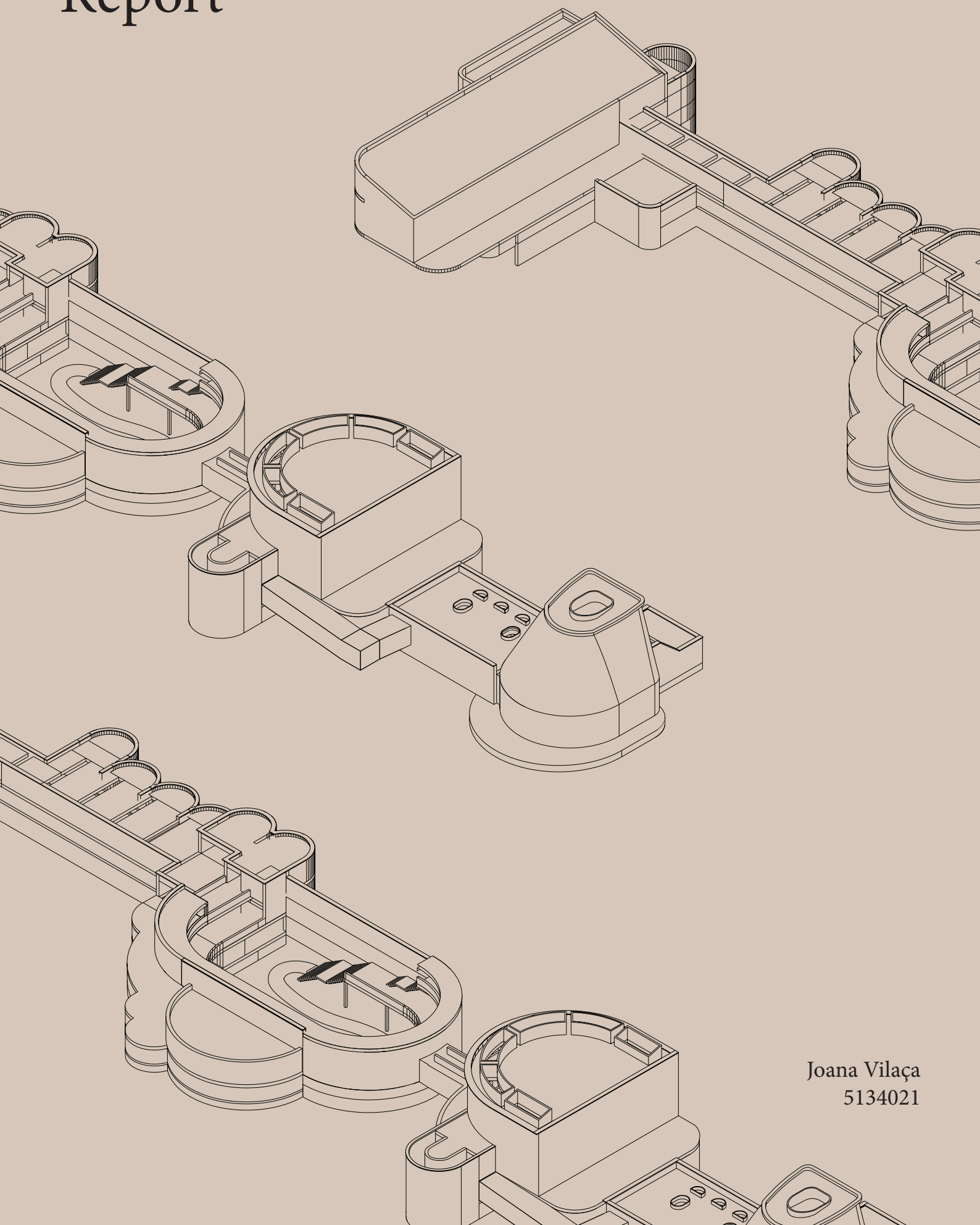


# Graduation Report

Architecture and Public Building



Joana Vilaça  
5134021

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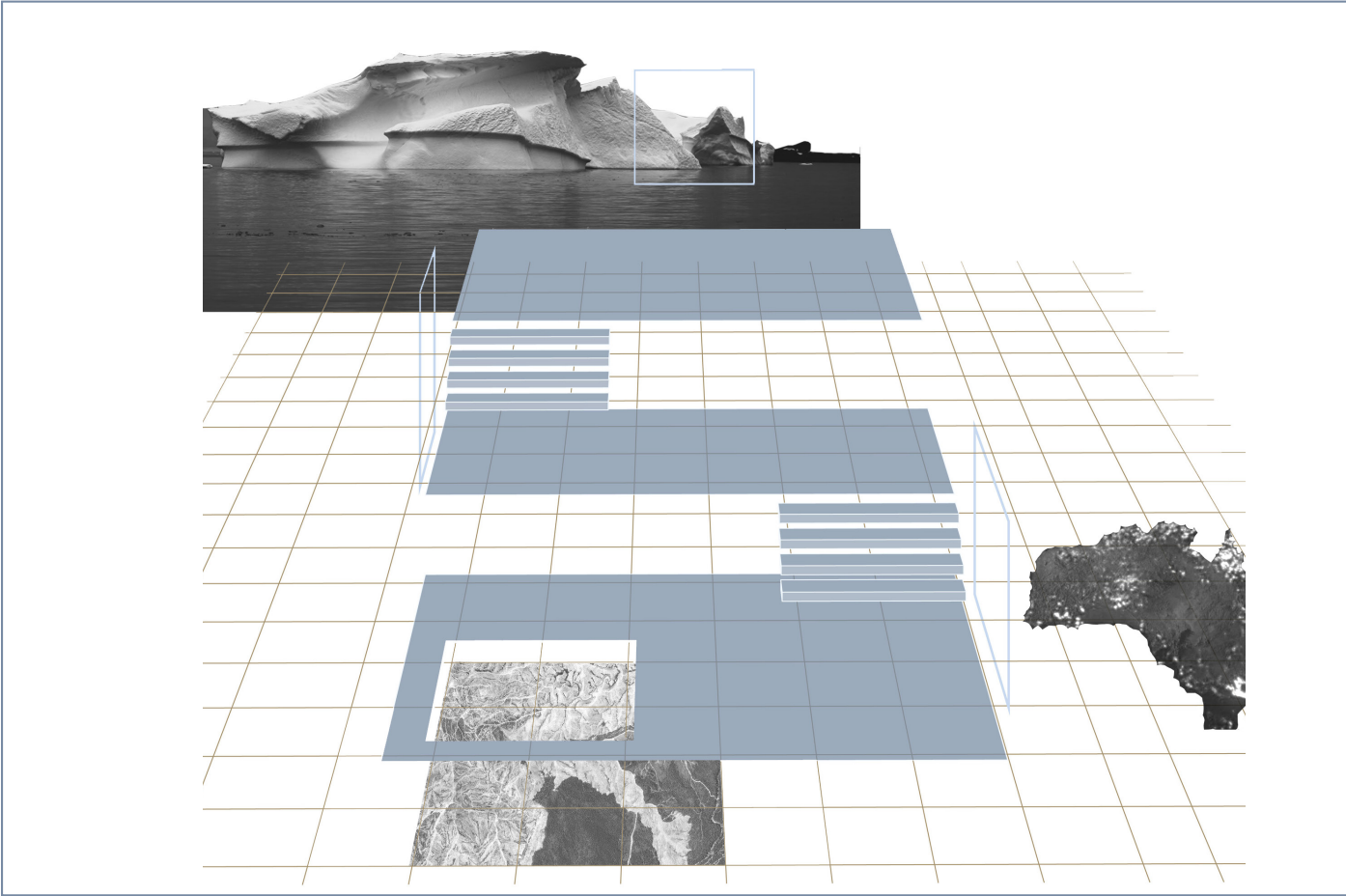
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# Design Manifesto

# Design Manifesto

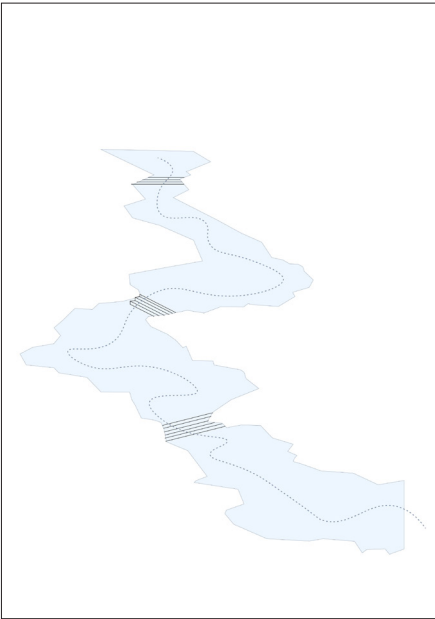
## Initial Design



1 A museum should be a platform for environmental activism, this must to be reflected in its program

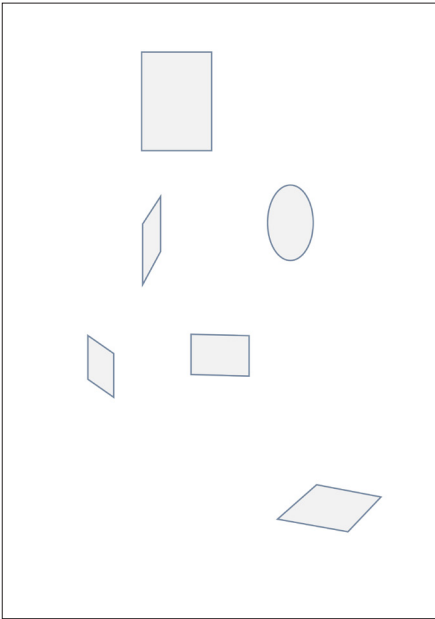
2 The collection must showcase art that directly deals with the environment

3 Architectural decisions in the building should be an example of environmental awareness.



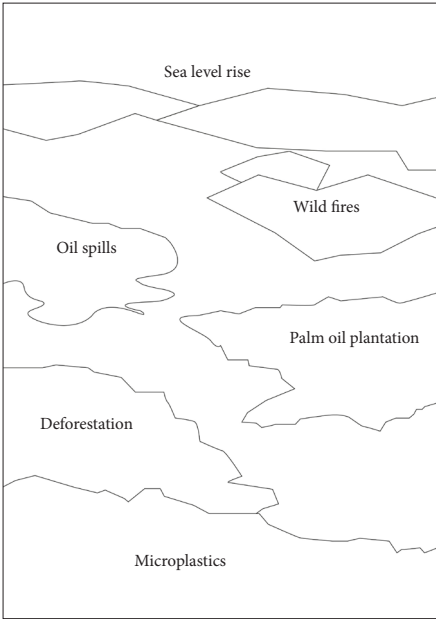
Path

The path represents the trajectory of the visitor through the museum, although previously designed each visitor is free to explore the pieces they wish thus forming their own path.



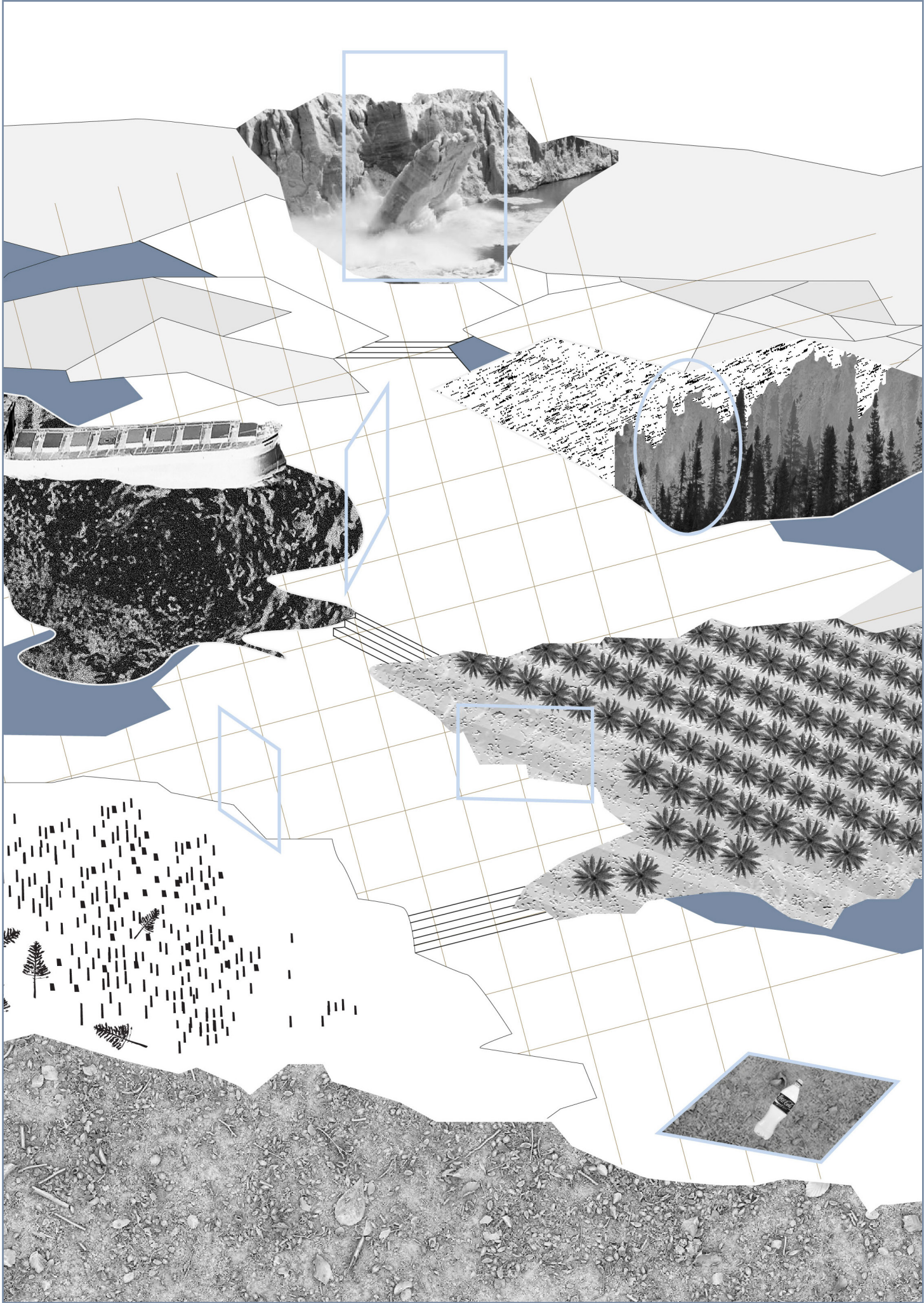
Frame

The frames stand for the artworks which highlight or capture different issues relating to the environment. Art is used this way to draw attention to certain important issues or subjects.



Fragments of nature

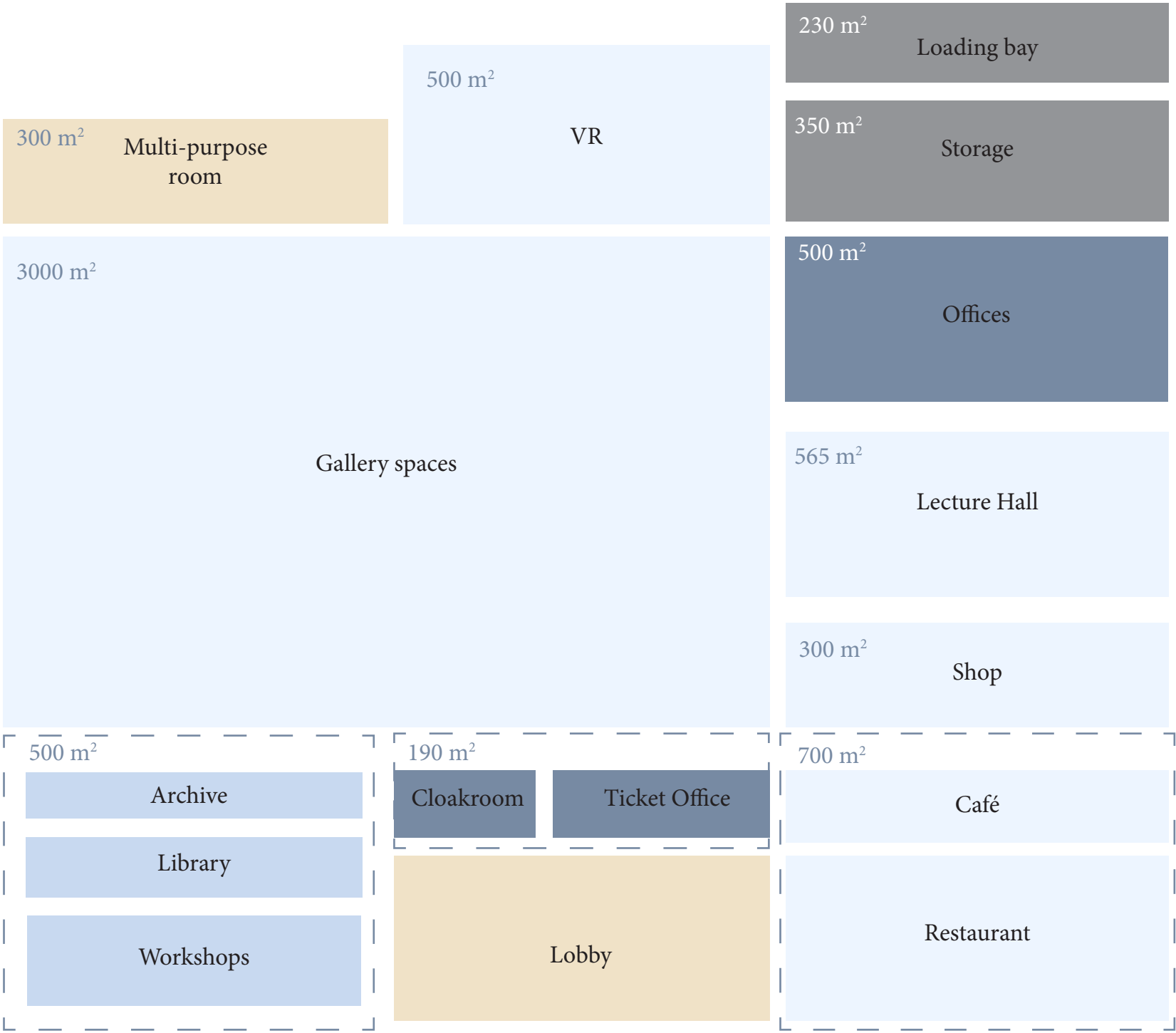
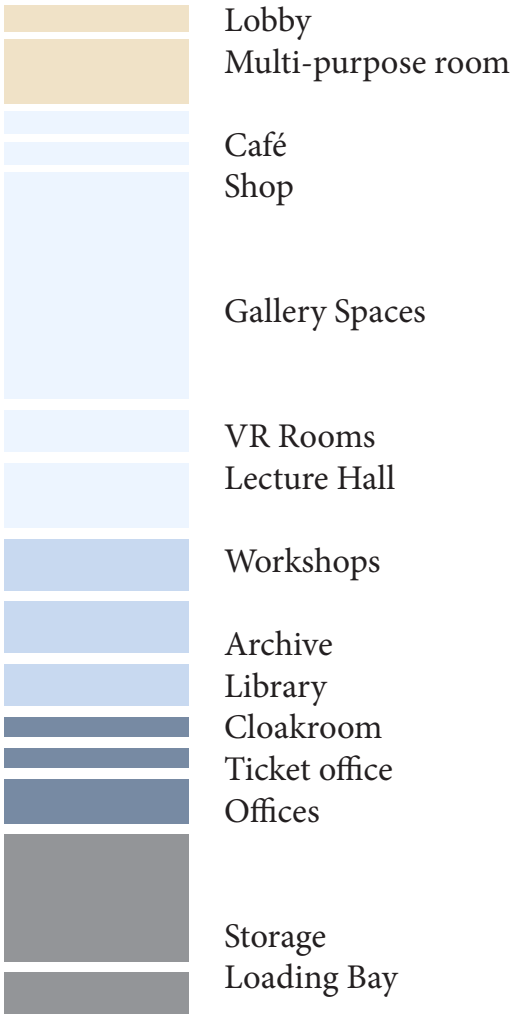
The different fragments juxtaposed show some of the relevant environmental issues to be displayed in the museum. Overall the three elements create a kind of landscape of current events in the anthropocene.

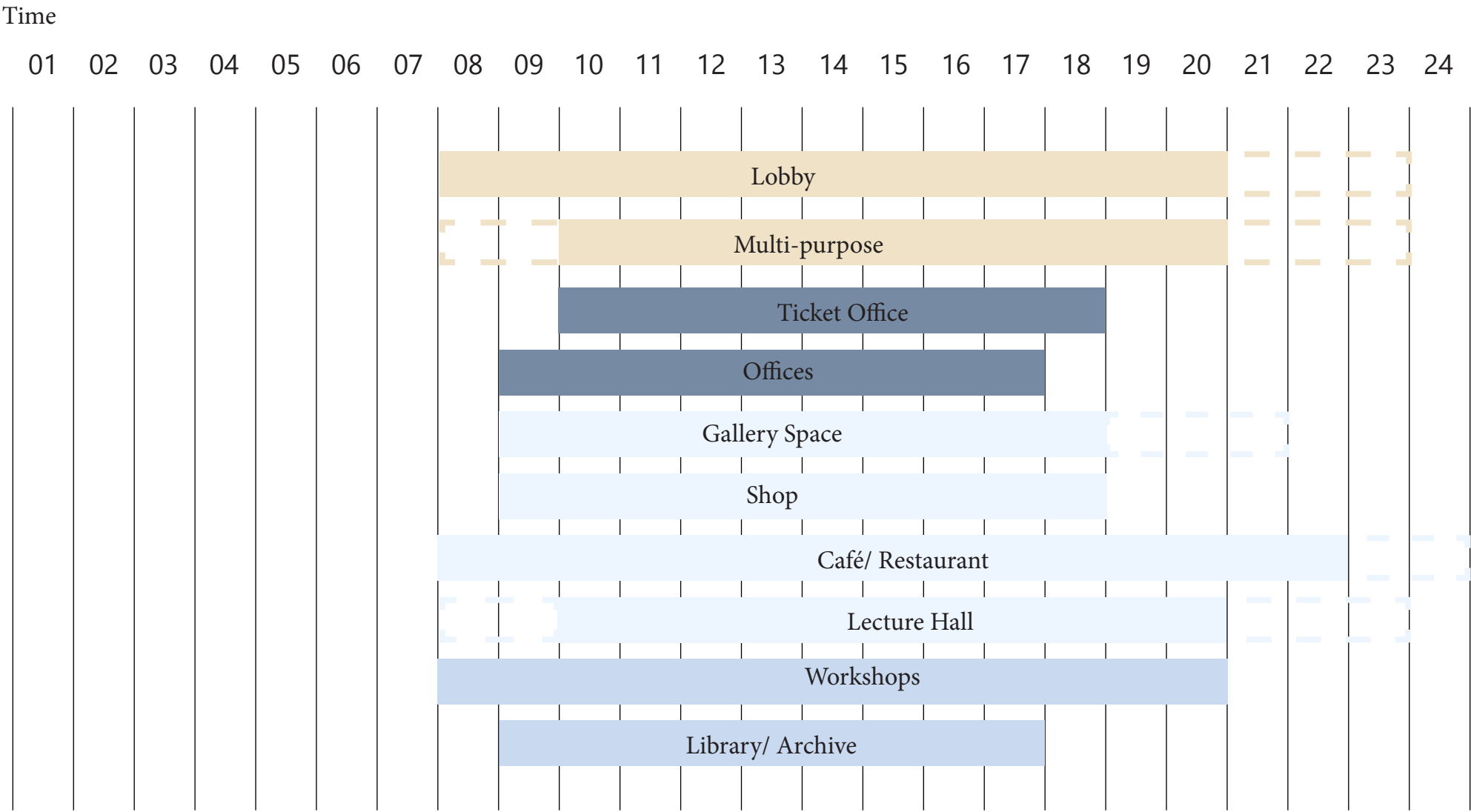






- Multi purpose rooms
- Recreational Spaces
- Educational Spaces
- Administrative Spaces
- Logistical Spaces





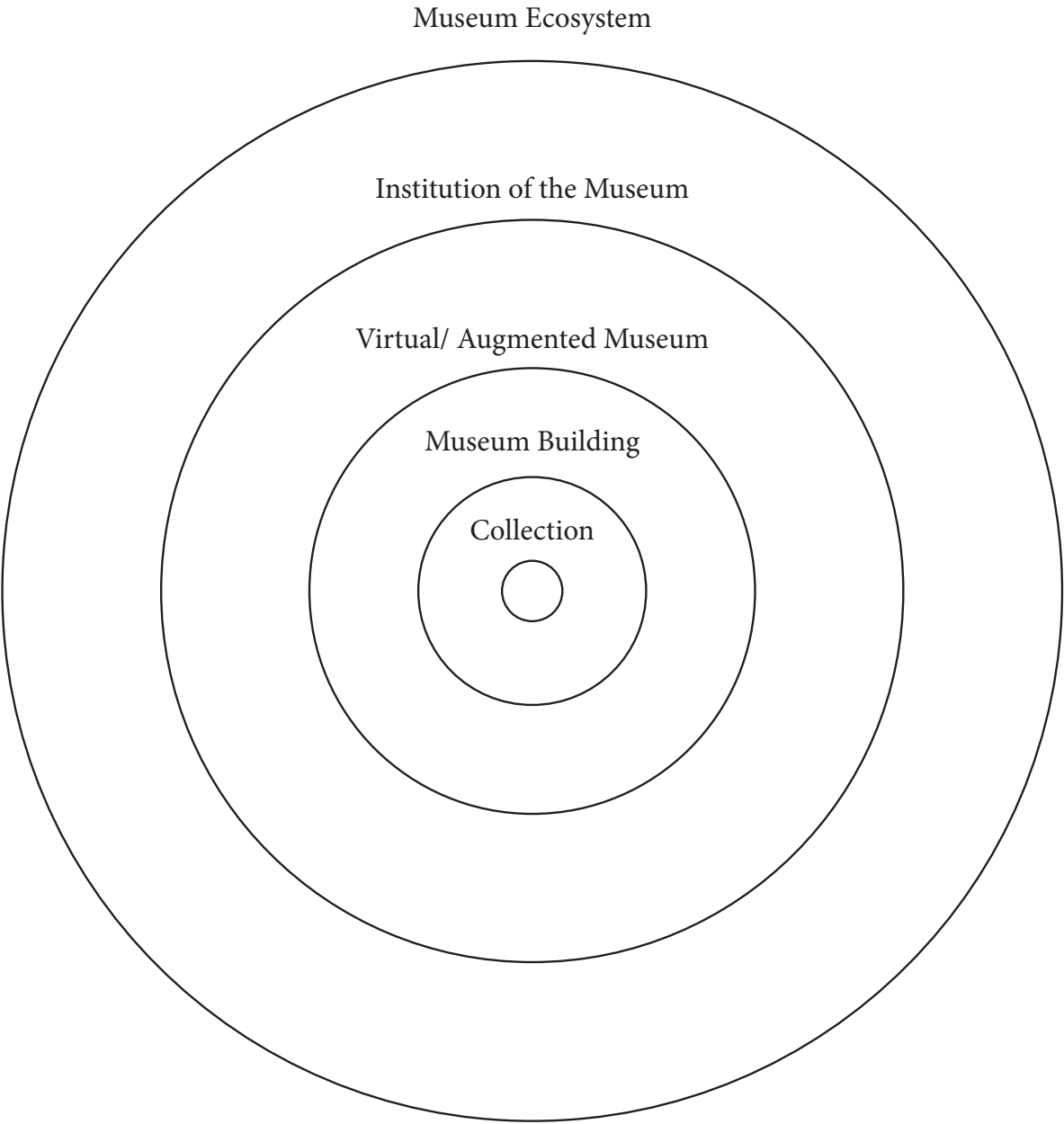
Program Breakdown

		Net percentage		Net area m²		Gross area m²	percentage	Public/ Private	Open/ Enclosed
<div></div>	Multi purpose rooms	12	Lobby	250			8%	Public	Open
			Multi-purpose room	600				Public	Closed
<div></div>	Recreational Spaces	56	Café	100			33%	Public	Open
			Shop	100				Public	Open
			Restaurant	200				Public	Open
			Gallery Spaces	1500				Private	Enclosed
				1500					
<div></div>	Educational Spaces	14	Lecture Hall	500			8%	Public	Enclosed
			Workshops	300				Public	Enclosed
<div></div>	Administrative Spaces		Archive	100				Semi-private	Enclosed
			Library	100				Public	Open
<div></div>	Logistical Spaces	10	Cloakroom	100			6%	Semi-Private	Enclosed
			Ticket office	100				Semi-Private	Enclosed
			Offices	500				Private	Enclosed
<div></div>	Circulation	8	Storage	300			4%	Private	Enclosed
			Loading Bay	250				Private	Enclosed
			Unassigned areas				41%	Public	Open
		-				5000			
	Total:			7000 m²					
	Total Building Area:					12000 m²			





Museum ecosystem



Map of neighbouring museums and cultural venues



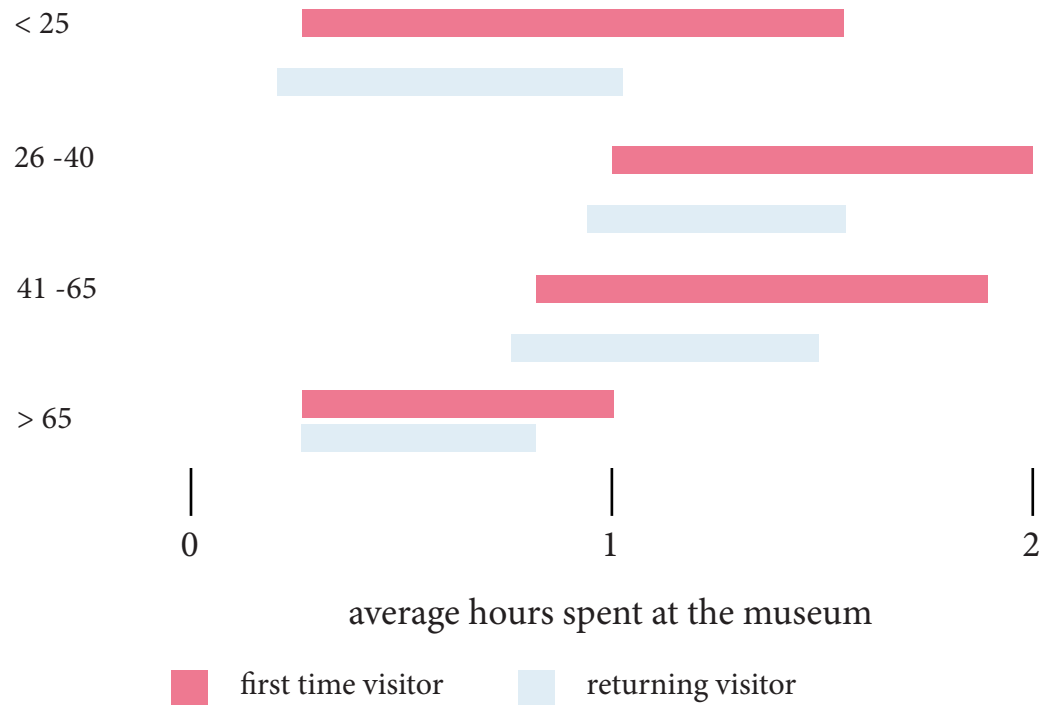
Individual Research

Museum visitor profile

- restless
- discontent
- quest for stimuli
- looking for customized experience

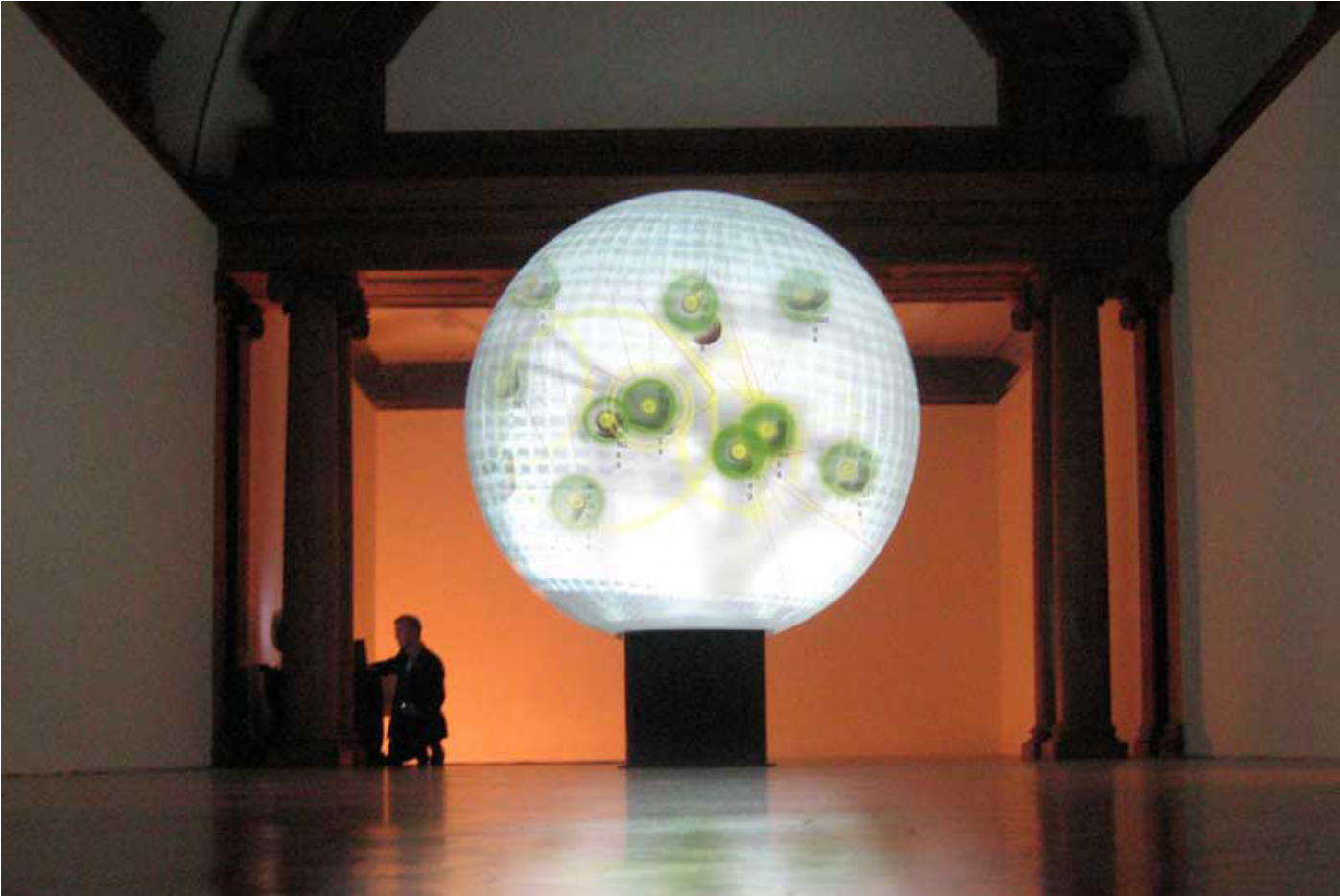


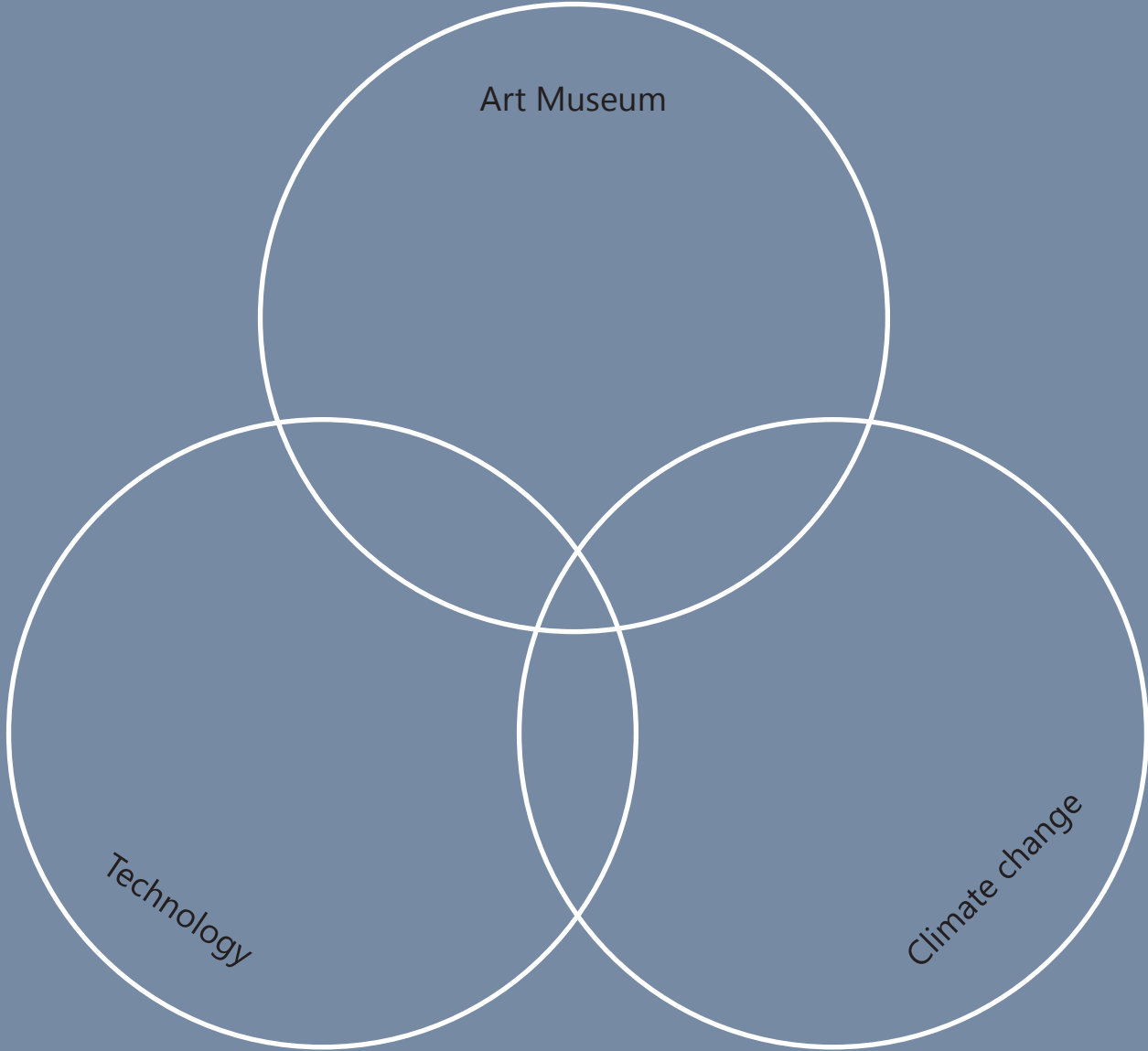
age group



Immersive installations

Immaterials: light painting wifi

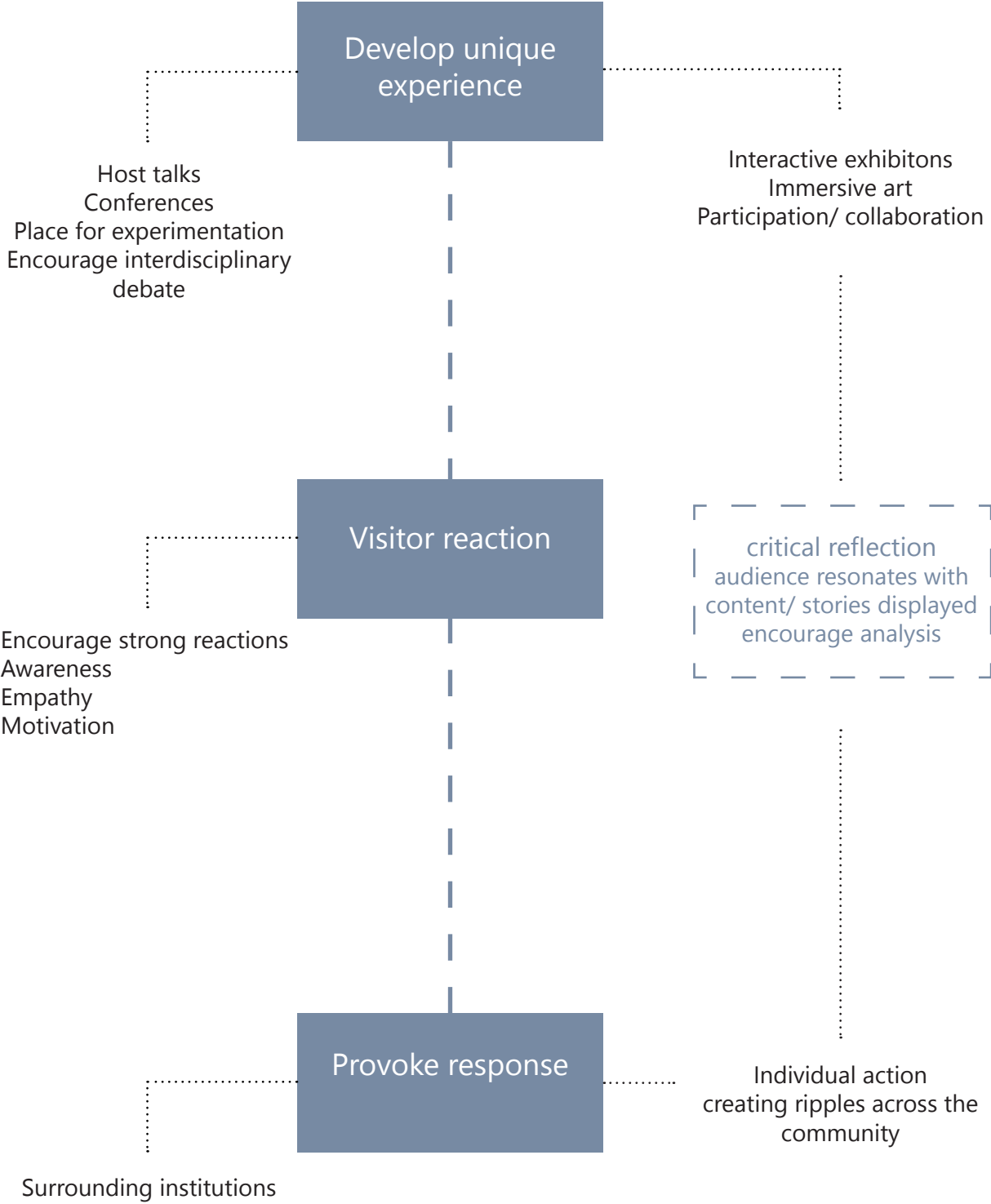




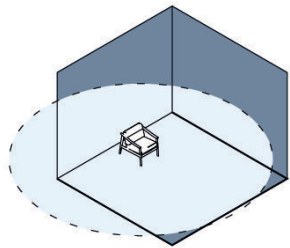
01 DISPLAY

02 ENGAGE

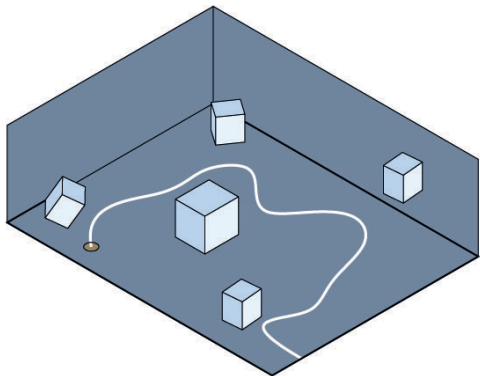
03 CHANGE



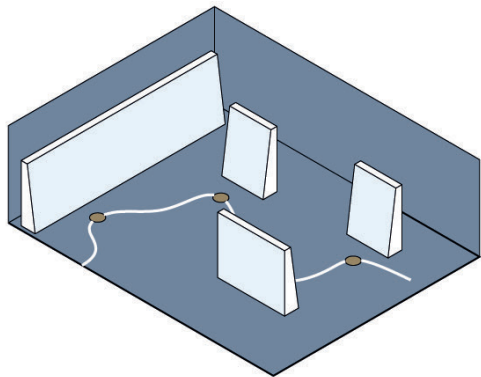




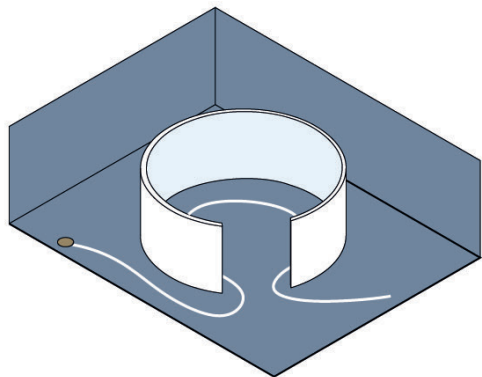
Virtual Reality  
Seating



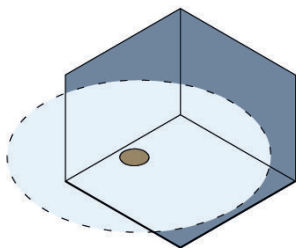
Augmented Reality  
Moving looking at a phone



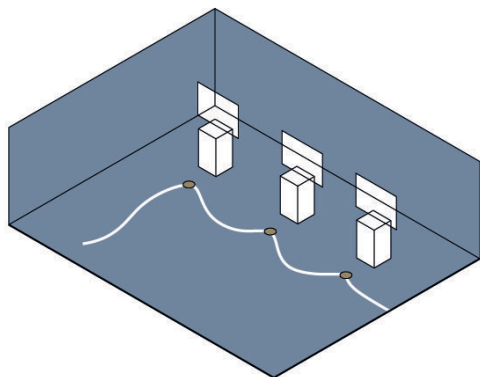
Screens  
Independent modules



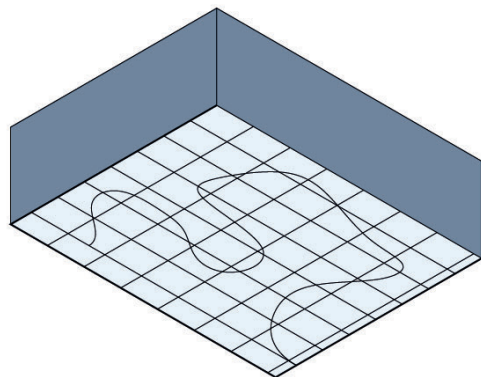
Screens  
LED volume



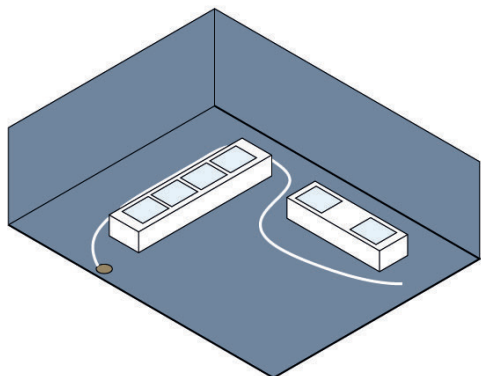
Virtual Reality  
Standing



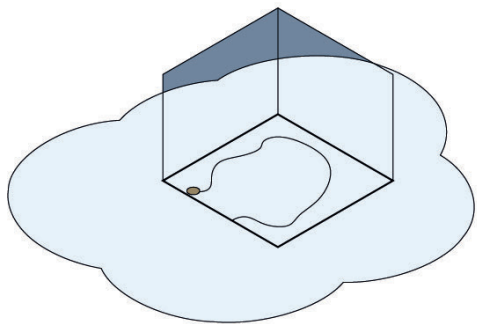
Augmented Reality  
Pointing tablet at artwork



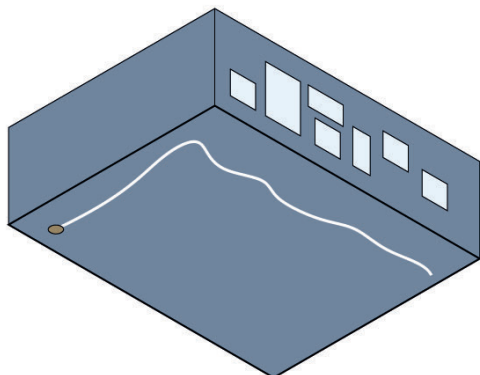
Screens  
Floor surface



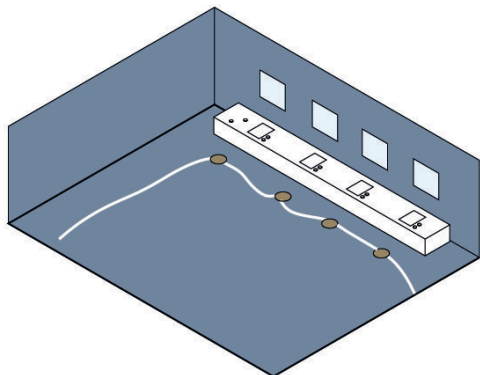
Screens  
Tables



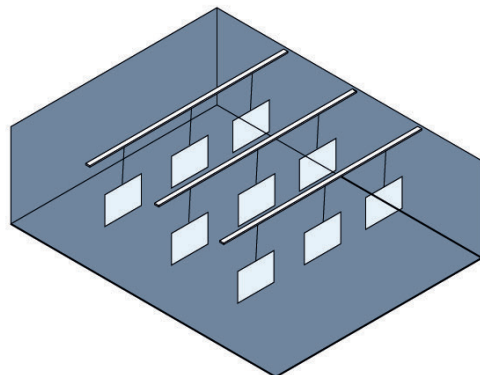
Virtual Reality  
Walking



Screens  
Attached to walls



Screens  
Interactive buttons



Screens  
Free-floating



Individual Research

Environmental Art



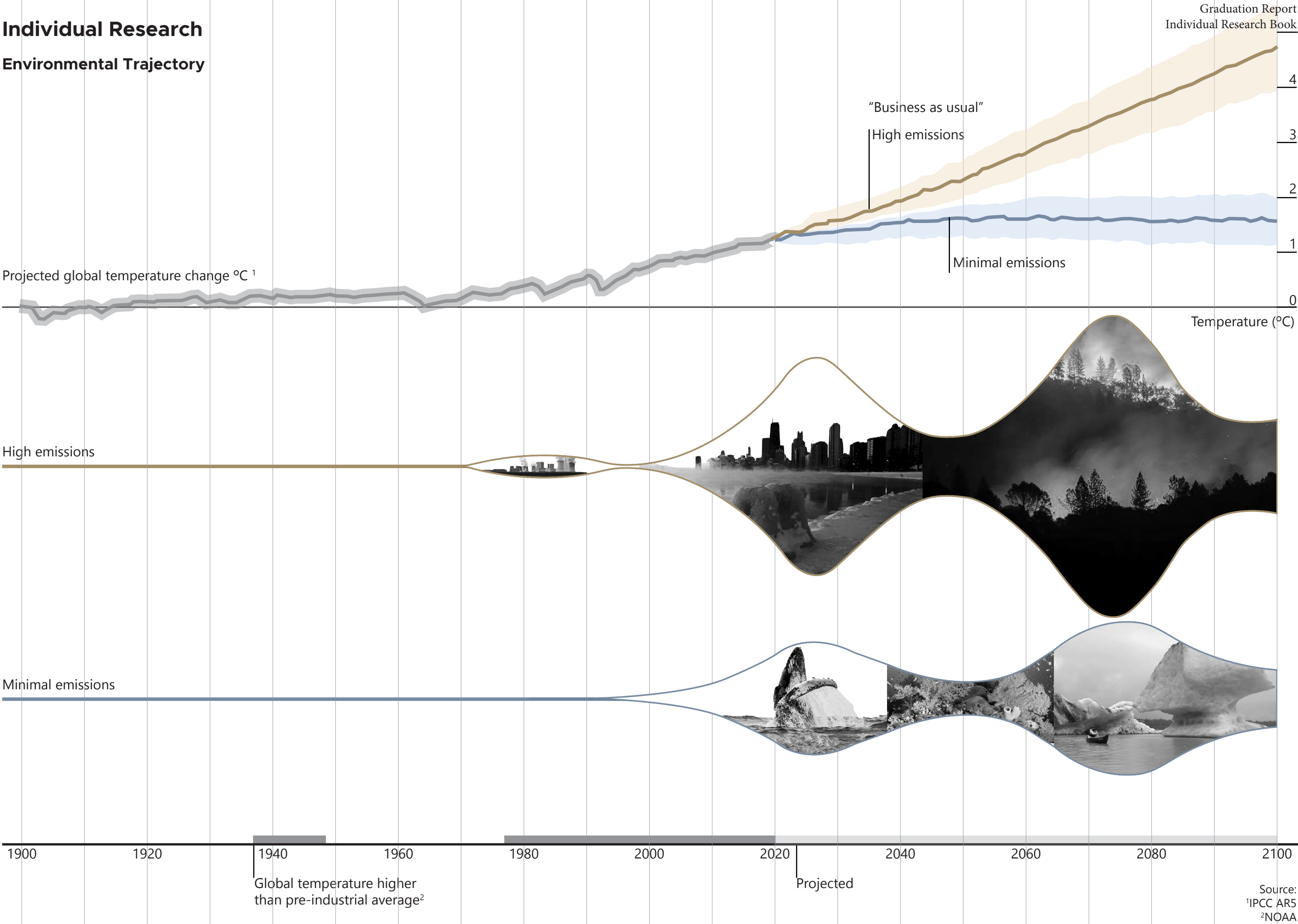
Past/current events



Future Visions

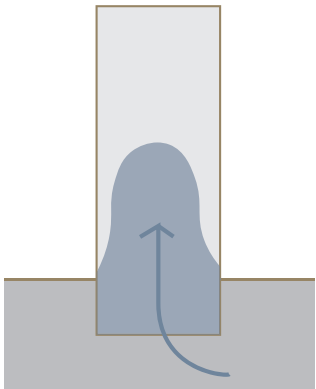


Individual Research  
Environmental Trajectory

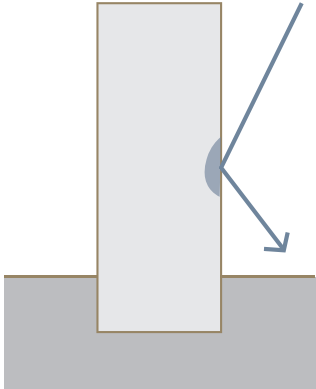


# Erosion Research

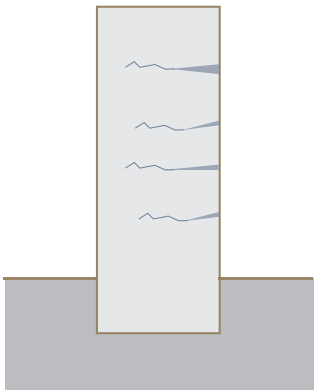
## Durability of Earthen Structures



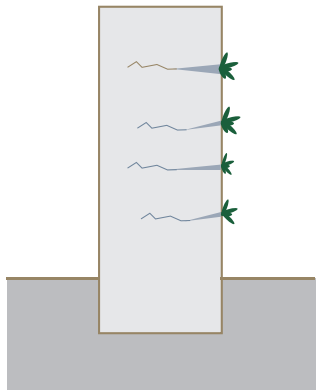
water infiltration from the ground



surface erosion from rainfall/ rain splash



freeze thaw due to moisture in wall



damage from abrasion, plants, insects

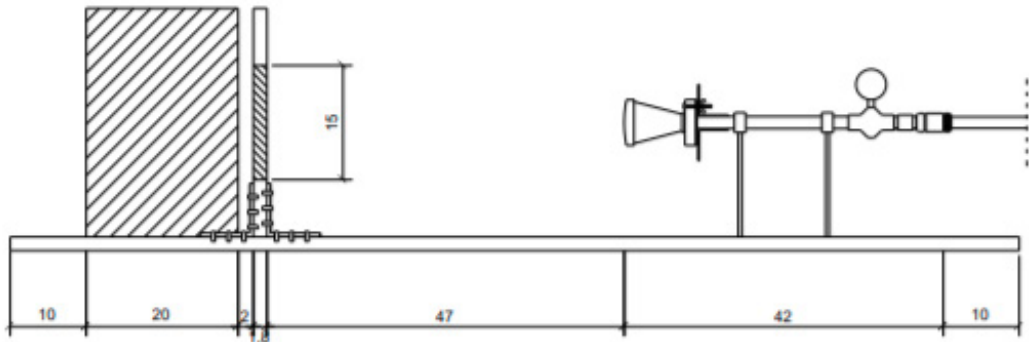


Fig. 6. The scheme of the constructed research stand

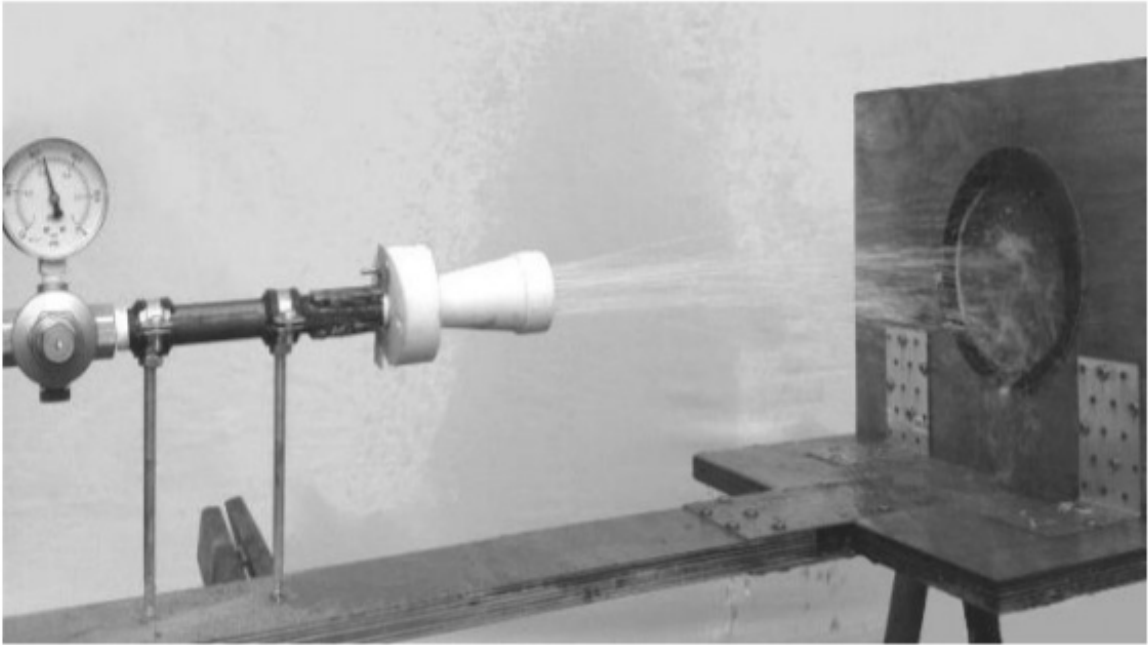
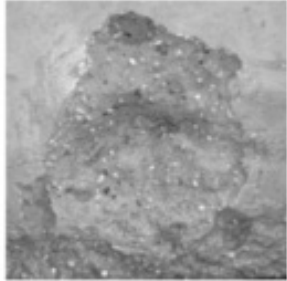
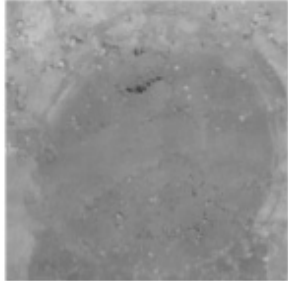


Fig.7. Sample testing

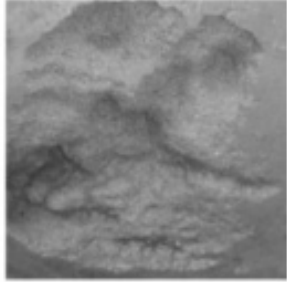
613 0% cement



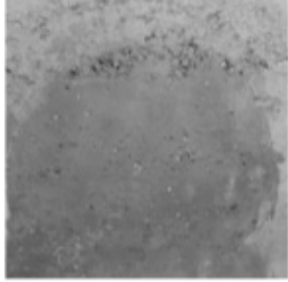
433 6% cement



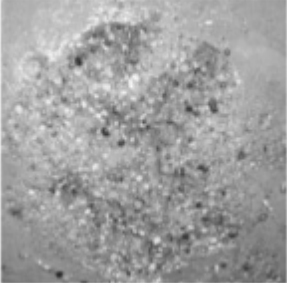
703 0% cement



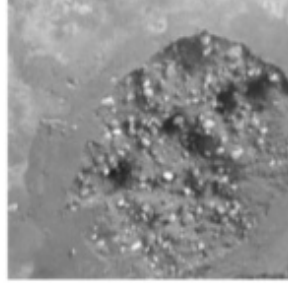
523 6% cement



433 0% cement



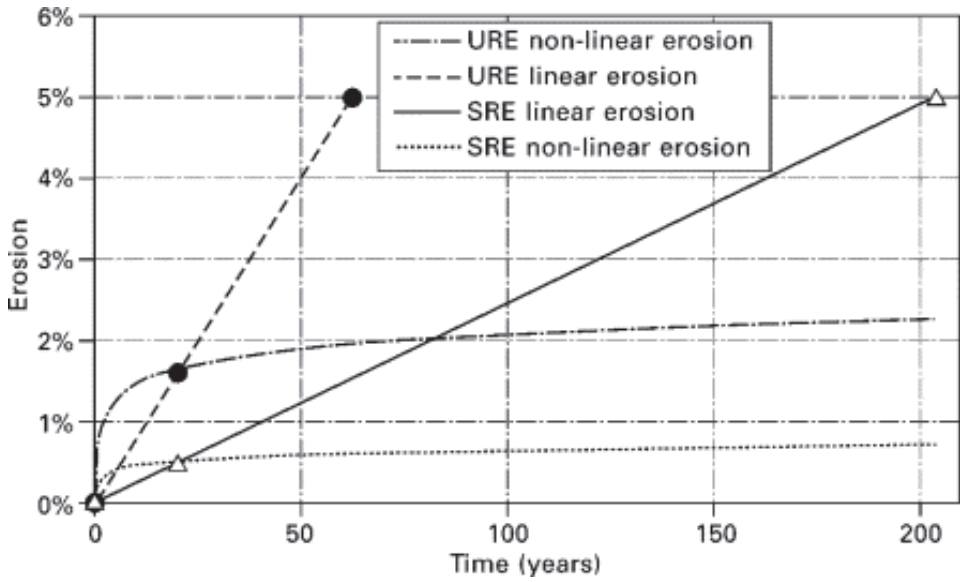
523 0% cement



# Erosion Research

## Long term performance rammed earth

Because erosion with time is not linear, the lifetime of these walls may be much longer than 63 and 204 years, respectively, for unstabilised and stabilised rammed earth walls.



rammed earth wall section

safe to erode 10%  
aesthetic preference 5%

## Test 2 20 year durability test - Grenoble, France

	Test site	Rotterdam
Average annual rainfall	aprox. 1000 m	815 m
mean wind speed	2.75 m/s	3.5 m/s



### Stabilized rammed earth wall stabilised with 5% hydraulic lime

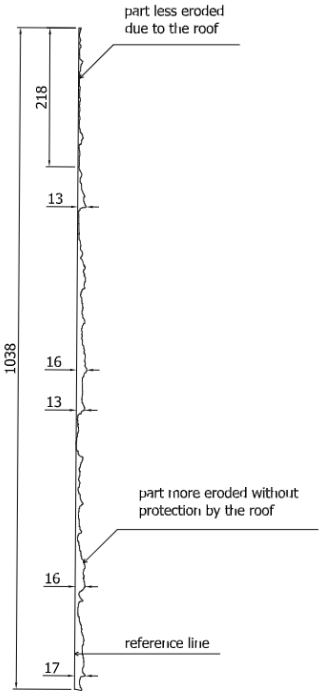


mean erosion depth - 2mm  
(0.5% wall thickness)  
  
Life expectancy > 200 years

### Unstabilized rammed earth wall



mean erosion depth - 6.4mm  
(1.6% wall thickness)  
  
Life expectancy > 60 years





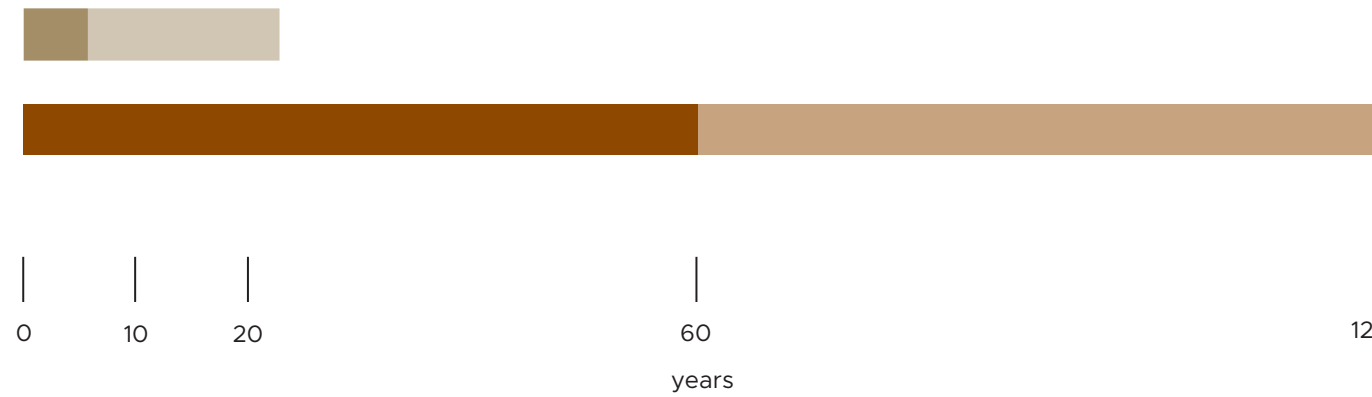
Erodable structure

- increase **water** presence to speed up erosion
- opt for **unstabilized structures** - recyclable and more prone to erosion
- **cracks** present after initial drying will expand and promote scaling and erosion
- erosion is **not linear**, structure will erode faster at the start due to formwork removal
- **increase sand** proportion in areas meant to erode by precipitation
- **increase clay** in areas meant to widen cracks

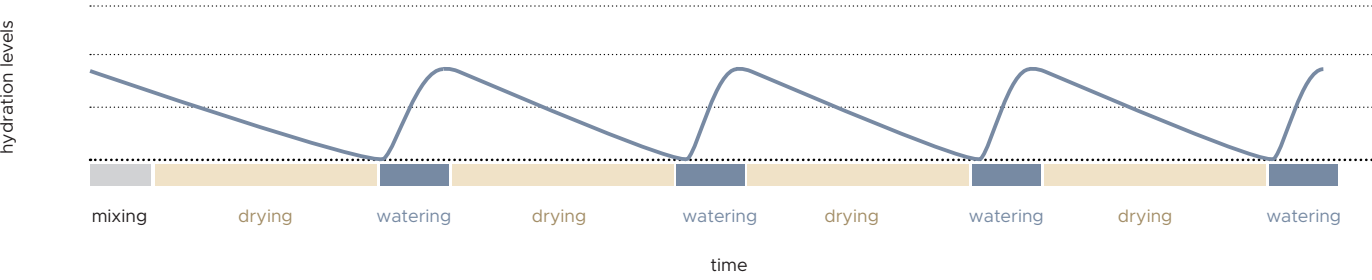
Permanent structure

- traditional construction techniques of earthen architecture are **durable** and long lasting
- extra protection can be provided by **sheltering from rain** and water infiltration
- **erosion checks** help regulate moisture and control erosion

Life span



Test layout



Material combination



Sand



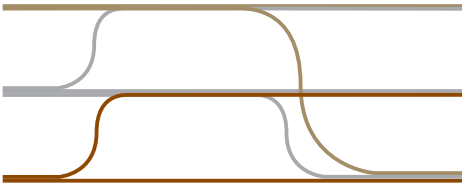
Plaster



Clay



Fibers



Sand + Plaster

Plaster + Clay

Sand + Plaster + Clay

Sand + Plaster + Fibers

Ratio

1:2

1:2

1:2:2

1:1

1:1

1:2:2

2:1

2:1

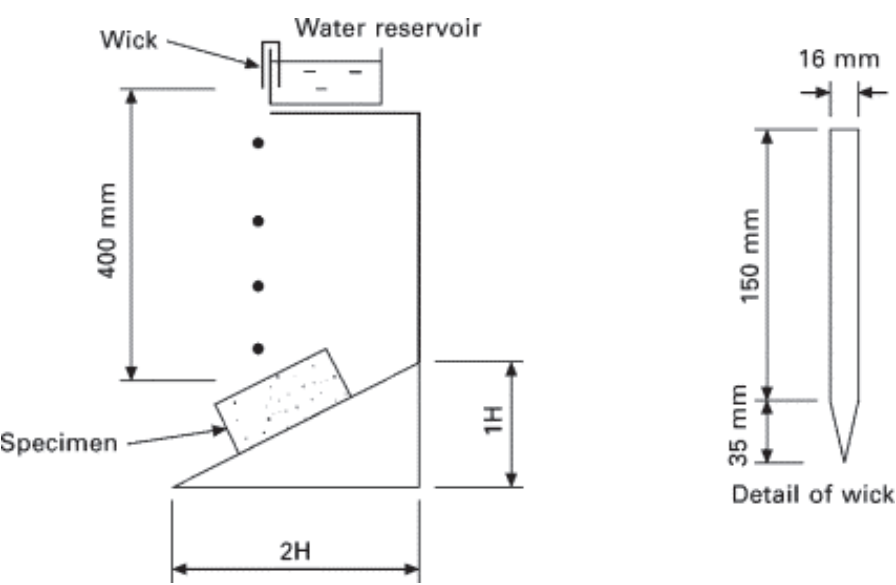
1:2:2





Physical test

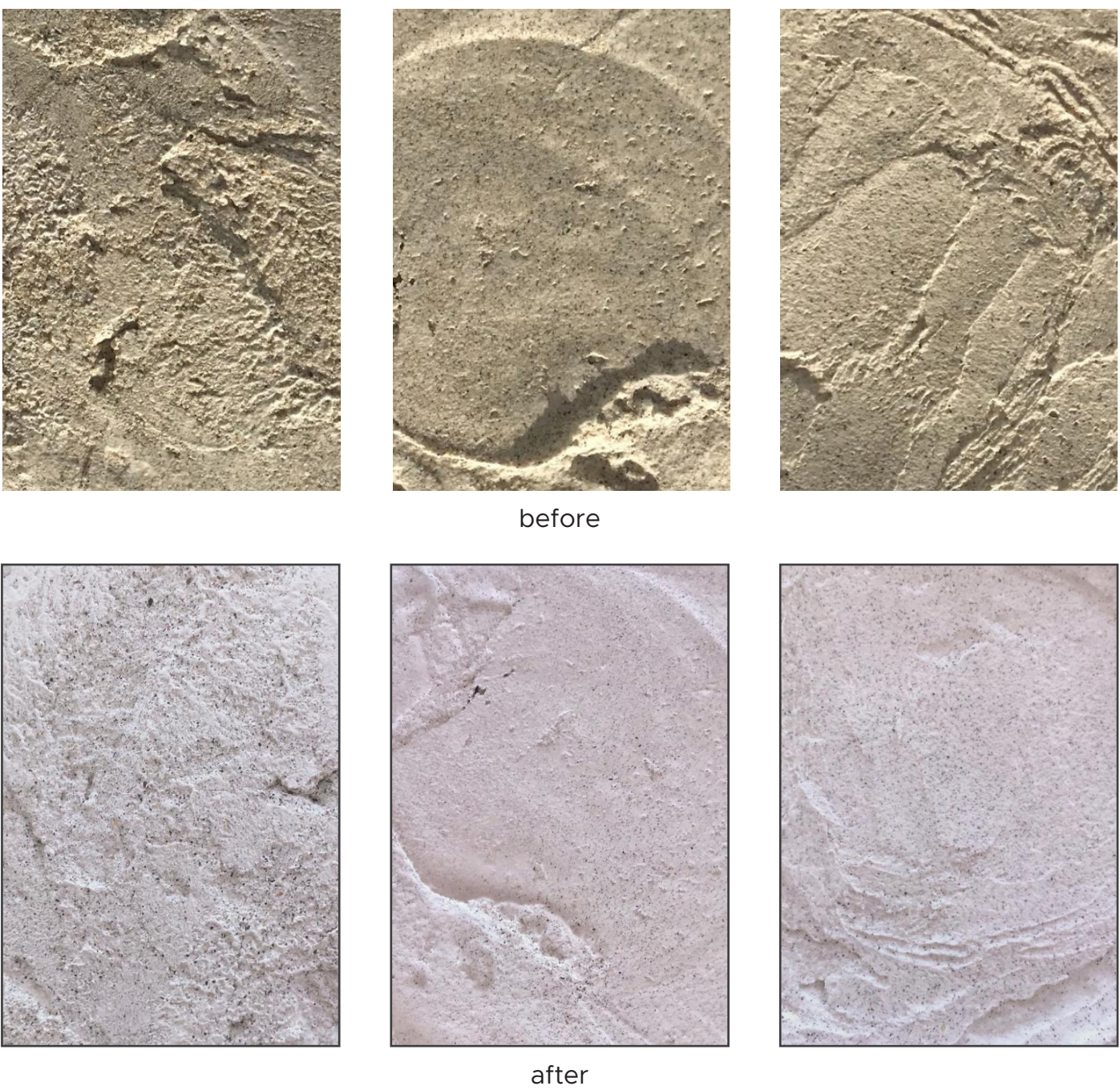
Point irrigation system



The drip test setup was selected as it is commonly by builders to used to simulate the action of raindrops

Close up texture

+ Sand ..... + Plaster



Erodability index ( $E_I$ )	Depth of pitting d (mm)	Note
1	0	Non-erosive
2	$0 < d < 5$	Slightly erosive
3	$5 < d < 10$	Erosive
4	$d > 10$	Very erosive



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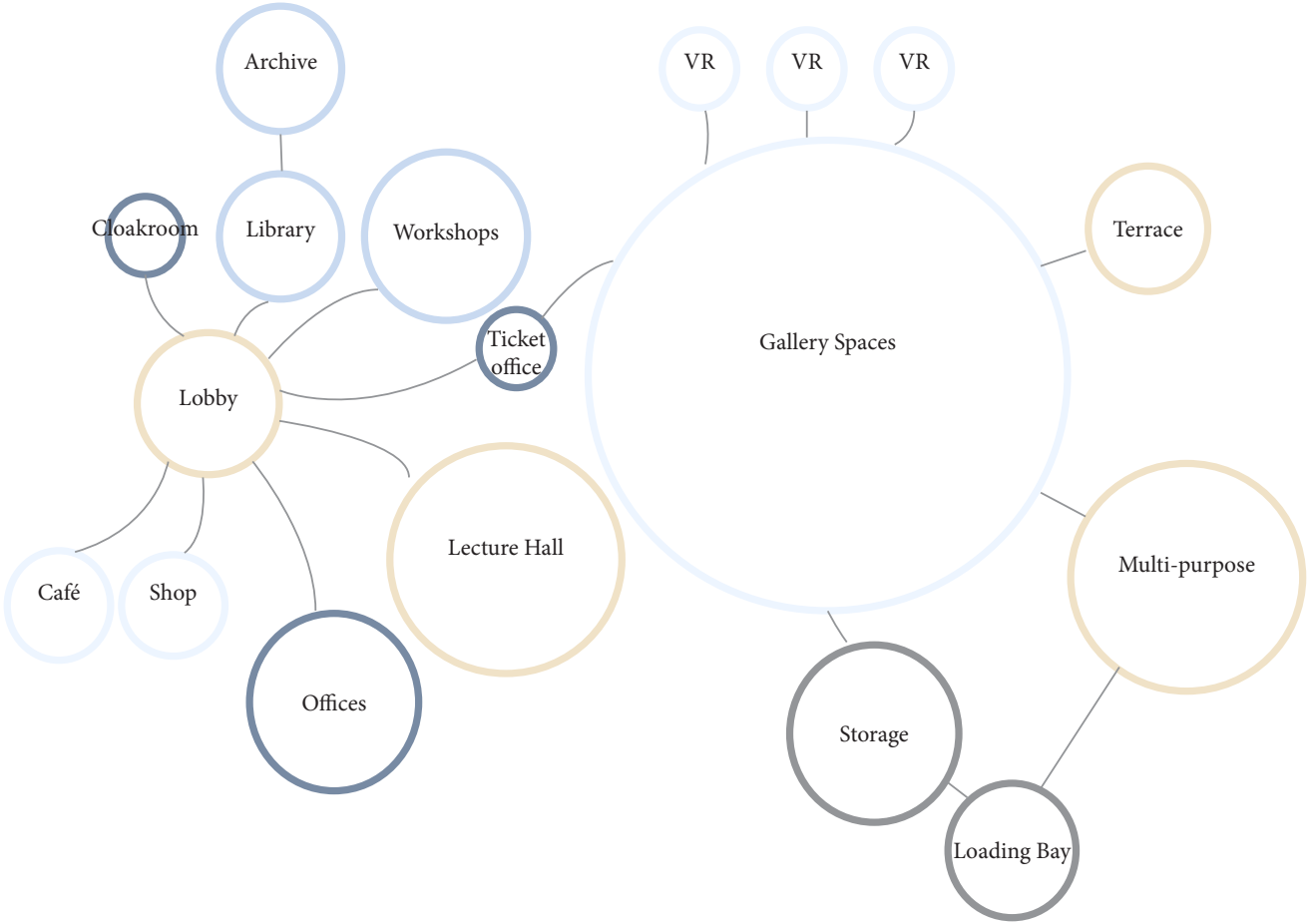


Design Journal


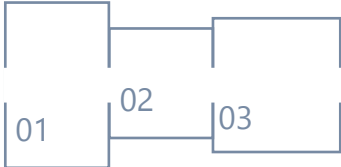
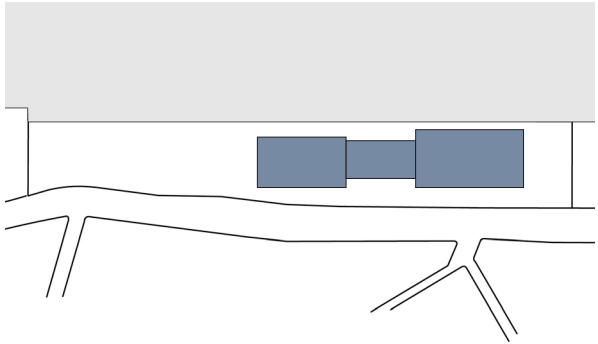
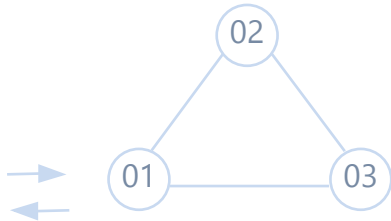
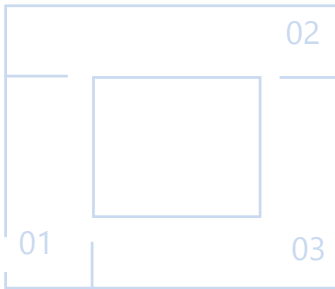
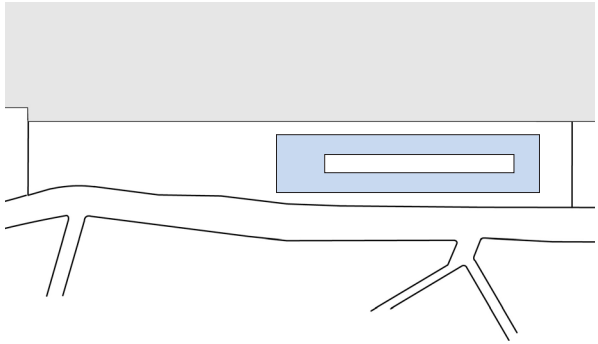
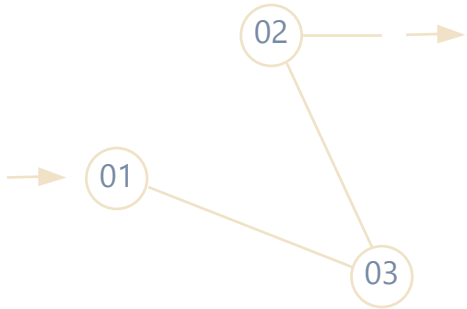
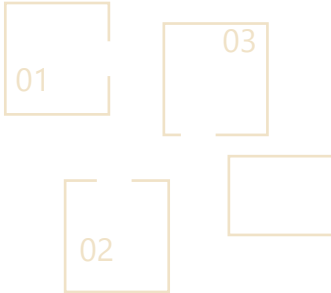
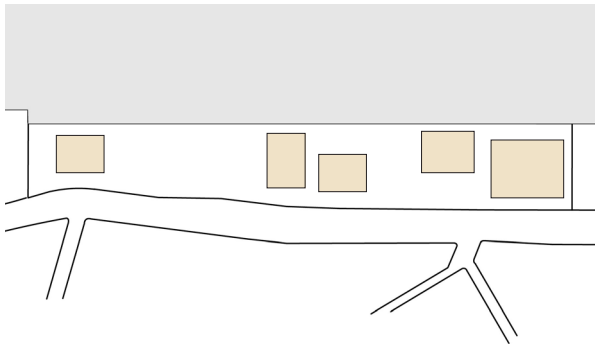
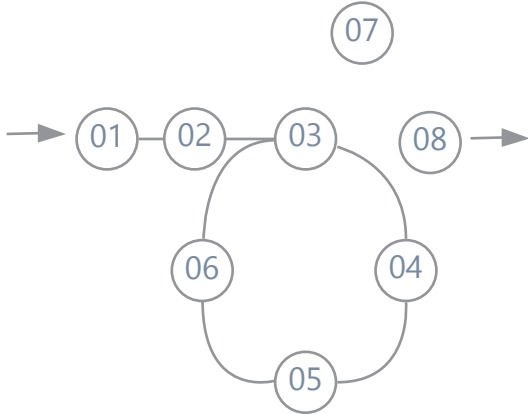
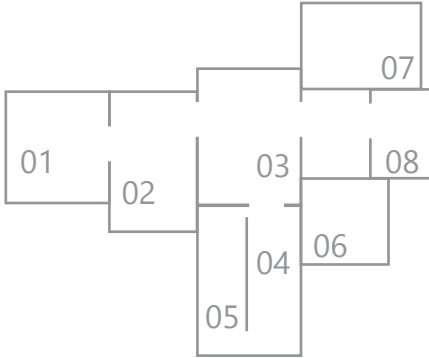
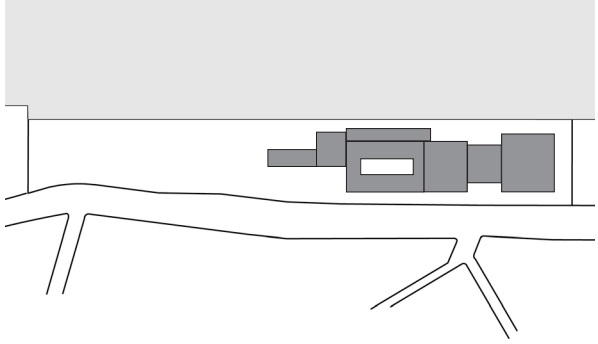
Program



Adjacency Diagram

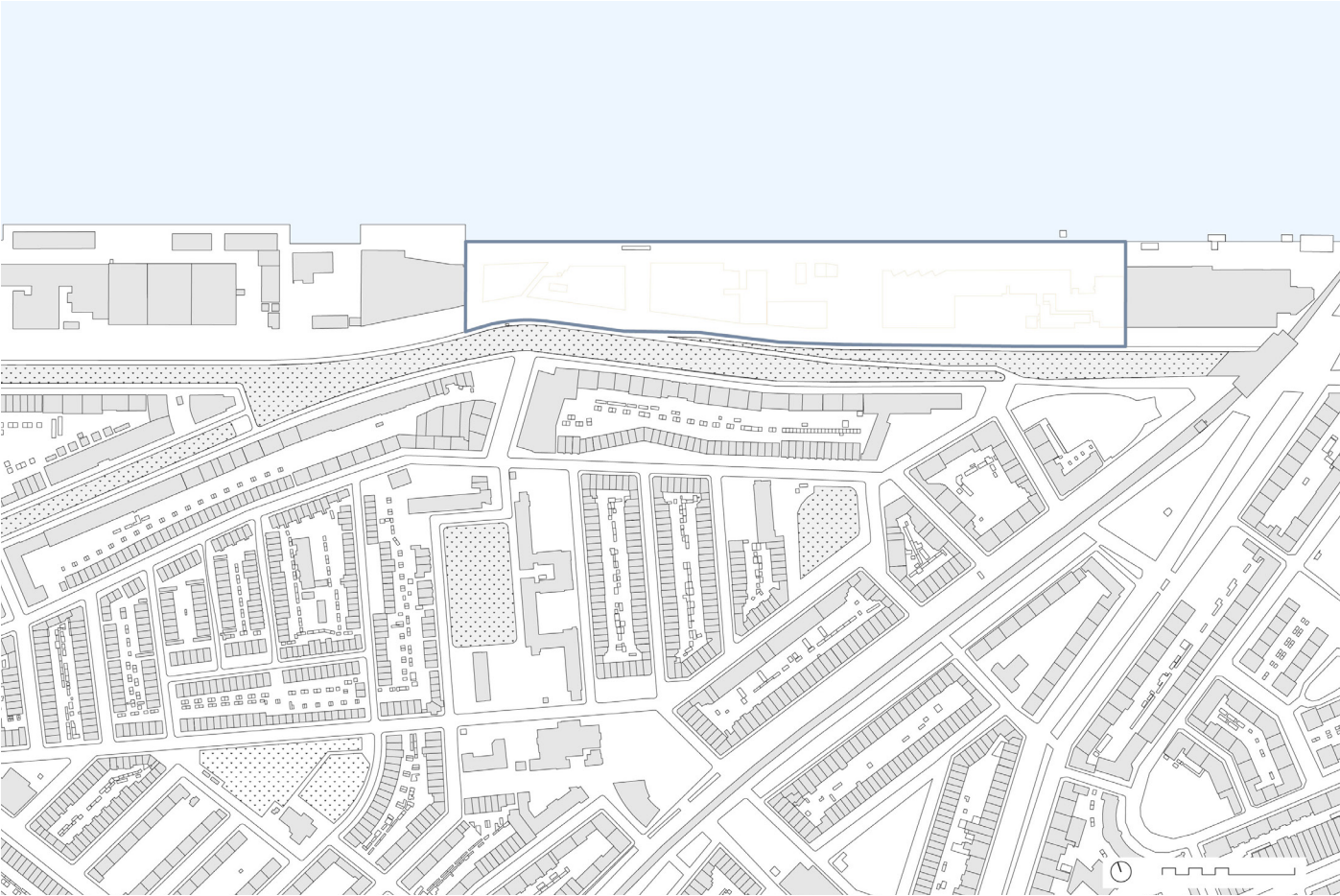


Internal Sequence

Type	Circulation	Organization	Experience	Application	Site
LINEAR			Narrative Didactic All inclusive	Entrance/ Exit Lecture Hall Offices Shop Multi-purpose	
CIRCULAR			Traditional Central Connection	Library Gallery space VR room Workshops Café	
EXPLORATORY			Dynamic Discovery Autonomous Personalized Selective	Gallery space	
HYBRID			Complex Versatile Adaptable	Gallery space	

# Design Journal

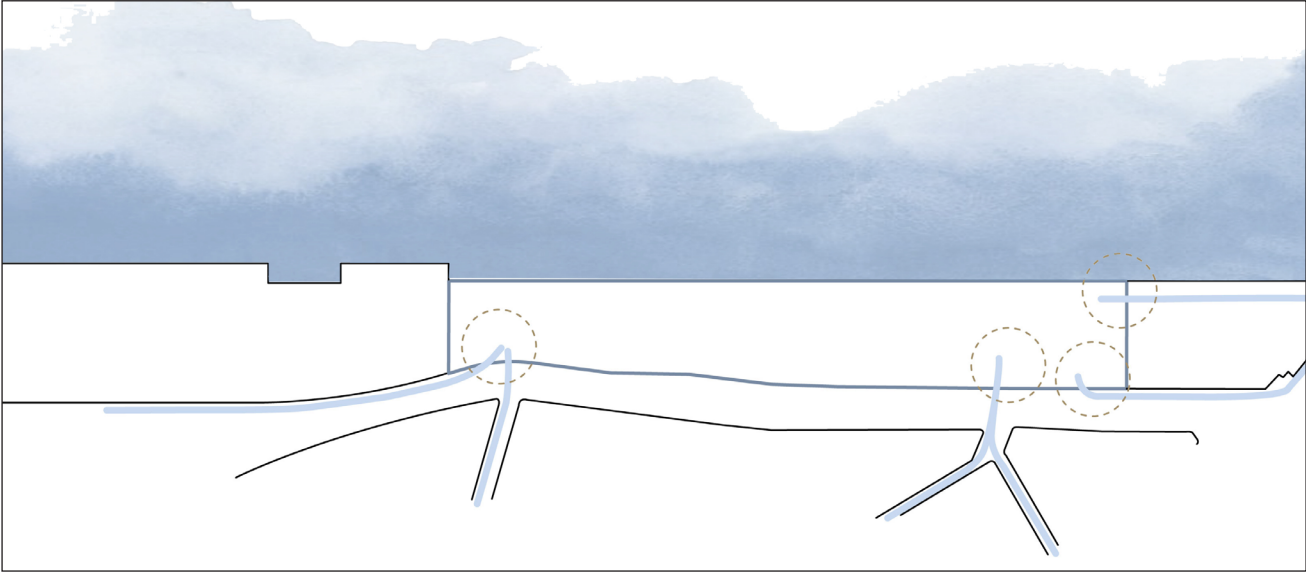
## Site



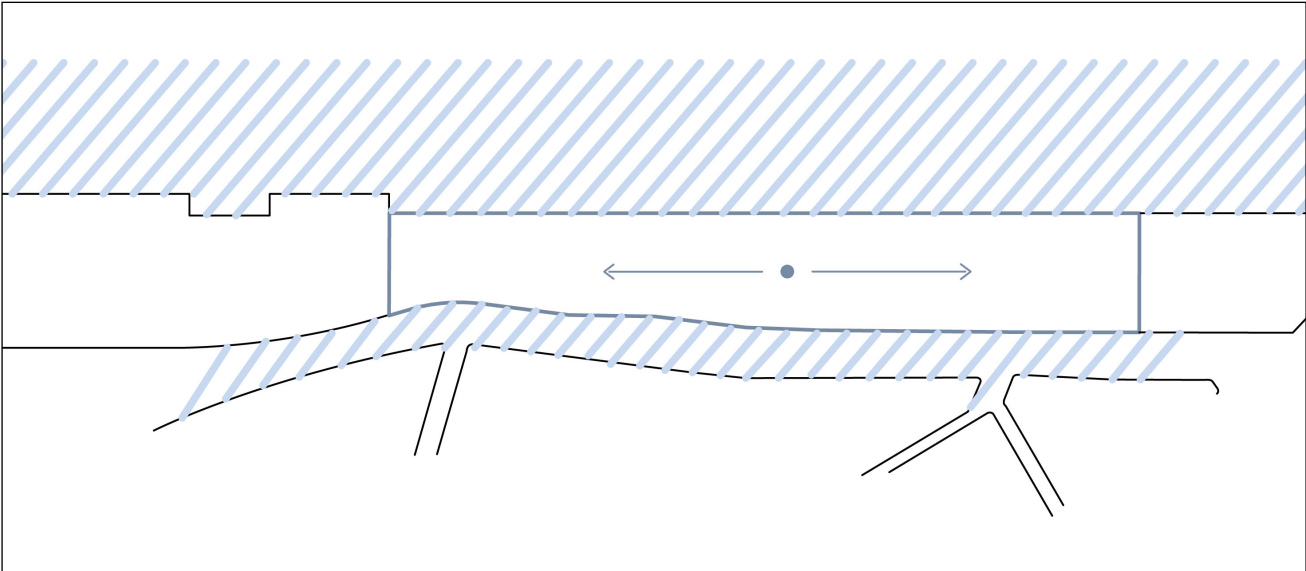


# Design Journal

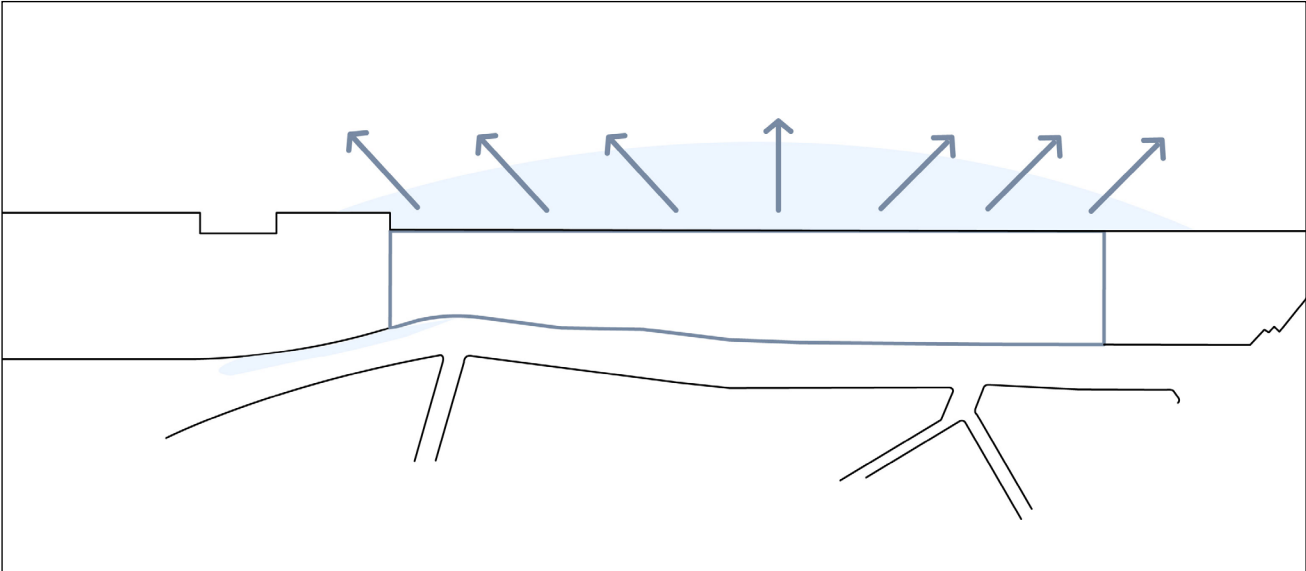
Accessibility



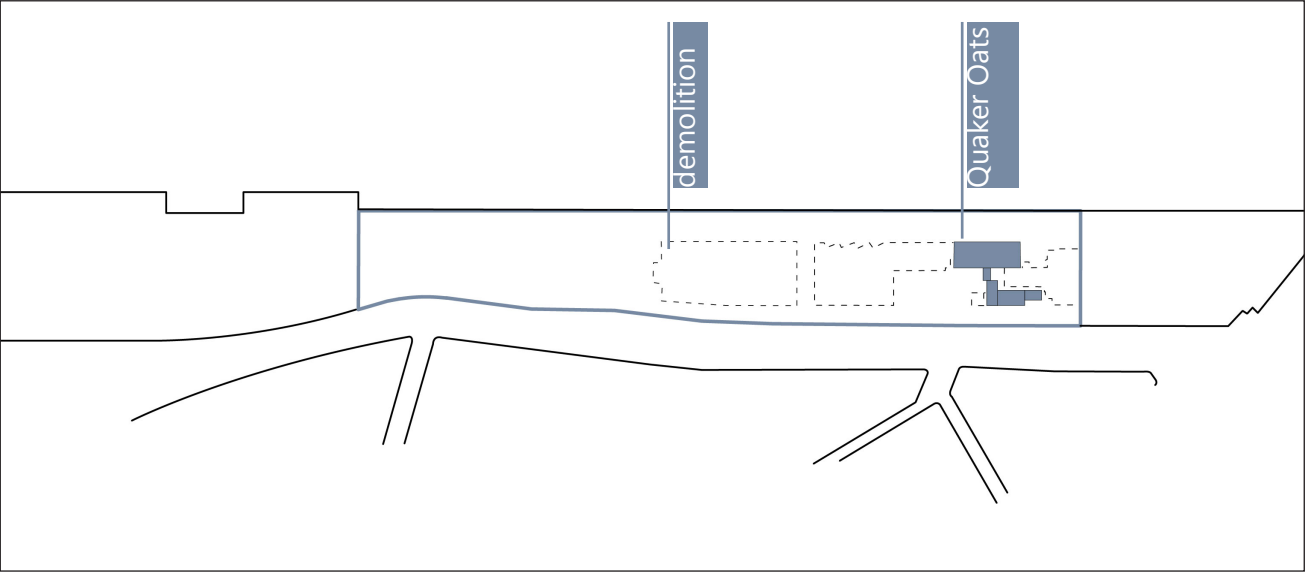
Barriers



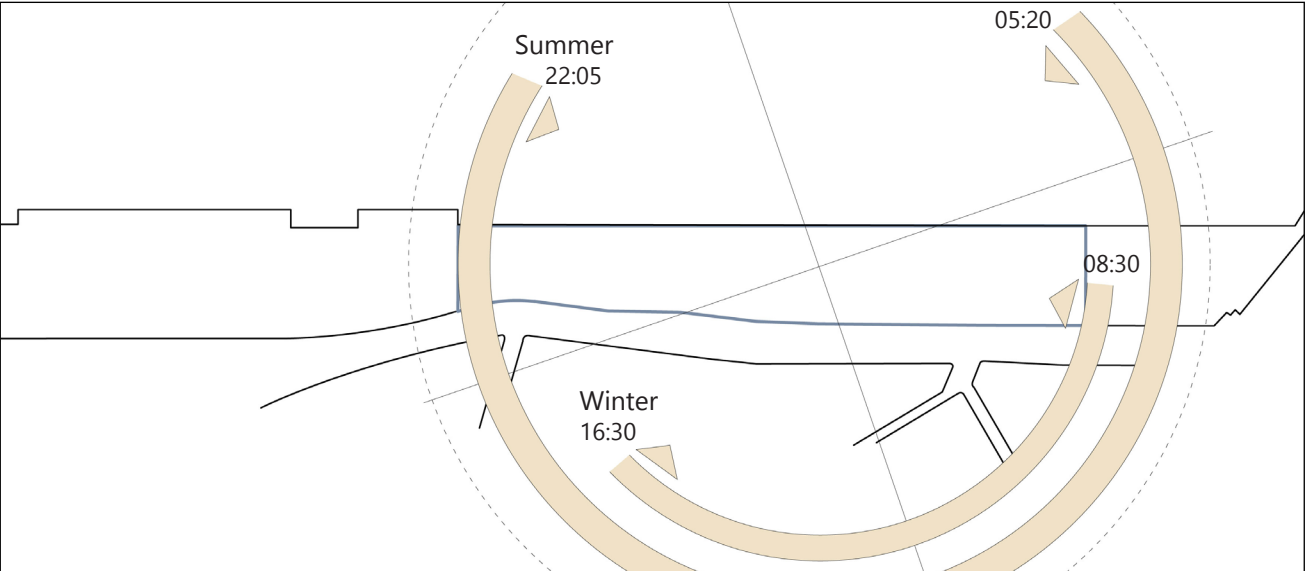
Vistas



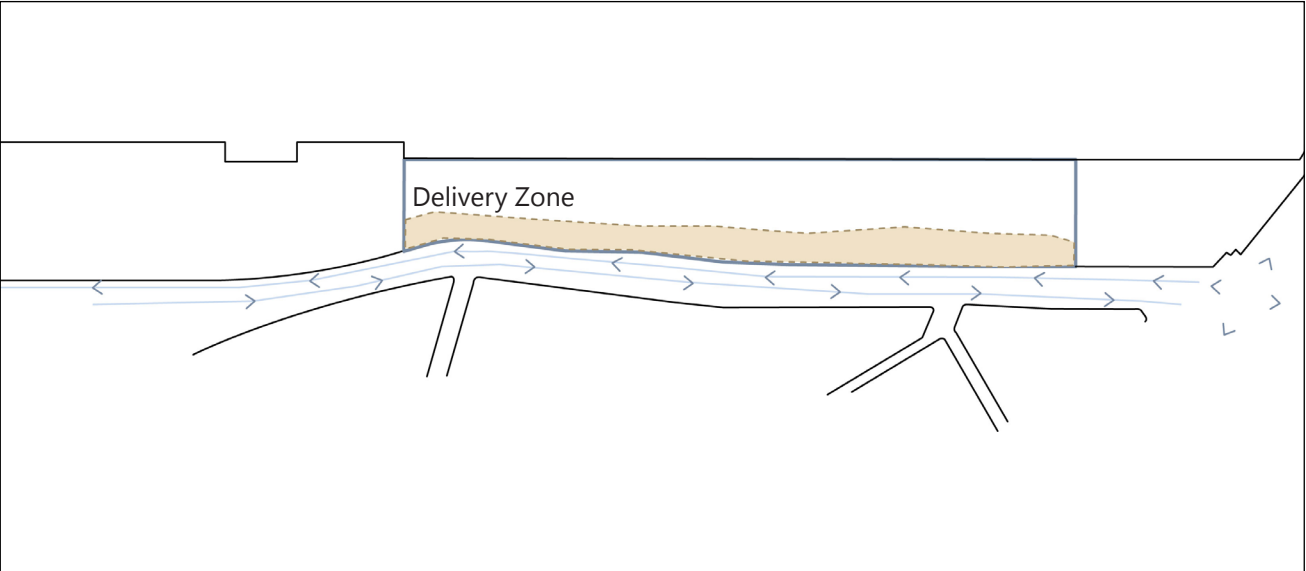
Landmark



Sunpath

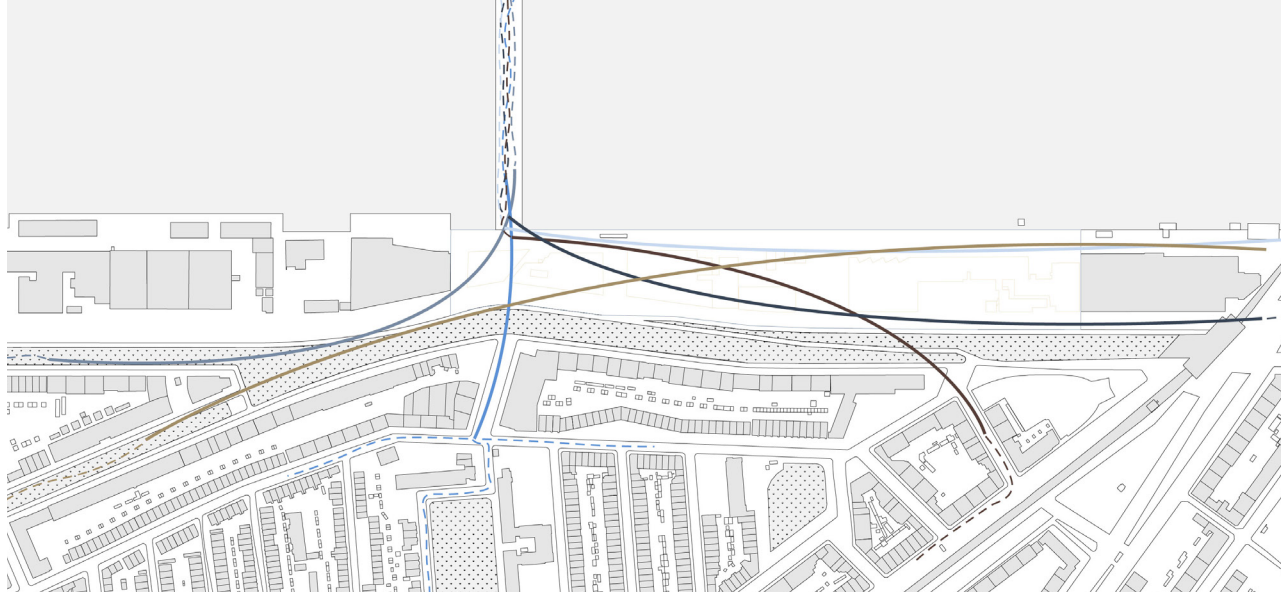


Traffic Flow

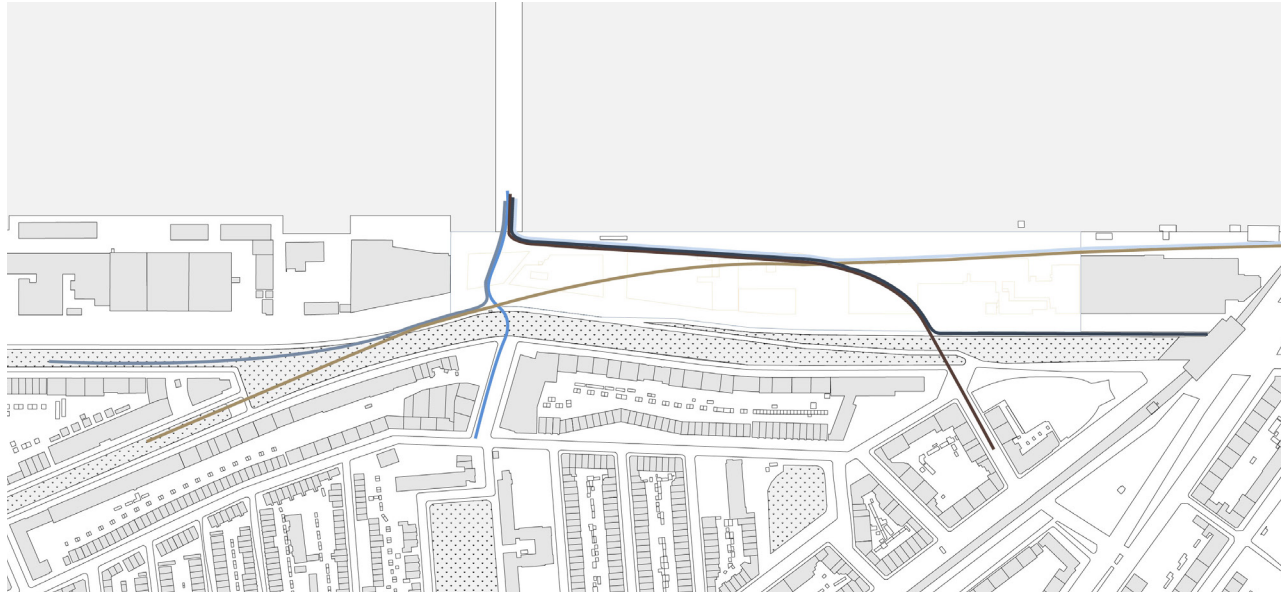




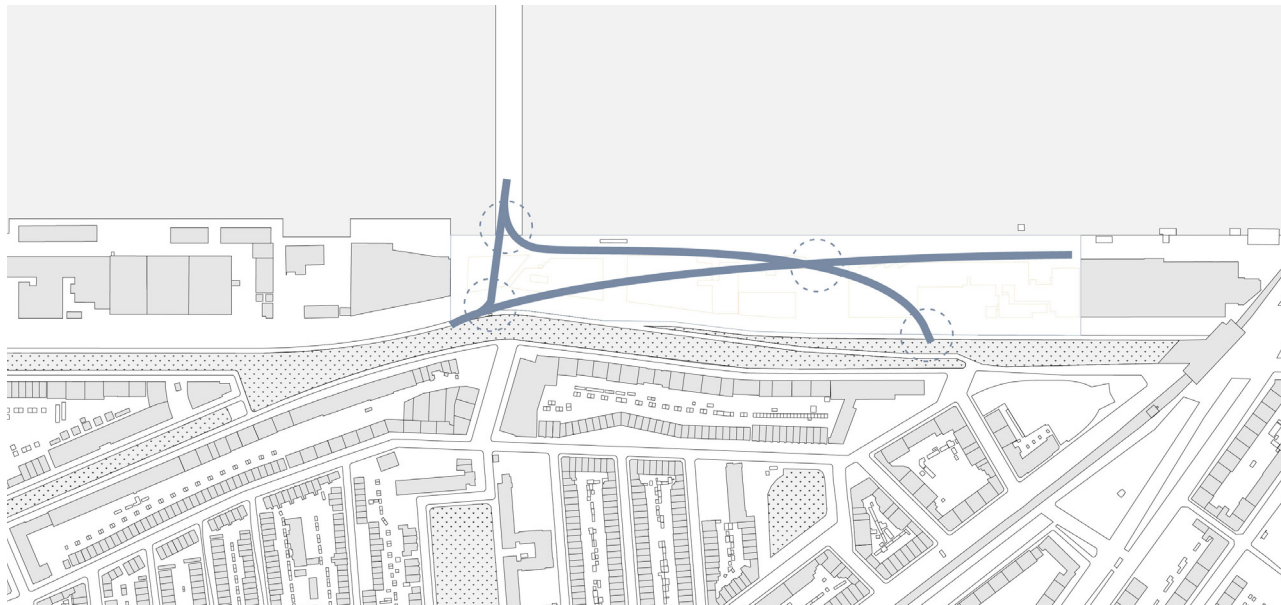
Natural approaches



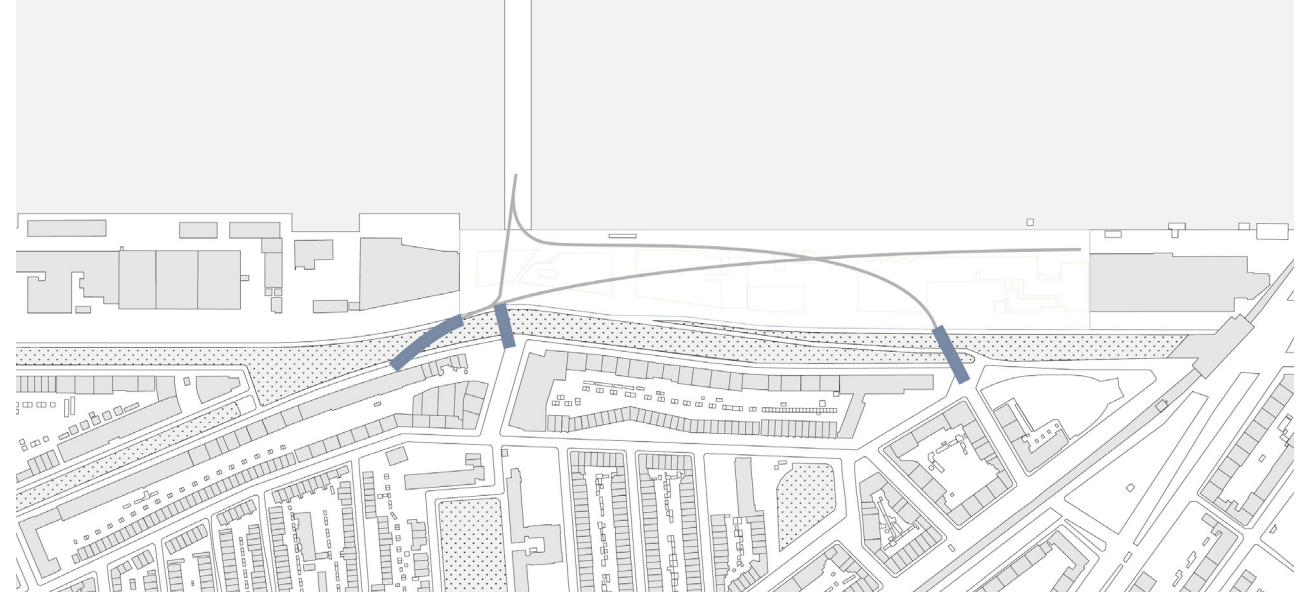
Converge paths



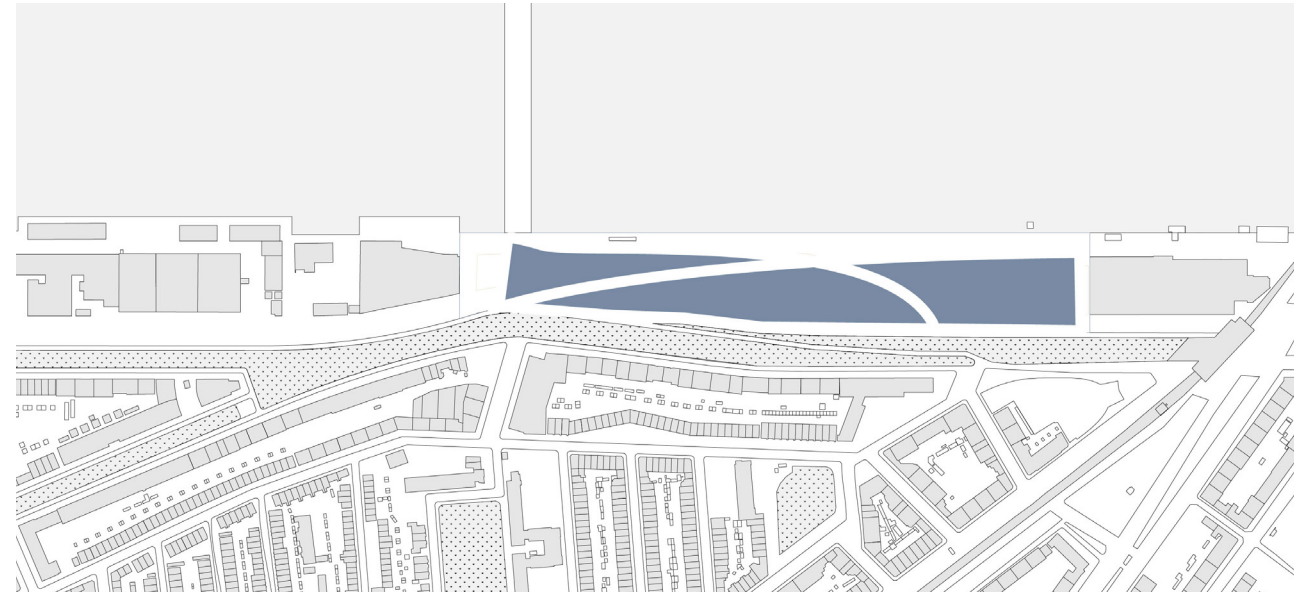
Meeting points



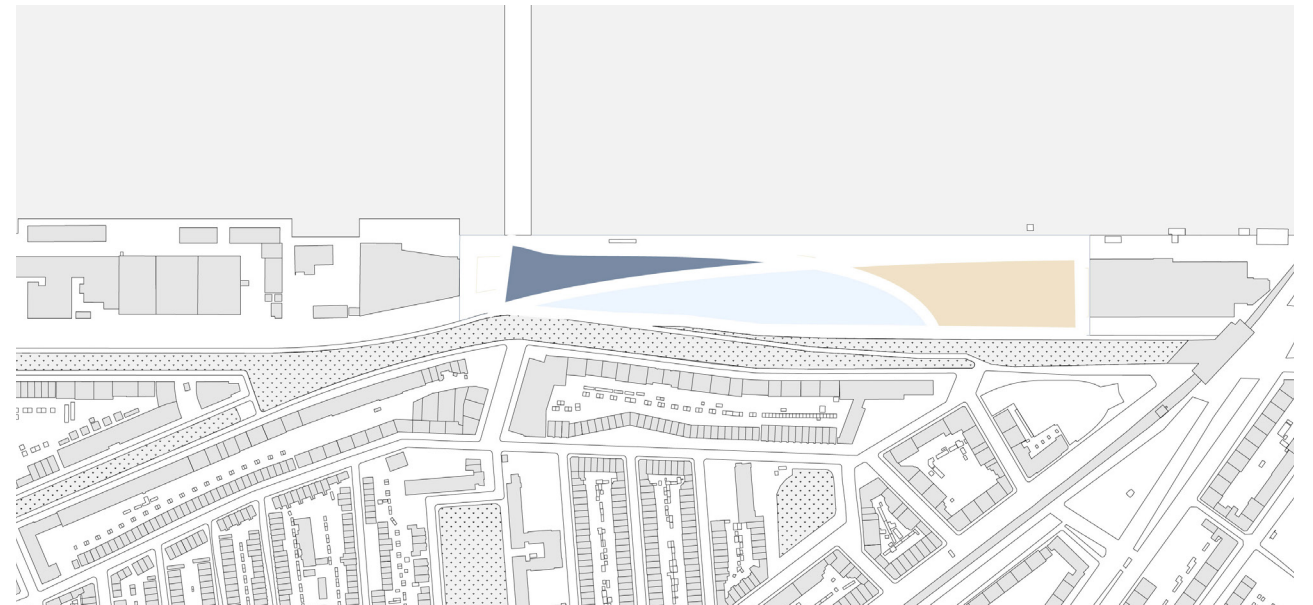
Links



Buildable area



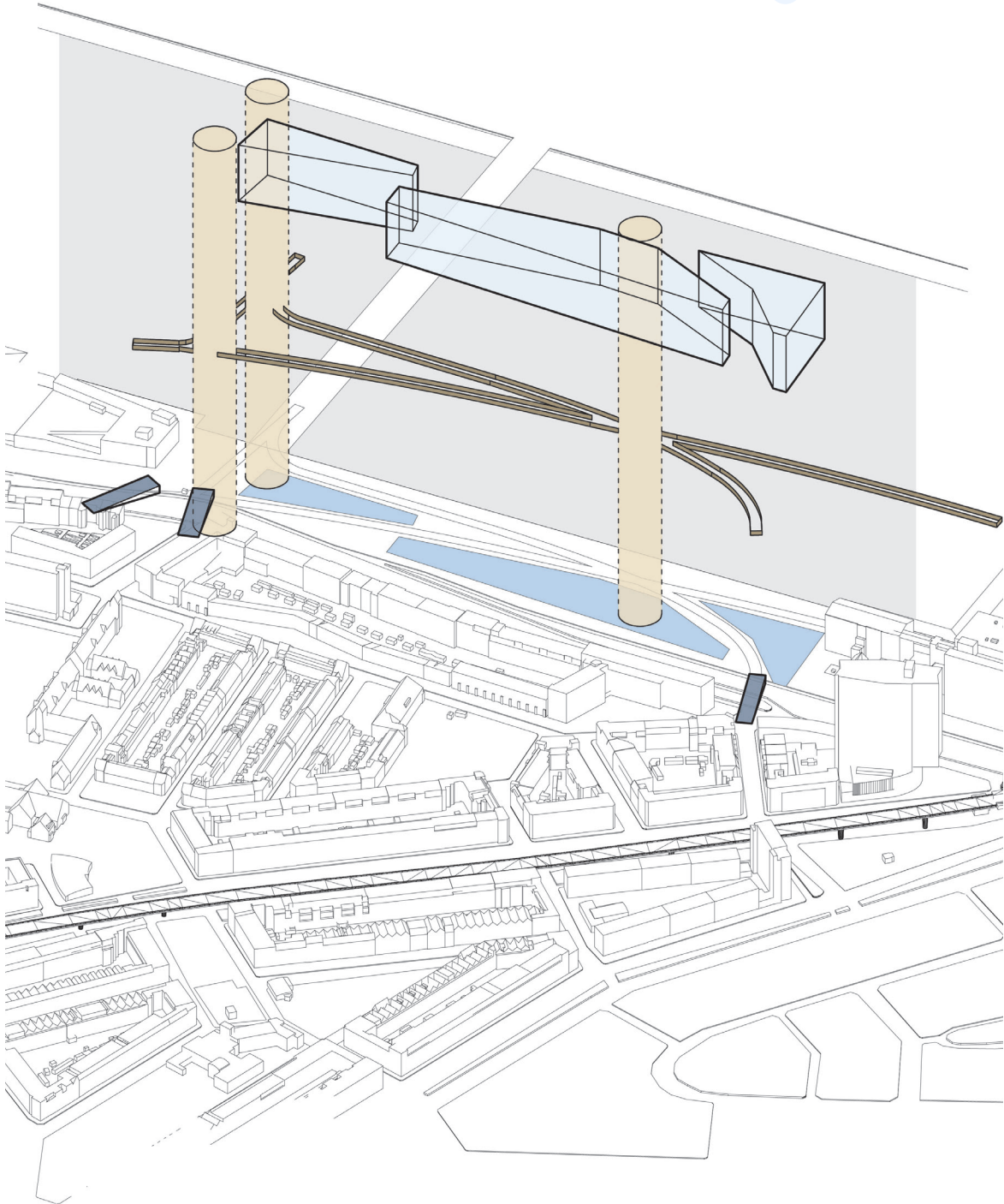
Zone division



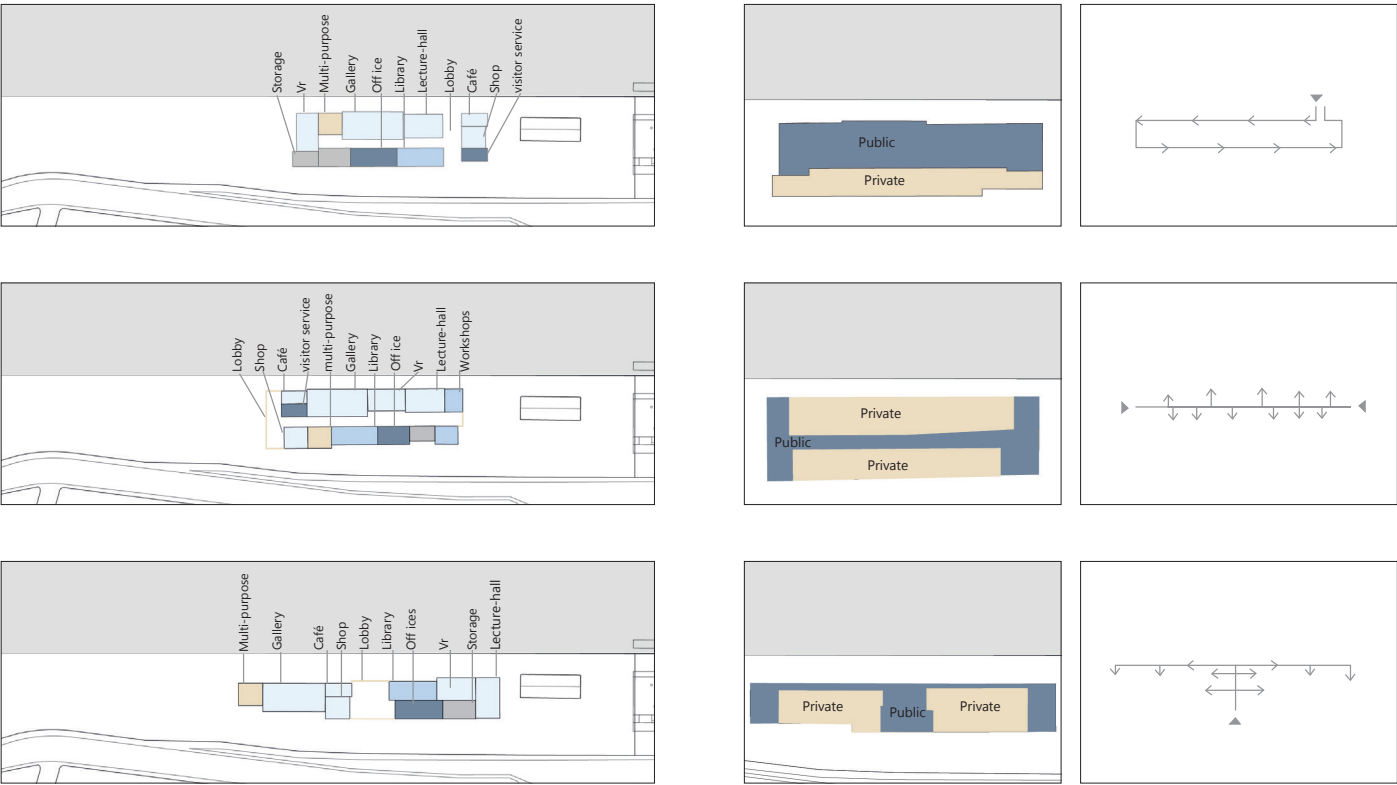
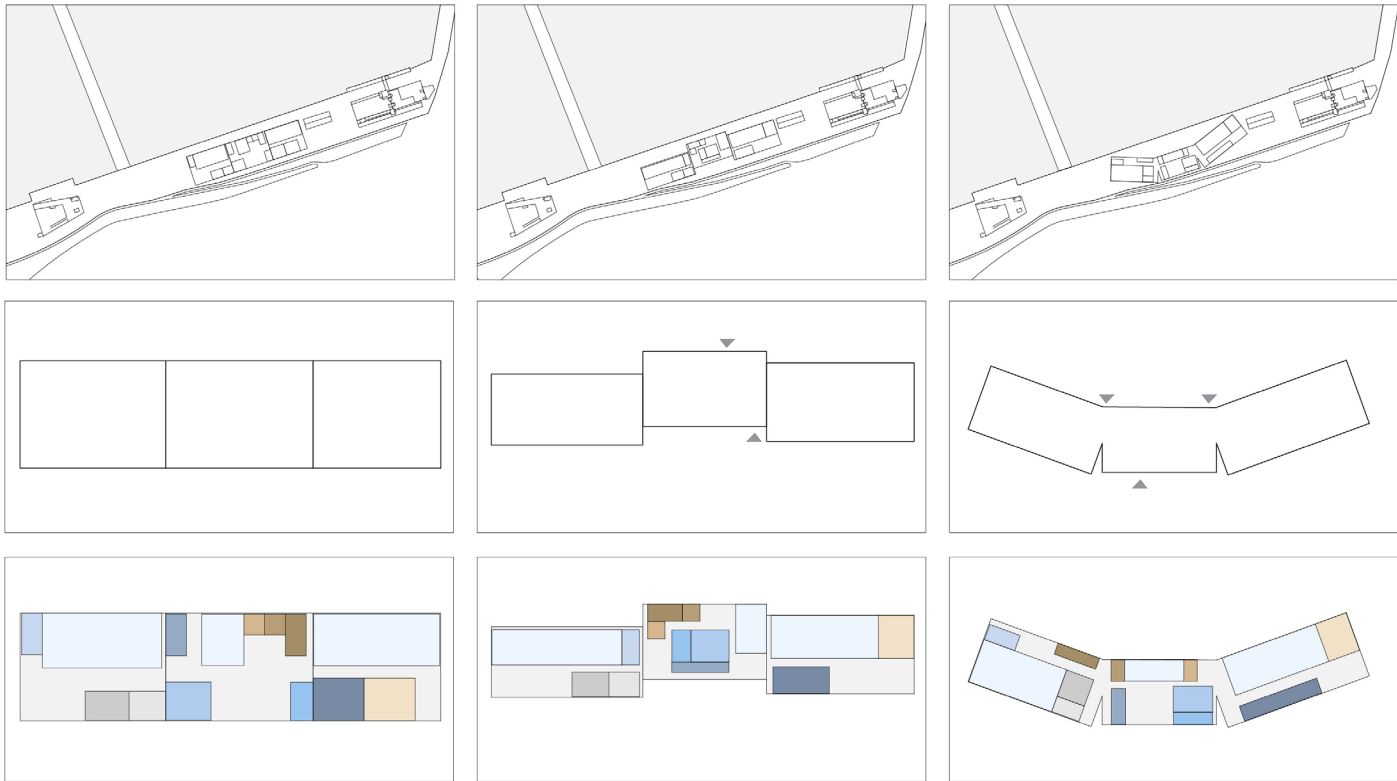
# Design Journal

## Site Strategy

- Key:
- Link to the neighbourhood
  - Meeting point
  - Designated paths
  - Distinct plots
  - Maximum volumes



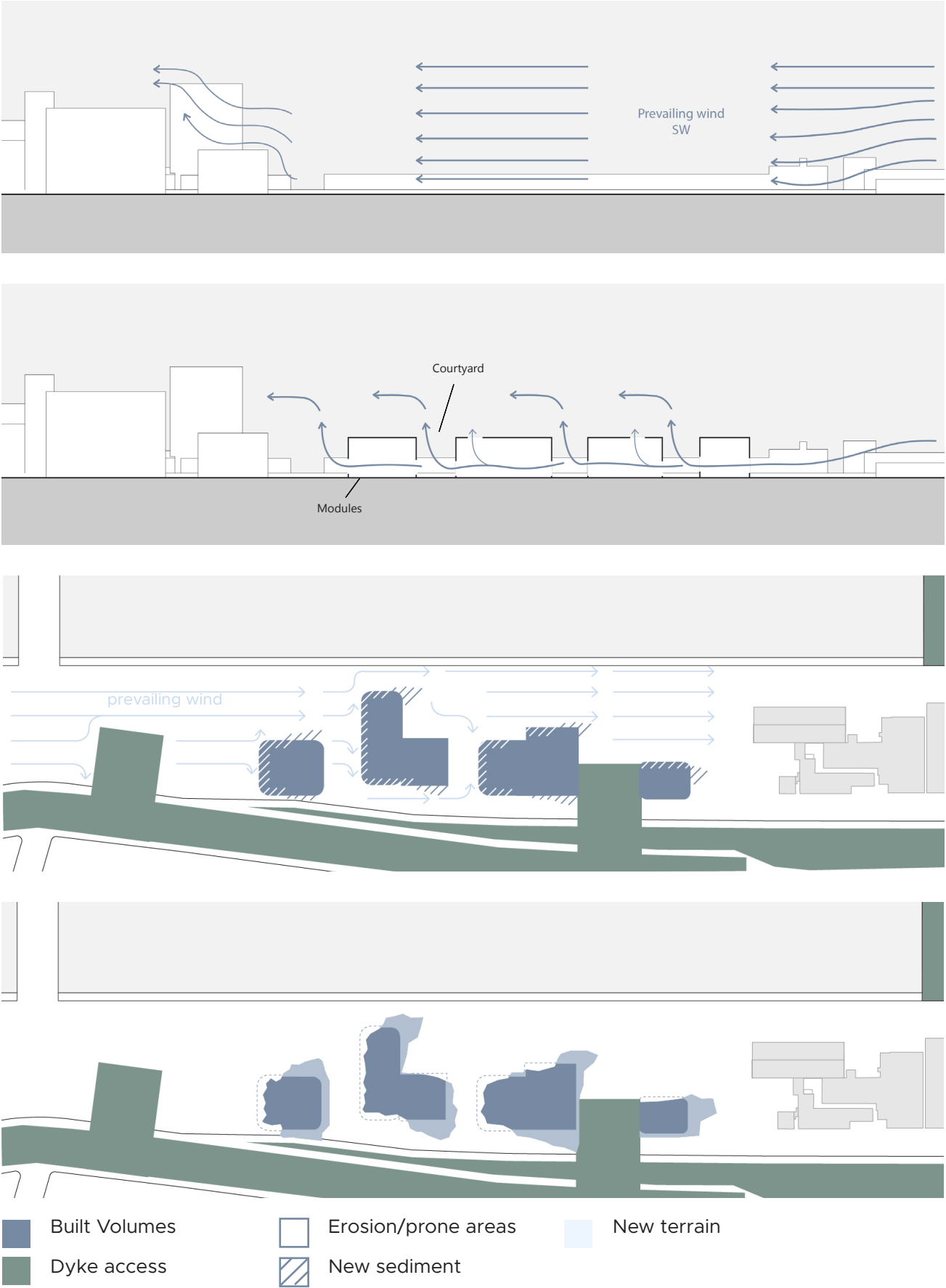
## Program Iterations



- |                  |                  |               |
|------------------|------------------|---------------|
| Exhibition space | Visitor services | Multi-purpose |
| Library/ archive | Offices          | Shop          |
| Lecture Hall     | Storage          | Café          |
| Workshops        | Loading bay      | Restaurant    |



Design Journal

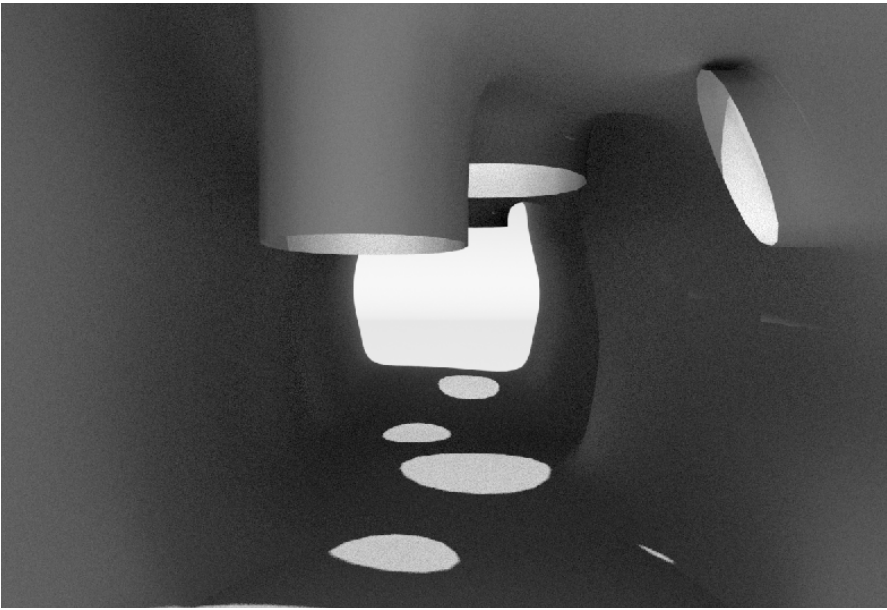
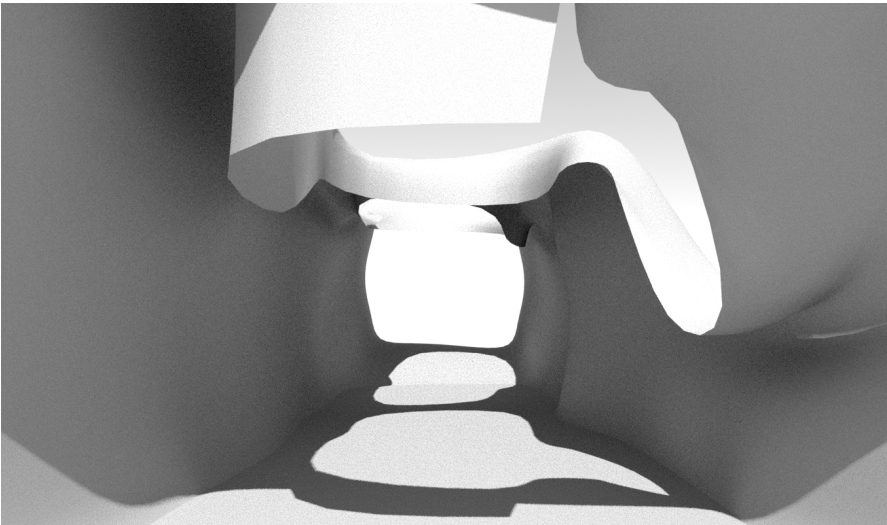
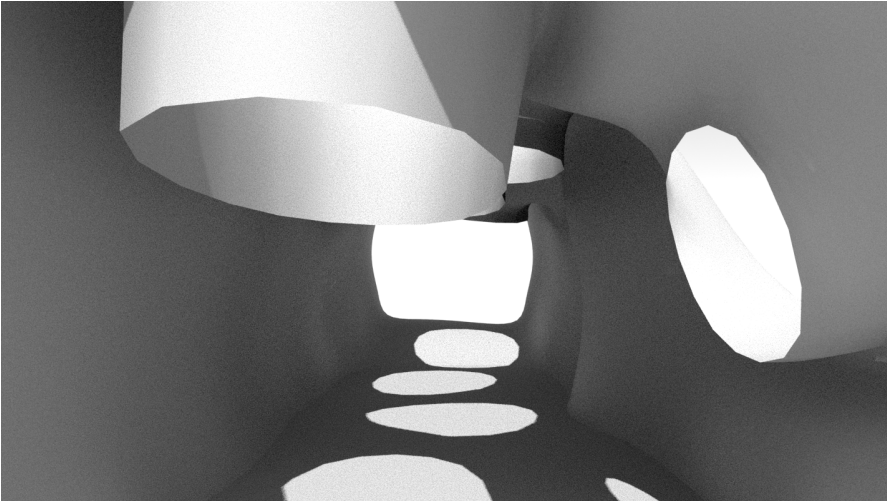
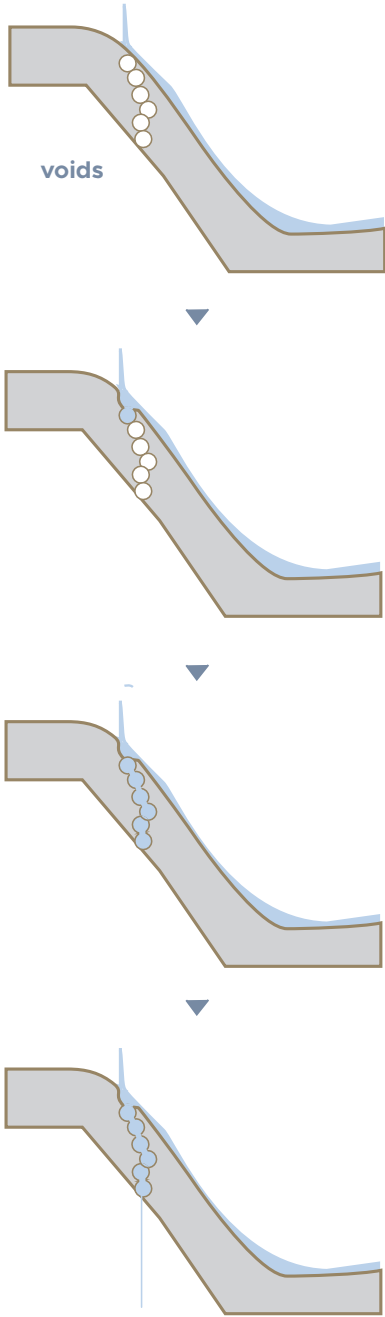
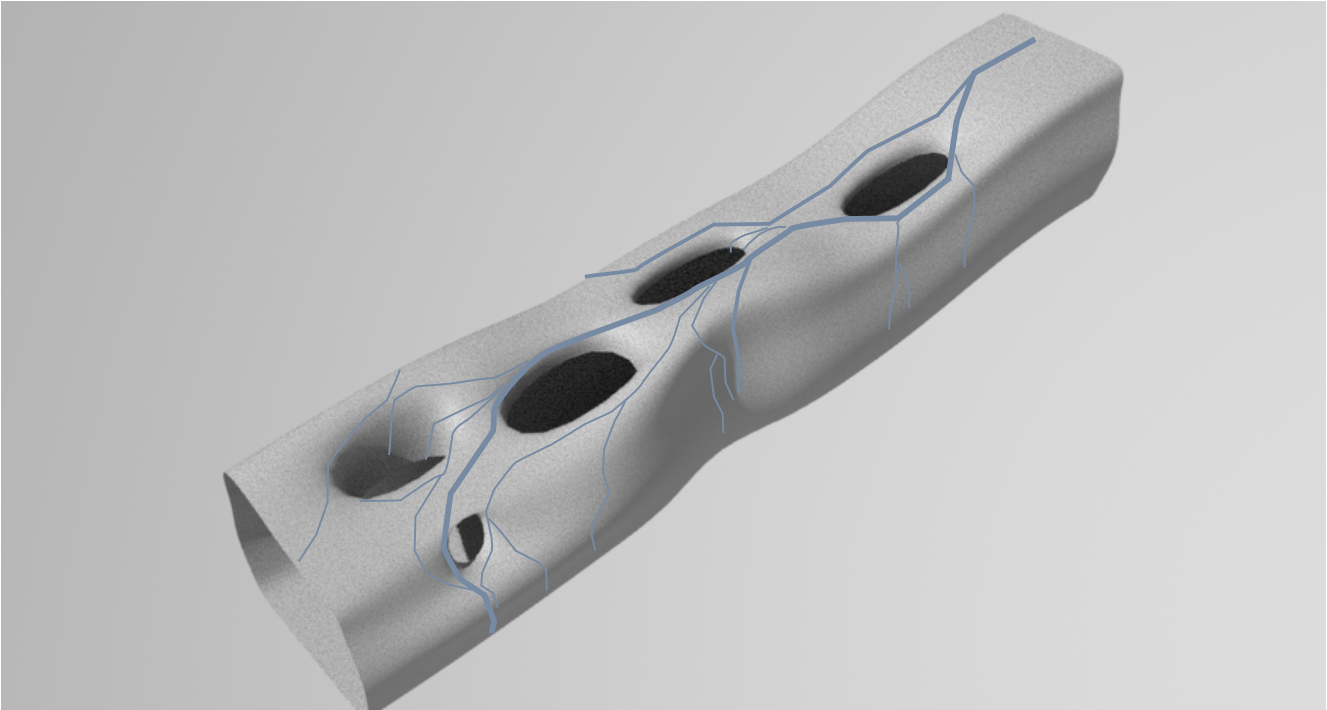
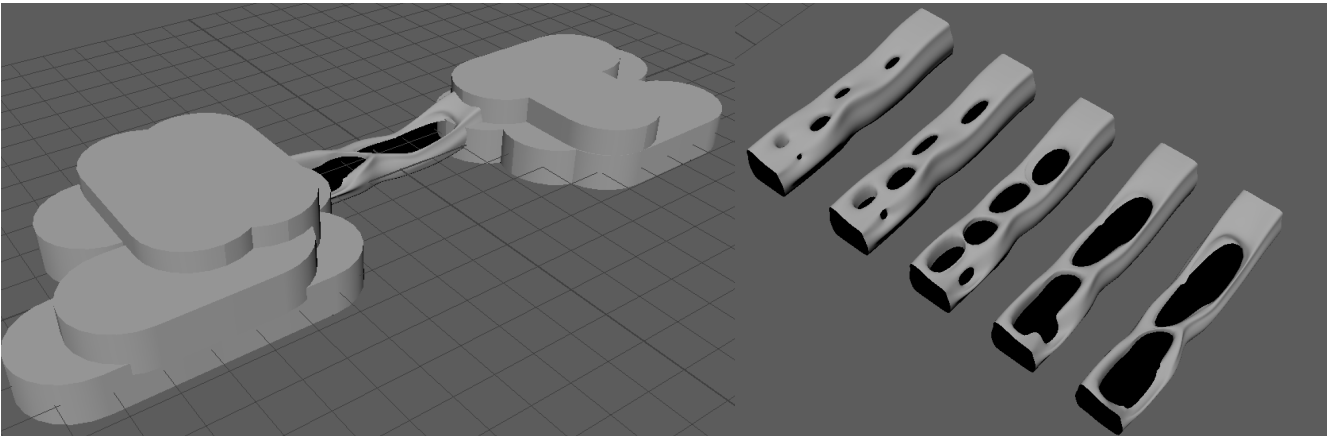
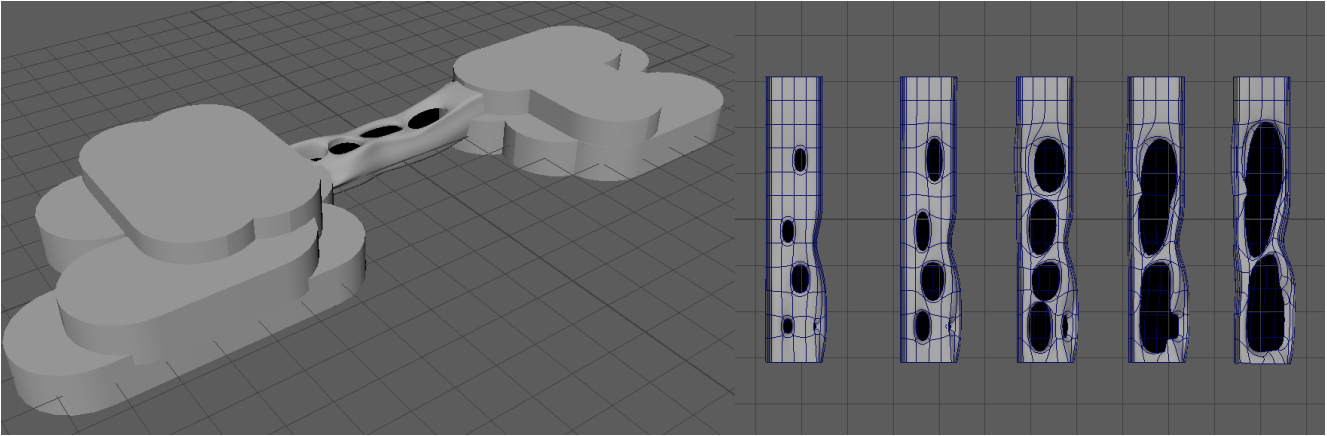


wind rose



# Schematic Design

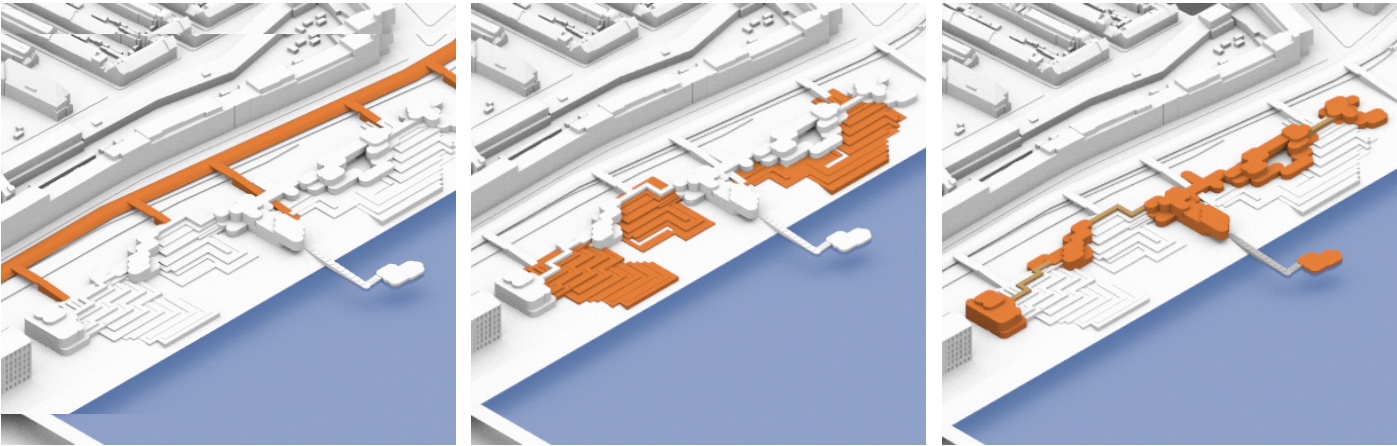
## Erosion pattern simulation





# Schematic Design

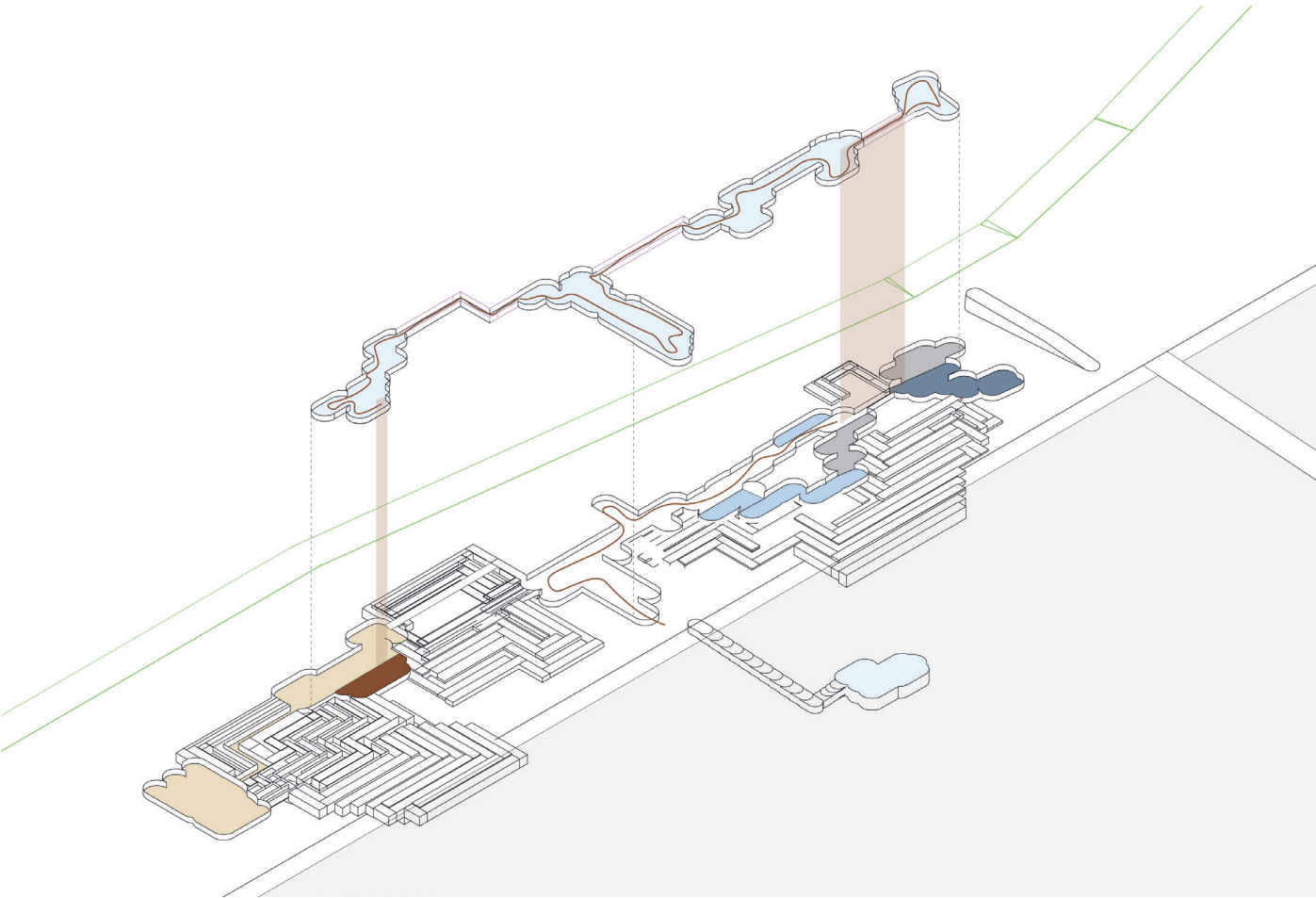
## Site Strategy



Access to the site

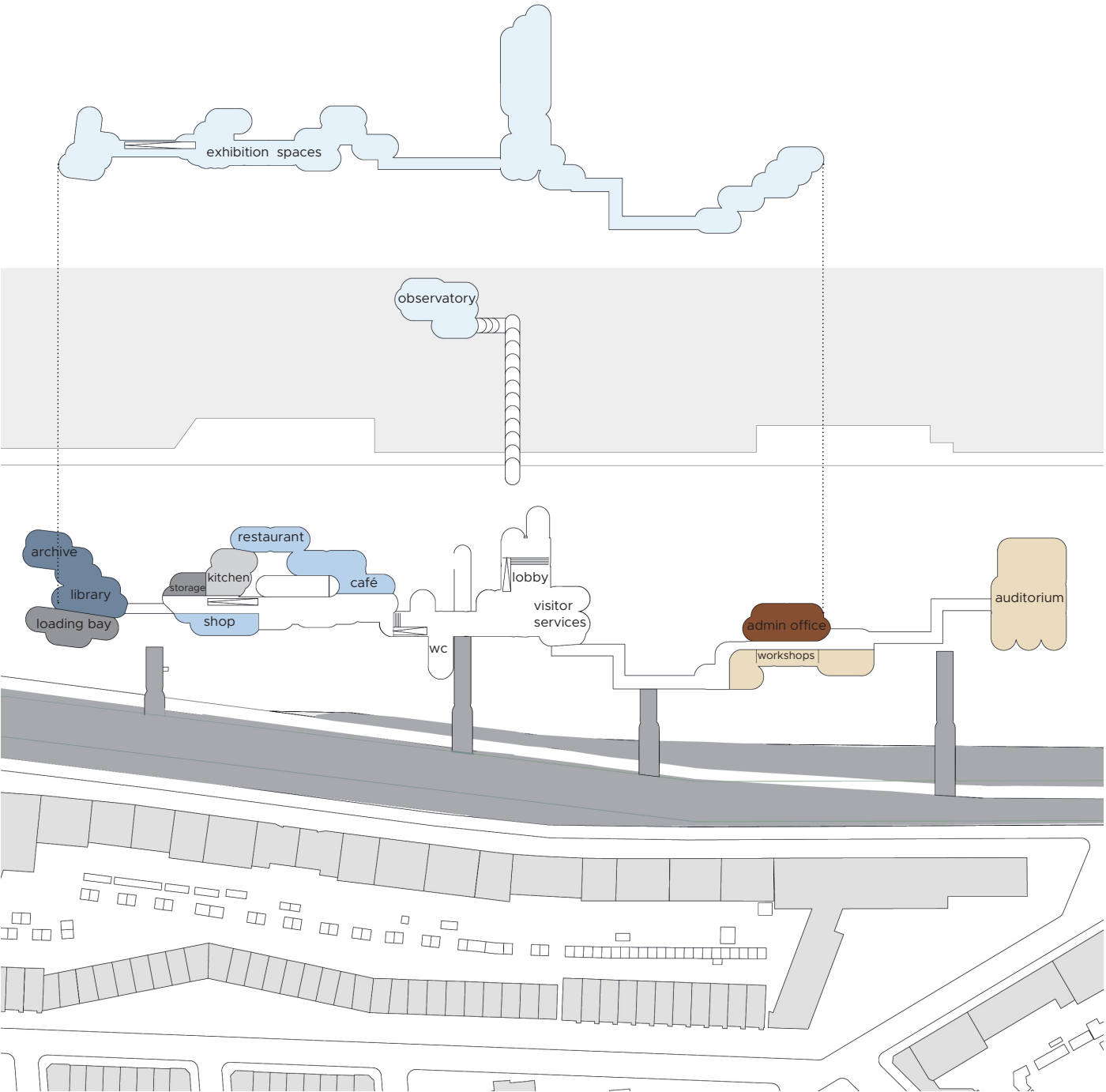
Erodable Landscape

Climatised Pavillions



- Multi purpose rooms
- Recreational Spaces
- Commercial spaces
- Educational Spaces
- Administrative Spaces
- Logistical Spaces

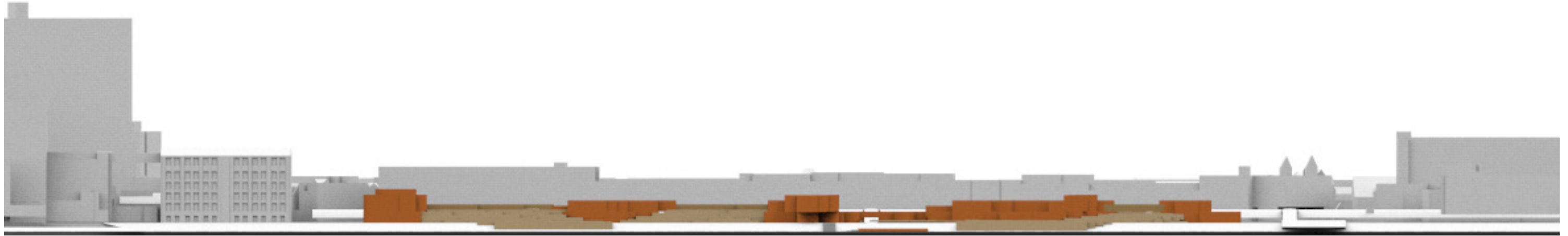
## Program



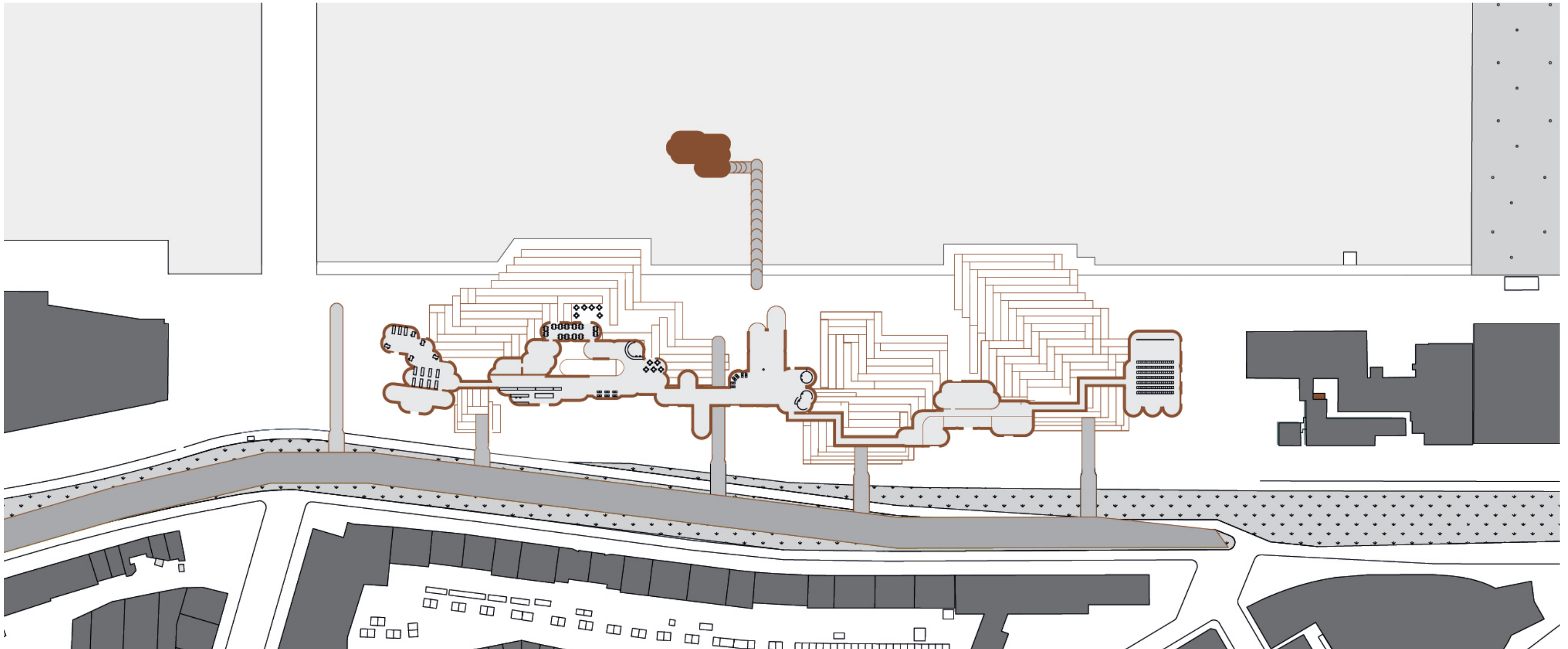


# Schematic Design

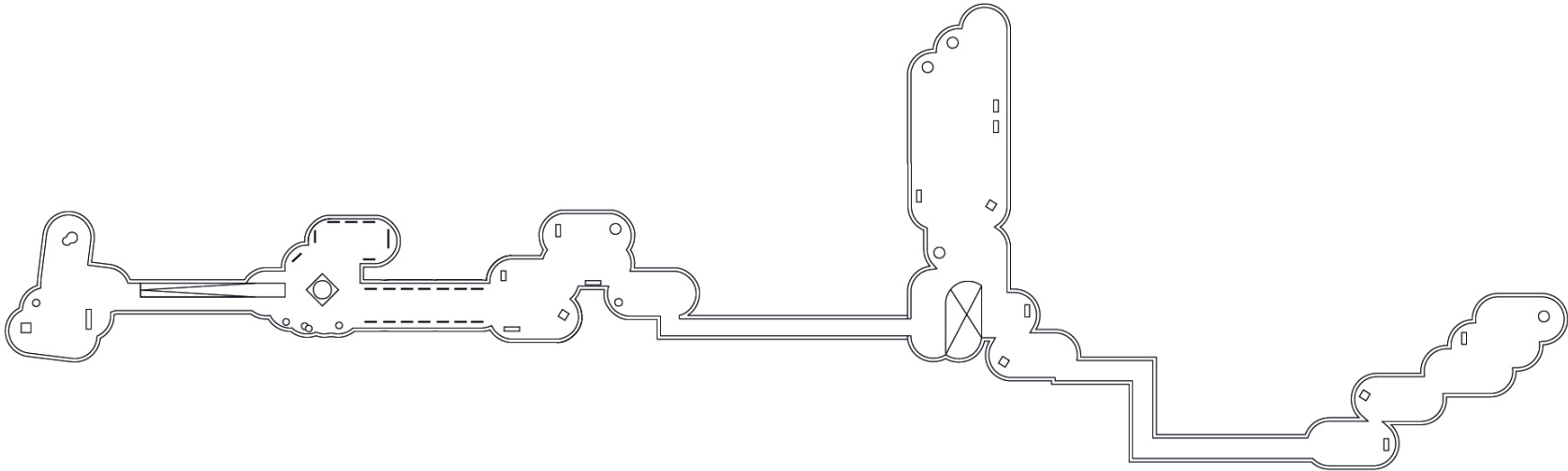
## Site Elevation



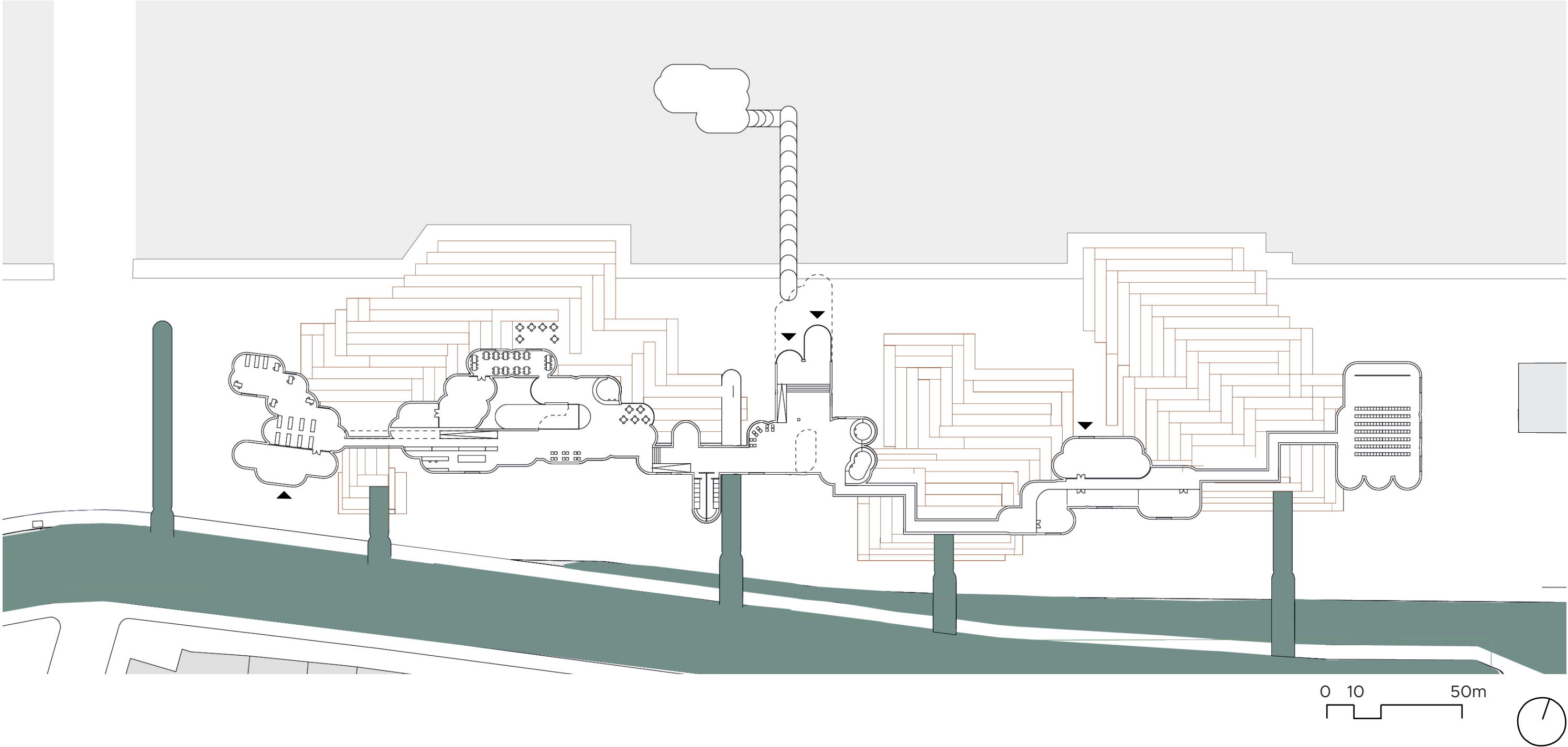
## Site plan



First Floor Plan



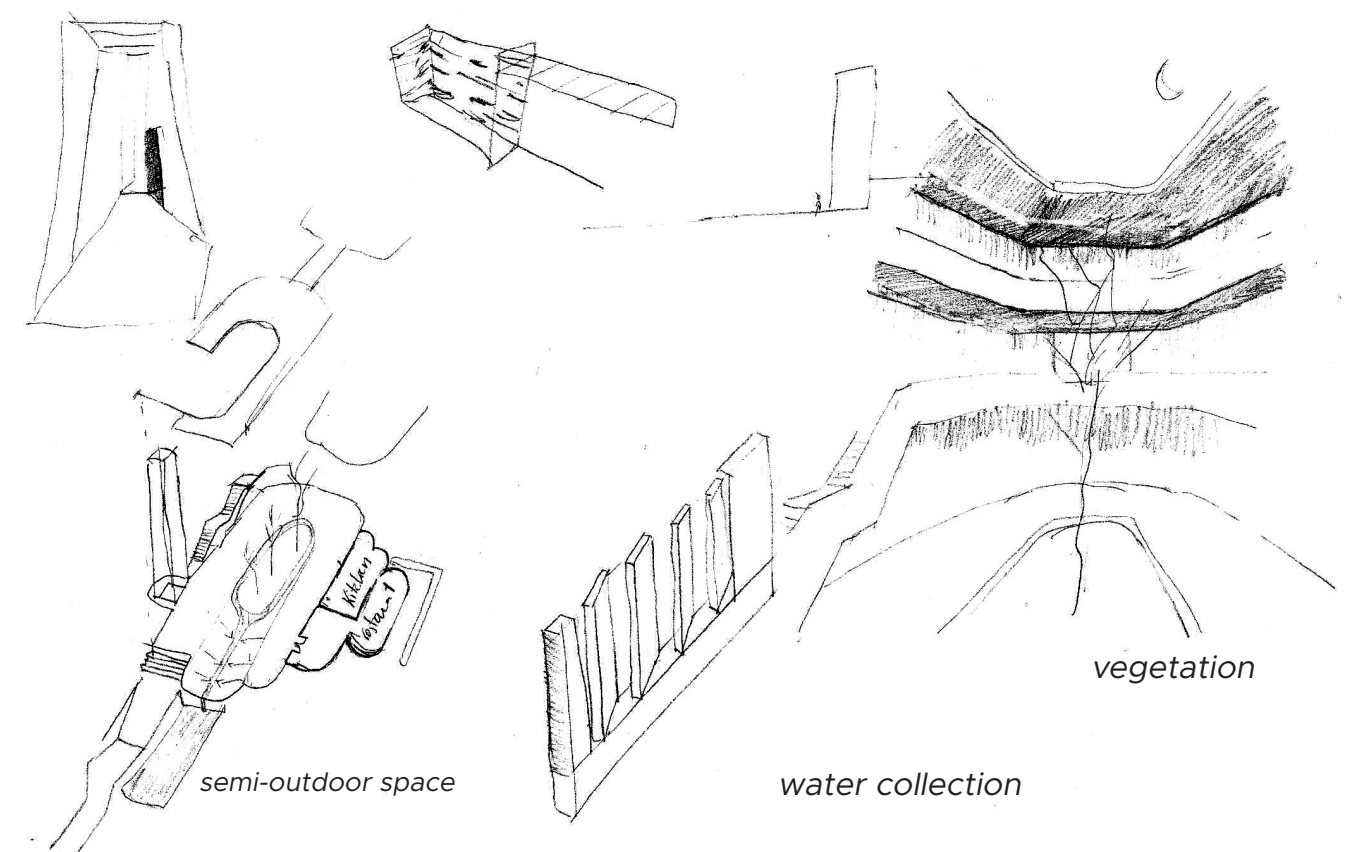
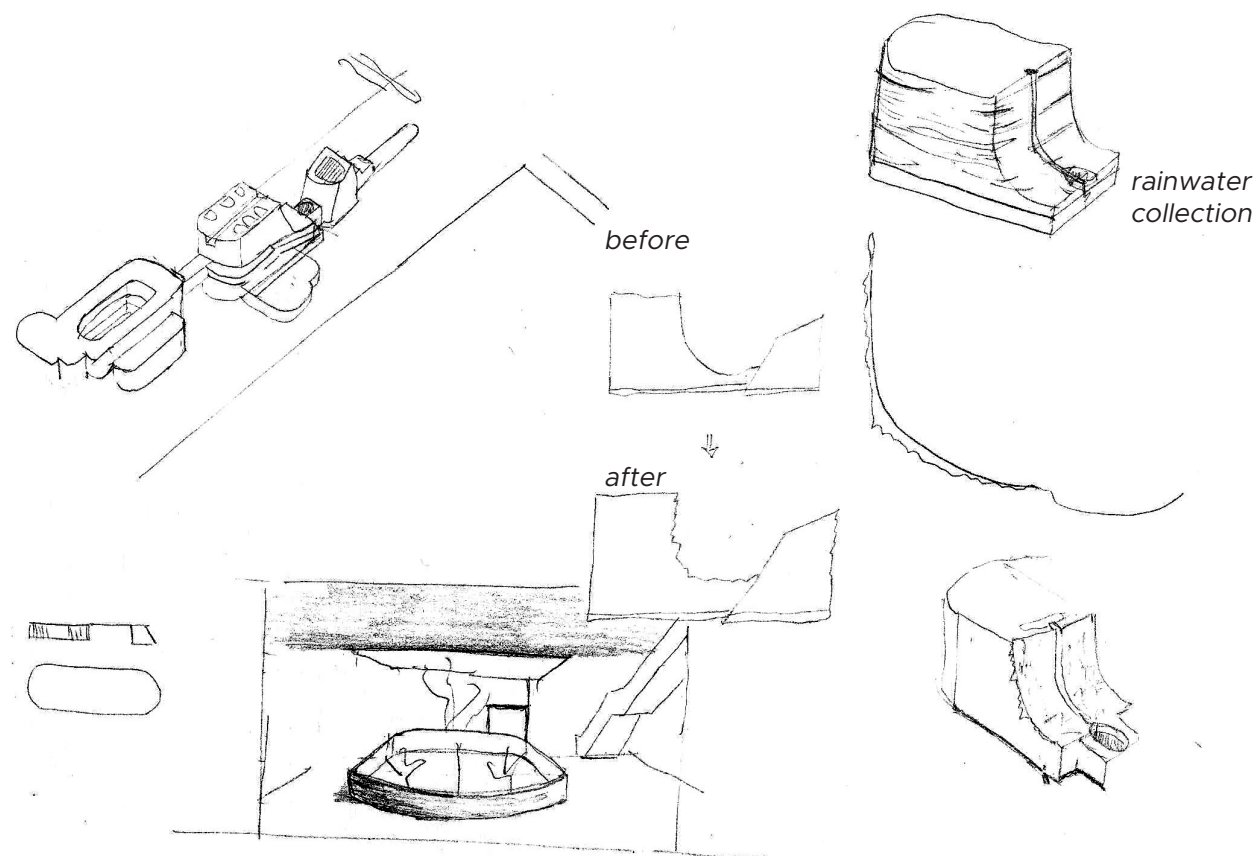
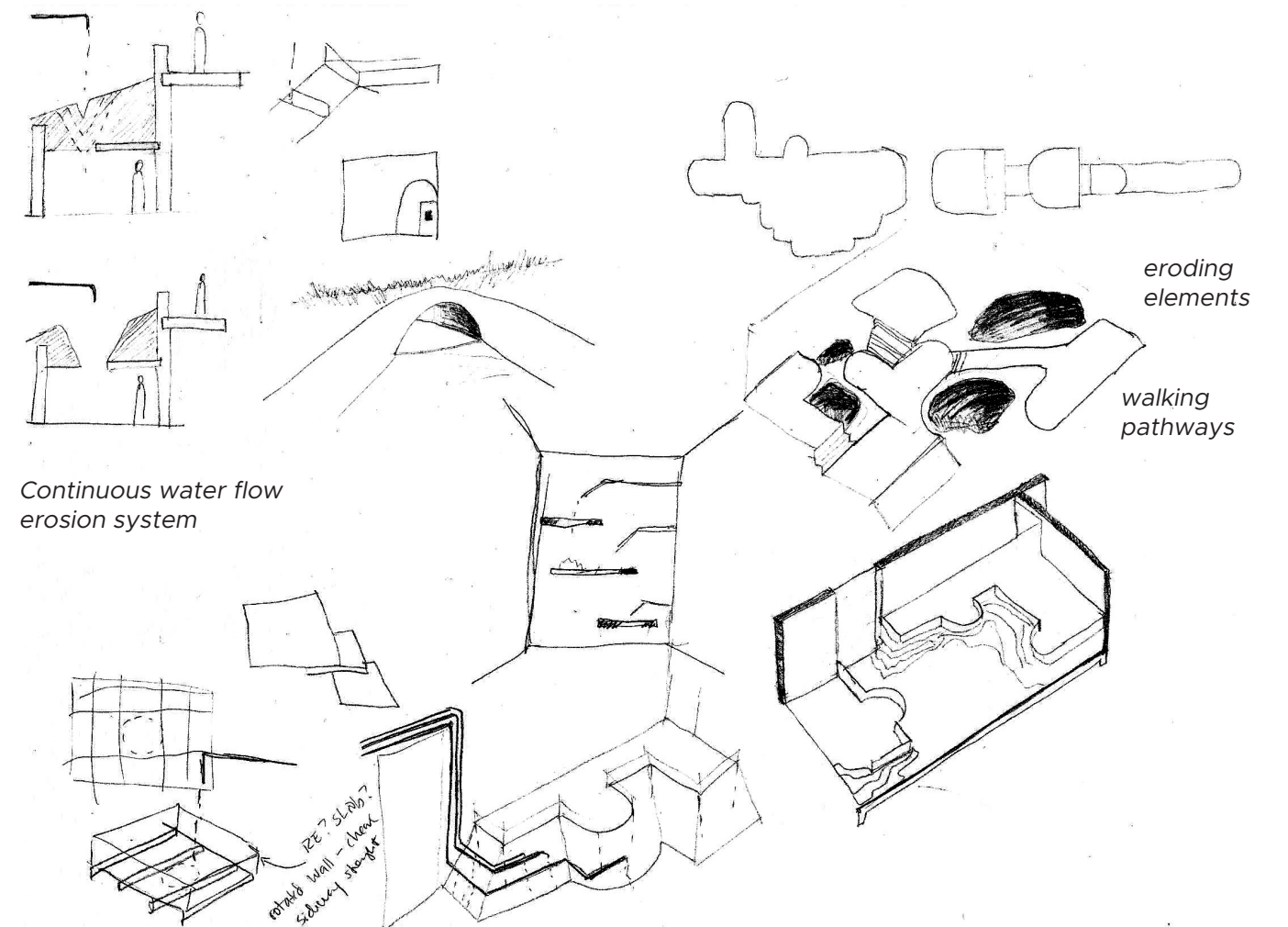
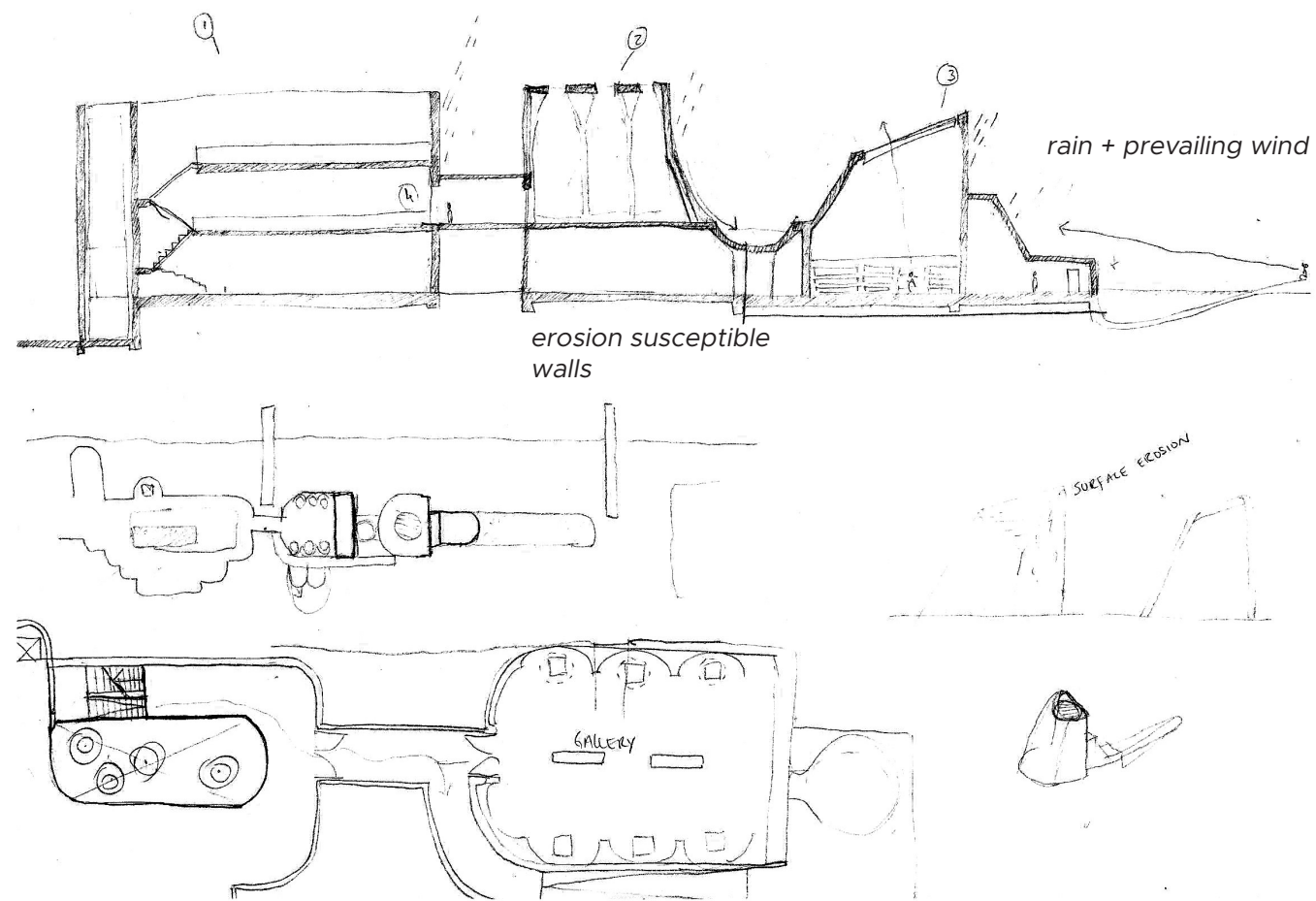
Ground Floor Plan





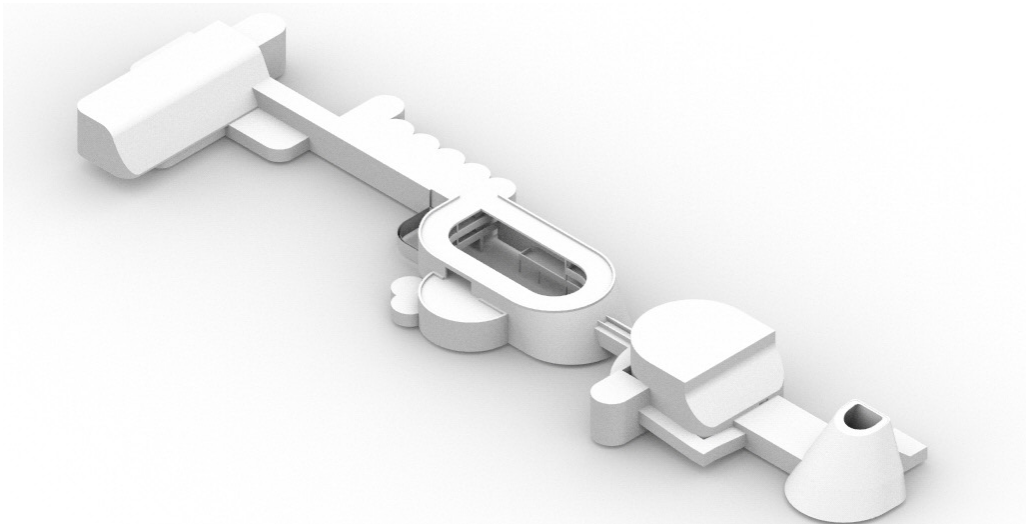


# External erosion

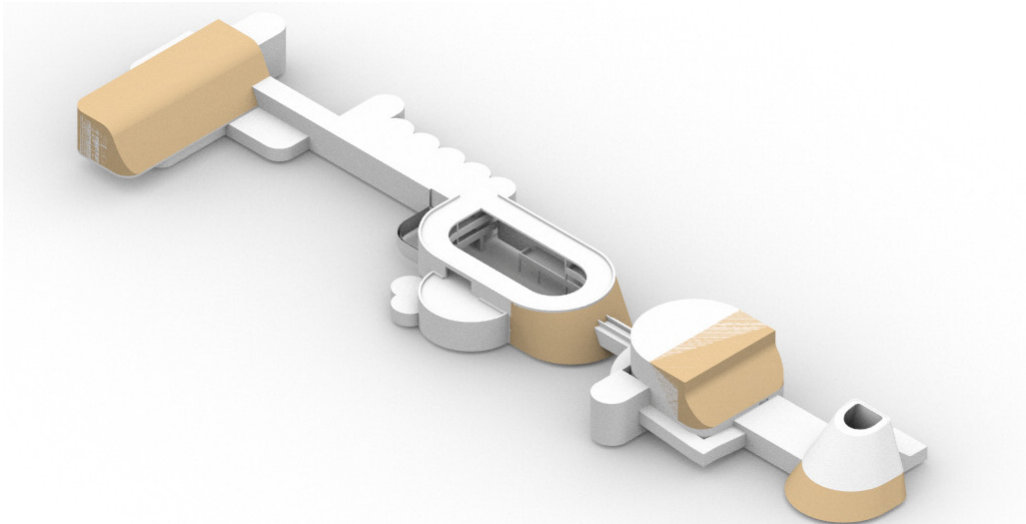


Erodable Volumes

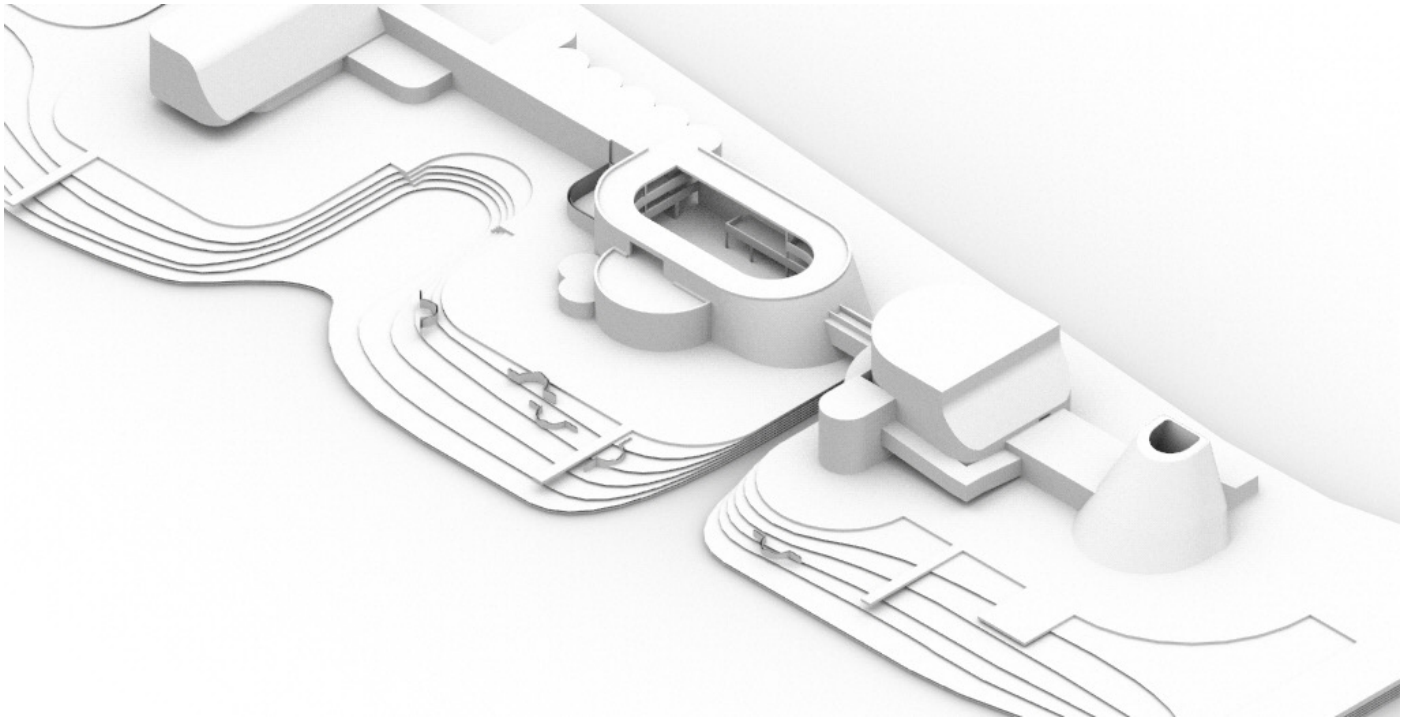
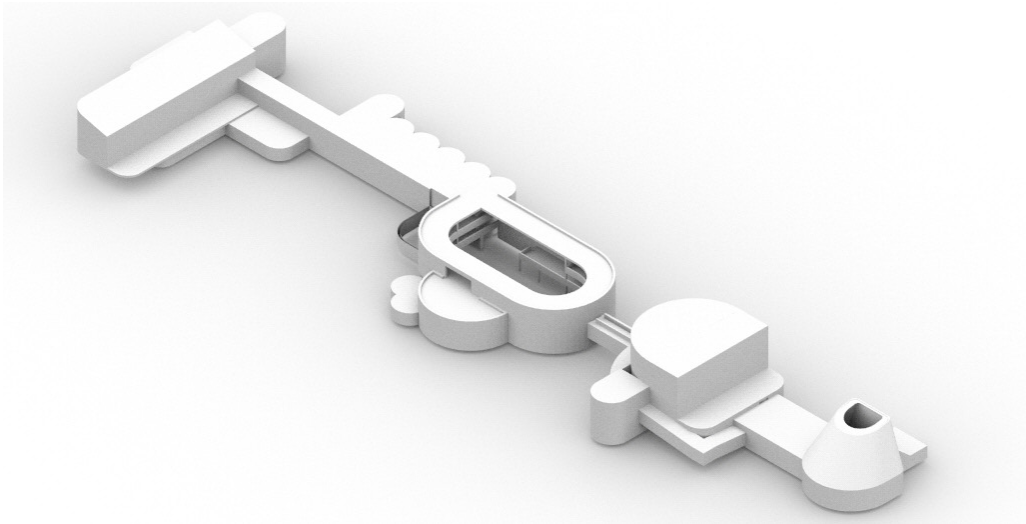
1



2

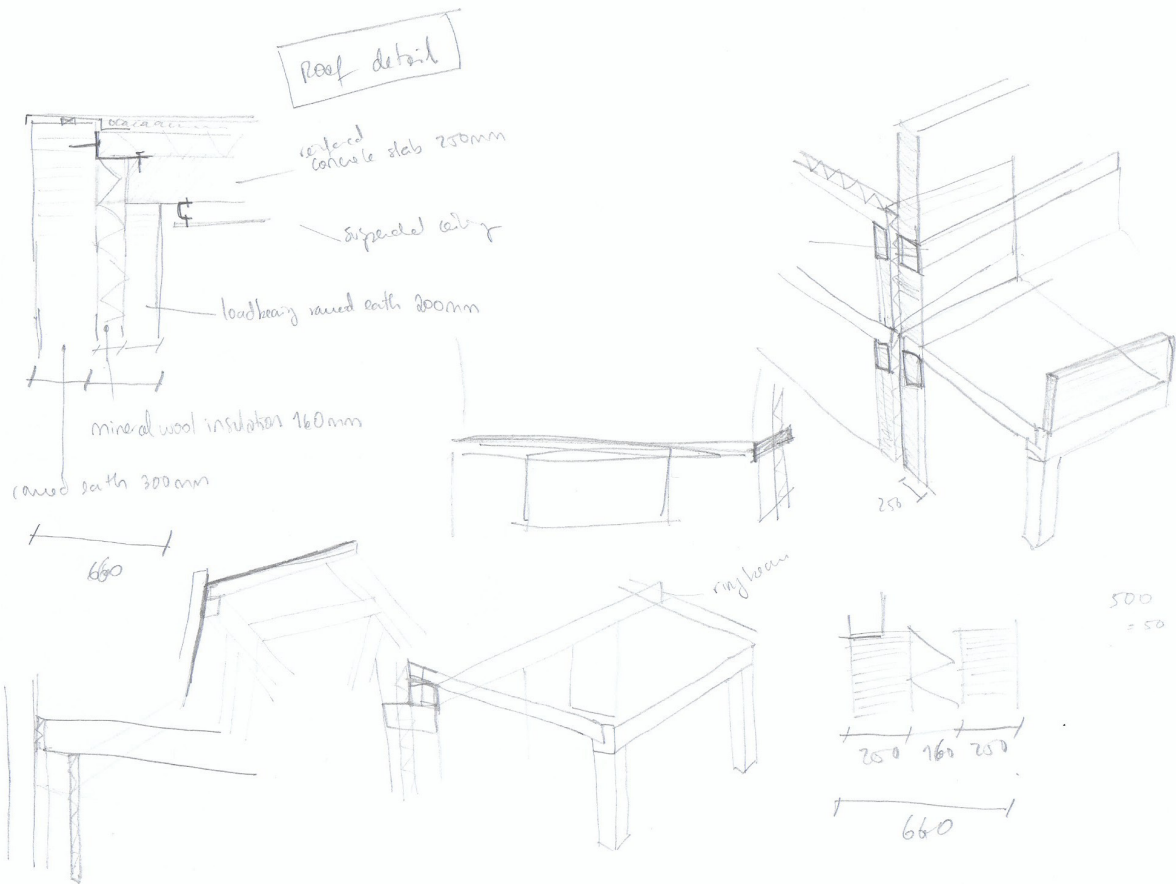
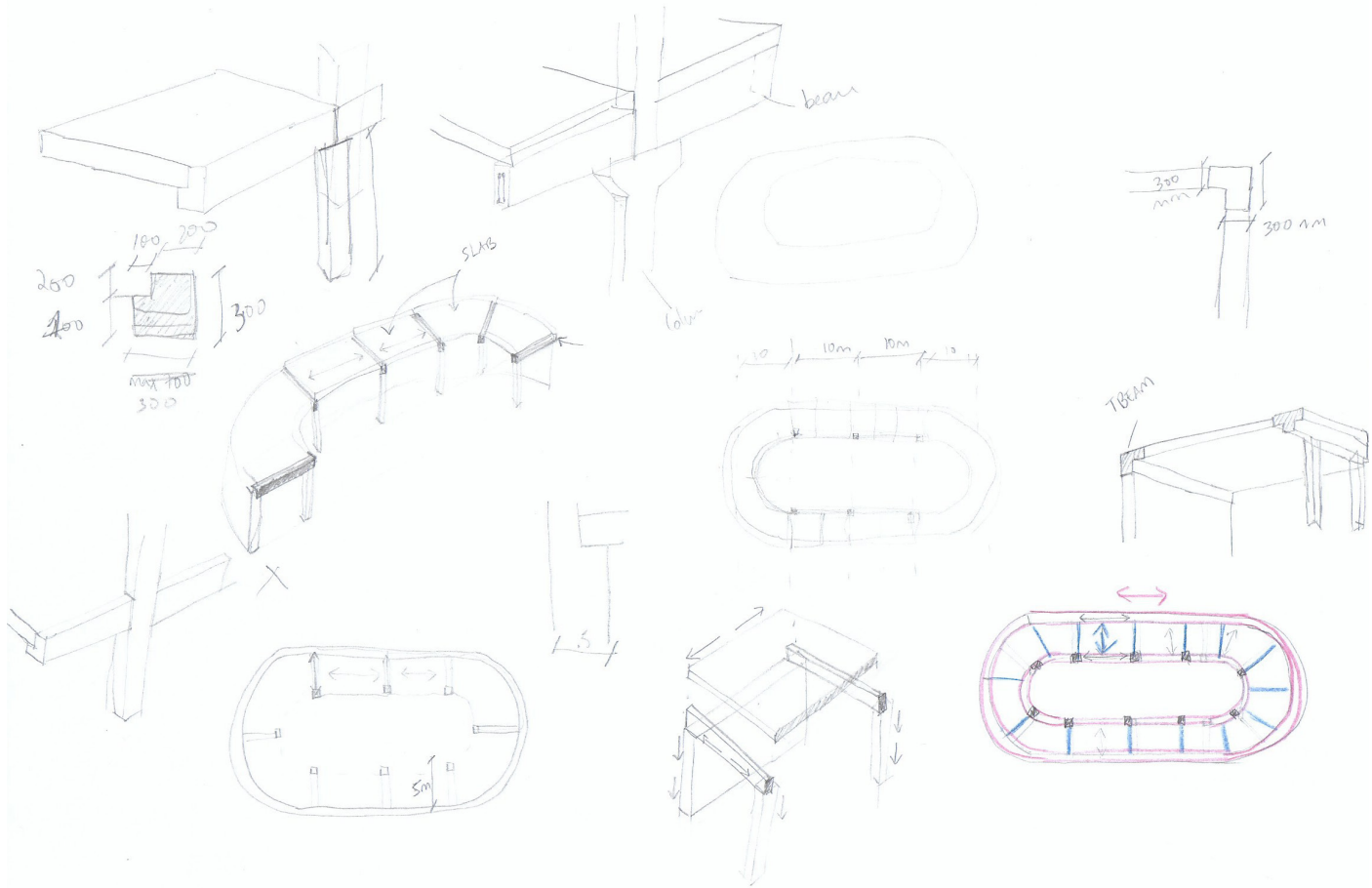
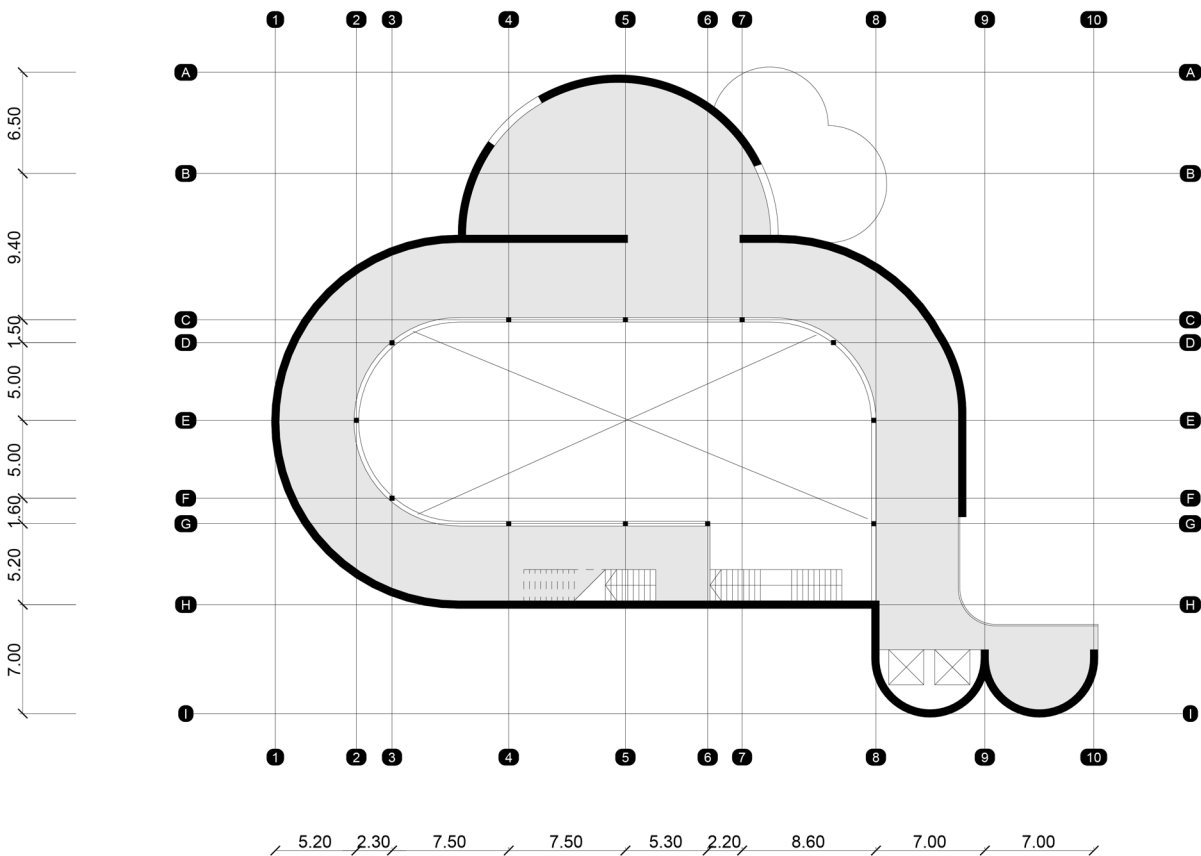
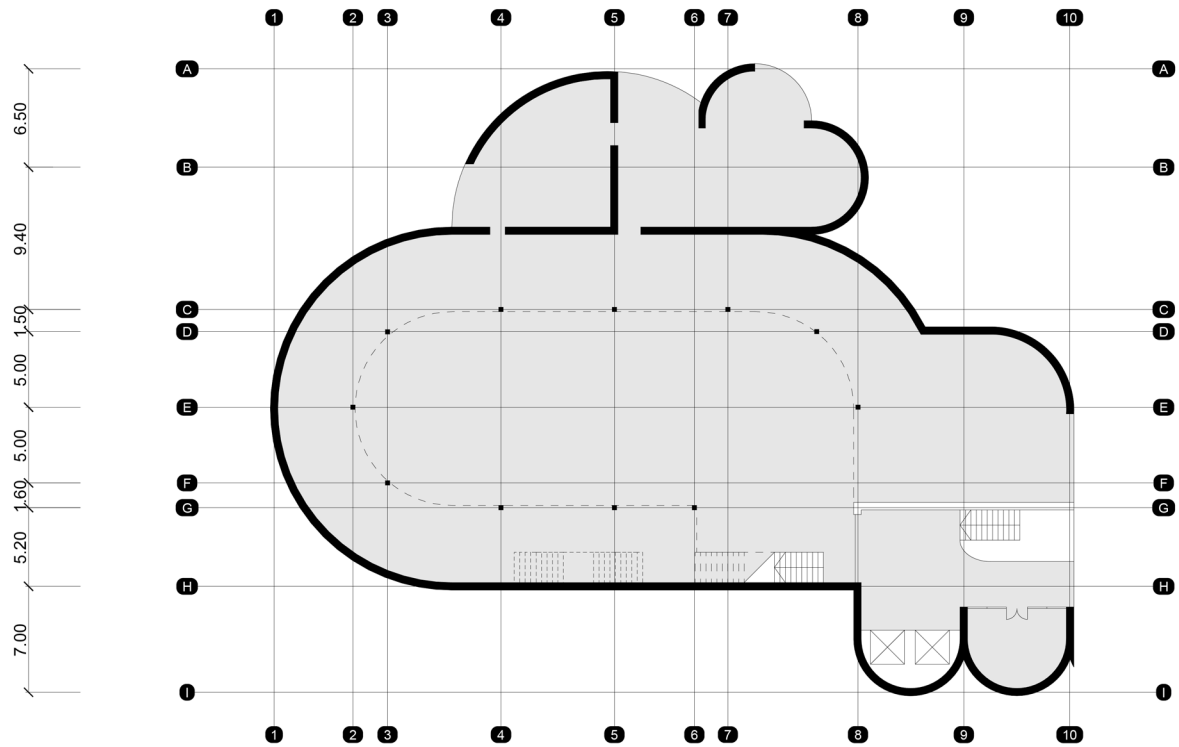


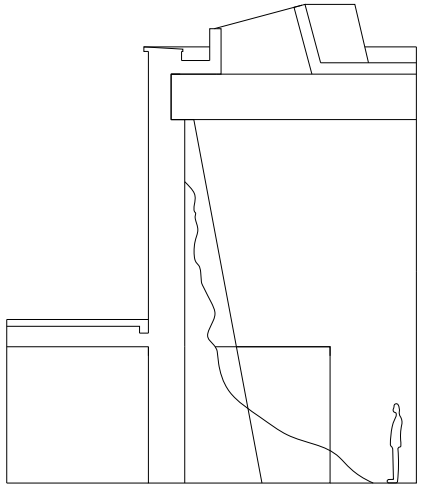
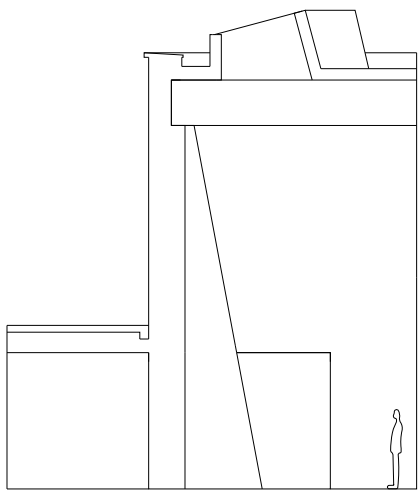
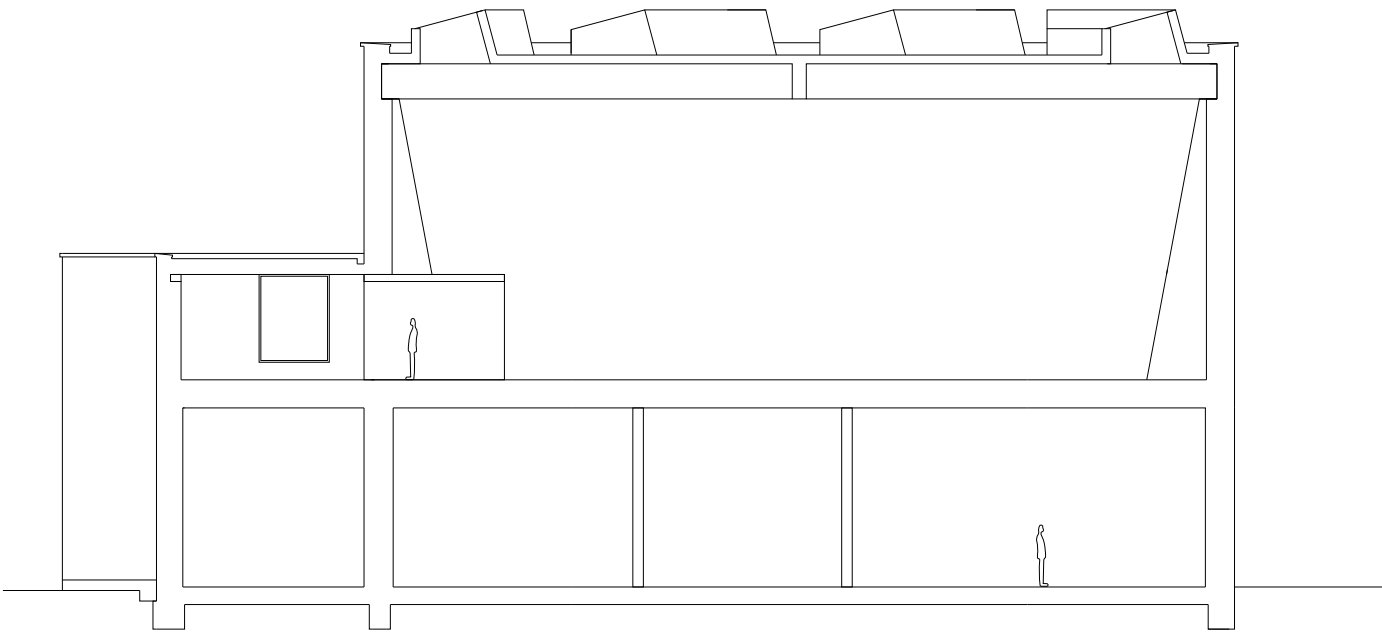
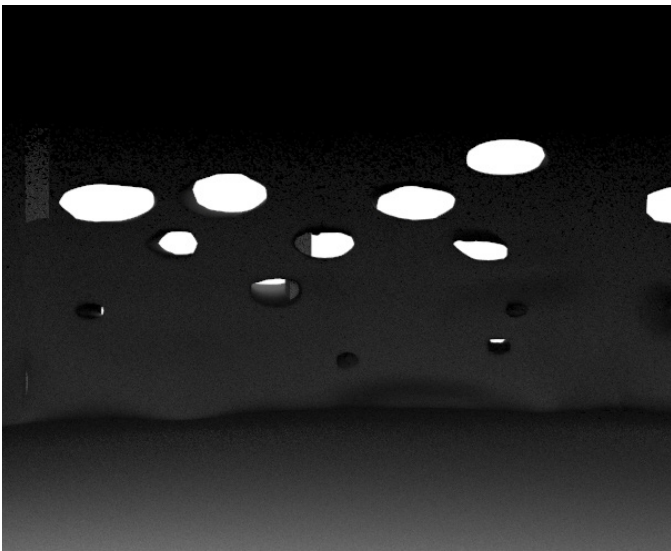
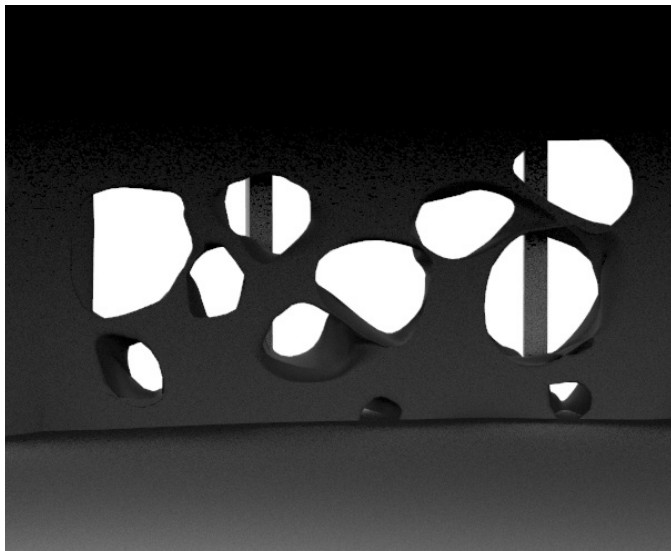
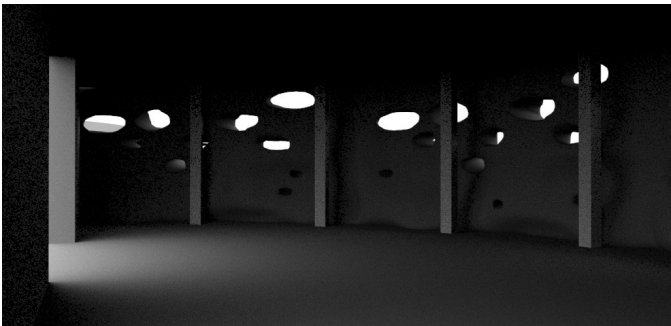
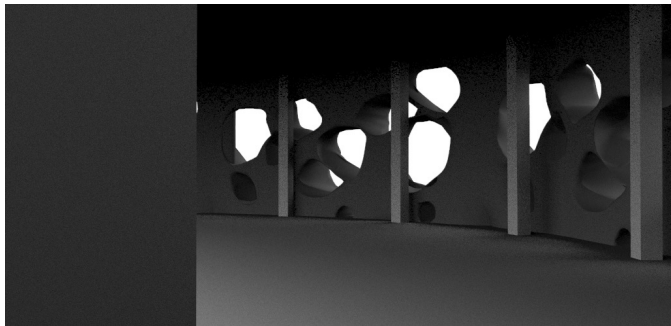
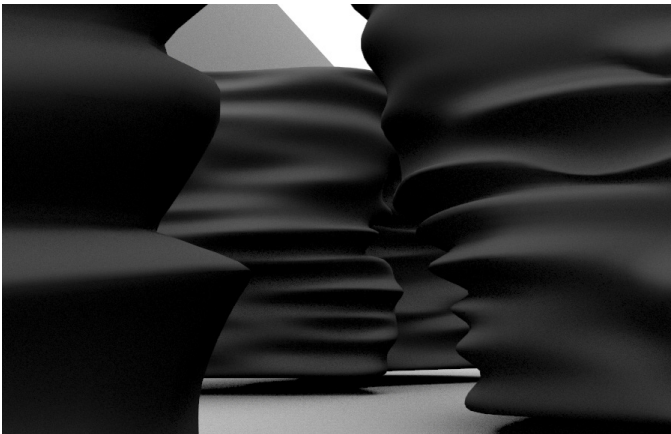
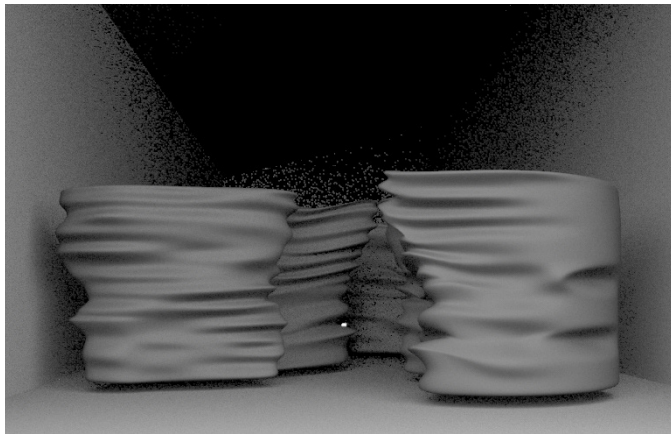
3



Landscape strategy

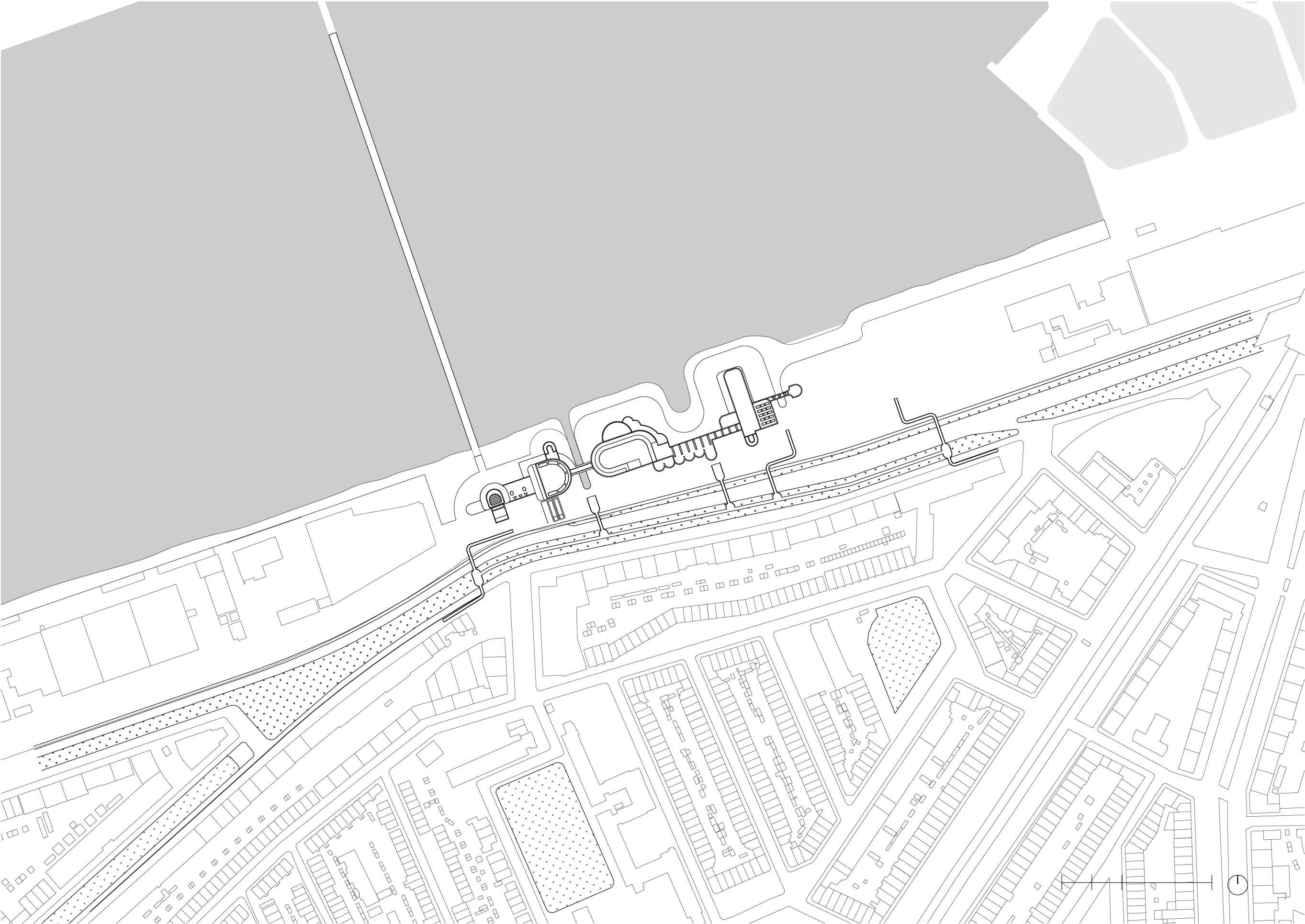








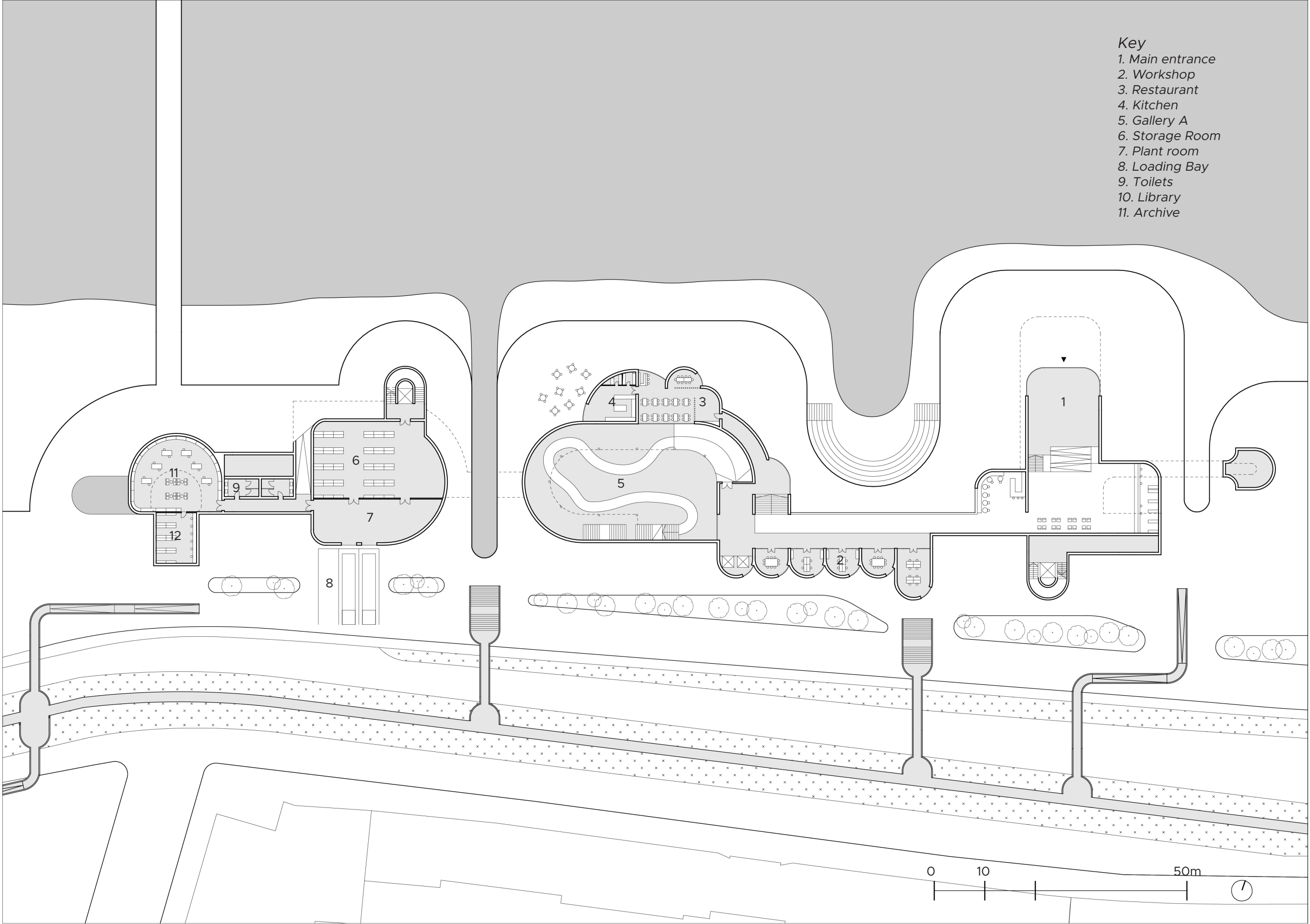




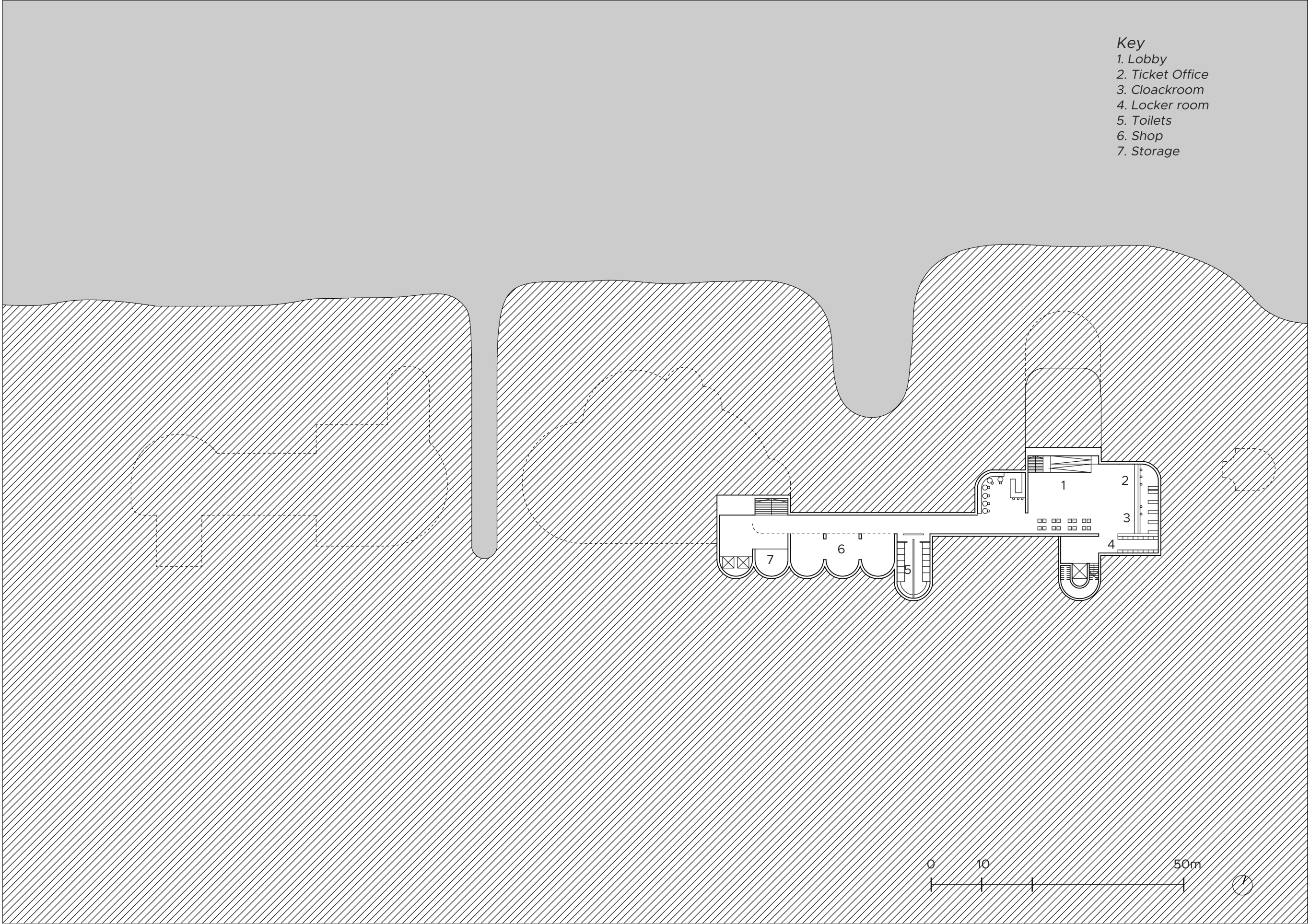


Final Design

Ground Floor 1:200

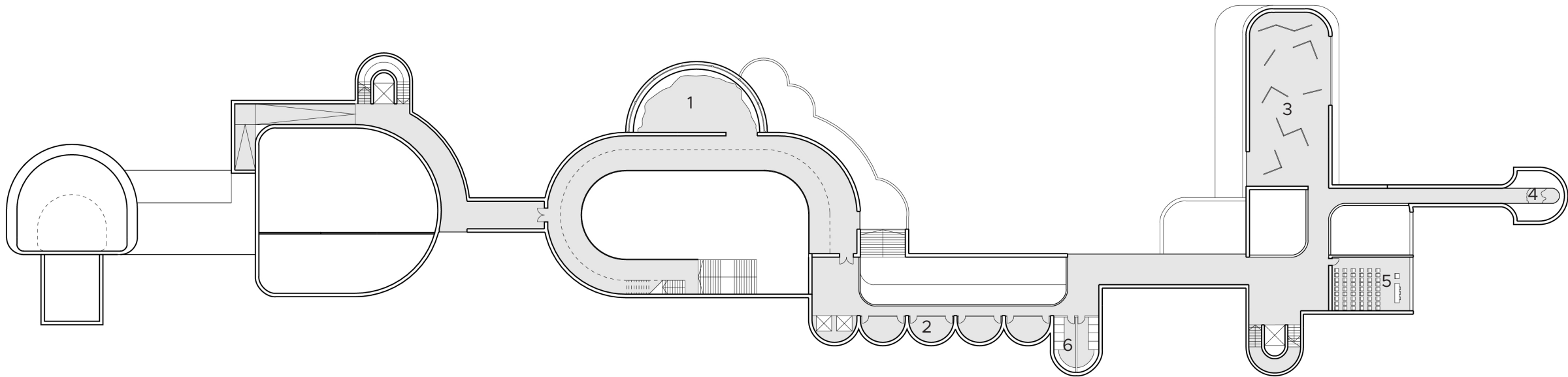




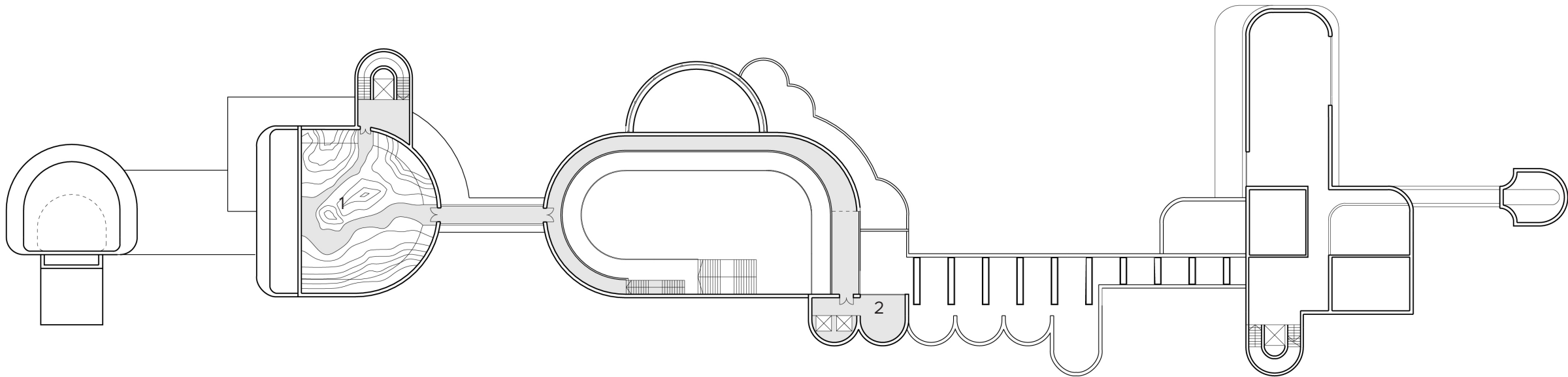


Key

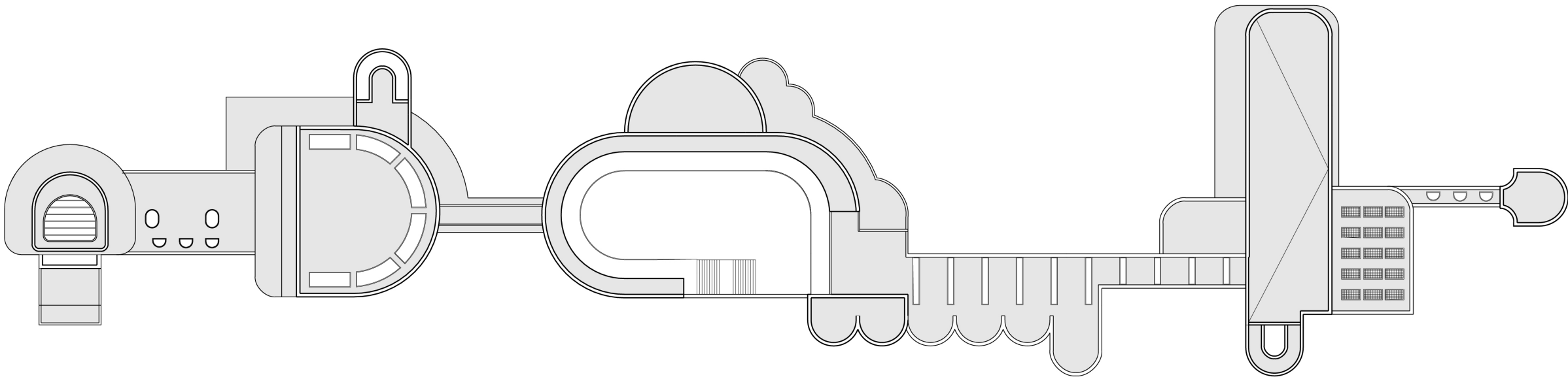
- 1. Gallery C
- 2. Gallery D
- 3. Gallery E
- 4. Gallery F
- 5. Lecture Room
- 6. Toilets



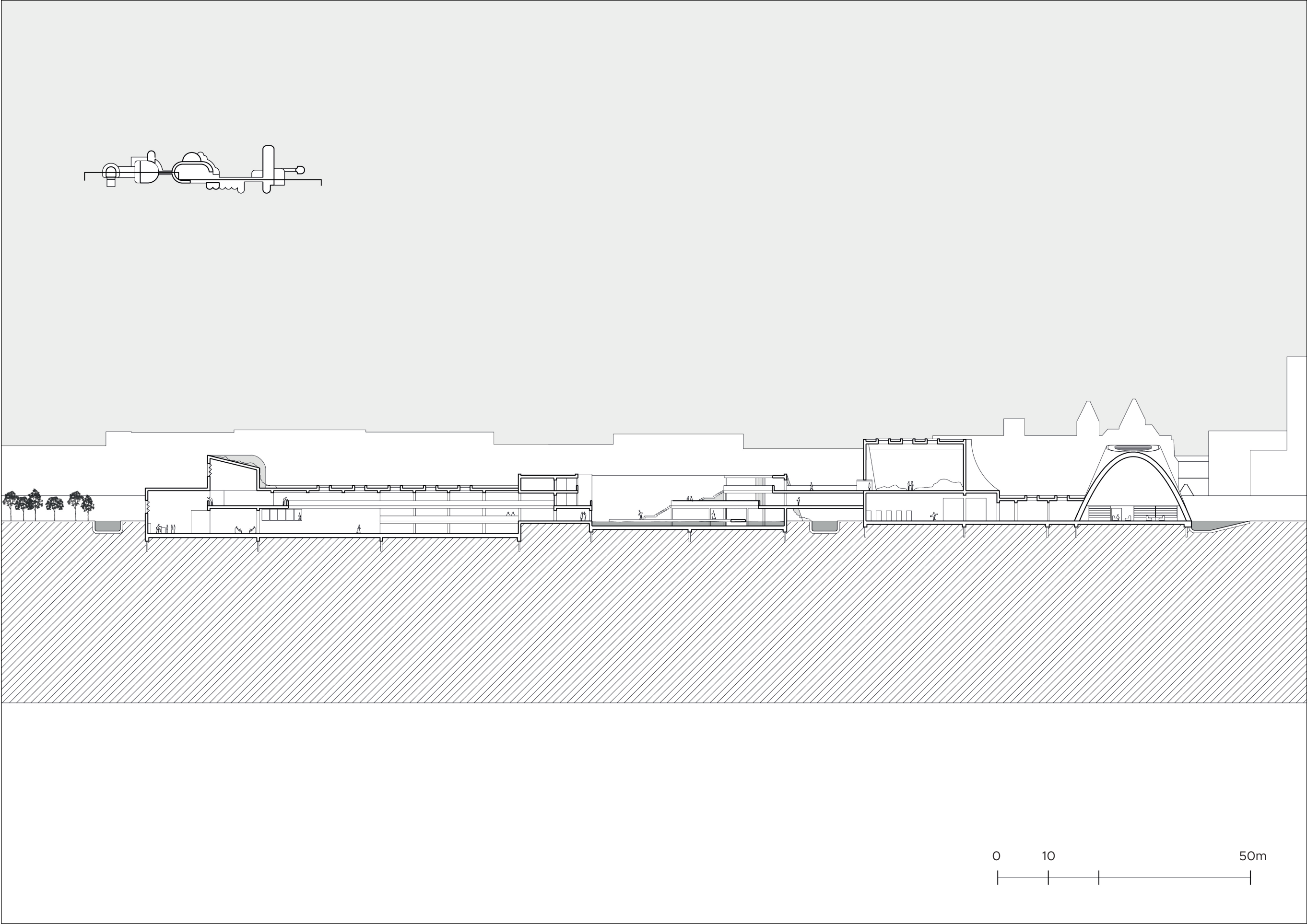
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2. Storage

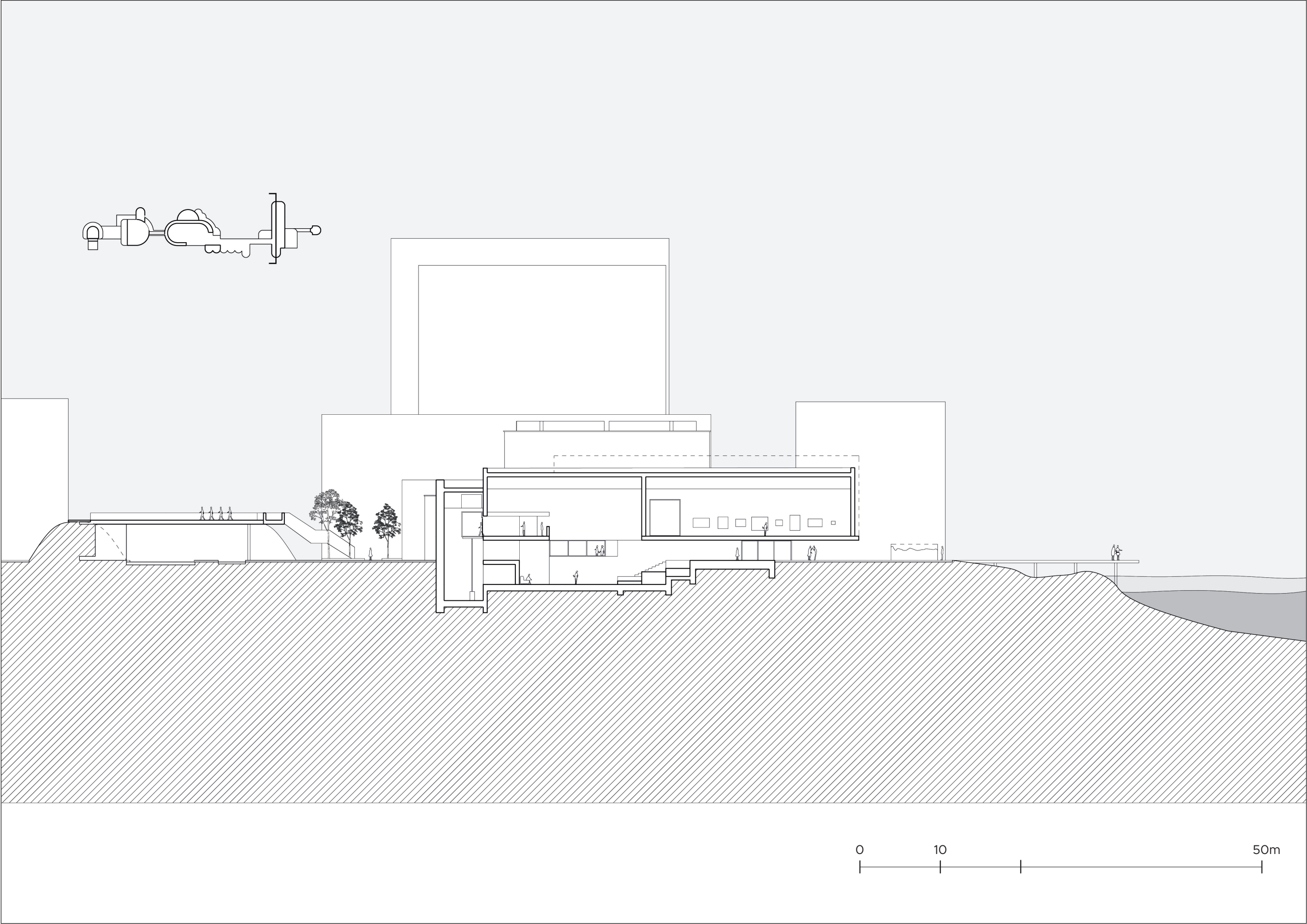




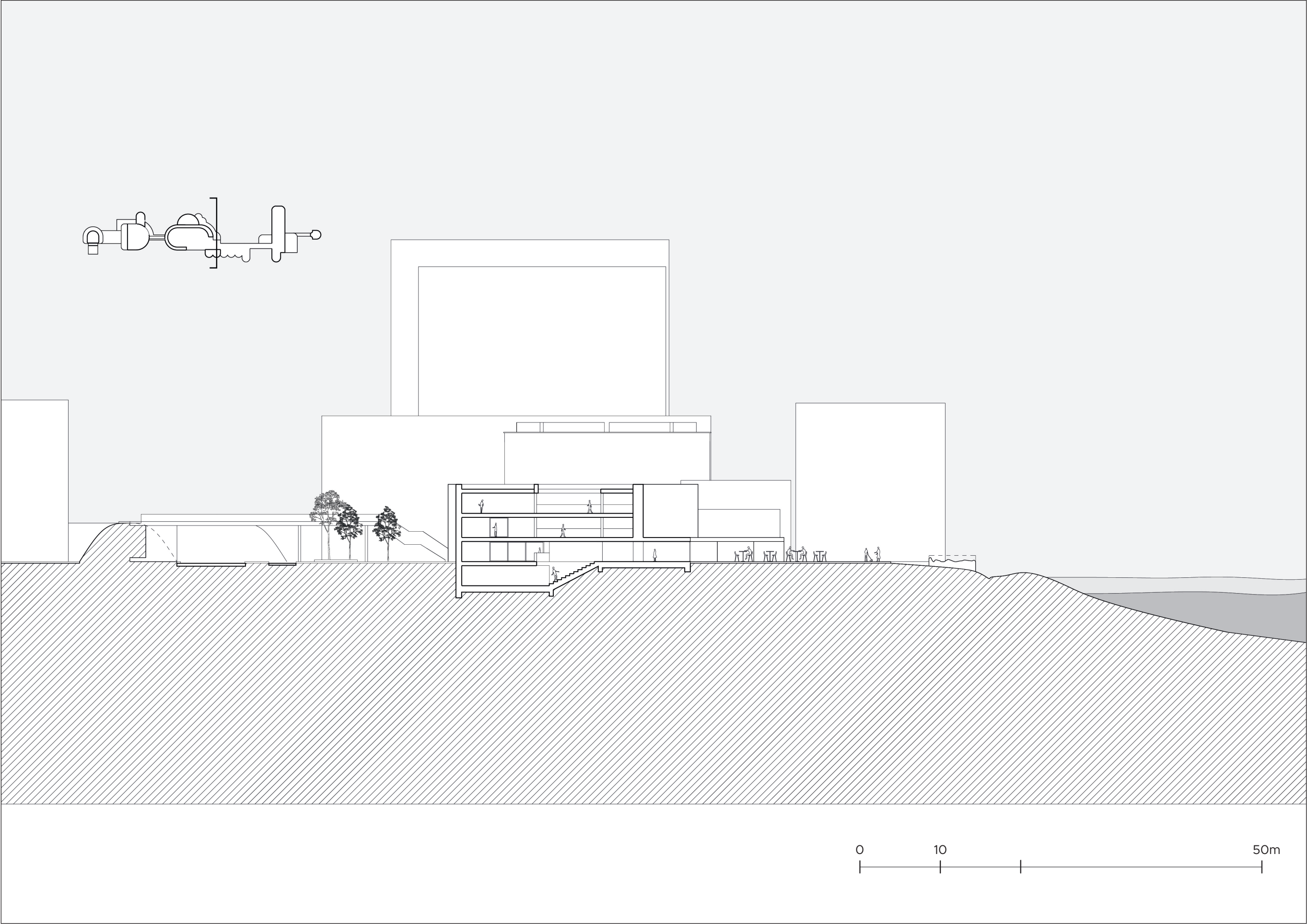


Long Section 1:200









# Final Design

North Elevation 1:200



South Elevation 1:200





Final Design

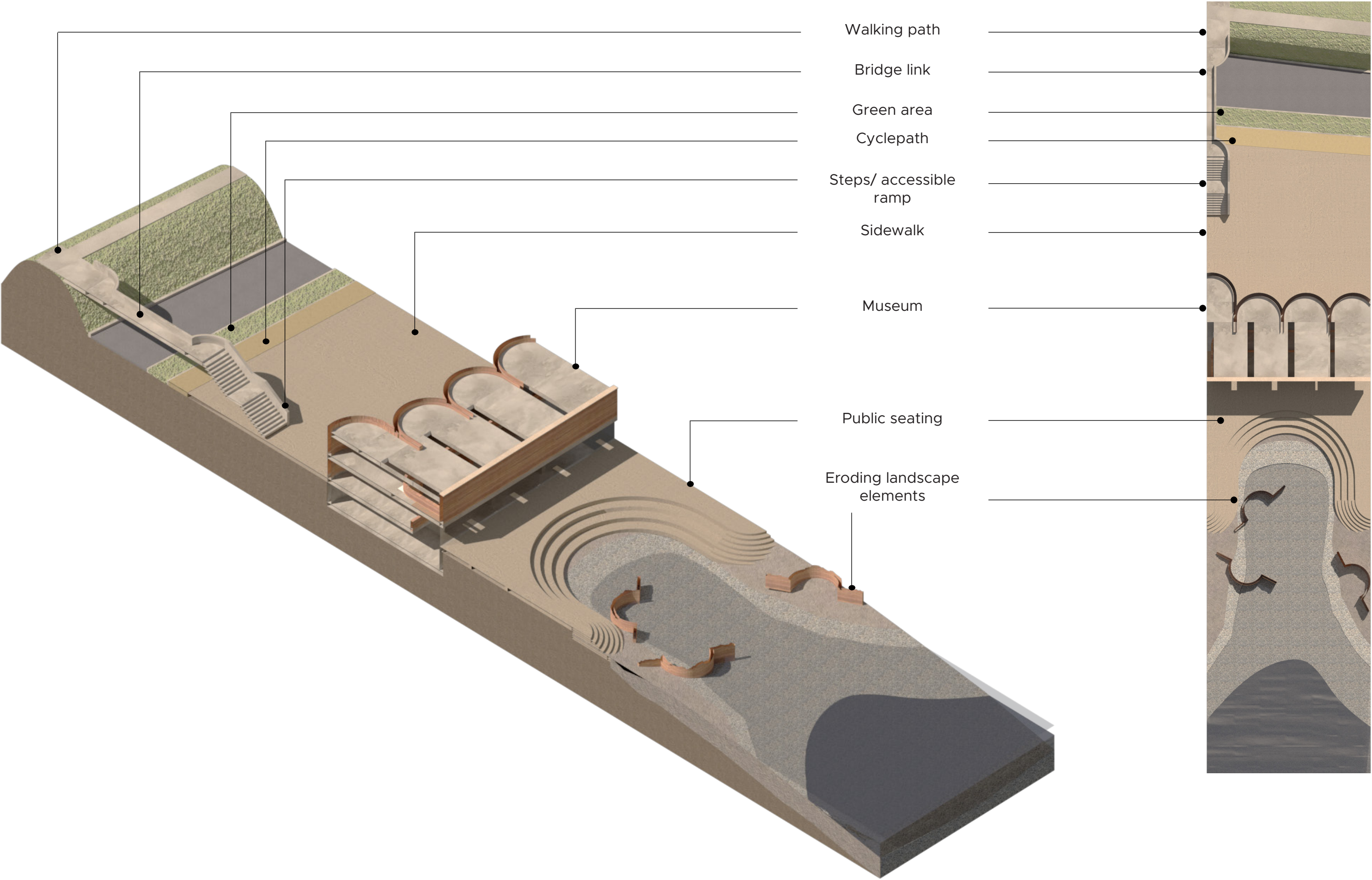
East Elevation 1:200



South Elevation 1:200

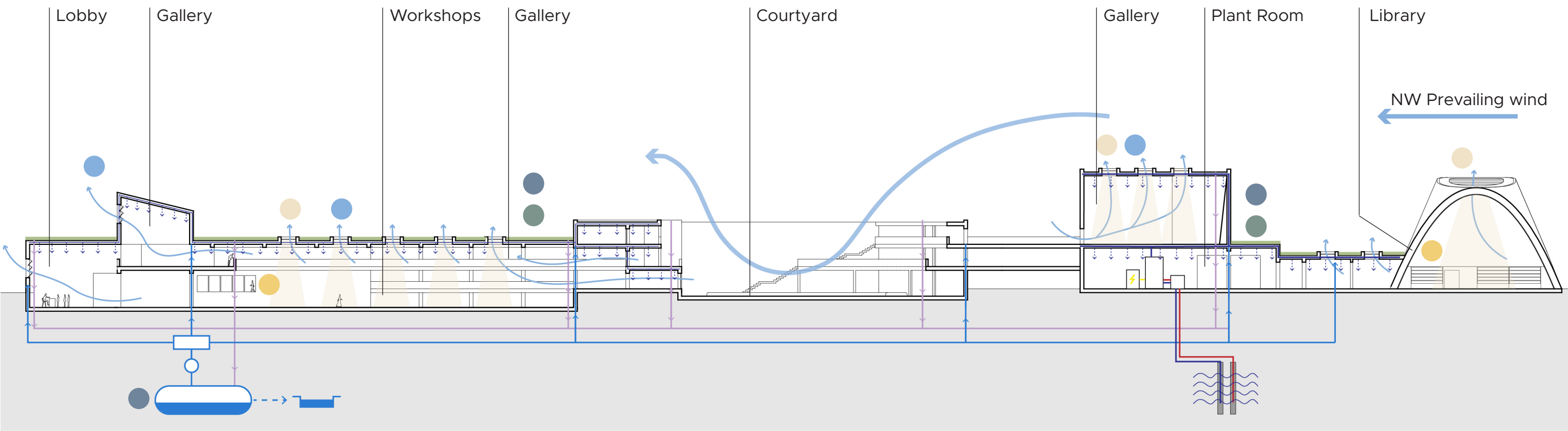






# Climate Strategy

## Overview



- **Outdoor Comfort**

Plants provide shading and comfort to outdoor social spaces. Also plants help regulate humidity levels and clean polluted urban air.
- **Natural Ventilation**

The environmental design approach aims to maximize naturally ventilated spaces. This is achieved by ensuring every space has direct access to the exterior allowing for the cross flow of air.
- **Daylight Maximization**

Natural lighting was prioritized throughout the building through the implementation of floor to ceiling windows and skylights to reduce the overall energy consumption. It is complemented with artificial lighting in heavily used spaces.
- **Solar Control (Shading)**

Plants along the southern façade provide shading and help prevent overheating. There are fewer openings in façades with greater solar exposure and the openings there are setback to reduce direct lighting.
- **Green Roof**

The design has a large roof surface so incorporating vegetation on the roof is crucial to help reduce solar radiation and thus reduce cooling demands.
- **Rainwater Collection**

Rainwater collected is filtered and re-used as gray water in the building and as to irrigate plants.

# Climate Strategy

## Summer

**Passive ventilation**  
Openings are arranged to facilitate air flow, driving hot air to escape through high placed windows or skylights. Similarly, narrow horizontal floor plates aid internal air flow and mechanical ventilation reserved to frequently used areas.

**Solar control**  
Plants give shading and prevent overheating

**Thermal insulation**  
Insulation in the buildings' envelope will decrease the amount of heat transferred by radiation, reducing the need for active cooling.

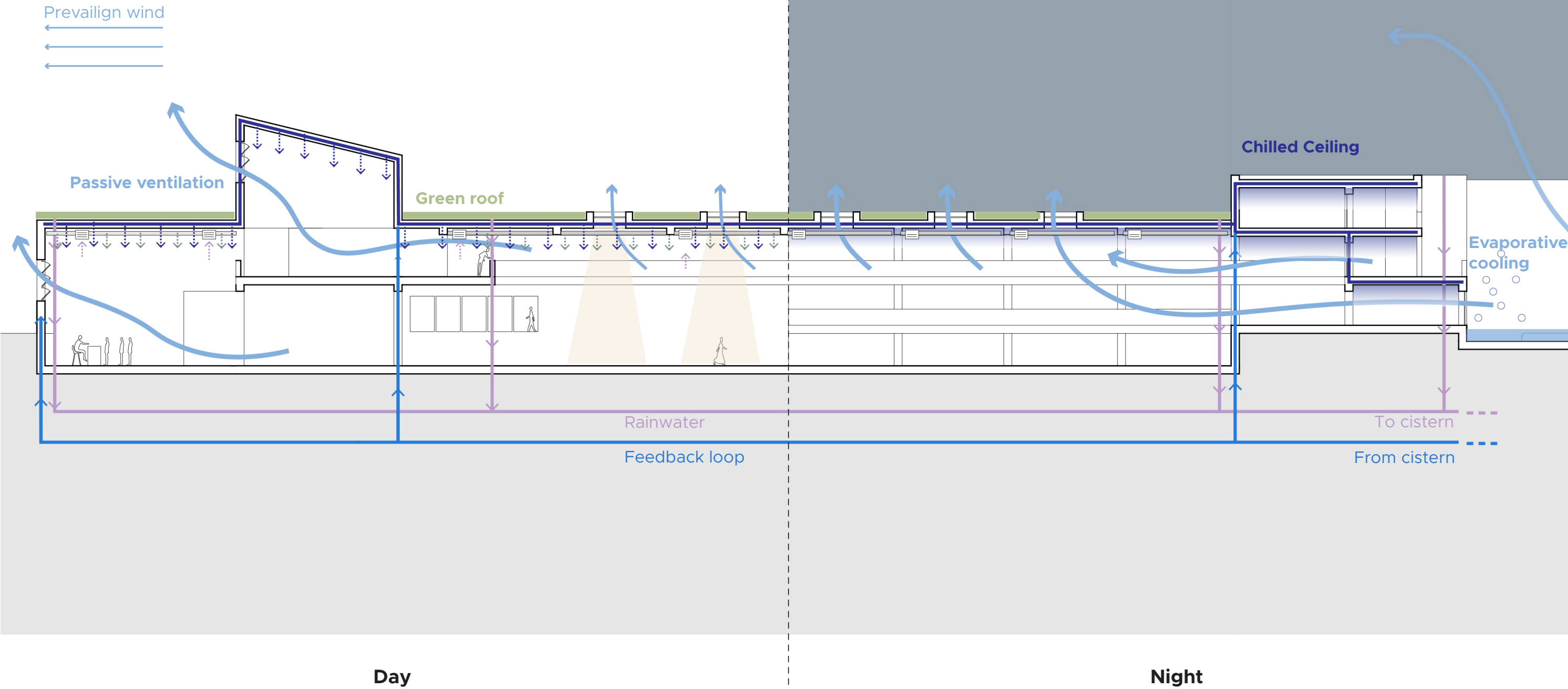
**Thermal Mass**  
Rammed Earth walls and concrete floors act as heat sink through the day as they absorb heat gains from the occupants/ equipment and solar radiation.

**Thermal Mass**  
At night, when outside temperature drops, the heat accumulated in the rammed earth walls/ concrete floors is released by opening the envelope and allowing cooler air to pass through the building

**Evaporative Cooling**  
A passive cooling system which uses evaporating water from the ponds and harbour to cool pass through the building and cool it.

**Passive Ventilation**  
Skylights and high placed windows can be opened to exhaust warmer air

**Chilled Slabs**  
Water is passed through the pipes to transfer heat stored in thermal mass during the daytime





# Climate Strategy

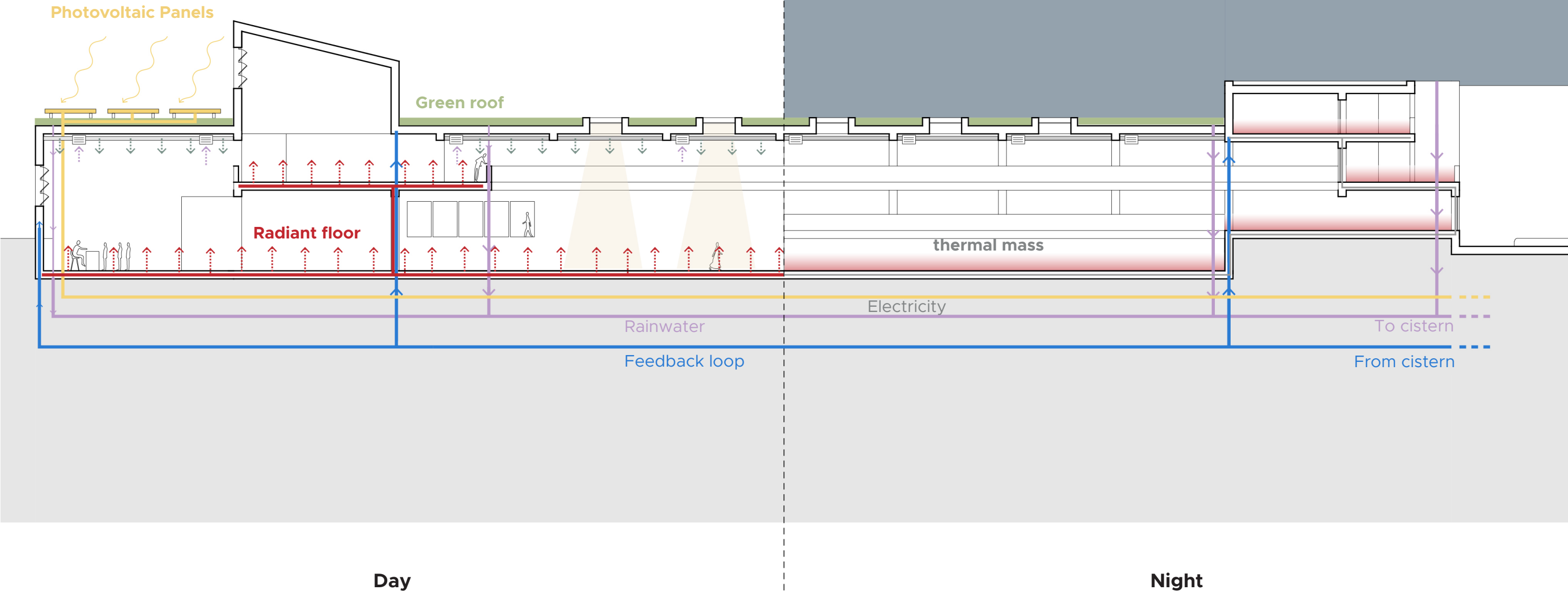
## Winter

**Indoor Air Renewal**  
In heavily used areas - lobby, restaurant, library air more frequently refreshed through the air vents

**Thermal Insulation**  
Climatised areas are wrapped in mineral wool insulation to retain heat in the building. The green roof adds an extra layer of insulation to the area where typically the majority of heat loss occurs

**Thermal Mass**  
Heat gain from solar radiation, underfloorheating, users and equipemnt is stored in elements with thermal mass properties (rammed earth walls and concrete floors) during day time.

**Thermal Mass**  
At night, heat stored in thermal mass is radiated back to the building helping to reduce big temperature fluctuations between day and night.

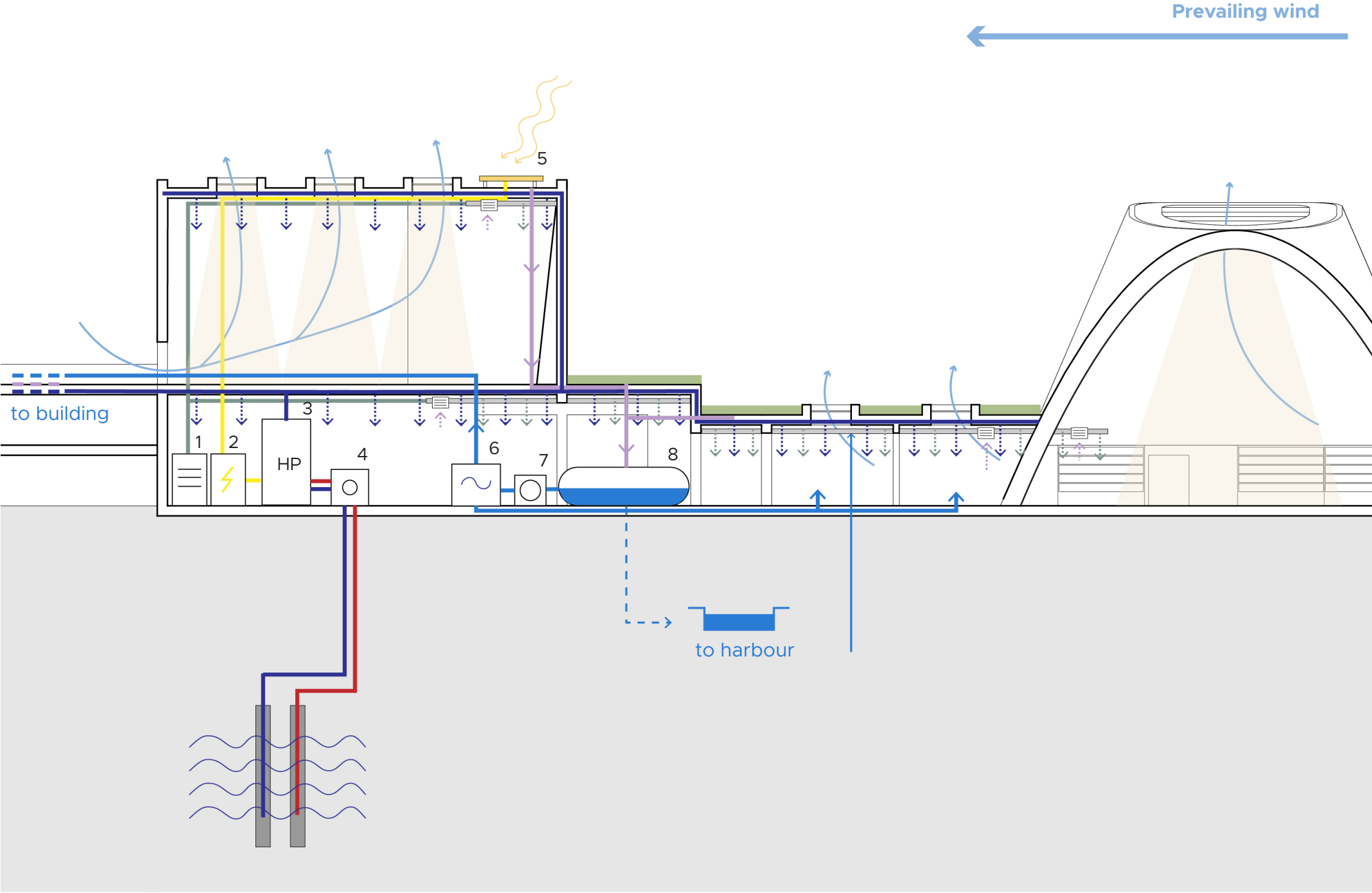


# Climate Strategy

## Systems

### Key

- Electricity
- Ventilation
- Filtered water
- Rainwater collection
- Liquid heating system
- Liquid heating system
- 1 Mechanical Ventilation with Heat Recovery
- 2 Electrical Transformer
- 3 Watsource Heat Pump
- 4 Preheating Unit
- 5 PV Panels
- 6 Water Filtration System
- 7 Pump
- 8 Water Retention Pond



Detail

Façade Fragment 1:20

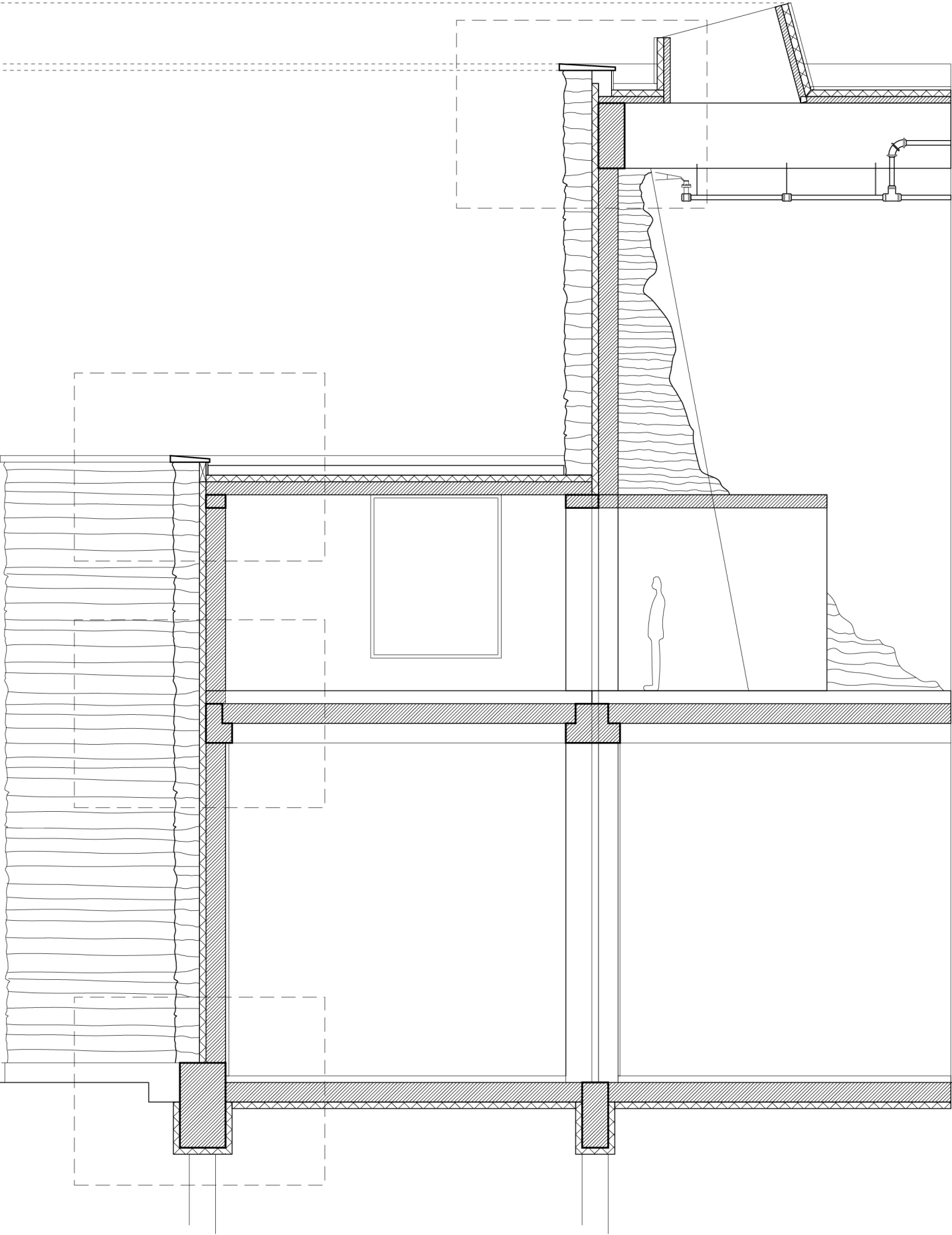
▽ 17 m

▽ 16 m

▽ 9 m

▽ 6 m

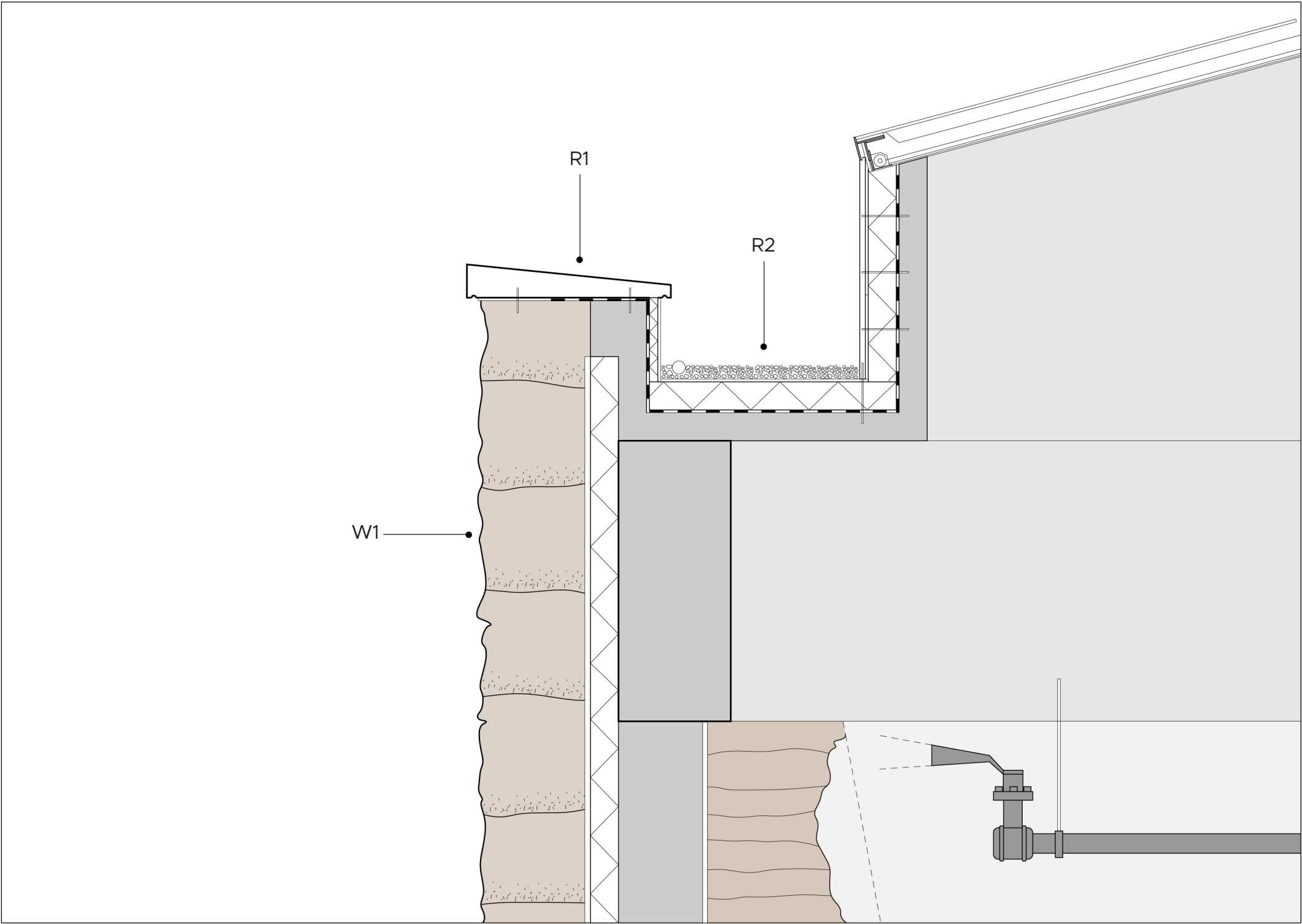
▽ 0.3m





Detail

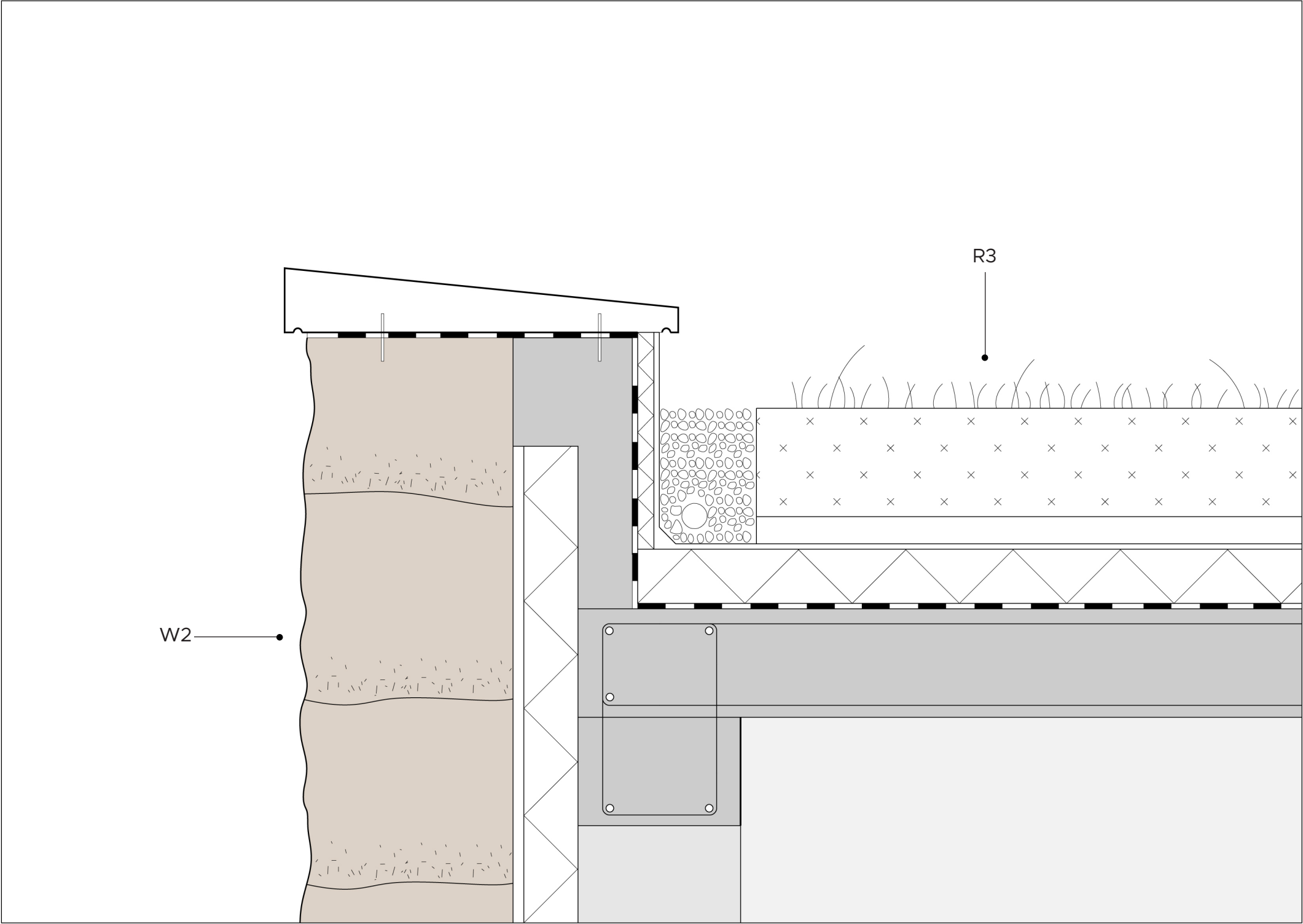
Parapet 1:10



- R1
- Stone covering 3% slope 3 mm
  - Waterproofing layer 5mm
  - Metal fixtures
- R2
- Drainage cells at a slope 50mm
  - Protection layer 2mm
  - Flax Thermal Insulation 100mm
  - Waterproof membrane 2mm
  - Concrete slab 150mm
  - Galvanized steel skylight frame 100mm
- W1
- Rammed Earth Wall 400mm
  - Air gap 2mm
  - Flax Thermal Insulation 100mm
  - Concrete Ring beam 400x1000mm
  - Concrete Column 300x300mm
  - White Plaster 3mm
  - Erodable Clay composite Wall 500mm
  - Copper water spraying piping 32mm

Detail

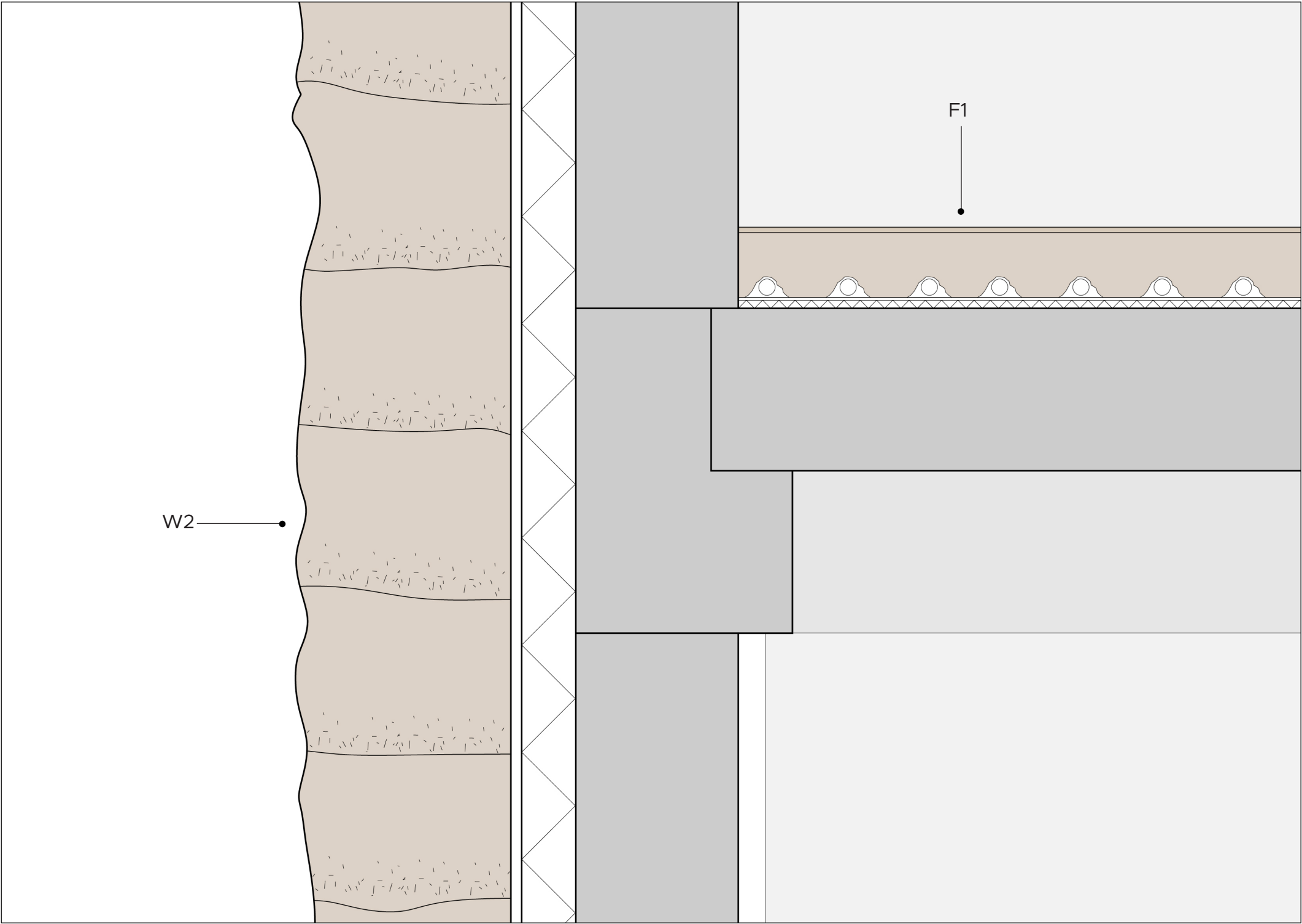
Green Roof 1:5



- R3
- Growth Substrate 200mm
  - Drainage cells 50mm
  - Drainage cells at a slope 50mm
  - Protection layer 2mm
  - Flax Thermal Insulation 100mm
  - Waterproof membrane 2mm
  - Concrete slab 200mm
- W2
- Rammed Earth Wall 400mm
  - Air gap 2mm
  - Flax Thermal Insulation 100mm
  - Concrete Ring beam 400x1000mm
  - Concrete Column 300x300mm
  - White Plaster 3mm

Detail

Intermediate Floor 1:5



F1

- Surface finish 1mm
- Rammed earth floor 100mm
- Clay mortar 20mm
- Heating pipe 10mm
- Footfall Insulation 20mm
- Foil 1mm
- Concrete slab 200mm

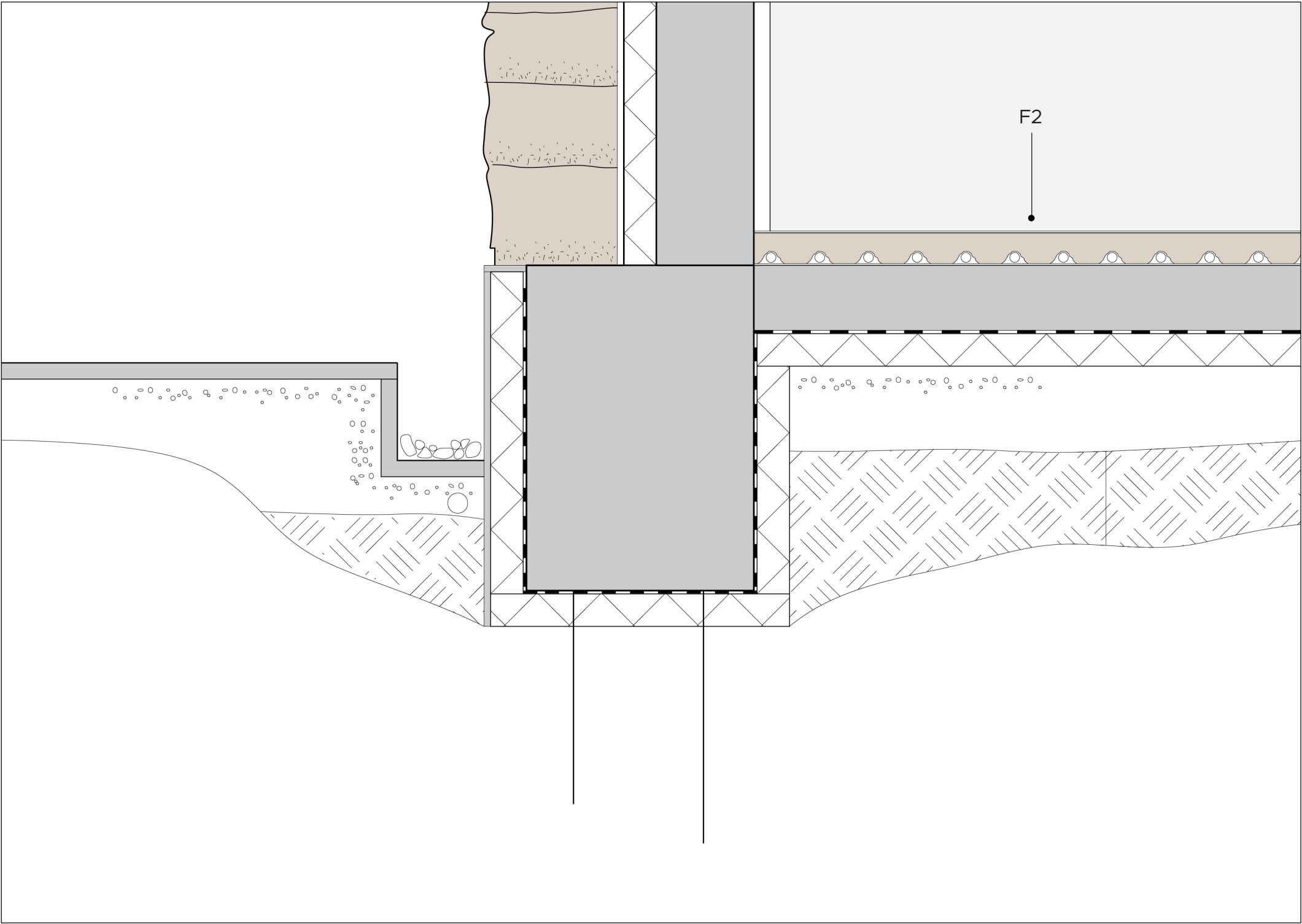
W2

- Rammed Earth Wall 400mm
- Air gap 2mm
- Flax Thermal Insulation 100mm
- Concrete Ring beam 400x500mm
- Concrete Column 500x300mm
- White Plaster 3mm



Detail

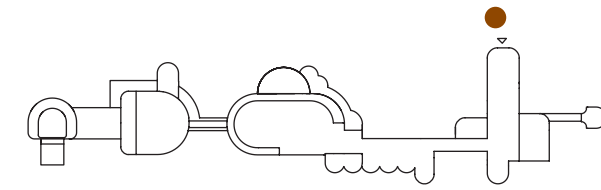
Ground Floor 1:10



- F2
- Surface finish 1mm
  - Rammed earth floor 100mm
  - Clay mortar 20mm
  - Heating pipe 10mm
  - Foil 1mm
  - Concrete slab 200mm
  - Concrete pile foundation
  - Flax Thermal insulation 100mm
  - Damp proof membrane 2mm
  - Compacted ground
  - Gravel drainage layer

# Views

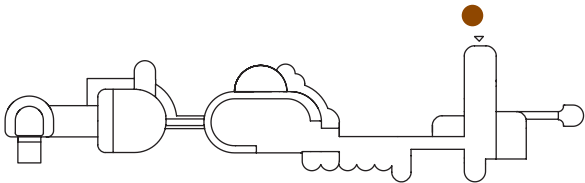
## Main Entrance



Time of day: 10am  
Month: June 2021



Views  
Main Entrance

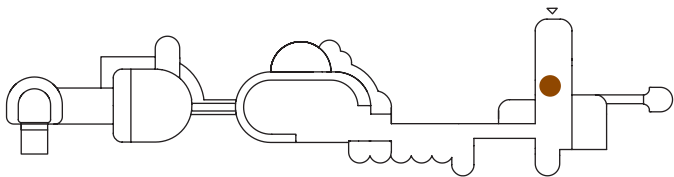


Time of day: 11am  
Month: April 2022



Views

Main Entrance/ Lobby



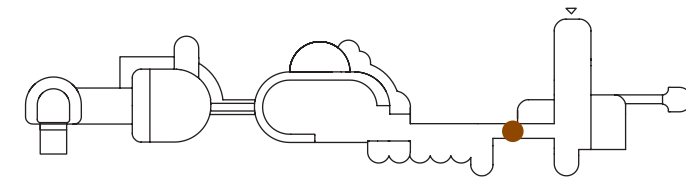
Time of day: 10am  
Month: June 2021

Program: Lobby, ticket office, cloak room, lockers, meeting point



# Views

## Interior corridor



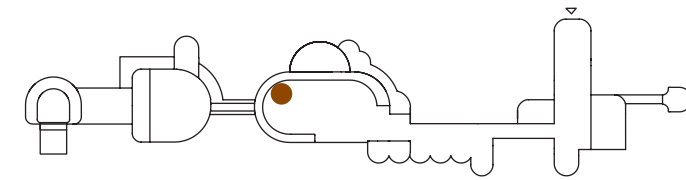
Time of day: 10am  
Month: June 2021

Program: hallway, workshops, café,  
shop



# Views

## Courtyard



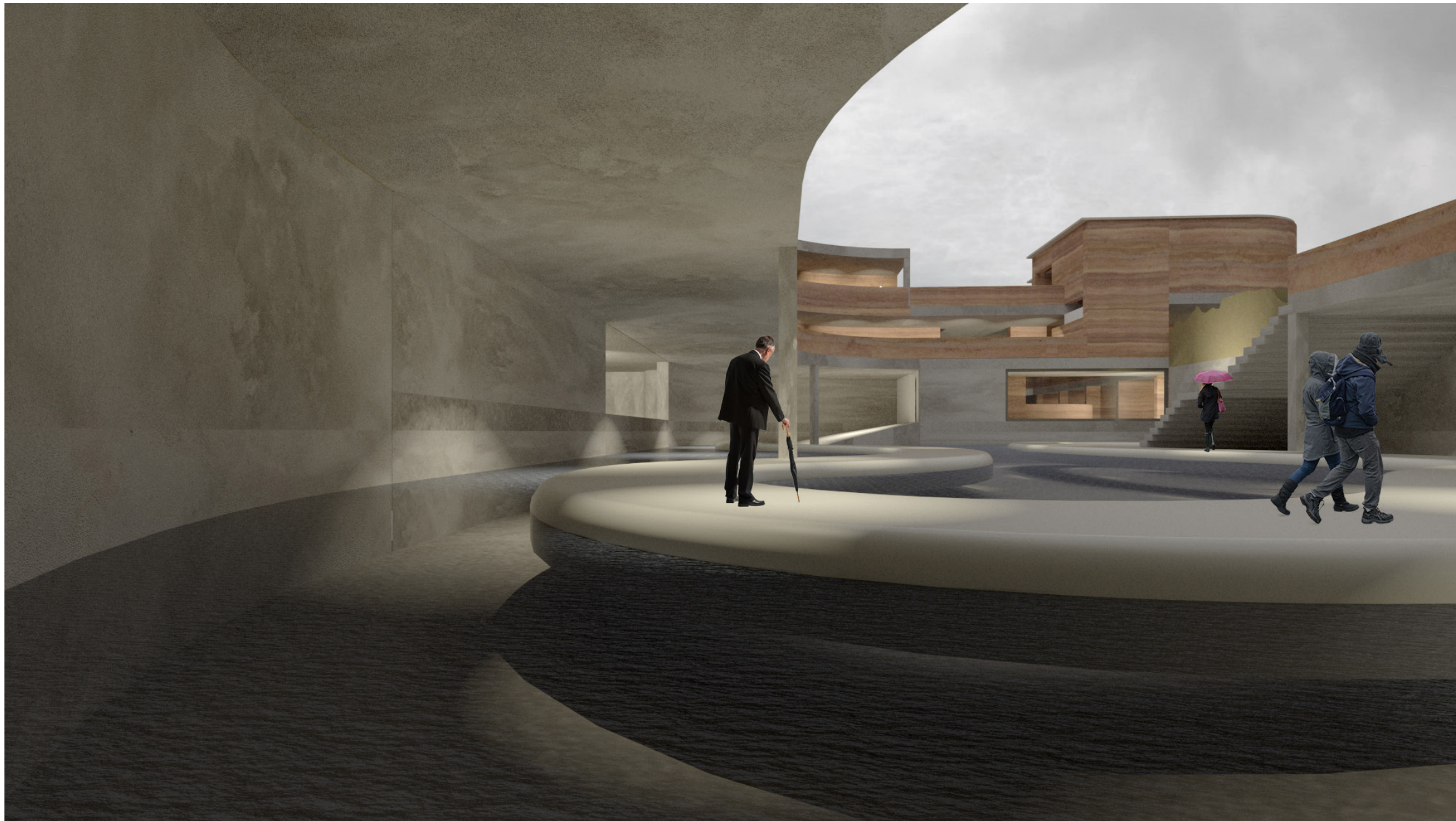
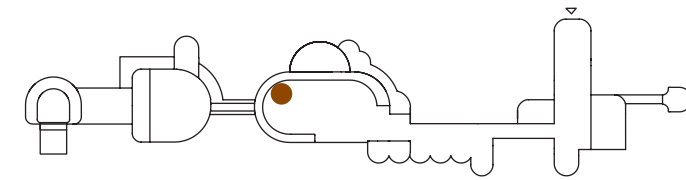
Time of day: 11am  
Month: June 2021

Program: Courtyard, Gallery A,  
Flood room



# Views

## Courtyard



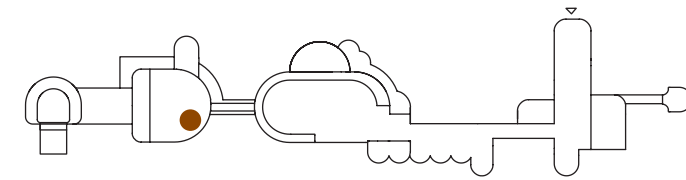
Time of day: 11am  
Month: April 2022

Program: Courtyard, Gallery A,  
Flood room



# Views

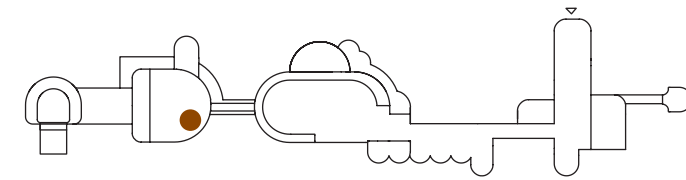
## Gallery



Time of day: 1pm  
Month: June 2021

Program: Gallery B





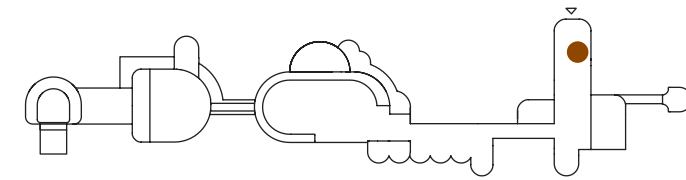
Time of day: 1pm  
Month: April 2022

Program: Gallery B



# Views

## Gallery

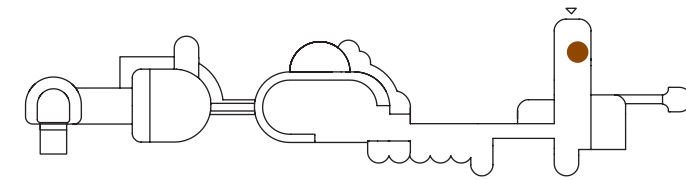


Time of day: 10am  
Month: June 2021

Program: Gallery E

# Views

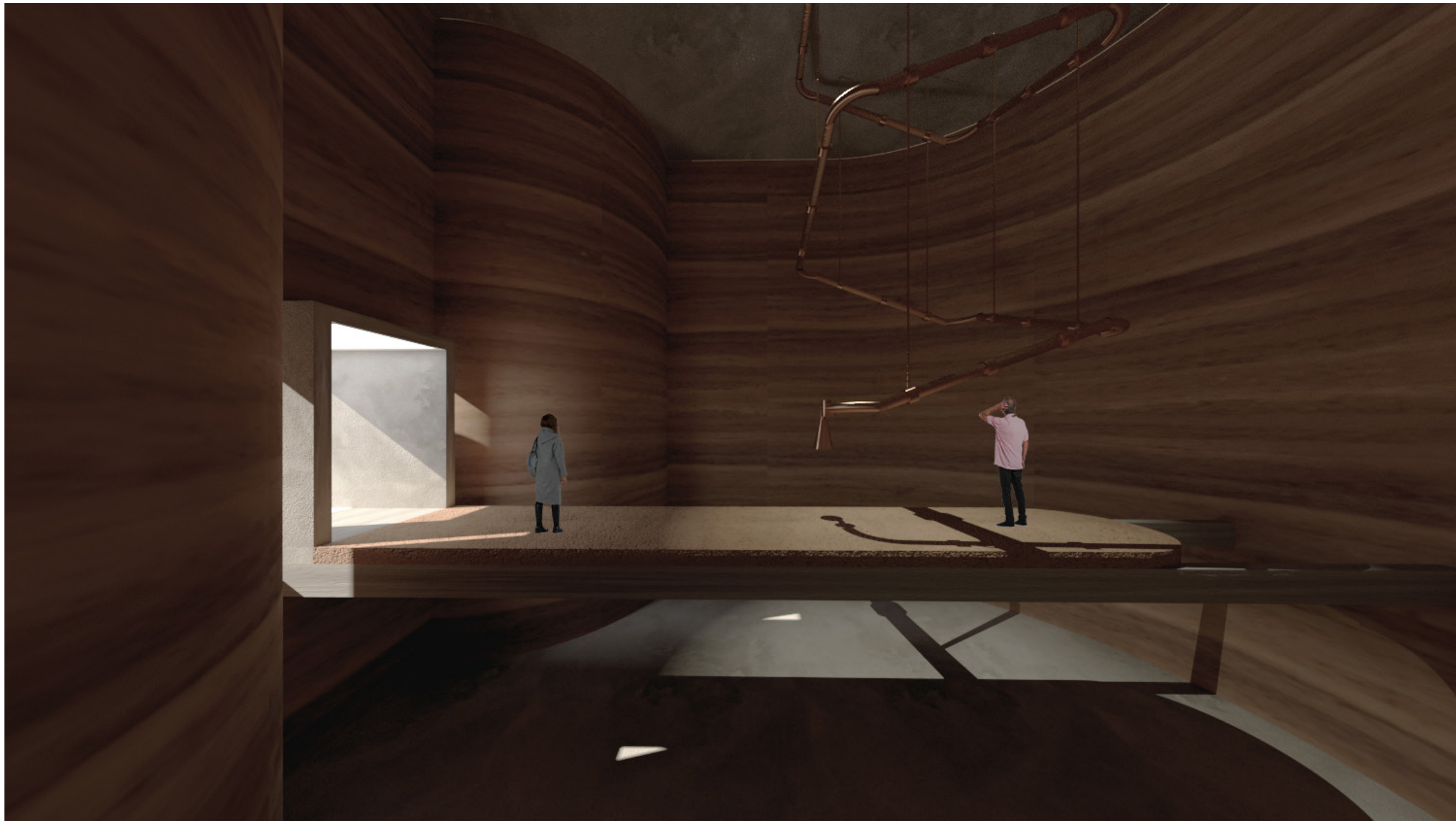
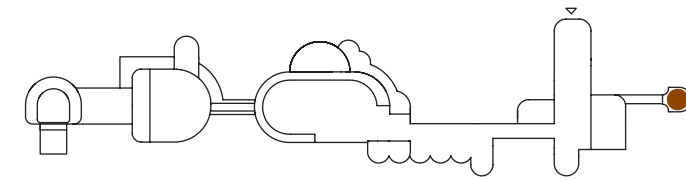
## Gallery



Time of day: 10am  
Month: April 2022

Program: Gallery E

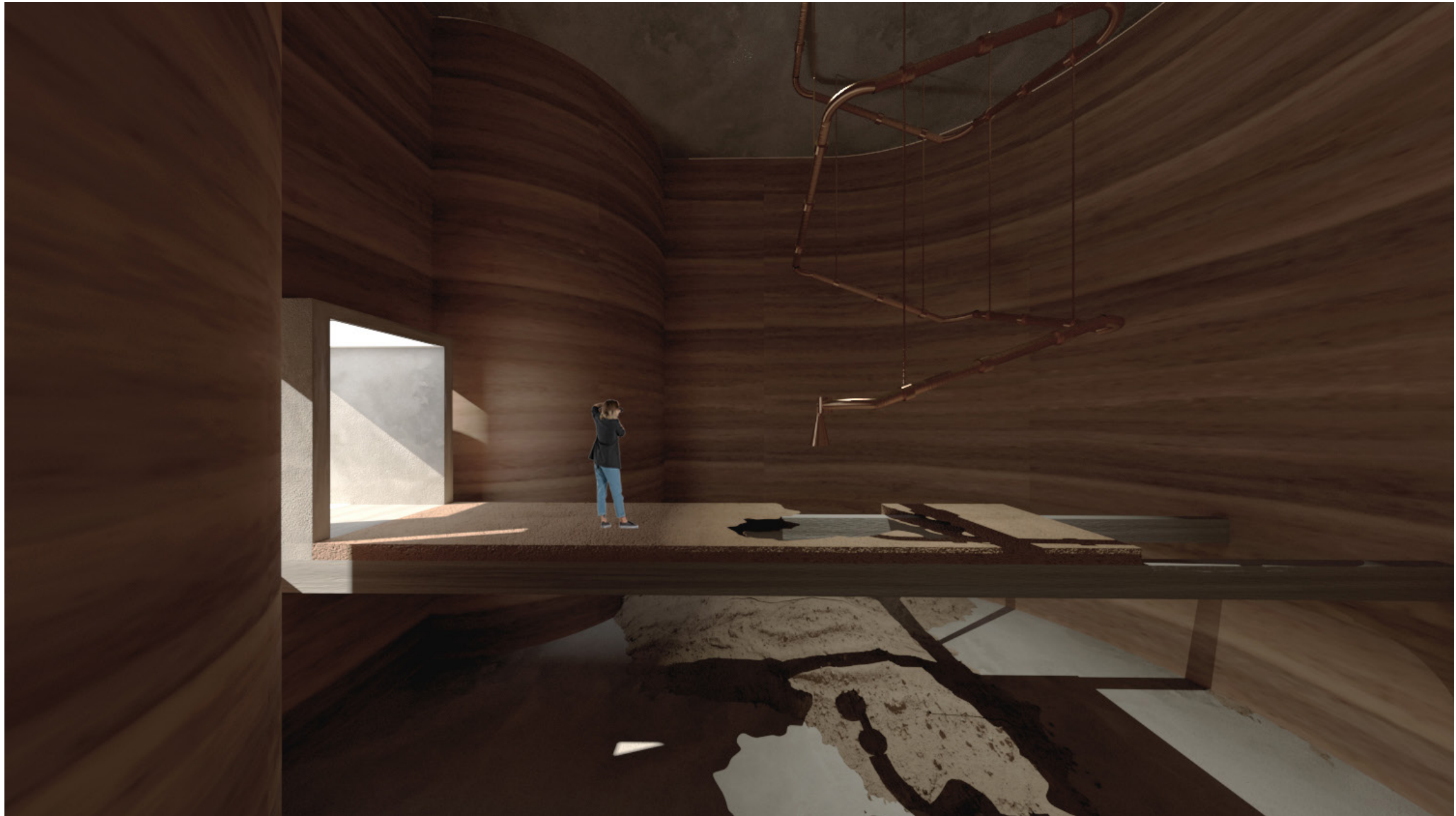
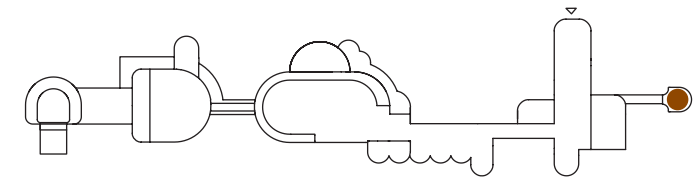




Time of day: 4pm  
Month: June 2021

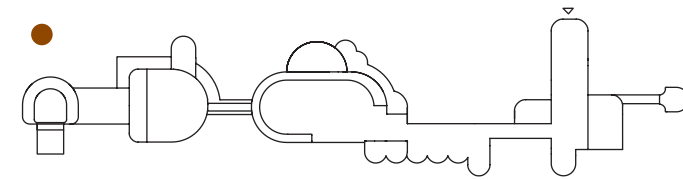
Program: Gallery F





Time of day: 5pm  
Month: April 2022

Program: Gallery F



Time of day: 6pm  
Month: June 2021





## Reflection on the method and argumentation

The research plan that was completed by late January was centered around the theme exploring ways to exhibit artwork about the environment. While that topic remains crucial to the design project of creating a museum about climate change and the environment, the method of researching has since been expanded to better suit the needs of the design process. Rather than limiting the research to the types of environmental art and the ways of exhibiting it, the focus was later shifted to finding building techniques and designs that convey change and that respond to the stimulus around it. In short the research scope was expanded to include the subject of ‘responsive design’. This was done in order to improve the argument behind building an art museum dedicated to the environment. The new approach looked to create a design that would actively respond to the nearby climatic conditions as a way to demonstrate, in a visible way, the climatic alterations or the worrying trends caused by a changing climate. The new method involved taking a climate change premise and looking for a material or process that can visualise it and be applying to the design of the museum. For instance, events of heavy rainfall are expected to become more severe and more frequent, so the research looked for materials, organisms, design features that react to water and show this trend.

## Your reflection upon the feedback that was given by your mentors

Looking back at the feedback from the P2 presentation, two main comments stand out. First, the premise of being a sustainable building should become the main strategy and driving force behind the design, otherwise the project risks becoming ‘superficial’ and lacking meaning. Essentially, the key issue behind making a museum that aims to be environmentally conscious is how to justify the act of designing and build a new structure in the first place. One tutor suggested attempting to fulfill the project without using standard terms such as ‘building’, possibly as a way to stimulate new ways of thinking and avoiding relying on easy but not revolutionary solutions to the problem of sustainability. Secondly, it was also stressed at the P2 presentation that it should be avoided to take a very cynical position regarding the sustainability question. Rather than assuming that the future is doom and very little can be done about it, it is more effective to remain thoughtful but optimistic that something can be done to mitigate and prevent the worst case scenario for the environment. In architectural terms this means that it is preferable for the visitors to leave the museum with a powerful but somewhat hopeful experience or feeling that might be translated into some personal action or change in behaviour that is ultimately beneficial to the community and beyond.

## How you have translated the feedback into your work

In order to implement the comments from the P2 presentation, the first step was to reframe the research topic to include ways of demonstrating change and climatic alterations in a visual fashion. Following this research method, led to the finding of several interesting materials and organisms that are responsive to climatic conditions and that have been previously employed in design projects (very few findings were applied to the built environment, most of the results were from the fields of art and design). The next step was to apply these findings to create a working concept of the museum and explore ways in which visitors can experience this change. The last step was to translate the concepts into working designs, with considerations for the site, approach, routing etc. It was key to note that this was not always a linear process and in fact most weeks involved part research and part applying the findings to the design and testing different options.

## How you’ve learned from your own work

The past semester has been enlightening on various levels. On one hand it allowed me to discover fascinating projects and innovations that deal with the field of sustainability, responsive design and environmental art. Even though the research process was lengthy and many of the findings did not end up being used in the design, there were some enjoyable discoveries and that helped me become more comfortable with trusting the design process and understanding that it is ok if most ideas/ drawings end up not working out. The most important thing to remember is that every step is part of a process that will ultimately lead to the final design.

## What is a museum/ the new museum for you

It was very important during the course of this semester that I reframe the preconceived notion of what a museum is in order to come up with a new way of thinking about and also designing a museum. The museum for environmental art that this project aims to create aims to offer a new type of experience to the visitor as a way to encourage reflection on their thoughts and habits concerning the environment and perhaps to trigger a change. The museum is conceived not as a traditional super sophisticated, stone clad, white cube modern art museum, but rather as a collection of pavilions that are shaped by and respond to the change in climatic conditions around it. To achieve this, parts of the museum were designed to intentionally erode and change, thanks to the forces of the rain and wind. This museum not only offers a new kind of experience but as part of it erodes and changes over time, the museum itself becomes something altered or ‘new’ with the passage of time.

## How the final quarter of the year will be filled out

At this stage, although the concept and general setup of the museum are defined, there are still many refinements to be made. In the weeks to come special attention will be given to the structure and construction details and some close up drawings can be made. Additionally, the interior spaces can still be further developed in order to give each pavilion its own set of characteristics, such as in the exhibition spaces. In this case, I look forward to playing with lights and shadows that are experienced indoor and to develop the promenade experience. Finally, it will be important to create a set of final drawings and visualizations that can convey the concepts developed, it is especially important to find a way to communicate the idea of erosion and alteration of parts of the museum over time.