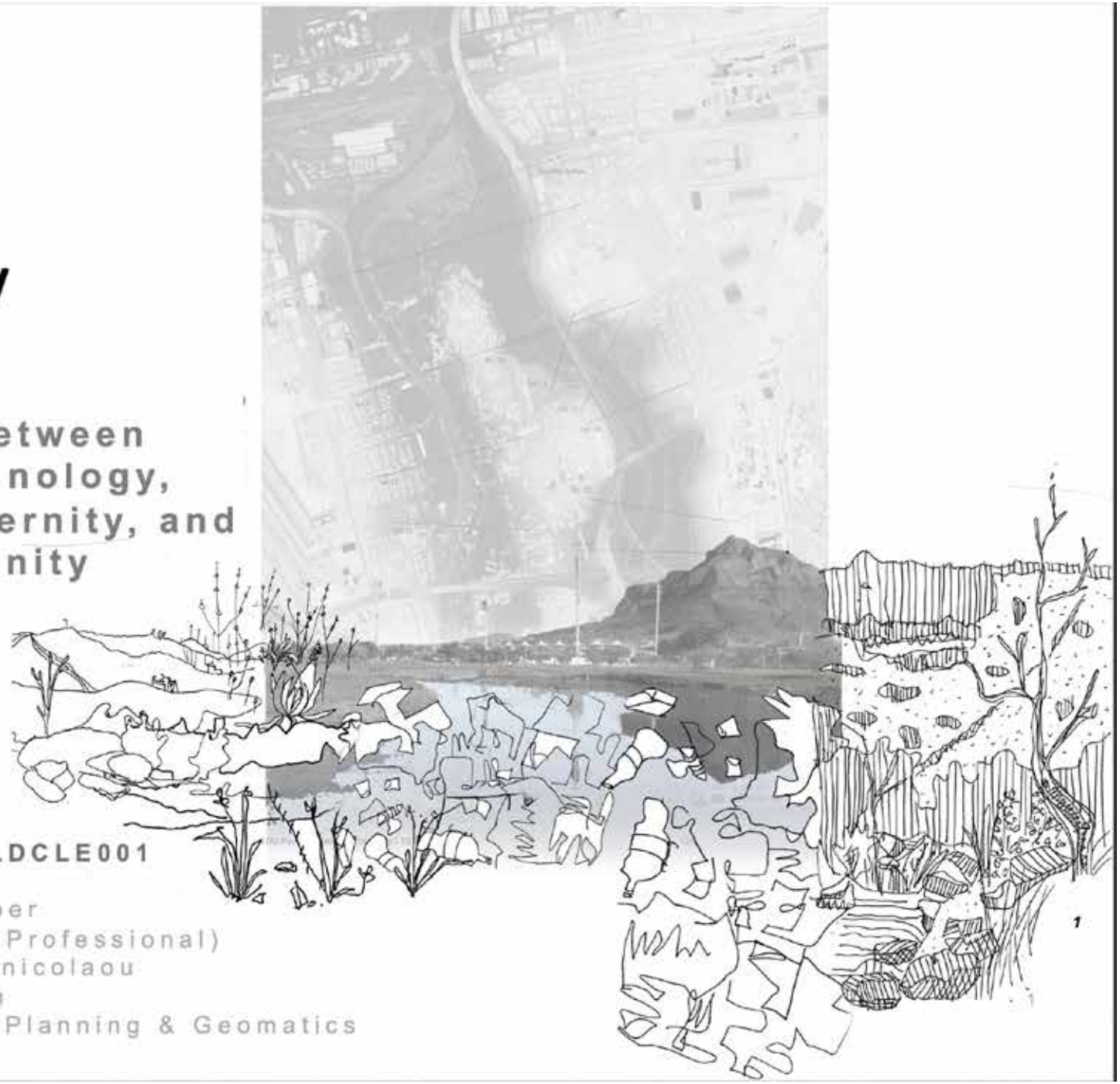
Connected by Nature

The mediation between biology and technology, history and modernity, and nature and humanity



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Design Dissertation Paper
Master of Architecture (Professional)
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September 2022

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Thank you to all the homies for getting me through this year.

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01 INTRODUCTION

Every now and again, the slow evolution of human knowledge takes a quantum leap across the bridge of the unknown: Galileo Galilei using a Dutch telescope for the first time to find craters on the moon, Isaac Newton developing the theory of gravity observing a falling apple, Charles Darwin's study of tortoises and finches emerging the theory of evolution and Albert Einstein perceived the multi-dimensional curve of space-time (Bristow, 2020).

A lesser-known moment was when explorer Alexander von Humboldt, who coined the word 'ecology,' stood at the summit of Mount Chimborazo in Ecuador and had a revelation that "everything in nature and indeed the universe is connected" (Bristow, 2020). Moreover, perceptive nature writer, David Quammen (1996) cited in Bristow (2020), equates the natural environment to the finely woven Persian carpet with all the threads attached to one another, "pull on one thread of the universe and you will find yourself tugging at the entire fabric" (Bristow, 2020).

In the year 2020, the mass produced by humans in the built environment (concrete, metals, bricks, glass and plastics) superseded the amount of biomass (trees, plants, animals, bacteria, fungi and viruses) on our planet (Milo, 2020) cited in (Oxman, 2021). Humanity's separation from nature, induced by the industrial revolution, forced us to think of building in monofunctional units of construction rather than the growth of a single multifunctional material, as it is in nature. Similarly, industrial manufacturing and global transportation has left modern architecture removed from the context and culture to which it was designed to serve. Furthermore, while vernacular architecture is designed with its decay in mind, the annual waste of modern construction is expected to contribute 2.2 billion tons globally to landfills by 2025 (BigRentz, 2021).

Figure 1
[Front page] Layers of the landscape: under water, earth and sky

Figure 2
Layers of the landscape: standing he old entrance to the River Club looking at the Liesbeek path.

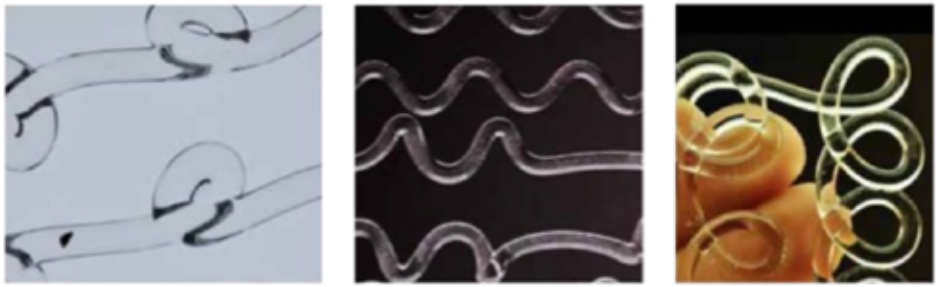
In this context, my research question is:

How can we leverage design and shift the paradigm of construction norms to mediate between biology and technology, history and modernity and nature and humanity?

In this study, I explore methods of weaving in nature and in traditional vernacular construction to uncover how these construction methods and their social connections can be translated into modern construction technologies whilst preserving the ecosystems they inhabit.

In this study, I aim to investigate the theoretical and technical method of manipulating ancient building materials to act in varied occupations seen in the construction of natural materials. I then attempt to amalgamate ancient methods such as weaving with 3D printing and digital modelling, to achieve a greater resolution, minimising material waste while exploring the spaces they offer.

Figure 3
3D printed glass varied coiling based on heat and height ratio.



Intricate to the making of space and materials is the process of their maintenance or decomposition. I explore how materials can return to the earth to feed the growth of its successor. Recognizing architecture as impermanent allows the craft and knowledge of building to become permanent; allowing the next generation to learn and improve, sustain and advance. This production leads to the effects of how these substantial paradigm shifts in the making of buildings could affect societies, economies and their environments.

This base of theory and technology has been adapted to the site of the River Club in Observatory, Cape Town. This highly contentious site is historically significant to the Khoi and the San people. In lieu of this, the events on this land are significant to the formation of what we know Cape Town to be today. These explored ways of making, that are in line with the indigenous people's respect for, and relationship with nature, will form the bases on which I design an intervention that serves nature, acknowledges the past, and educates communities to give opportunity for the future.

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THEORY AND TECHBOLOGY

Figure 4
3D Printing with mud sourced from Emerging Ob jects , 2019.

Figure 4.1
Linear poles interweave to comprise a complex knot, while connecting you to the sky.

Figure 4.2
Conical lodge described by Ingold.

In this study, I explore methods of weaving, natural systems and in traditional vernacular construction to uncover how these construction principles and their social connections can be translated and woven into modern construction technologies whilst preserving the ecosystems they inhabit.

I look at how vernacular principles can reorientate the hierarchy of current-day construction, placing priorities on local materials and community engagement resulting in an architecture that reflects its context. The following sections investigate the origins of vernacular construction, its connection to the landscape, how it unites communities and its decay or mobility. Furthermore, I explore how technology can weave itself into these fundamental principles, to develop a vernacular of the modern age.

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In my investigation, I looked at the method of weaving in nature, vernacular craft and 3D printing. The common element that binds them is a notion of a thread that can be guided, wrapped and folded to knot, connect and vary in density to allow for varying ventilation and heat and light exchange.

As opposed to current-day manmade structural design, where a distinct material is used for a single function (bricks for load, steel for span, glass for light), nature "combines multiple systems to accommodate constant shifting forces over time" (Oxman, 2015). Studies on the construction of nature led to the notion of a multifunctional, porous, woven fibre that is an eggshell. It is made of fibres that distribute load equally around the surface giving it its form as well as allowing for heat and light exchange and food absorption. Nature is simultaneously doing the analysis, modelling and fabrication in one process. An example of this process is the human bone. It is subtly and continuously adapting to accommodate the change of structural load. It has the capacity to build and lose bone tissue when simulated with additional load. During pregnancy one gains structural fibres in specific areas of the bone to support the extra weight, similarly, the bone loses these fibres when they are no longer needed like if one went to space. To design with the principles of nature: multifunctionality, dynamic renewal and life cycles, to build structures could lead to a design that creates environments rather than poses threat to them.

An example of this construction is Neri Oxman's 3D printing with biopolymers; cellulose, chitin and pectin, materials found in trees, crustaceans and apple skins. The result was a structure that ranged in structural and optical properties that decayed to fuel new growth of the same material that led it to be. The notion touches on the idea of obsolescence. Shifting the paradigm of construction to designing with the decay in mind could lead to significant environmental advancement, limiting landfill disposal while maintaining the current capitalistic conviction.

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Figure 5
3D printing with chitosan concentrations

Figure 6
3D printed product

Figure 7
Varying degrees of chitosan concentrations in gel state

Figure 8
Shrimp-shell derived chitin

Figure 9
Dried chitosan derived from chiton

Figure 10
Aguahoja wing, 3D printed from varied chitosan sourced from Neri Oxman (2019)

03 SITE ANALYSIS AND APPROACH

Figure 11
Locating the site in its greater context

With construction methods that are inspired by vernacular principles and environmental preservation I investigated the history of Cape Town before the colonial destruction of natural elements. Induced by colonisation and later the industrial revolution, Cape Town's ecological landscape changed dramatically with the piping and canalising of main rivers, the reclaiming of the foreshore and the destruction of a huge wetland to form the industrial area that is today, Paarden island. With the focus of the design intention shifting construction norms to work with nature, I was drawn to a site that is in real time being victim of an ideology of 200 years ago, favouring construction by a linear assembly of parts and fuel by fire.

With the premise of a culturally rich history and ecologically sensitive site on which to preserve and enhance, I settled on the river club site in Observatory, Cape Town. This threatened and mismanaged environment serves my investigation in making architecture that can positively contribute to the ecosystem in which it sits, through traditional systems improved by modern technology, while bringing together different cultures and their histories.

Although I am admonishing the method in which the industrial revolution has established designers' approach to construction, a scientific notion rose from the movement that will help inform my design. In the 19th century, the efficiency of steam engines was being examined by engineers. The outcome of the questioning of what to burn and how hot to burn it surfaced the theory of thermodynamics. This is when concepts like "heat", "temperature" and "energy" entered the scientific vocabulary (Cox, 2013). Along with these profound questions at the time emerged what is probably the "most important law of physics for understanding the evolution of the universe and the passage of time" (Cox, 2013). It is called the second law of thermodynamics. At the centre of this new concept is what physicists call entropy. Entropy explains why, left to the mercy of the elements, mortar crumbles, glass shatters and buildings collapse. It supports that in order to keep a system intact, "increasing amounts of effort in the form of heat, energy, work and money must be invested. If you don't things fall apart" (Bristow, 2020). This is a theory that I will use to my advantage in some elements, giving opportunity for new growth with natural materials and a theory I will combat with a design function and program that is active and self-preserving inspired by natural ecological cycles and vernacular principles of community maintenance.

This theory does not apply to natural systems. As we all know, left to its own device, nature thrives in the absence of human interference.

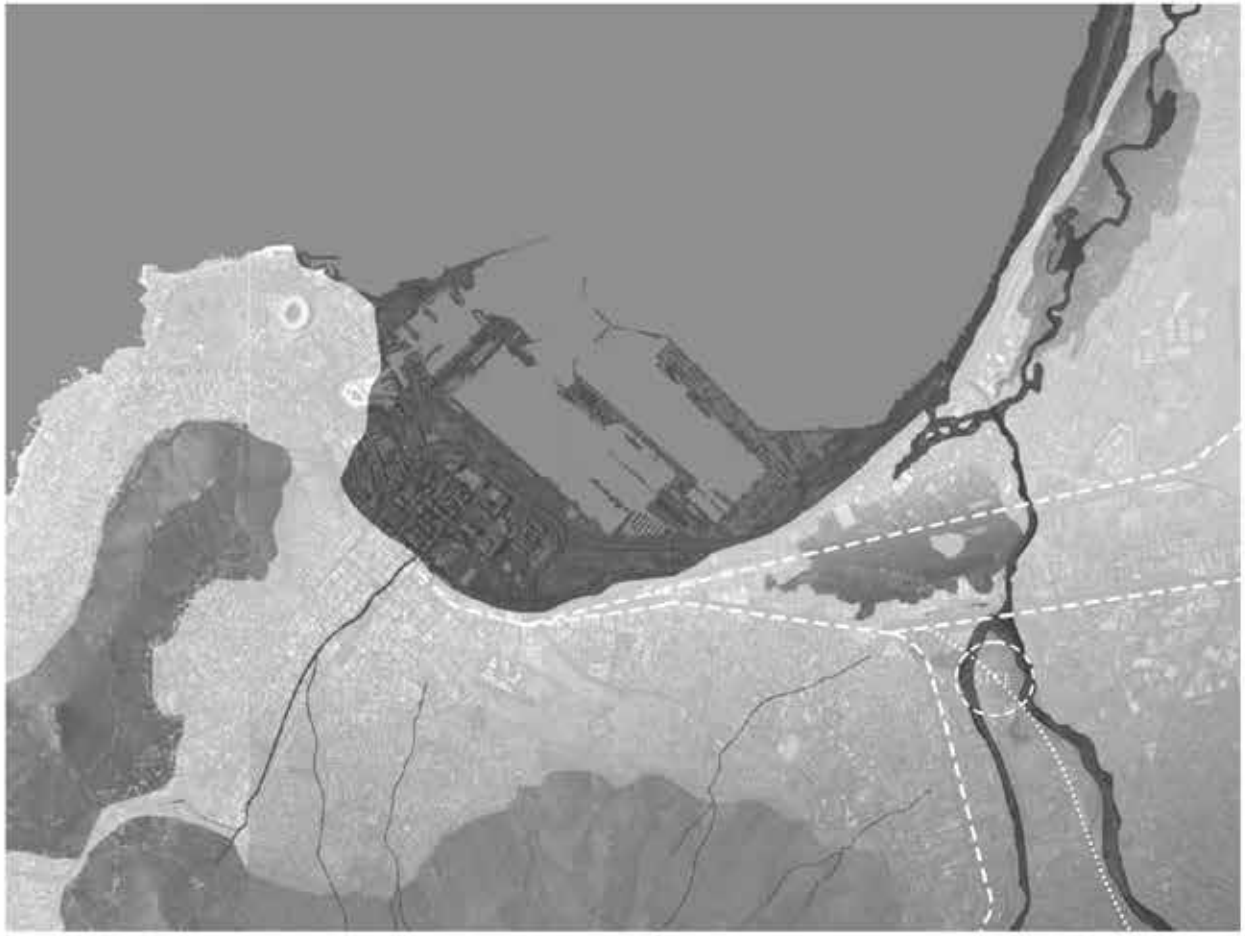


Figure 12

Layering precolonial and current-day Cape Town. Showing the reclaimed foreshore, rivers that are now piped underground and what was once a wetland in present day Paarden Island. The image also shows the site selected in this context.

3.1

3.1 History of the site

The site that is now being destroyed by human intervention was once considered the most biodiverse land in the cape with its nutrient rich cape granite batholith and Malmesbury shale soil, and unique climatic conditions that give rise to a perennial river. These elements were vital for the survival of the Cape's indigenous people; the Khoi and the San.

Cape Town's Mediterranean climate is characterised as "winter rainfall followed by 6 months of summer drought" (Hallinan, 2022). The winter rainfall falls as much as 4 times more on the Liesbeek Valley than other parts of the peninsula. This is due to the northwest wind pushing the rainfall up western slopes of the mountain and over onto the eastern slopes. Moreover, in summer the south-easterly winds carry moisture from the sea that is pushed up the escarpment and condensed into the well-known tablecloth, "from which nearly twice as much water in the form of fog precipitation is deposited than falls as rain each year" (Hallinan, 2022). Water slowly falls down the Table Mountain sandstone slopes to replenish the Liesbeek river. This phenomenon is one of "paramount importance during the driest months of summer drought at the Cape for the Khoisan groups" who migrated south each summer for this essential water resource (Hallinan, 2022) .

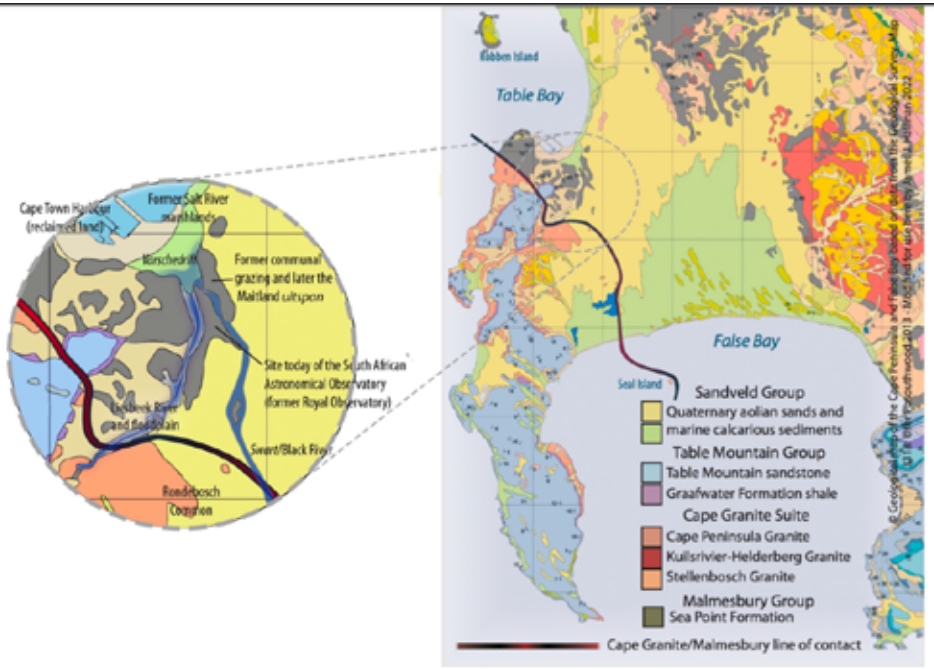


Figure 13
Soil type in the Cape Town

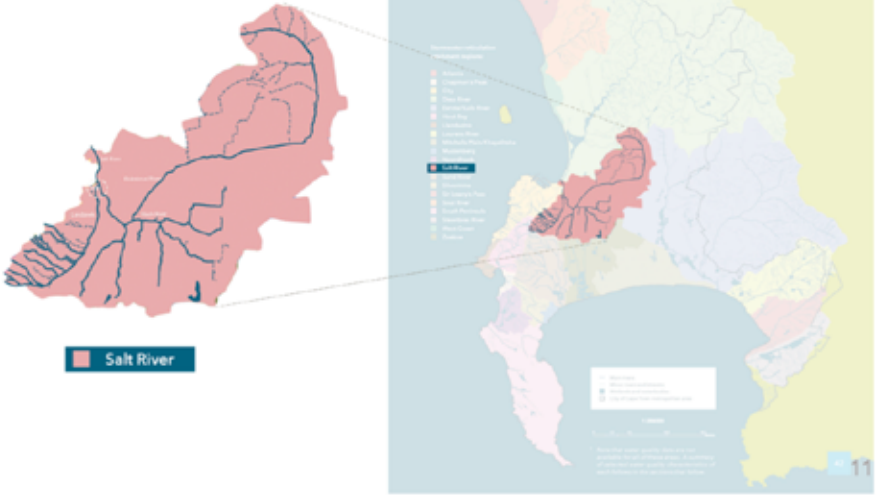
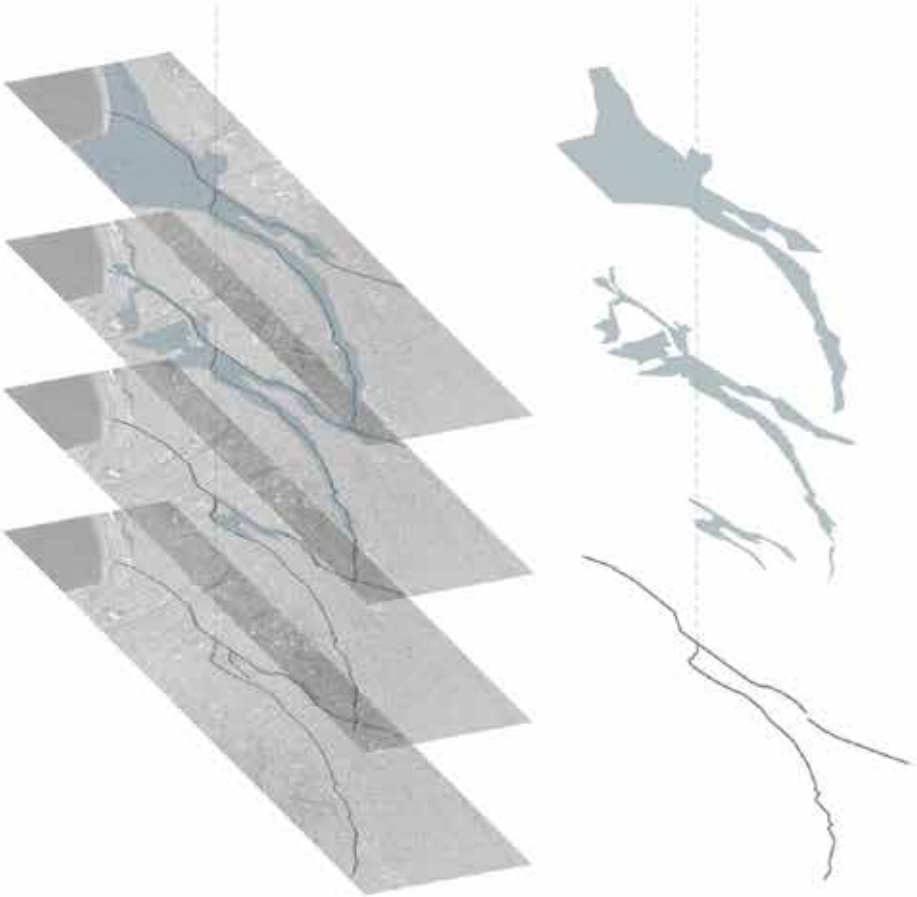
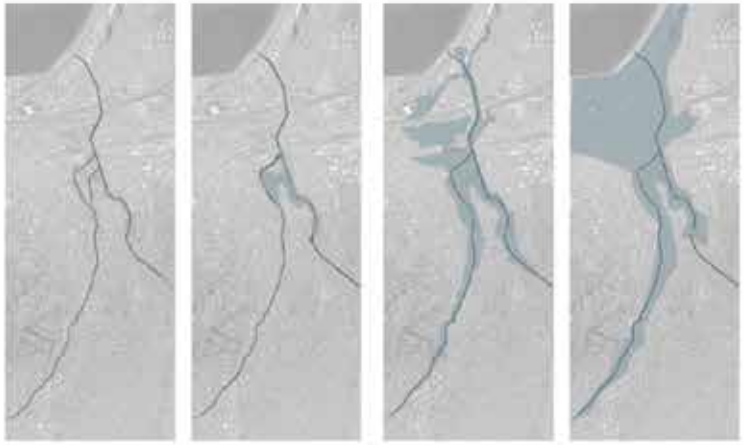


Figure 14
Catchment areas in Cape Town





The importance of the water and its life-giving qualities is expressed in the Khoisan names "Camissa" meaning 'the place of sweet water' for the Cape Peninsula. Water is such a significant element in San and Khoi culture as it is the element that gives life to all and connects the earth with the sky. This importance placed on water in all its forms will be highlighted in the design with openings to the sky, connecting users to the river through framing views, paths and filtration pounds in an attempt to create interest and awareness in order for activists to take ownership.

Figure 15
100-year flood plain of site

The place in which the Khoi and the San crossed the river is where the Black River and the Liesbeek River meet. This point was the most practical as the velocity was low due to the gentle decline plain and the push back from the salt water tidal water. This significant crossing will be acknowledged in the design in an attempt to connect the surrounding communities to the site and its history.

This site was host to and protected by indigenous people. It was also the site in which the Khoi fought off the Portuguese in 1503 and won by using their cattle as shields "and advanced on their adversaries all the while throwing fire-hardened spears over the backs of their animals" (Hallinan, 2022). These events through history will be captured in the architecture with metaphors of mobile screens to protect the user from the elements.

The Khoi, however, were later pushed back from this land in 1656 when the VOC realised the site's perfect conditions for growing wheat. The growing demand for food by colonialists led to the incentive of the company granting land to encourage independent commercial farmers. The "Free Burghers" that took up the plots along the Liesbeek blocked the Khoi from entering the land except for occasional trade of cattle. This conflict that resulted would become of "symbolic significance" as the "first act of armed resistance in South African history against a colonising power" (Hallinan, 2022).

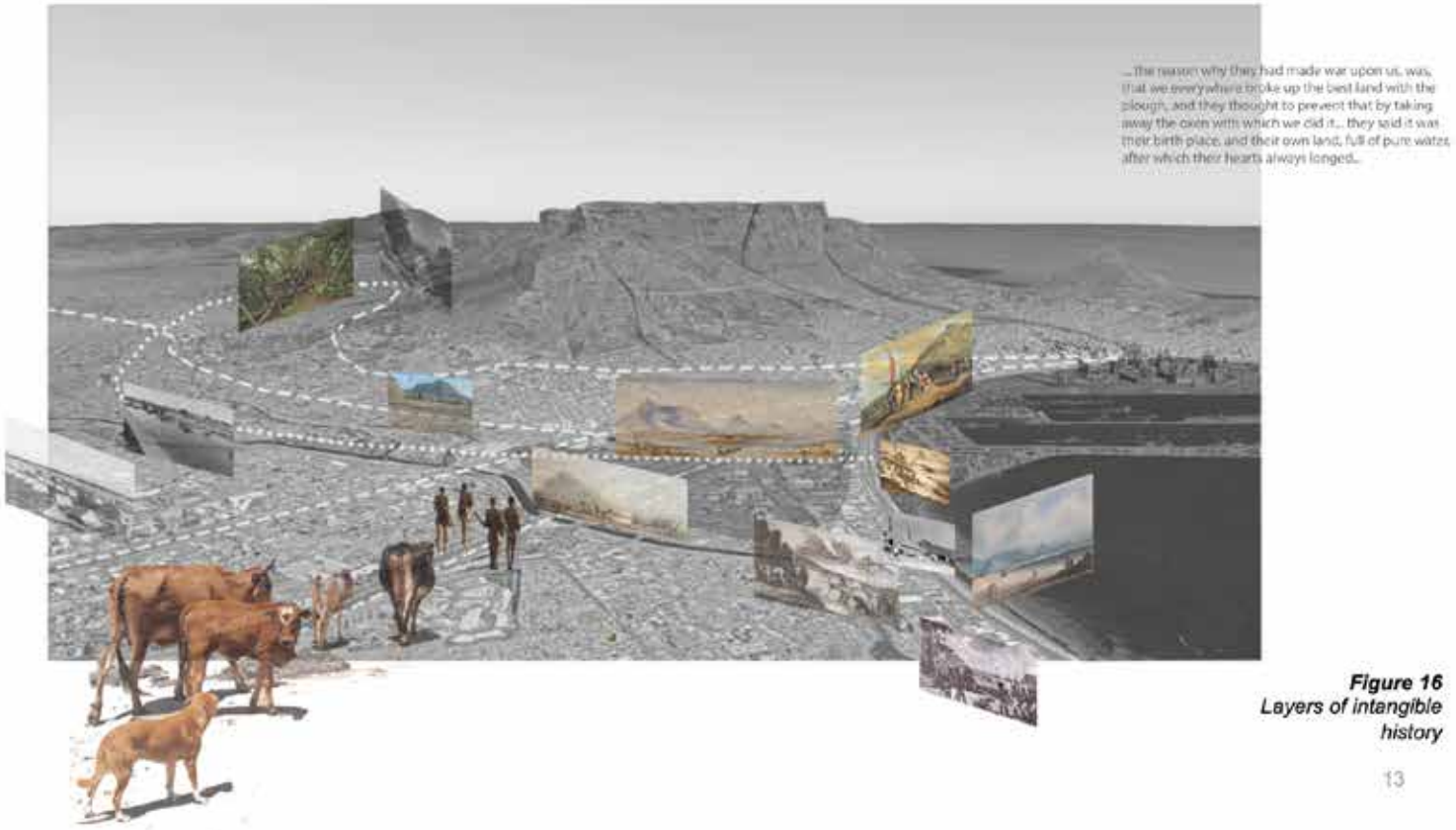


Figure 16
Layers of intangible history

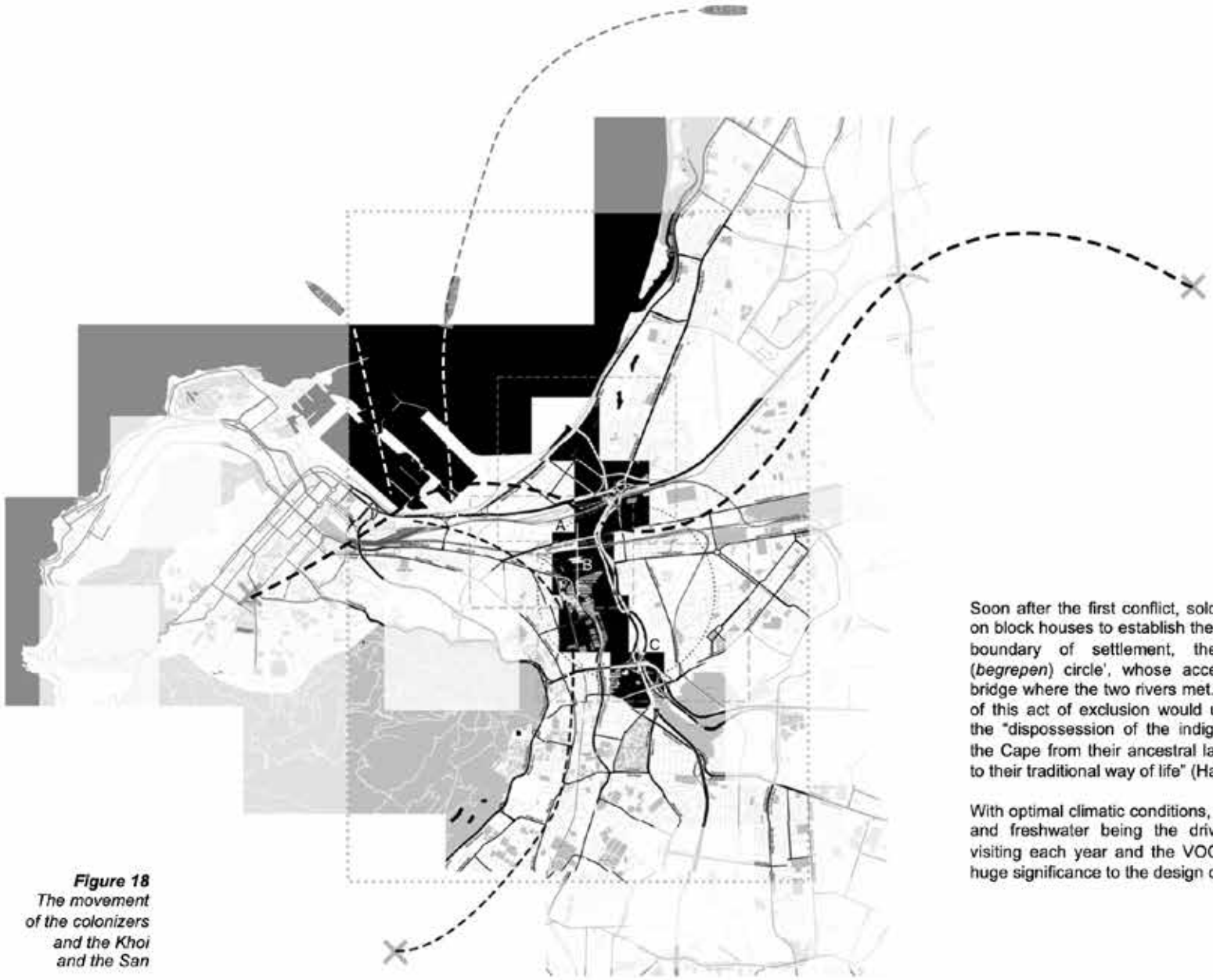


Figure 18
The movement of the colonizers and the Khoi and the San

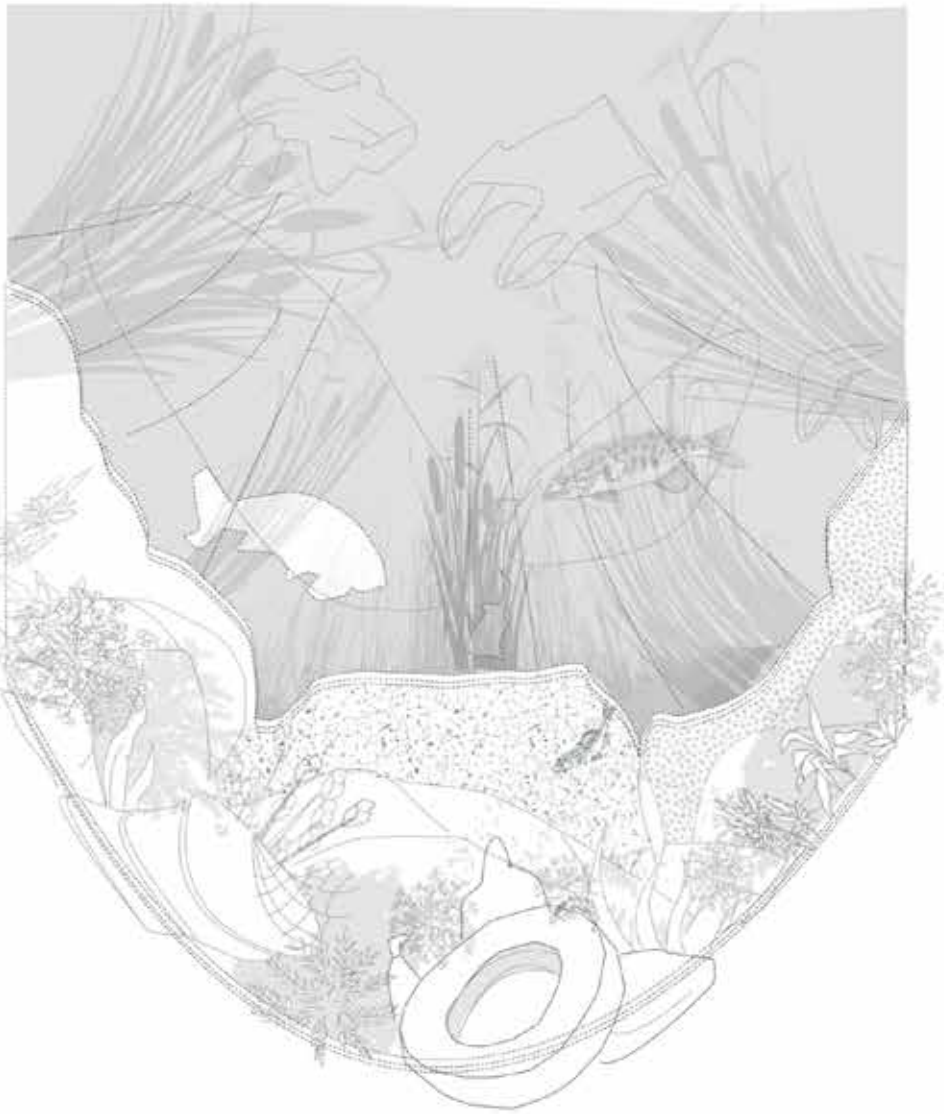
Soon after the first conflict, soldiers stood guard on block houses to establish the VOC recognised boundary of settlement, the 'circumscribed (*begrepen*) circle', whose access point was a bridge where the two rivers met. The significance of this act of exclusion would ultimately lead to the "dispossession of the indigenous people of the Cape from their ancestral lands and the end to their traditional way of life" (Hallinan, 2022).

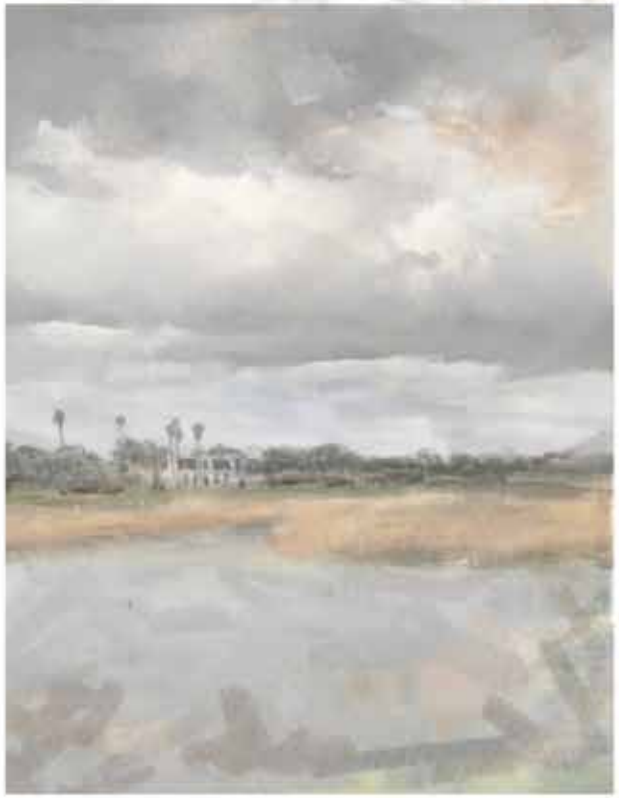
With optimal climatic conditions, nutrients rich soil and freshwater being the driver for the Khoi visiting each year and the VOC settling, it is of huge significance to the design on the site.

3.2 Approach to analysis

Figure 19
Representing the landscape from below

Due to the layers of intangible indigenous practices and history of the site and the current construction site by the company "Amazon" excluding access, I had to investigate the site through a range of means. With the site once valued for its bountiful natural systems, it is now under huge ecological threat. Today the Black River is full of pollution, single use plastic as well as sewage and chemicals (Webster, 2019). It is therefore appropriate for the site analysis to be a dialogue between the tangible and intangible, digital data capture and analogue atmospheric assembly. This is in an attempt to capture what is invisible: in the past, temporary with seasonal change, underground and under the surface of the water and in the sky in the day and night. Furthermore, through digital capture to understand written history, the evolution of the land through maps, and the surrounding programs and present-day interactions. Looking at the site from above, on the ground and from below.





Through sketching and painting I tried to capture the feeling of the site and how it interacted with its surrounding, and its changing environment. I tried to capture each translucent layer of landscape and how everything is connected in one continuous landscape with no boundaries. I thought of Tim Ingold's (2021) concept of "landscape" and "knowledge scape" and to think of knowledge as a landscape. It is a field of "continuous differentiation rather than divided up into distinct internally homogeneous territories" (Ingold, 2021). We used to think of cultures as a mosaic; each piece adjacent to the other with the difference pushed to the boundaries between them. The landscape concept enables us to think of a continuous terrain that has no end yet "it always looks different depending on where you stand in it" (Ingold, 2021). You can go from point A to point B without crossing any boundary, but the vista is continually changing because what you see depends on where you stand. The same can be applied for knowledge. It is not divided with fixed bounded territories. Although there can be large overlap, no one knows the same things as another person because what they know depends on precisely where they stand within this continuous variation (Ingold, 2021). The idea of what you know depends on your positionality within a field of relationships with humans and nature seems like a productive foundation on which to carry my analysis of site and approach to design.

Figure 2
Layers of the landscape: standing the old entrance to the River Club looking at the Liesbeek path.

Figure 20
Layers of the landscape: standing in the middle of the site, looking at the astronomy observatory.

Figure 21
Layers of the landscape: standing on the Liesbeek path, looking at Lion's Head.

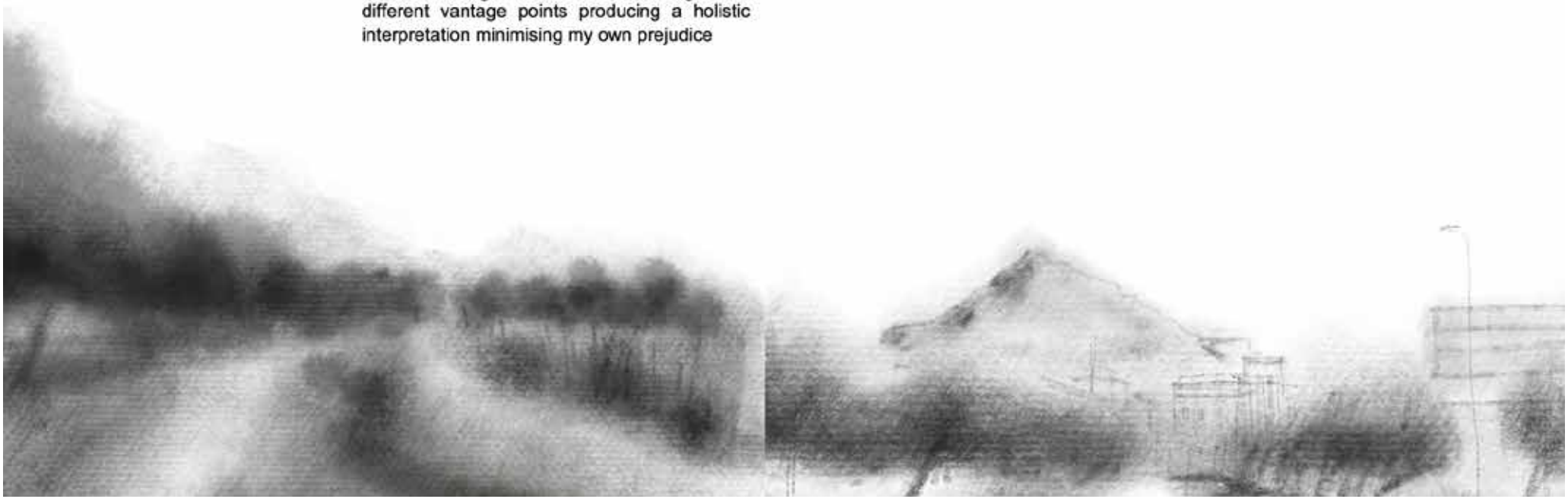
Figure 22
Layers of the landscape: walking up the Liesbeek path towards the site

Figure 23
Layers of the landscape: Standing at the Riverclub entrance, looking at Devil's Peak.

This method brought to light the question: what role does the landscape have in relationship to the building? And what role does the building have in relation to the landscape?

To unpack the importance and opportunity the landscape brings I had to walk the site through other means, including other peoples' experience through documented interviews, activities, events through history, technical studies and research papers. This collection of other people's experience and digital records was collaged with my own studies of the surroundings to get my interpretation of the site.

Documenting the site through the lens of others gave me a deeper insight into the ideas and knowledge of others standing from different vantage points producing a holistic interpretation minimising my own prejudice



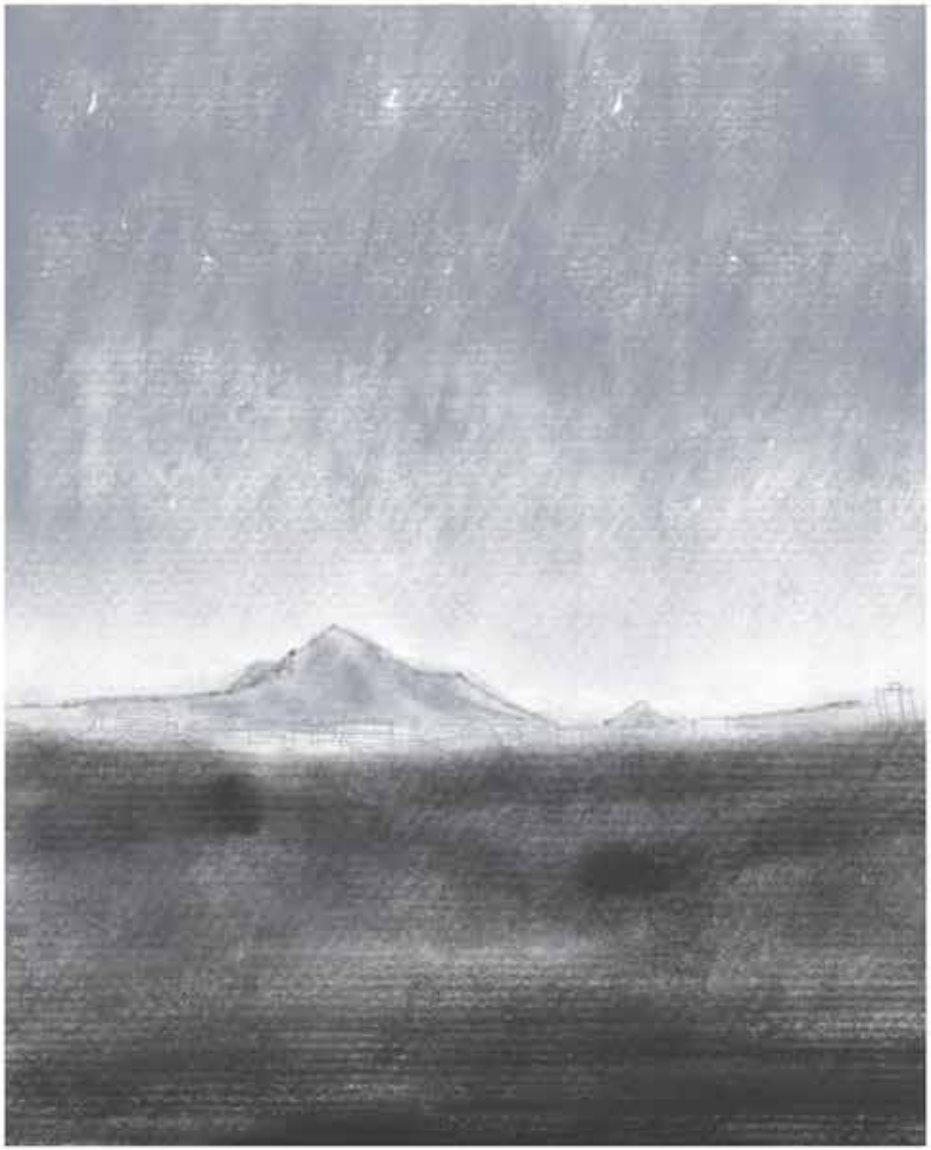


Figure 24
Layers of the landscape: standing in the middle of the site, looking at Devil's Peak Lion's Heat and Signal Hill at night.

3.3 Analysis and intention

Through analogue interpretation I tried to capture the atmosphere, layers of history and ecological value of the site. The sounding networks were best documented digitally from above.

The site is surrounded by transport networks that disconnect it from its surrounding neighbourhoods rather than connecting it. The surrounding programs also have heavily restricted access with one controlled entrance and exit with institutional spaces needing verified reason for entering and is certainly car dominated.

With open green spaces running along these main transport routes, it has the potential to promote bike paths and running or walking routes that are direct while connecting the periphery of Cape Town to the centre and communities with nature and its rivers.

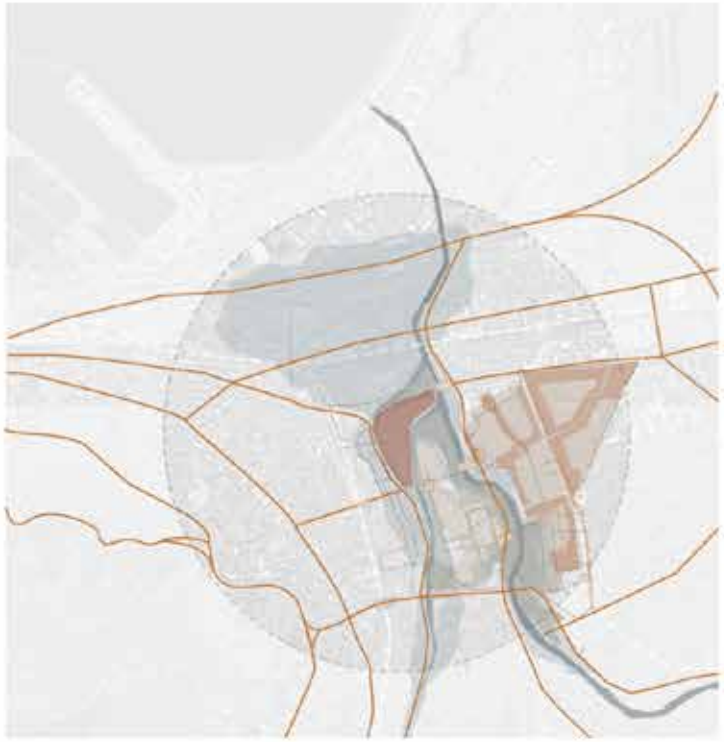
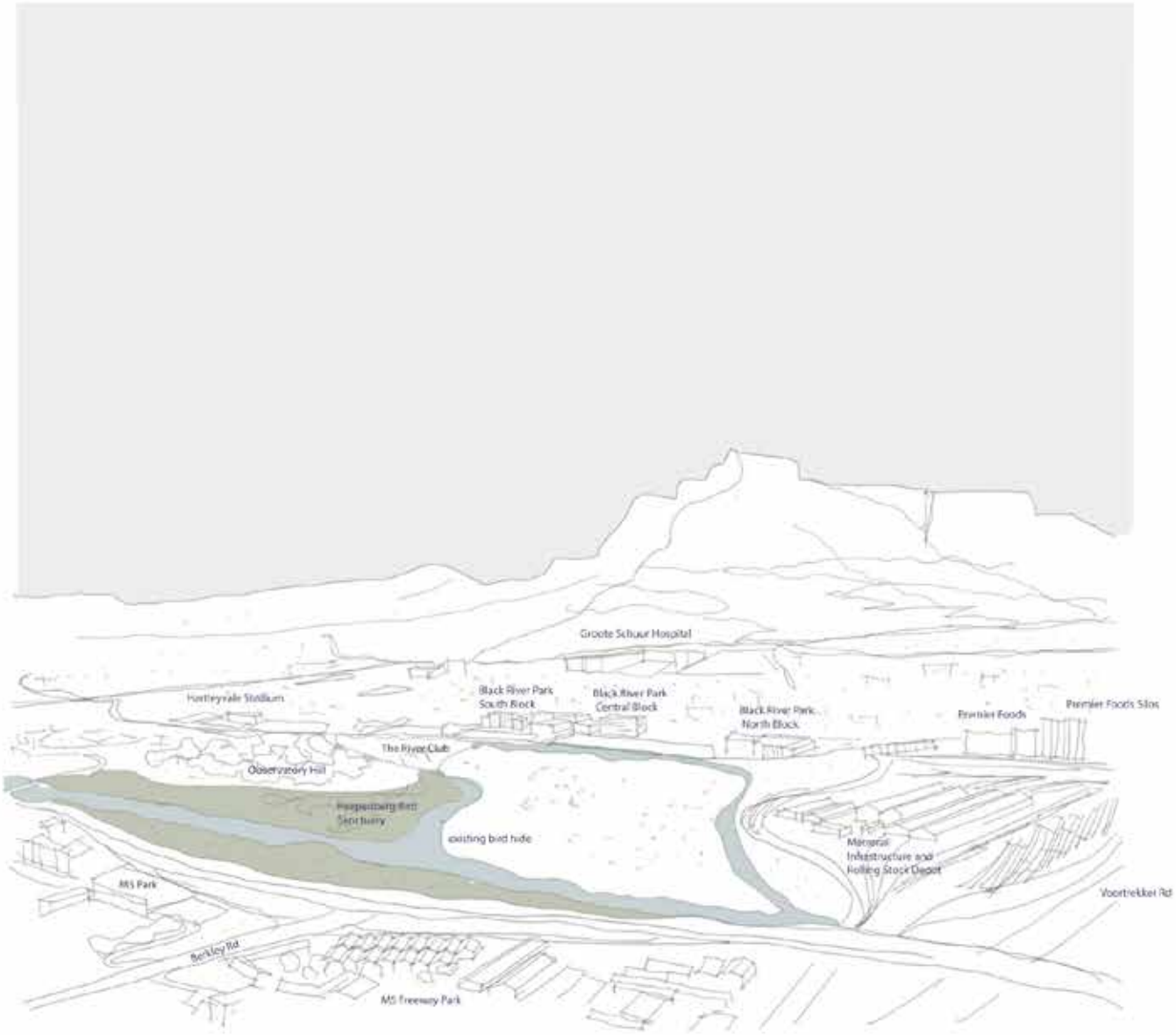


Figure 25
Isolating and excusive surrounding programs

Figure 26
Connective and restrictive elements of landscape



The site is seen as an island amongst large institutional and industrial programs. The first intention is to connect the site with its green spaces, the river and its history with surrounding communities through bridges and activating pedestrian routes and making them safe with secondary functions such as residential for eyes on the street at night and economic activity in the day.

Figure 27-29
The site in its context with potential connection opportunities

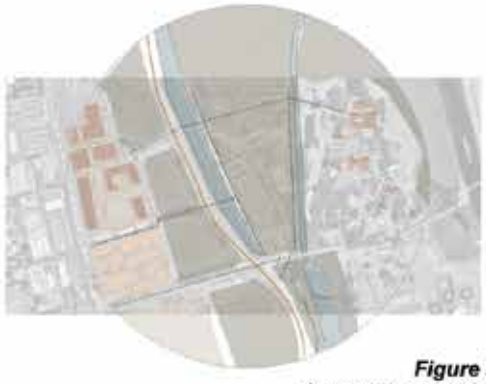
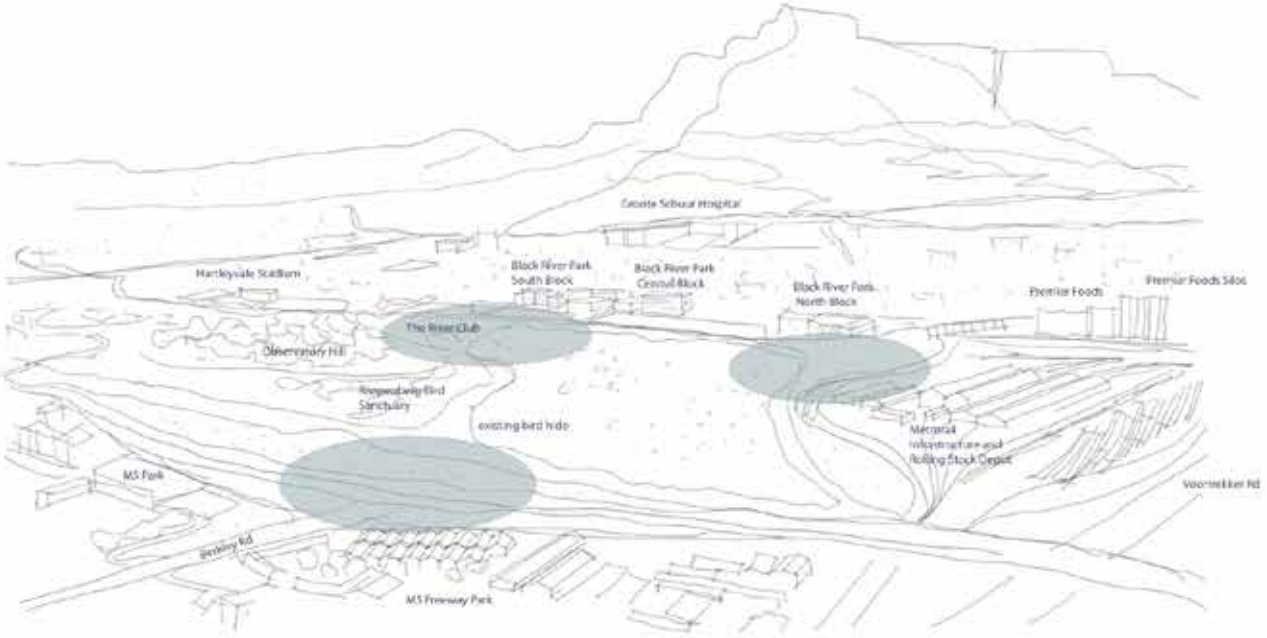


Figure 30
South entrance of the River Club

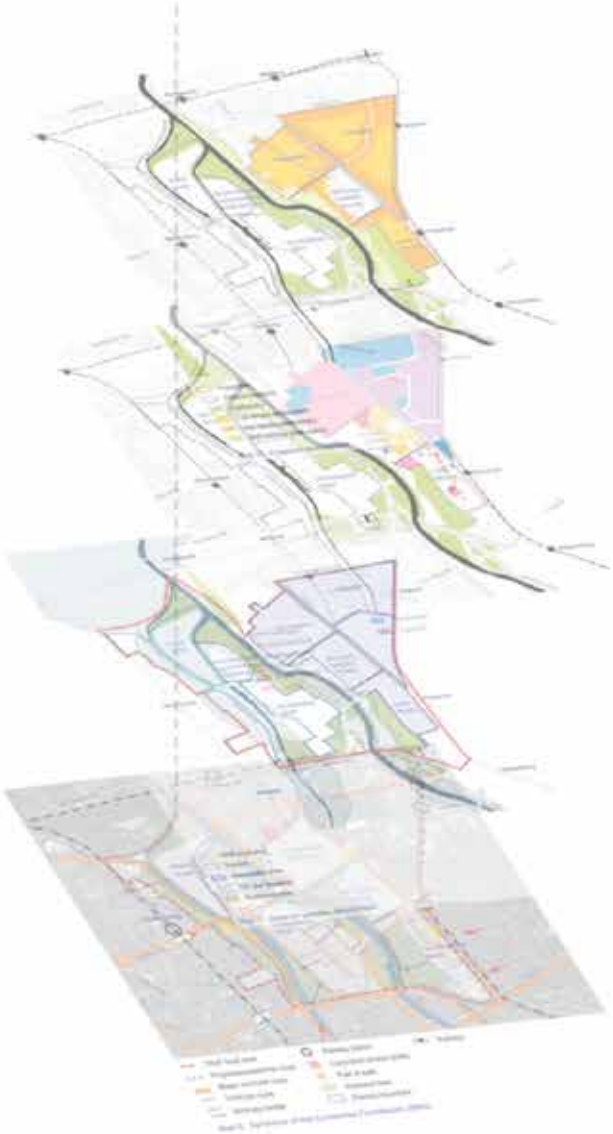
Figure 31
Northwest entrance of the site

Figure 32
Crossing the Black River

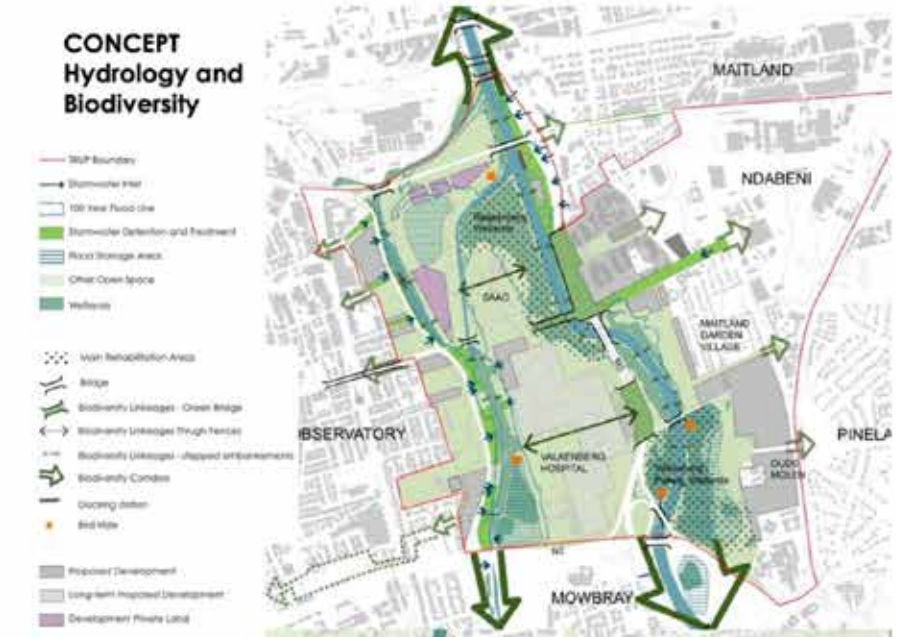


From this I identified 3 nodes of connection on which to develop. The intervention is seen as a gateway to the site, providing and promoting access.

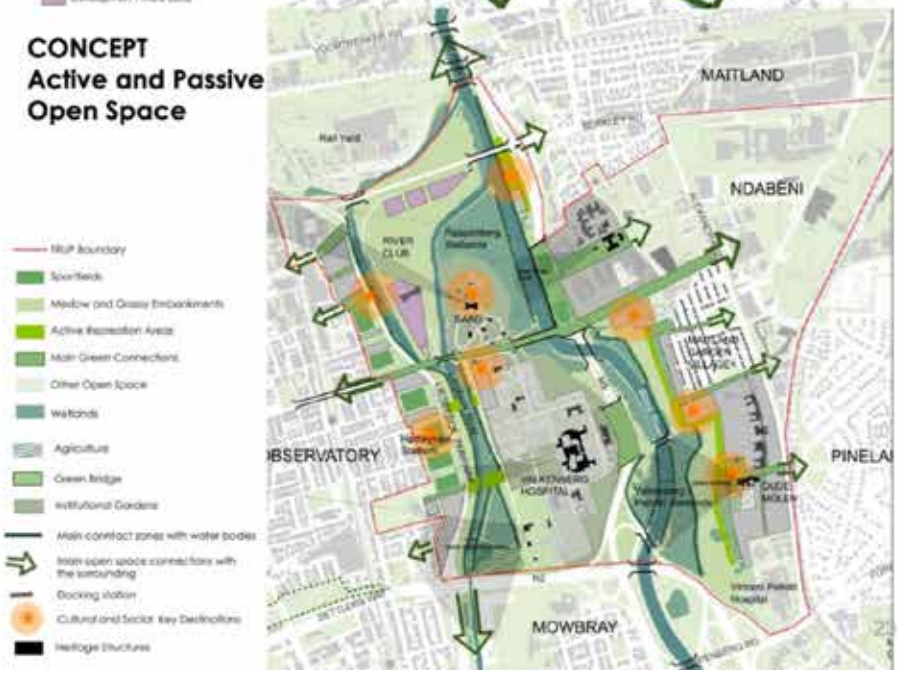
Figure 33
Potential access points to the site

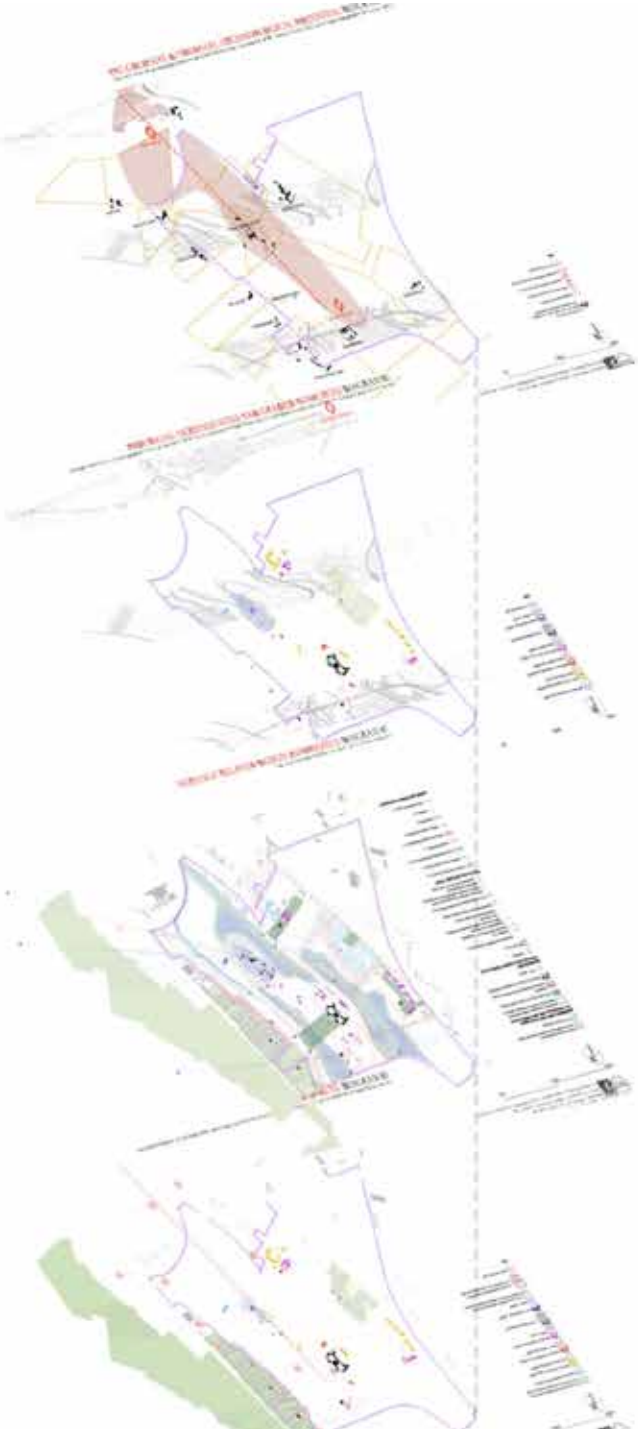


CONCEPT
Hydrology and Biodiversity



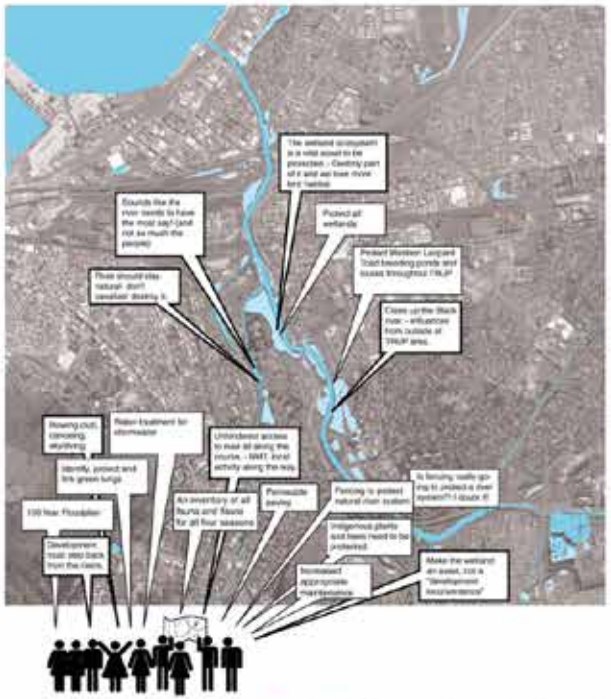
CONCEPT
Active and Passive Open Space

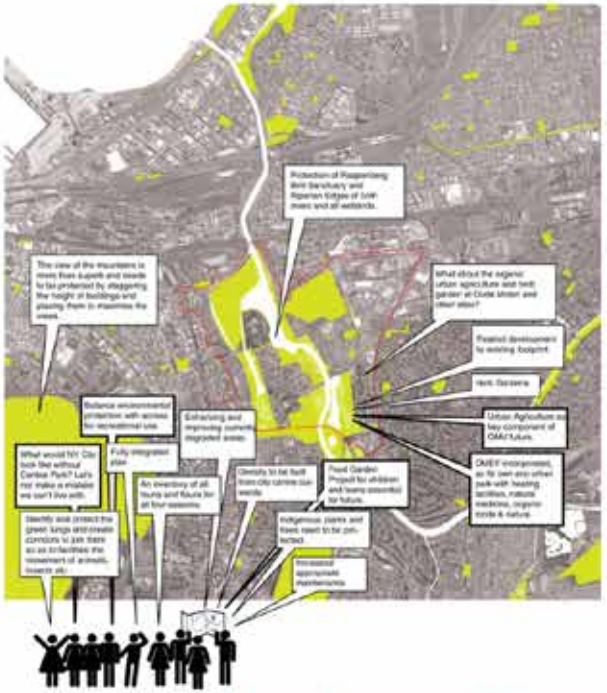


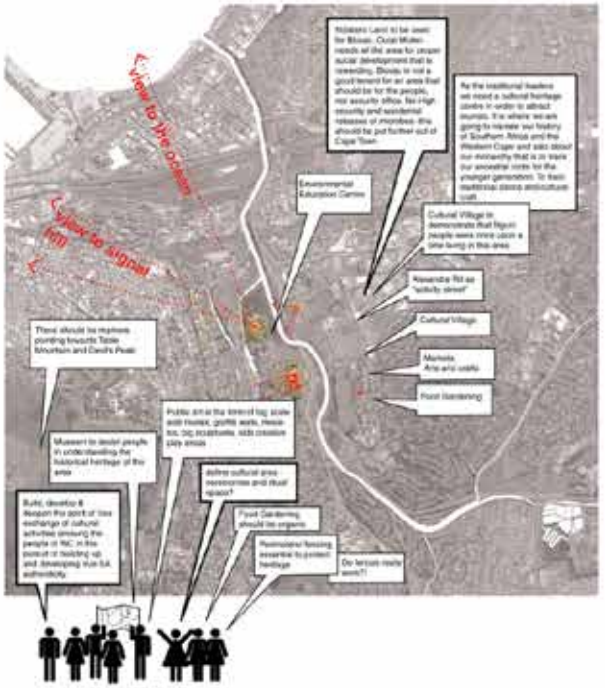


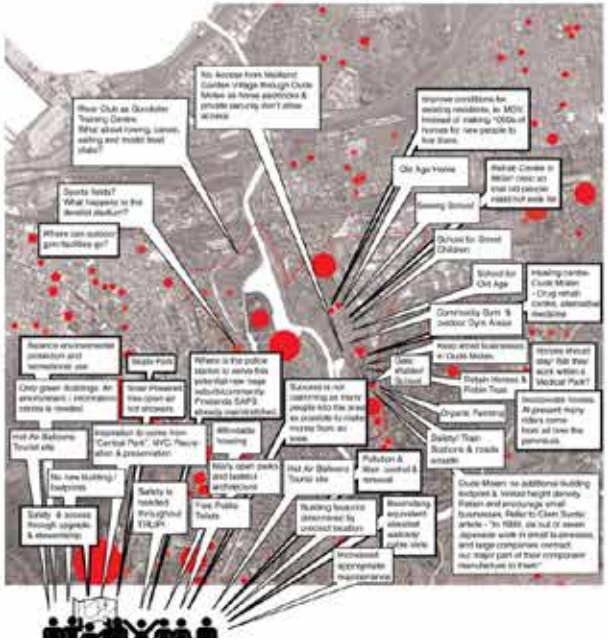
HERITAGE RELATED DESIGN INFORMANTS DIAGRAM 07

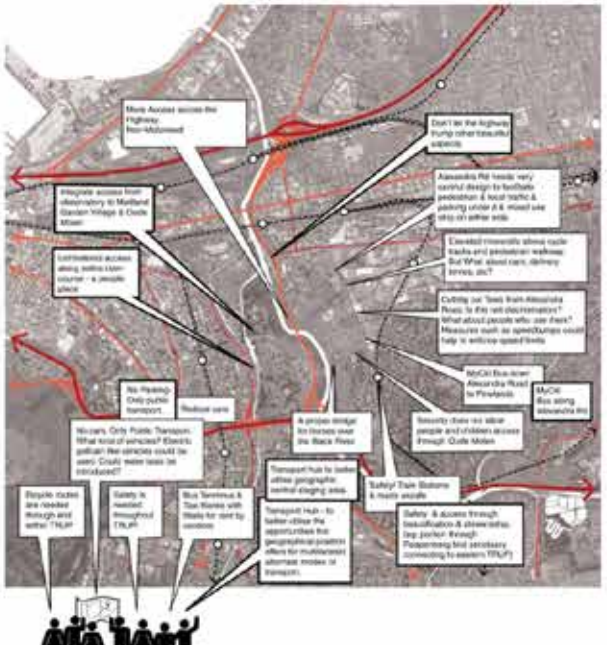
High level heritage-related informants for future development











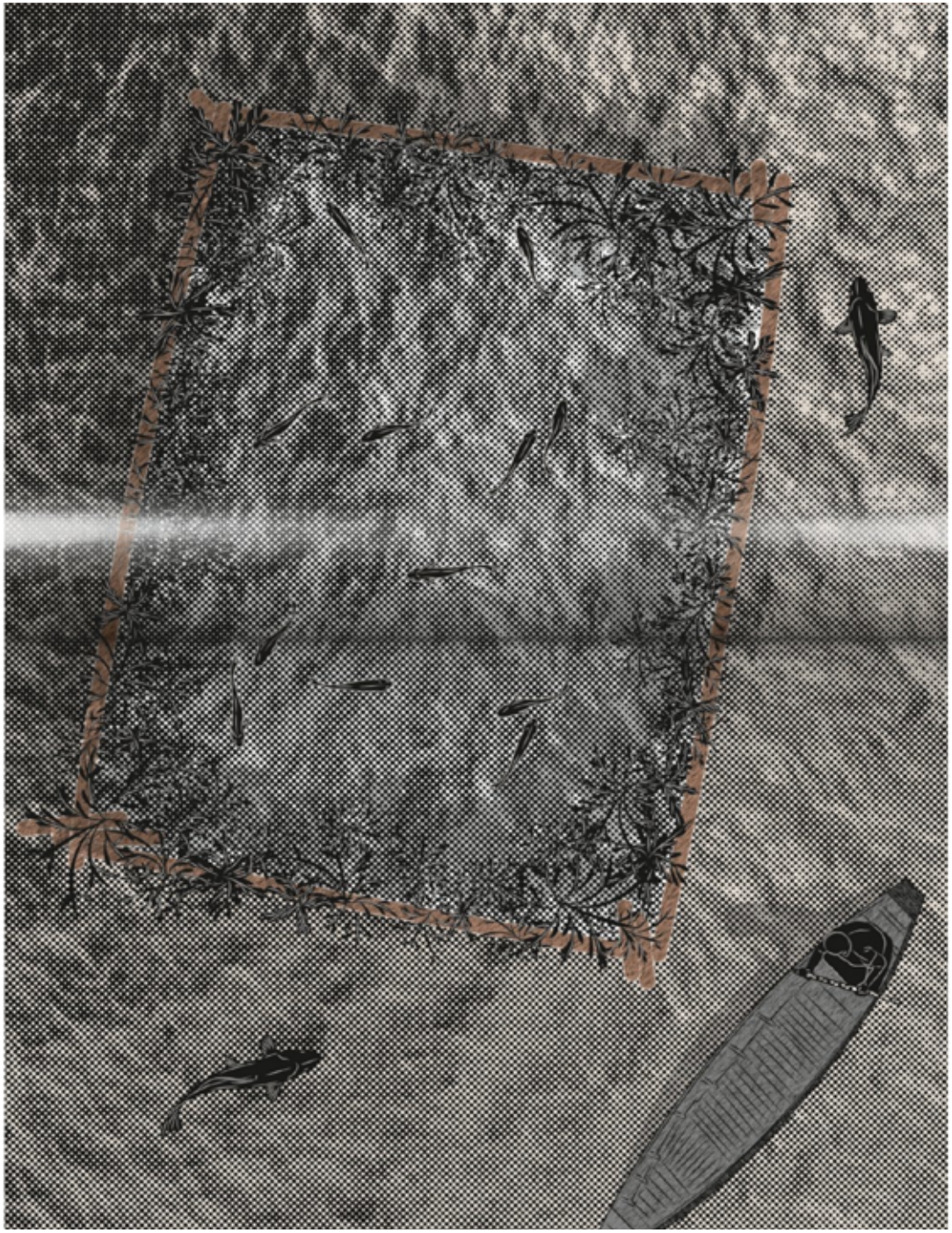
The TRUP 2017 Co-Design workshop enabled me to access vast amount community research and opinion on how to develop the site. This was a key source of information in reaffirming the need for the following in summary.

- Clean the water through a broader purification strategy.
- Protect and enhance ecosystems, heritage landmarks and views.
- Identify spaces for ceremonies and rituals.
- Celebrate the diverse cultural narratives associated with the site.
- Promote pedestrian and Public transport routes Wide variety of social infrastructure.
- Access to all.

03 PRECEDENT

Figure 34
Symbiotic relationship between nature and human construction with fish traps

The site selection and theory and technology has enabled me to adopt an environmental ethos inspired by the Khoi and San's respect of the earth and sky and the water that connects them both. Furthermore, with the technical approach of learning from traditional knowledge of sustainable construction and pushing it forward with the help of modern-day knowledge, I investigated Julia Watson's (2019) research into Local Traditional Ecological Knowledge ("Lo-Tek"). In her research she documents indigenous technologies of wetlands, desert, mountain and forest whereby human construction enhances the natural environment rather than harming them. These systems show how to live in symbiosis with nature, an ethos key to the project.



4.1

4.1 Wetlands

Figure 35
Uros Island constructed from one species of reed that actively cleans water

The first systems I would like to utilise and further explore comes from the 4500-year-old Uros people that live on lake Titicaca in the Andes mountains in Peru. One species of reed is foundation, floor, wall, roof, mats, clothes, insulation, blankets, beds, boats, animal feed, food, and medicine. The floating islands improve the water quality of the lake by filtering polluted water discharging from the city. The islands actively filter water by reducing suspended soil and dissolving organic carbon, also breaking down natural nutrients and other waterborne pollutants.

Figure 36
Uros Island technical constructed

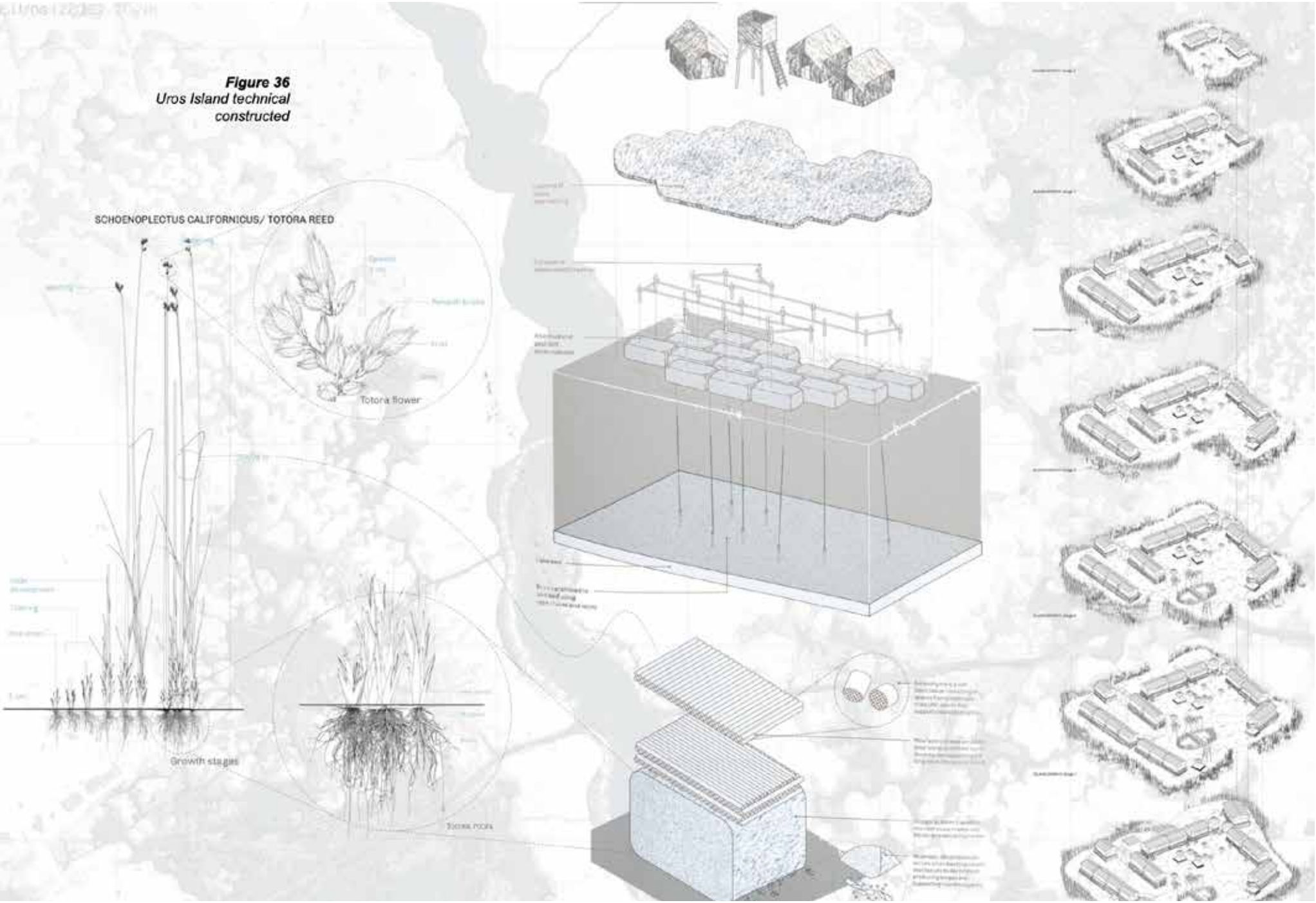
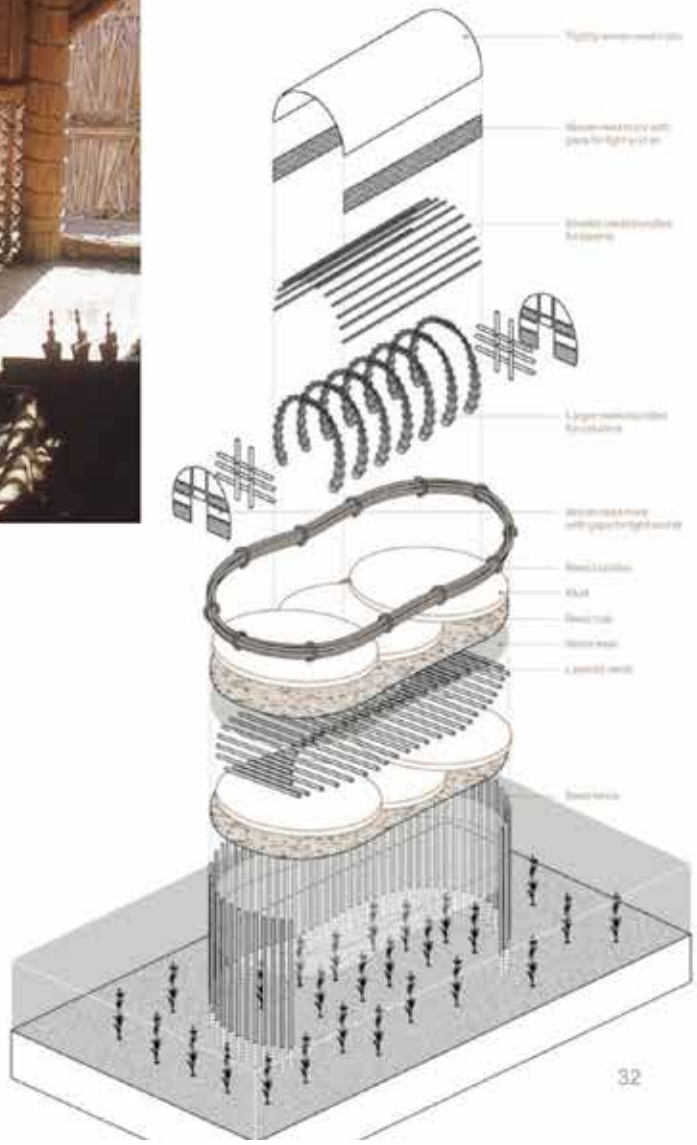


Figure 37
Ma'dan people's read construction

Figure 38
Community participation and transfer of knowledge

Figure 39
Cathedral like construction's varied light and ventilation

Figure 40
Technical diagram of the reed construction



A similar concept is done by the Ma'dan people of southern wetlands of Iraq, where their structure is built onto existing reed beds. The intervention cleans water, protects and enhances biodiversity by using one building material that is multifunctional and able to decay.

The villages are constructed on islands that stay afloat for 1 generation/ 25 years providing the opportunity for the technological knowledge to be passed on.

Similarly, these cathedral-like buildings are made from woven reed that is structure, insulation and fenestration with the ability to decay.

Figure 41
Symbiotic relationship in a flood plain

Another fascinating local traditional ecological knowledge is that of the Bengalese people of Kolkata India where its river is contaminated with sewage. This city with 15 million people, cleans its wastewater with its flood plains. An indigenous technology of 300 fishponds, cleans its water while producing its food. Through a symbiotic relationship between algae and bacteria, the wastewater is broken down. Fishponds then continue this cleaning of the water in a process that takes 30 days. This method is not just a model for chemical and coal power free purification, it also estimated that 80 000 people make a living from this wetland and it saves the city 22 million USD on running expensive sewage treatment system.

Figure 42
Great Mosque of Djenne, Mali

Figure 43
nerging Object's 3D printed hearth

Figure 44
David Adjaye's translation of old to new

Figure 45
ola People dwelling, Guinea

Figure 46
Creating gathering ace with a functional roof that captures rainwater. shiko Mori's cultural centre in Senegal (2016)

Figure 47
Wind ducts

Figure 48
ranslating vernacular techniques of mediating climate to nodern construction. Taroudant University.

4.2

4.2 Traditional principles in modern construction

David Adjaye's (2020) design of a "new space for learning, research, discourse and cultural exchange predicated on the African perspective" embodies the "visible and invisible knowledge of ancient and contemporary African history through both form and program". The Thabo Mbeki Presidential Library will "harbour the knowledge of the land whilst acting as a space for connection in which the advancement of an African Renaissance becomes the premise of the structure" (Adjaye, 2020). The new building references the granaries' structure, a symbol for knowledge-based production, growing and nurturing.

Emerging objects, a design studio in California, developed a method of combining traditional methods and natural materials with technology. They have manipulated a 3D printer to print with mud and clay in the scale of a dwelling. This method is taking mud, a unit from a whole that would usually be used for stereotomic assembly but is converted into a "string" that is pushed out of a nozzle into a digitally designed pattern, making a form. This method is using traditional materials with efficient climatic functions while using technology to digitally de- sign and fabricate with no waste. Like traditional mud structures, this 3D printed structure still requires the same maintenance and therefore the need of the wooden scaffolding. It has traditional knowledge with the potential to build innovative

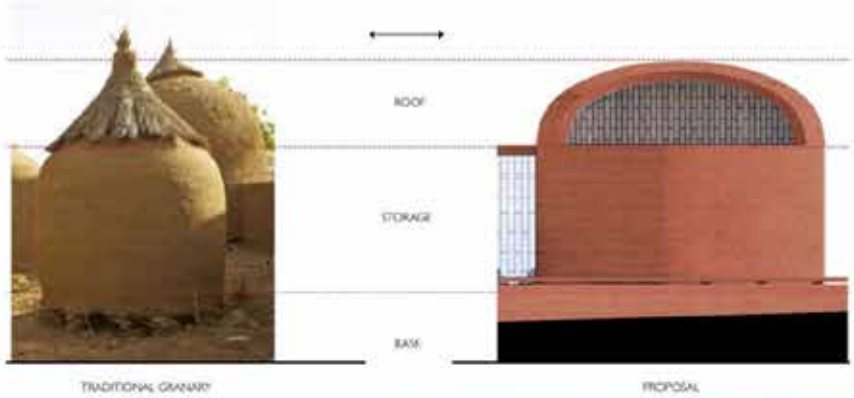


Figure 49
Tshiko Mori translating traditional materials with modern technology

The dialog between contemporary and vernacular architecture occurs with a sensitivity to site and appropriate use of local and climatic materials. An innovative project that emerged from this approach is Toshiko Mori's cultural centre in Senegal (2016). The project takes tradition- al and local materials such as thatch and mud brick but transforms its traditional typology with an undulating roof and courtyards. The roof rises and falls around the two courtyards, creating opportunities for people to connect as well as the ability to collect rainwater, hide from the sun and let the breeze through. Other projects that have created new material expression with local building traditions are Mariam Kara's Hikma complex, and the work of Peter Rich in Mapungubwe and Francis Kere in Gando.

When the architecture reflects its unique history and culture as well as its socio and economic circumstances, the result will remain relevant and resilient through time. The collaborative practice that arises from this approach lends itself to a dialogue between architect and the public, including many voices rather than a single idea with a single narrative.

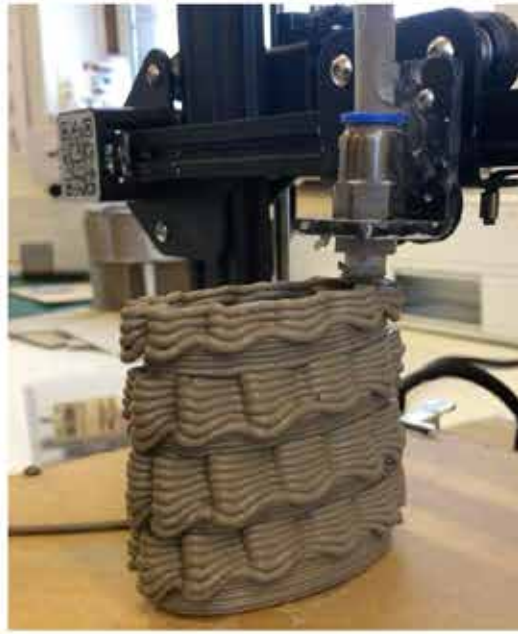
Figure 50
Mariam Kara's Hikma complex translating traditional materials into modern typology

04 DESIGN DEVELOPMENT

Figure 51
Models embodying vernacular climatic principles

Figure 52
Translating vernacular principals with modern technology such as 3D printing with clay.

From these findings I developed concept models that house the climatic principles of vernacular architecture that I then translated into modern ways of making with 3D printing. These models allowed me to explore spatial relationships, opening to the sky, playing with light and water reflection and shelter and exposure.



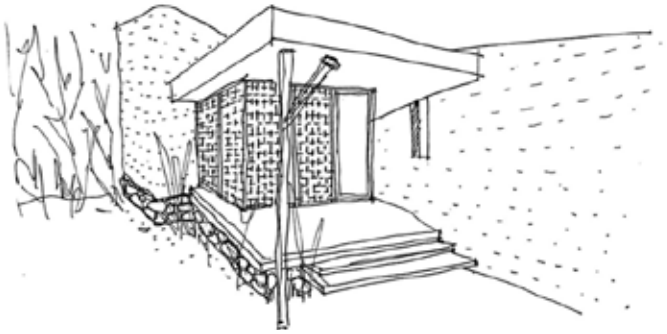
This led me to develop a module that can be a basis on which to design. A 3D printed mud structure is an anchor on which a lightweight structure celebrating woven reeds is attached with its accompanying fishpond and reed filtration. The links between woven plight materials and 3D printed mud weights on the degree and variation of light and air filtration. How the light enters the space will be specific to its function and aims to celebrate the Khoi and the San's connection to the sun, sky, and stars. Furthermore, the way light reflects off water attempts to connect the user with the sky and earth and portray the importance of its connecting element: water. Furthermore, spaces will be developed to celebrate this connection.

The structure will sit on a foundation of stones to allow for parts of the building to remain while others can decay. This will be a mindset that will filter through the grand design. From buildings to paths, elements that are designed to decay can fall away when their function is no longer needed, giving rise to opportunity for future development and advancement based on unpredictable future needs and knowledge.

Module for co

This playful mediation between the different relationships with nature throughout the building serves to form a common platform on which everyone that comes to the site can connect with all the histories of the site and with nature. These different climatic rooms house the appropriate function to form in entirety a symbiotic building that works with nature, through nature, by nature.

The **materials** pallet collected through the analysis process is predominantly two locally found materials. Mud and clay to form walls that moderate climate and reduce sound pollution. These 3D walls will incorporate locally derived patterns or 'weaves' developed by participants of the Riverclub site. The spaces they yield can range to be open to the sky, allowing in the moving sun, stars, and rain highlighting the Khoisan's close relationship to the sky and its elements throughout history as well as acknowledging the scientific breakthroughs of the astronomy observatory just metres away. This balance and correspondence of science and ecology, history and modernity run through the whole building prompting the production of knowledge that learns from the to the past and advances the theories through modern technology, empowering locals and protecting the environment while creating a tight knit community of understanding and appreciation.



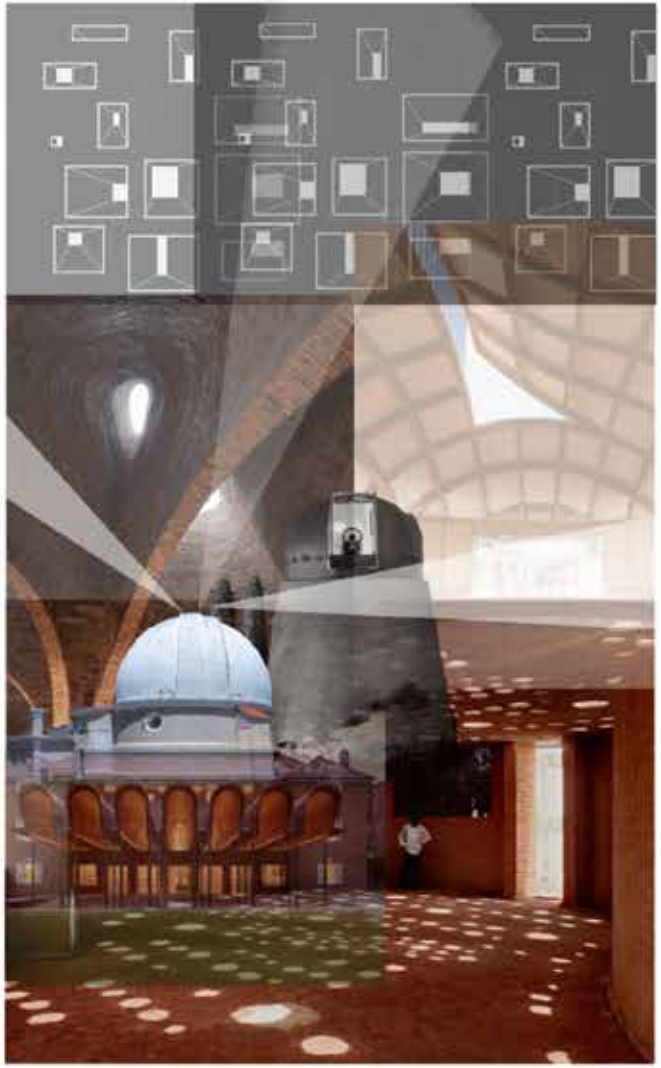
The second primary material is woven reeds. This material will be planted throughout the building and surrounds to clean the river water as is done in previously mentioned studies, while providing secondary productions of compost and food. The second function of the reed is the building material that is woven into the ecosystem and will grow, live, die and decompose to fuel that same ecosystem. This material further emphasises how the built environment can be incorporated into the ecosystems they inhabit, while providing jobs, enhancing skills and actively enhancing the ecosystem rather than being passive or causing harm.

The woven walls, floor, column and roofs are constructed to moderately allow nature in. they are contracted for nature, and by nature. Alternative, previous case studies have shown how this material can be impermeable such as waterproof from rising damp or water, and rain. These qualities of flexibility of permeability will also be played with in various occupations throughout the building, introducing new alternatives to existing harmful building materials thus prompting further investigation and production of knowledge.

Water will interact with the building in various ways. Water will be temporarily diverted from both rivers, naturally cleaned through a symbiotic process with algae and bacteria, growing fish and hyacinth then returned to the river. The way in which water interacts with the building emphasises the importance of the life-giving properties of water

Principles that are embodied in this concept model are:

- Connection to sky with openings to let the sun move around the building connecting you to the changing times of the day. Opening for the rain to come in certain places of the building to then flow into the nearby pond.
- Cross ventilation with openings high and low
- Dramatic changes in light with a dark ascent to the building to arrive in light.
- Nearby water system cooling the building and cleaning water
- Light reflecting off water onto building
- Permeable and woven walkways with layers of soft thresholds to protect the user from wind and cast dappled shadows on different areas in morning and evening.



I will explore how light can enter this 3D printed structure celebrating the Khoisans connection to the stars and sky.

Figure 57 *Atmosphere with varied light.*

This is an exploration how to use light reflecting of water.

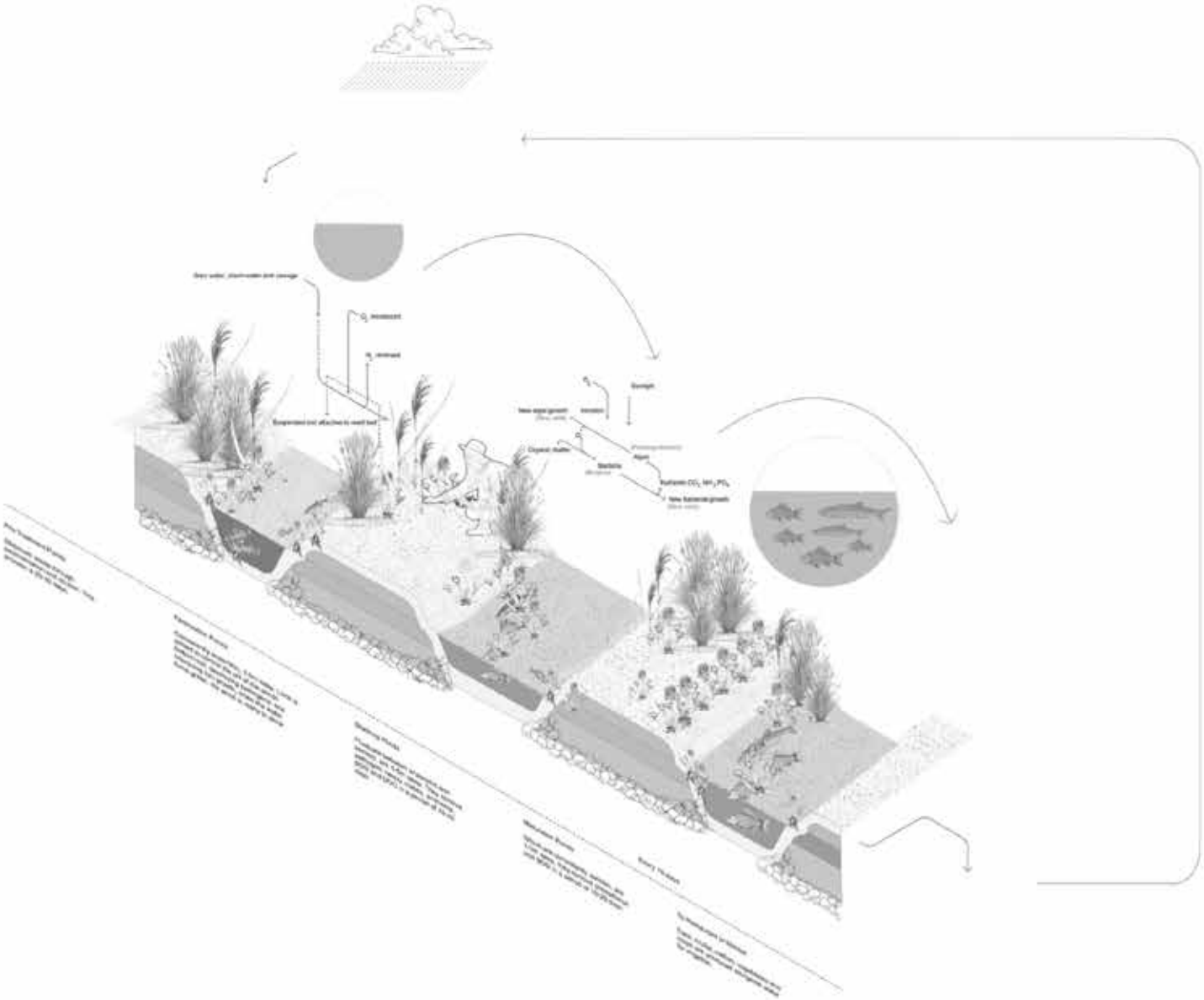
Figure 57.2 *Atmosphere with light reflection.*

These explorations are an attempt to uncover how to connect you with the sky and earth through water.

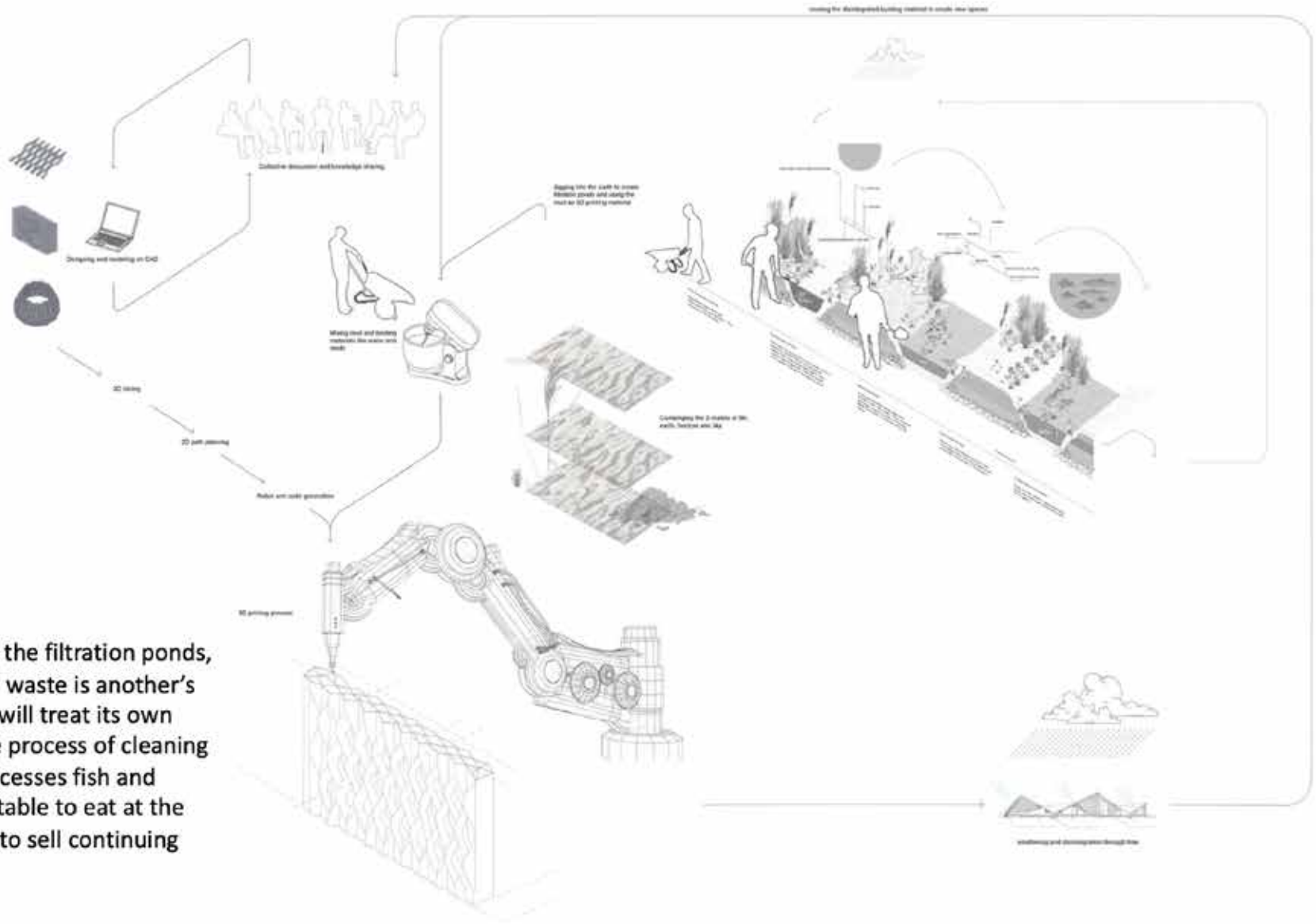
Figure 57.3 *Atmosphere with water and building*

Conceptualizing spaces to
celebrate this connection.

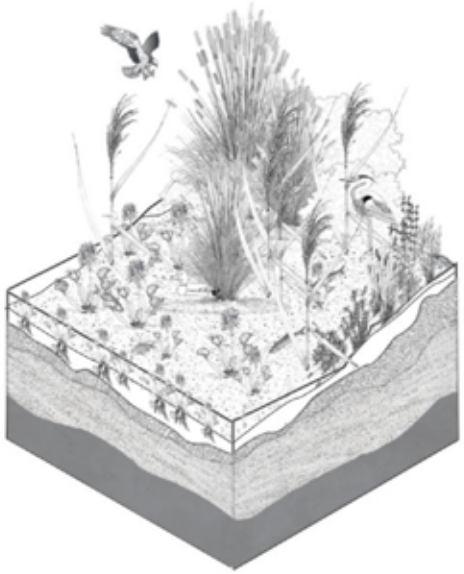
Figure 57.4 *Atmosphere with framing views*



ll systems on site are closed systems,
inimizing waste and maximizing
onnectively of disciplines for
ollaborative innovation. The collective
ommunity knowledge sharing leads to a
lea that is designed and made. Soil that
dug from the earth is used to create
ltration ponds. This soil is mixed with
inders like water and reed, binding the
arth, horizon and sky. Through time the
lements are either maintained or
ecays. This soil is then reused to solve



Similarly with the filtration ponds, one elements waste is another's fuel. The site will treat its own water off. The process of cleaning the water processes fish and irrigates vegetable to eat at the restaurant or to sell continuing the system.



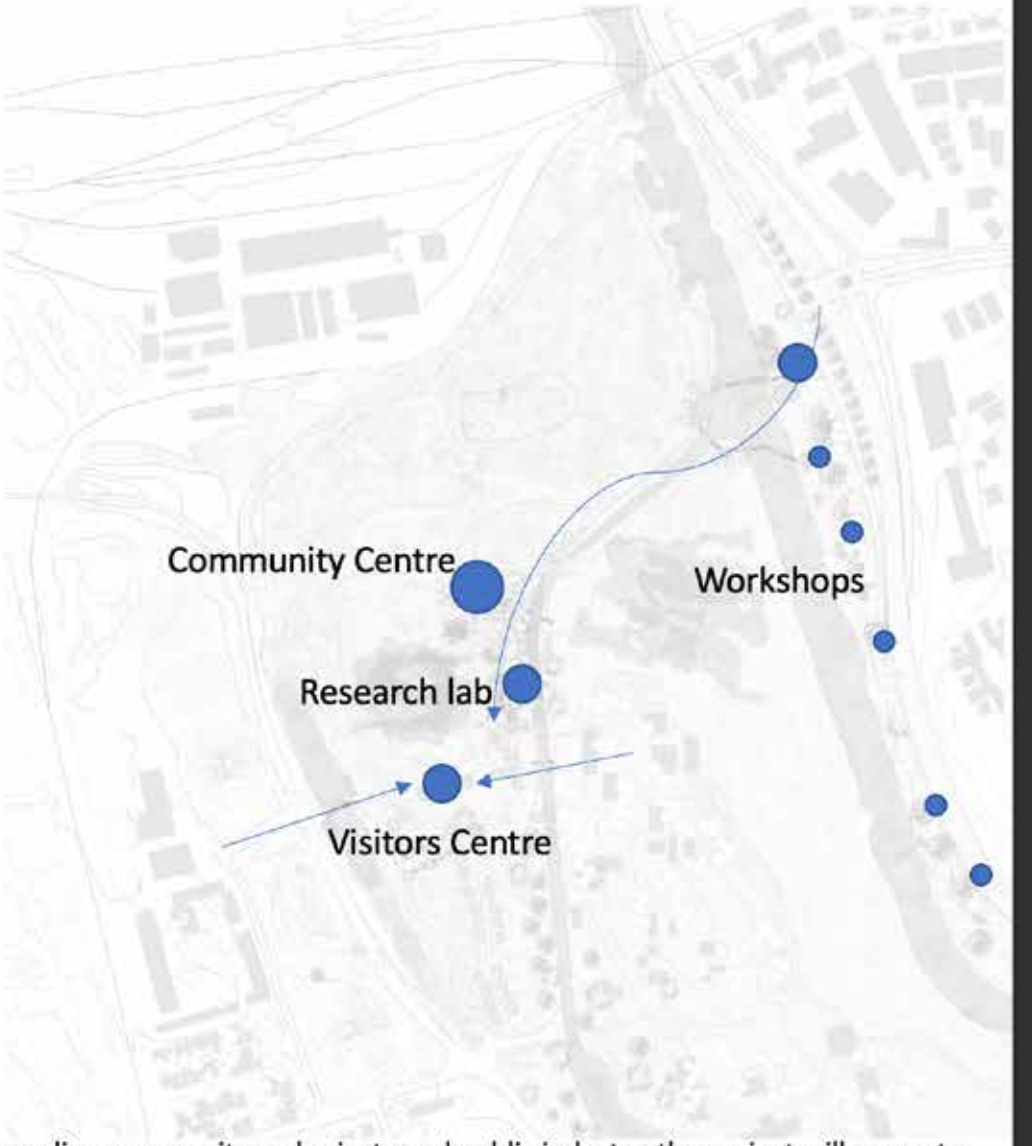
The development of the site aims to establish a research, technology demonstration and skills development centre that will focus on advancing knowledge of how to combine ancient and modern technologies and systems with nature and ecosystem cycles. Thus, cleaning polluted water while providing food, building structures and materials that can decompose and connecting communities with nature and their histories.

Commercial Residential Academic Hospital Industrial

Amazon Proposal

Routes in landscape

Proposal in landscape



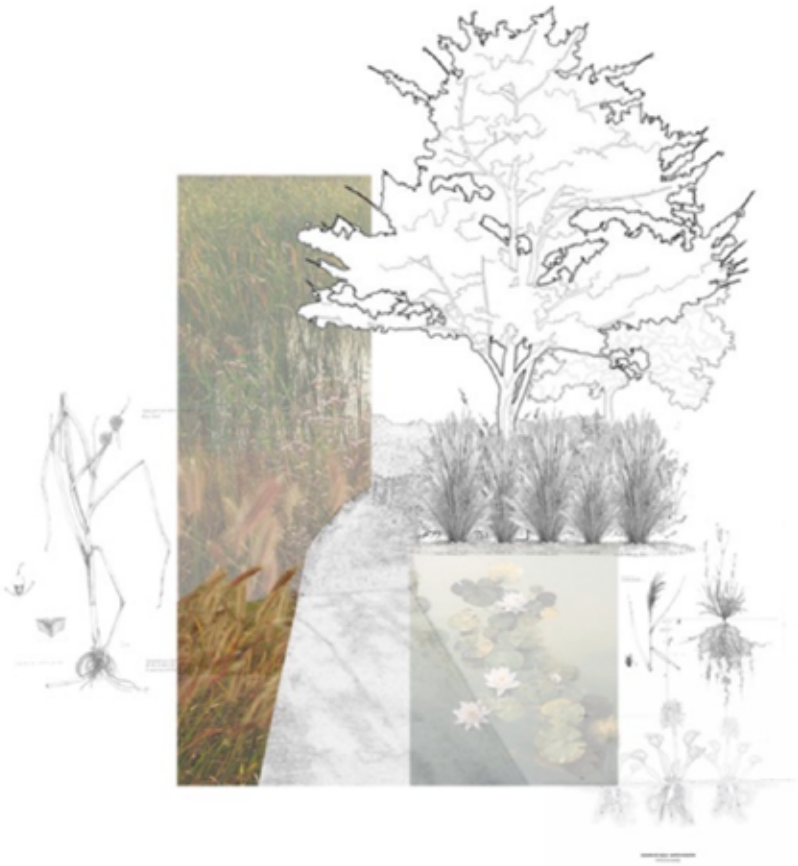
Through strong collaborative efforts between students and academia, the surrounding community and private and public industry, the project will promote living in symbiosis with nature with healthy wetlands and rivers and technological innovation with simple and complex natural organisms that will be

Although the site is somewhat disconnected from its immediate surrounds, it is deeply connected to phenomena that occurs km away.

The two rivers collect and carry stormwater, sewage, plastics and chemicals from catchments areas like Kirstenbosch, Epping and Gugulethu.

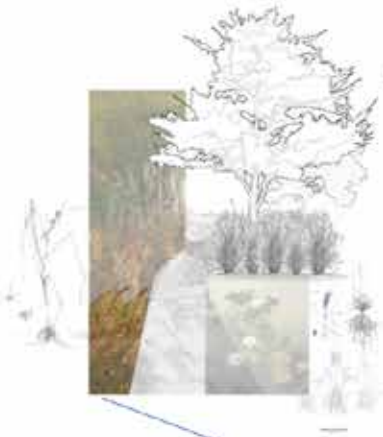
The stark realities and contrast in climates highlight the imperative of working together in a developmental space across borders and boundaries with an initiative starting on site, sparking interest in surrounding communities and then implemented upstream.

The challenge is to collectively build new knowledge and understandings about efficiencies, performance and operations and maintenance of these surrounding systems.



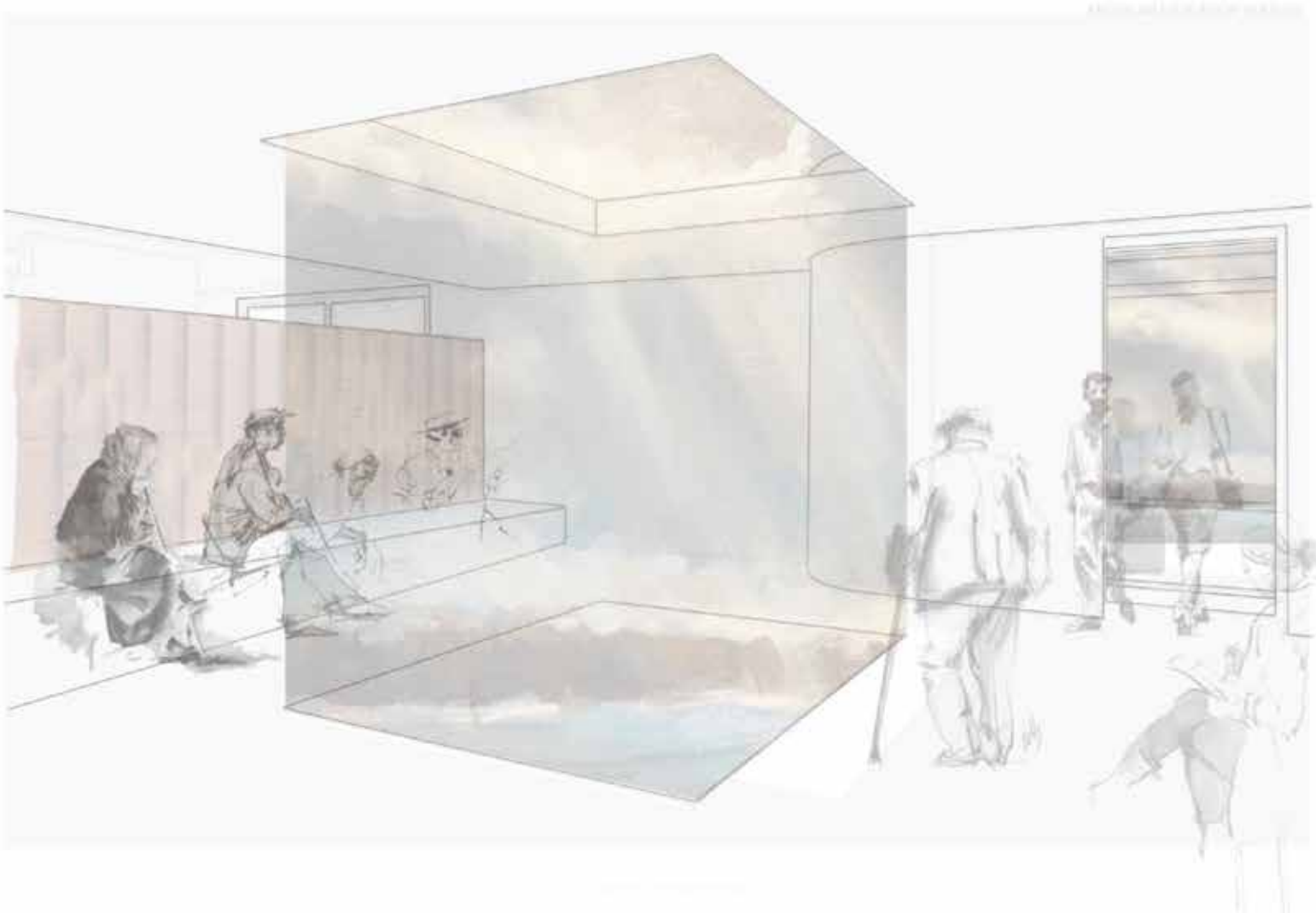
One can access the site 3 main points, continuing up from the Liesbeek path, crossing the black river and crossing the old Liesbeek path.

Old Liesbeek River



Black river

New Liesbeek River

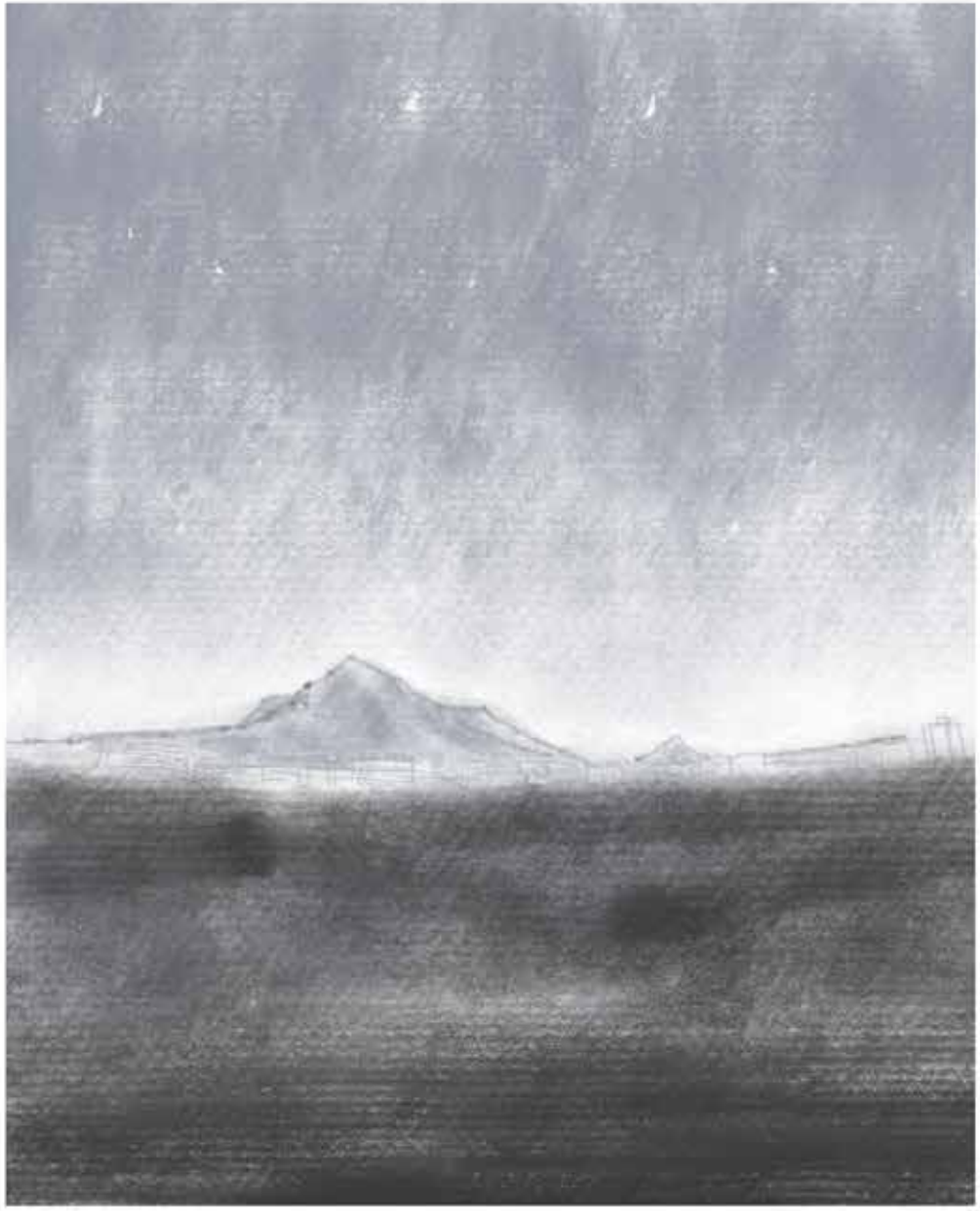


The design is an arrangement spaces with varied relationships with nature though openings to the sky, and letting the natural earth come through.

It is designed with elongated soft thresholds like walking through a forest of trees or wetland of reeds.

These painting depicts the hard and soft ground conditions that
explored in the approach and exit of the building.

This render shows how the building would open to the stars at night. Highlighting the principles of respect for nature that are in line with the Khoi and San.



Present day cultures and traditions of the Khoi and the San people have been largely adapted and modified due to 90% of indigenous people being kill or enslaved by the colonial oppressor. Cultures and traditions have therefore been mixed as generations have passed. The present-day Khoi and San people therefore are trying to adopt a way of life that is unique to their specific line of heritage.

In Konoffofskraal, a Khoi settlement that has grown rapidly in the last 2 years, regular ceremonies take place to cleanse, gather and welcome new people. This specific ceremony consisted of a clear hierarchy of 5 leaders that lead the event. Participants took their shoes off to be grounded, connected with the earth and put on equal terms with their fellow participant. I type of sermon was said in Afrikaans, fynbos (Asteraceae) was burnt in the center of a circle. While a chant was sung, the participants walked in a circle. At the end of the ceremony, a certificate was given to welcome these people into this specific group of Khoi descendant people, Goringchau khoi group.

The importance of place in these ceremonies will translate into the architecture. A ceremonial place must be designed to have one speaker leading the event but then transition to a circular area where everyone is on equal terms. The place must have a clear connection to the earth and sky and facilitate fire or water, a cleaning agent and symbol of gathering and connection to nature. This ceremony further enchases the significance of learning from the past while creating a vernacular or tradition for the modern-age.

Figure 60- 60.1 Goringchau khoi group cleansing and welcoming ceremony

Figure 60.2 *Entrance to the ceremonial area*

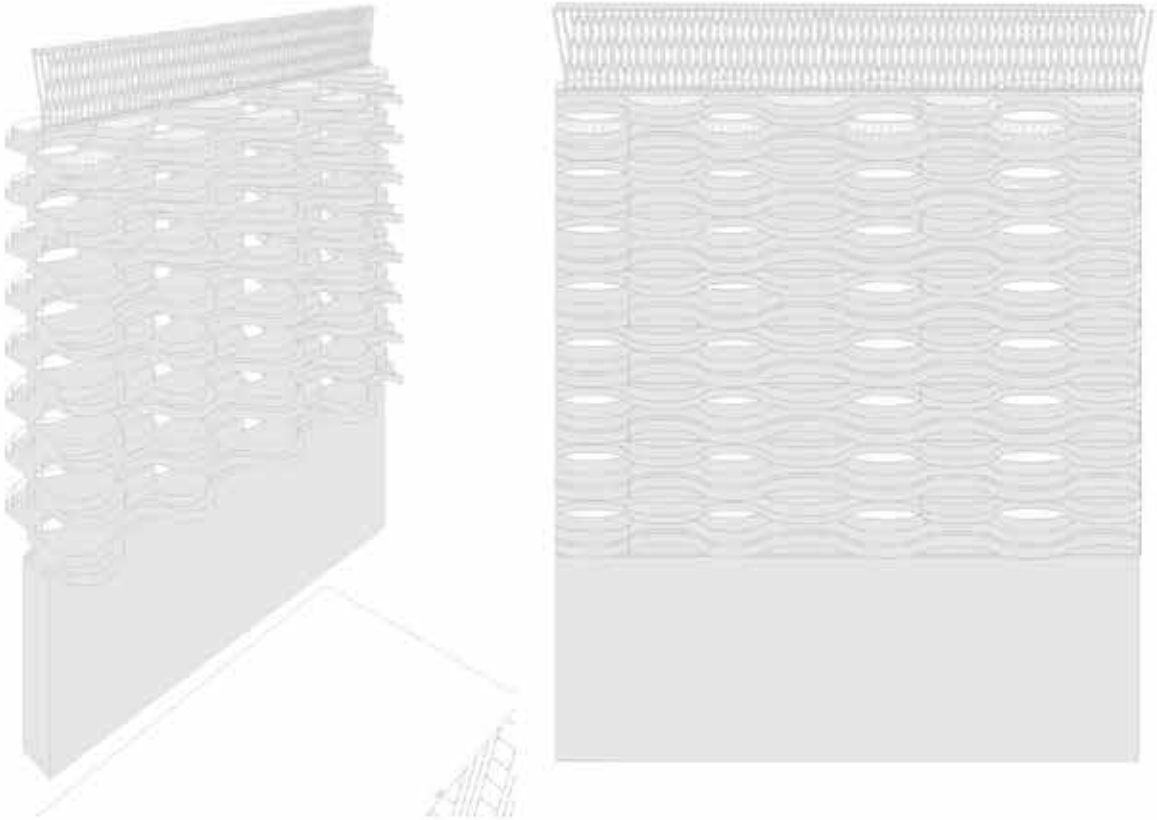
Figure 60.3 *Leader of the* Goringchau khoi group

Figure 60.2 *Central fire, a cleansing and gathering agent*

54.2

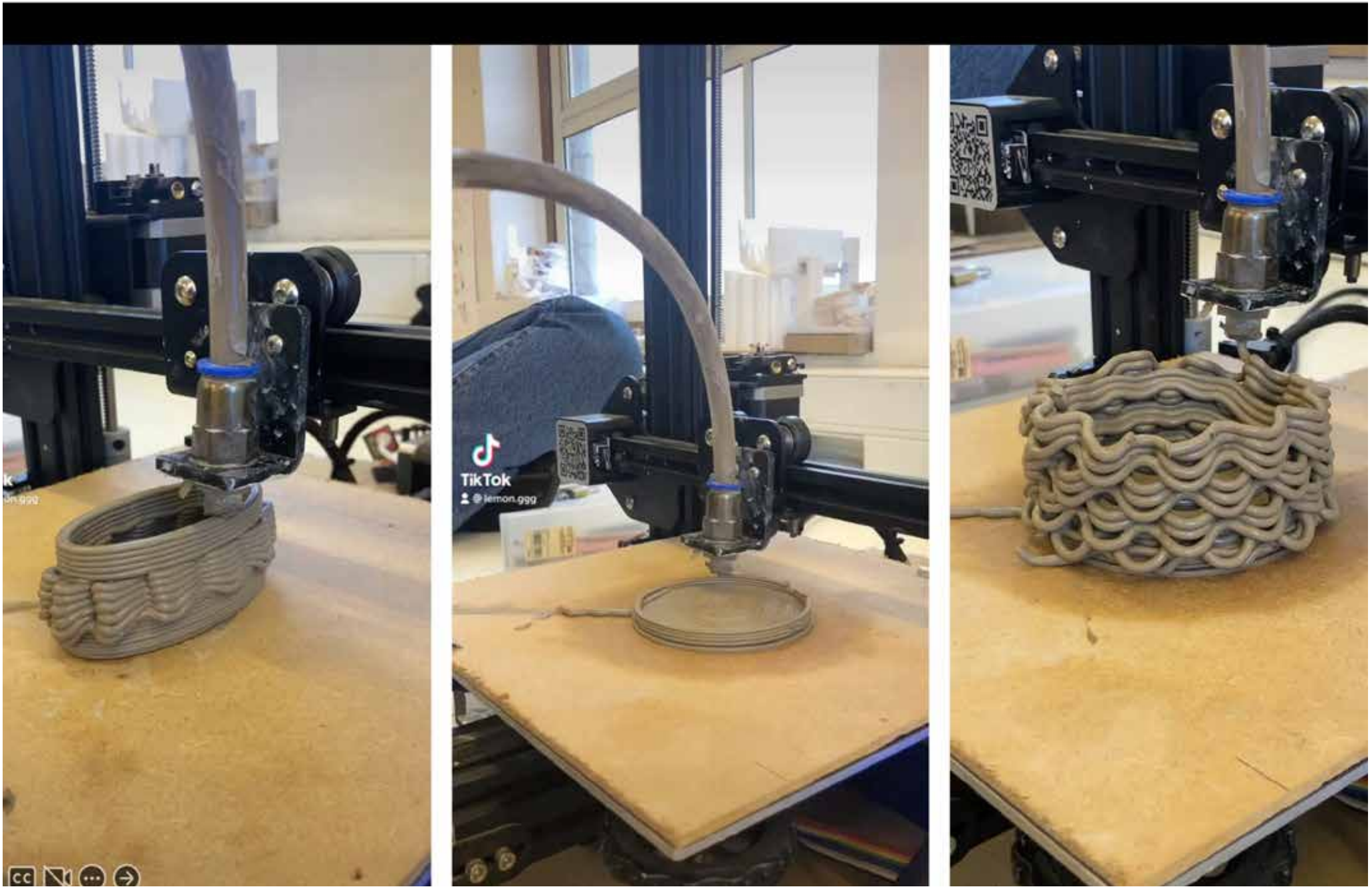

60.3

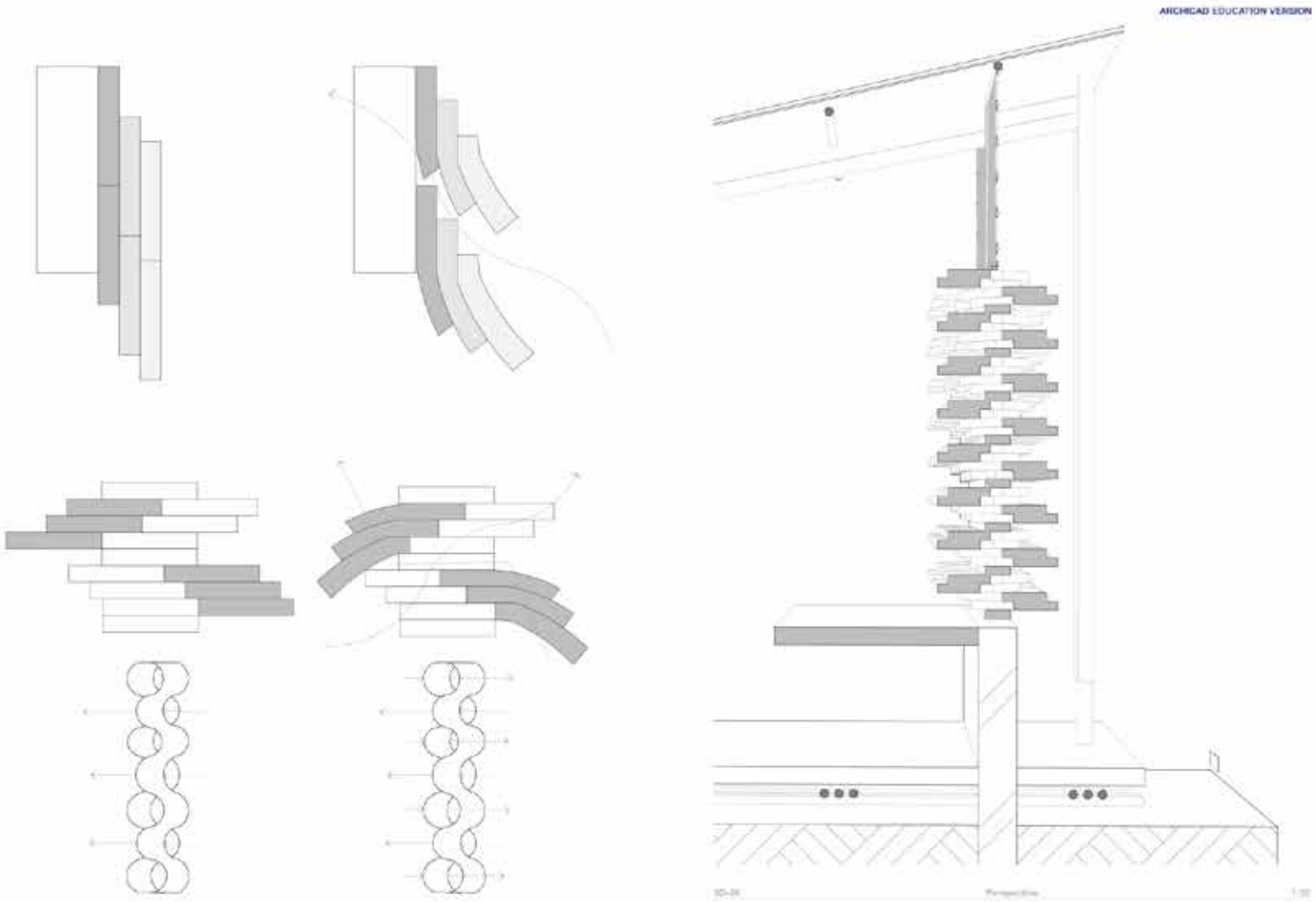
The ideas of “allographic” (meaning other) and “autographic” (meaning self) that I explored in my dissertation came through in the modelling the 3D printed elements as I hope it would in real construction. Conversation developed an idea of spatial quality which led to a form, that ha sliced and digitally modelled without the effects of gravity for then gravity to affect the printed pattern.



Images showing how the 3D printed element is designed digitally then broken down into layers and stacked.

Image showing the result of the digital model being printed and how gravity influences the design.

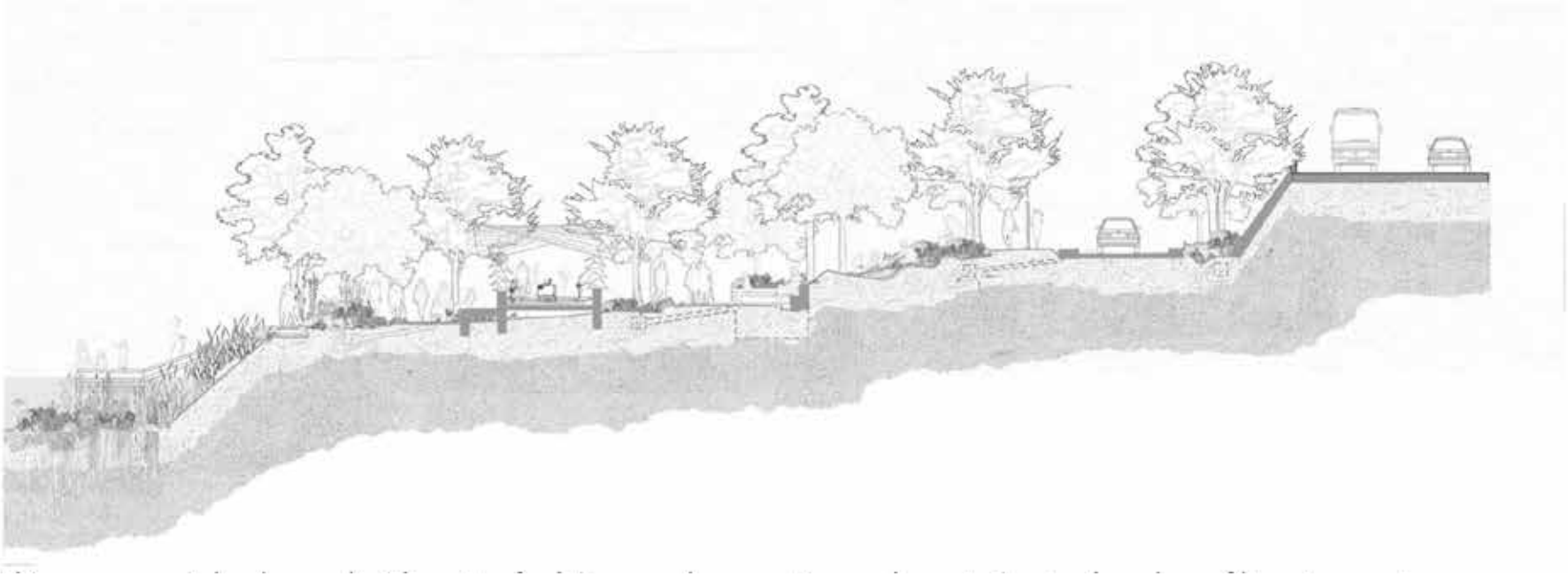

TikTok
@lemon.ggg



The real construction gives way to varied ventilated spaces that could be utilized horizontally and vertically.

Advanced materials could be programmed to curl up when exposed to heat from the sun. This could lead to an active building wall that opens when hot and closed when cold.

These innovative technologies that are tested in the construction of the buildings can be prototyped in the workshop spaces along the black river with failed attempted simply going back into the ecosystem promoting innovation while limiting waste.



These programs could be like precious plastic. An initiative that collect plastic from the river, grind it and print into sellable items.

Another resident for the workshop space could be "sheltersuit". It is an initiative that upcycles tents and fabrics into an item that is coat, sleeping bag and tent for the homeless.

This is a Sheltersuit

This is a product for people in need.

Water- and windproof jacket that can be transformed easily into a sleeping bag.

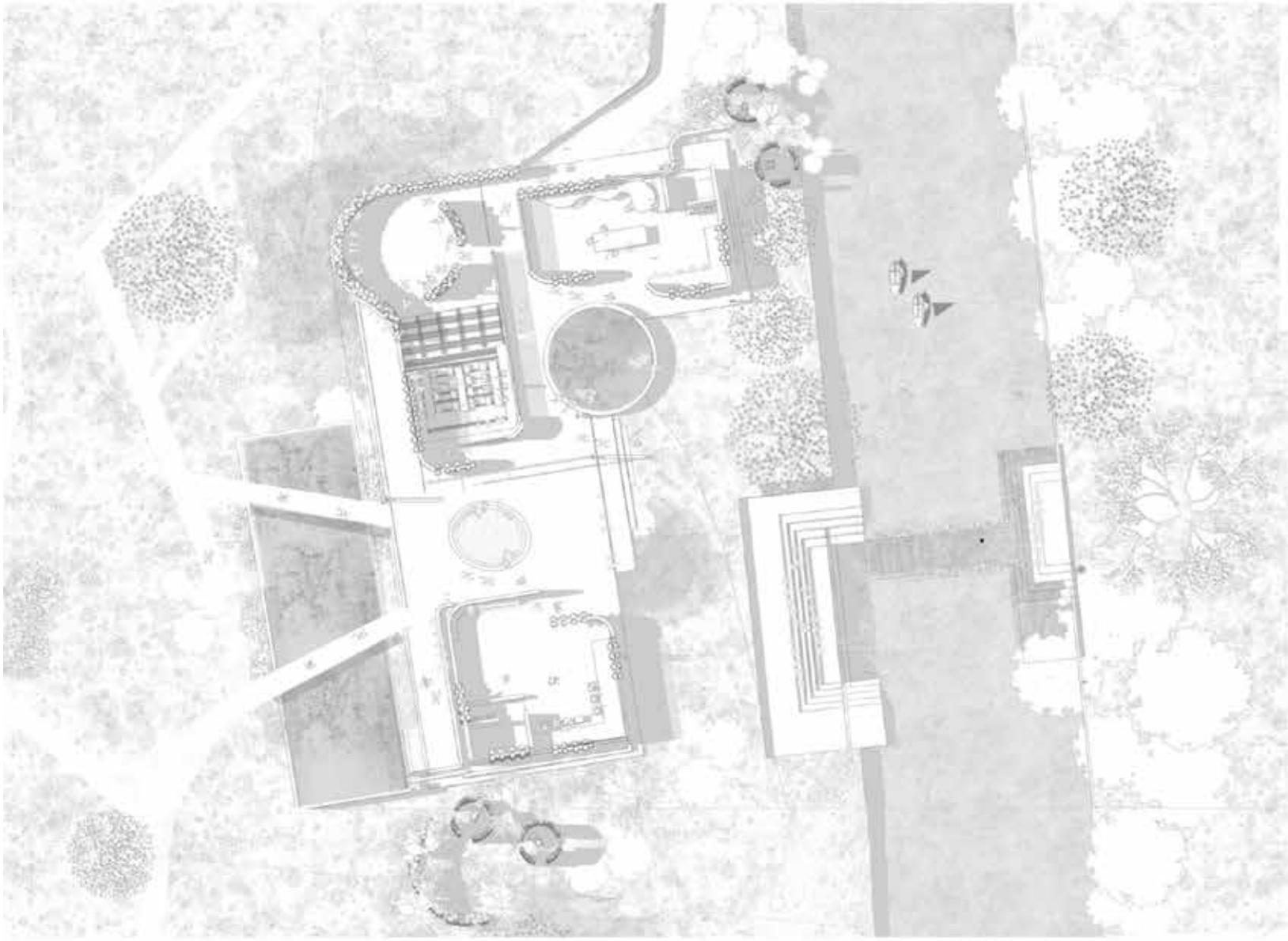
Made by former refugees who are distanced to the labour market.

Equipped with a large hood, integrated scarf and large pockets.

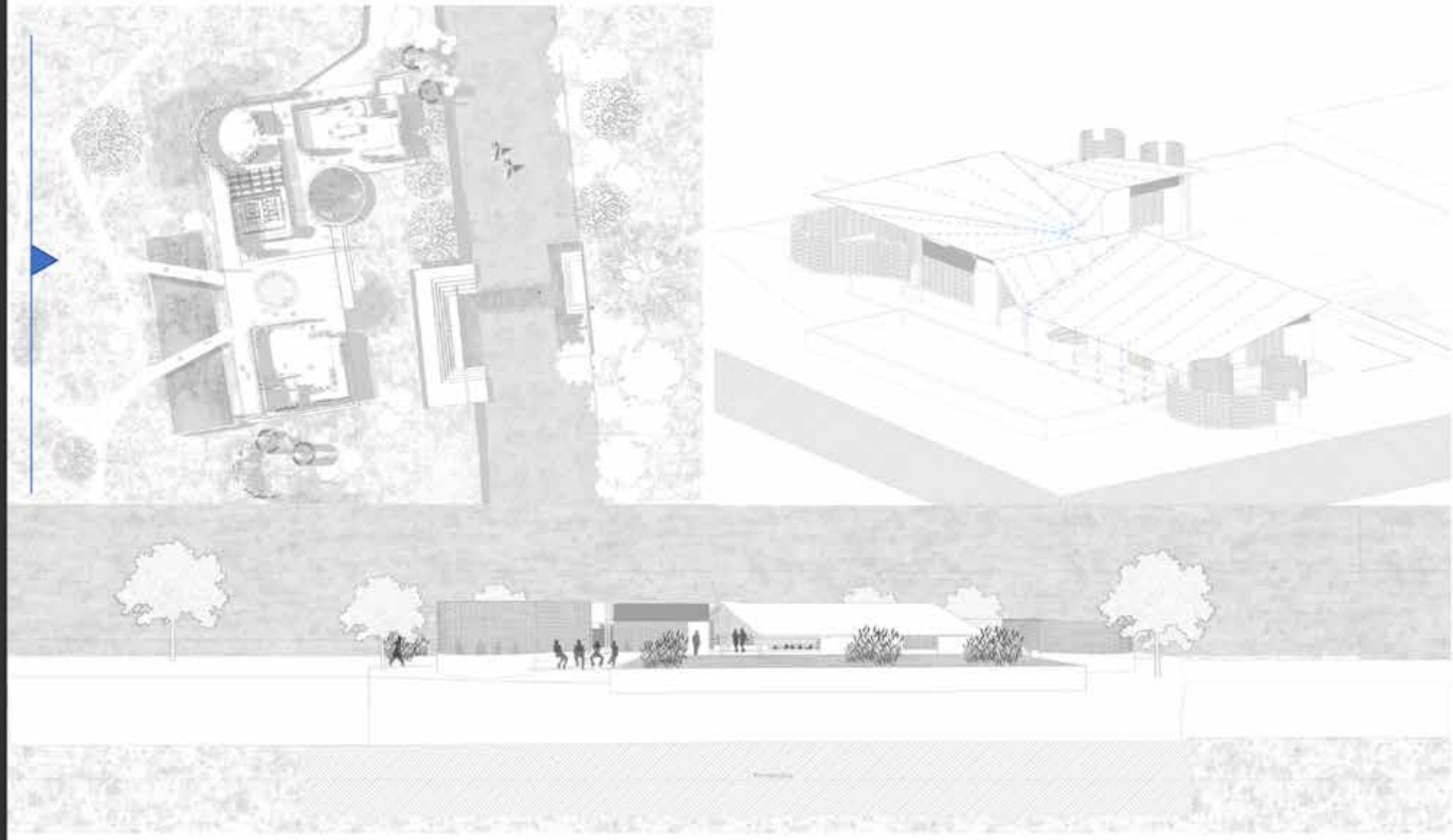
Made entirely from upcycled materials.

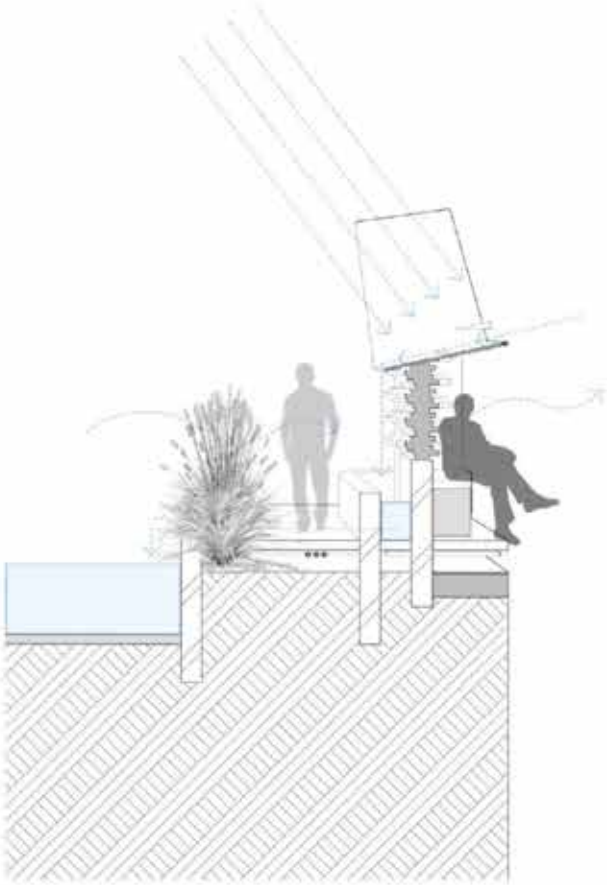
The sheltersuit has an opening in the bottom to make it easier for the user to move.

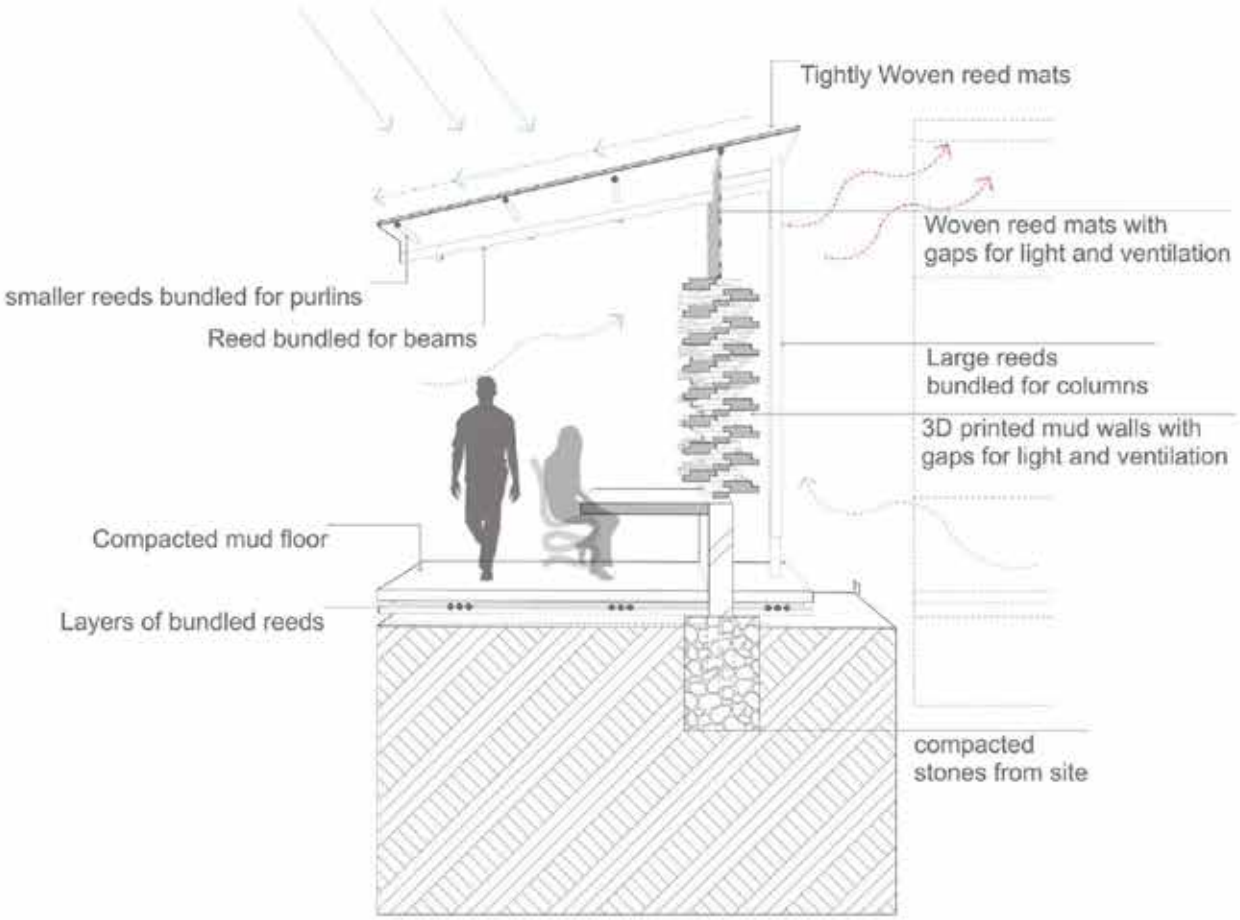
Images from Sheltersuit



The main research lab facilitates oral research through story telling and conversation, written research and research through making and prototyping of materials and systems.

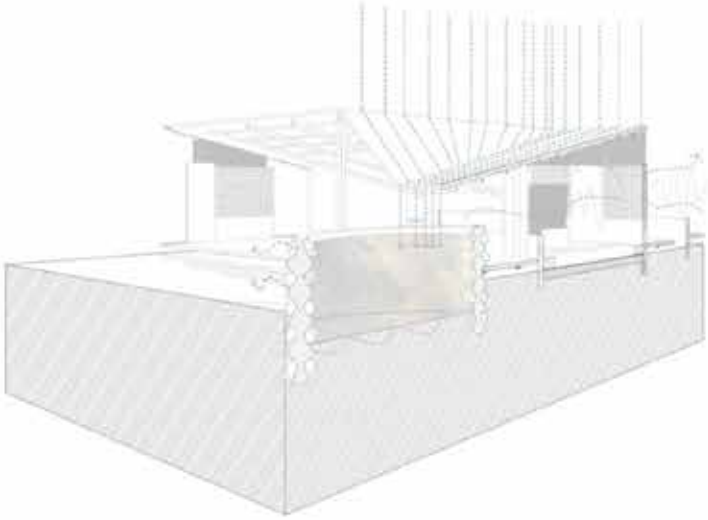




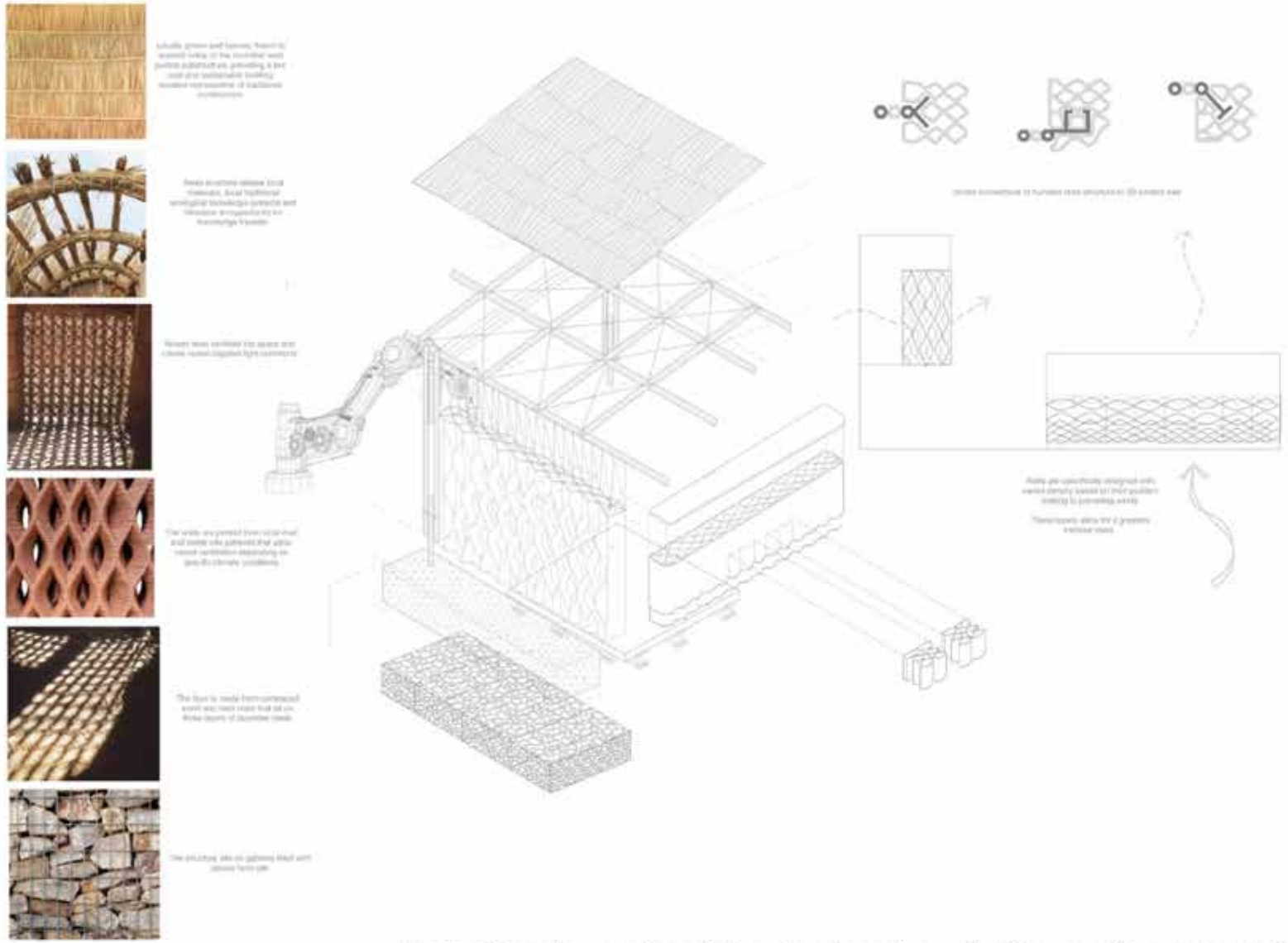


The roof comprises of 3 mono pitched roofs in altering directions.

It rises to welcome visitors, direct your view to the mountain and let in sunlight. The roof falls to direct water into the filtration ponds, direct your view down to the river and create shade.



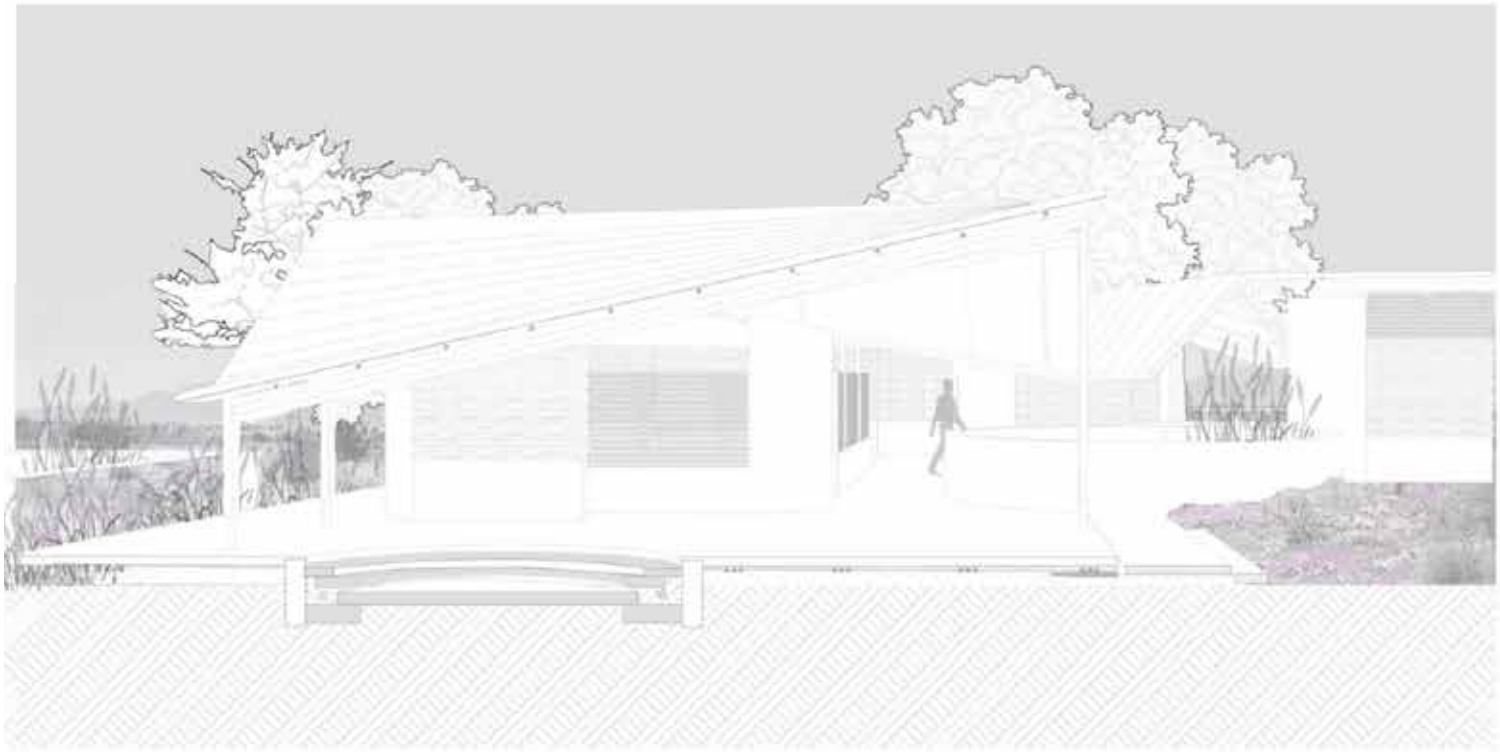
These ponds act as natural air-conditioning to the building.
They also slowly irrigating the surrounding vegetation
though a porous walls in summer.

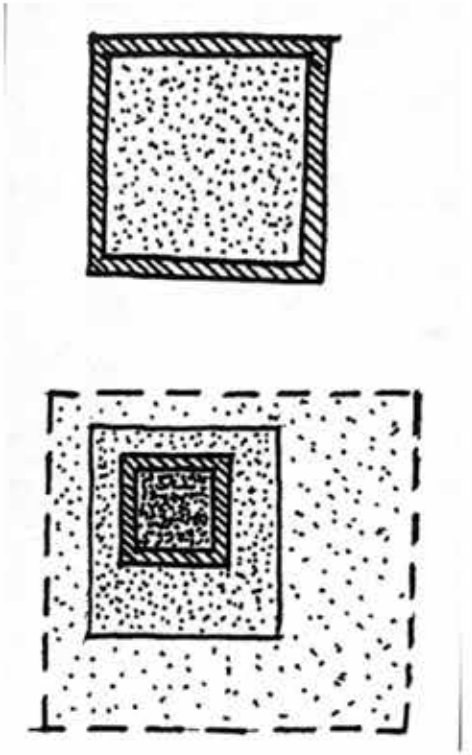


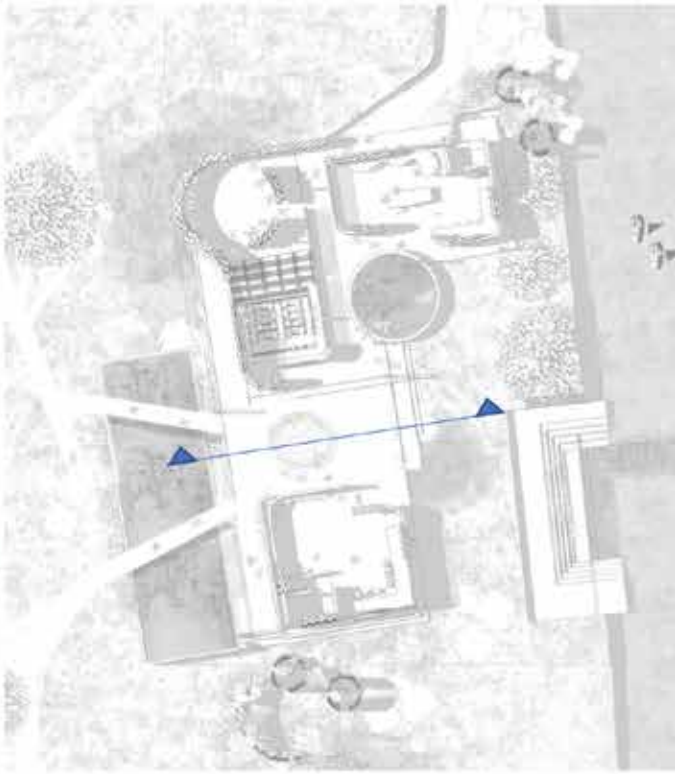
The building sits on gabions filled with stones from site, 3 layers of bunded reeds harvest from site, mut and reed mat floor, 3D printed walls that vary in density to protect from prevailing wind and rain, woven reed mats for natural light, bunded reed purlins and with a thatch roof.

The simple circulation allows for direct routes through and secondary circulation into the research labs that are designed for gathering and sharin of ideas in orange, and written research and prototyping in green.

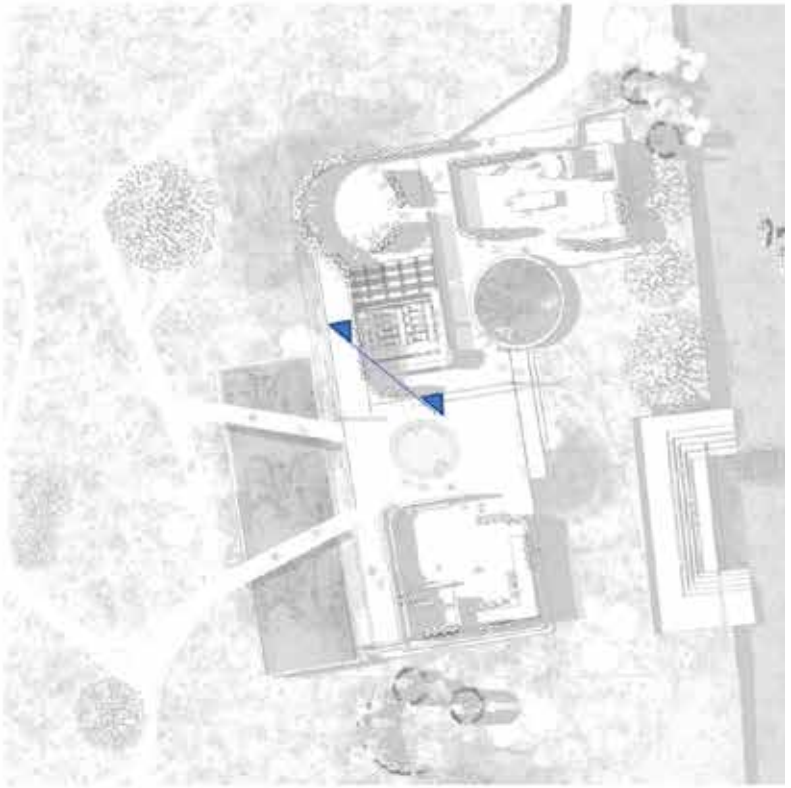
Western construction's uniform thermal environment is divided by outside and in. This is contrasted with this construction where the rooms are designed with varied climatic condition which offer a sequence of comfort opportunities.



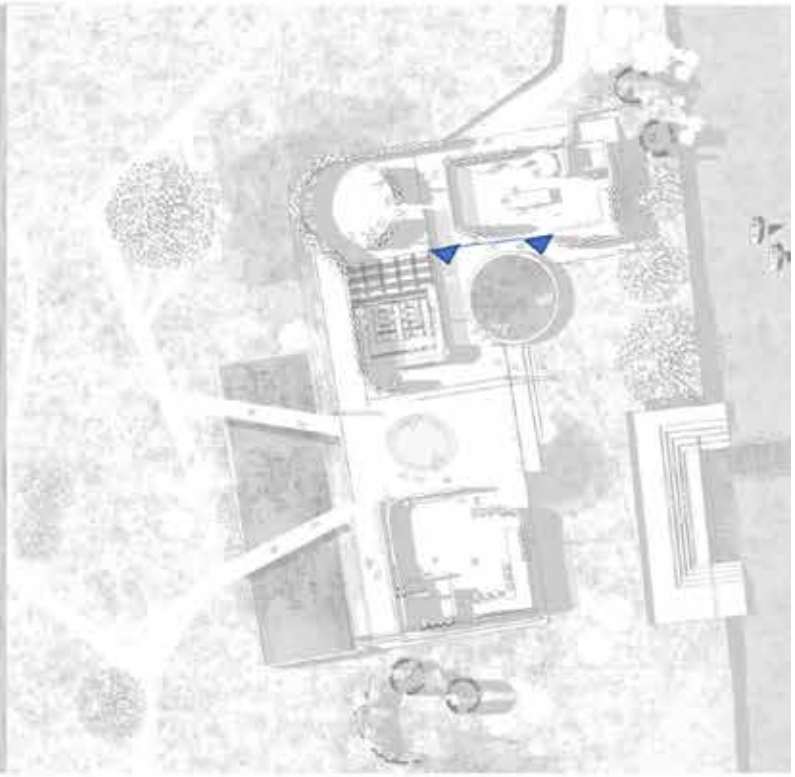


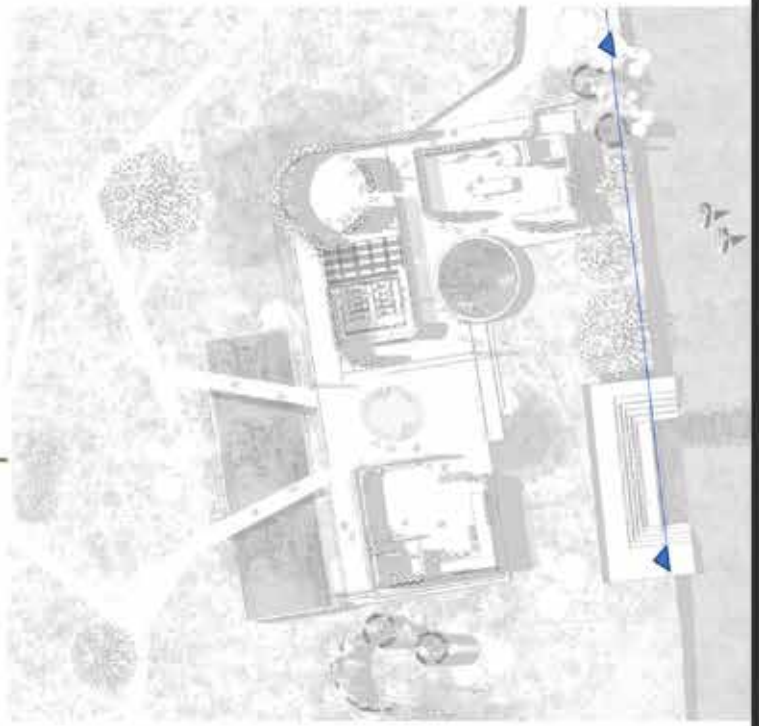


The double layered walls block the wind with no need for doors.



The layers of 3D printed mud walls add to thermal mass while the woven screen ventilate the space.

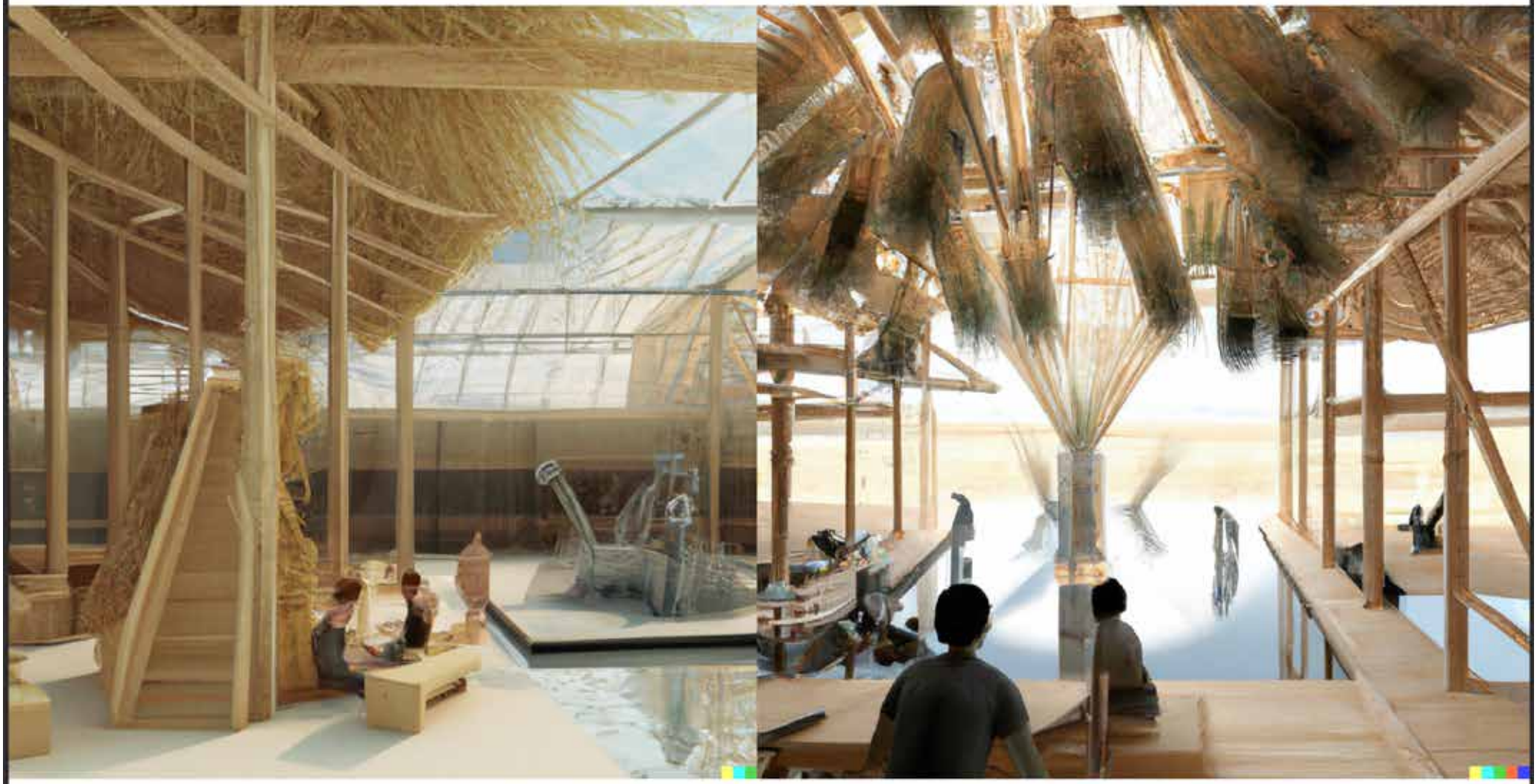


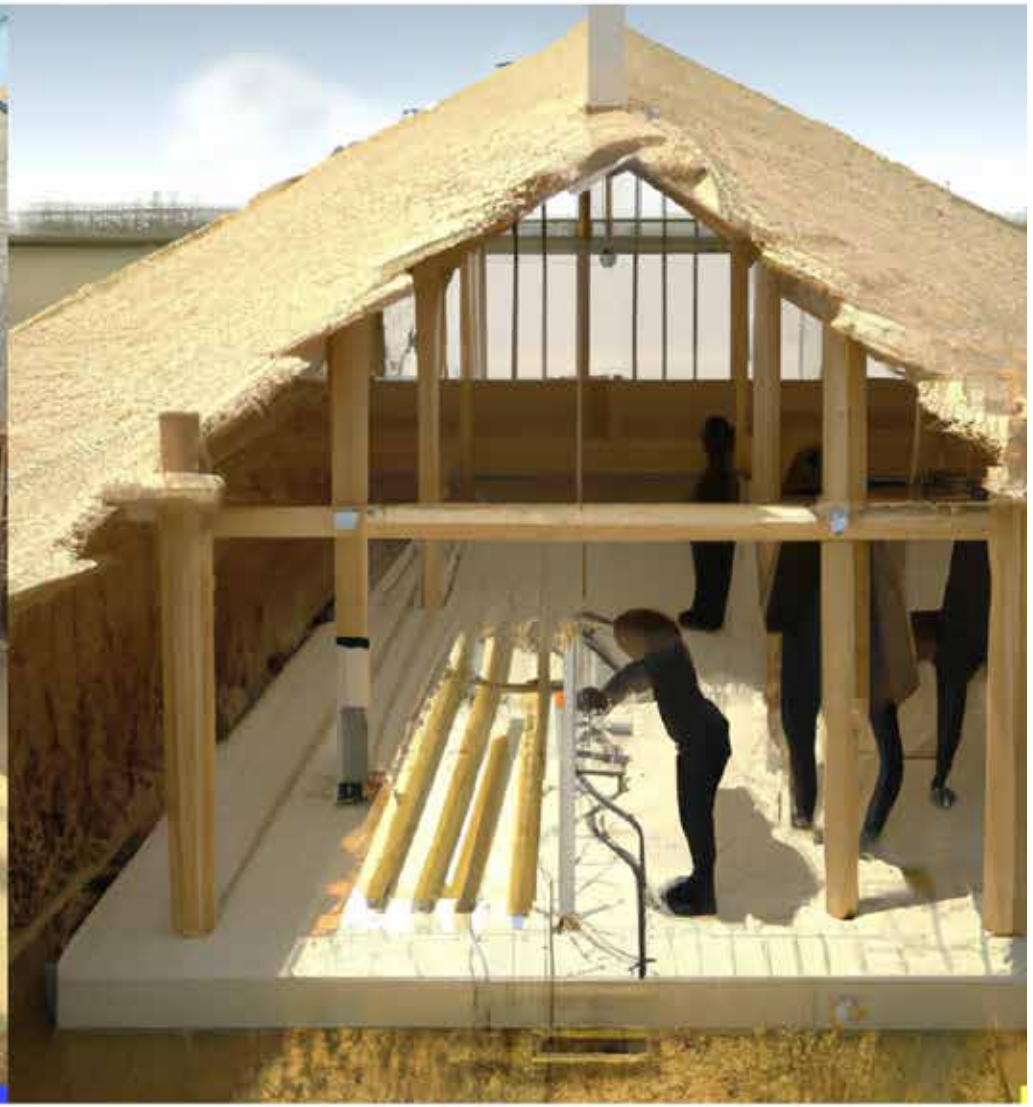


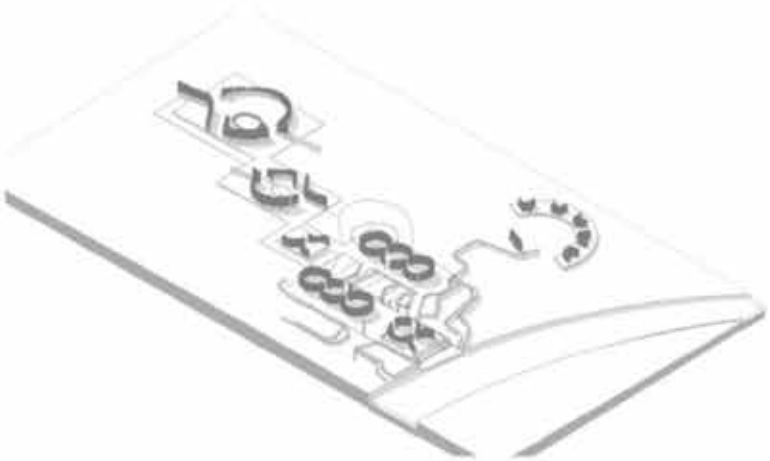
Elevation showing the two mono pitched roofs reflecting Devils peak.

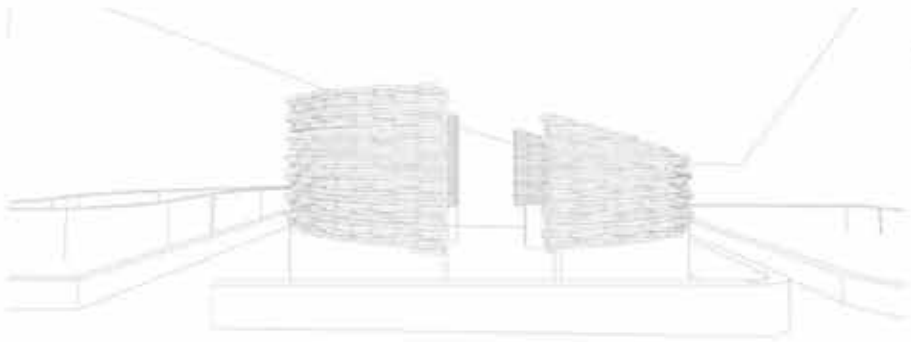
When walking north from the research lab is the community centre for gatherings, concert, small and big workshops and exhibitions. The Landscape becomes not only experiences but rather an educational medium raising awareness of nature protection.

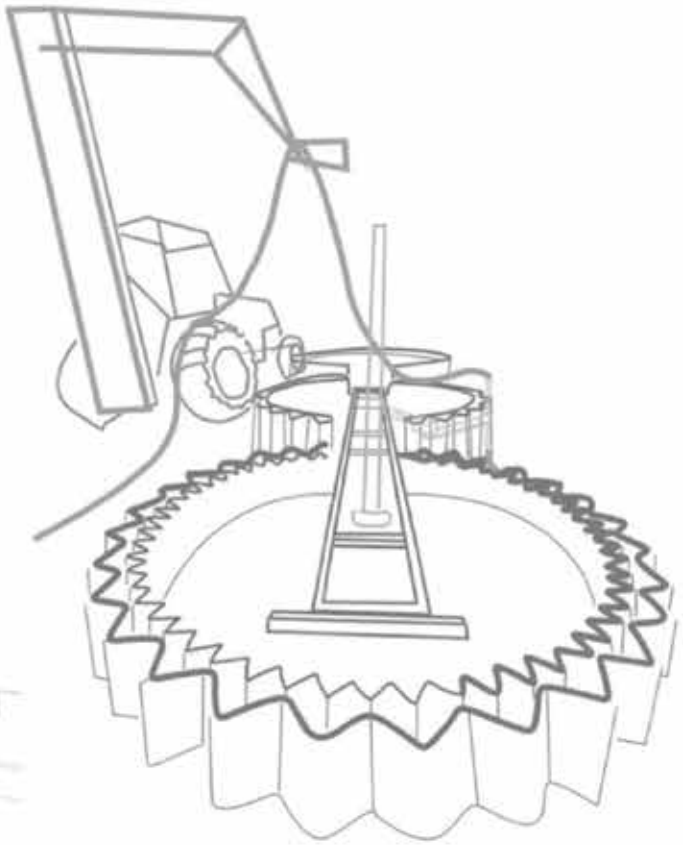
In line with synthesising traditional and new knowledge I explored how the written language of space, atmosphere and material can be translated into image with artificial technology. This is another platform that can inspired placemaking and construction.





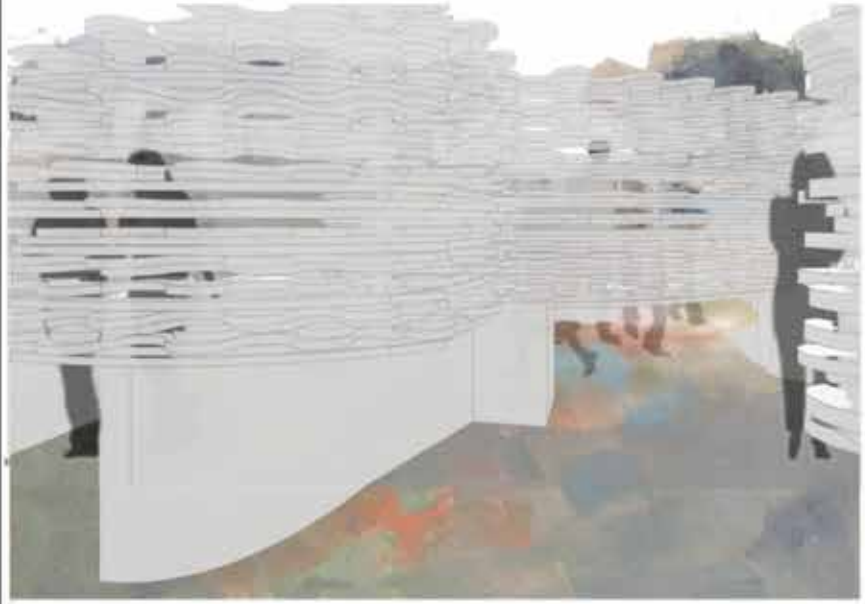


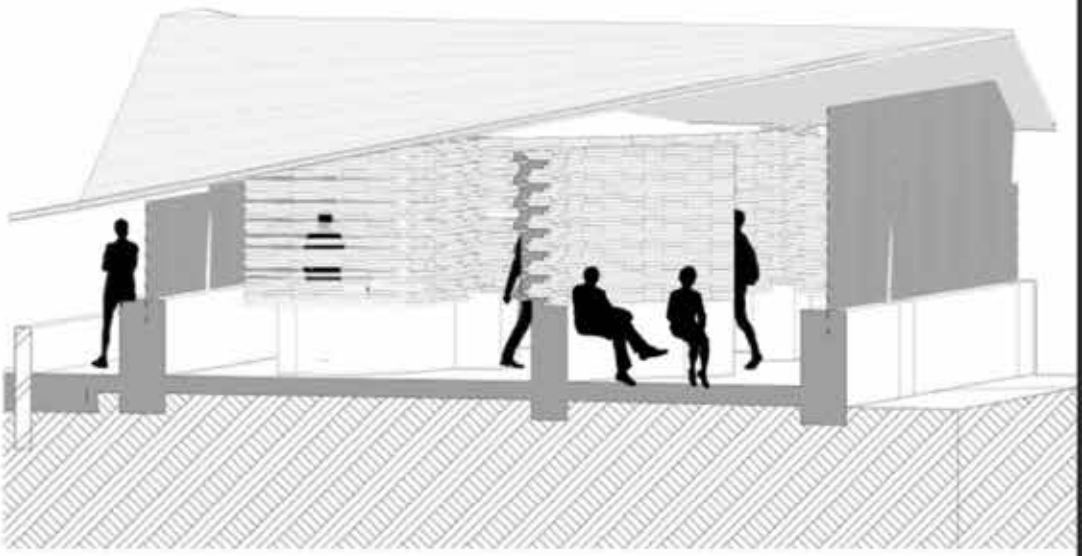




Here the circulation and openings are dictated by the construction method. The printer is placed on a platform so that it can slide from one room to the next while layers dry.

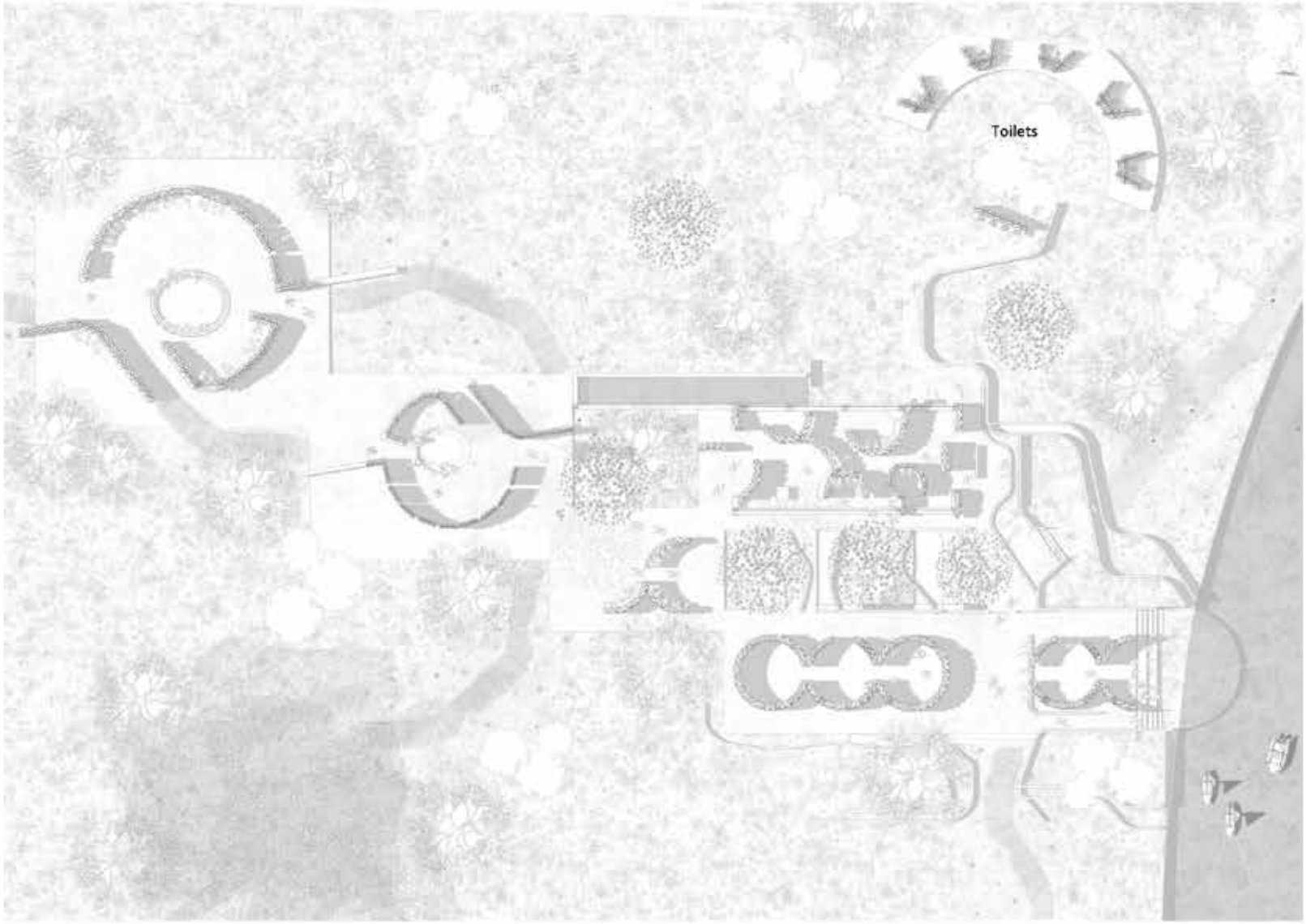
This method and openings allow framed views to the mountain between denser walls, and connections across multiple spaces and rooms.

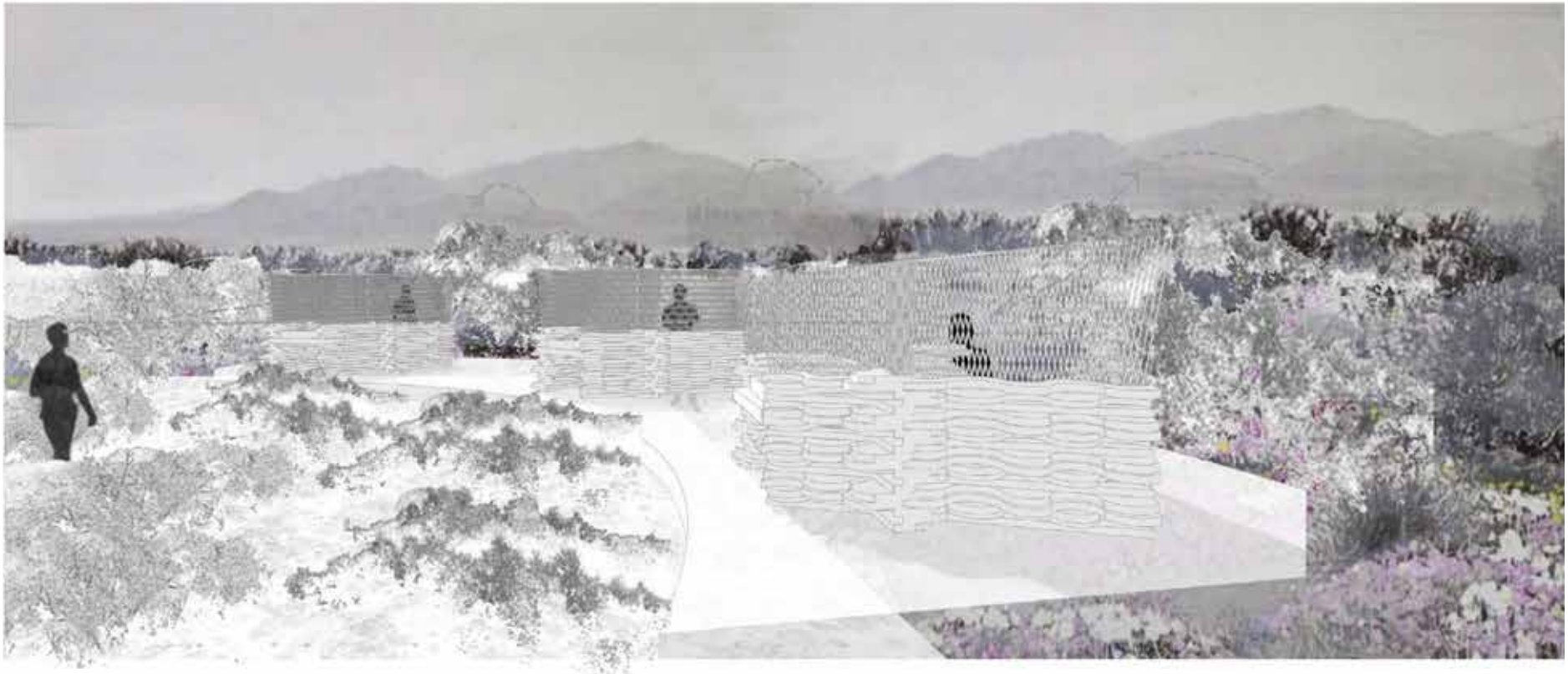




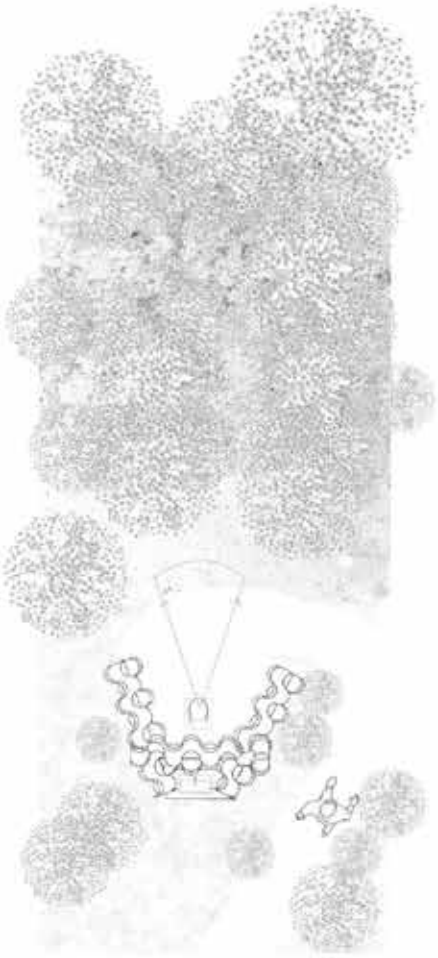
Less dense walls give varied degrees of connection and privacy. This is ideal for break out room discission from a larger group and exhibition spaces.

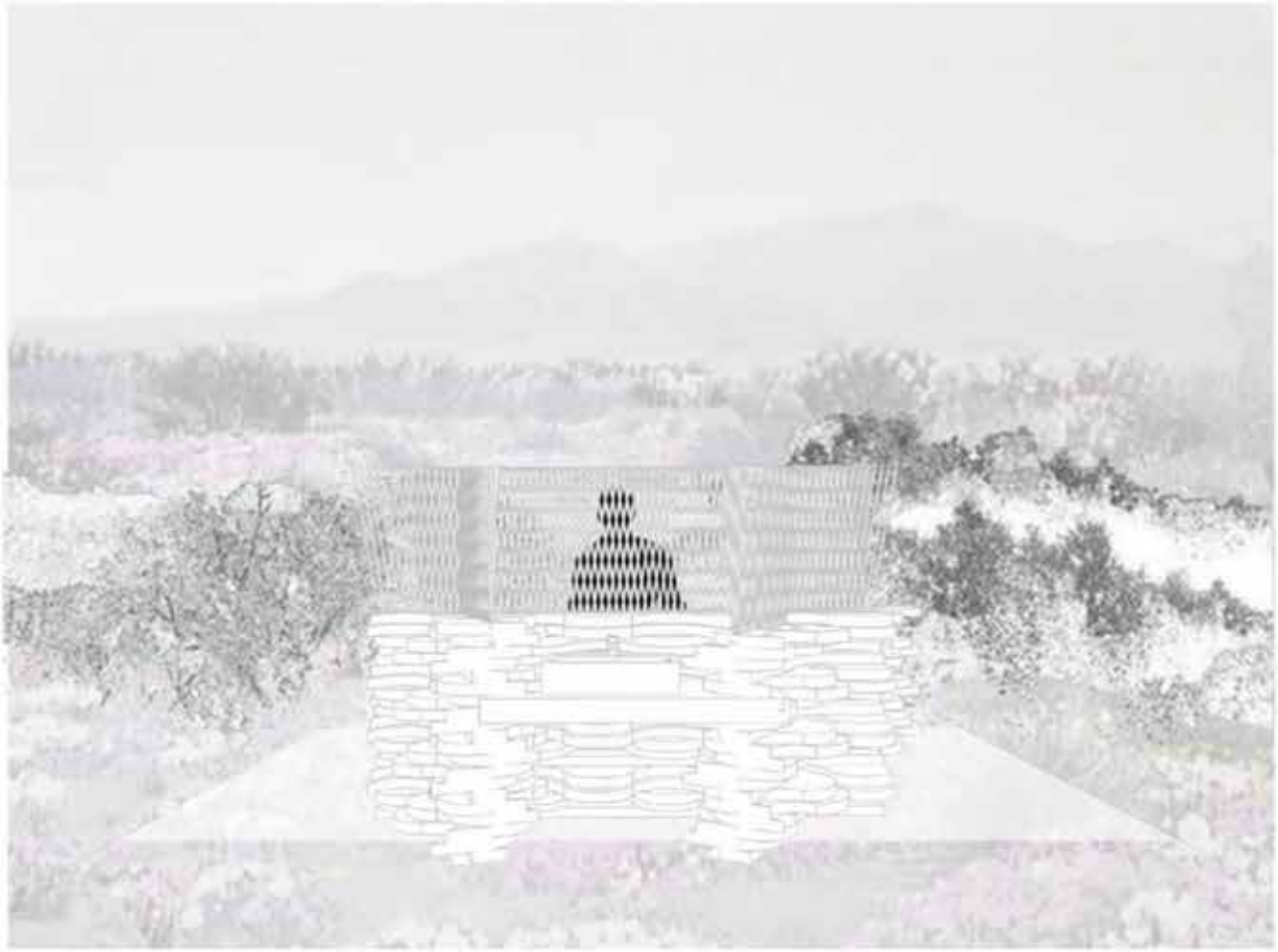
Locating toilets in plan





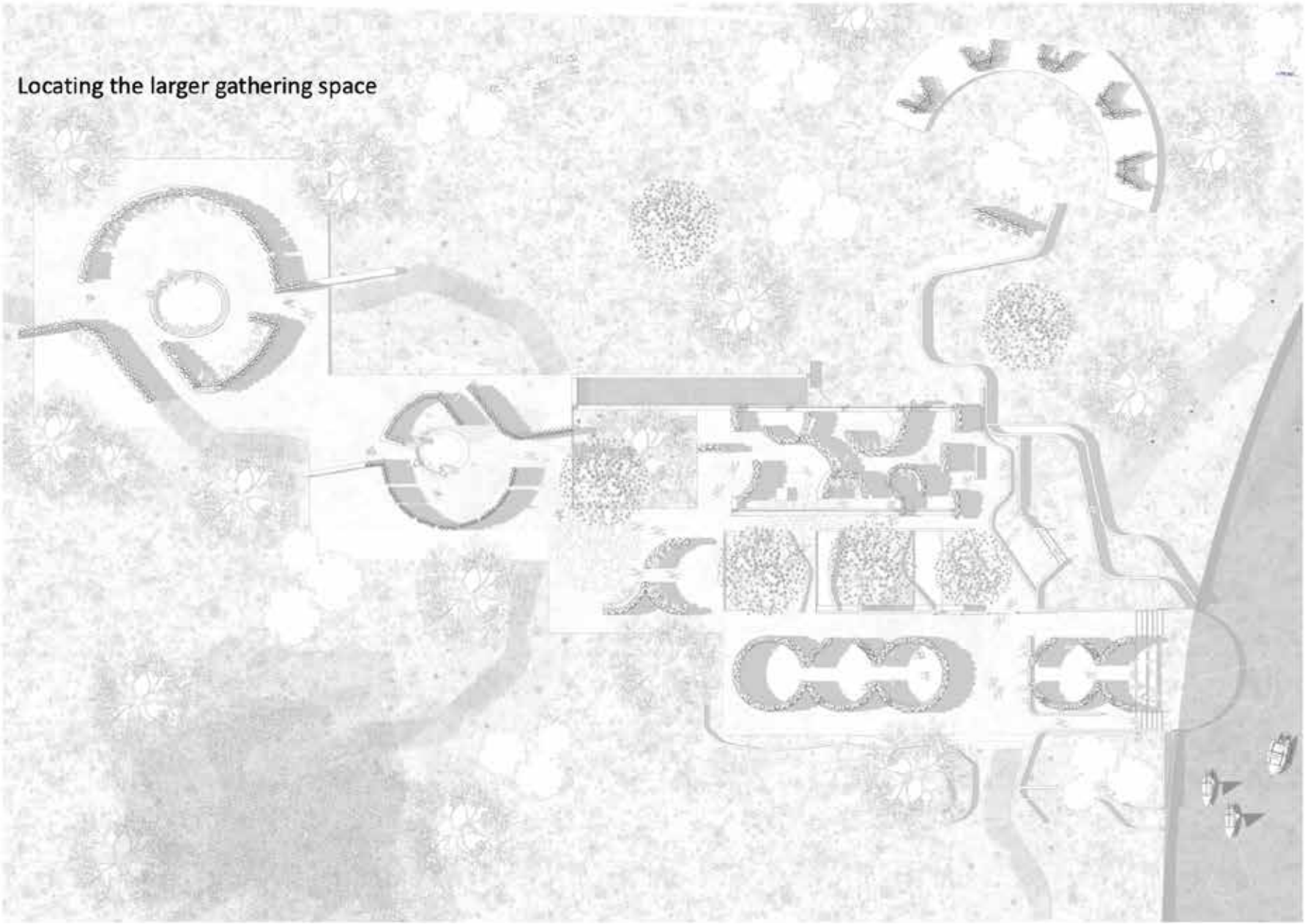
This idea of permeability was applied to the composable toilets that are open to air and landscape,





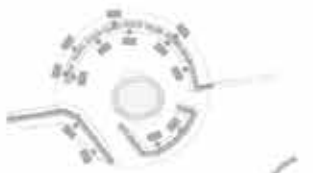
with occupancy noted from afar.

Locating the larger gathering space



Larger Gatherings for Music, Dance and Discussions

Smaller Workshops and Classes



Informal Community Market

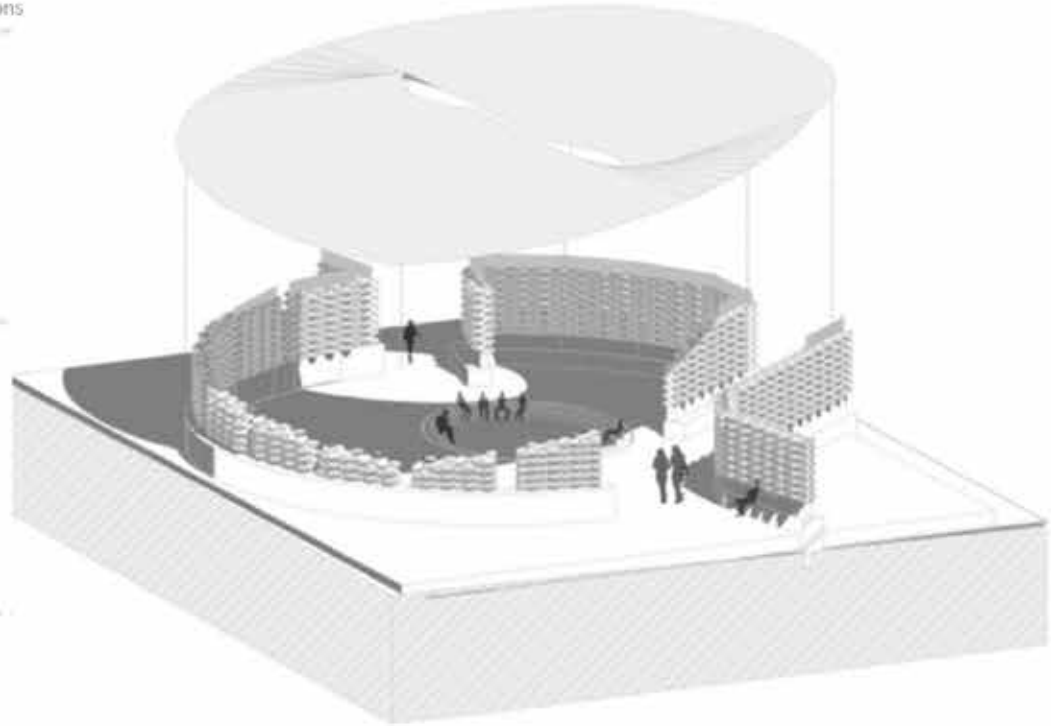
Direct and meandering routes

Intimate Discussions

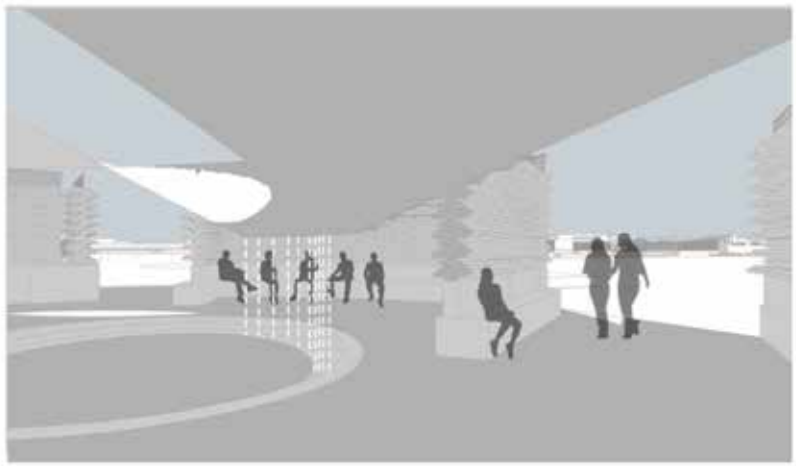
Exhibitions

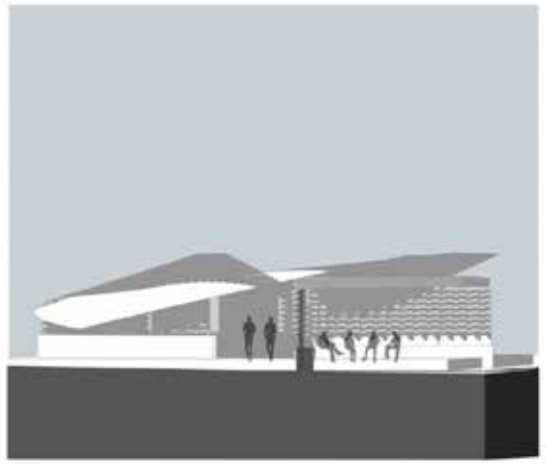
Summer Sun Path

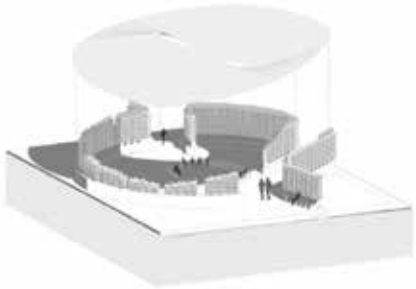
Winter Sun Path

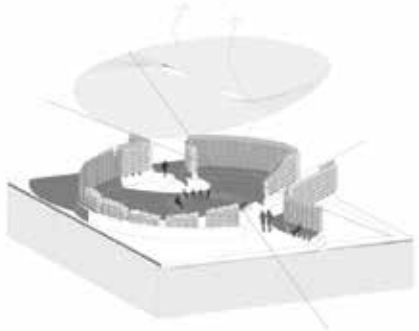


The larger gathering spaces house a variety of programs. The roof has the same principals as the lab with two mono pitches supporting social and climatic function. The spaces hold large and small

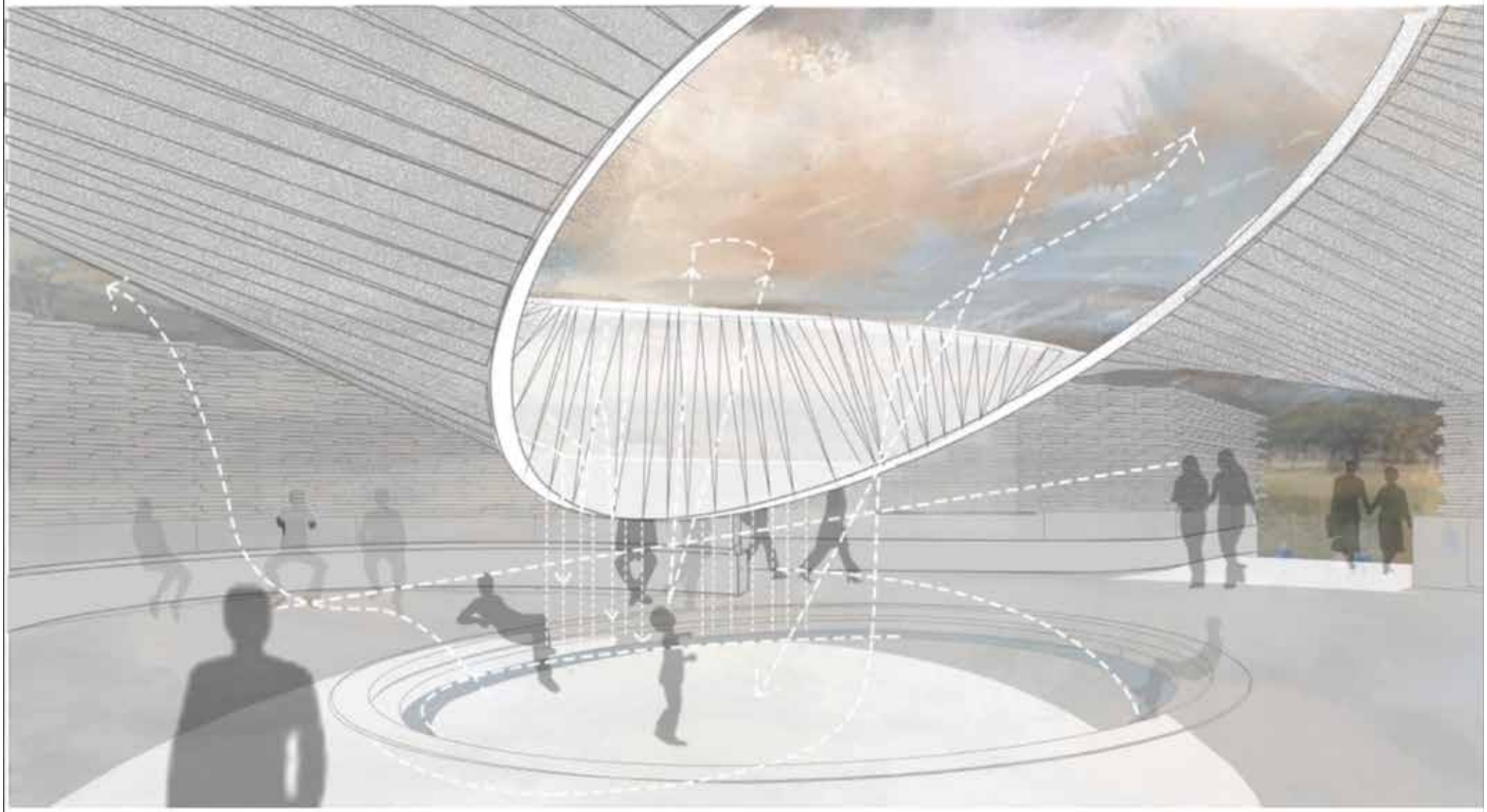








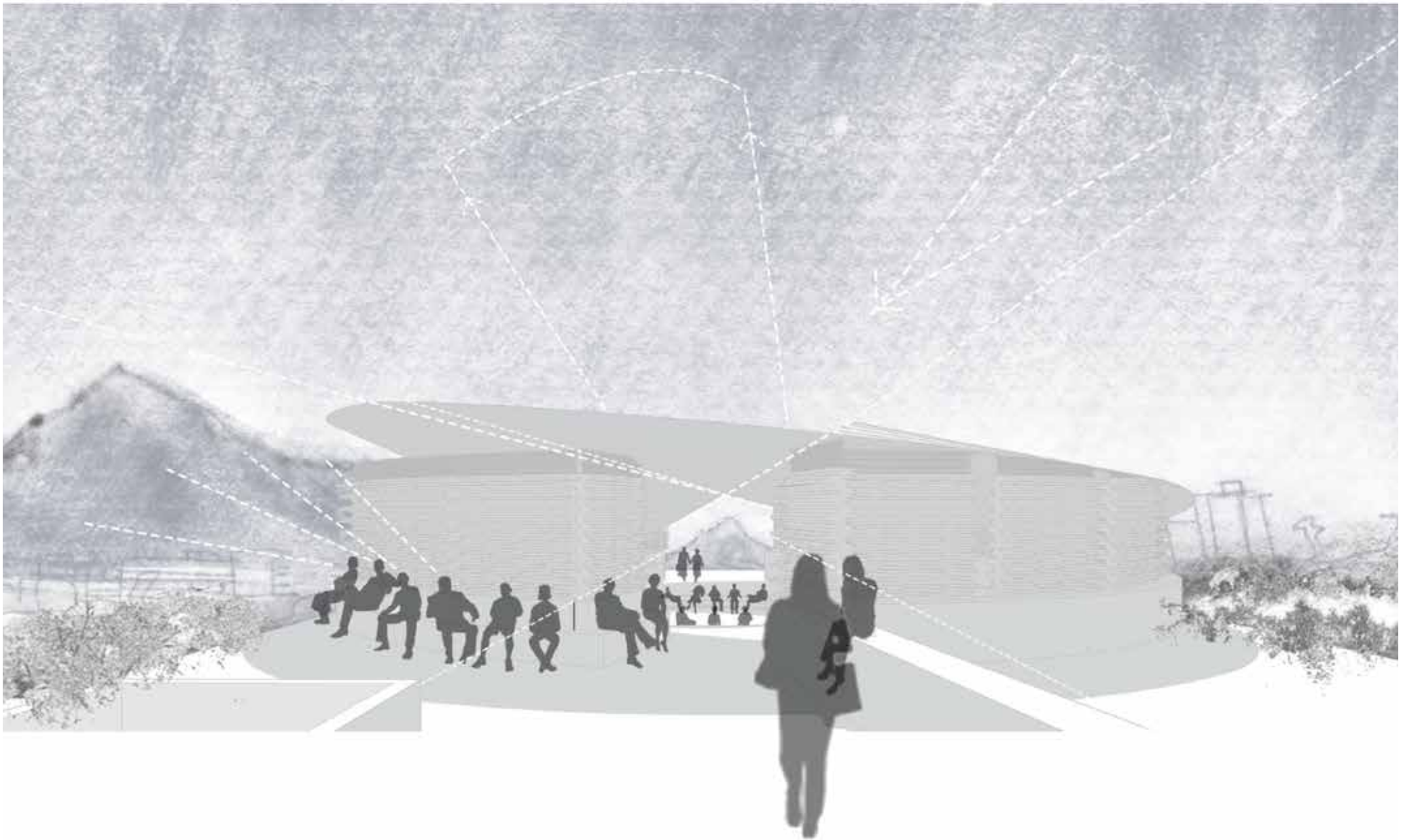
while letting the rain and sun in with sheltered space



further enhancing your connection to the sky while being comfortable.

Connecting, amplifying and reflecting on nature

New knowledge and experience grounded in research and science will be transferred through hand on workshops, practical experiences and joint learning. This system is critical for the development of skills and building capacity for the future. It will inspire a new generation that will lead to a sustainable future.



Conclusion

In conclusion, in this study I investigate how architects can leverage design and shift the paradigm of construction norms to mediate between biology and technology, history and modernity, and nature and humanity. This mediation starts with understanding successful vernacular principles such as community participation and close connection to context. Tim Ingold's "Conical Lodge" (2013) sponsored thought of traditional dwellings as being woven into the earth and sky, being so deeply rooted in their context. Furthermore, the idea of weaving emerged, as being the origin of ancient construction. This knowledge of weaving is the technical and theoretical notion that I then weave through studies on existing biology's multifunctional structure and 3D printing technology. The traditional building principle of "design by decay" parallels with natures lifecycles of using one organism's waste to fuel new growth. This notion briefly touches on the idea of obsolescence. Shifting the paradigm of construction to designing with the decay of the building and its typology in mind could lead to significant environmental advancement, limiting landfill disposal while maintaining the current capitalistic conviction. While contemporary materials are monofunctional, as studied, nature grows one material that is both structure, insulation, and fenestration with the capability of disintegration

This concept as well as traditional weaving, drove my exploration into 3D printing. Technology has the power to reinvent the originally intended typology of a material as seen in Neri Oxman's "Glass 1" (2015). This investigation facilitated a significant shift in the relationship between the craftsman and the craft. Through practice, the craftsman can manipulate technology so precisely that the technology shifts from a disconnecting middle- man, described as allographic, to an artist's tool, producing autographic work. In tern this conception, has significant implication on the professional relationship between architect and construction, and community and craftmanship. Furthermore, this dialogue between digital and analogue is explored through innovative representation of mapping and experience. This exploration was intended to find ways of connecting the viewer or community to the exclusive work of an architect and their technology.

Using these methods explored, I will conceptualize, map and design a configuration that will connect one or many communities to their land, history and each other. With the right intent technology progress construction norms that are rooted in tradition while uniting communities and connect us with nature.

06

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6.1 FIGURES

Figure 1 Image compiled by author, 2022. *Layers of the landscape: under water, earth and sky [collage]*

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Figure 3 Oxman, N. (2015). Glass 1. Retrieved from Oxman: https://oxman.com/projects/glass-i

Figure 4 Rael, R. (2018). 3D Printed "Hearth" with cedar embedded for structural stability of adobe walls. Retrieved April 2022, from Emerging Objects: http://emergingobjects.com/project/ mud-frontiers-part-ii/

Figure 4.1 Jastad, H. (2012). *Looking up through the apex of the tent, the linear poles interweave to comprise a complex knot, from which each nevertheless continues, reaching up into the open sky.* Ingold, T. (2013). The Conical Lodge at the Centre of the Earth–Sky World. ANDERSON PRINT.indd.

Figure 4.2 Jastad, H. (2012). *The Thicho conical lodge, viewed from outside, in the grounds of the Tromso Museum. This Lodge, made from 30 caribou skins, was one of two made in 2000 by Thicho seamstre from Behchoko and Whati. L-R: Tom Andrews, Alizette Drybones, and Sam Drybones.* Ingold, T. (2013). The Conical Lodge at the Cen tre of the Earth–Sky World. ANDERSONPRINT.indd.

Figure 5 Oxman, N. (2019). AGUAHOJA: Parametric chemistry: A scientific design framework for 3D printing biocompati ble multi-functional material combination. NYC, New York: SFMOMA. 2020. SF, California (Aguahoja I). Cooper Hewitt Smithsonian Design Museum.

Figure 6 Oxman, N. (2019). AGUAHOJA: Parametric chemistry: A scientific design framework for 3D printing biocompati ble multi-functional material combination. NYC, New York: SFMOMA. 2020. SF, California (Aguahoja I). Cooper Hewitt Smithsonian Design Museum.

Figure 7 Oxman, N. (2019). AGUAHOJA: Varying degrees of chitosan concentrations in gel state. NYC, New York: SFMOMA. 2020. SF, California (Aguahoja I). Cooper Hewitt Smithsonian De sign Museum.

Figure 8 Oxman, N. (2019). AGUAHOJA: Shrimp shell derived chitin. NYC, New York : SFMOMA. 2020. SF, California (Aguahoja I). Cooper Hewitt Smithsonian Design Museum.

Figure 9 Oxman, N. (2019). AGUAHOJA: Dried chitosan derived from chitin sourced. NYC, New York: SFMOMA. 2020. SF, Califor nia (Aguahoja I). Cooper Hewitt Smithsonian Design Museum.

Figure 10 Oxman, N. (2019). AGUAHOJA: Aguahoja wing, 3D print ed from varied chitosan. NYC, New York: SFMOMA. 2020. SF, California (Aguahoja I). Cooper Hewitt Smithsonian Design Museum.

Figure 11 Image compiled by author, 2022. *Locating the site in its greater context. Images sourced from web.*

Figure 12 *Image compiled by author, 2022. Images sourced from Steenkamp, A. (2021) Imagined Cape Town, Architecture and/as the city.*

Figure 13 Hallinan, J. J. (2022). *Soil type in the Cape Town. Report on the cultural historical significance the Varschedrift area of the Cape Peninsula holds for the Khoekhoen people of the southwestern Cape and southern Africa more widely.* Cape Town : Observatory Civic Association.

Figure 14 Hallinan, J. J. (2022). Catchment areas in Caoe Town . *Report on the cultural historical significance the Varschedrift area of the Cape Peninsula holds for the Khoekhoen people of the southwestern Cape and southern Africa more widely.* Cape Town : Observatory Civic Association.

Figure 15 Imaged compiled by author, 2022. *100-year flood plain of site.* Imaged sourced from web.

Figure 16 Imaged compiled by author, 2022. *Layers of intangible history. Imaged sourced from web.*

Figure 17 Drawing by author, 2022. *Khoi using their cattle to shield them from the Portuguese. this movement and protection will be translated into architecture. Imaged sourced from web.*

Figure 18 Drawing by author, 2022. *The movement of the colonizers and the Khoi and the San. Referenced from web.*

Figure 19 Drawing by author, 2022. *Representing the landscape from below. Referencing* Zhicheng Xu, 2021 : https://www.instagram.com/p/CXwJRzEuSgf/

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[digital painting].

Figure 25 Image compiled by author, 2022. *Layers of surrounding programs and heritage. Sourced from* TRuePark Co-Design Workshop, 2017. Retrieved from City of Cape Town, Western Cape Government: https://www.westerncape.gov.za/assets/departments/transport-public-works/Documents/170218_trupark_co-design_workshop_introduction.pdf

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Figure 34 Watson, J (2020). *Lo-TEK: Design by Radical Indigenism.*

Figure 35 Watson, J (2020). *Lo-TEK: Design by Radical Indigenism.*

Figure 36 Image compiled by author, 2022. Image sourced from Watson, J (2020). *Lo-TEK: Design by Radical Indigenism.*

Figure 37 Watson, J (2020). *Ma'dan people's read construction.* Sourced from *Lo-TEK: Design by Radical Indigenism.*

Figure 38 Watson, J (2020). *Community participation and transfer of knowledge*
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Figure 40 Watson, J (2020). *Technical diagram of the reed construction.* Sourced from *Lo-TEK: Design by Radical Indigenism.*

Figure 41 Imaged compiled by author, 2022. *Symbiotic relationship in a flood plain* [collage]. Sourced from Watson, J (2020). *Lo-TEK: Design by Radical Indigenism.*

Figure 42 Maganga, M. (2021, October 16). *Great Mosque of Djenne, Mali*. Image Wikimedia user Ruud Zwart Licenced under CC BY-SA 2.5 NL. Retrieved April 2022, from ArchDaily: https://www.archdaily.com/970228/the-distinctive-mosques-of- sub-saharan-africa/61687459f91c8130680000f8-the-distinc ive-mosques-of-sub-saharan-africa-photo

Figure 43 Rael, R. (2018). *3D Printed "Hearth" with cedar embedded for structural stability of adobe walls*. Retrieved April 2022, from Emerging Objects: http://emergingobjects.com/project/ mud-frontiers-part-ii/
Figure 44 Adjaye, D. (2020, November 18). Thabo Mbeki Presidential Library in Johannesburg Retrieved from https://www.instagram.com/p/CHu6PH_HI3J/

Figure 45 Adjaye, D. (2022, April 1). *Jola People dwelling, Guinea*. Retrieved from Adjaye Visual Sketchbook: https://www.instagram.com/adjaye_visual_sketchbook/

Figure 46 Castro, F. (2015). *New Artist Residency In Senegal / Tshiko Mori*. Retrieved from ArchiDaily: https://www.archdaily. com/608096/new-artist-residency-in-senegal-toshi ko-mori?ad_medium=office_landing&ad_name=article

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Figure 49 Castro, F. (2015). *New Artist Residency In Senegal / Tshiko Mori*. Retrieved from ArchiDaily: https://www.archdaily. com/608096/new-artist-residency-in-senegal-toshi ko-mori?ad_medium=office_landing&ad_name=article

Figure 50 Wang, J. (2018). *HIKMA - A Religious and Secular Com plex / atelier masomi + studio chahr*. Retrieved from Archdai ly: https://www.archdaily.com/920427/ hikma-a-religious-and-secular-complex-atel ier-masomi-plus-studio-chahar/5d1ea792284dd1abe90003d0- hikma-a-religious-and-secular-complex-atelier-mas omi-plus-studio-chahar-photo?next_project=no

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