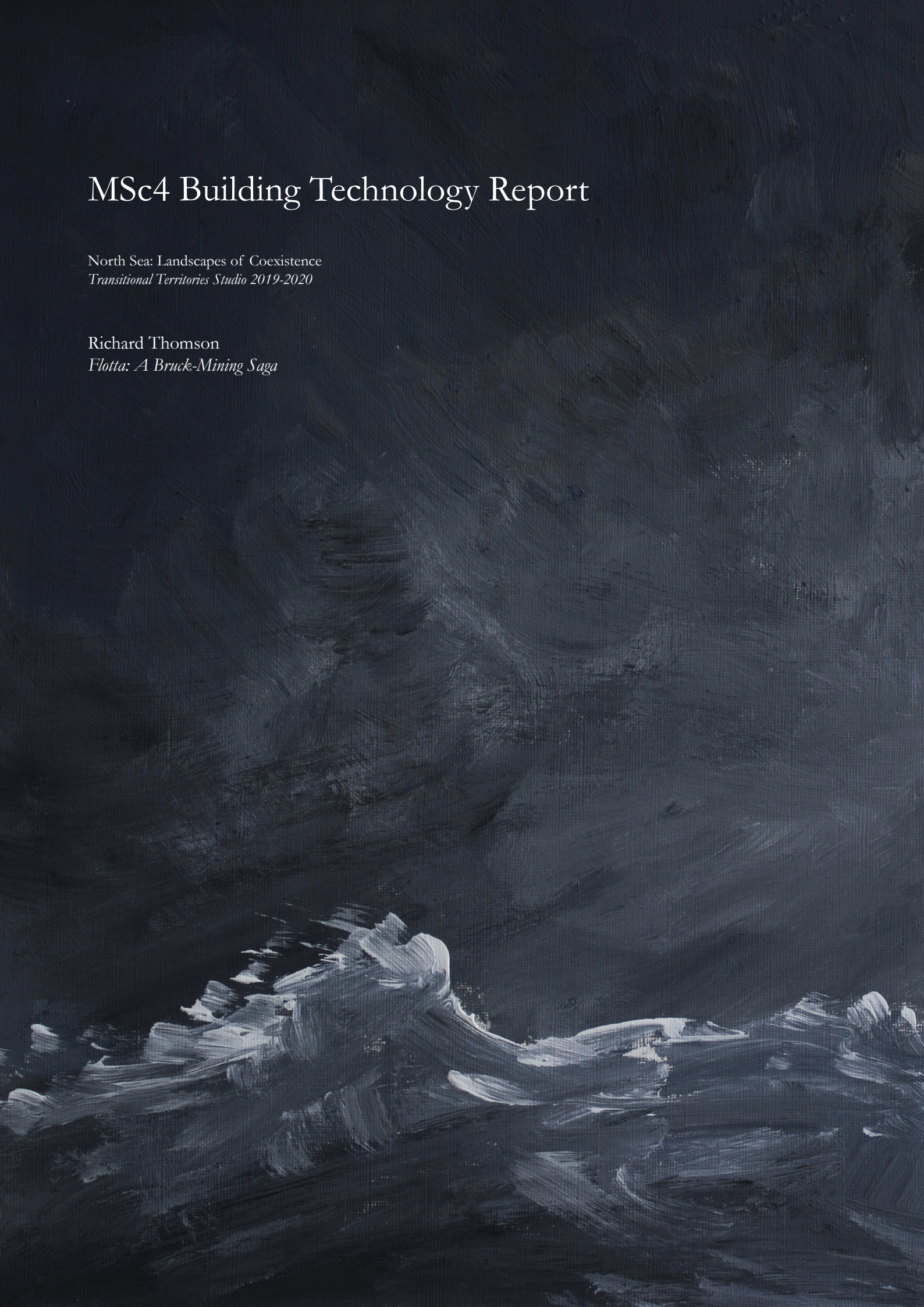
MSc4 Building Technology Report

North Sea: Landscapes of Coexistence
Transitional Territories Studio 2019-2020

Richard Thomson
Flotta: A Bruck-Mining Saga



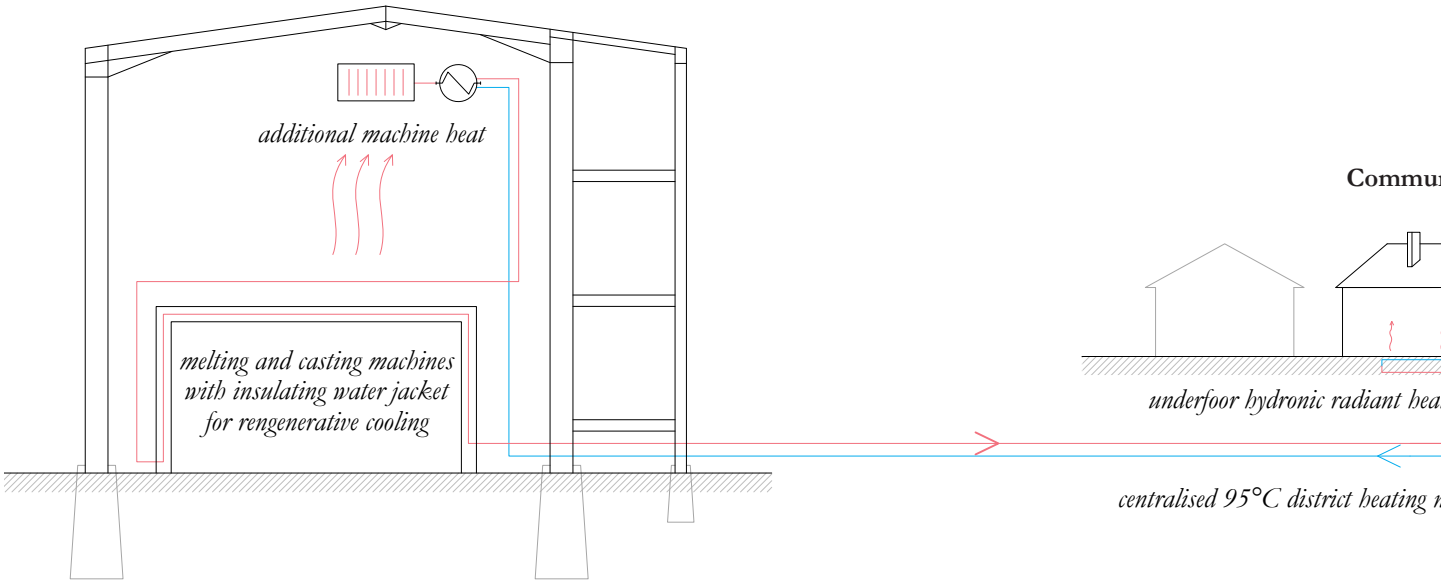
Contents

Overarching sustainability concept

Centralisation vs Decentralisation

The project is unsual in scope in that it questions the standard idea of 'centralisation as good' as a (now often outdated) result of centuries of fuel dependence. This notion is considered outdated because of the limitations of centralised electricity networks and their unsuitability to widespread a transition to renewable energy. The project therefore explores notions of centralisation vs remoteness/decentralisation. Central needs such as heating are to be centralised on the island of Flotta, with the heat provided by a new metal recycling plant and distributed through a district heating network. Otherwise however, the components of the island are otherwise almost entirely separated pieces in the landscape. This is considered sustainable in infrastructural terms at a global scale, and socially sustainable in human terms at a territorial scale.

Bruck-mining infrastructure



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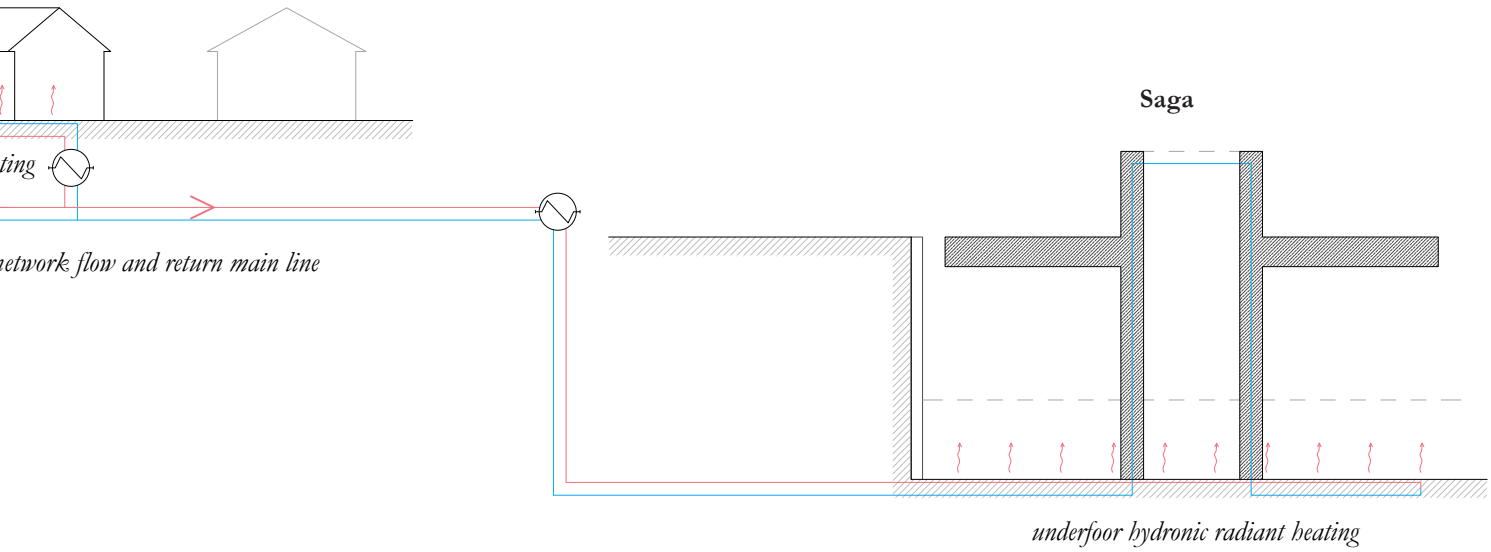
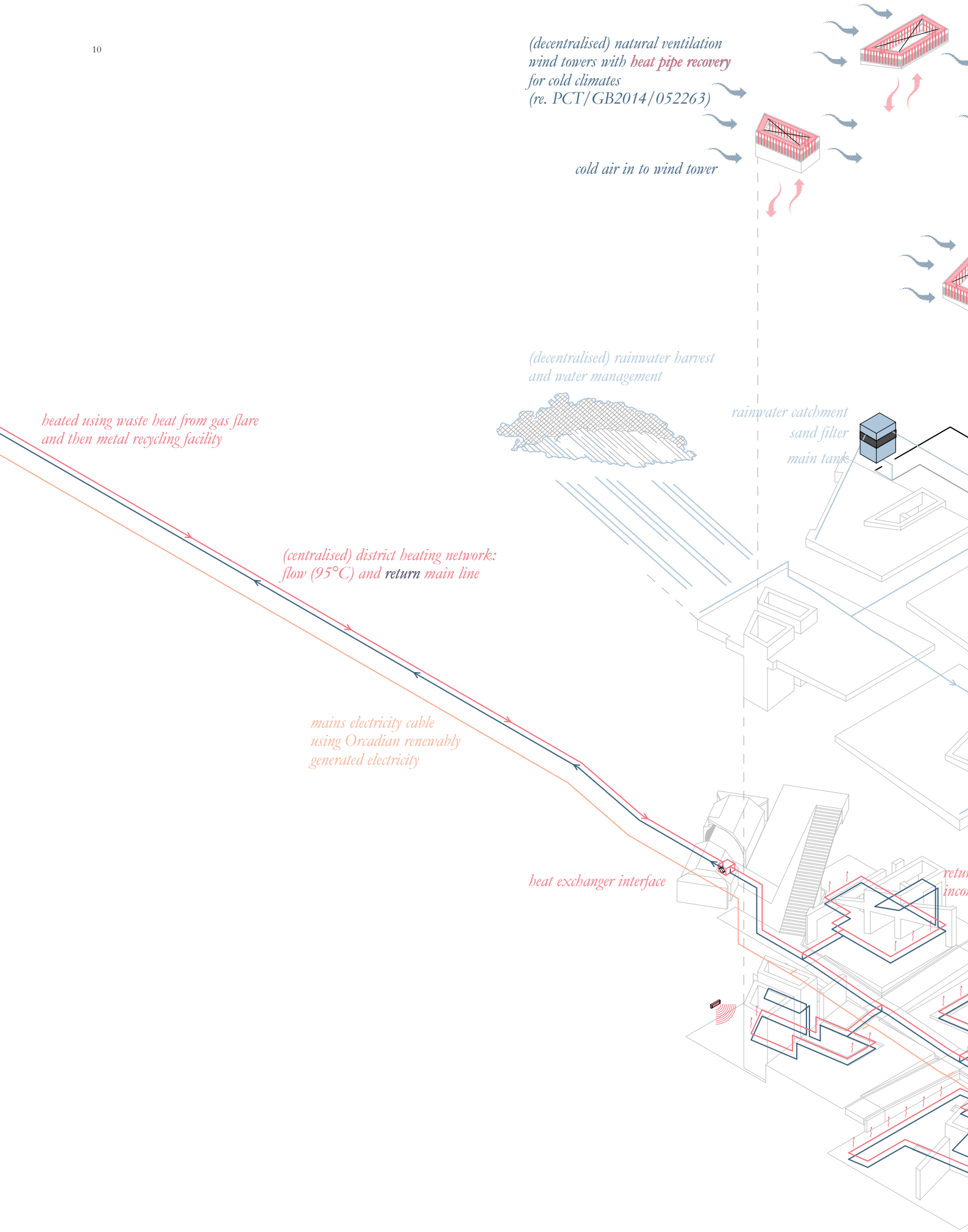
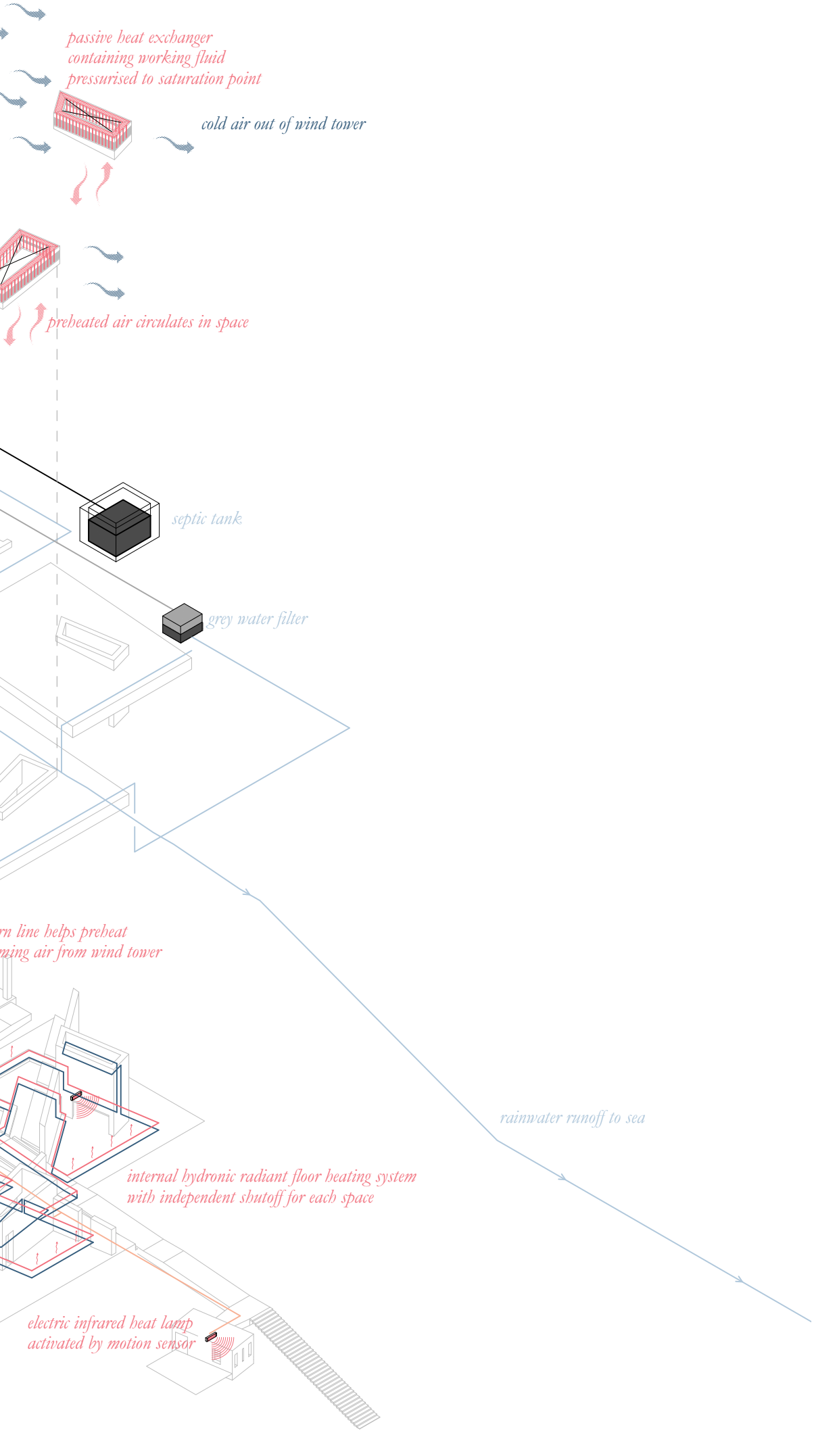

ting
network flow and return main line
Saga
underfoor hydronic radiant heating

Climate Design


(decentralised) natural ventilation
wind towers with heat pipe recovery
for cold climates
(re. PCT/GB2014/052263)
cold air in to wind tower
(decentralised) rainwater harvest
and water management
rainwater catchment
sand filter
main tank
heated using waste heat from gas flare
and then metal recycling facility
(centralised) district heating network:
flow (95°C) and return main line
mains electricity cable
using Orcadian renewably
generated electricity
heat exchanger interface

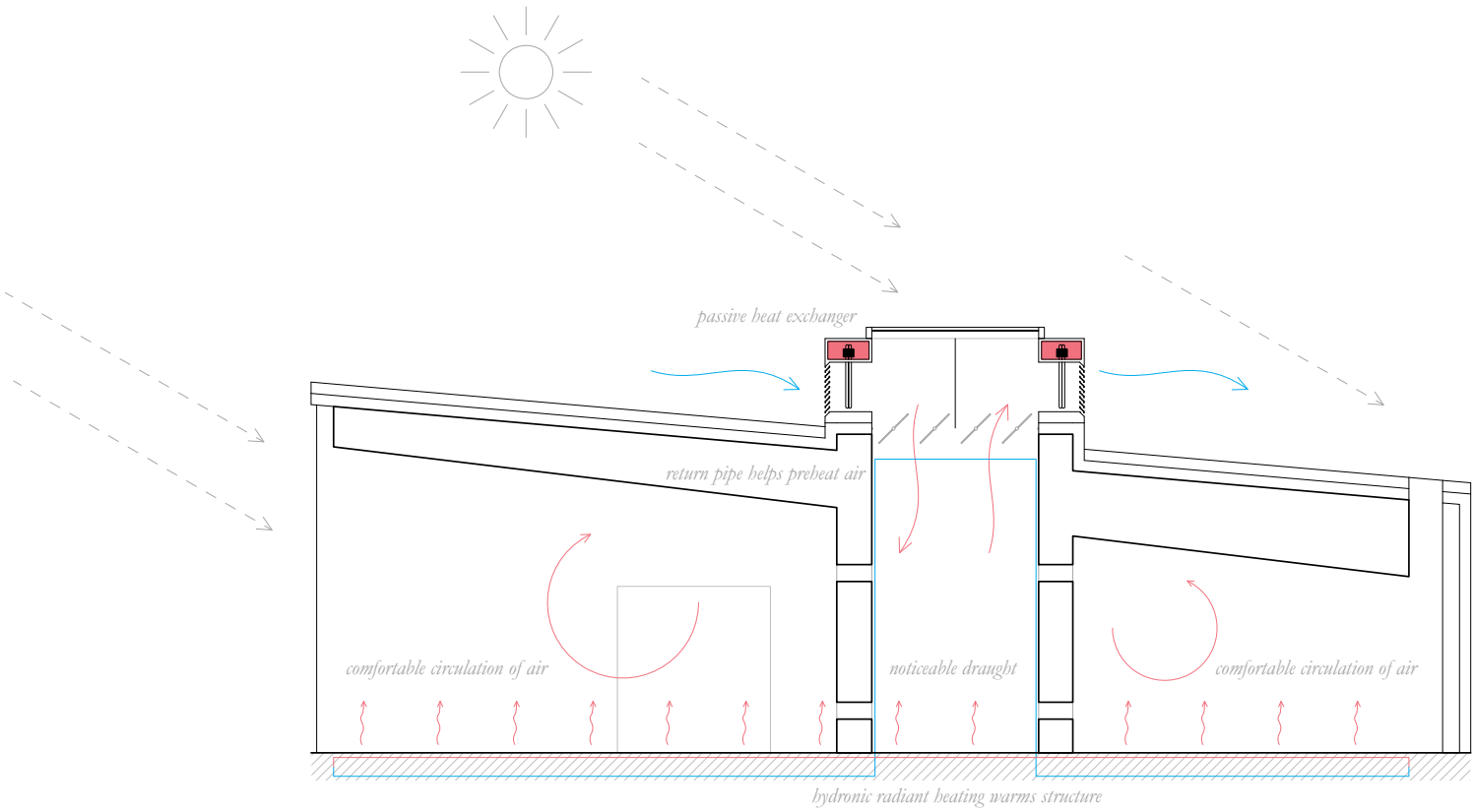

passive heat exchanger
containing working fluid
pressurised to saturation point
cold air out of wind tower
preheated air circulates in space
septic tank
grey water filter
rn line helps preheat
ming air from wind tower
rainwater runoff to sea
internal hydronic radiant floor heating system
with independent shutoff for each space
electric infrared heat lamp
activated by motion sensor

Heating and Passive Ventilation

Termperatures are unusually consistent for such latitudes thanks largely to the archipelago's location at the northerly meeting of the Gulf Stream and the North Sea. Thus, heating is generally a year round requirement. A centralised underfloor hydronic radiant heating system creates a warm structure where the thermal mass is less affected by regular opening and closing of doors. Due to the monumental scale of the structural elements, the structures are warmed over monthly cycles rather than the typical day-night cycle- which is appropriate for the cold Orkney climate (typically between 2^0C and 16^0C).

Passive ventilation is a significant challenge in cold climates as it requires energy (normally solar) to stimulate airflow. Heat losses are also typically problematic. However, the project circumvents this problem by relying instead on wind energy (which Orkney and Flotta have an abundance of). The project utilises this through a divided, four-sided wind tower with heat pipes which brings air into a central core. Cold incoming air is preheated using the heat pipes, while the heat pipes absorb warmth from the outgoing air. A liquid pressurised to saturation point circulates between the pipes and acts as a passive heat exchanger.

This technology is adapted from a patent from staff at the University of Sheffield's Mechanical Engineering Department. See PCT/GB2014/052263 for further details.


passive heat exchanger
return pipe helps preheat air
comfortable circulation of air
noticeable draught
comfortable circulation of air
hydronic radiant heating warms structure

Natural Light

Orkney is the land of the Northern Lights. It experiences 18 hour days in summer (when most visitors come) and 6 hour days in winter. Light is therefore a centrally important quality to the character of Flotta, which the project seeks to respond to.

In the words of William Cairns, who undertook the design of the Flotta Oil Terminal in the 1970s:

"Although unimpressive physiographically any visual assessment of Flotta must take account of the subtly powerful relationship which the islands and the peninsulas of Scapa Flow have in relief with sky and sea, and the continually changing quality of light. For many it is the purity of the atmosphere, the long shadows, the low horizons, the whole land, sea and skyscape which expresses their aspirations and gives returning Orcadians a very profound sense of homecoming."

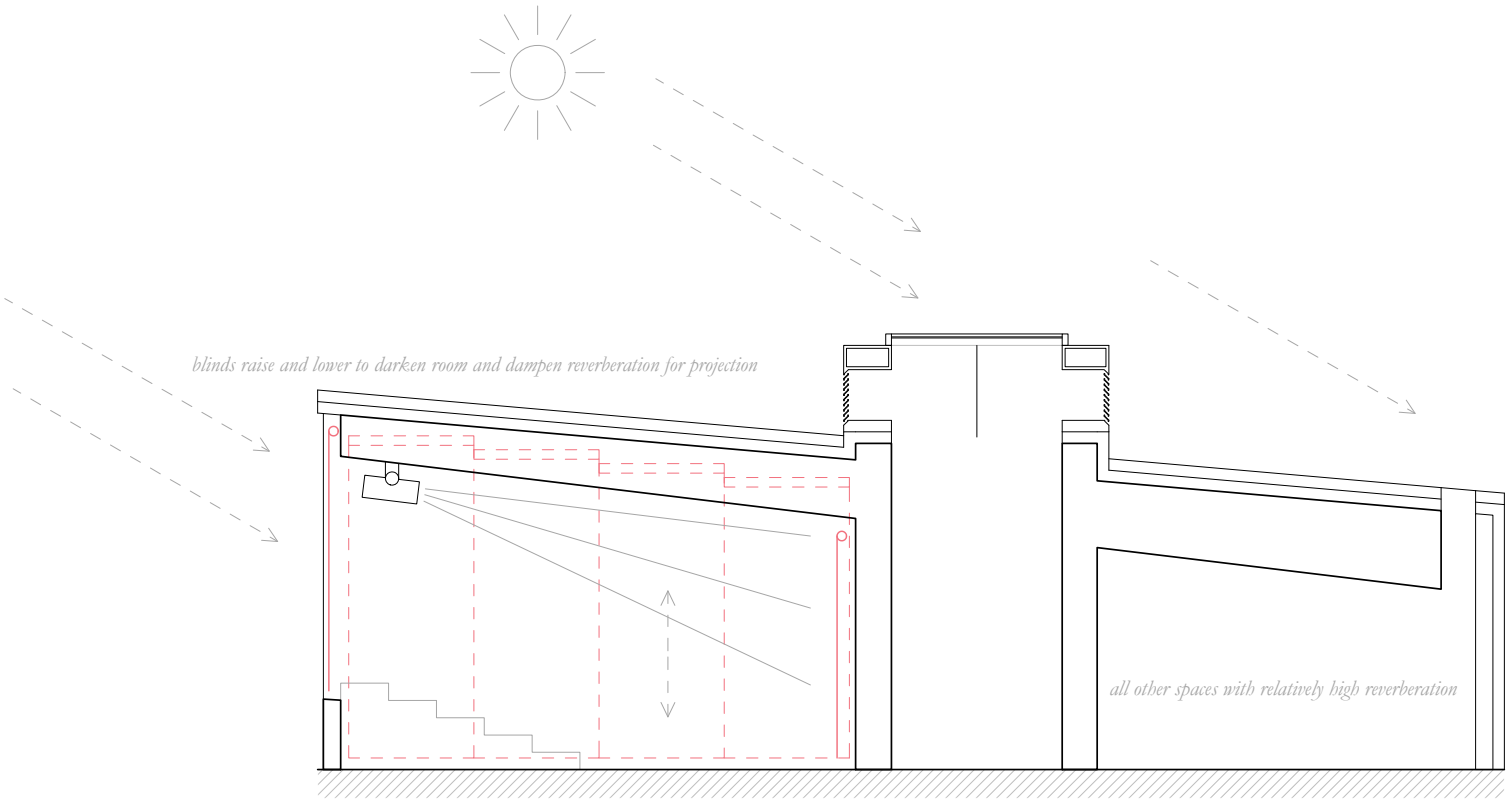
The opposite lighting exploration investigates the changing light and shadow during a long summer day.


earlier
later
0500
1100
1700
0630
1230
1830
0800
1400
2000
0930
1530
2130
morning
midday
evening

Acoustics and natural light

With a massive structure and designed as modern monument to record the stories of Flotta, the project uses hard, solid materials which create high reverberation. This is considered desirable for most parts of the project, where the sound of each inhabitant is magnified and given new importance.

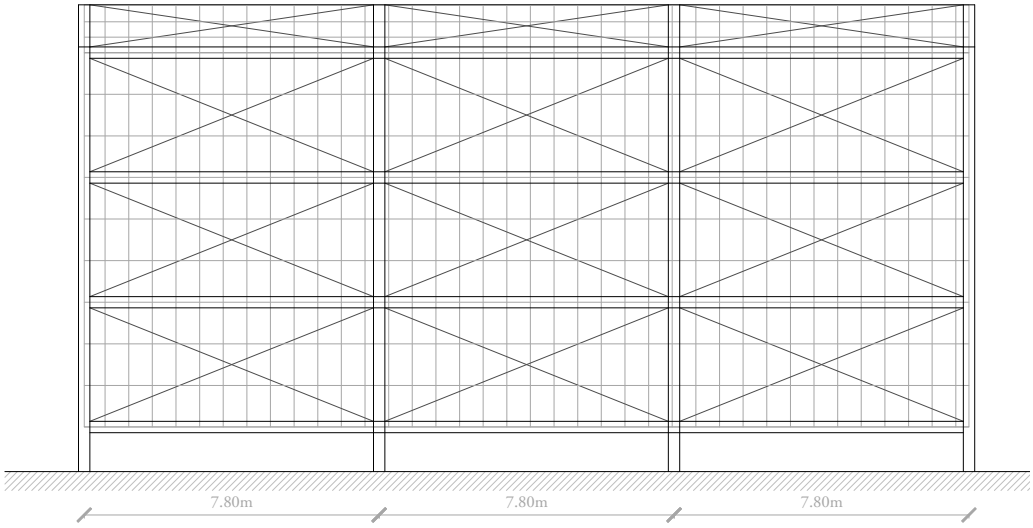
This is not (always) the case in the community arts space however. A projection/presentation space requires both lighting and acoustic control, provided by heavy fabric blinds which dampen the reverb.

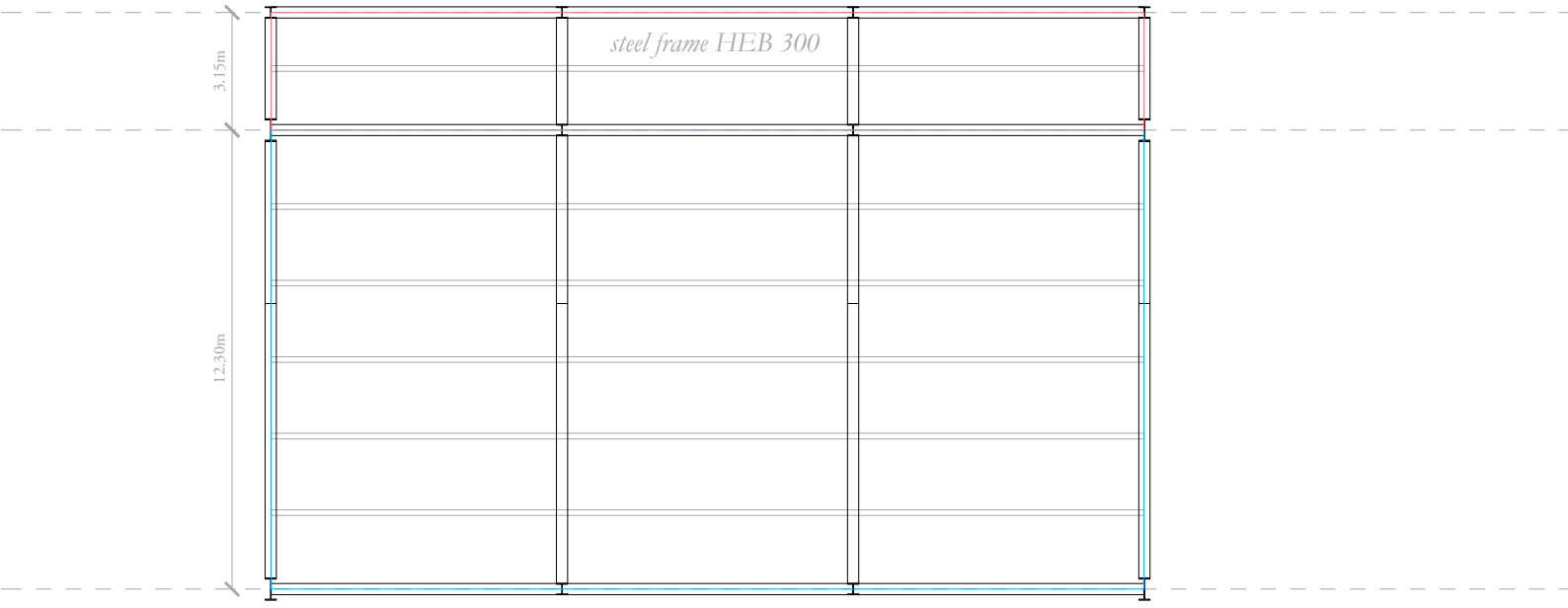

blinds raise and lower to darken room and dampen reverberation for projection
all other spaces with relatively high reverberation

Structure

Tectonics | Recycling Facility

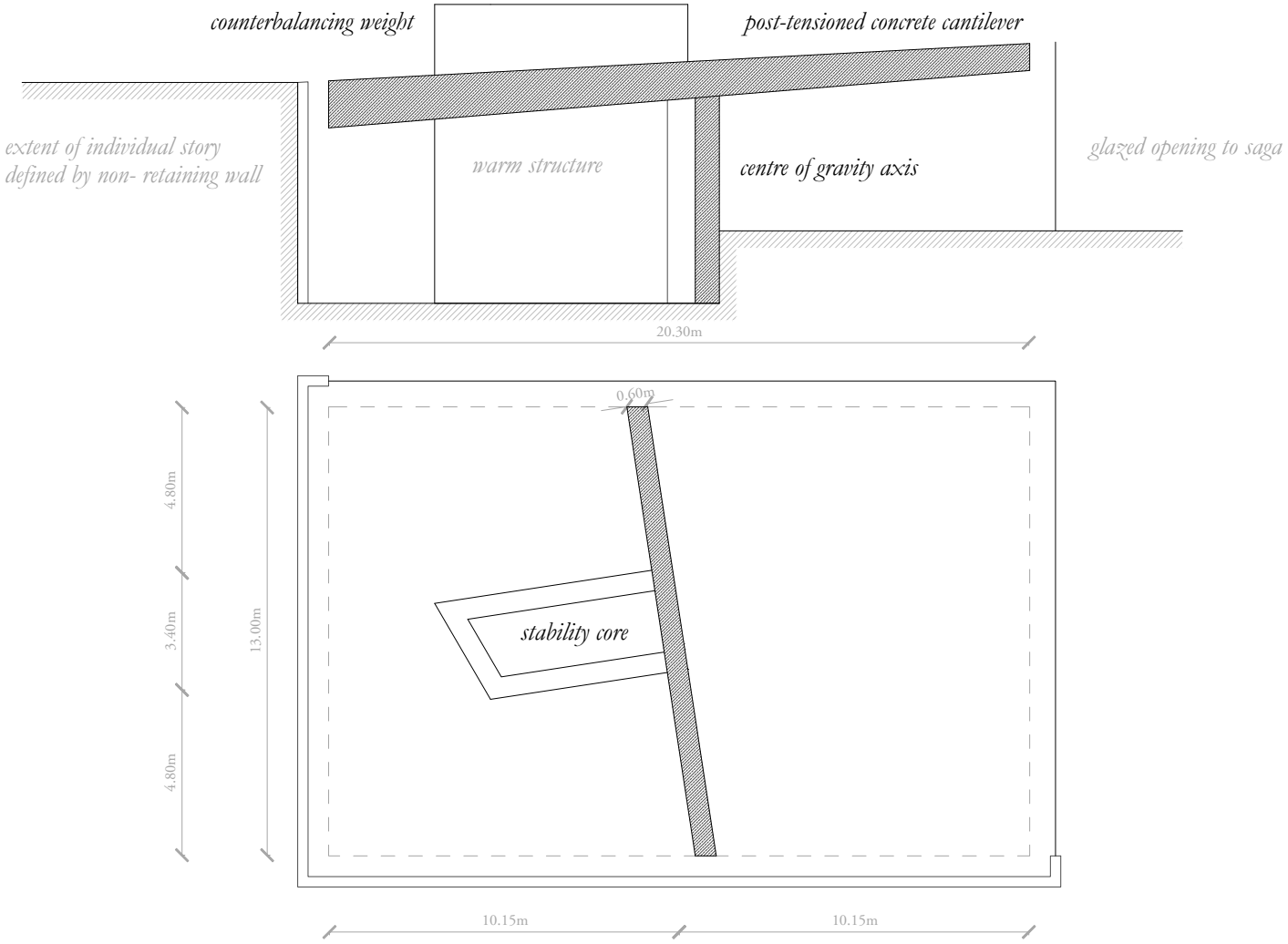
Pragmatic and utlitarian, the recycling facility is designed as a typical piece of infrastructural architecture. A portal frame houses the metal recycling machines, while the external mezzanine houses administrative spaces. This tectonic structure emphasises the permanence of the stereotomic saga space.


7.80m
7.80m
7.80m


3.15m
12.30m
steel frame HEB 300
steel frame HEB 600

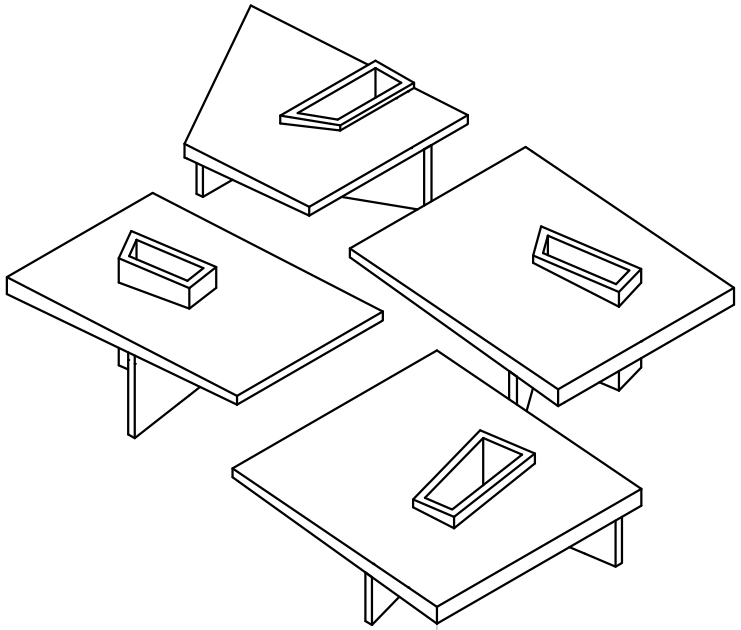
Stereotomic | Saga

In contrast, the saga space is massive, with oversize structural members and embedded in the rock of the island. Landscape and architecture merge here- a modern repository of stories in the ancient Orkney tradition of monumental architecture.


counterbalancing weight
post-tensioned concrete cantilever
extent of individual story
defined by non- retaining wall
warm structure
centre of gravity axis
glazed opening to saga
20.30m
0.60m
4.80m
3.40m
4.80m
13.00m
stability core
10.15m
10.15m

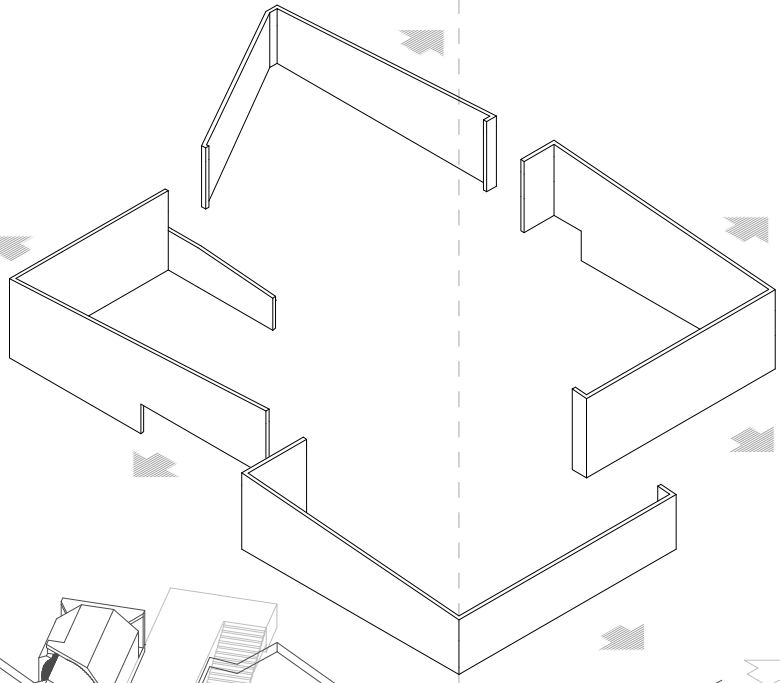
Structural hierarchy

A consistent structure of cantilever's and stability cores unites the four main spaces into one saga. Being carved into the rock, the usual need for earth retention is minimal, and so the perimeter walls form a secondary structure with primarily compressive load bearing requirements. These walls change in materiality to reflect the individual stories of the saga. Openings in the perimeter walls reveal the rock of the island and connect the story to the landscape, while also serving to aid orientation when moving through the spaces and towards the sea. Openings to the saga line are glazed to bring in light and connect the individual stories visually to the overall saga.



Primary Structures

(reuinforced concrete)



openings to reveal rock, connect story to landscape, and for orientation while moving through spaces

Perimeter Structures

(material varies according to story)

Saga line

ruin cut through

infrastructure stories

bruck-mining stories

wartime stories

community stories

Carving into rock

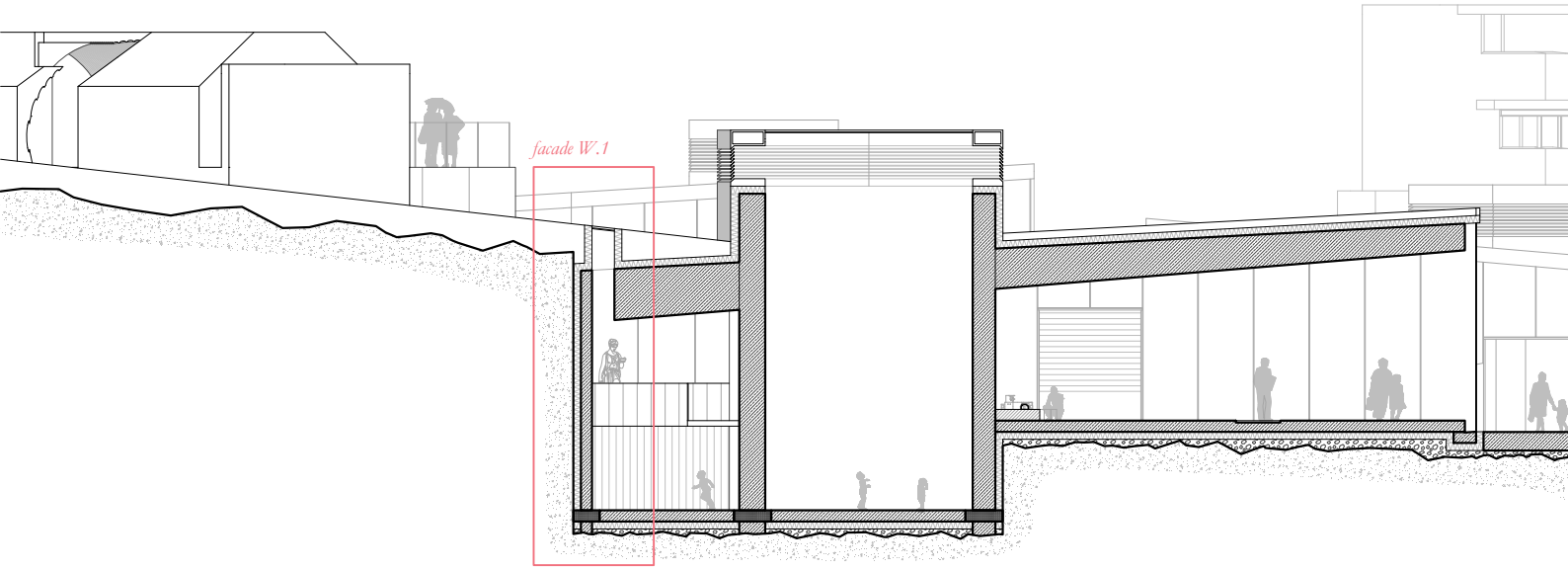
(Middle-old red sandstone)

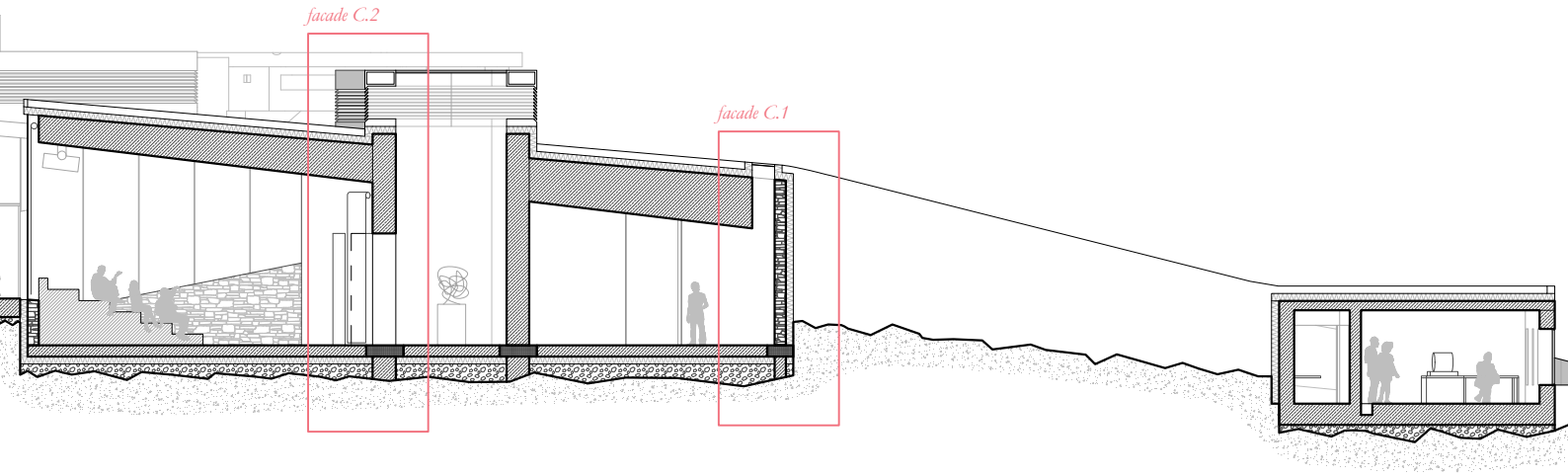
ruin transformed

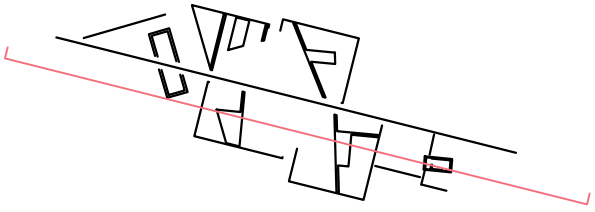
Facades

Facade locations

Buried in the landscape, the concept of facade has a different meaning to the typical one in architecture. Instead, the facades here are primarily interior.

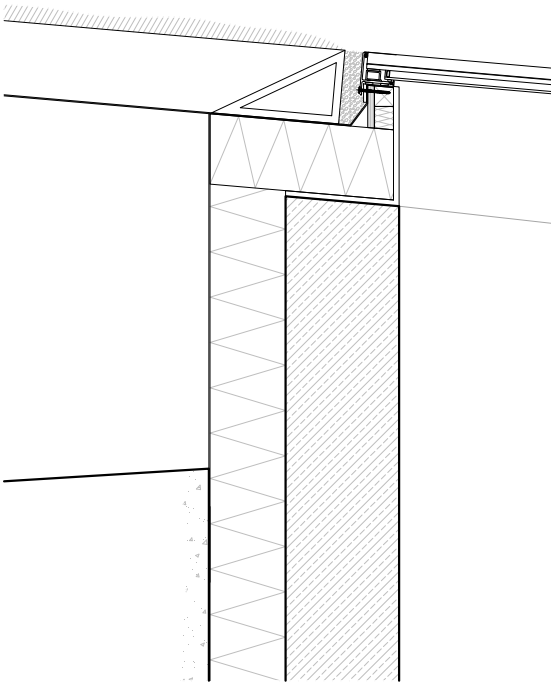


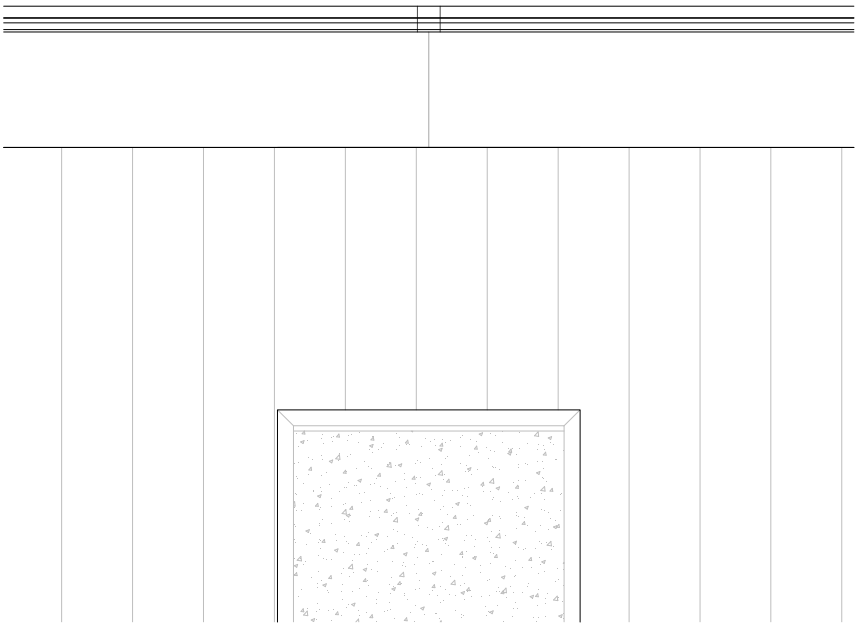

facade C.2
facade C.1

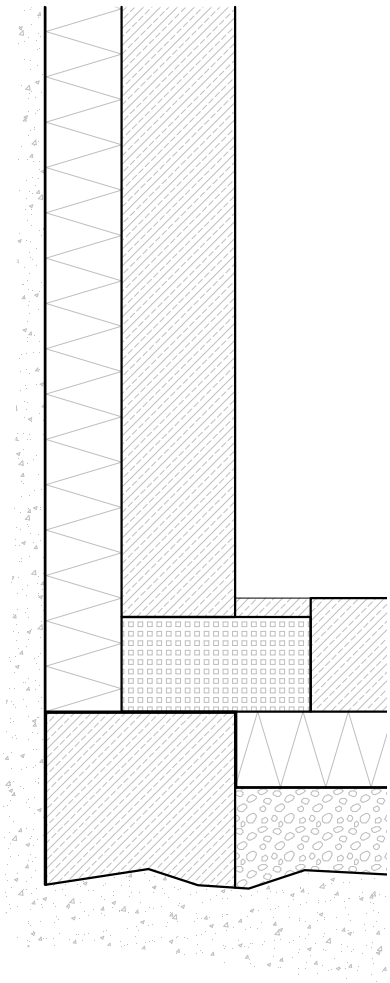


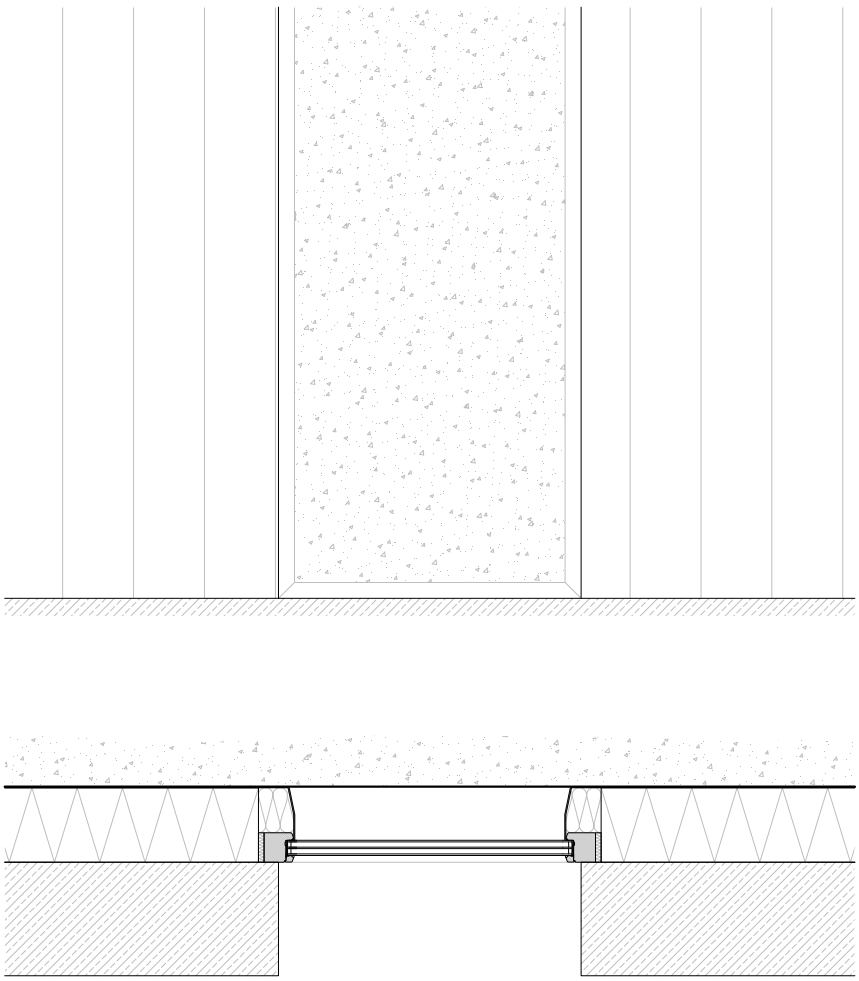
Stories of wartime past

This is the deepest part of the project, almost entirely embedded in the rock. The perimeter walls are shutter concrete to reflect the materiality of the wartime ruins dotted around the island. The opening to reveal the rock of the island is almost full-height here. The Armatherm™ 500 Structural Thermal Break negotiates the transition from warm structure to cold landscape.



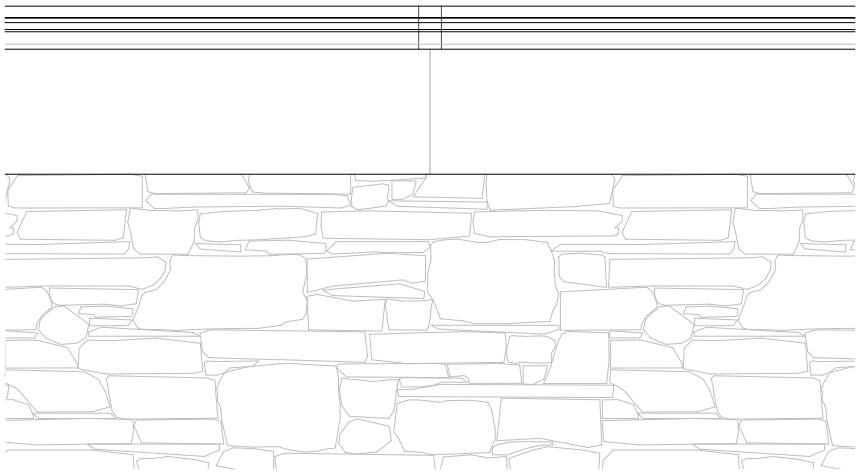


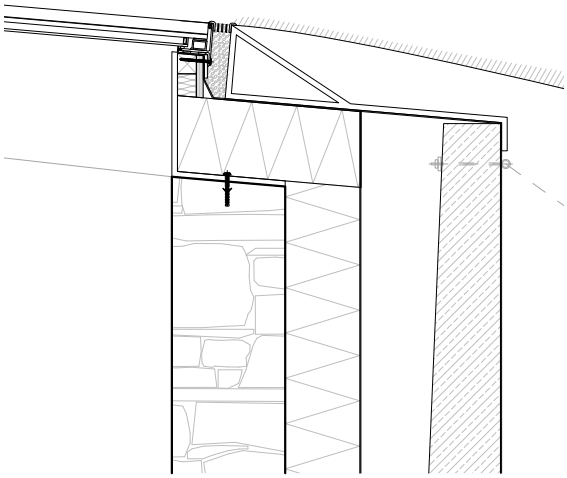


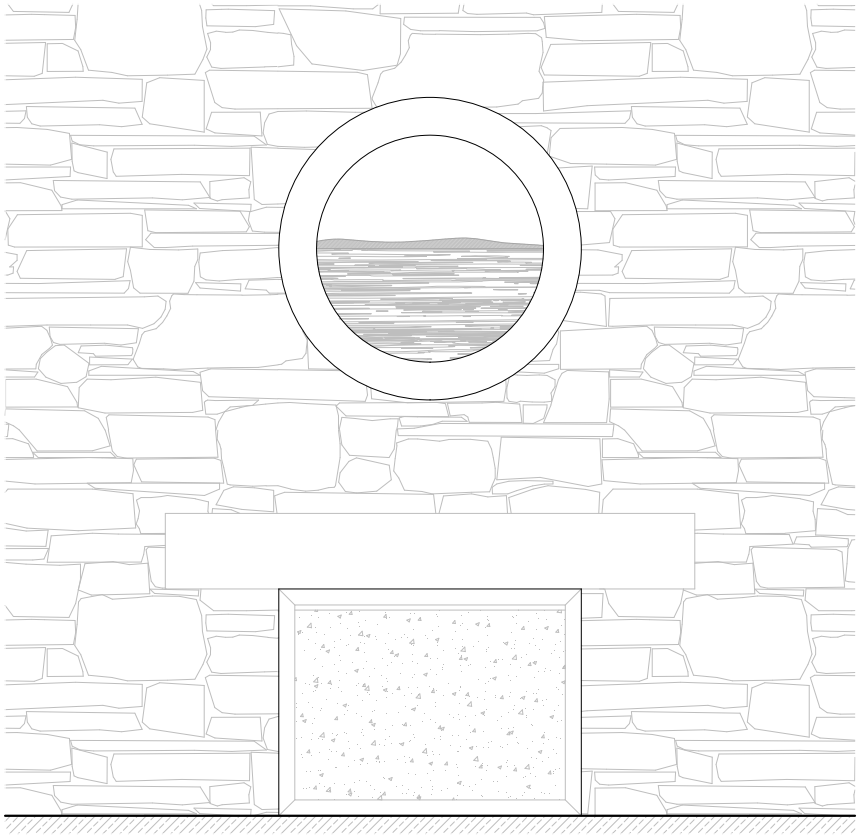


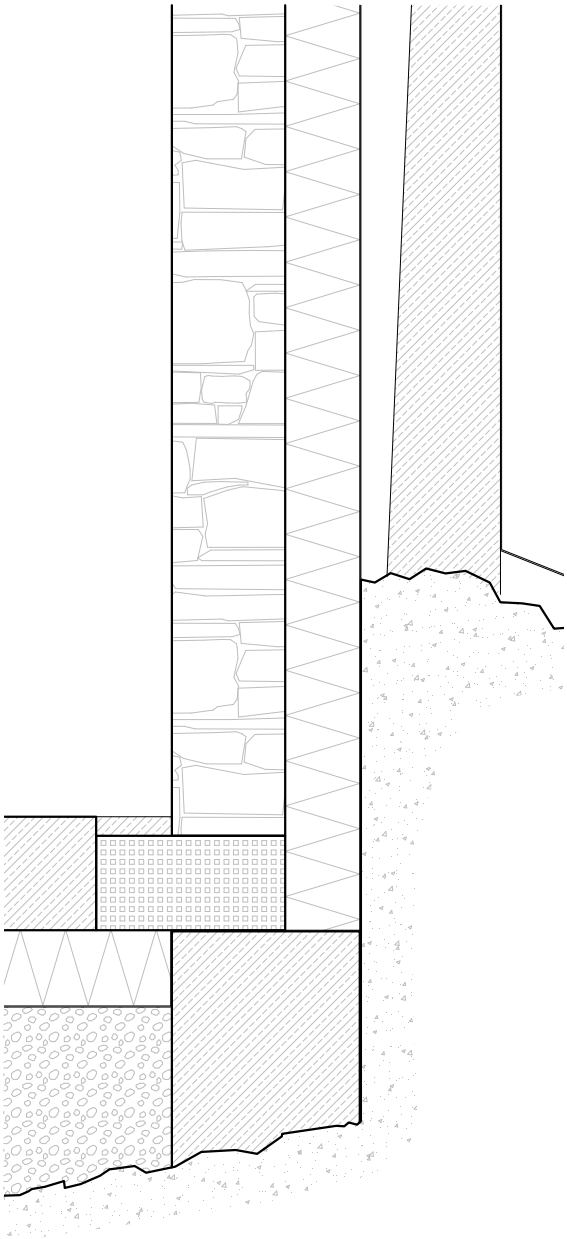
Stories of community future (1)

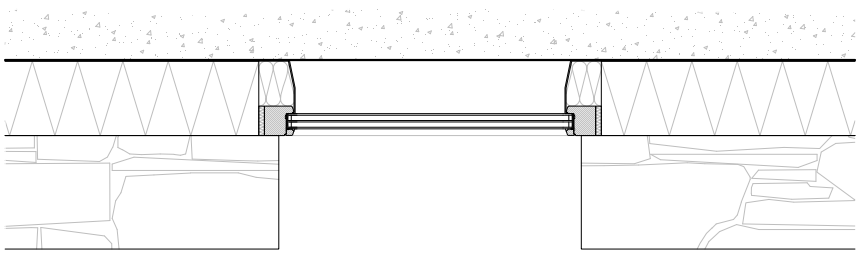
This is the shallowest part of the project, with earth retention required to a much greater extent than elsewhere and provided by a roughcast concrete wall. the stone walls reference the traditional construction of the community, while the openings here reveal a small portion of the rock, as well as a view out to sea, thus emphasising the remoteness of the territory and the limitations of centralised infrastructure. The openings also reference a fireplace and Frank Lloyd Wright's notion of the hearth as 'the heart of the home itself'. In this case of course, the 'fire' is substituted for the rock of the remote territory, and thus the remote territory is the heart of the community itself. The Armatherm™ 500 Structural Thermal Break negotiates the transition from warm structure to cold landscape.











Stories of community future (2)

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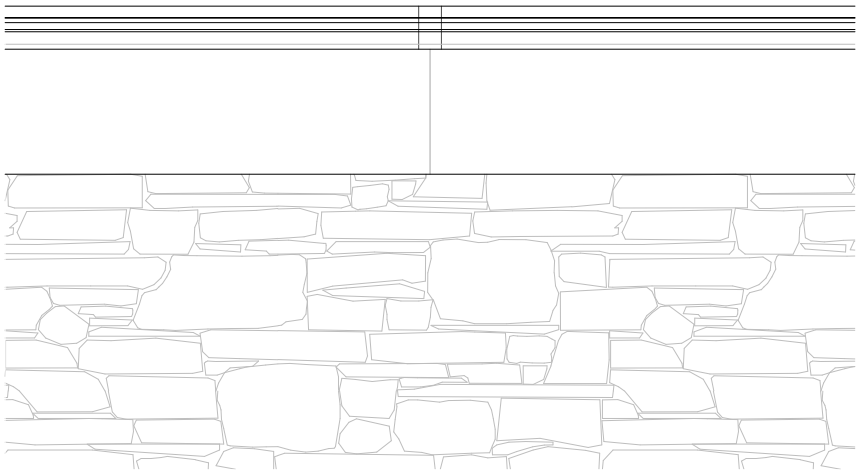
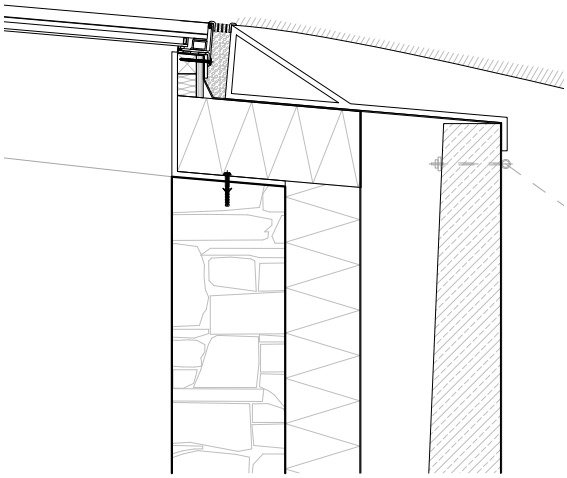
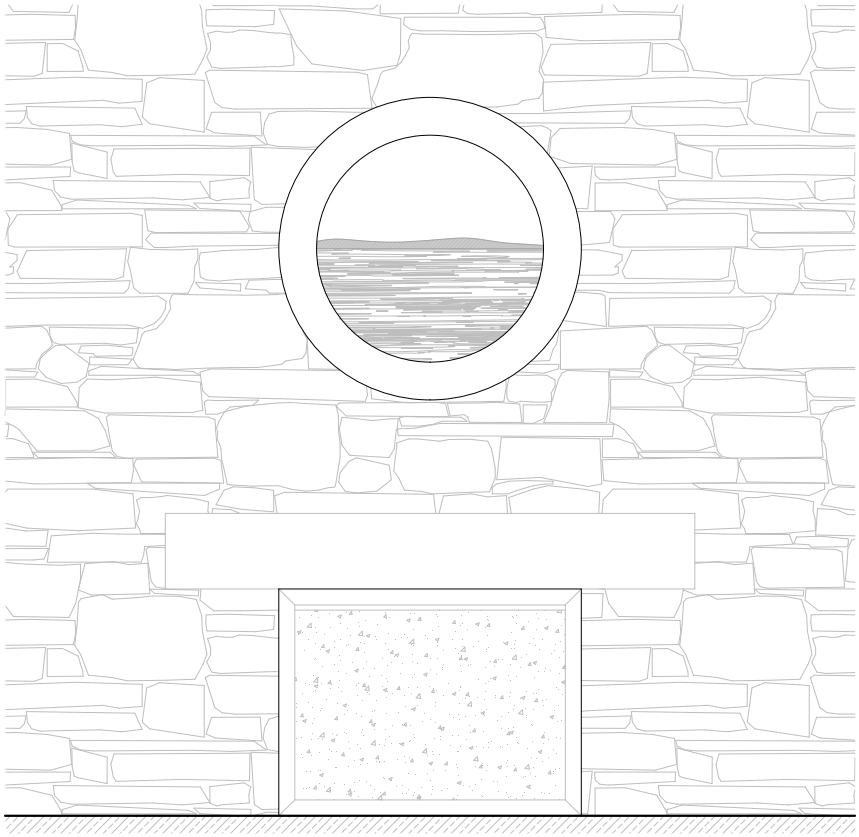
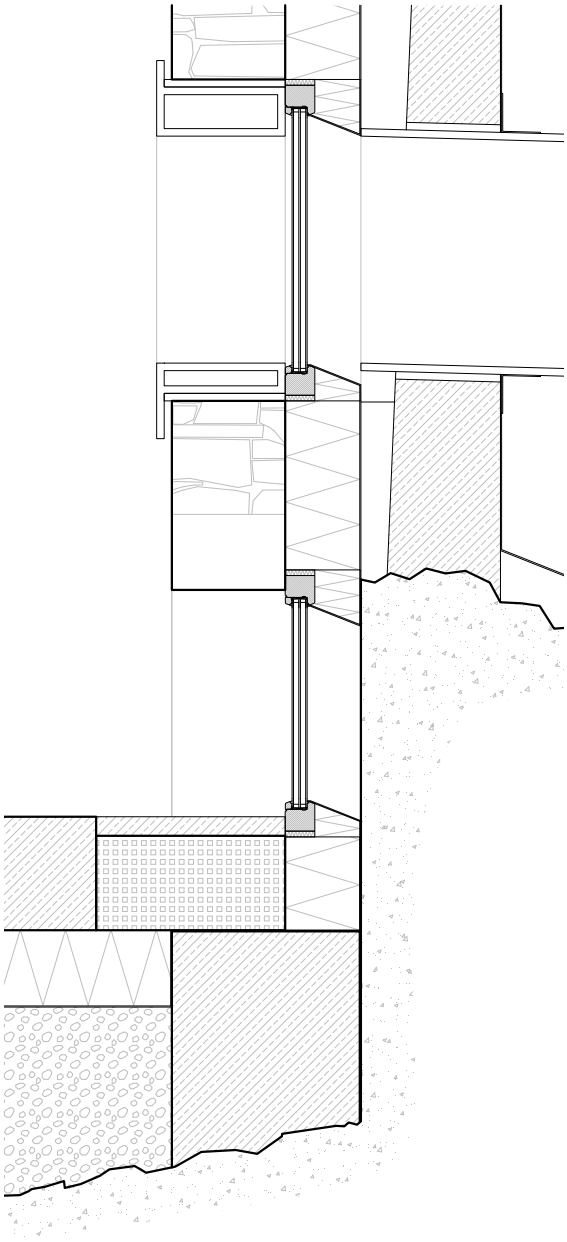
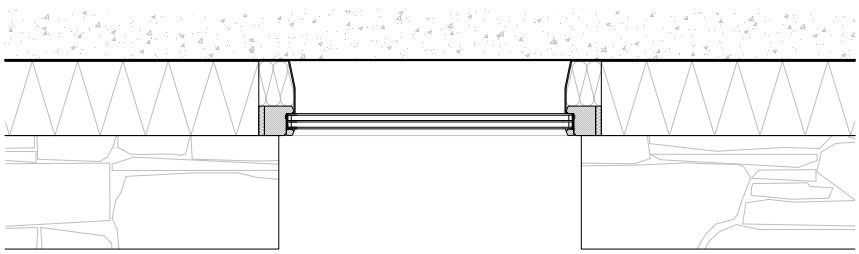




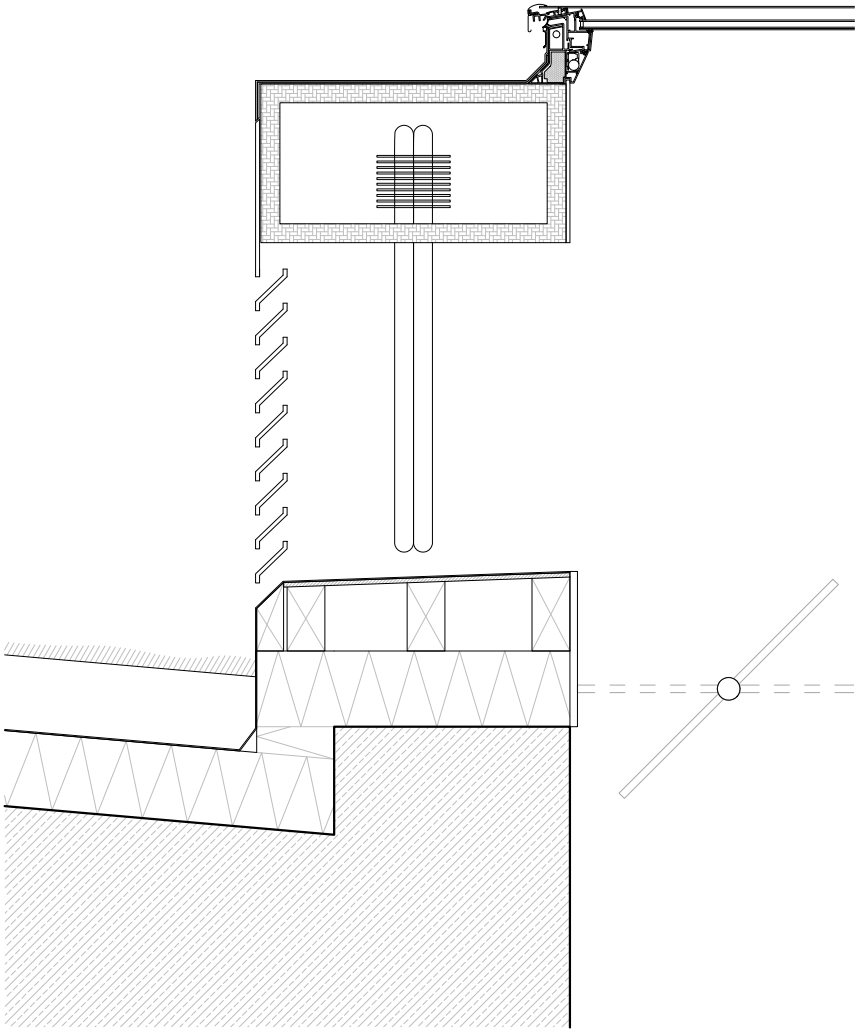


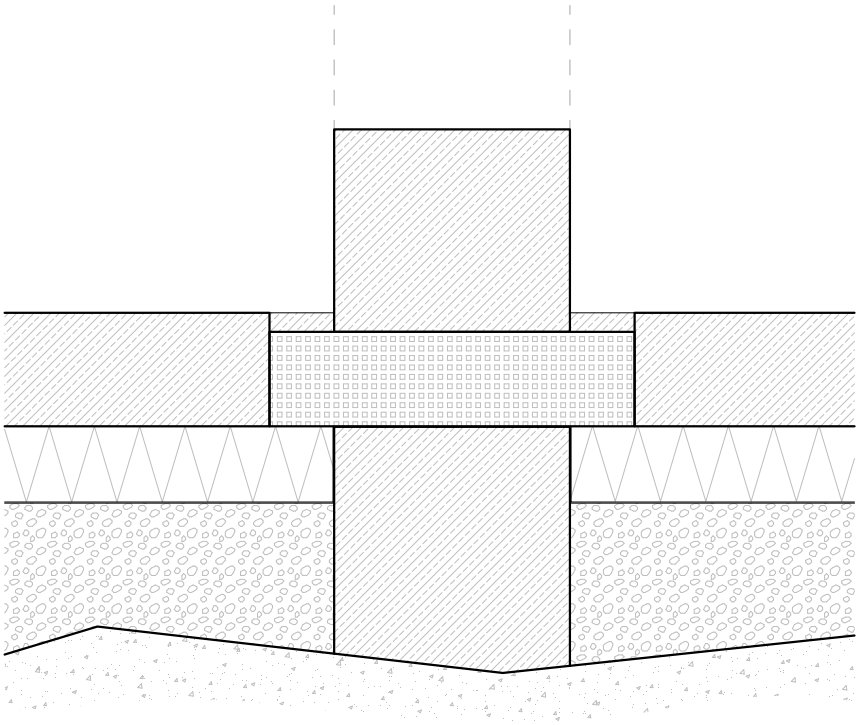




Structural and climate cores

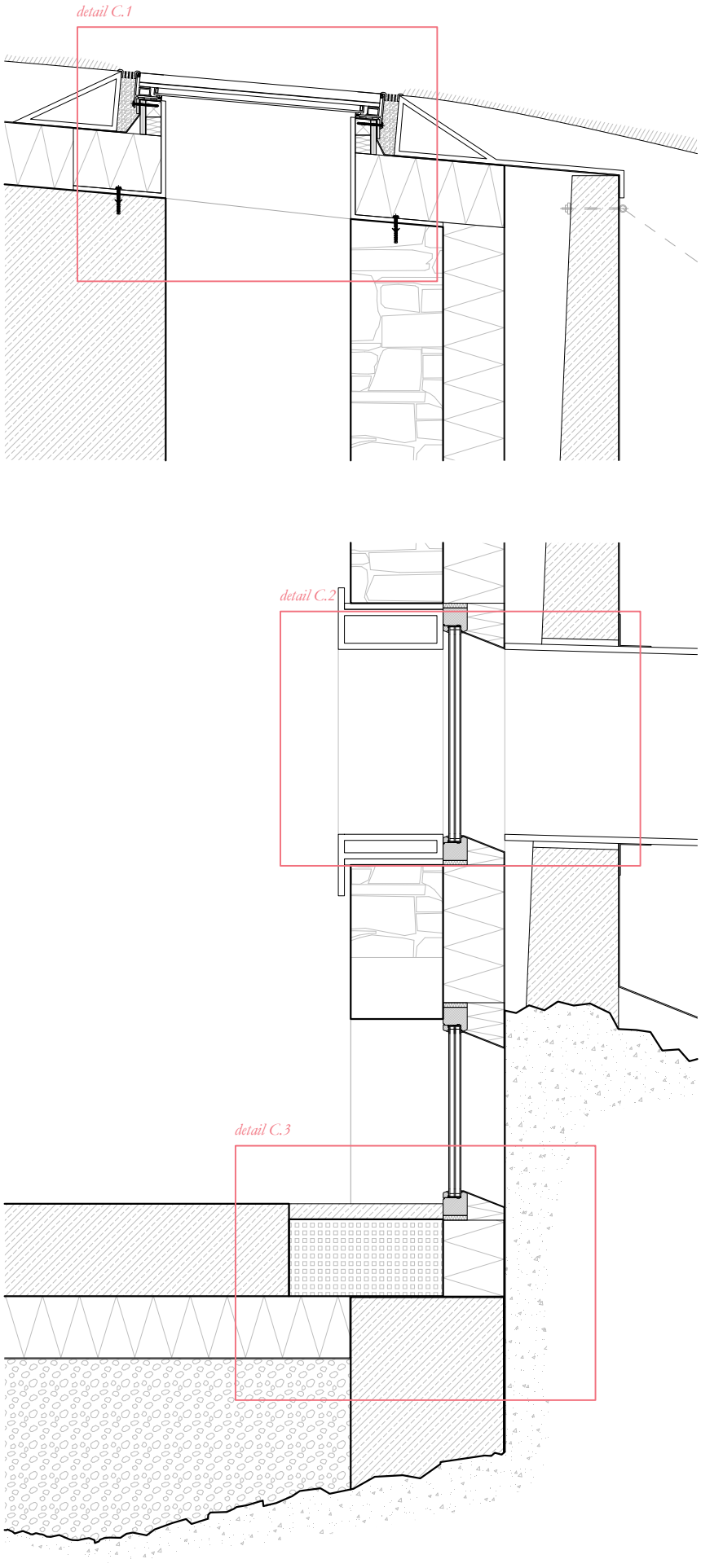
At the heart of the project are the previously discussed structural cores, which react to the gentle gradient of the landscape. These cores bring in light as well as fresh air. The Armatherm™ 500 Structural Thermal Break negotiates the transition from warm structure to cold landscape.


Velux ZCE flat skylight
pressurised heat sink
heat pipes
transparent control damper


opening to main spaces
structural core
infloor hydronic radiant heating
Armatherm™ 500 structural thermal break
bedrock

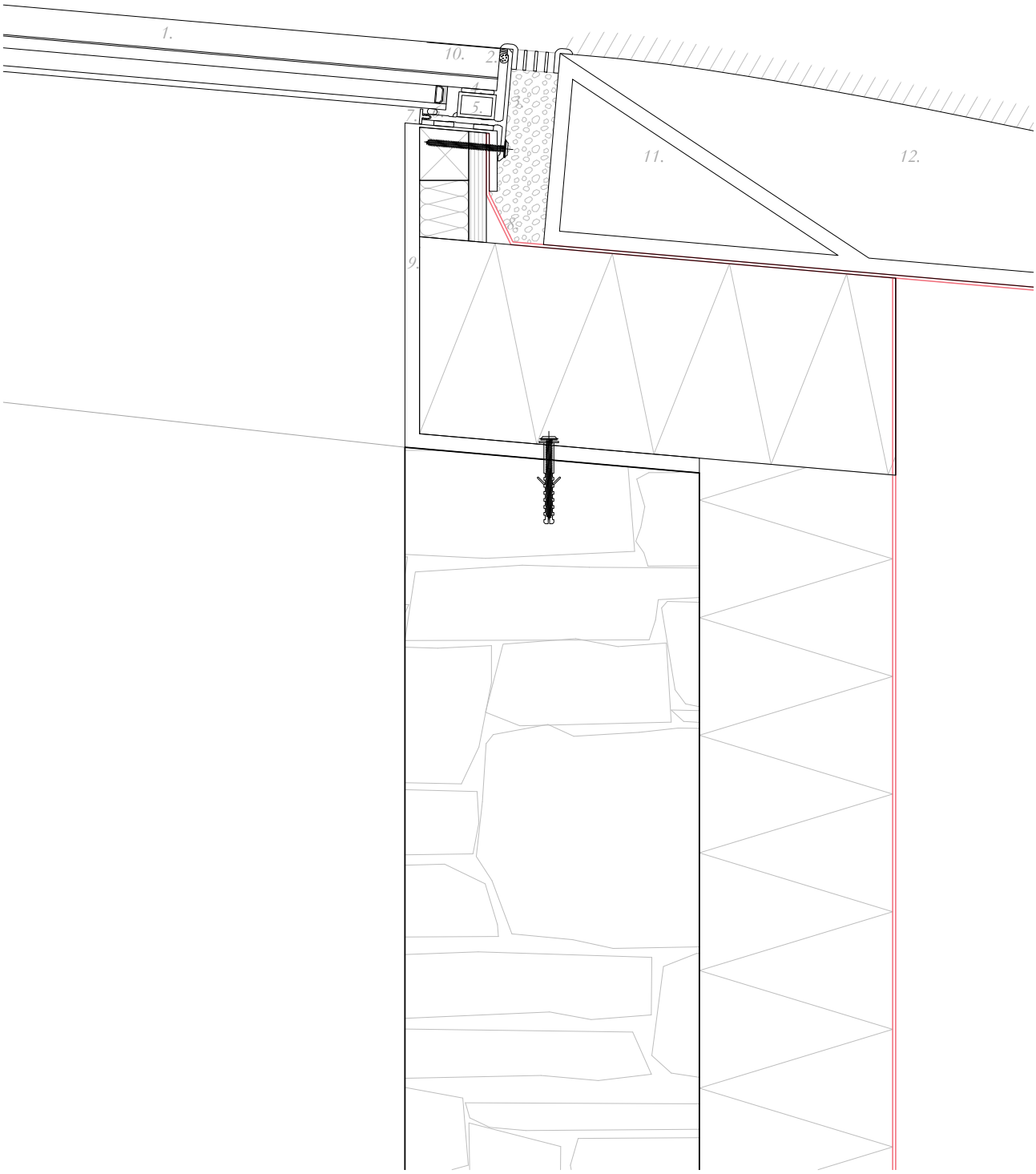
Details

Location of details


detail C.1
detail C.2
detail C.3

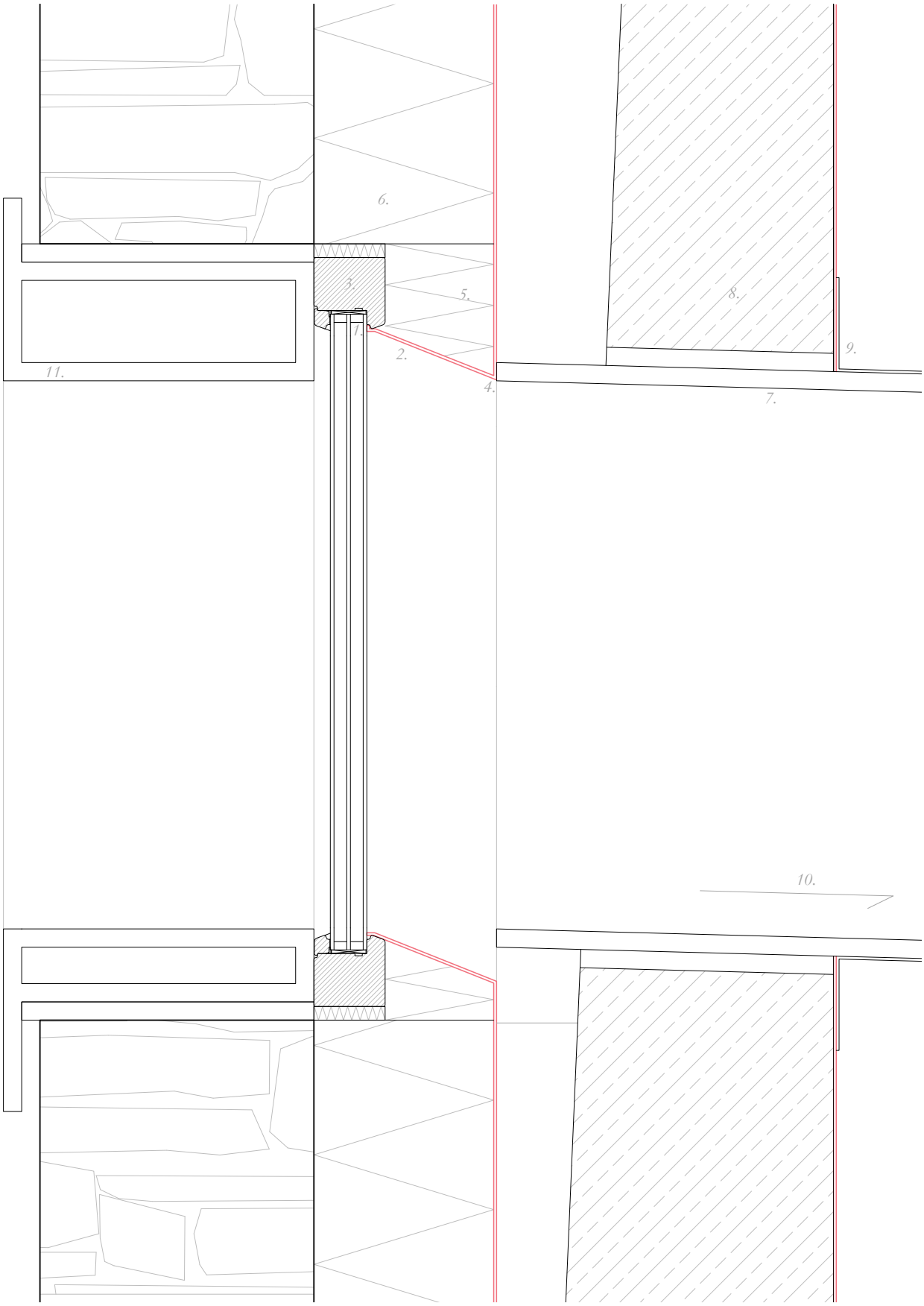
detail C.1

1. structural pane
2. structured silicone joint (black)
3. adapting profile bedded on expanding tape
4. butyl seal
5. steel profile
6. butyl seal
7. thermal barrier
8. water proof membrane
9. steel facing
10. back painted border
11. steel profile with non-trip non-slip face
12. back fill soil


1.
10.
2.
5.
11.
12.

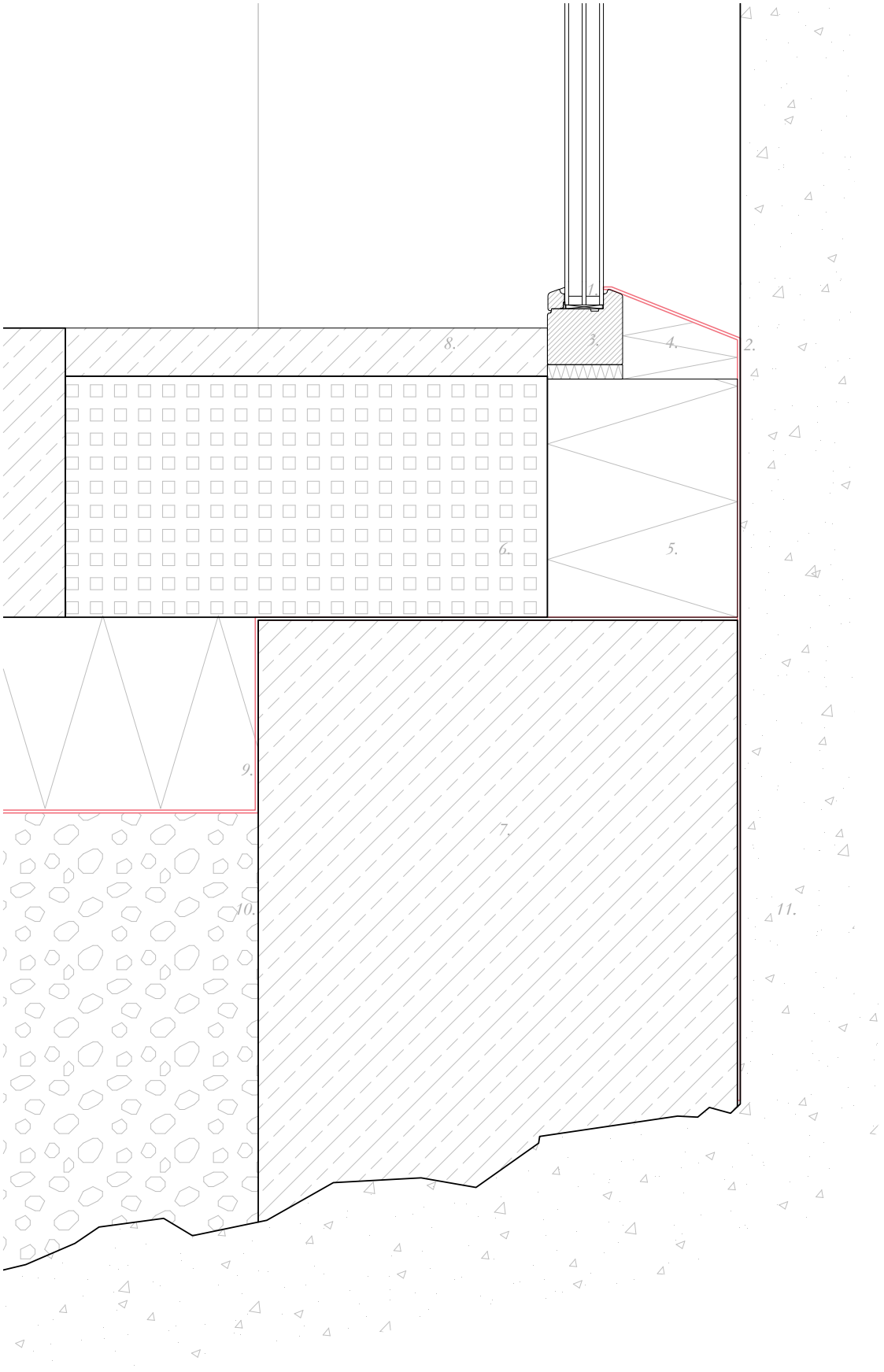
detail C.2

1. glass housing
2. water proof membrane
3. wood frame
4. drip edge
5. high density rigid insulation cut to fit
6. rigid insulation cut to fit
7. 640mm diameter galvanised steel pipe
8. anchored rough concrete retaing wall
9. pipe socket
10. 2% gradient
11. internal finishing for ‘pipe’
12. back fill soil


6.
3.
5.
8.
1.
2.
9.
11.
4.
7.
10.

detail C.3

1. glass housing
2. water proof membrane
3. wood frame
4. high density rigid insulation cut to fit
5. rigid insulation cut to fit
6. Armatherm™ 500 structural thermal break
7. levelling found upon bedrock
8. screed finishing
9. damp proof membrane
10. levelling bed
11. bedrock


1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.

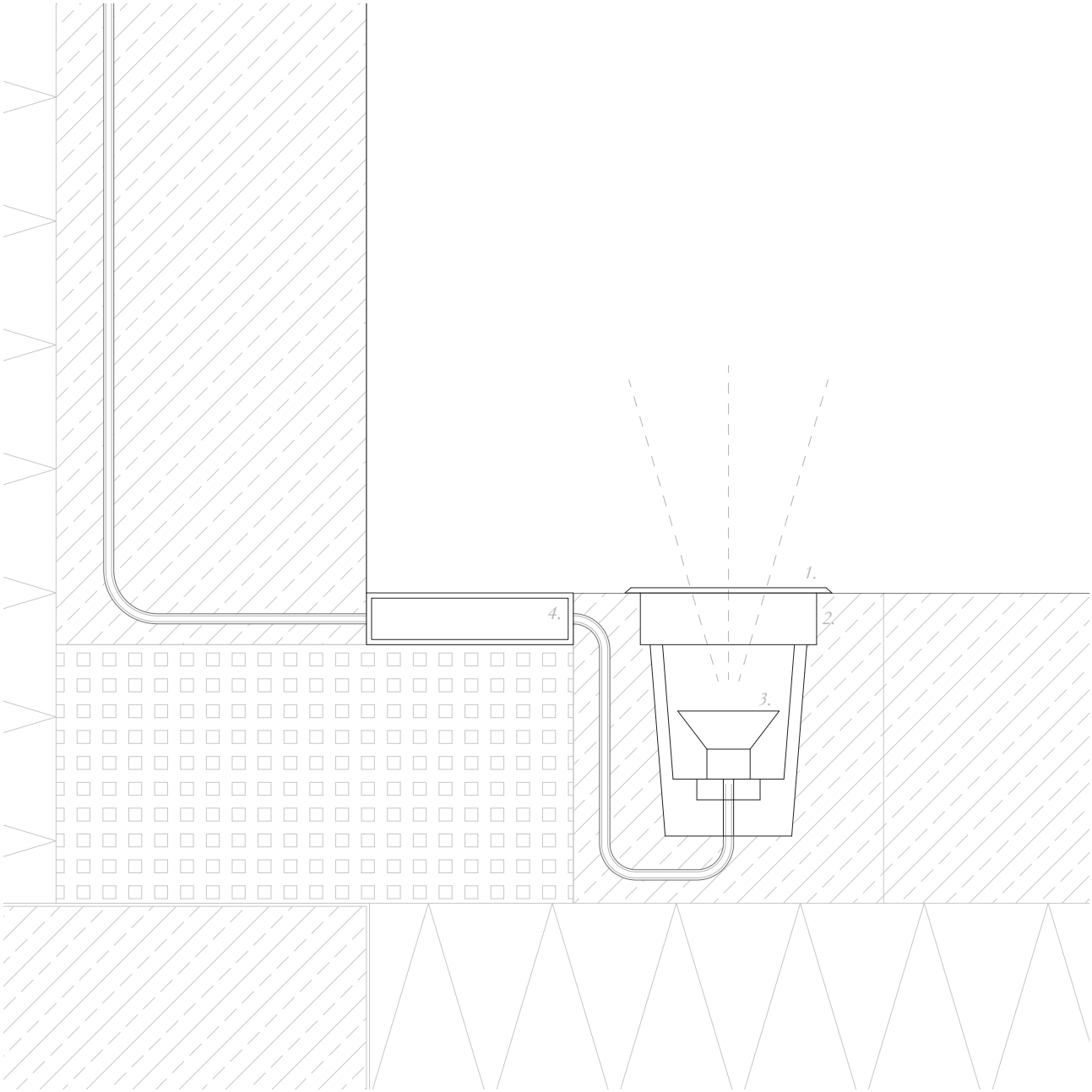
Artificial Lighting

By day, openings at the perimeter of the roof draw light into the space; at night, this is reversed. Floor spots shine light back up the wall and out through the openings- illuminating the structure and indeed even the sky in monumental fashion. Further LED lighting is integrated into the structure to help construct form, our to provide lighting for specific characters who inhabit the space to tell stories. The lighting is therefore specific to the story of the individual space while also illuminating the saga of the territory.


detail L.3
detail L.1
detail L.2

detail L.1

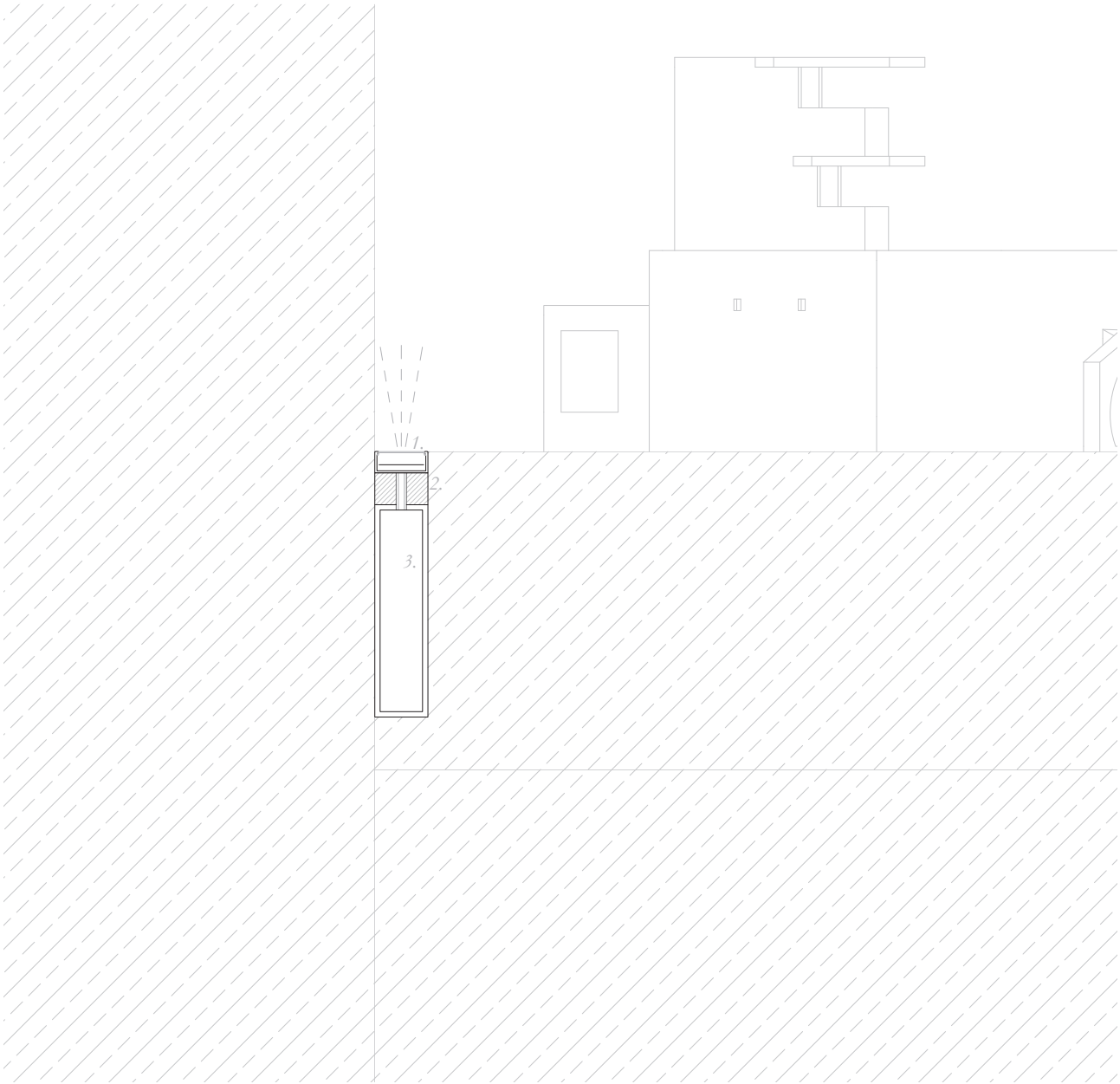
1. stainless steel front
2. LED housing
3. Chip on Board LED, colour 3000K
4. 230V mains AC housing channel



Inspired by:
https://www.simes.it/en/

detail L.2

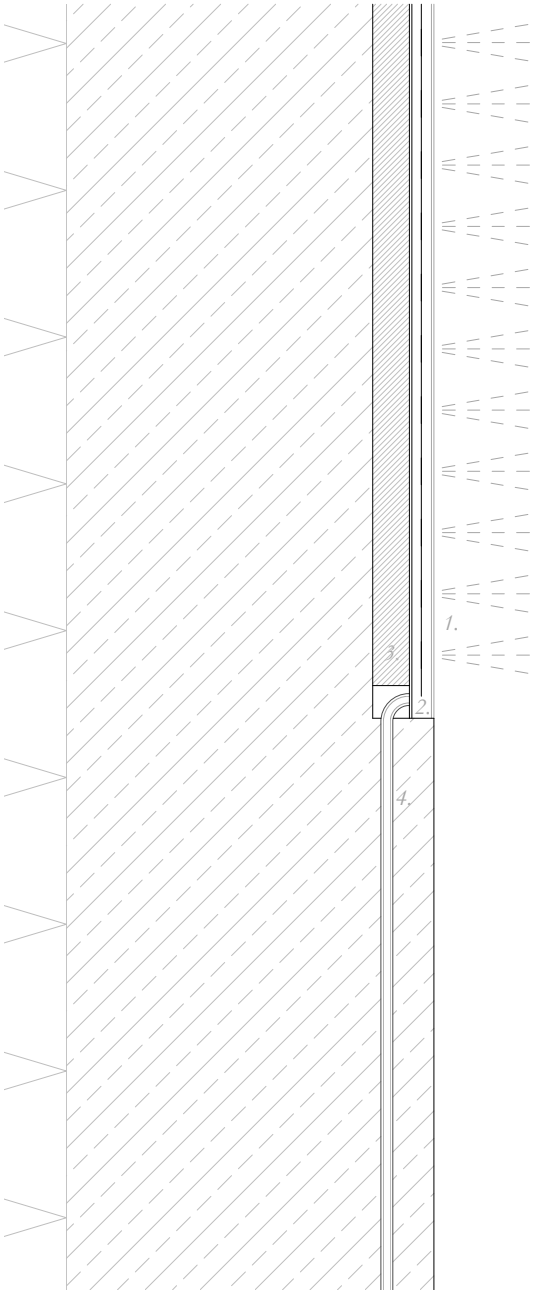
1. transparent acrylic cap
2. low intensity LED strip in aluminium channel,
   mounted on low grade timber
3. 230V mains AC housing channel



Inspired by:
https://www.simes.it/en/

detail L.3

1. transparent acrylic cap
2. high intensity LED strip in aluminium channel
3. OSB (or other low grade timber) mount
4. housing for wiring


1.
2.
3.
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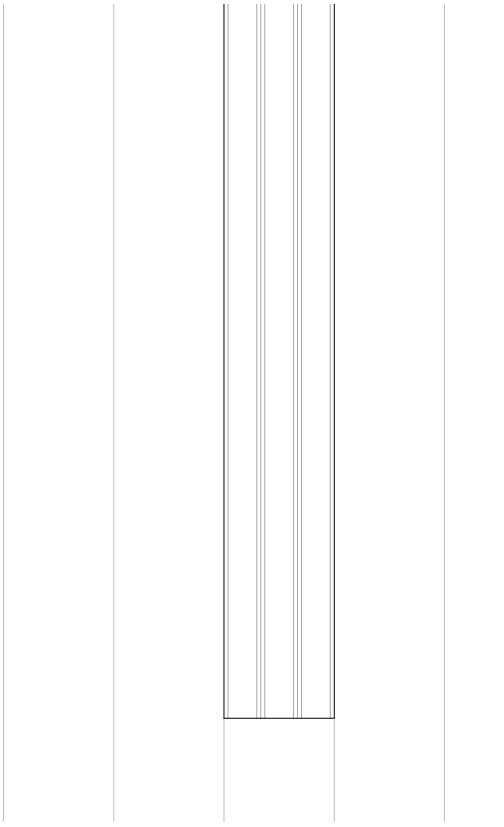
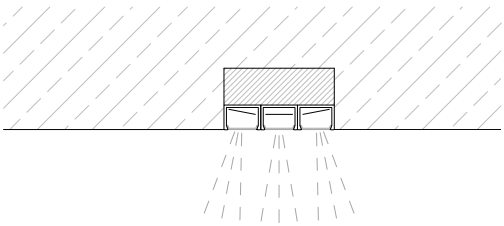




Artificial Lighting

By day, openings at the perimeter of the roof draw light into the space; at night, this is reversed. Floor spots shine light back up the wall and out through the openings- illuminating the structure and indeed even the sky in monumental fashion. Further LED lighting is integrated into the structure to help construct form, our to provide lighting for specific characters who inhabit the space to tell stories. The lighting is therefore specific to the story of the individual space while also illuminating the saga of the territory.

Senses

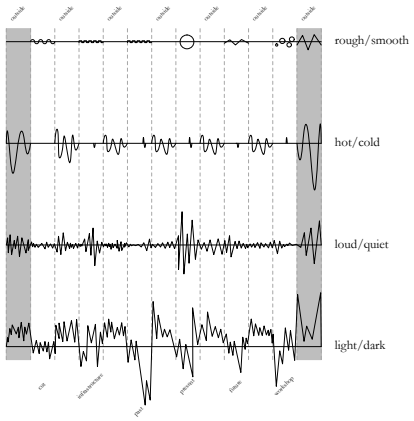
Senses

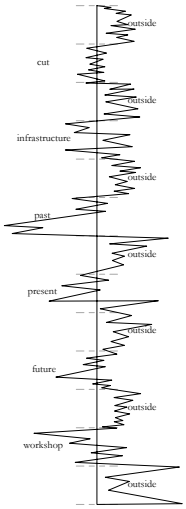
With the importance attached to humanity in the territory, the human scale part embraces an array of the human senses. Natural and artificial light (top right) is carefully controlled to visually shape a structure which appears almost as an impossible space, separated as it is from the perimeter walls.

This in turn highlights the changing materiality and texture of the different perimeter walls (middle right). Airflow is controlled passively, with specific parts of the project experiencing noticeable draught- cold draught in the 'air raid' space of the wartime past, and warm draught in the 'furnace' space of the bruck-mining present. Specific areas are warmed using infrared heaters with motion sensors to emphasise the warmth of a 'crowd', or the 'furnace', or to provide comfort without insulation in the wartime ruins.

The varying materiality and form in turn shapes the acoustic experience (bottom right), with a corten steel walkway echoing more, and again more when it becomes 'elevated' as the ground falls away from it. This forms an element of wayfinding as we follow the path around (red), while the edges create greater reverberation.

Each of the spaces uses the senses slightly differently to readjust the focus to the needs of the individual space. However, the beginning and end are the moments at which the senses collectively receive their strongest stimulus- emphasising the rough character of the remote, unbuilt territory. Thus, in the space between, we undergo a transition in appreciation for this remote island.

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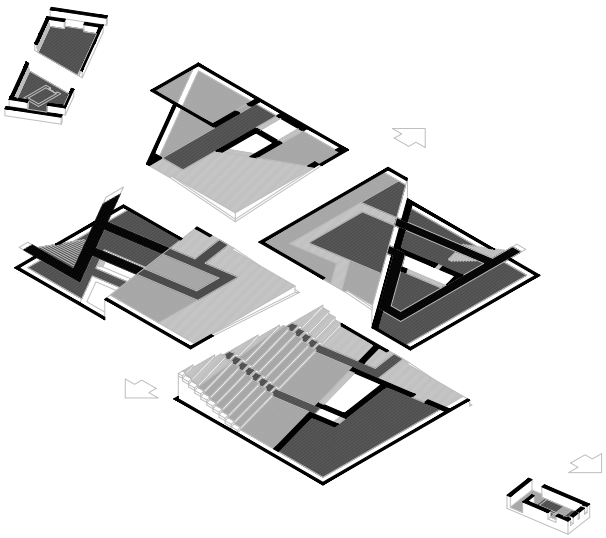

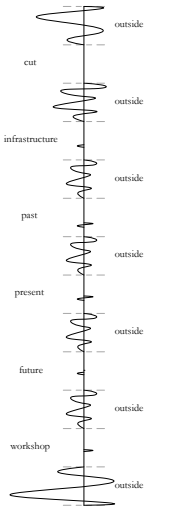
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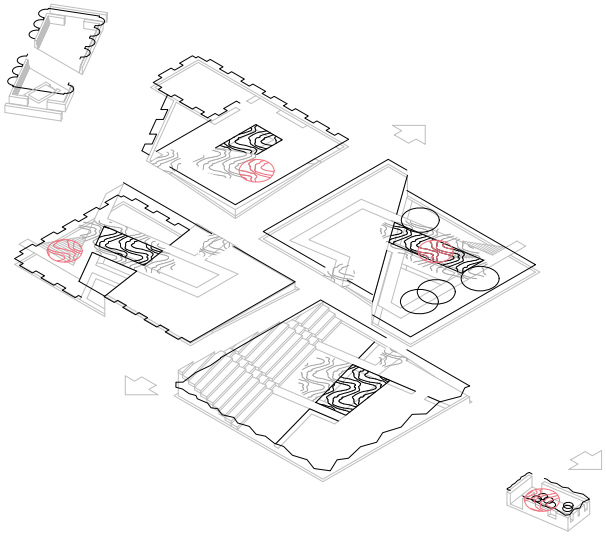

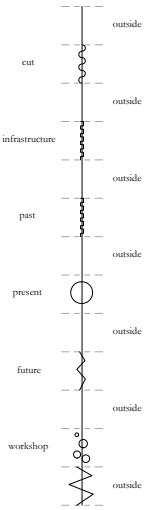
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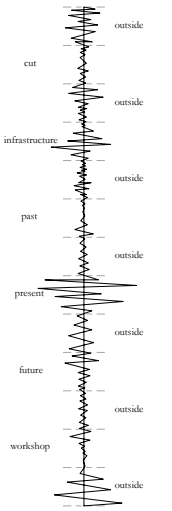
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