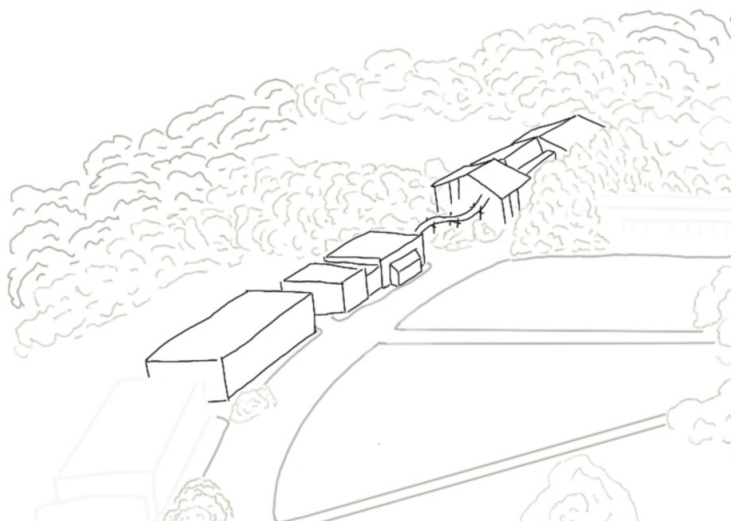


# Auderød Højskole



55°58'54.4"N 12°04'47.0"E

Re-purposing a navy camp to  
a sustainable højskole

## Preface.

Aalborg University  
Master in Architecture

Department  
Architecture & Design

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Supervisor  
Tenna Doktor Olsen Tvedebrink

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Pages: 65



Anna Leilani Denker



Johanne Lyngklip Gaardbo

## Brief.

### Site:

Auderødvej 90, 3300 Frederiksværk ,  
Denmark  
55°58'54.4"N 12°04'47.0"E

### Typology:

Unconventional Education

### Function:

Højskole- For alternative architecture  
and sustainable practices

### User group:

Mixed students & staff

### Area:

5730 m<sup>2</sup> of which 1000 m<sup>2</sup> is basement

### Construction:

Re-purpose & Design for disassembly  
Up-cycling & Circular economy design

### Energy Classification:

Low energy class 2020

### Materials:

Up-cycled & Recycled  
Low CO<sup>2</sup>-emission  
Bio-based materials

### Material evaluation:

Material Mapping  
LCA  
Design for disassembly



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# Introduction

At the far end of the half island of Arresø, the history of the site can be seen in the shape and the material composition of the buildings- the strict layout of the access roads, the repetitive façades as well as the many different functions on the site. Here a new school rises from the material remains of a once decaying abandoned navy camp. The Auderød Højskole took what to the eye of the beholder was trash and transform it into an unconventional learning hub that has sustainability embedded not only in theory but in practice. The campus is a place where

adults and adolescents can attend courses in general sustainability practices up to specialized in environmental courses where one comes to learn- by experimenting, thinking, playing, and creating, the importance of the responsible use of resources.

The presentation is designed to guide the reader as if they were coming along to explore the school and what it has to offer, going from big scale, zooming into the specific details of the project.

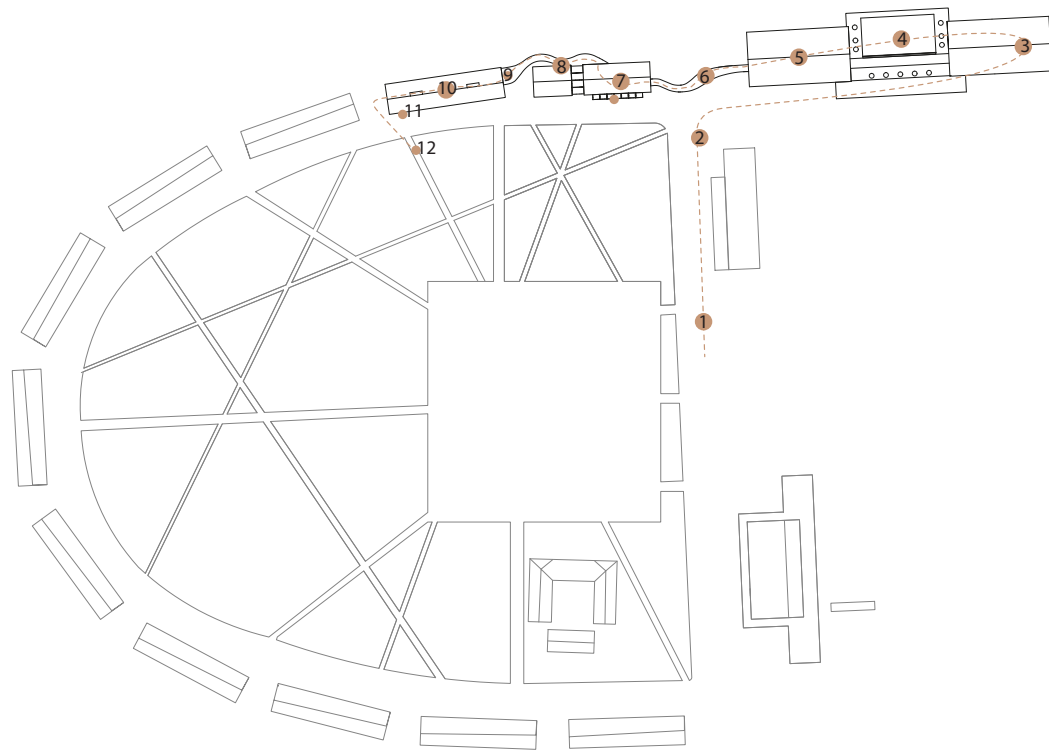




fig.2 Situation Plan

# Welcome to

## Auderød Højskole

The first stop on our journey is approaching the campus. The original roads of transporting military equipment are still intact but new pathways have been placed to allow easy access between the buildings and add dynamic to the flat terrain, the new campus has to offer 4 main buildings:

### Building One - Accommodation Building I

Houses the students giving them a place to sleep and socialize with their peers.

### Building two - Accommodation Building II

Houses the staff and the students who prefer to have a more private and calmer space.

**Building three- Dinning Hall** has a dinning area, kitchen and a orangery with fresh produce.

**Building Four- The school** where one has enough room to explore and create sustainable projects from scratch. Courses from general sustainable practice to pottery, art, Construction with up-cycled materials and much more...



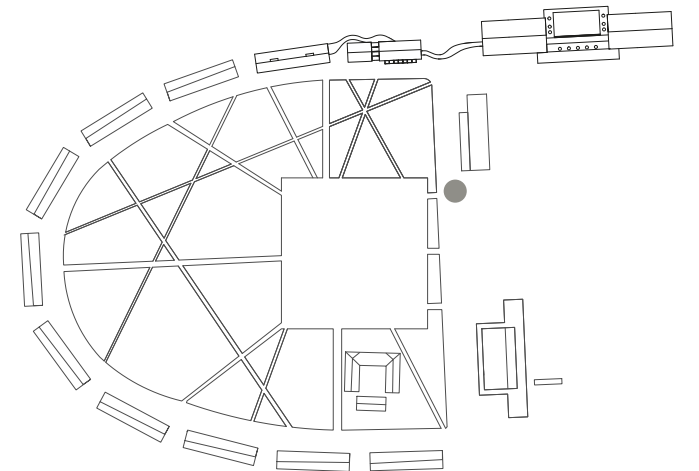


fig.3 Outdoor render

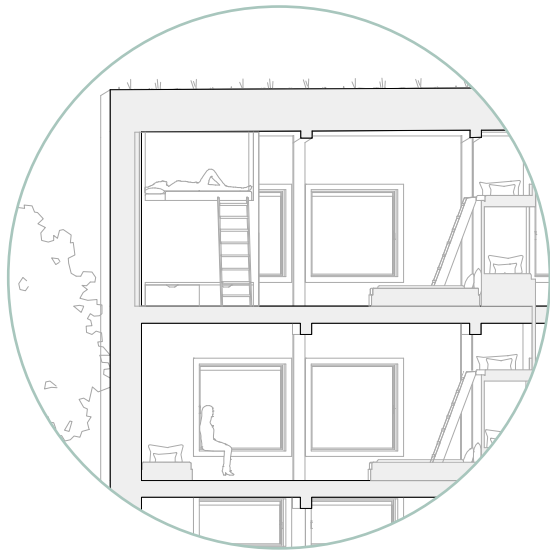
## Approaching to the campus:

When arriving to the site one will notice the campus at the far end, the new concrete façades hugged by the wooden bridge connects the buildings to form an identity by marking a line between the old and the new,

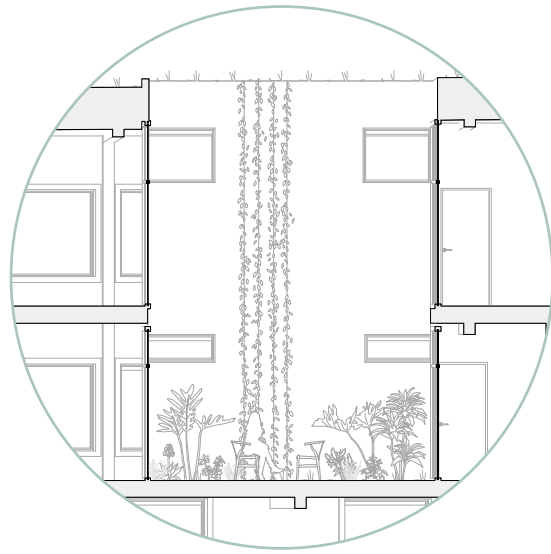
the school blends in with the rest of the site and allows the opportunity for further development of whatever the rest of the buildings may become in the future. -Integration while marking identity.



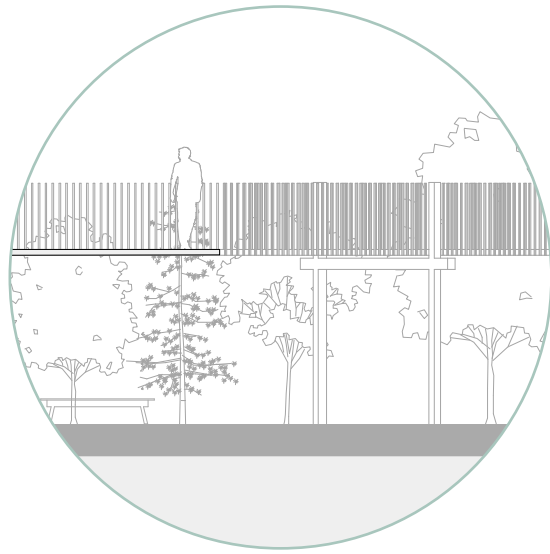




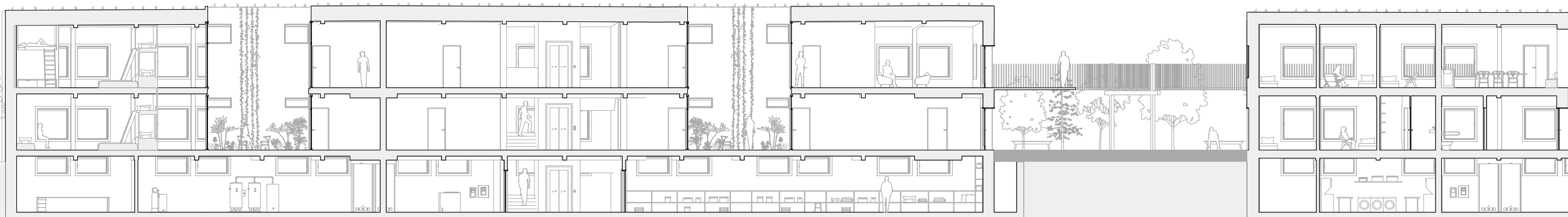
Student Accommodation



Atrium garden



Bridge



Accommodation Building I

Accommodation Building II

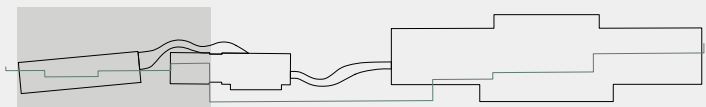
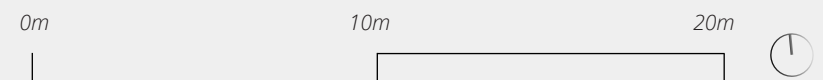


fig.4 Longitudinal section ( West to east ) 1/3

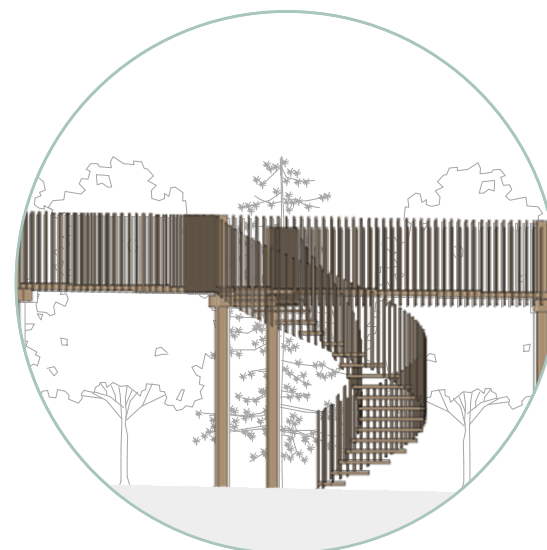




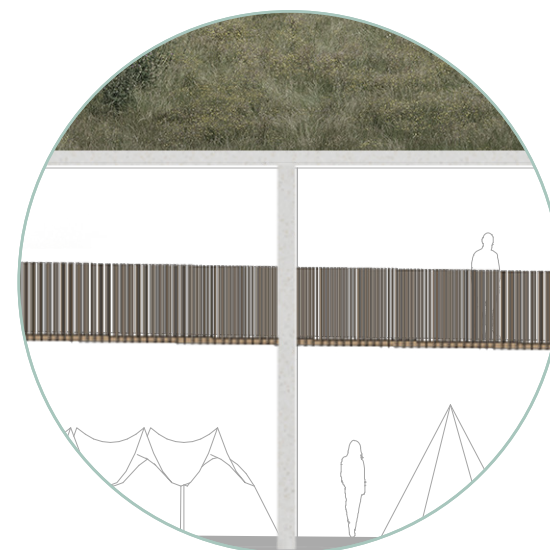
Conservatory



Orangery - Nursery



Staircase to bridge



Outdoor exhibition space

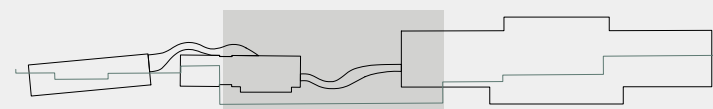
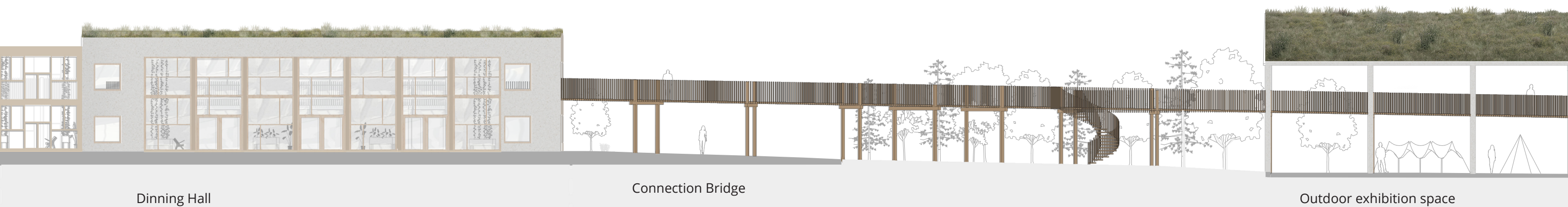
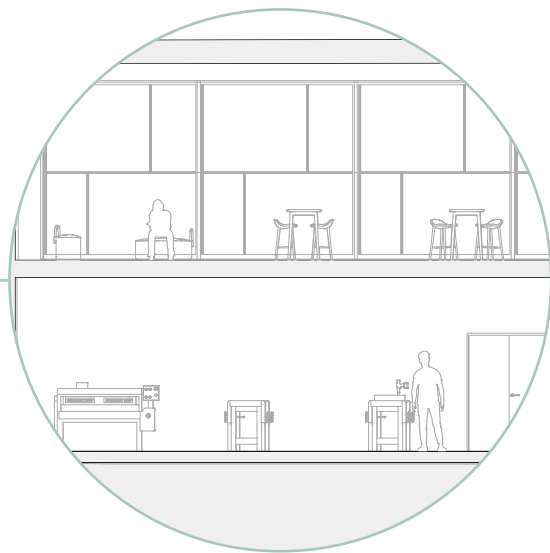
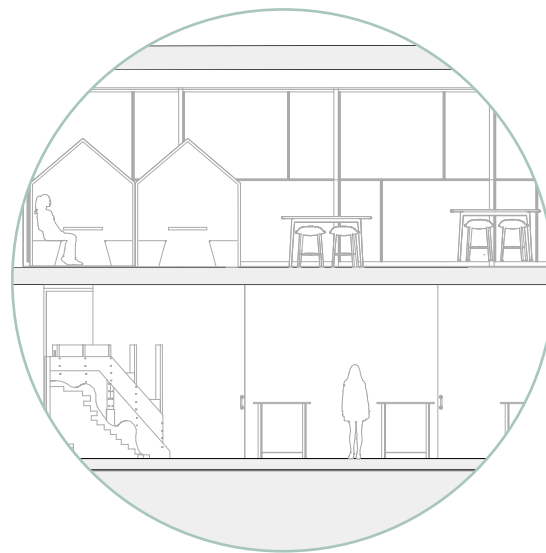


fig.5 Longitudinal elevation ( West to east ) 2/3

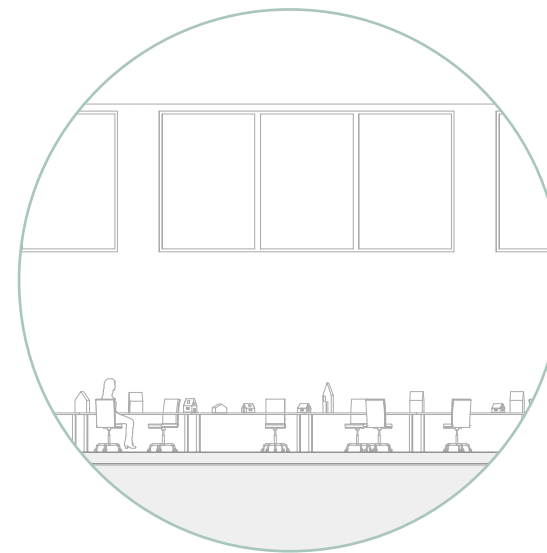




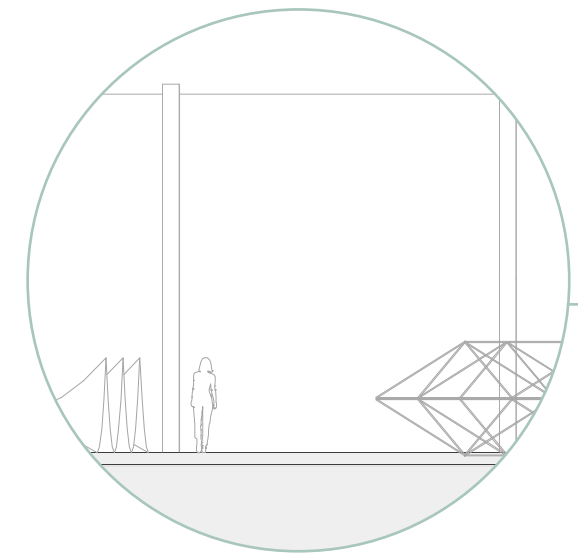
Up: Co-working area  
Down: Woodworking workshop



Up: Co-working area  
Down: Big workshop



Studio



Outdoor working space



Experimentation wing

Heart of the school

Creation wing

Outdoor working space

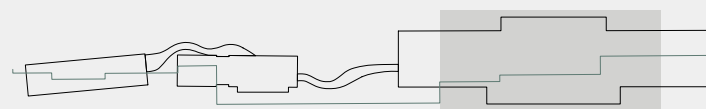


fig. 8 Longitudinal section ( West to east ) 3/3



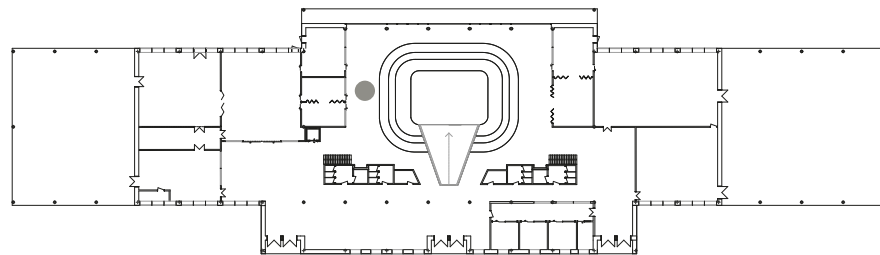


# Auderød Højskole

From Navy pool to alternative school for sustainable practices



fig.8 Render: Heart of the school - Common/ Exhibition space

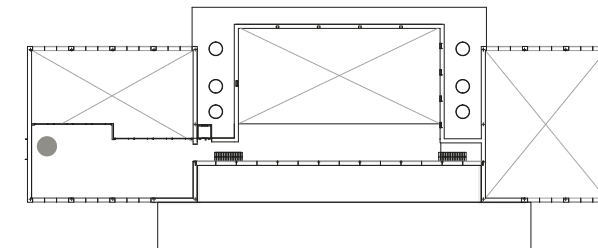


The new Auderød Højskole, was transformed respectfully keeping the best features of the former pool building and such as the beautiful slanted roof enhancing it with warmer touches such as the wooden railing and added recycled cladding on the walls. On the east wing of the school- the creation wing: (See page. 24-25) In small workshop spaces, a teaching room and a big studio are found as well as an outdoor workshop space. On the middle of the school- The heart of the

school, The former Pool was transformed into a sunk in amphitheatre designed to be used as a space where students gather themselves to socialize, create and get inspired by each-other. It is accessible with a gentle ramp that connects the main entrance almost intuitively for the users, which also allows to wheelchair users to access it. The mezzanine was further extended to create an observation deck where students can have a panoramic view of what the heart of the school



fig.9 Render: Co-working space



has to offer, This observation deck connects to the Co-working space (Fig.12) A free flow space created to boost creativity, for students to work in groups and develop sustainable projects. The large recycled window panels provide a overhead view on the ground floor workshops where students can observe what their peers are working on and inspire themselves. The ceiling cladding in this area is restored and brought to life to create a warmer feeling to the concrete whilst creating sound

insulation to lower the noise levels. The bridge that connects the site can be accessed directly from the co-working space to have a view over the outdoor exhibition space which is accessible to all visitors.



- 1. Outdoor working space
- 2. Studio
- 3. Teaching room
- 4. Small workshops
- 5. Reception
- 6. Office quadruple
- 7. Meeting room
- 8. Office single
- 9. Staff break room
- 10. Student Cafe
- 11. Heart of the school / Exhibition space

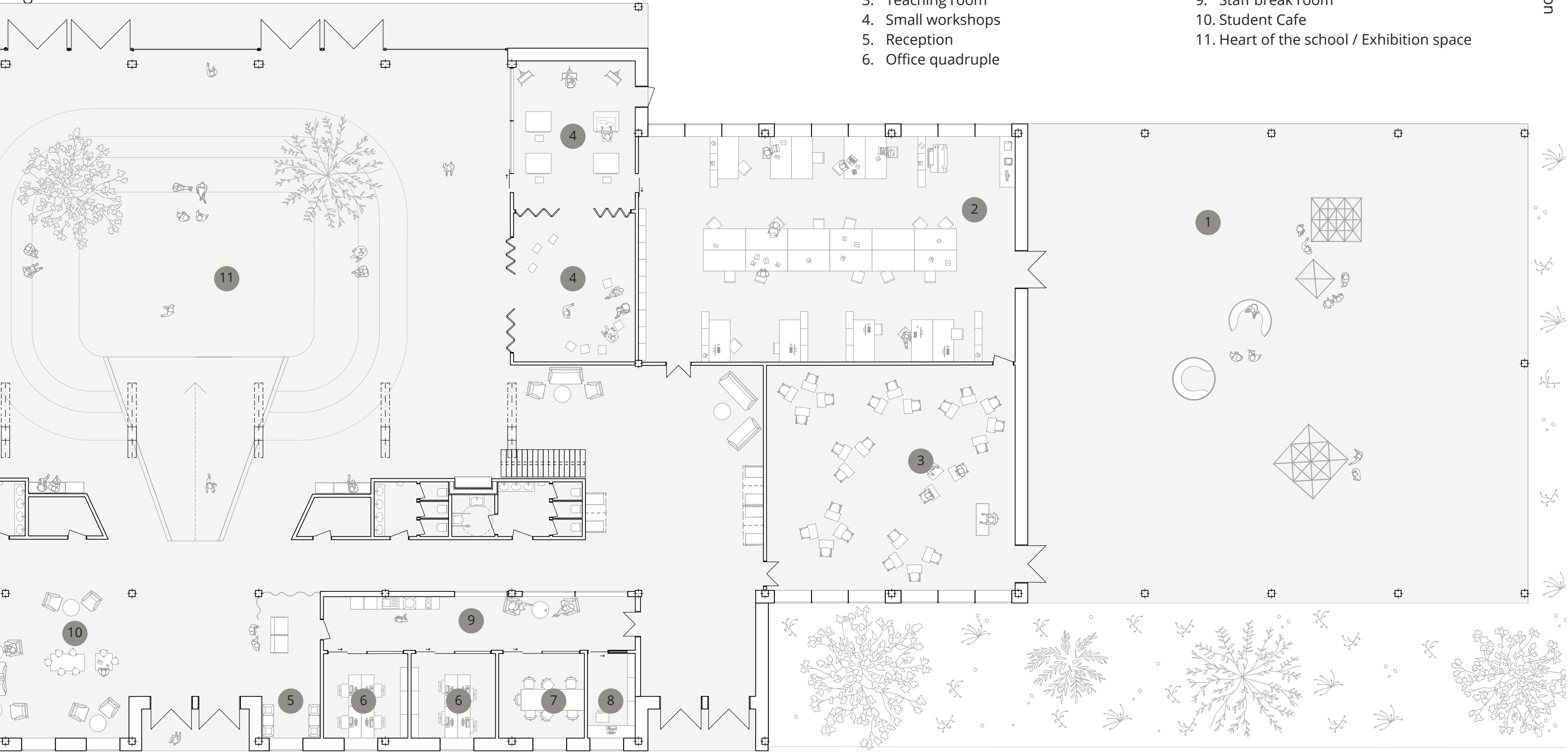
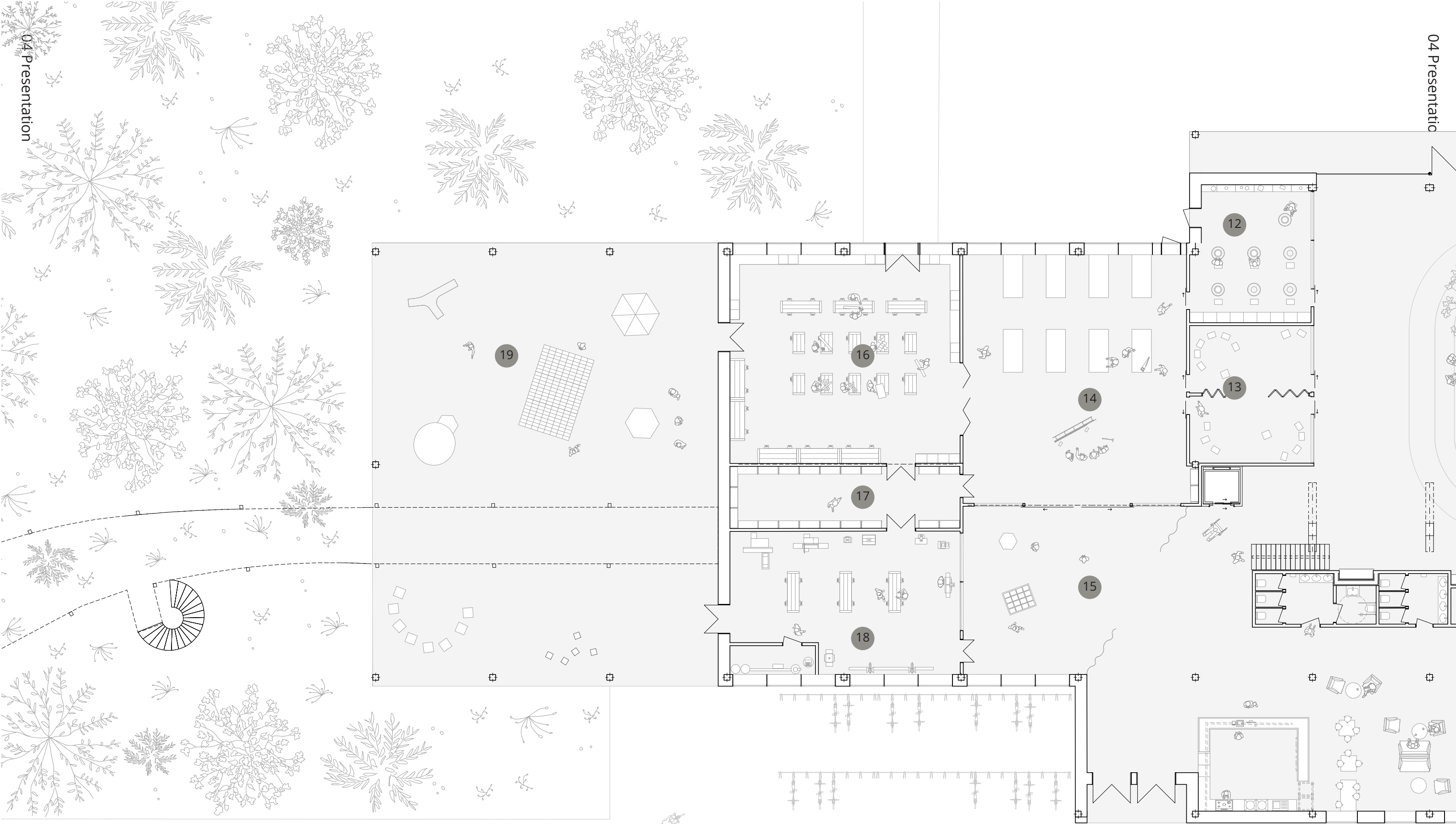
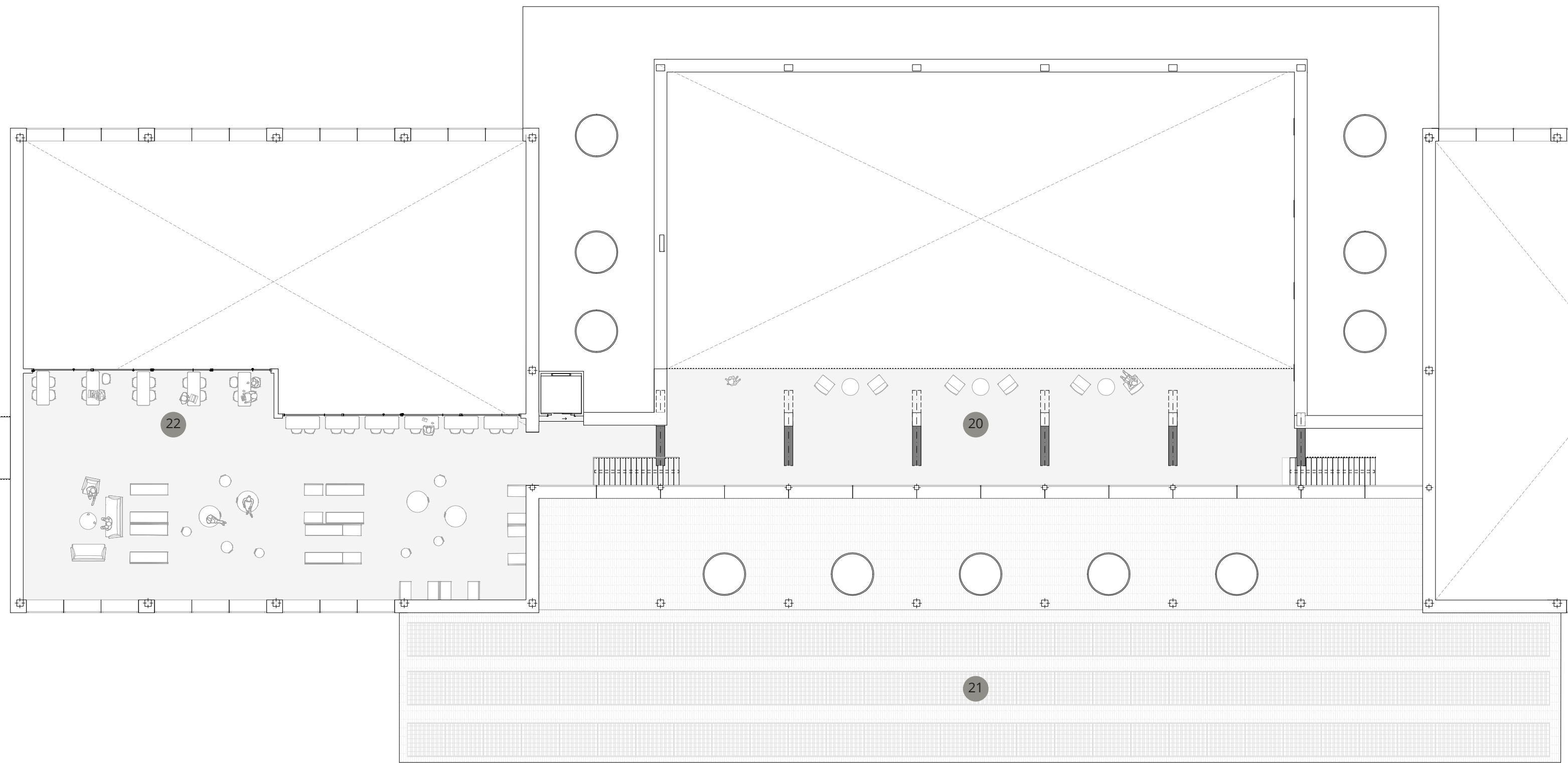


fig. 10 Floor plan: School (Ground Floor) 1/2



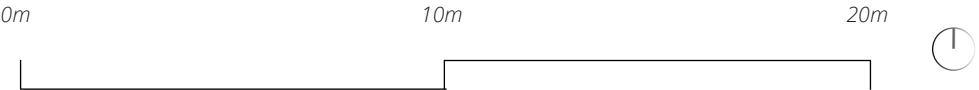
- 12. Pottery workshop
- 13. Extra small workshops
- 14. Big workshop
- 15. Exhibition space
- 16. Medium workshop
- 17. Material library
- 18. Woodworking workshop
- 19. Outdoor gallery

fig.11 Floor plan: School (Ground Floor) 2/2



- 20. Observation deck
- 21. Solar panels
- 22. Co-working space

fig.12 Floor plan: School (First Floor)



# Accommodation + Dinning

Everyday spaces tied by a bridge and greenery

The bridge connects the school to the upper part of the dining area. Part of the transformation of the building was to separate the navy barrack into two different buildings attached by a conservatory, made with recycled window panels. The Accommodation II building houses the staff in the upper floor,

with an equipped homely kitchen and dining space, to allow them to have a private time away from their daily tasks at the school. They all have private rooms with a comfortable bed, storage, and a seat by the window that the added thickness of the walls provided. (see page. 38)

1. Dinning Lounge
2. Staff kitchen and dinning space
3. Reading area
4. Bedrooms

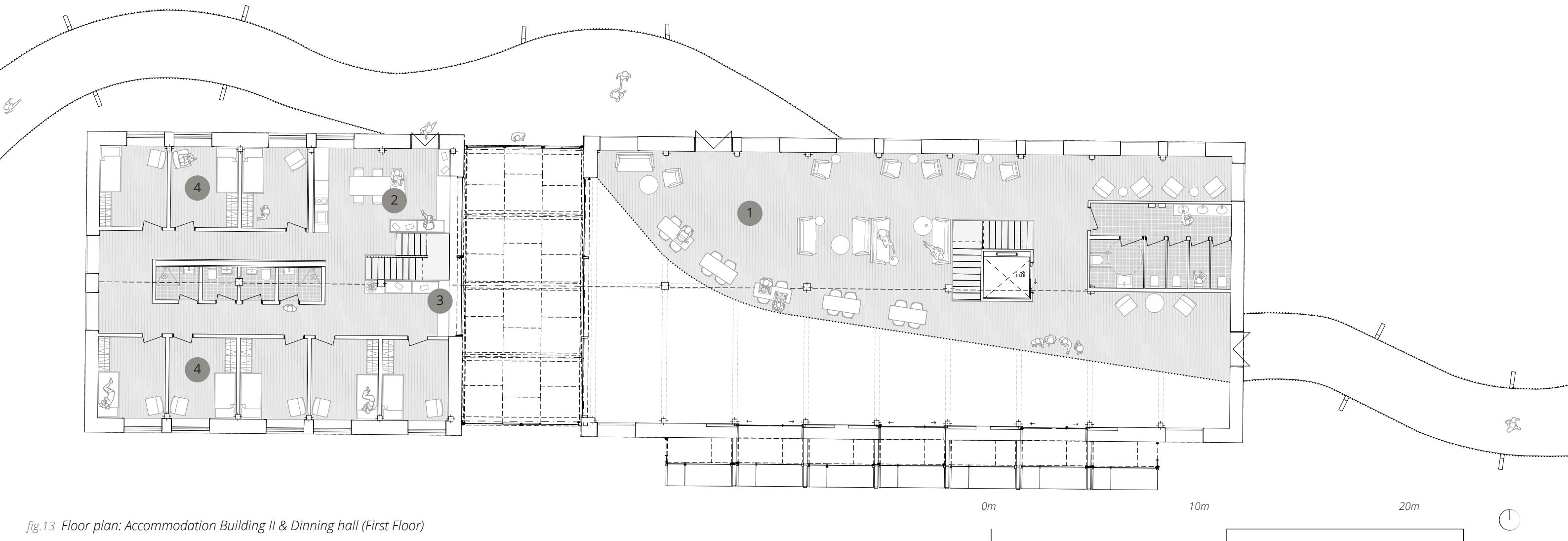
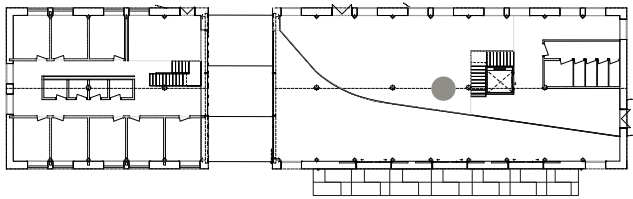


fig.13 Floor plan: Accommodation Building II & Dinning hall (First Floor)





fig.14 Render: Dinning Lounge



On the ground floor there are two small apartments that can be used either by staff or students who prefer a calmer experience at the school. It also has a special room designed for a wheelchair user. Both open to an

conservatory that divides the two buildings, this space is a green refuge to rest and admire nature, designed to provide daylight but also a space where teachers and students can enjoy.

- 5. Staff entrance and changing room
- 6. Food equipment and storage
- 7. Kitchen
- 8. Dinning hall
- 9. Working greenhouse
- 10. Orangery / Nursery
- 11. Conservatory
- 12. Disabled friendly room
- 13. Extra staff rooms
- 14. Small apartments with kitchenette

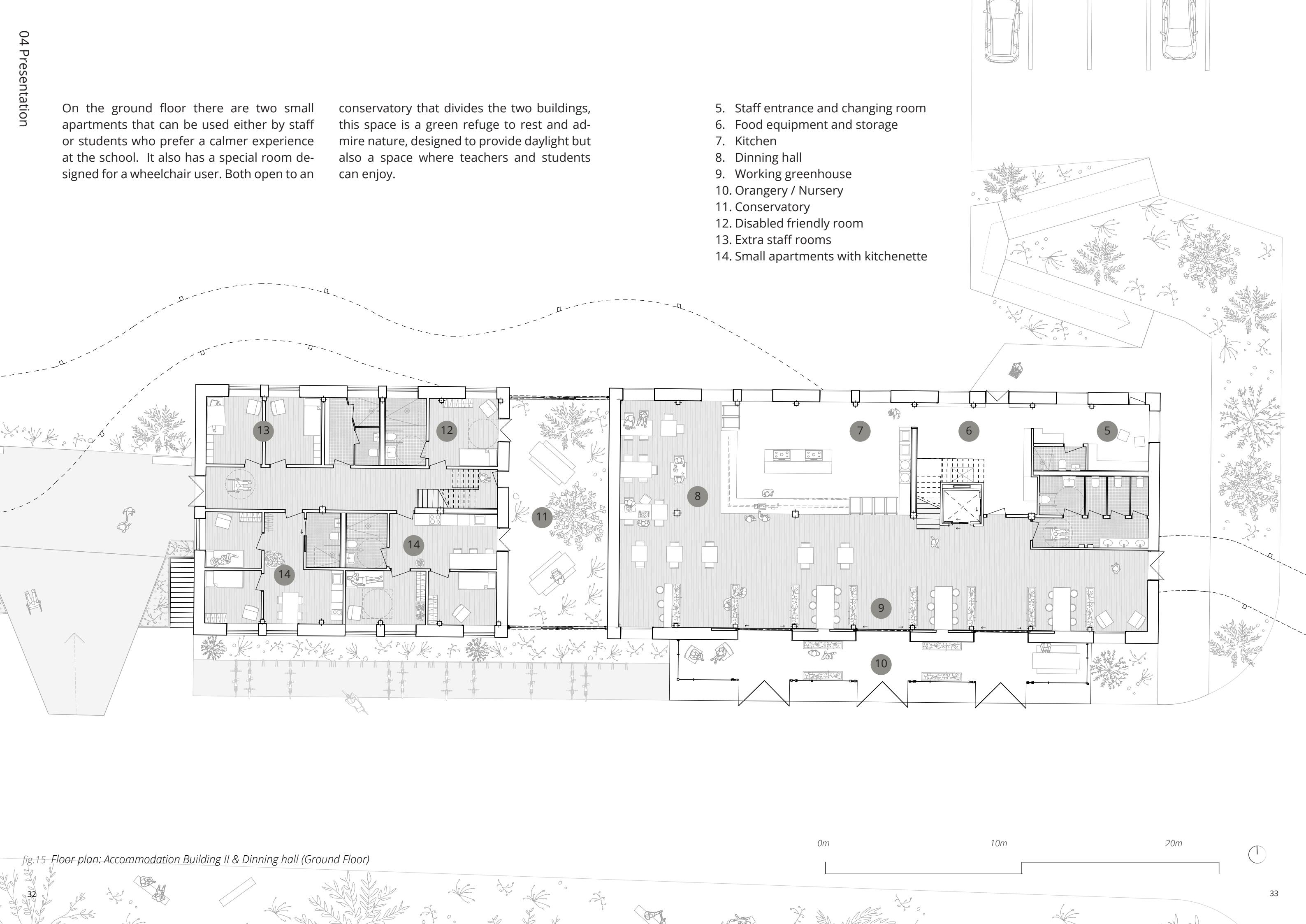
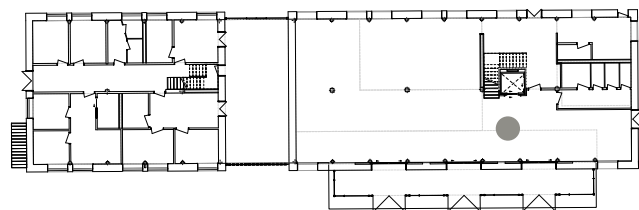


fig.15 Floor plan: Accommodation Building II & Dinning hall (Ground Floor)





fig.16 Render: Heart of the school - Common/ Exhibition space

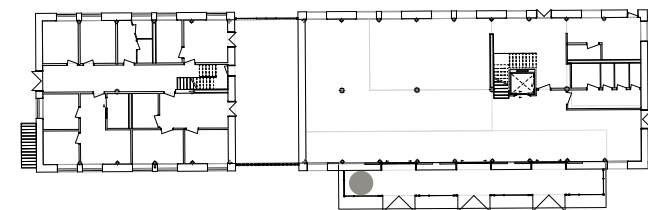


The Dinning Hall was designed to keep the existing structure while allowing for a more open space to exist. Therefore it was transformed into a double height green space, the exposed beams and columns kept from the

previous building hold the dinning lounge on top while also providing aid to hold poles for plants to climb creating a jungle like feel, which is the working space for students to take courses of sustainable agriculture, while



fig.17 Render: Orangery Nursery



producing fresh vegetables, herbs and fruits to be used in the kitchen. An attached orangery serves as nursery for fresh produce as well to obtain and control solar gains. Students can watch their plants grow in the

nursery and also enjoy a cup of coffee while enjoying the view and the sun even during the winter.





fig.18 Wooden Facade Elevation Accommodation Building I (East)

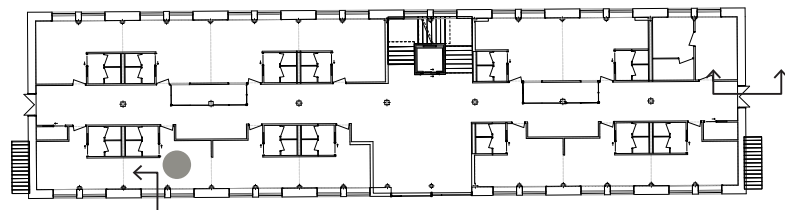


# Student Accommodation

Co-living in harmony



fig.19 Render: Heart of the school - Common/ Exhibition space

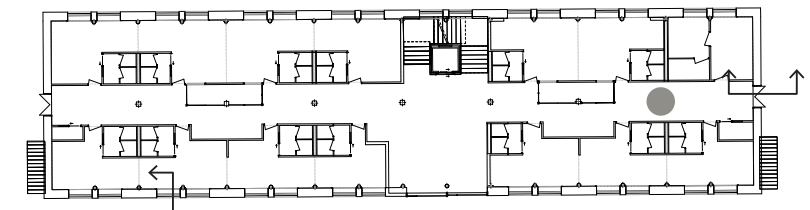


The layout of the building allows students to choose from a variety of rooms ranging from two to five students per bedroom, some of the beds are built in dynamic beds that saves space while ensuring students have privacy and extra storage. Each bedroom has an en

suite wash-room that has a sink, toilet and shower separate to allow the students to have efficient use of space, meaning that in the morning while one student can shower, the other can use the sink or toilet without interfering each other. Alike the staff bedrooms



fig.20 Render: Orangery Nursery



the student bedrooms also have a seat space in front of the window, the bedrooms were designed to feel comfortable and homely with reduced space intentionally to incite the students to use the many common spaces available on site, the central atrium gardens

provide ventilation and light while it also provides a space to sit and contemplate, read a book, or relax with a friend.

- 1. Disabled friendly room
- 2. Shared bedrooms (2-5 people)
- 3. En-suite wash room
- 4. Seating / contemplation space
- 5. Common lounge
- 6. Atrium garden



fig.21 Floor plan: Accommodation Building I (Ground Floor)





## 7. Common Lounges

fig.22 Floor plan: Accommodation Building I (First Floor)



# Construction

## Recycled wood Facade

The construction elements marked with a **lighter color** in the following list are left from the former barrack building. The wood is salvaged on-site and is used in the gable walls of the Accommodation buildings and dinning hall.

### Light weight green roof 750mm

1. Sedum mix mat over Filter of geotextile (Green roll) 60mm
2. Integrated drainage system
3. Waterproofing membrane with root protection
4. Straw insulation with timber structure 400 mm
5. Paper vapour barrier
6. 100mm Light concrete
7. Exposed concrete structure (beams/columns)

### Bridge

8. Wood railing max distance between 100mm
9. Hardwood H structure system
10. Recycled reinforced concrete slab 200mm
11. Load-bearing thermal insulation element, Schock Isokorb XT 120mm

### Facade

12. Recycled facade Lamellas 25mm
13. Ventilated air gap in counter-battens 45x45
14. Hunton wind proof 25mm
15. Straw insulation with timber structure 400 mm
16. Pressed straw insulation
17. Velfac 200 Energy door in wooden frame
18. Drainage system
19. Weather strip
20. Airtightness tape
21. Paper vapour barrier
22. Light concrete 100mm

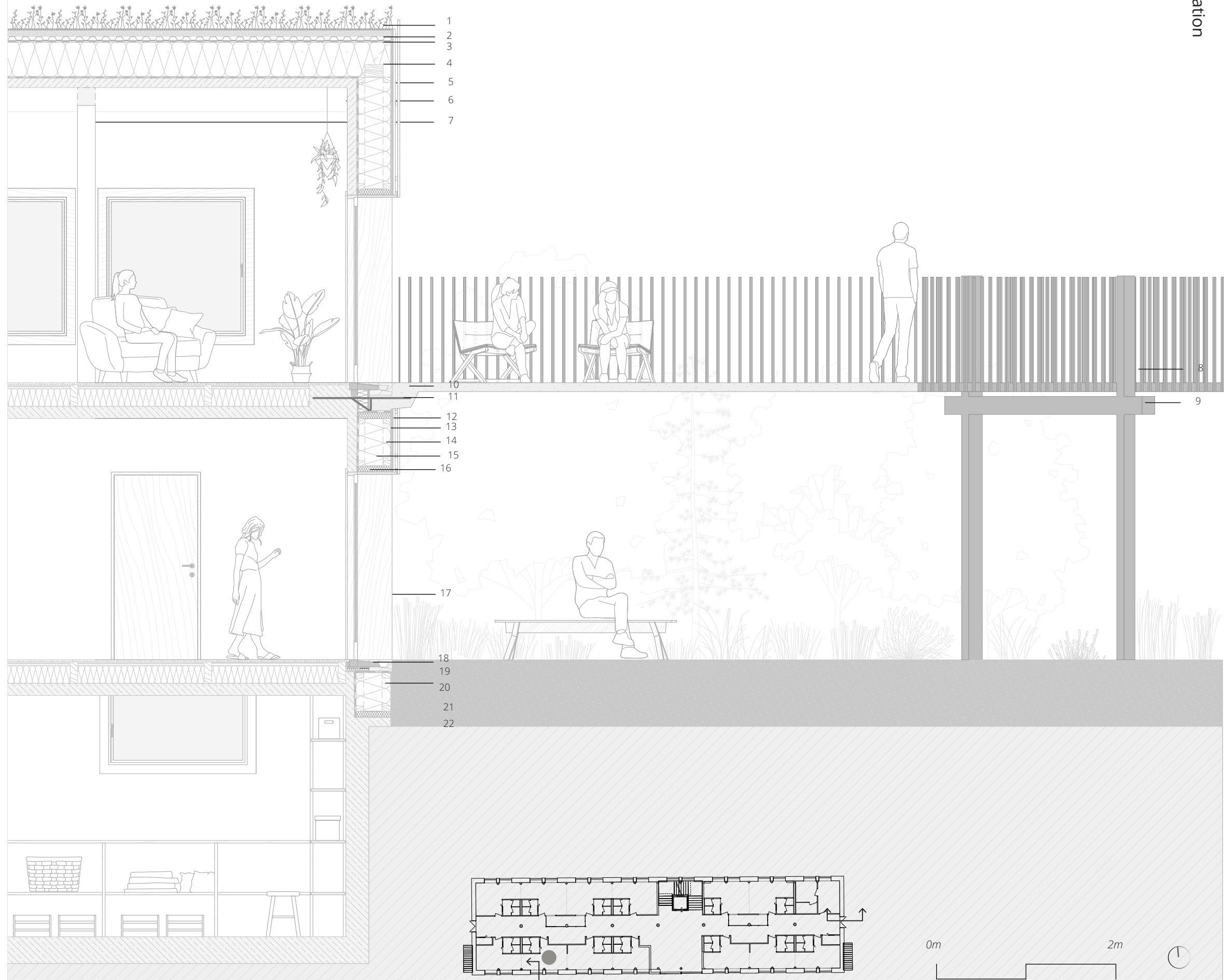
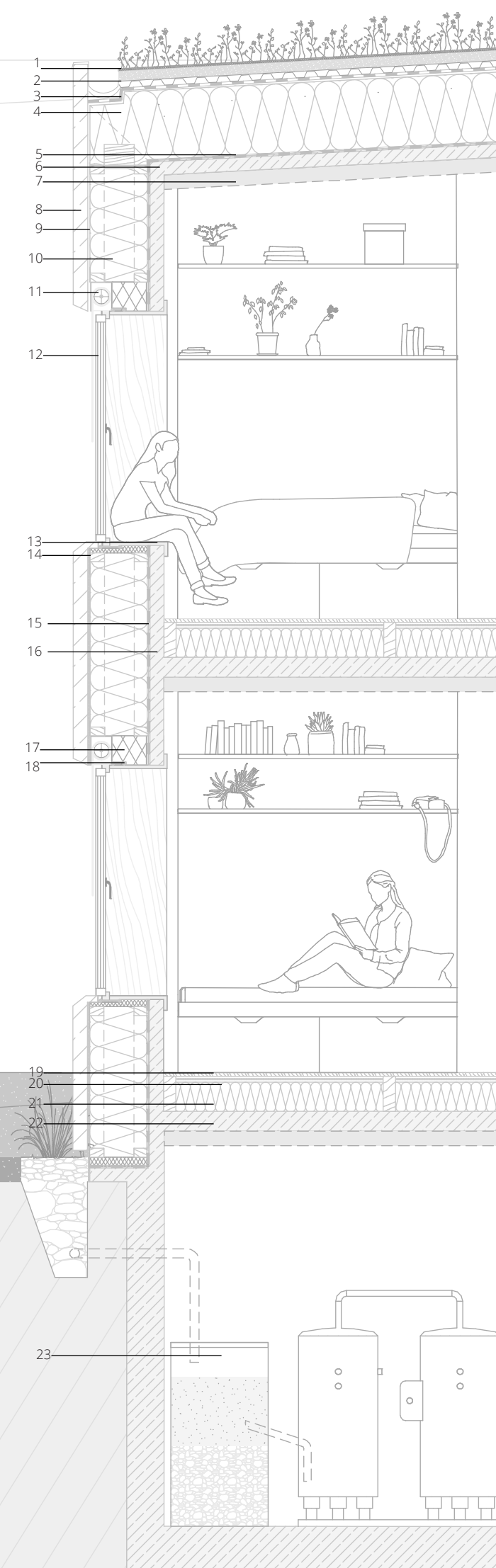


fig.23 Construction detail Wood facade

# Construction

Recycled concrete Facade



## Light weight green roof 750mm

1. Sedum mix mat over Filter of geotextile (Green roll) 60mm
2. Integrated drainage system
3. Waterproofing membrane with root protection
4. Straw insulation with timber structure 400 mm
5. Paper vapour barrier
6. 100mm Light concrete
7. Exposed concrete structure (beams/columns)

## Facade

8. "Terrazzo" Recycled concrete facade panels 100 mm
9. Sprayed on mortar over protection layer 15mm
10. Straw insulation with timber structure 400 mm
11. Facade integrated roller blind
12. Velfac 200 Energy window in wooden frame
13. Solid wooden sill
14. Airtightness tape
15. Paper vapour barrier
16. Light concrete 100mm
17. Pressed straw insulation
18. Weather strip

## Floor

19. Parket flooring 20mm
20. Underfloor heating 40mm
21. Straw insulation with timber structure 400 mm
22. Light concrete slab 100mm connected joined to basement walls
23. Water filtration system (see page xx)

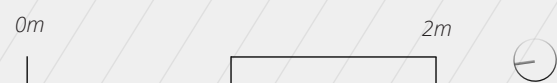
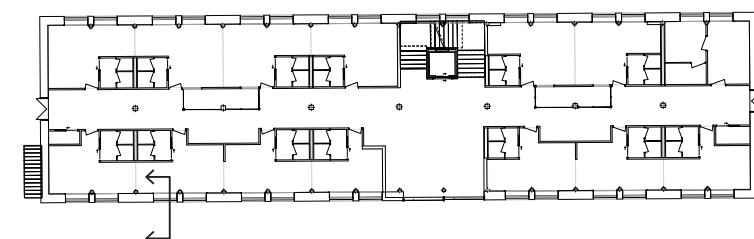
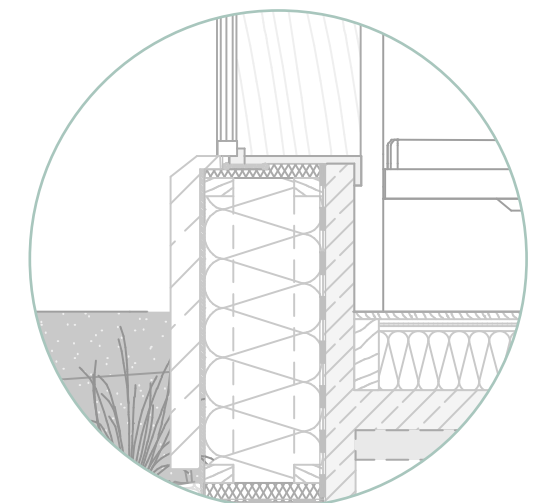
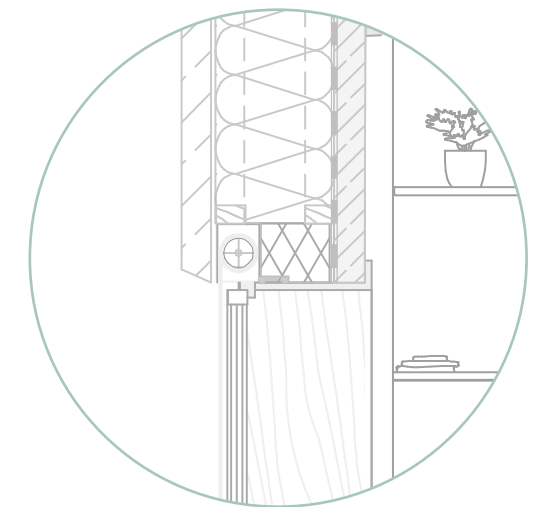
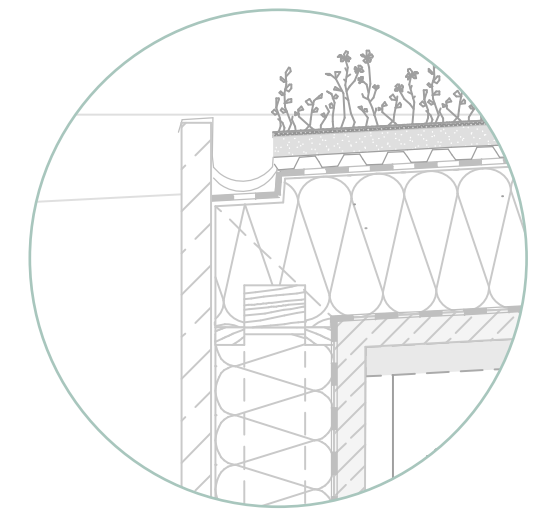






fig.24 Recycled concrete Facade Elevation Accommodation Building I (East)

Concrete is the most predominant construction material on site, therefore new concrete recycled "terrazzo panels" were created to clad the exterior façades. To preserve historical significance of the site as well as

In order to reach the U Value of  $0.12 \text{ W/(m}^2\text{k)}$  to comply with regulations. New insulation needed to be added making the walls thicker

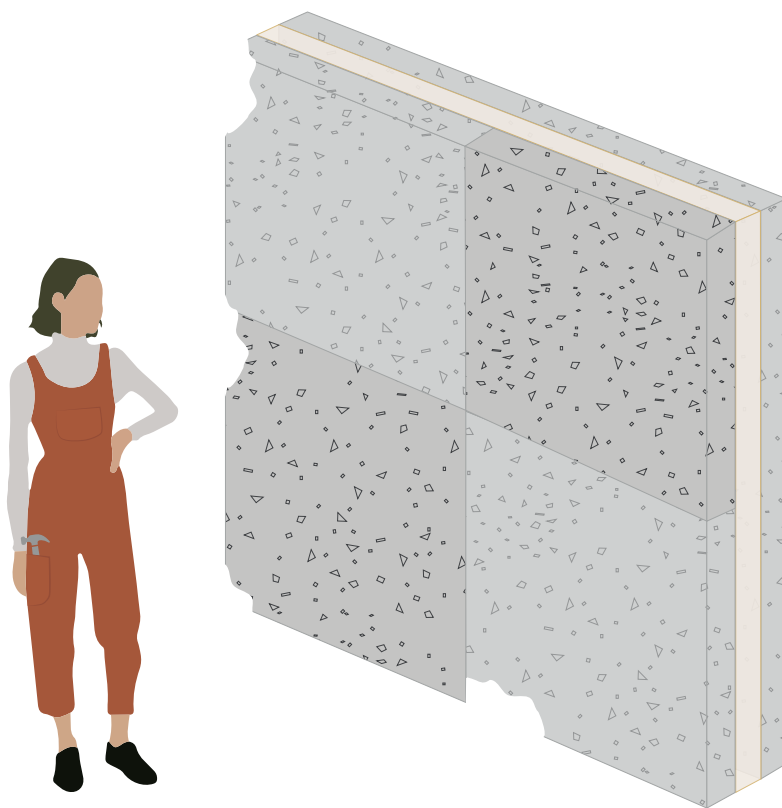
to 600mm in total, which allowed the rooms to have an extra seating space by the window.

A green roof is integrated to the buildings with integrated water management system. As a sustainable alternative from the old asphalt roof- The asphalt material is reused to create new ramps and pathways on site.





# Disassembly of Existing structure



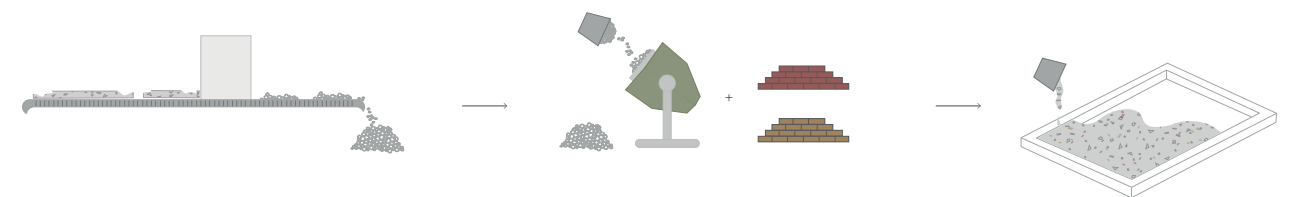
**1** The original external concrete is damaged and worn

By evaluating different scenarios of how to process the mapped materials in the buildings scenario 4 has been chosen as the final concept. The advantage of choosing this scenario is to directly reuse as much material as possible, since this is the most sustainable way to handle reuse. This means, that the interior concrete element of the exterior walls is kept as is, the exterior element is demol-

ished and down-cycled and the insulation material is taken out. The insulation material can be used as acoustical panels elsewhere as the material does not contaminated. The concrete is crushed, mixed with cement and other stone materials such as brick from other demolished buildings. The process of how to demolish the original walls are showed above.



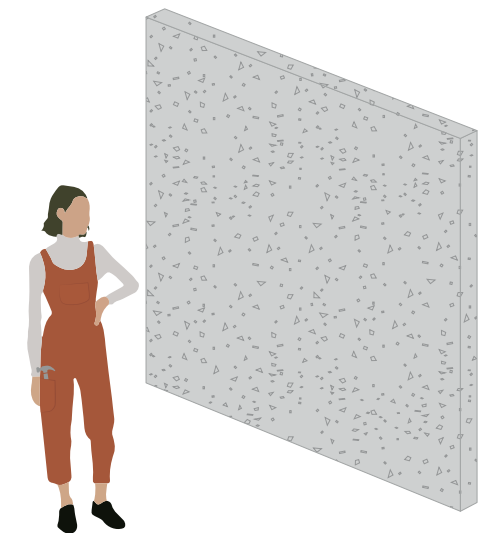
**2** A simple tool can separate the concrete from the connectors and be taken down in small elements



**3** The small elements are put through a crusher to ensure the pieces are crushed properly. The crushed concrete is mixed with cement and other stones and casted into new elements



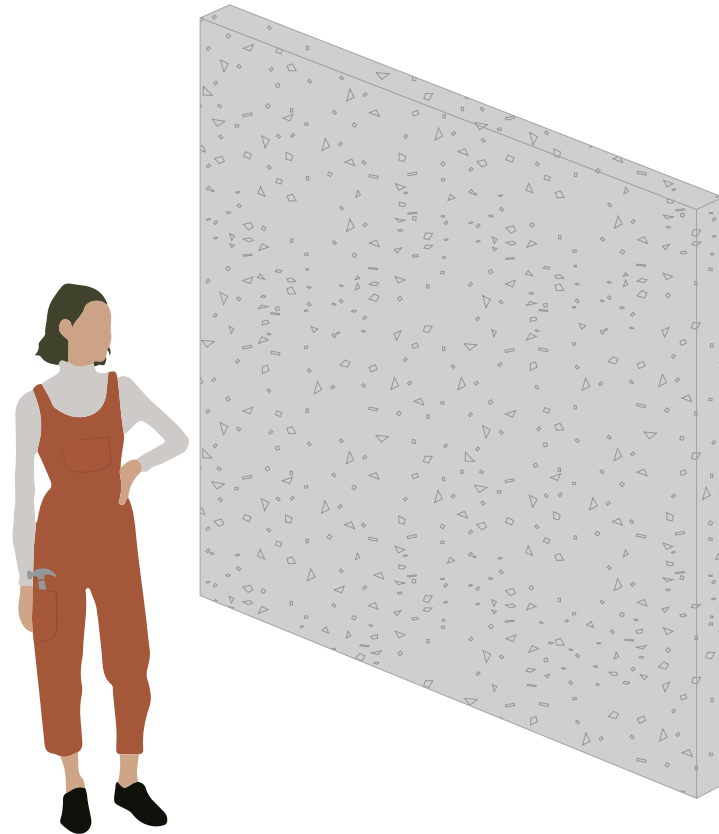
**4** Insulation material is separated from the concrete



**5** Finally, the interior concrete element is displayed



# Designing of Existing structure



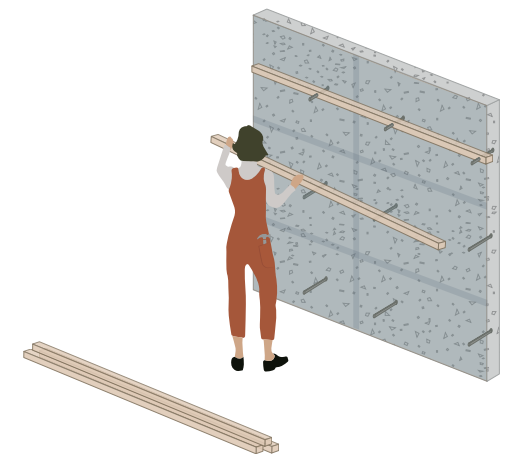
**1** The naked interior concrete wall needs protection to ensure a tight envelope

The naked interior concrete wall needs additional material to comply with the building regulation and insure a high quality indoor environment. Adding material to the outside of the wall opposed to interiorly secures a tight envelope and avoids thermal bridges. Changing the exterior have great influence on the architectural expression of the buildings and according to the cladding material it

is important to consider the structural build-up to avoid unwanted moist transportation. Sustainable straw battens fastened in a wooden structure has been chosen as insulation material. The exterior is down cycled concrete of the original external façade elements.



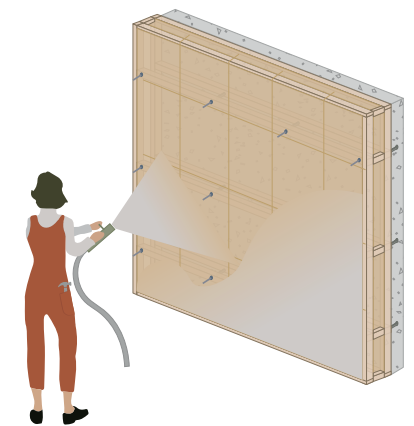
**2** A paper vapor barrier is fastened with air-tightness tape



**3** A wooden skeleton is built on the wall fastened to the existing connectors in the concrete and assembled with wooden screws



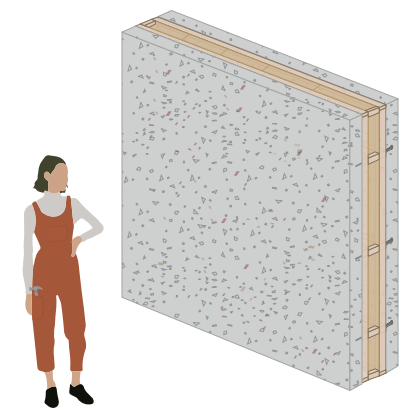
**4** Straw insulation battens are secured in the wooden construction



**5** A sprayed on mortar layer is added to the straw insulation panels as a protecting layer to avoid the use of excessive material and to reduce the thickness of the wall.

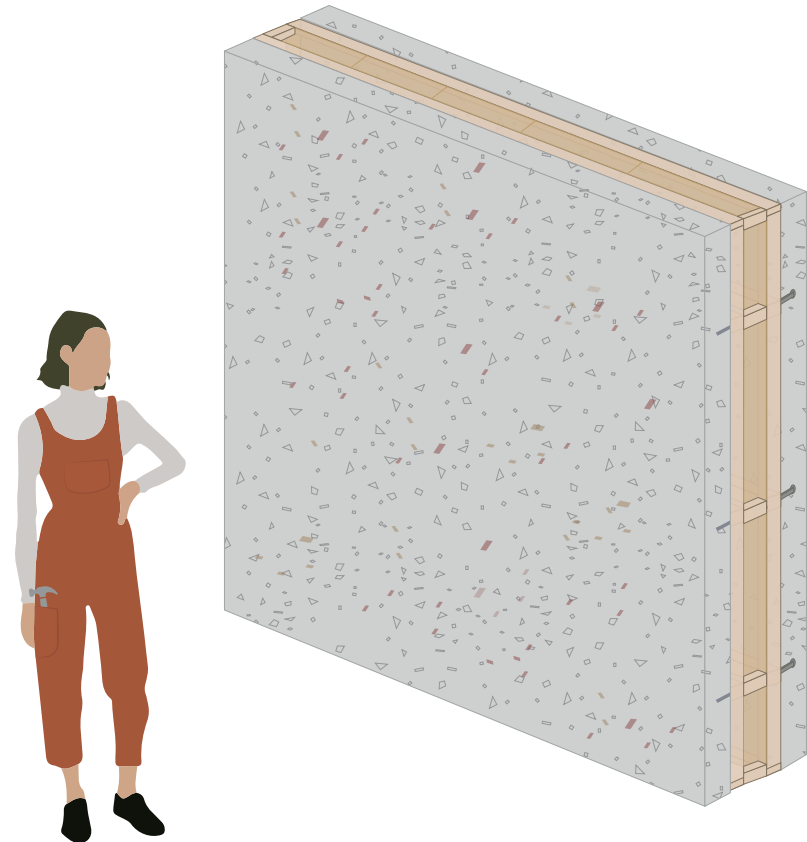


**6** The new down-cycle concrete elements are placed on the exterior and fastened with connectors



**7** The final look is a concrete terrazzo finish that tells the story of the original materials

# Design for Disassembly



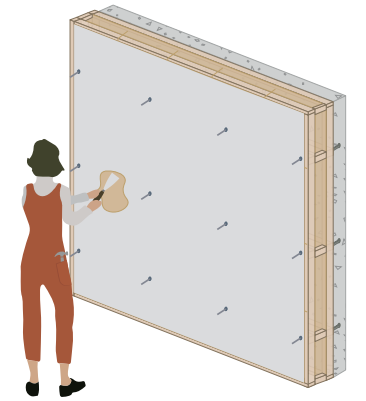
**1** The wall element in its glory with concrete terrazzo finish on the exterior

To prepare for future demolishing of the building with the potential of reusing the material as easy as possible, a disassemble and re-assemble plan has been developed. With Bio-based materials, design for disassembly and re-assembly is not an option as the duration of the natural materials is not as pro-

longed as synthetic materials, however in the natural world, living beings are designed to live, exist, and decompose naturally. Therefore, no plan for reusing the straw insulation panels is developed but a strategy of removing the panels from the concrete elements is included in the dis- and reassemble plan.



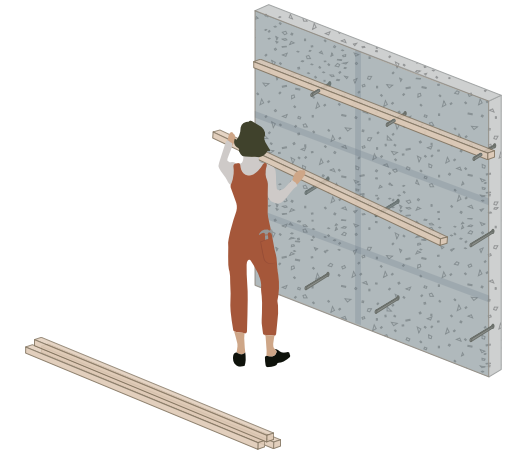
**2** The exterior element is carefully detached by removing the plastic connectors. The connectors can be recycled



**3** The sprayed-on mortar layer can be scraped off and recycled even if it contains some straw fibres



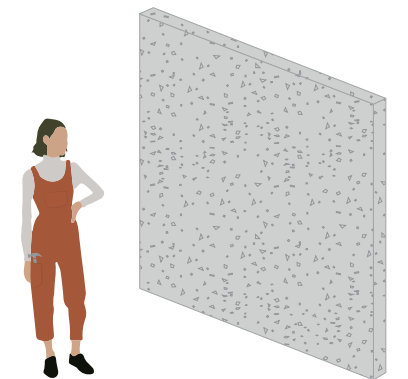
**4** Straw insulation panels are removed and left on the fields to decompose naturally



**5** Wooden structure is taken down, and because of the use of wooden screws, they can easily be taken apart and reused somewhere else



**6** The paper vapor barrier is taken down by removing the airtightness tape and can be reused elsewhere



**7** Lastly, the only material left is the original concrete interior element

# Mechanical ventilation and water management

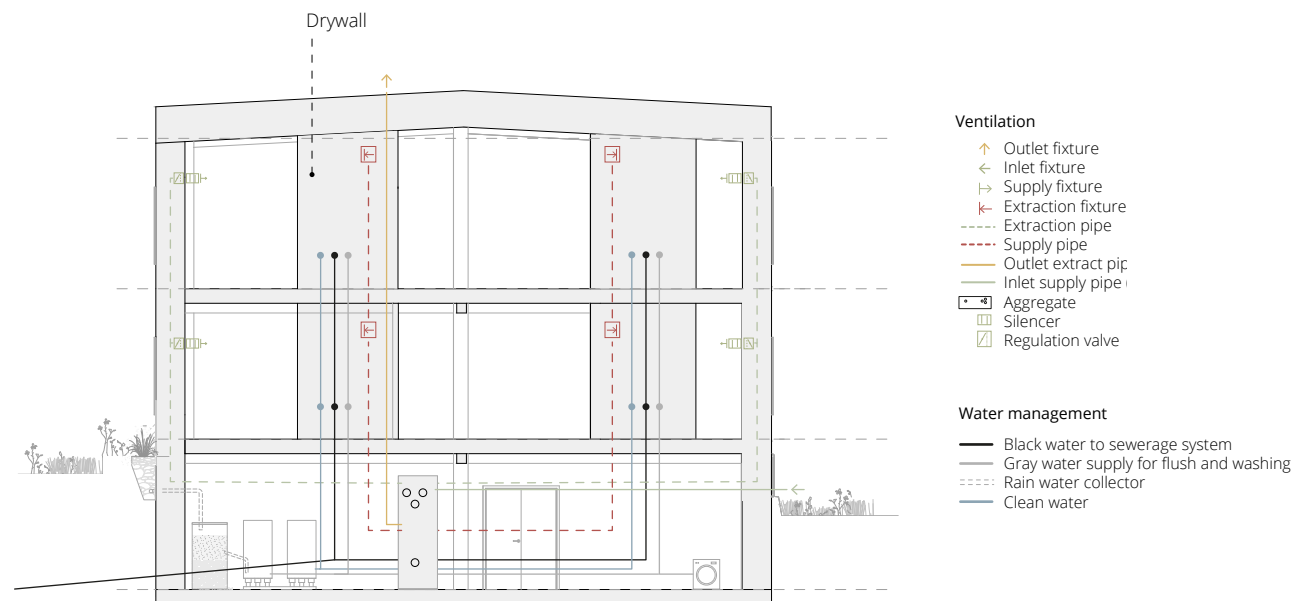


fig.25 Cross section

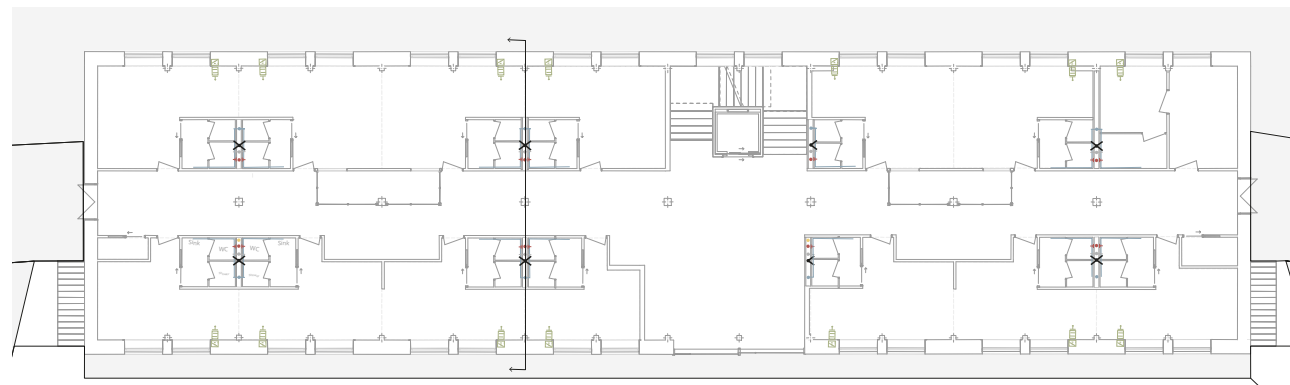


fig.26 Ground floor plan

## Bedroom facility

Ventilation pipes are distributed in the basement and only led through the floors vertically as illustrated in the section. Vertical distribution secures a hidden system that does not disturb the architectural expression of the repeating visible beams. By placing the piping and the fixtures in the walls the bedrooms are more comfortable, especially because they have been designed to limit the amount of unused space through beds in two levels. Supply air is led to the bedroom through the exterior wall whereas extraction

of air only happens in the bathrooms through the drywall. The plan layout of the bedrooms is systematized so the piping can be centralized in a core drywall shared between two bedrooms on each floor. Therefore, the water management piping is easily distributed vertically through the floors to a central system in the basement where water can run to the washing and cleaning stations for the users. The piping systems are only illustrated for the ground floor in the plan, but the same system is valid for the first floor.

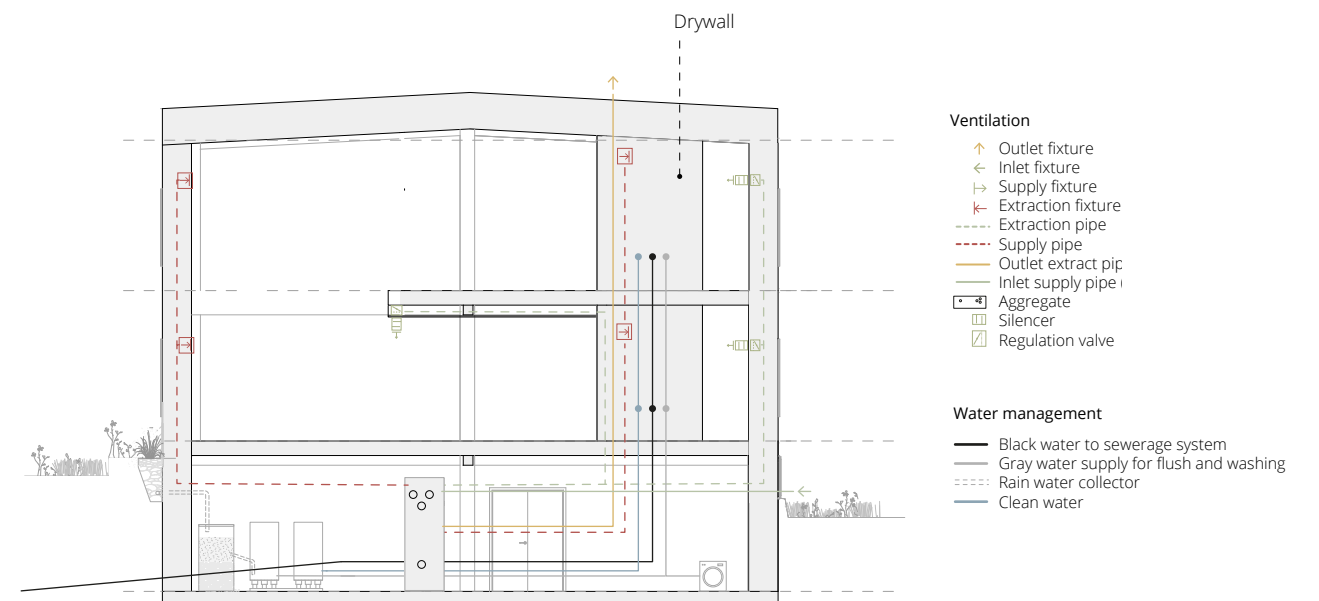


fig.27 Cross section

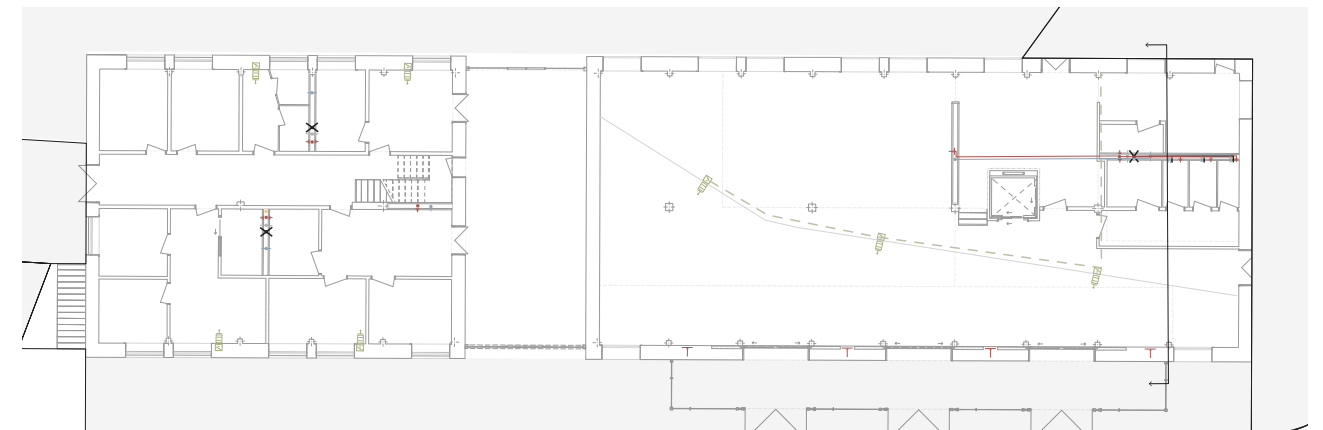


fig.28 Ground floor plan

## Dining facility

The system in the barrack hosting dining and workshops are similar to the principle used in the sleeping barrack except less water management piping is needed but a bigger ventilation system is required to meet the use of the building. Ventilation supply fixtures are placed in a suspended ceiling underneath the 1st floor to keep the clean look of the ceiling on the ground floor. Supplying the first floor happens through the exterior walls in order to not disturb the visible beams in the ceiling. Extraction fixtures are likewise placed

in the walls for easy distribution and a clean look. Only extraction of air happens in the bathrooms to ensure atmospheric comfort. The system is collected through the drywalls in the wet rooms and led to a centralized system in the basement similar to the one in the sleeping barrack. Maintenance of the systems is easily accessible through the basement with a normal room height.

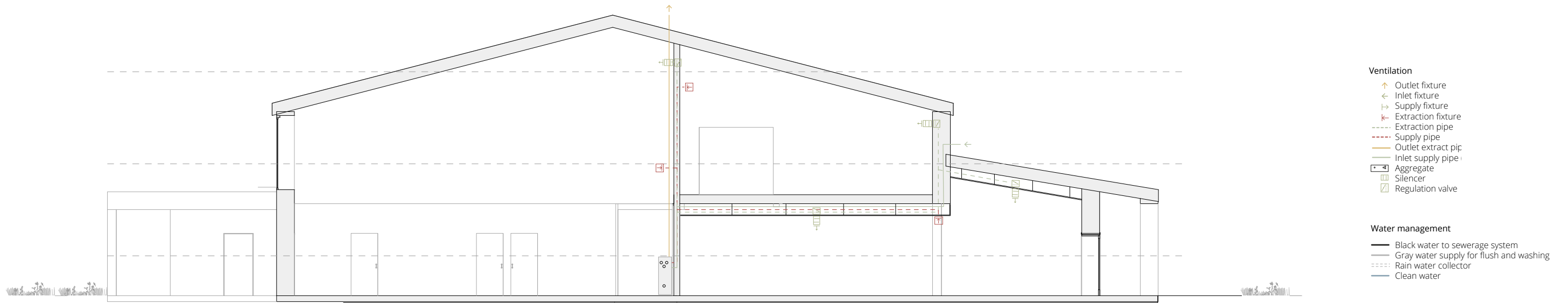


fig.29 Cross section

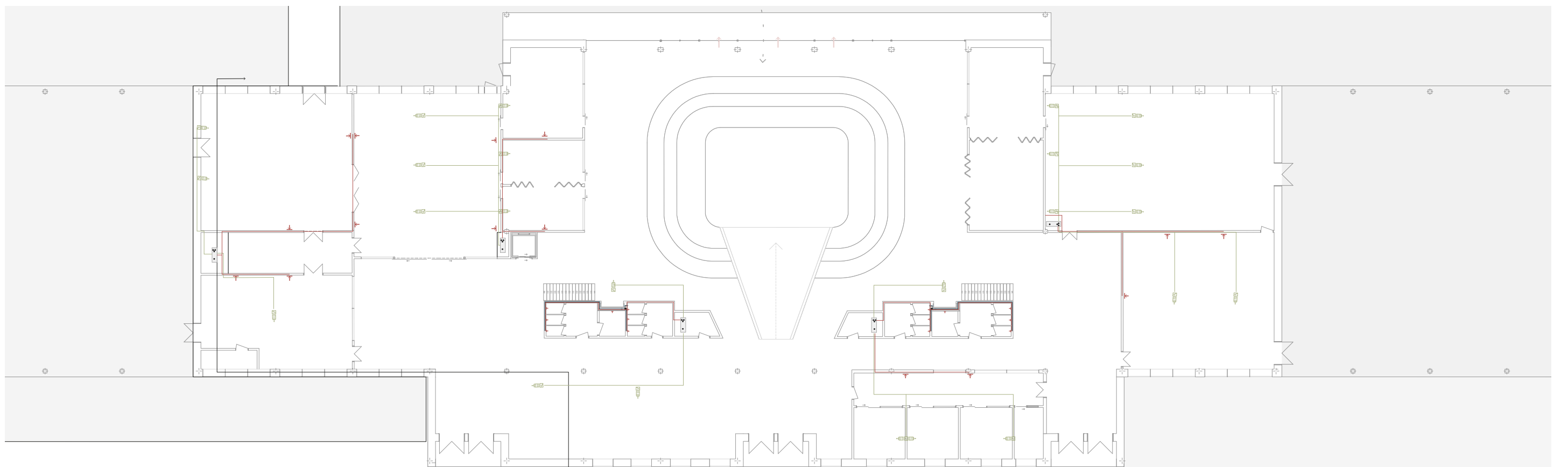


fig.30 Ground floor plan

### Education facility

Different principles of ventilation system distribution have been used in the educational facility as the rooms differ greatly. The double height rooms with vaulted ceilings need a system that leads the fixtures inside the walls to secure a clean architectural expression in the ceiling. This also allows for supply and extraction of the air to be distanced so the system does not extract the freshly supplied air

before it is mixed with the polluted. The remaining rooms, with no vaulted ceilings, are supplied with air through a suspended ceiling and so is the extraction of the air.

Due to climate change, the rain in Denmark is getting heavier. The large amounts of rainwater must therefore often be handled locally. It can be difficult to drain the water properly

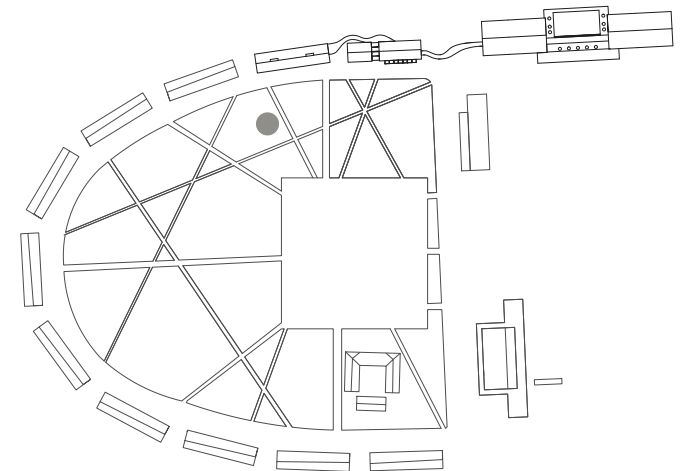
so reusing the rainwater is an efficient way to collect the water and save clean water, where it is possible. According to The Ministry of Environment of Denmark, rainwater should not be used as drinking water, unless a spacious and advanced cleaning system is used to clean the water properly. Therefore, the collected water in the buildings can be cleaned through a smaller system and sup-

plement the water use in washing machines, for cleaning the facilities, watering the garden and flush the toilets. (The water is collected through the integrated drainage system in the green roof and through a gutter system in the ground alongside the building.)





fig.31 Outdoor render





# Conclusion

## Problem statement

### Problem statement

How can an abandoned military camp be transformed into a Folk School that embraces alternative and flexible learning through hands-on and practical teaching? And how will the fixed military order and structured plan layout meet such flexible learning?

How can such a space be developed through circular economy as a design tool with focus on reuse of the existing material, harvesting of materials elsewhere and new sustainable material?

### Conclusion

Auderød Højskole, is the final project proposal of re-purposing an abandoned navy camp from the 50's into a modern folk school. The school embraces alternative and flexible learning through the various sizes of workshop rooms facilitated in the educational building. The

building is divided in three zones: creating noisy, social, and creating teaching. The bigger workshop areas are placed in the 'creating noisy' zone designed for hands-on and practical work because of the double height room with enough space for big machinery and the concrete flooring and walls that are strong enough to withstand someone dropping a hammer.

The smaller workshop and teaching rooms are of a more intimate atmosphere and therefore placed in the 'creating teaching' zone. The size of the rooms is smaller and located far from the big noisy workshop spaces.

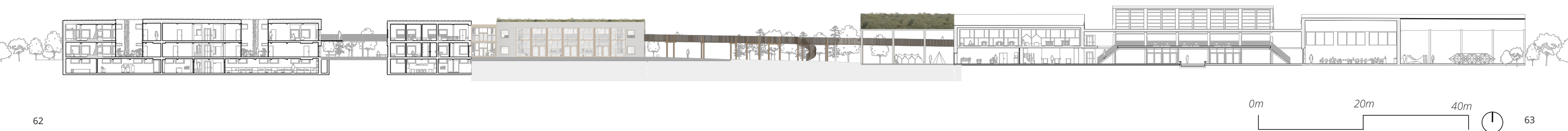
The centre of the educational building is the social 'heart of the school' where the original pool is transformed into seating areas imitating the depth of the pool. The plan layout is open and flexible with curtains and separation walls so the

students can transform the space as the wish. There are moreover spaces free for exhibitions of projects, so the students can inspire and learn from each other.

An organic shaped bridge, that connects the bedroom facility, the staff facility, the dining facility and the educational building breaks with the military order of structure and logic and contributes to a dynamic and playful environment. Everyone can access the bridge either by staircases, which is placed multiple places, both in and outside or by elevators in all four buildings.

The entire project has been developed through circular economy as a design tool. This means, that the material found on site are reused on site. Some single cases of incorporating new materials are seen in the straw insulation materials, which are natural and biodegradable and, in the paper vapor barriers of securing a tight envelope.

It is important for us to show that quality construction can be done with reuse of materials. In fact, we would go so far as to say that recycled construction is of higher quality than new because it conveys the story, we have all become so quite good at forgetting.



# Reflection

## What is sustainability?

Working with sustainability is challenging. We have, through the process of this project, asked ourselves many times if the solutions we choose are the right ones, and if they are as sustainable, as we want. But what is sustainability? Sustainability is mostly described as a unified harmony of social, environmental, and economical, especially if you want to use the evaluation tools available, such as DGNB. It is important to take all three aspect into consideration, but it is also very complicated. The possibilities are endless like an intersection in the middle of Tokyo where you can go any direction you wish.

This thesis has its primary focus on environmental sustainability, especially through materials, because we think it is an important and interesting way of working with sustainability that is still fairly new in the building industry. We want to push the agenda towards thinking about reuse of material in every single project made in the future.

It is about using the products already available to us rather than to exploit natural resources. We believe that the change must be social and political. To inspire other architects, engineers, politicians, and further professionals to create platforms, and resources to facilitate the process of doing re-purposed architecture. Our take this time is to hopefully

inspire other minds to question themselves on the way we design.

## What are the challenges of working with sustainability?

The topic for many years has been developing passive, almost zero-energy, buildings with good indoor environment, well insulated envelopes and energy supply from responsible renewable sources which is important aspects of building sustainable. Those aspects are, nowadays, very incorporated in the industry through regulation, guidelines, and cases and its nearly impossible to complete a project without complying with low energy demands.

The regulation has in fact become so strict to ensure quality of every project that it is nearly impossible to work with reuse of materials. The political agenda and traditional building costumes ('byggeskik') Will need to become more flexible and innovative to really put circular economy on the agenda. We live in a world so rich that the "use and throw away" culture is paramount and cultivated like never before. Even though the average Dane is well aware of climate change, very good at reusing clothes and furniture, recycling plastic, paper, metal, and general waste the box that we live is still build from new material. We need to scale it up to be successful. And this is where the challenge lays.

## How does theoretical methodologies work in practice?

Working with circular economy in buildings is complex. Each project must be treated individually because they vary in types and quality. As described in the chapter of working with circular economy as a design tool on pages 46-53 in the programme report, the registering, harvesting, testing, and evaluating process of a project is very time consuming and thereby expensive. This is where the limitation of the method lay.

We have directly been met with the challenge of a time-consuming process of registering available materials because of the size of the project. We have, moreover, not been able to stress test the quality of the materials and because the technical drawings are protected by the Danish Defence, we have been forced to estimate according to reference cases and literature on building methods in the 1950's. We can therefore only speculate if the final project proposal is possible in practise.

## How is scale affecting integrated design?

It can, moreover, be reflected upon how working with integrated design in a project of this size influences the process and the final outcome. We have only been able to test sections of the project because of the time limit of 5 months of writing the thesis. Such sectional testing can be seen in the combined architectur-

al and engineering process of designing the façade according to the indoor environment of a critical room in the facility housing the bedrooms of the students. This "critical testing" has the advantage of optimizing the places with the worst conditions in the project. It is, on the other hand, difficult to say, and time-consuming to test, if the same strategy used for the worst-case scenario will function in the rooms, that are not critical. They will probably need additional or perhaps different strategies.

The documentation of the final outcome also becomes less accurate if only testing and optimizing the critical areas, but with time-limitations it is the only possible way to give an indication.