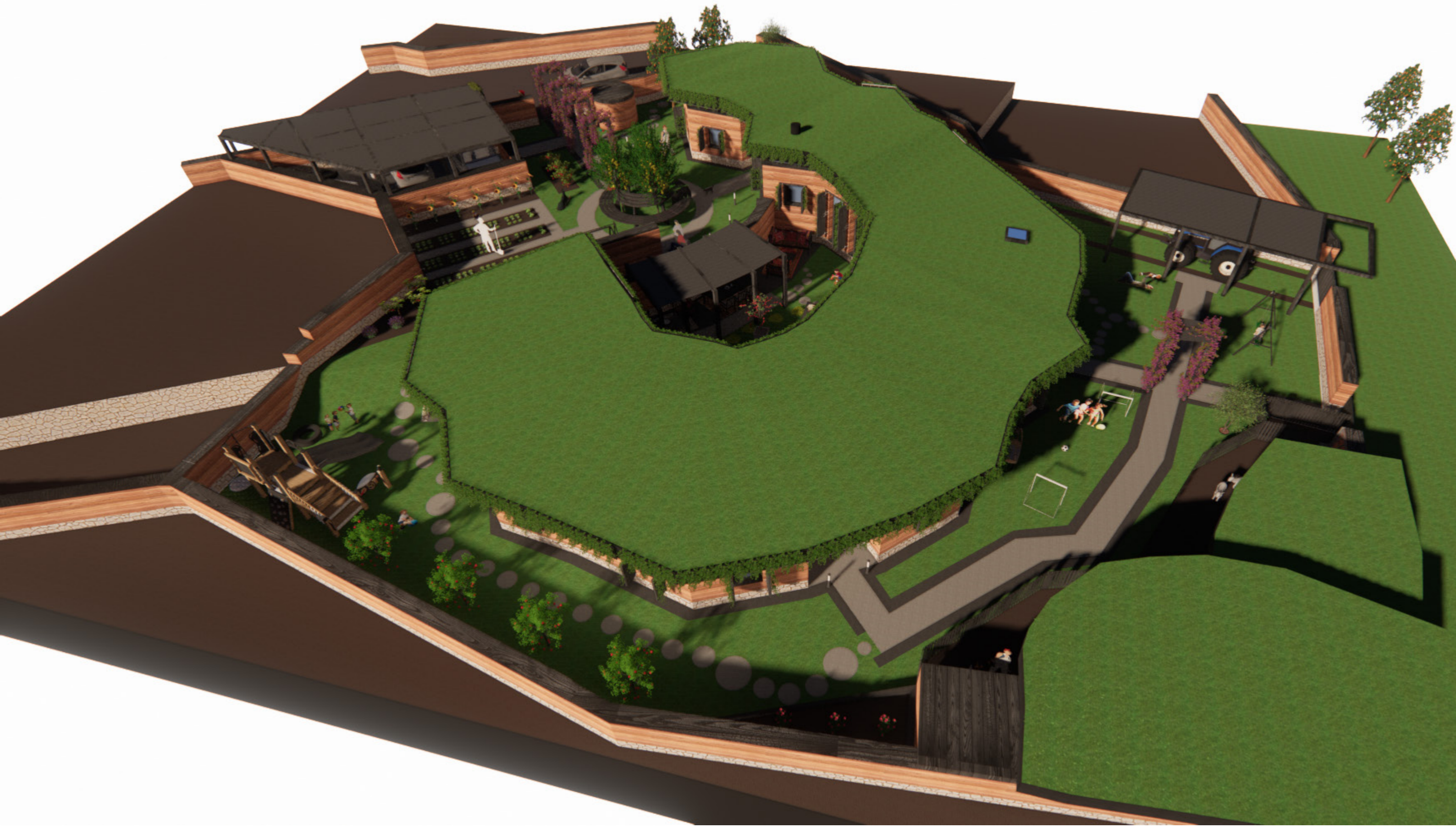
**1:5 vertical detail  
Interior top window**

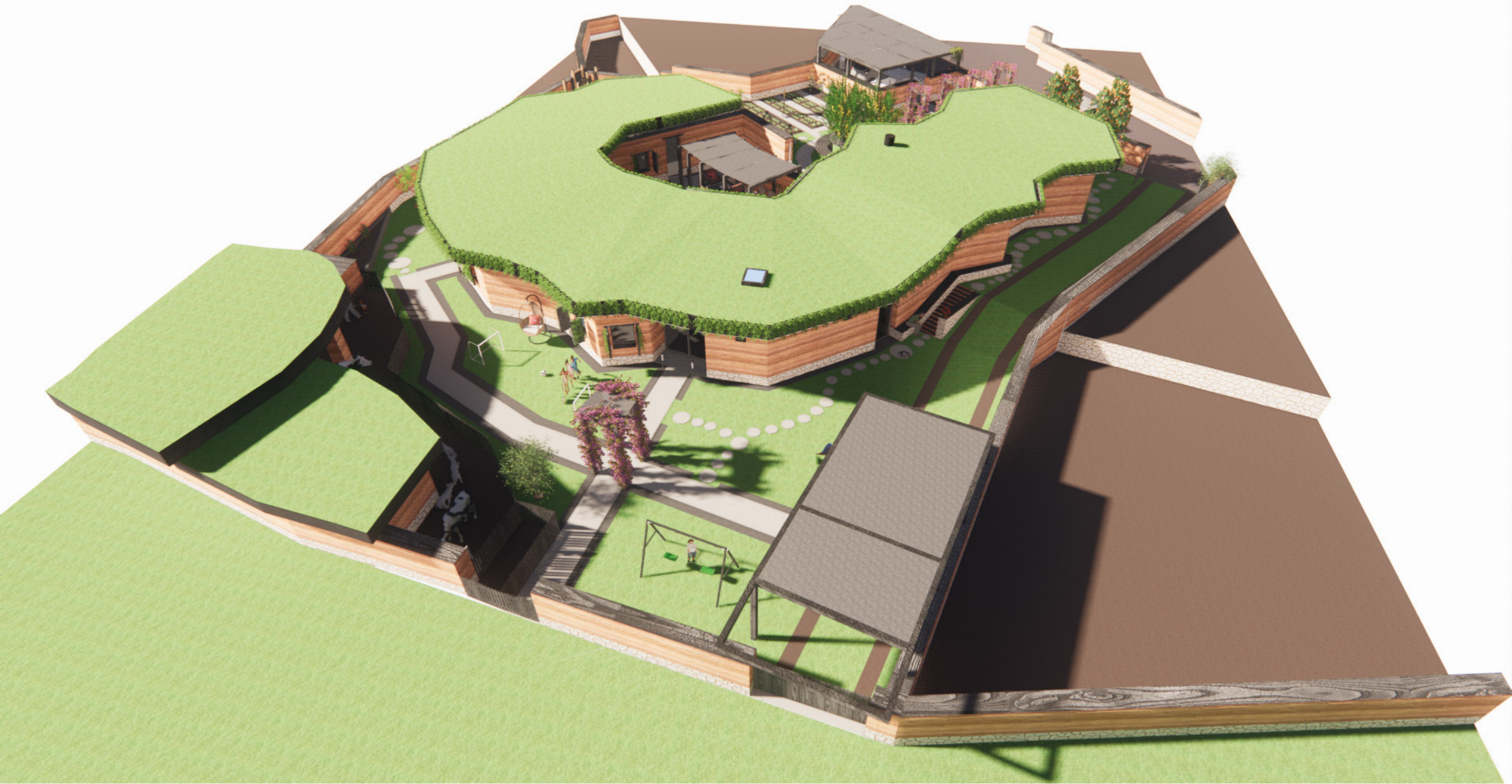


**1:5 horizontal detail  
window shutter in wall**











## Definitions:

### Wildfire resilience:

*“The ability to cope with wildfires in such a way that as little damage as possible is caused to the environment, including buildings, people, flora, fauna, work, and daily life. This concept encompasses several aspects, one of which is architectural resistance to fires.”*

*(Own definition)*

### Fire resistance:

*“So resistant to fire that for a specified time and under conditions of a standard heat intensity it will not fail structurally or allow transit of heat and will not permit the side away from the fire to become hotter than a specified temperature.”*

*(from Merriam Webster Dictionary, 2021.*

*<https://www.merriam-webster.com/dictionary/fire%20resistance>)*

*The chosen material earth also has resistance properties within the resilience context.*

## **Images reference**

Unless stated differently on the presentation page,  
all images and drawings from  
*Kiliçaslan, E. (2022)*

