

https://dspace.org/

Lilitha: an agricultural training center in Keiskammahoek : transforming rural communities through sustainable, innovative architecture and competitive agricultural education

Vokwana, Lwando

2021
https://hdl.handle.net/10539/31990

Downloaded from a DSpace repository. https://dspace.org/

Lilitha – an Agricultural Training Center in Keiskammahoek

Transforming rural communities through sustainable, innovative architecture and competitive agricultural education

Lilitha ("lee-lee-tah", a Xhosa name meaning beam of light or light)

Author: Lwando Vokwana (669316)

School of Architecture & Planning

University of the Witwatersrand

Johannesburg, South Africa

Supervisor: Ariane Janse van Rensburg

A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Architecture (Professional).

Date: 18 February 2021

DECLARATION

I Lwando Vokwana (669316) am a student registered for the degree of Master of Architecture (Professional) in the academic year 2020.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.

Lwando Vokwana



Johannesburg, 18 February 2021

ACKNOWLEDGMENTS

I would like to extend a special thanks to my thesis supervisor, Associate Prof. Ariane Janse van Rensburg for making this journey grateful. Thank you for being supportive and encouraging every step of the way.

I am grateful for the invaluable advice throughout the semester, tremendous assistance in the decision making, and valuable time spent in guiding me through this chapter.

I am thankful for my Thesis group for the valuable discussions and comments that have assisted in guiding me through this journey.

Above all, I am thankful to the creator for the vision, my family and friends for the immense support.

Lwando Vokwana

18 February 2021

CONTENTS

Page

DECLARATION ……3

ABSTRACT ……4

ACKOWLEDGMENTS ……5

1 INTRODUCTION ……11

2 RESEARCH METHODOLOGY ……13

3 CONTEXTUAL BACKGROUND ……15

3.1 Indigenous and modern farming practices in South Africa ……15

3.2 Agricultural education ……17

3.3 Keiskammahoek area ……18

3.3.1 Land use ……19

3.3.2 Major Crops in Keiskammahoek ……20

3.3.3 History & Timeline ……21

3.3.3.1 Timeline ……21

3.3.4 Town Analysis ……22

3.3.5 Geography & Climate 23
3.3.5.1 Sun Path diagram 24
3.3.5.2 Microclimate 24
3.3.5.3 Major Plants/Vegetation in the area 25
3.3.5.4 Local resources 26

4 SITE SELECTION AND ANALYSIS 27
4.1 Water Bodies 27
4.2 Surveyor Site information 28
4.3 Locality analysis 29
4.4 Existing infrastructure analysis 30
4.5 Existing Agricultural Schemes/Production facilities/Training Institutions 31
4.6 Existing Site plan 32
4.7 Orientation & organization of residential 33
4.8 Site views 34
4.9 Biomes near chosen site 36

5 SCOPE & PROFILE OF THE PROJECT 37

5.1 Financial Management 38

5.2 Economic sustainability 38

5.3 Organogram 39

5.4 Functional Diagrams 40

5.4.1 Functional Diagram: Agriculture Farm 41

5.4.2 Functional Diagram: Educational Institution/Agriculture School 41

5.4.3 Functional Diagram: Tourism Accommodation 42

5.5 Understanding the Components 42

5.6 Parking requirements 46

5.7 Area program 47

6 PRECEDENT STUDIES 50

6.1 BIG Yin-Yang shaped Panda Enclosure for Copenhagen Zoo 50

6.2 Rural House #01 52

6.3 Eco Farm & Educative Park in Vietnam 54

6.4 Inside Out School 56

6.5 Nelson Mandela Museum 58

6.6 Rural School Alto del Mercado 60

7 DESIGN DEVELOPMENT 62

7.1.1 Land distribution & program 62

7.1.2 Site conceptual planning 62

8 CONSTRUCTION TYPOLOGIES 67

8.1 Existing Building Typologies in Keiskammahoek 67

8.2 Exploring Building Typologies 68

9 DESIGN DRAWINGS 70

9.1 Site plan 70

9.2 Floor plan 71

9.3.1 Section 1 72

9.3.2 Section 2 72

9.4.1 Elevations 1 73

9.4.2 Elevations 2 74

9.5 3d perspectives 75

10 TECHNICAL SYSTEMS ……73

10.1 Building materials chosen ……..……...……...73

10.2 Precedent Studies ……

10.3 Classroom technical systems ……..75

10.4 Produce Greenhouse technical systems ……..……...78

11 REFERENCES ……88

APPENDICES

See separate volume.

1 INTRODUCTION

My interest is in the challenges of the "rural context" in the Eastern Cape province of South Africa, which include the quality of education, socio-cultural differences between rural and urban contexts, urbanization by the younger population, and low agricultural productivity, which relate to economic challenges, health, and lifestyle-related issues and access to adequate integral resources (see Figure 1.1). On the other hand, the area has heritage and tourism potential. I am interested in transforming rural communities through sustainable, innovative, and competitive agricultural practices and education, and by creating a centre of interest that can also attract outside inputs and economic investment, through research and tourism.

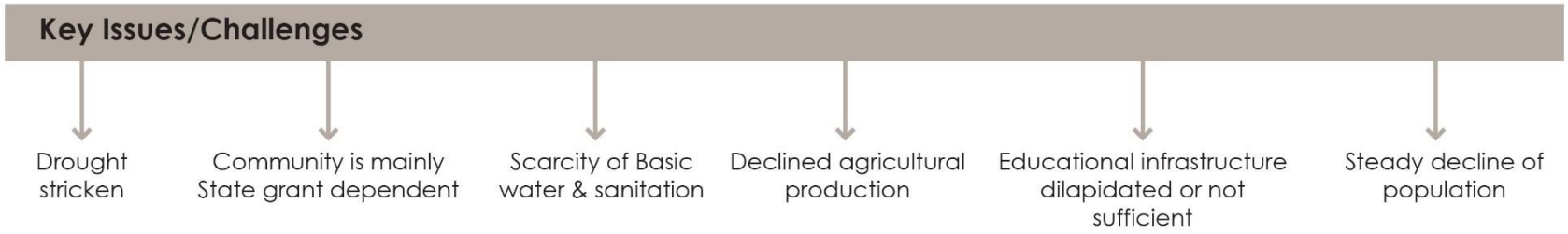


Figure 1.1 Key Issues/Challenges

My proposal involves researching an appropriate design for an agricultural training centre that combines an agriculture farm (combining indigenous farming practices that are specific to the context and modern farming practices that ensure food security and production for the future), an agriculture school that will cater for learners from Grade 7 – Grade 12, and tourism accommodation for researchers, local and international tourists.

I intend to design a self-sustaining and inclusive environment that promotes the fusion of indigenous and state-of-the-art agricultural education and training skills as a step towards renewing the decline of the agricultural productivity the area was commonly known for.

The proposal calls for a design that integrates a variety of issues and provide a holistic approach towards each of them. These include biodiversity conservation, sustainable design, flexible spatial design, interactive learning, affordability, inclusive design, replicability, community involvement, and upliftment.

The scope also contains the study of the relationship between the proposed spaces, their functional and structural needs, and interaction with the user. Alongside that, the project needs to incorporate the concept of multi-functionality and inclusive design of spaces and their simultaneous working.

The design ultimately should respect the existing geographic & climatic conditions of the site, the socio-cultural premise, and the contemporary relevance and possibilities of the project.

The area under consideration is in the Eastern Cape, about 30+ km north west of King William's Town. The rural town is called Keiskammahoek (a Dutch and Khoi Khoi name meaning "corner of shining waters" (SA Venues, 2020), it falls under the Amahlathi Local Municipality which forms part of the Amathole District Municipality.

The rural town is sentimental to me, as it is the area where my grandparents were born and where I have spent a portion of my upbringing. It is situated near the Keiskamma river catchment area and is centrally located amidst four Biomes. The town boasts significant remains of architectural heritage.

In the past, Keiskammahoek was a significant commercial center for the timber and agricultural production industries. Unfortunately, in the 1800s the timber industry relocated closer to the Stutterheim area and the agricultural production later declined due to a massive-scale exploitation and eradication of the natural environment.

The population of the community has since then decreased, people have migrated to urban areas for better opportunities and lifestyles. The community has also been mainly dependent on a grant from the state. The educational infrastructure, apart from one private school, has deteriorated and will be unable to provide competitive education to a growing group of learners should economic decline be reversed.

Some of the great concerns are the community's access to basic water and sanitation. Rural houses do not have running water nor formal sewerage removal and cattle roam around water sources. Water sources might be contaminated thus having the potential of causing water and sanitation-related diseases.

2 RESEARCH METHODOLOGY

The aim of this research is to be able to

1. create an inclusive environment to promote the fusion of indigenous and revolutionary agricultural education and training as a step towards renewing the decline of agricultural productivity the area was commonly known for.
2. create an intervention that could be utilised by the greater Keiskammahoek community to create a more self-sustaining, economical hub to address the reliance on a state grant.
3. understand the nature of the boundaries between the distinct activities to put together to create a meaningful intervention without compromising each other, but also to understand and utilise potential synergies.

My research question is: How can I design a rural agricultural training centre to become a catalyst for prosperity in the Keiskammahoek community?

Creative research through design is a combination of inductive reasoning, interpretation, and imagination linked to various themes, constraints (such as technological considerations, building site, client and user groups), and precedents (urban and architectural). The creative research process in terms of discourse and design alike, take on an iterative (inductive-deductive), non-linear, cumulative, cyclical, and open-ended exploration to achieve its creative outcomes. The research combines qualitative and quantitative approaches to knowledge and argumentation, whilst the creative component translates the same into the defensible architectural proposition.

This data will be gathered using the following researching instruments: site visits, desktop research, and informal conversations with experts, from whom I will receive informed consent, subject to ethical clearance by the University of the Witwatersrand Research Committee.

Limitations of this study: Since the data collection period coincided with the Covid-19 national emergency lockdown period and the Keiskammahoek area has poor digital connectivity, my access to community experts was limited, government planning offices were closed and I could only visit the site once. This proposal is therefore primarily a conceptual exploration.

Major aims of the intervention are (see Figure 1.2):



Figure 2.1 Major aims of intervention (Vokwana, 2020)

3 CONTEXTUAL BACKGROUND

In order for me to design this facility, I needed to research the following aspects:

1. Indigenous and modern farming practices
2. Agricultural education

3.1 Indigenous and modern farming practices in South Africa

This theme draws knowledge from a report by L. Notsi (Notsi, 2012), titled: Indigenous farming methods used in the cultivation of African indigenous vegetables.

The author (Notsi, 2012) argues the importance of indigenous African vegetables and application of indigenous farming practices that ensure food security and nutrition. This investigation involves two rural communities, one in Lesotho and the North West province of which both still use these methods for nutritional and food security purposes.

The author (Notsi, 2012) reinforces that these indigenous principles compared to modernised approaches prove to be cost effective, sustainable, and environmentally friendly. They both possess limitations and strengths, and the possible application of both these practices in ensuring food security and nutrition, seems relevant.

One can also argue that most often the older generation is in possession of indigenous knowledge, practices, and socio-cultural customs. There's beauty in the multi-generational exchange of both modern and indigenous knowledge. (Notsi, 2012).

It is apparent that in some communities these indigenous farming practices have been overshadowed by Western farming practices and philosophies, based on the premise that some have neglected them and might not prove relevant/fashionable to the changing times and climatic conditions.

Indigenous knowledge is important to also pass down through generations, with my intervention I am proposing the facilitation of both the indigenous knowledge and farming practices that is specific to the community of Keiskammahoek together with modernised knowledge and practices.

Through the fusion and exchange of both, agricultural production in the area can be sustained, studied and replicated in other similar areas. Most importantly food security for the future can be guaranteed for the communities. (Notsi, 2012).

There is great recognition that can be reserved for indigenous knowledge, in most cases it has been part of the steering instruments of native decision making in agriculture, health practices, sustaining of cultural practices, food production and security, education, conservation of natural resources/natural environment and various other significant customs in rural settings (Notsi, 2012).

This impression further cements the need to continue to maintain indigenous practices that are considerably governed by indigenous knowledge, ones that are still relevant, and are also reliable. (Notsi, 2012)

In addition to this there is also a great need for one to interrogate the practices that are no longer relevant in the conditions we live in and explore revolutionary alternative practices, and philosophies that can succeed indigenous systems that are now obsolete. (Notsi, 2012)

Benefits of Indigenous farming methods (Notsi, 2012).

- This method is capable of greater yields and increased food production.
- Some crops can be good for immediate consumption and others for long term storage. A variety of crops can be managed at the same time.
- Irrigation systems used with these principles can prove less expensive, compared to modernised and demanding alternatives.
- They have proven consistency (in some areas) for quality food production and security.
- Can be reliable drought mitigators.
- Human labour with a more delicate hand, rather than use of machines.

Shortfalls of indigenous farming methods (Notsi, 2012)

- Some practices might demand significant amounts of water.

In the light of food security, rural communities are faced with numerous challenges. And agricultural schemes that have been proposed/implemented to alleviate poverty might prove inconsistent. There is a strong call for entities that can help change these challenging situations in our rural communities, through the implementation of state-of-the-art working systems that can pair up with indigenous "context specific" working systems in ensuring brighter futures, more economically sustainable and self-reliant communities.

3.2 Agricultural education

This theme seeks to further investigate the potential of agricultural instruction as one of the possible remedies to higher food security in under privileged agriculture-oriented nations. (Engler et al, 2020)

As in most African educational frameworks there is a prominent gap between urban and rural areas. This is regarded as a serious challenge that has been present for centuries, there have been programs designed to better bridge the gap between the two, of which some have provided noticeable changes. (Engler et al, 2020)

In the present context, there are numerous educational facilities that have included agricultural education and practicing in their curriculums. Maybe in the form of extra mural obligations to encourage learners to stay in school, gain interest in agriculture, or to ultimately develop young emerging farmers. (Engler et al, 2020)

This is a notion that has been present throughout history and has proven its significance in society. Certain organisations contribute sizeable funds annually in maintaining the training, nurturing, and producing of emerging young farmers in bettering communities, alleviating poverty, creating opportunities, and overall impacting economic growth of nations. (Engler et al, 2020)

Agricultural education combined with the daily practice of the acquired knowledge in real time, proves to be a functioning pair. My intervention seeks to combine the educational, and scientific aspect of agriculture together with the physical and daily application of indigenous and modern farming practices to better equip the young and elderly generation in ensuring a self-sustainable, self-reliant agriculture-oriented community with a promising bright future. (Engler et al, 2020)

3.3 Keiskammahoek area

The following illustrations indicate the positioning of Keiskammahoek in the Eastern Cape region and great context of South Africa (see Figures 3.1 – 3.3).



KEISKAMMAHOEK: 15,67 km² (census, 2011)

POPULATION: 4,429 (census, 2011)

DENSITY: 280/Km² (census, 2011)

Figure 3.1 Map of South Africa, position of Keiskammahoek (Vokwana, 2020)

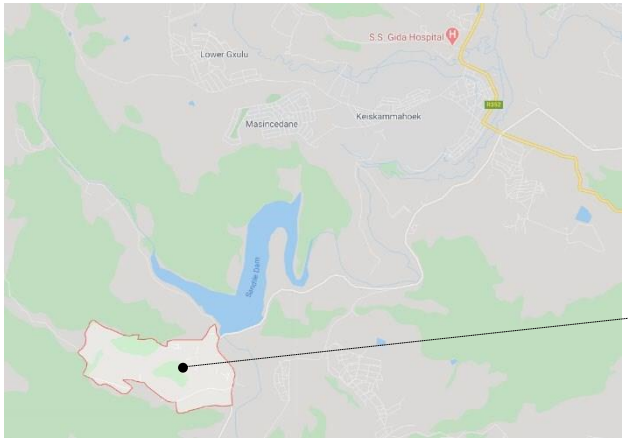


Figure 3.2 Position of Lower Wolf (Google maps, 2020)



Figure 3.3 Lower Wolf, Keiskammahoek (Google maps, 2020)

3.3.1 Land use

The following illustration show the analysis of the Land use (see Figure 3.4).

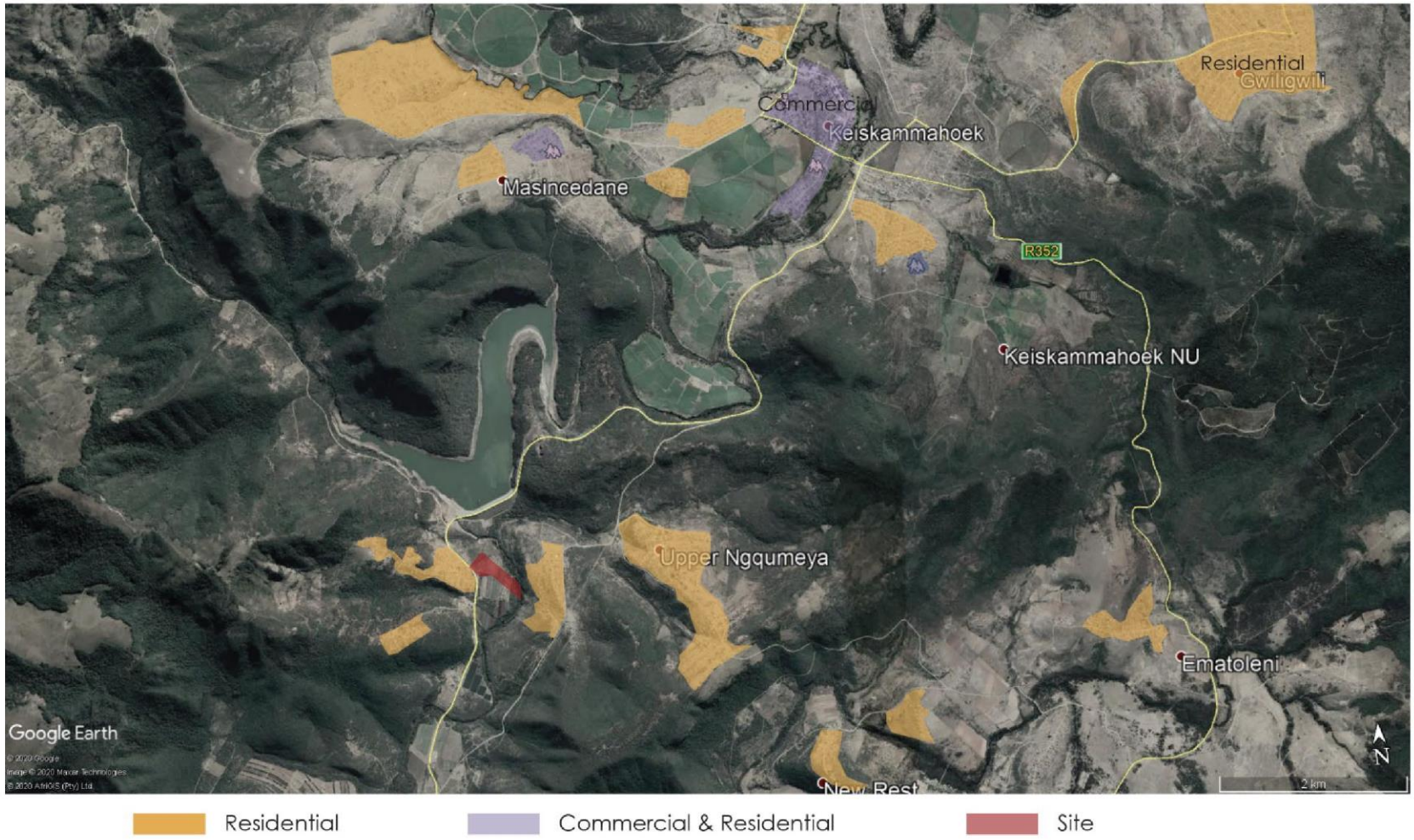


Figure 3.4 Land Use analysis (Vokwana, 2020)

3.3.2 Major crops in Keiskammahoek (Journal of Development and Agricultural Economics, 2016)

The illustration below outlines the major crops (see Figure 3.5) that are specific to the Keiskammahoek area:



Figure 3.5 Major Crops in Keiskammahoek (Vokwana, 2020)

The following crops will be grown in a controlled environment (Produce Greenhouse) to ensure production all year round; (Volante, 2020)

- Tomatoes
- Green Pepper
- Carrots
- Dry Beans
- Spinach

3.3.3 History & Timeline

Keiskammahoek (see Figure 3.6) has a significant history and was home to English settlers during the 1846 – 1847 Border conflict, also known as the War of the Axe. A Scottish missionary also settled in the area in 1849, permanent homes were shortly built following a war in 1850. (Wikipedia, 2020)

Thereafter there has been a significant influx of British and German settlers between 1857 – 1877. From 1981 up until the last years of apartheid era, Keiskammahoek was part of the Ciskei Bantustan. (Wikipedia, 2020)

District: Amathole

Municipality: Amahlathi



Figure 3.6 Keiskammahoek from the hill (Wikipedia, 2020)

3.3.4 Timeline (Wikipedia, 2020)

1800 – Settlement is established by locals in the area, during the period the massive-scale exploitation and eradication of its natural habitat occurs, and the timber trade moves closer to Stutterheim, and agricultural productivity declines.

1854 – St Mathew's High School is founded as a mission school, just outside of town**,** by Bishop John Armstrong of Grahamstown.

1923 – The opening of a Hospital and training facility for nurses within the donated land of St Matthews Mission.

1953 – St Matthews mission Church disengages from any involvements with St Matthews Mission School due to consequences of the Bantu Education Act.

1970 – The acquisition of a large portion of St Matthew's land by the State.

1976 – The Ciskei Government takes over the Hospital.

1986 – The Hospital closes in the grounds of St Matthews and relocates to Keiskammahoek, where it then operates as SS Gida Provincial Hospital.

1986 – present – St Mathew's High School continues to operate as a state boarding school for Girls (with male day students).

3.4.4 Town Analysis

- **Population status** (census, 2011)

  4,429 people

- **First Languages prominent in Keiskammahoek** (see Table 1.1)

LANGUAGE	PERCENTAGE
Xhosa	97,6%
Afrikaans	1,8%
English	1,1%

Table 1.1 First languages prominent in Keiskammahoek (Census, 2011)

- **Racial Makeup in Keiskammahoek** (see Table 1.2)

RACE	PERCENTAGE
Black African	97,1%
Coloured	1,4%
Indian/Asian	0,2%
White	0,3%
Other	1,0%

Table 1.2 Racial Makeup in Keiskammahoek (Census, 2011)

3.3.5 Geography & Climate

The Amathole district has a reputation of representing low rainfall patterns and soil depths are often shallow (below 1m), the soils tend to be highly erodible, are of poor quality, struggle to drain, and possess low fertility abilities. (Van Averbeke, 1991). In this regard one must consider approaches that encourage effective agricultural production which will combat the current soil and climate conditions.

The climate of Keiskammahoek is one that also represents a temperate to a sub-humid environment, with rainfalls mostly in summer months except for June and July being the driest of months. (Van Averbeke, 1991)

The area has an estimated annual rainfall of about 647mm per annum and irrigation is necessary to supplement the low rainfall. (Journal of development and Agricultural Economics, 2016)

3.4.5.1 **Sun Path diagram** (see Figure 3.7)

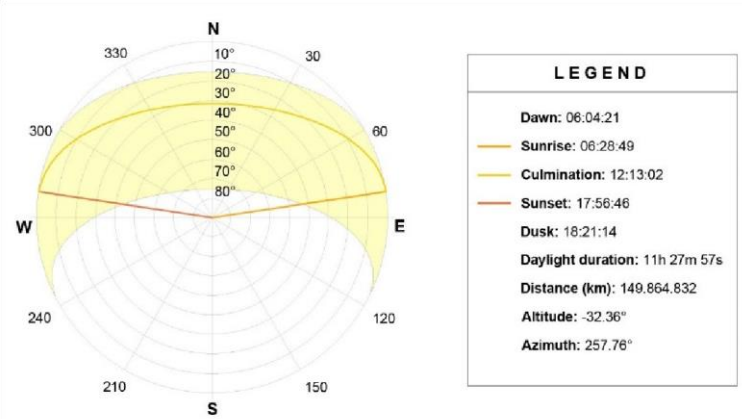


Figure 3.7 Sun Path diagram, Keiskammahoek (SunCalc.org, 2020)

3.4.5.2 **Microclimate of Keiskammahoek** (see Table 1.3) (worldweatheronline.com, 2020)

ITEM	PERCENTAGE
Max Temp (˚C)	25˚C
Average Temp (˚C)	22˚C
Minimum Temp (˚C)	13˚C
Rain (mm)	205,1mm
Max Wind (kmph)	17,2
Average Wind (kmph)	14,9
Average Gust (kmph)	9,9
Average Pressure (mb)	1 015,5
Average Cloud (%)	50

Average humidity (%)	76
Average UV Index	5
Average Visibility (km)	8

Table 1.3 Microclimate of Keiskammahoek (worldweatheronline.com, 2020)

3.4.5.3 Major Plants/Vegetation in the area (Vincent Ralph et al, 2016)

The area has a large population of Indigenous and endemic South African plant species and trees, Aloe ferox/Eastern Cape Wild Aloe (see Figure 3.8.1), Acacia Karoo/Sweet thorn tree (see Figure 3.8.2), Macowania revoluta (see Figure 3.8.3 & 3.8.4), and Lotononis harveyi (see Figure 3.8.5 & 3.8.6) are very common in the Keiskammahoek natural environment. (Vincent Ralph et al, 2016)

These plant and tree species constitute the Biodiverse nature of Keiskammahoek, (Vincent Ralph et al, 2016) and are attractive species for locals, tourists, and researchers. One of the ecological principles of my proposal is to conserve the existing Biodiverse nature of the area, and to further celebrate it by the inclusion of a Forest Observatory facility which will accommodate and attract researchers, learners, and tourists with the aim of educating about the rich biodiversity of Keiskammahoek.



Figure 3.8.1



Figure 3.8.2

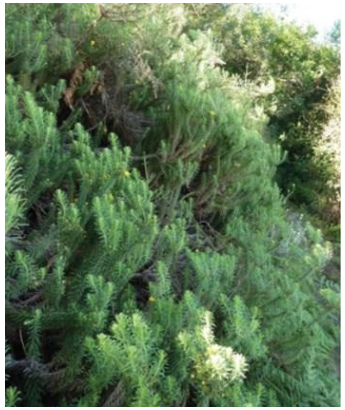


Figure 3.8.3



Figure 3.8.4



Figure 3.8.5



Figure 3.8.6

Figure 3.8.1 Aloe ferox/Eastern Cape Wild Aloe (Vokwana, 2020)

Figure 3.8.2 Acacia Karoo/Sweet Thorn tree) (Vokwana, 2020)

Figure 3.8.3 & 3.8.4 Macowania revoluta (Vincent Ralph et al, 2016)

Figure 3.8.5 & 3.8.6 Lotononis harveyi (Vincent Ralph et al, 2016)

Keiskammahoek is home to two types of grassland ecosystems, one of which is the Sourveld grassland. The characteristics of the Sourveld grassland are shared with those of a Mesic Highveld Grassland, which are:

- It is made up of highly productive Sourveld grasslands, with enduring grasses that favour re-sprouting, and plants that can withstand above-ground disturbance.
- It often consists of impervious soil layers.
- It has diverse soil types that are influenced by the elementary geology with foundational layers of sedimentary rock, cut through by embankments, and ridges of dolerite, quartzite, and gabbro. (Grassland Ecosystem Guidelines, 2013)

The characteristics of the Sourveld grassland type encourages a design approach in the Keiskammahoek area that seeks to celebrate the richness of the natural environment and its immense potential of a diverse ecological reproduction.

3.4.5.4 Local resources

The area has prominent Dolerite (Mountain, Edgar D., 1952) intrusions which provide stone for building stone walls, because the stone is such a hard-volcanic stone, it can't be easily cut unlike sandstone. Dolerite (Mountain, Edgar D., 1952) can therefore be used as raw stone to build hand-packed stone walls, that can function as plinth walls. Local loam soils are also suitable for either rammed earth or wattle and daub construction.

Detailed information regarding the major soils found in the area of Keiskammahoek (see Appendix A, Major Soils).

4 SITE SELECTION & ANALYSIS

4.1 Water Bodies of Keiskammahoek (see Figure 4.1)



Figure 4.1 Water Bodies of Keiskammahoek (Vokwana, 2020)

4.2 Surveyor Site Information (see Figure 4.2)

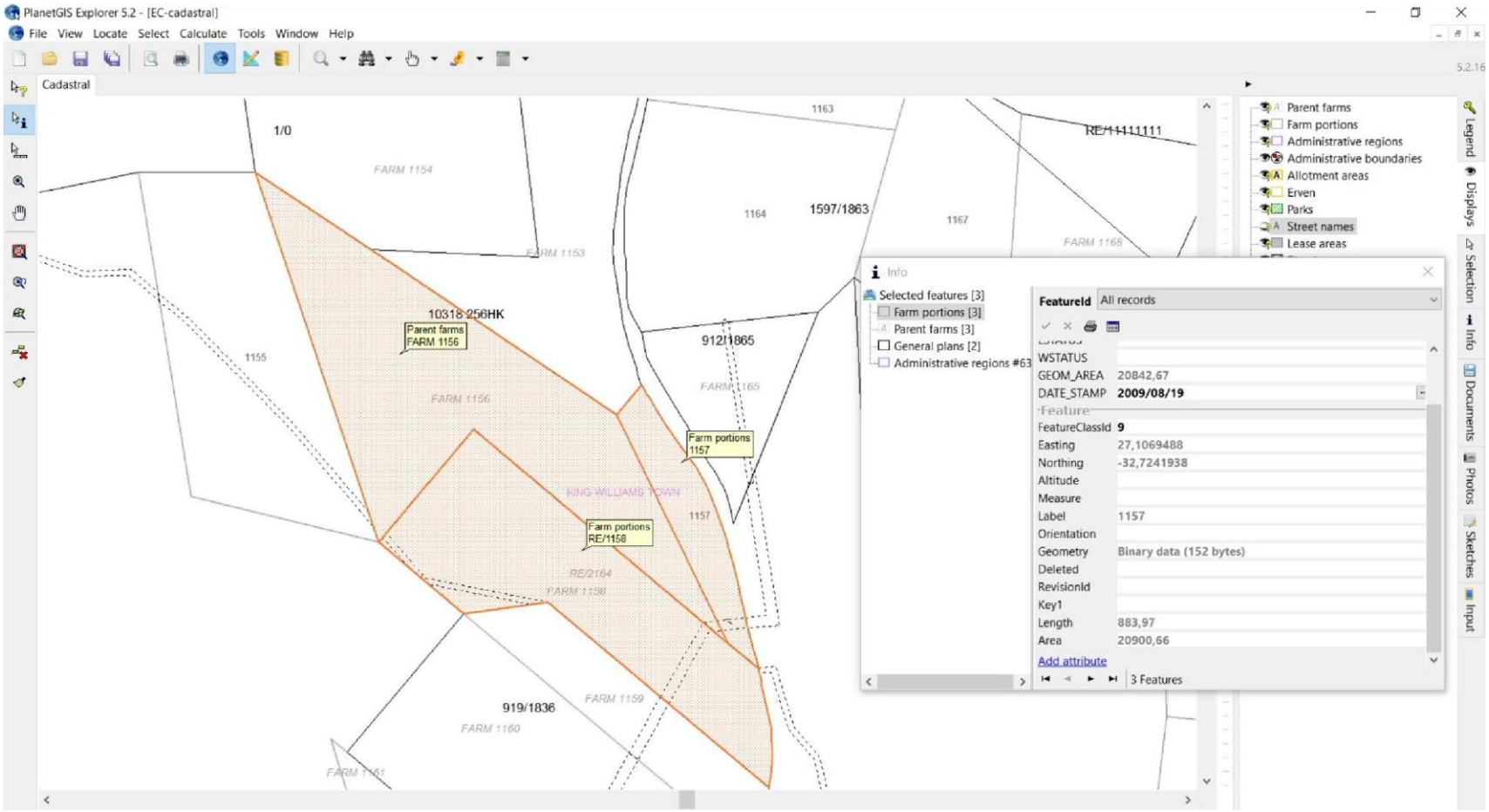


Figure 4.2 Surveyor Site Information (Planet GIS, 2020)

4.3 Locality Analysis

The site identified for this project, as per the map below (see Figure 4.3), is a 5,1 h.a farmland that is staged as a 'Parent Farm'. The diagram shows the proximity of the site to significant towns and roads in the Eastern Cape. The site is situated approximately 48km from the friendly N6 route and corridor, 16km from the R63 route and corridor that connects King Williams Town to Middledrift and Alice. Predominant winds are from the South West and Secondary winds are from the South East, the site orientation naturally faces East.

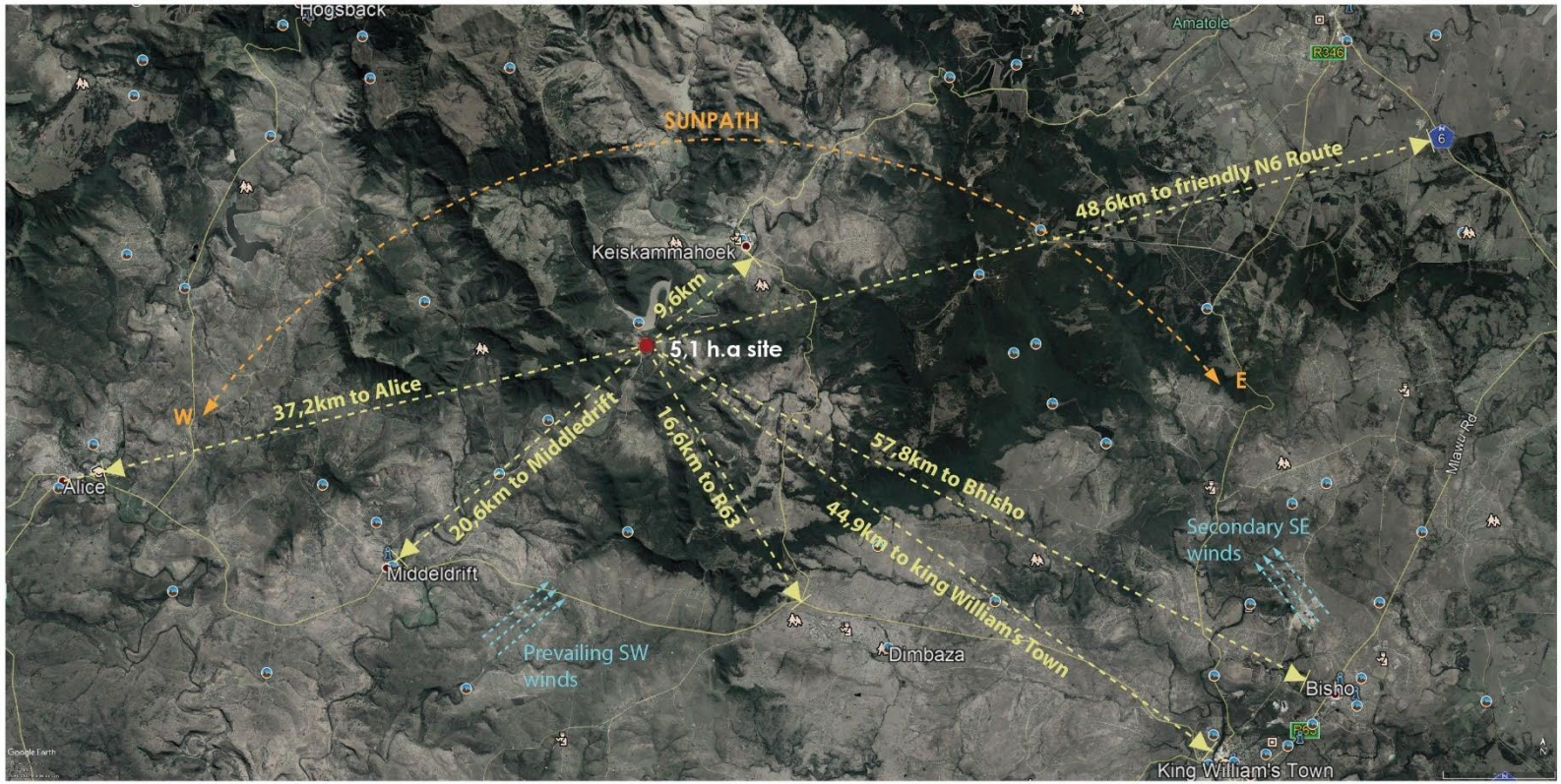


Figure 4.3 Locality map analysis (Vokwana, 2020)

4.4 Existing infrastructure of Keiskammahoek (see Figure 4.4)



Figure 4.4 Existing infrastructure (Vokwana, 2020)

4.5 Existing Agricultural Schemes/Production facilities/Training Institutions

The following diagram is an analysis of the existing local agricultural irrigation schemes, production facilities and training institutions (see Figure 4.4). The map identifies their positioning in proximity to my selected site, and the affiliations that can be facilitated between my Centre and these already established developments.

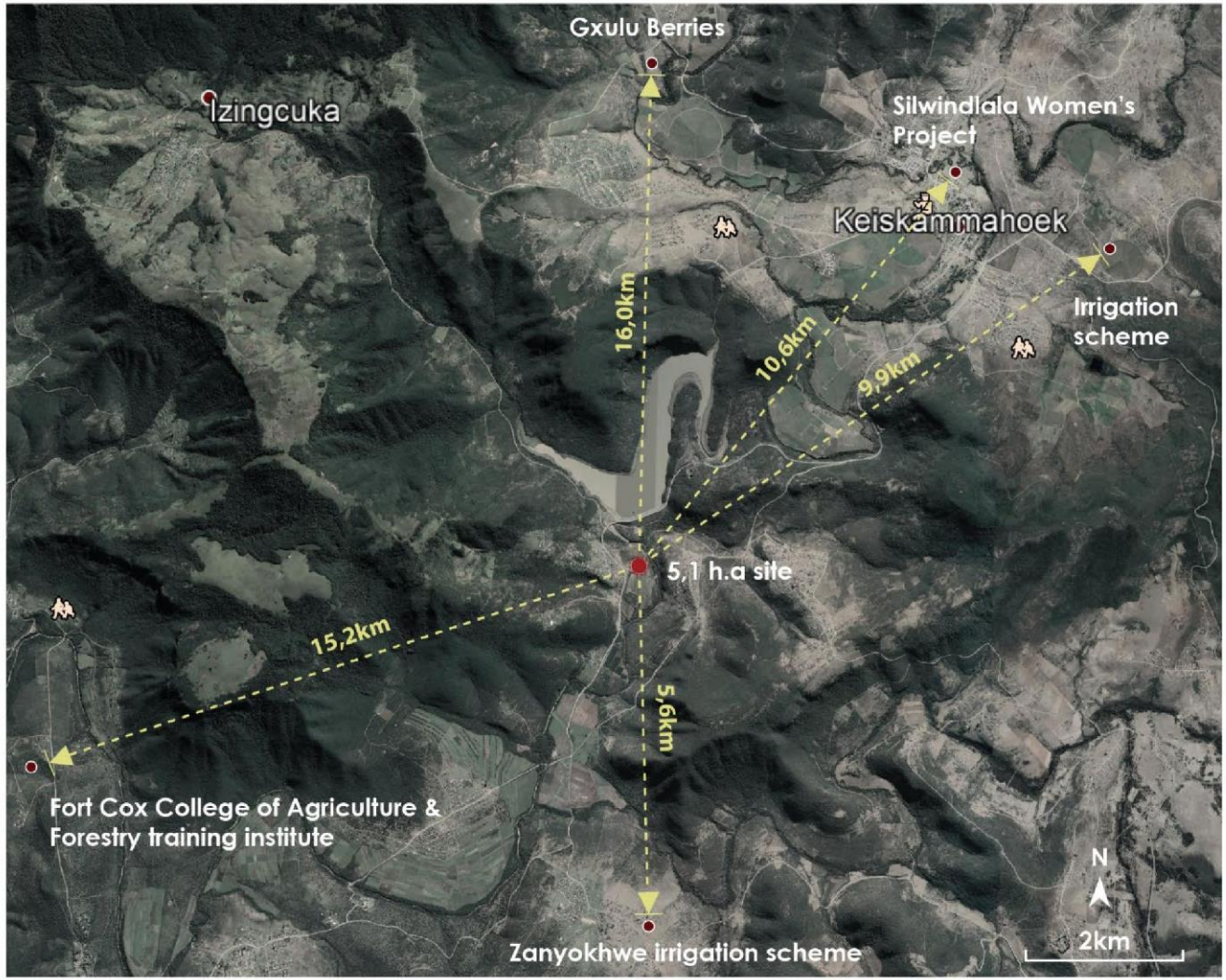


Figure 4.4 Existing Agricultural facilities (Vokwana, 2020)

SILWINDLALA WOMEN'S PROJECT -

- Legal entity (Co-operative), small holder farm operating on a 36 h.a land for crop production.
- Established with the idea of trying to reduce poverty and try to sustain their living.
- Produces cabbages, onion, spinach, beetroot, carrots, maize and potatoes.

GXULUBERRIES -

- A programme that grows Blueberries for export in a controlled environment.
- Young people who take interest in blueberry farming are also employed.
- Part of the Amathole Berries Outgrowers Programe, initiated by Amathole Economic Deevelopment Agrncy.
- Operates on a 9 h.a land of orchards.
- Created market linkages with Pick n Pay & Woolworths, even the United Kingdom.

ZAYOKHWE IRRIGATION SCHEME -

- Established with the aim of improving the standard of living for the people ofZanyokhe & surrounding communities.
- Sought to create job opportunities for the locals.
- Scheme extends over 635 hectares, but operates only on 471 hectares and comprises of 66 individual small farms that is irrigable land for crop production.
- My selected site can affililiate with this irrigation scheme and make use of the water for harvesting purposes.

FORT COX COLLEGE OF AGRICULTURE AND FORESTRY -

- It is one of 12 Agricultural Colleges in South Afrrica.
- Offers Agricultural and Forestry Education and Training.
- Extends over 1 354 hectares.
- Entrance requirement for students is Standard 10 (Grade 12) or a National Senior Certificate. Matriculants from my scheme can be enrolled at Fort Cox, to further their educational training.
- The college is affiliated with the University of Fort Hare (Alice).
- Also offers a 3-year diploma in Nature conservation.

4.6 Existing Site plan (see Figure 4.5)

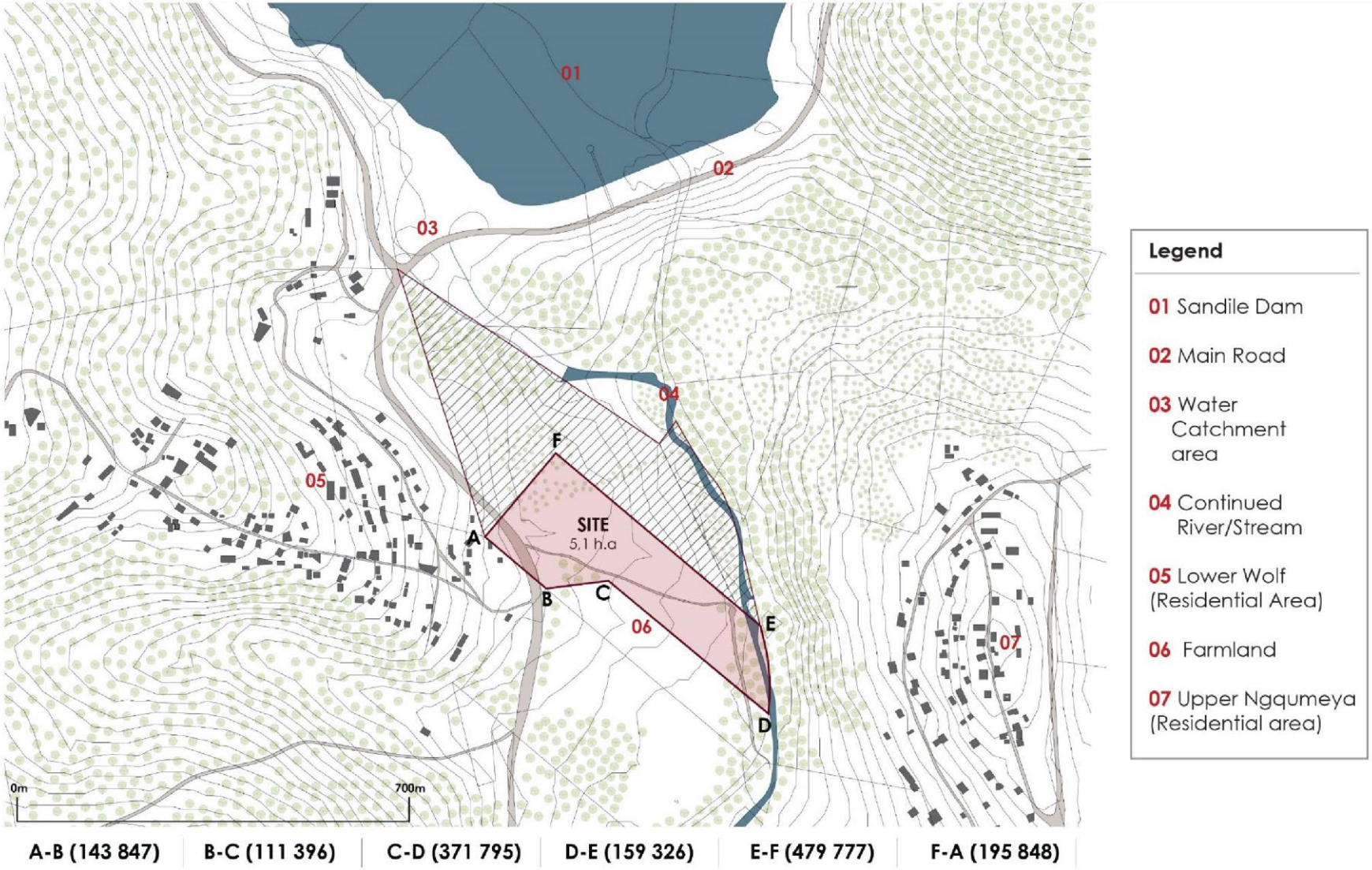
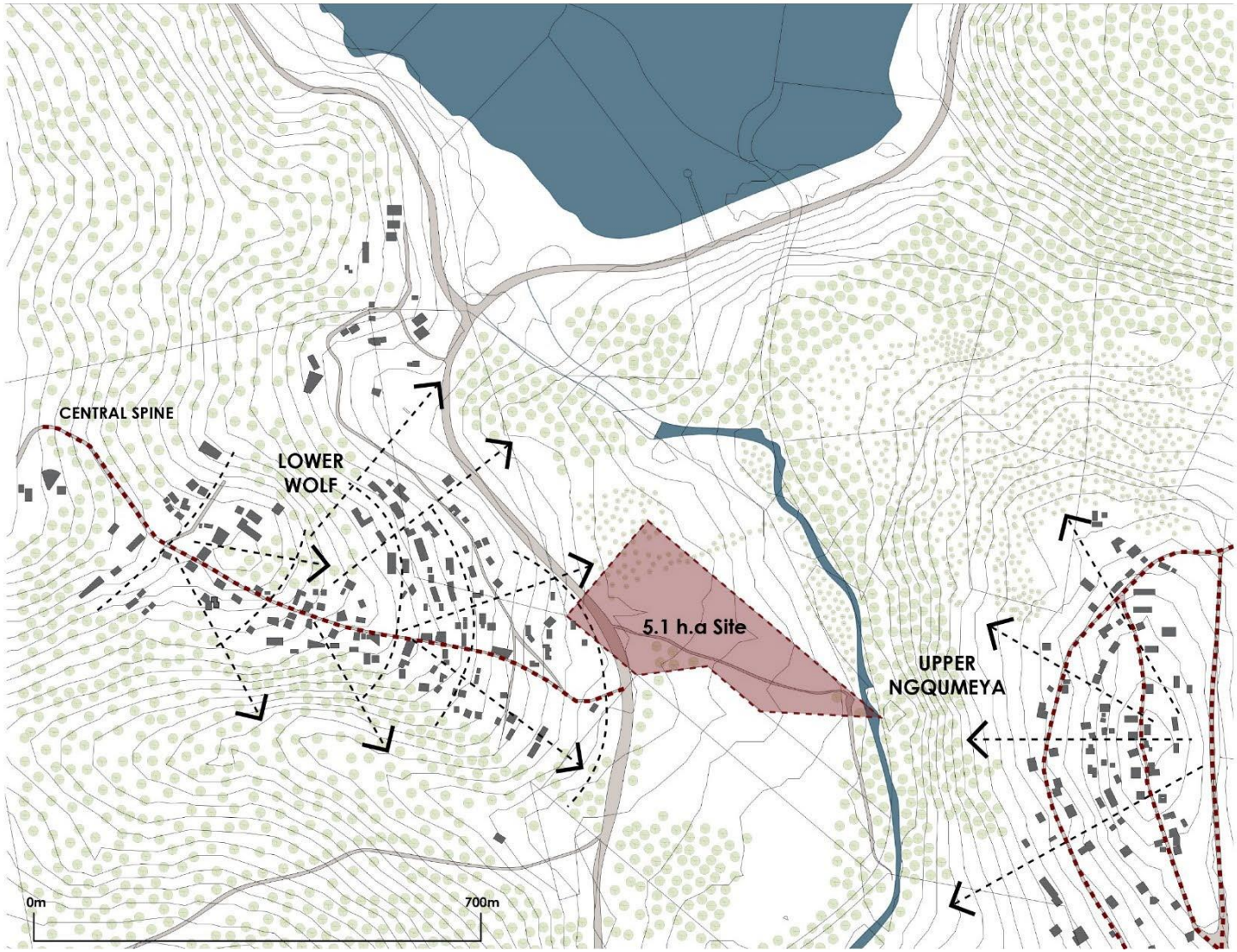


Figure 4.5 Existing Site plan (Vokwana, 2020)

4.7 Orientation & Organization of neighbouring residential areas (see Figure 4.6)



NOTES:

The diagram beside is a study of the vehicular and pdestrian circulation, residential orgaisation and orientation of the existing context.

Lower Wolf and Upper Ngqumeya are residential areas that neighbour my chosen site. It was important that I studied existing layouts of the context, how spaces (dwellings) have been organised, how circulation works on a bigger scale, what views were being captured and how they have responded to sloping contours.

LOWER WOLF -

- The pedestrian circulation offsets from a central spine (Vehicular & Pedestrian access)
- Residential placement has been arranged to work with the slope, by placing them on secondary footpaths that go hand-in-hand with the slope.
- Houses are orientated to capture views of the valley, Sandile Dam, Upper Ngumeya and neighbouring mountains.

UPPER NGQUMEYA -

- The pedestrian circulation is offset from two horizontal spines (Vehicular & Pedestrian access).
- Houses are placed on the upper and lower sides of these main vehicular spines, placement of houses also work with the slope.
- Houses are orientated to capture views of the valley, Lower Wolf, Sandile Dam, and neighbouring mountains.

Figure 4.6 Orientation & organization (Vokwana, 2020)

4.8 Site Views (see Figure 4.7.1 & 4.7.2)



Figure 4.7.1 Site Views 1 (Vokwana, 2020)



Figure 4.7.2 Site Views 2 (Vokwana, 2020)

Upon visiting my proposed site, I was exposed to a series of key informants that could better steer my overall approach relating to my scheme, these deal with the current state of the context and its challenges, the composition of the different layers from the residential fabric to the biodiverse richness of the natural environment.

The above images captured on site are a means of documenting the current state of the Sandile Dam, which is one of the main attractions of the area and plays an enormous role in sustaining the character of Keiskammahoek. My site visit made me aware of the dense indigenous plants and trees, the topographical character of the area and more specifically my chosen site. I have discovered site limitations and opportunities, grasped and connected with the atmosphere and spirit of the area.

4.9 Biomes near chosen site (see Figure 4.8)



Figure 4.8 Biomes near chosen site (Vokwana, 2020)

5 Scope & Profile of the Project

The scope of the project includes the understanding of an Agriculture Farm and its functions as well as understanding the working of an Agriculture school, and the functions of self-catering cabins for accommodation. The scope (see Figure 5) also contains the study of the relationship between these spaces, their functional and structural needs, and interaction with the users. Alongside that, the project needs to incorporate the concept of multi-functionality and inclusive design of the spaces.

The design should respect the existing geographic and climatic conditions of the site, the cultural premise, and the contemporary relevance and possibilities of the project. The development will also need to cater to consider a sustainable approach and universal design.

In its entirety, the project would be a combination of an Agriculture farm, Agriculture school, and accommodation for researchers, local and global tourists.

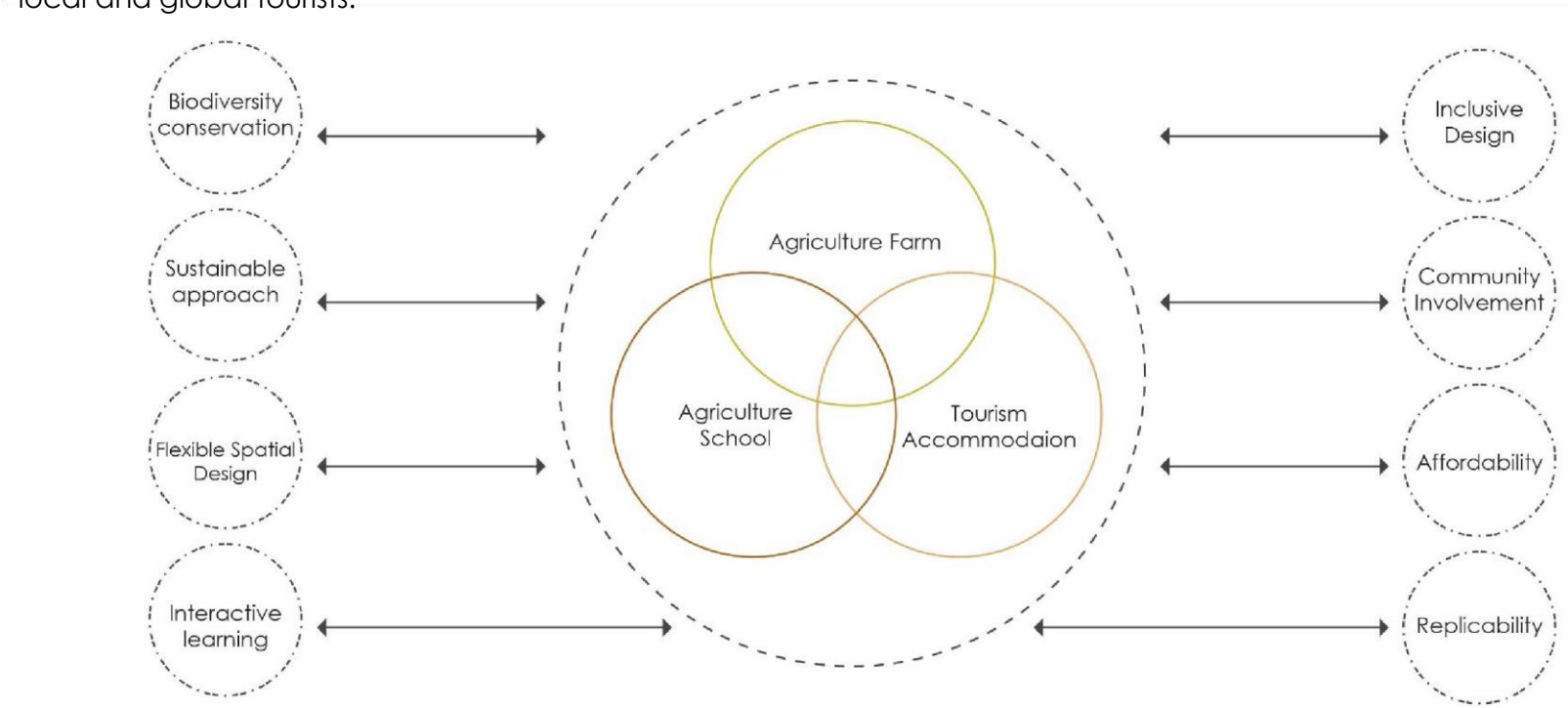


Figure 5 Project components (Vokwana, 2020)

5.1 Financial Management

In 2016, SAB (South African Breweries) had made a R1-billion public interest commitment to the South African government at the time of its 2016 merger with AB InBev. Part of the R1-billion investment by SAB, there was a R610-million 5-year investment that was dedicated to agriculture. (Nicolette Pombo – van Zyl, ESI Africa, Africa's power journal, Sep 13, 2019)

In the Western Cape, SAB developed an R80-million agricultural research and development facility in Caledon, with the intentions of piloting new farming techniques, technology, and crop varieties to accelerate agricultural development in South Africa.

The R&D facility is part of this 5-year financial investment plan in agriculture. My proposed intervention, Lilitha – an Agricultural Training Centre in Keiskammahoek can attract the interests of the SAB public agricultural investment as it shares similar objectives such as, developing agricultural education in rural communities, attracting researchers from the immediate and foreign/international contexts, alleviating poverty, and creating job opportunities for the immediate context.

5.2 Economic sustainability

The project consists of three components, an Agriculture Farm, Agriculture School and Accommodation/lodge for locals, Tourists, and researchers. All three of these components can generate a viable income to sustain the agricultural training facility. The Agriculture Farm has the intention of producing agricultural produce for local retail markets, also having a retail plaza/organic market for the selling of the in-house organic produce to locals and tourists. The Agriculture school generates incomes through an ecosystem that involves the government, local communities, and educational interests towards agricultural education. The tourism aspect of the development generates revenue through the influx of locals, tourists, and researchers from neighbouring and distant contexts.

5.3 Organogram of user and implementing agent (see Figure 5.1)

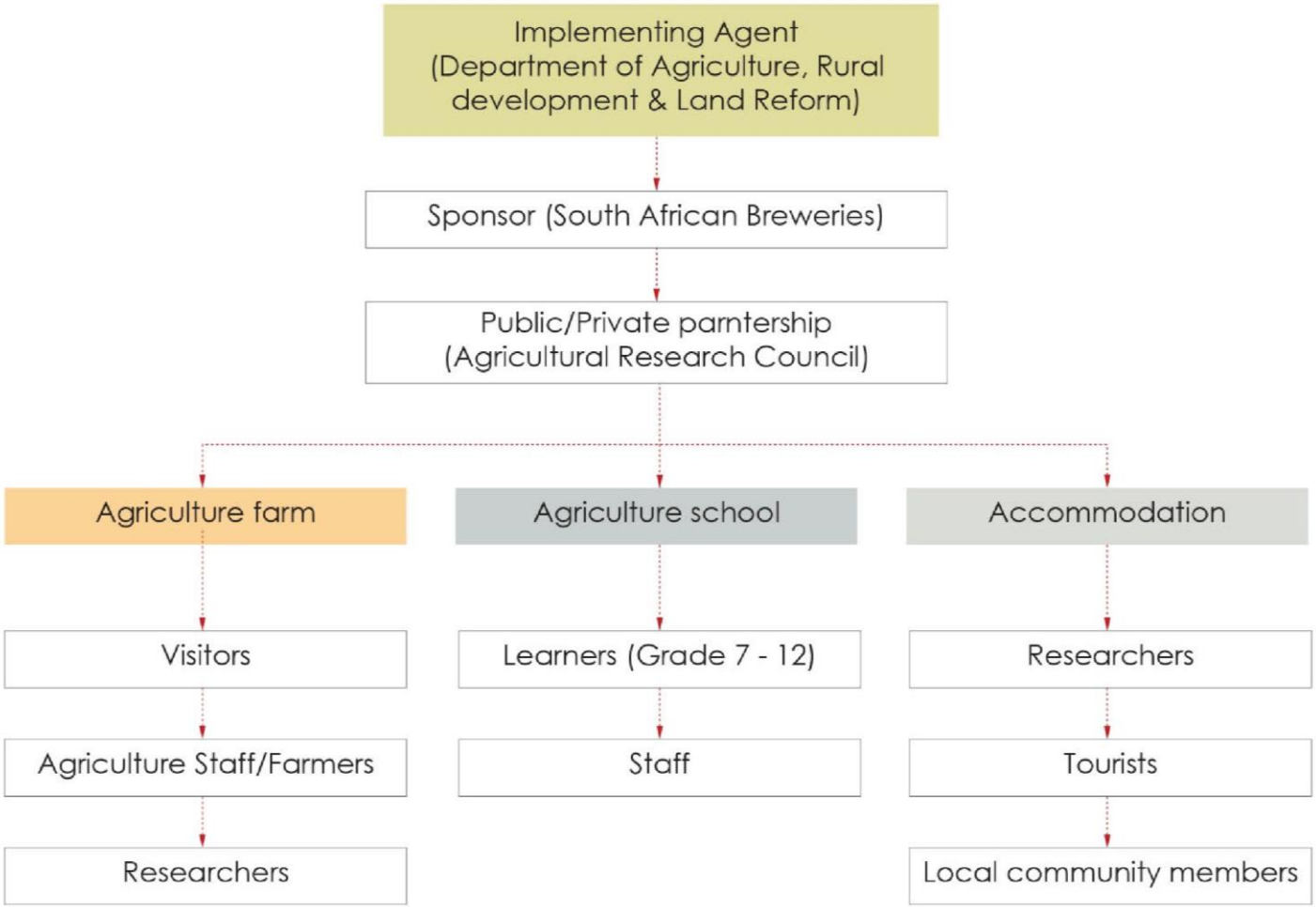


Figure 5.1 Organogram of users (Vokwana, 2020)

5.4 Functional Diagram: The Complex (see Figure 5.2)

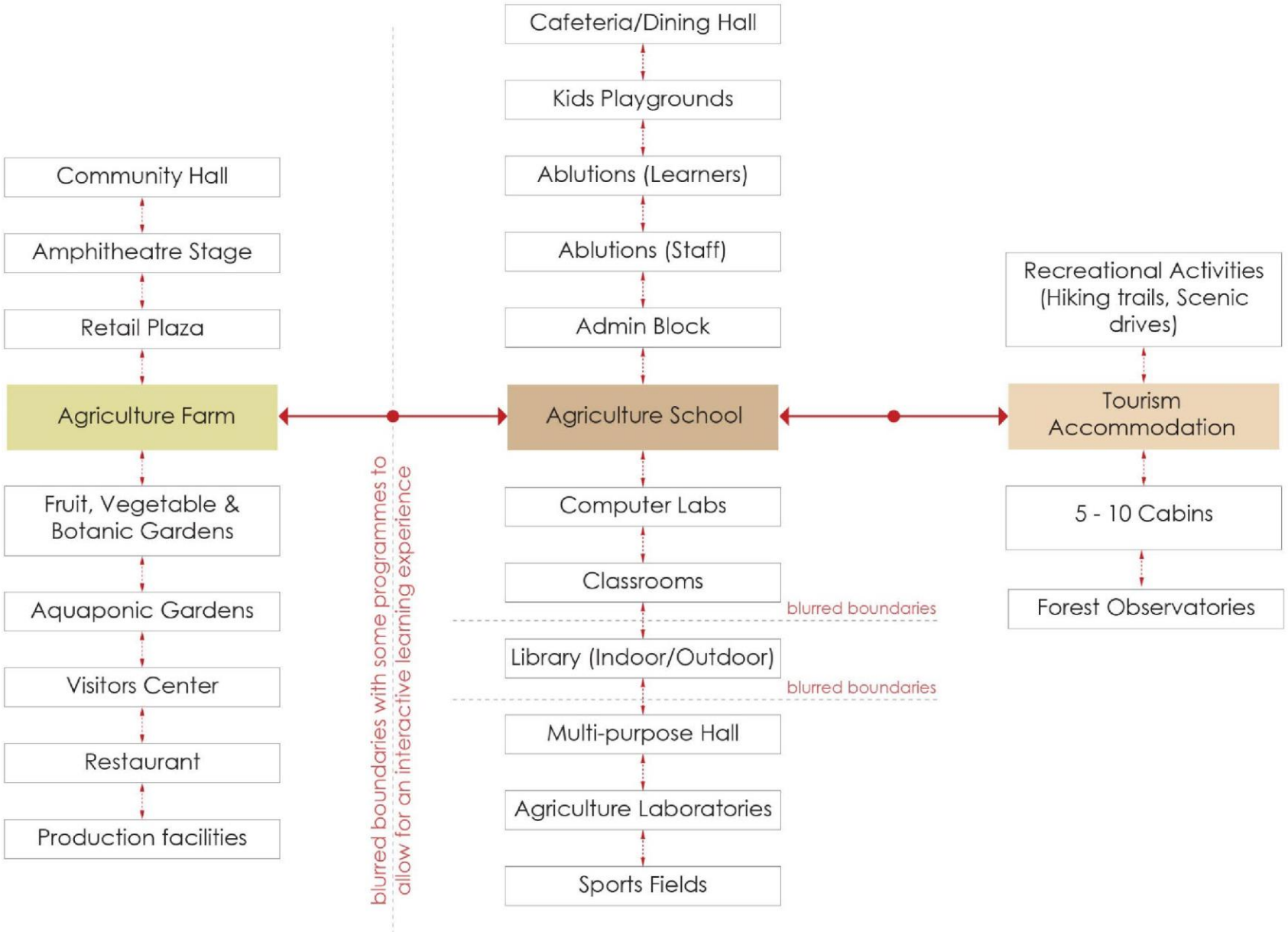


Figure 5.2 Functional diagram: the complex (Vokwana, 2020)

5.4.1 Functional Diagram: Agriculture Farm (see Figure 5.3.1)

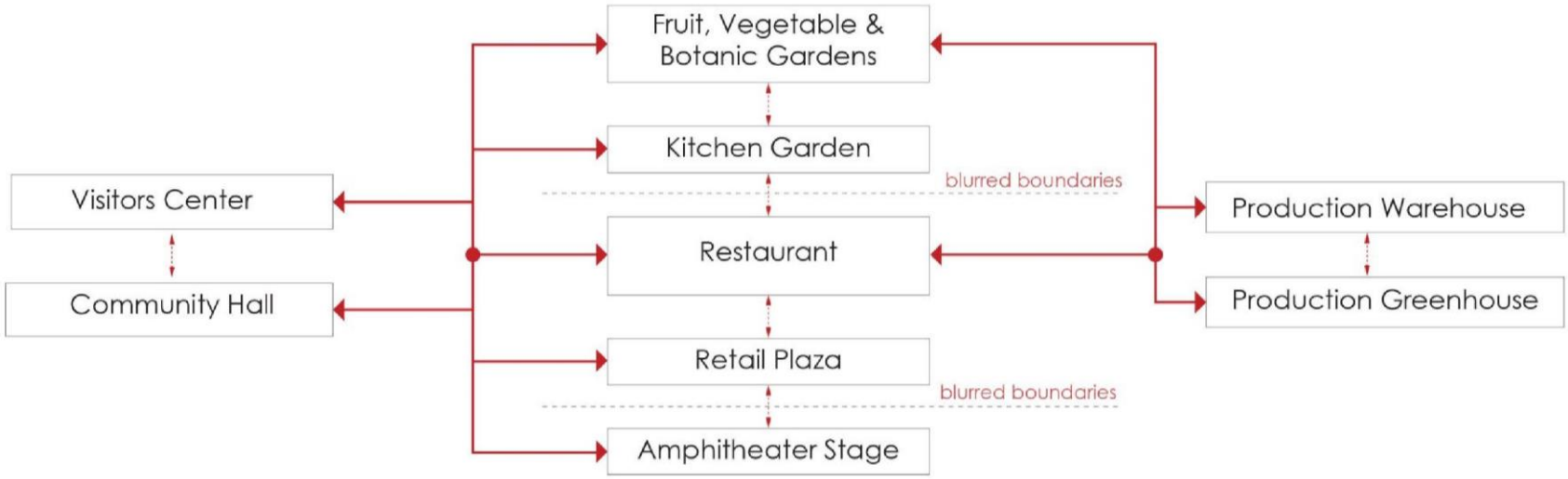


Figure 5.3.1 Functional diagram: Agriculture farm (Vokwana, 2020)

5.4.2 Functional Diagram: Educational Institute/Agriculture school (see figure 5.3.2)

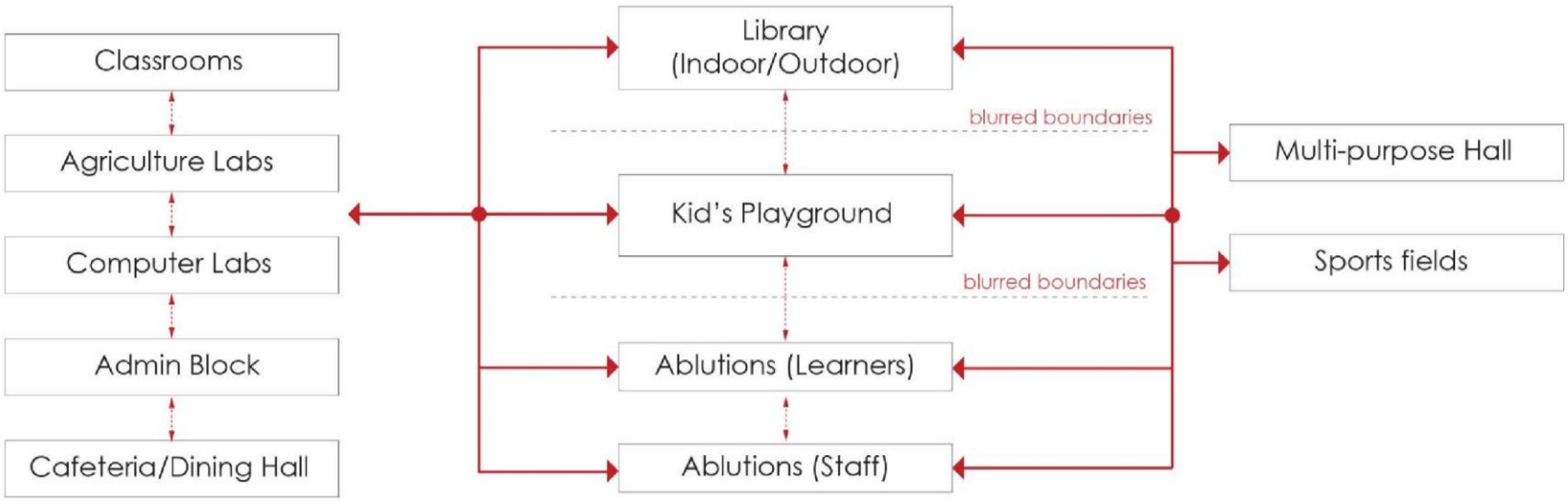


Figure 5.3.2 Functional diagram: Agriculture school (Vokwana, 2020)

5.4.3 Functional Diagram: Tourism accommodation (see figure 5.3.3)

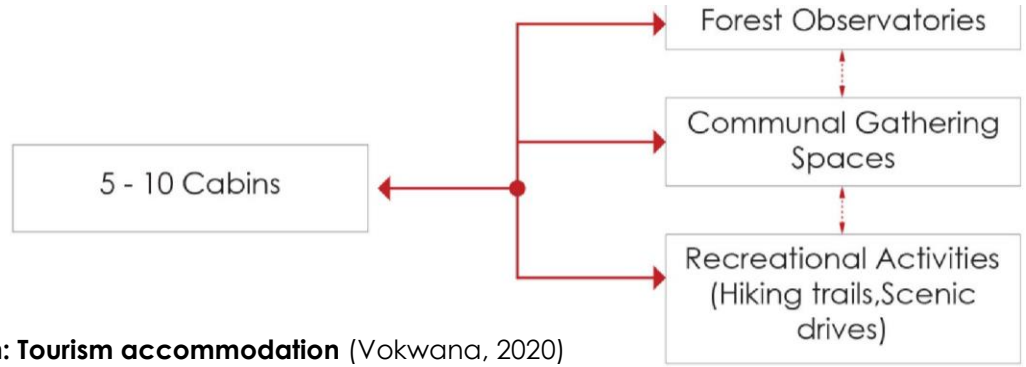


Figure 5.3.3 Functional diagram: Tourism accommodation (Vokwana, 2020)

5.5 Understanding the Components

The various components must be studied individually to understand their working and functional and structural needs. These components are detailed as follows:

Agriculture Farm

The Agriculture farm must be designed as per the South African Organic Sector Organization organic standards (SAOSO, 2020). This entity will practice indigenous farming techniques that are specific to the context of Keiskammahoek and state of the art farming techniques that ensure food security and production for the future. The farm looks to employ members of the community who have indigenous farming skills or are interested in the craft. The purpose is to encourage healthy and sustainable farming, healthy organic food production for today and tomorrow, promoting biodiversity and not impose harm or contamination to the already existing natural environment.

Employing members of the community can encourage interactive, multi-generational skills exchange programs between the knowledgeable elders and eager learners. This aspect of the scheme also seeks to financially benefit many families, by creating opportunities for employment on a smaller scale, and on a grander scale establish market linkages with national and possibly international produce retailers.

Thus, holistically impacting the economic aspect of the community, encouraging a more self-sustainable and self-reliant community, one that greatly contributes to its own economy, and is part responsible for infrastructural changes and overall natural wellbeing of its people.

This entity includes the following programs and their functions;

Visitors Centre:

Dedicated to welcome local and global tourists, it is the section that contains and exhibits artefacts from the rich history of Keiskammahoek. It also tells the historical narrative of the major influx of German, Scottish and British settlers between 1846 and 1877.

Community Hall:

Constructed by the community and designed to serve the community, this feature is a multi-functioning building that can host communal gatherings, cultural events, social support meetings, it can also double as a sleeping area for affected locals in the event of a natural disaster impacting the community of Keiskammahoek, it can also serve as accommodation for learners from other schools who are playing away games, tournaments in this centre.

Fruit, Vegetable & Botanic Gardens:

The outdoor harvesting of Berries, Cabbages, Potatoes, Maize, Spinach, Pumpkins, Beetroot and Onions and a botanical garden that conserves and celebrates the indigenous & endemic plant species and trees that are found in the Keiskammahoek area. These plant and tree species include Macowania revoluta (Vincent Ralph et al, 2016), Lotononis harveyi (Vincent Ralph et al, 2016), Aloe ferox and Acacia karoo (Vincent Ralph et al, 2016).

Kitchen Garden:

Dedicated to serve the school cafeteria and the farm's main restaurant. Fresh produce is harvested near the cafeteria and restaurant, it is then prepared in the kitchen, which is shared by both, this garden helps feed and nourish the learners.
The learners also take part in learning about and growing the produce in this section.

Retail Plaza:

This section is for public use, the fresh produce from the farm is sold in the retail plaza, crafts created by the locals are also sold here to help showcase the local talent and feed the families of the craftsman and craftswomen.

Production Warehouse:

The area that is responsible for the produce supply to local and possibly international produce retailers, this is the area where fresh produce is inducted, sorted and then dispatched.

Production Greenhouse:

Located adjacent the Production Warehouse for an undisturbed transferring of produce, it is a controlled environment which intends to harvest some of the prominent local vegetables and fruits e.g. Tomatoes, Lettuce, Peppers, Carrots, Herbs, Beans, Broccoli and Strawberries.

Agriculture School

The Agriculture School must be designed as per the standards of the Department of Education together with the Department of Agriculture, Forestry & Fisheries. The applicable Educational & Training programs need to be considered, these can include; Agribusiness (the business of agricultural production) (Goldberg et al, 1957), Agronomy (the study of how to raise a plant/crop), Horticulture (fruits, vegetables and flowers), Soil Science, Seed Science, Agricultural Economics, and forestry (Meena et al, 2018).

The agriculture school will cater for learners between Grade 7 – Grade 12, who take an interest in Agricultural production and aspire to be young leading farmers. This can be a foundational phase of education that can affiliate with Fort Cox College of Agriculture and Forestry, where Grade 12 learners upon their matriculation can be enrolled under this College to further education in Agriculture and Forestry. Fort Cox College is situated +-15km South West of my selected site.

Fort Cox College is one of 12 Agricultural Colleges in South Africa and has an entrance requirement of Grade 12 or a National Senior Certificate (South African History, 2019). A sustainable approach is an integral foundational element that will affect the choice of materials, sustainable principles applied to the physical design of the infrastructure.

The entire scheme needs to apply a 'Universal Design' approach to ensure an inclusive design that is accessible to all.

Herewith are the key factors that will be considered in the design of the school:

- Material choice
- Layout
- Orientation
- Passive design principles
- Insulation

- Acoustics
- Space Conditioning
- Lighting (natural and or Artificial)
- Form

Tourism Accommodation

The purpose of the self-catering accommodation cabins is to welcome all researchers interested in Forestry, indigenous and state of the art farming techniques. National and International researchers can reside in the self-catering cabins during the period they conduct their research and have programs where they teach the learners about their research/findings. Local and global tourists are also welcomed to stay in the cabins, allowing them to savour the cultural richness of the area, the biodiverse natural environment and genuinely experience the workings of the development. Recreational activities like Dam cruises on Sandile Dam, hiking on the hiking trails are also part of this entity.

5.6 Parking requirements

	Program	Area	Parking requirement	Total no. of bays
1	Agriculture Farm			
	Community Hall	435 m²	4 bays per 100 m²	17,4 parking bays
	Vistors Center	303 m²	4 bays per 100 m²	12,1 parking bays
	Offices	48 m²	4 bays per 100 m²	1,92 parking bays
	Produce Warehouse	715 m²	2 bays per 100 m²	14,3 parking bays
	Restaurant	614 m²	6 bays per 100 m²	36,84 parking bays
2	Agriculture School			
	Classrooms (12)	720 m²	1 bay per classroom + 1	13 parking bays
3	Tourism Accommodation			
	Cabins (14 rooms)	770 m2	1 bay per room	14 parking bays

As part of the parking requirements, the aspects of loading and off-loading, delivery, parking and maintenance garages/sheds for tractors need to be considered. The centre can expect medium sized delivery trucks and School buses to enter the premises and be provided parking. The following components can expect dedicated loading and delivery areas; Production Warehouse, Agriculture school, Research Laboratory, Restaurant and Visitors Centre.

School buses transporting learners from other schools, as well as local spectators can expect dedicated parking near the sports fields for convenient circulation and security. The agriculture farm component requires an everyday use of farm tractors, a dedicated parking garage and maintenance shed for tractors is located adjacent the produce warehouse and fruit & vegetable garden terraces for convenient circulation.

5.7 Area program

	Area	Section	No. of Spaces	No. of Users	Area/Person	Total Area (sq. m.)
1	Agriculture Farm					
	Community Hall	Foyer/Control desk	1	1	15	15
		Ablutions (M, F, P)	3			60
		Hall	1	300	1.2	360
		Total				435
	Visitors Center	Foyer/Control desk	1	1	15	15
		Admin Offices	3	3	16	48
		Exhibition Hall	3			120
		Library	1			75
		Ablutions (M, F, P)	3			45
		Total				303
	Agriculture Production	Produce Warehouse	1			715
		Produce Greenhouse	2			780
		Total				1495
	Restaurant	Lobby	1			20
		Dining area	1	100	2	200
		Kid's play area/zone	1	30	2	60
		Bar area	1			35
		Commercial kitchen	1			65
		Cold Store	1			12
		Dry Goods Store	1			12
		Terrace/Patio	1			150
		Ablutions (M, F, P)	3			50
		Refuse area	1			10
		Total				614
		Amphitheatre	1			250
		Total				250

	Area	Section	No. of Spaces	No. of Users	Area/Person	Total Area (sq. m.)
2	Agriculture School					
	Admin Block	Foyer	1			20
		Reception & Gen, office	1			30
		Staff Room	1			50
		Store Room	1			15
		Principal's Office	1			25
		Strong Room	1			9
		Ablutions (M, F)	2			12
		Total				161
	Classrooms	Grade 7	2 (60 sqm each)	20 max + Teacher	2 /learner	120
		Grade 8	2 (60 sqm each)	20 max + Teacher	2 /learner	120
		Grade 9	2 (60 sqm each)	20 max + Teacher	2 /learner	120
		Grade 10	2 (60 sqm each)	20 max + Teacher	2 /learner	120
		Grade 11	2 (60 sqm each)	20 max + Teacher	2 /learner	120
		Grade 12	2 (60 sqm each)	20 max + Teacher	2 /learner	120
		Total				720
	Computer Labs	Comp - Lab 1 (Grd 7 & 8)	1	20 max + Teacher	2,2/learner	44
		Comp - Lab 2 (Grd 9 & 10)	1	20 max + Teacher	2,2/learner	44
		Comp - Lab 3 (Grd 11 & 12)	1	20 max + Teacher	2,2/learner	44
		Total				132
	Agriculture Labs	Agri - Lab 1 (Grd 7 & 8)	1	40 max + Teacher	2,2/learner	44
		Agri - Lab 2 (Grd 9 & 10)	1	40 max + Teacher	2,2/learner	44
		Agri - Lab 3 (Grd 11 & 10)	1	40 max + Teacher	2,2/learner	44
		Total				132

	Area	Section	No. of Spaces	No. of Users	Area/Person	Total Area (sq. m.)
	Library	Control desk/Reception	2 (Ground & 1st FL)	4 (2 per floor)	3	12
		Offices	4	4 (2 per floor)	16	64
		Store rooms	4			48
		Library area	2 (Ground & 1st FL)	280	4	1120
		Ablutions (Staff)	2			12
		Ablutions (Learners)	2 (Ground & 1st FL)			25
		Outdoor area	1			150
		Total				1431
	Multi-purpose hall	Foyer/Lobby	1			20
		Hall	1	300	1.2	360
		Ablutions (M, F, P)	3			50
		Store Rooms	2			24
		Outdoor area				150
		Total				604
	Ablutions	Teachers (Male)	1			10
		Teachers (Female)	1			12
		Paraplegic (Adult)	1	1	3	3
		Learners (Boys)	1			14
		Learners (Girls)	1			16
		Paraplegic (Child)	1	1	3	3
		Store Rooms	4		3.5	14
		Total				72
3	Accommodation	Cabins	10	14	55	770
		Gathering space (Outdoor)	2	14	2	28
		Total				798

6 Precedent studies

The following precedent studies highlight important elements about the project, of which they are; typology, layout, structure, scale, use of light, materials and surfaces, details, context, social/cultural impact, Form, Function, Access, Aesthetics, and Ergonomics. The studies are of significant importance in also assisting me in making informed logical conclusions with regards to the design of my proposed intervention.

6.1 BIG Yin-Yang shaped Panda Enclosure for Copenhagen Zoo (see Figure 6.1.1 & 6.1.2)

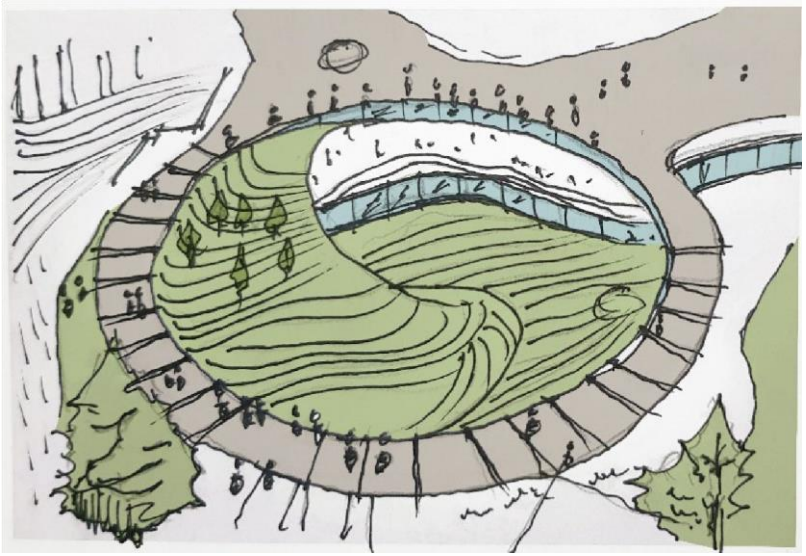


Figure 6.1.1 Circular and undulating form (Vokwana, 2020)

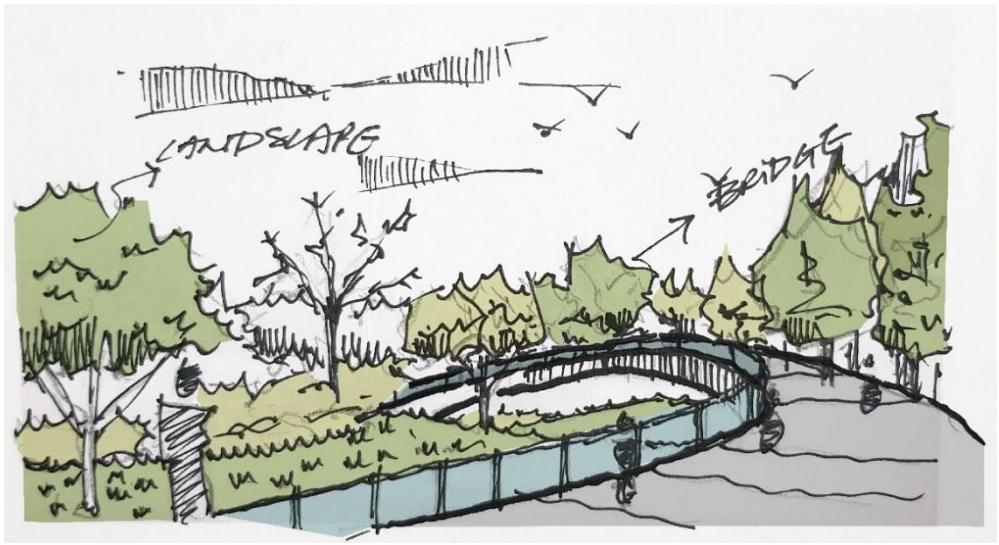


Figure 6.1.2 Integrated green landscape (Vokwana, 2020)

Architect: Bjarke Ingels Group (BIG), Schønherr, MOE

Location: Frederiksberg, Denmark

Scale: 2450.0 m²

Project year: 2018

Tenure: Copenhagen Zoo

What is it

It is a new yin-yang-shaped panda enclosure at the Copenhagen Zoo, and it serves as the new home of two Chinese giant pandas upon their arrival in 2018. The enclosure is located between several existing buildings, including the award-winning Elephant House by Foster + Partners, the circular-shaped habitat is split to create enclosures for the male and female pandas; to also increase the probability of mating, partnered pandas should not be able to see, hear or even smell each other for the majority of the year. (Patrick Lynch, 2018)

The purpose of the enclosure is to provide the pandas with a peaceful living environment and to provide ideal conditions for mating, the enclosures are designed to feel like "humans are the visitors in the panda's home, rather than pandas being the exotic guests from faraway lands." (Steffen Strœde, 2018).

Selected characteristics:

- The resemblance of the natural terrain.

This physical characteristic is one that takes the approach of undisturbing the existing natural environment, it seeks to better accentuate it than to alter it. How the development has assumed a natural form that coincides with the existing natural terrain also encourages an undisturbed connection between the inhabitants and its habitat. This is a characteristic that I aim to accommodate with the overall approach of my scheme, the intention is not to disturb the existing terrain but to accentuate it, to celebrate it.

- Circular shape and undulating form of the enclosure to influence the design of a gathering space/amphitheatre.

This design characteristic influences the development of a circular-shaped gathering space within my scheme, the undulating, circular form is a strong gesture that also encourages a social outdoor space that is formed naturally.

6.2 Rural House #01 (see Figure 6.2.1 & 6.2.2)

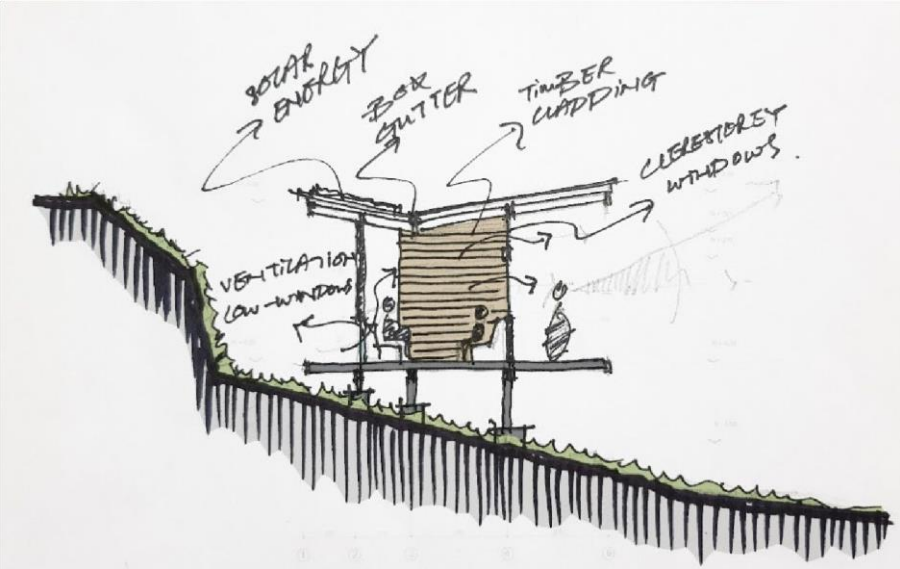


Figure 6.2.1 Rural House #01 cross section (Vokwana, 2020)

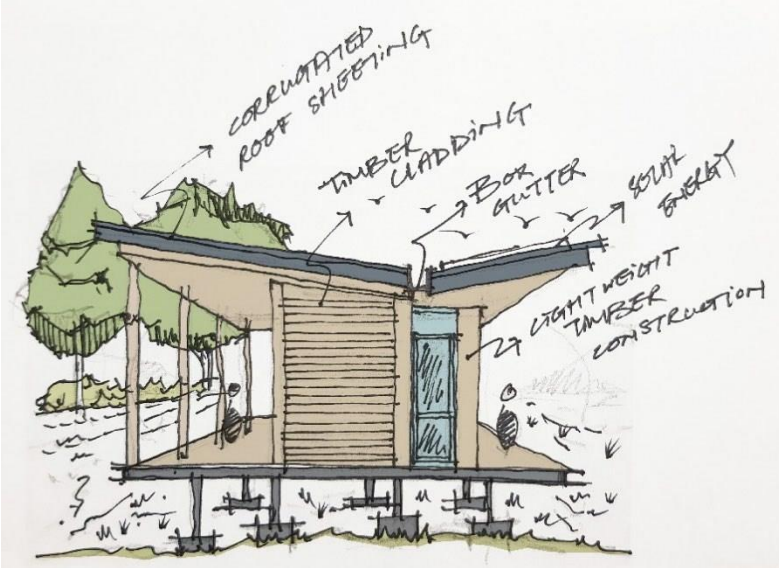


Figure 6.2.2 Side elevation (Vokwana, 2020)

Architect: Cristobal Vial Arquitectos

Location: Matanzas, Chile

Scale: 60 m²

Project year: 2020

What is it

The concept of these structures corresponds to a vacation home, it is a design of a single-family house that manages to incorporate a program that facilitates 3 bedrooms, a living room, kitchen, dining room, and a bathroom in just 60 m² of interior space, requested by the client. In addition to this, exterior terrace spaces were to be considered. (Ott, 2020)

The structures are proposed in a longitudinal form in favour of the slope, their orientation also allowing them to take advantage of the encompassing distant views of the Pacific Ocean and immediate territory. (Ott, 2020)

Selected characteristics:

- Spatial program (Bedrooms, living room, kitchen, dining room, bathroom, and exterior terrace spaces). (Ott, 2020)

This shares a similar program with the self-catering cabins that fall under the tourism accommodation aspect of my scheme. These are spaces that resemble a vacation home and that is the intention with the accommodation cabins, to resemble a vacation home for researchers and tourists.

- A distinction of public, children, and adults' spaces. (Ott, 2020)
- Butterfly roof construction, use of a box gutter, and material choice (timber and corrugated roof sheeting). (Ott, 2020)

The material choice is the major influence that the self-catering cabins draw from this precedent study. Timber is an environmentally friendly material and often blends effortlessly with the natural environment.

- The materiality of structure, mostly timber and glazing. (Ott, 2020)
- Use of solar energy through photovoltaic panels to provide electrical support to the house. (Ott, 2020)

Energy harvesting is a sustainable approach and is a great benefit for any small to big scale developments, in rural and urban settings. It is also a renewable source and is a selected characteristic to implement in the design of the self-catering cabins because it promotes sustainable, off-the-grid living.

6.3 Eco Farm & Educative Park in Vietnam (see Figure 6.3)



Figure 6.3 Development plan (T3 Architects, 2018)

Architect: T3 Architects & LJ-Asia

Location: South of Saigon, Vietnam

Scale: 14,8 h.a

Project year: 2018

Tenure: Private

What is it

A proposal by T3 Architects to mix organic agriculture production and an educative park opened to the Public and Students in the field of agronomy and environment. With the main intention to produce organic vegetables and fruits farm, consisting of the following program: entrance building, Conference Center, Ticketing, Organic Shop, Coffee Shop, Restaurant Building, sustainable agriculture and mushroom Museum, Eco-lodge of 30 bungalows, reception building and Office Building for management of the farm and park. (T3 Architects, 2018)

The buildings are designed to follow bioclimatic principles such as; natural ventilation, sun protection with large overhangs and louvers. The choice of material for the structures is wood (for a low carbon footprint), water palm leaves (for the roof construction, cheap and good efficiency in terms of insulation) as well as a few walls made by non-cooked bricks for humidity control. (T3 Architects, 2018)

The park has been designed to welcome families and student groups, both for educational and entertainment purposes with outdoor activities related to nature and the environment. (T3 Architects, 2018)

Selected characteristics:

- Organic agriculture production. (T3 Architects, 2018)

This aspect forms a great part of my proposal, it is also the area that encourages the renewing of the once prominent agricultural production history of Keiskammahoek. This feature will also be responsible for the creation of employment opportunities for the locals, education for the learners, a multi-generational exchange of knowledge amongst its users and ultimately promote a positive economic shift in Keiskammahoek and neighbouring communities. (T3 Architects, 2018)

- Conference Center.
- Organic Shop/Retail plaza
- Coffee shop
- Accommodation

These form part of the scheme's spatial program, the inclusion of a conference centre that can have multi-functions, and serve the community when hosting events etc.

- Natural ventilation
- Large overhangs
- Low carbon footprint material (timber/wood) (T3 Architects, 2018)

These are some of the sustainable design principles that I intend to use in the development of the centre.

6.4 Inside Out School (see Figure 6.4.1 & 6.4.2)

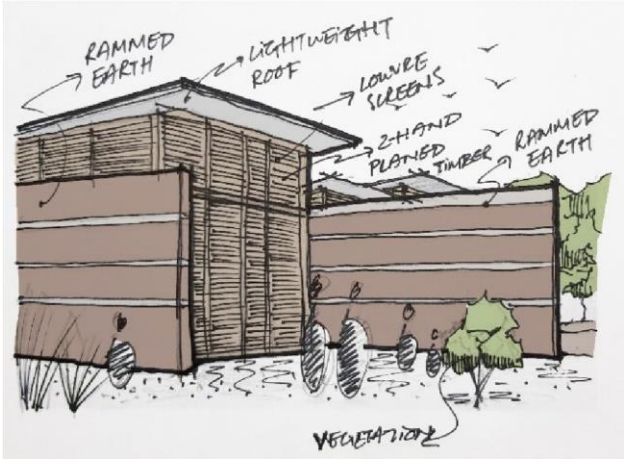




Figure 6.4.1 Perspective, Inside Out School (Vokwana, 2020) **Figure 6.4.2 Cross section, Inside Out School** (Vokwana, 2020)

Architect: Andrea Tabocchini & Francesca Vittorini

Location: Yeboahkrom, Abetenim, Ghana

Scale: 40 m²

Project year: 2017

Tenure: Yeboahkrom Village

What is it

Inside Out is a school prototype built in Yeboahkram, a rural village in Ghana where the wind had destroyed the only school in the area. It is a non-profit project, that has won several international awards and was constructed in 60 days with a budget of just 12 000 euros. The local population and volunteers from 20 different countries participated in the construction of this school. (González, 2020)

It was built by hand since no electricity was available, also crafted with materials that are found on site; earth, wood, and vegetation and consists of 58 000 kg of soil and 3km of 2-hand planed wood. (González, 2020)

The lack of resources and site limitations bred opportunities to propose a sustainable design that will merge architecture and the landscape. The walls are built through the compaction process of local earth, the light roof structure is lifted by wood, thus allowing zenithal light into the building and the spaces are naturally ventilated through that design decision. (González, 2020)

The idea of the porches continues to vegetation gardens and by having these outdoor spaces shaded, therefore, encourage outdoor studying. The school successfully blurs the boundary between inside and outside, therefore offering an alternative to standard introverted classrooms and proposes an affordable and fairly replicable design that values the local knowledge and dares to push its limits. (González, 2020)

Selected characteristics:

- Inclusion of local population and volunteers in the construction development process. (González, 2020)

This approach significantly benefits the community, it also encourages social upliftment and unity. The development can have a communal identity, a project that the locals can take pride in, that represents and serves them. One that they were completely involved in from the beginning till it's completion and later usage.

- Use of materials found on-site; earth, wood, and vegetation. (González, 2020)

A sustainable approach I intend to make use of in my proposal, it has great benefits of undisturbing the natural environment and gently identifying with its existing context.

- Sustainable design that merges architecture and the landscape. (González, 2020)
- Compacted earth walls, elevated light-roof-construction, penetration of light into spaces, and natural ventilation. (González, 2020)
- Outdoor shaded studying spaces. (González, 2020)

This characteristic is chosen because it inspires the organization of spaces that promote outdoor studying and productivity, where learners can interact with the natural environment and gain an education simultaneously.

- Blurring the boundaries between inside and outside. (González, 2020)

- Affordable and replicable design that values the local knowledge and dares to push those limits. (González, 2020)

This is a significant aspect of this precedent study; the idea of replicability is one that resonates deeply with the intention of my scheme. Granted the development of the scheme needs to be affordable and it becomes a great reward if the same principles can be replicated in a similar rural context.

6.5 Nelson Mandela Museum (see Figure 6.5)

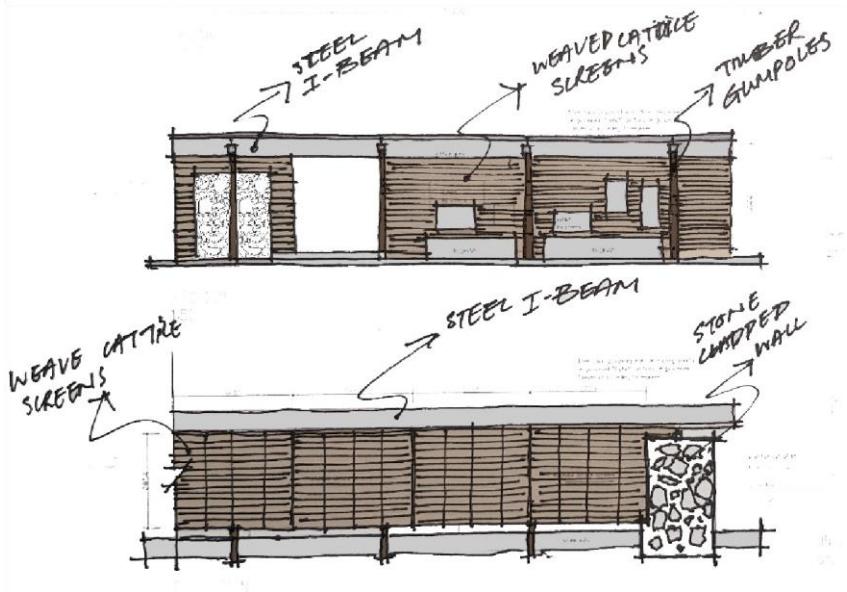


Figure 6.5 Cross section & elevation, Nelson Mandela Qunu Museum (Vokwana, 2020)

Architect: Cohen and Garson Architects

Location: Qunu, Umtata, Eastern Cape

Project year: 2000

What is it

The Qunu Museum is amongst two (2) other projects which altogether are situated in three (3) inter-related sites and collectively serve as one museum within the Umtata area. These Museums are represented as cultural working spaces for the local communities. The facilities are used to activate the memories, histories, and traditions of a community through their contemporary everyday practices. (Cohen and Garson Architects, 2000)

These cultural spaces also contribute to serving the need in providing basic infrastructure to rural communities. During construction, the buildings addressed many employment issues with the local communities such as the employment skillsets of the locals, especially women who have been previously excluded from such opportunities. (Cohen and Garson Architects, 2000)

Local trade skills comprising; traditional fencing, lattice weaving, and stone building skills were used and further enhanced during construction. (Cohen and Garson Architects, 2000)

Selected characteristics:

- Use and enhancing of local trade skills. (Cohen and Garson Architects, 2000)

A good characteristic with the intentions of developing and elevating the community, also allowing the community to identify itself with and through the scheme.

- Use of local materials, stone (cladding on feature walls), timber (lattice weaving). (Cohen and Garson Architects, 2000)

6.6 Rural School Alto del Mercado (see Figure 6.6)



Figure 6.6 Rural School Alto del Mercado, merged roofs (Vokwana, 2020)

Architect: Ana Elvira Vélez + Juan B. Echeverri

Location: Marinilla, Columbia

Scale: 870 m²

Project year: 2013

What is it

The design of a rural school situated in the Alto del Mercado village, Marinilla, Columbia. The school caters for 180 children of the Mercado village and is located on the top of a mountain ridge overlooking scenic cultivated vegetable slopes. (Danae Santibańez, 2018)

The building form is a repetition of modular naves with gabled roofs that vary in height. The program includes classrooms, a library, administrative office, playground, semi-outdoor dining room, and a multi-purpose room. (Danae Santibańez, 2018)

Selected characteristics:

- Merging of two (2) roofs with box gutter as illustrated above.

This characteristic is mostly applicable in the connected design of the dining hall/learner's cafeteria and restaurant that serves the scheme. These two structures share a kitchen and are physically connected by that space. Here the detailed explorations of joining roofs, inclusion of box gutters, water proofing will be considered.

- Timber framed roofs.
- The connection between interior and exterior spaces.
- Shuttered glazing that encourages the relationship between the interior spaces and exterior landscape.

The natural environment is stunning and should be celebrated, it is designs like these that consider visual connections through large undisturbed openings, but also responding to reducing extensive solar penetration into spaces by factoring in shutters to control solar penetration in principle but also adding that layer of texture.

7 DESIGN DEVELOPMENT

LAND DISTRIBUTION & PROGRAMME



1 AGRICULTURE FARM

- Conference Hall
- Amphitheatre stage
- Retail Plaza
- Visitors Center
- Fruit, Vegetables & Botanic Gardens
- Forest Observatories
- Aquaponic Gardens
- Restaurant
- Kitchen Garden

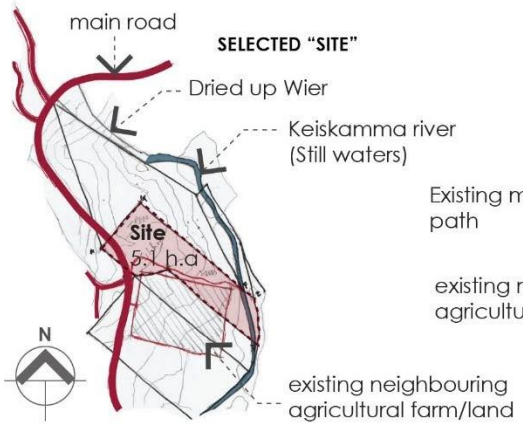
2 AGRICULTURE SCHOOL

- Kids Playgrounds
- Ablutions (Learners & Staff)
- Admin Block
- Computer Labs
- Classrooms
- Library (Indoor/Outdoor)
- Multi-purpose Hall
- Agriculture Laboratories
- Cafeteria/Dining Hall

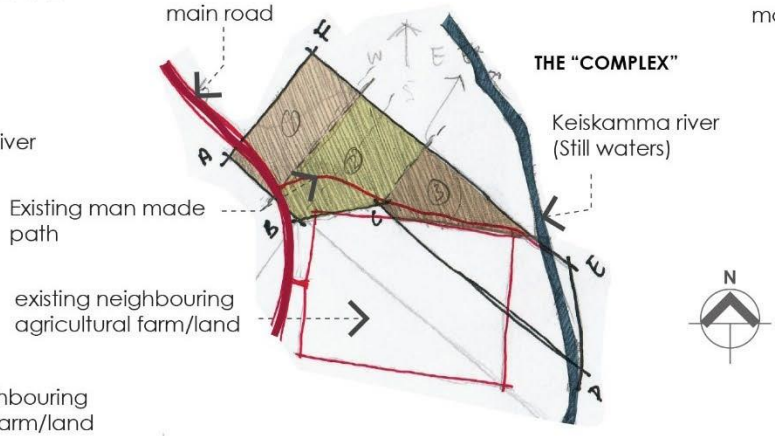
3 TOURISM ACCOMMODATION

- 5 - 10 Cabins for Tourism accommodation
- Recreational Activities (hiking trails, Scenic Pass drives etc.)
- Forest Observatories

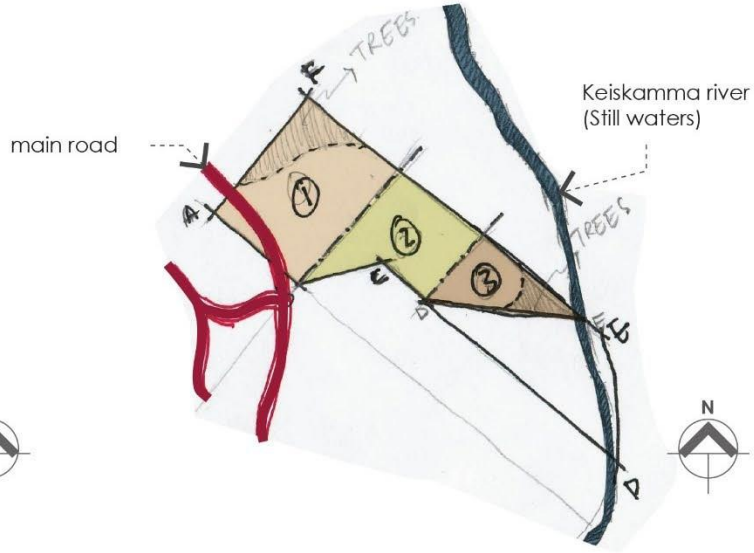
2 - SITE CONCEPTUAL PLANNING



The chosen site is Farm 1158, according to Chief Surveyor General it is classified as a parent farm. The size of the chosen site is 5.1 h.a, it mostly clear of any obstructions and has a gradual slope towards Keiskamma River.

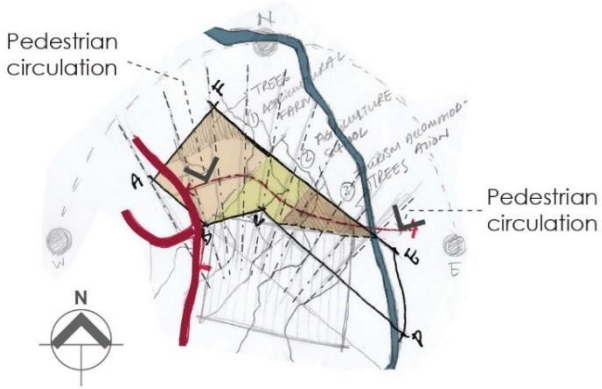


The conceptual illustration indicates marked site corners from point A to point F throughout the site. The main road and river are key contextual elements that are also illustrated.



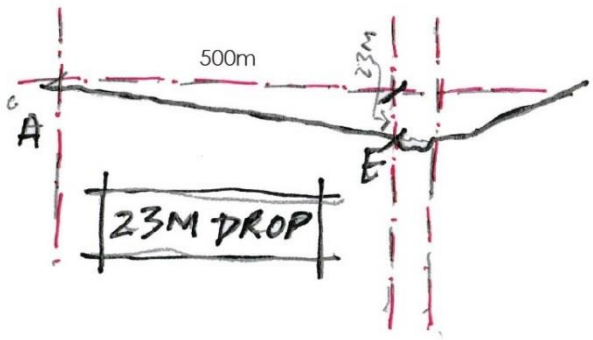
With this conceptual illustration, the existing man made path has been removed in order to create a new vehicular and pedestrian pathway that is properly arranged alongside the distinct programs. Ideally the circulation spine will run in the center of the site and pathways to buildings will stem from that central spine.

ESTABLISHING BUILDING ORIENTATION



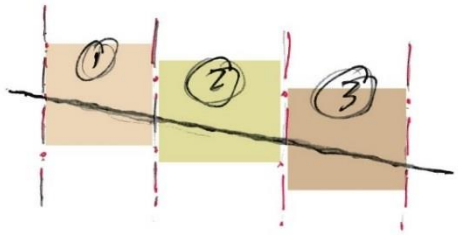
Dashed lines in the above illustration establish orientation of the different buildings to predominantly face North. Pedestrian access is illustration by a red spine cutting through the site towards the Keiskamma River.

CONCEPTUAL EXISTING SITE SECTION



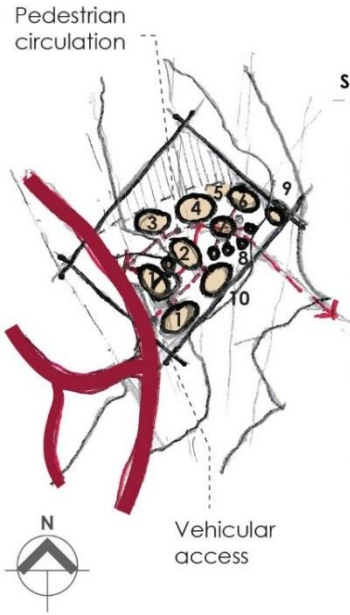
The above diagram is a conceptual "section" illustration of the existing site terrain. From point A (highest level of site) to point E (lowest level of site) there is a **'23m'** vertical drop, this forming opportunities of developing the intervention in a way to flow/step with the sloping site.

CONTEXTUAL APPROACH



A conceptual approach to flow with the sloping site, cut & fill where necessary...But mostly work with the slope of the site. Segmenting the "program clusters" in sectional view responding to the sloping site.

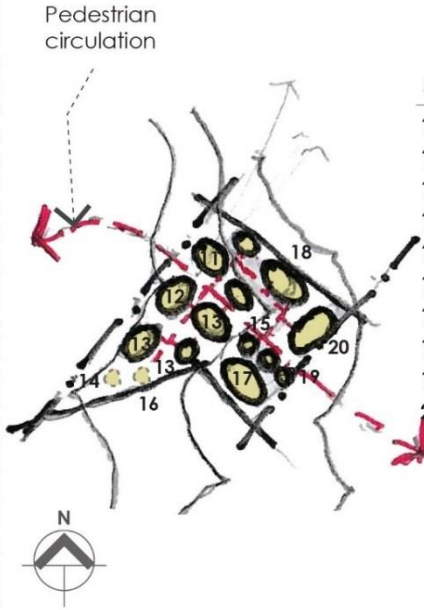
1 AGRICULTURE FARM (PROGRAM CLUSTER)



SPATIAL PLANNING BREAKDOWN

1. Parking
2. Visitors Center
3. Conference Hall
4. Fruit, Vegetables, Botanic Gardens
5. Kitchen Garden
6. Restaurant
7. Amptheatre Stage
8. Retail Plaza & Communal Space
9. Aquaponics Gardens
10. Animal Barn

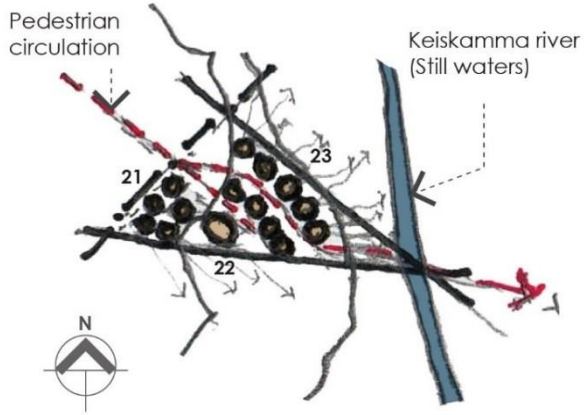
2 AGRICULTURE SCHOOL (PROGRAM CLUSTER)



SPATIAL PLANNING BREAKDOWN

11. Admin Block
12. Cafeteria/Dining Hall
13. Classrooms
14. Ablutions (Staff)
15. Agriculture Labs
16. Ablutions (Learners)
17. Kid's Playgrounds
18. Library (Indoor/Outdoor)
19. Computer Labs
20. Multi-purpose Hall

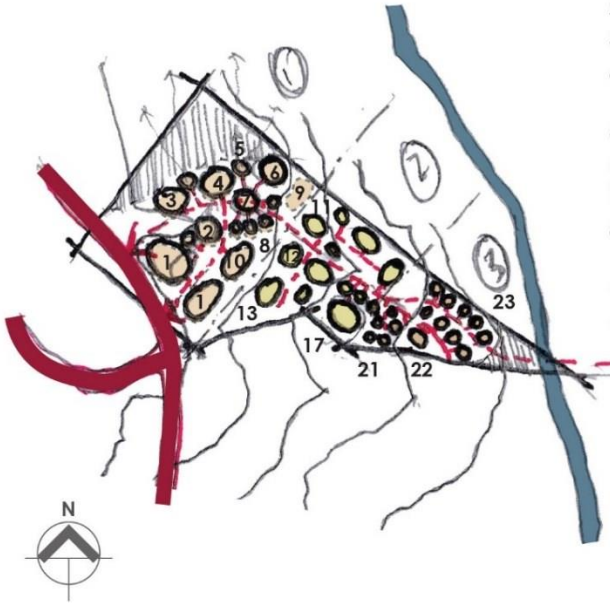
3 TOURISM ACCOMMODATION (PROGRAM CLUSTER)



SPATIAL PLANNING BREAKDOWN

21. Forest Observatories
22. Communal gathering spaces
23. Cabins

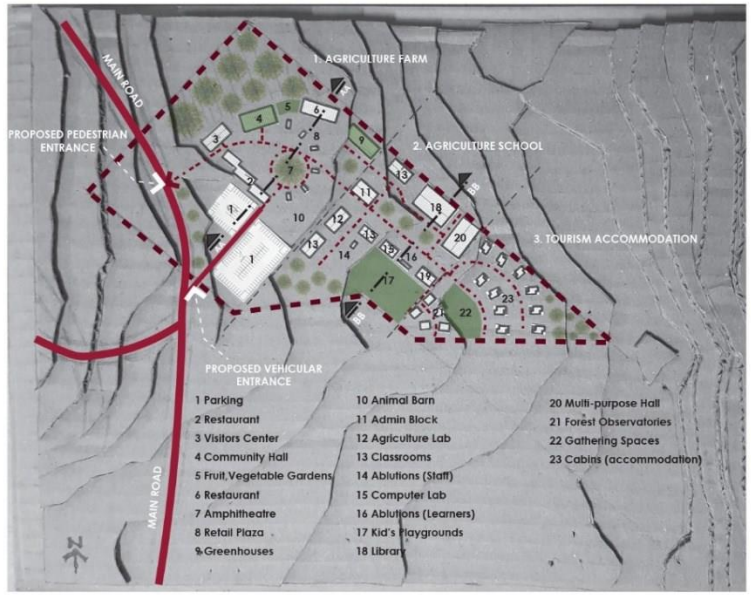
THE "COMPLEX" CONCEPTUAL LAYOUT



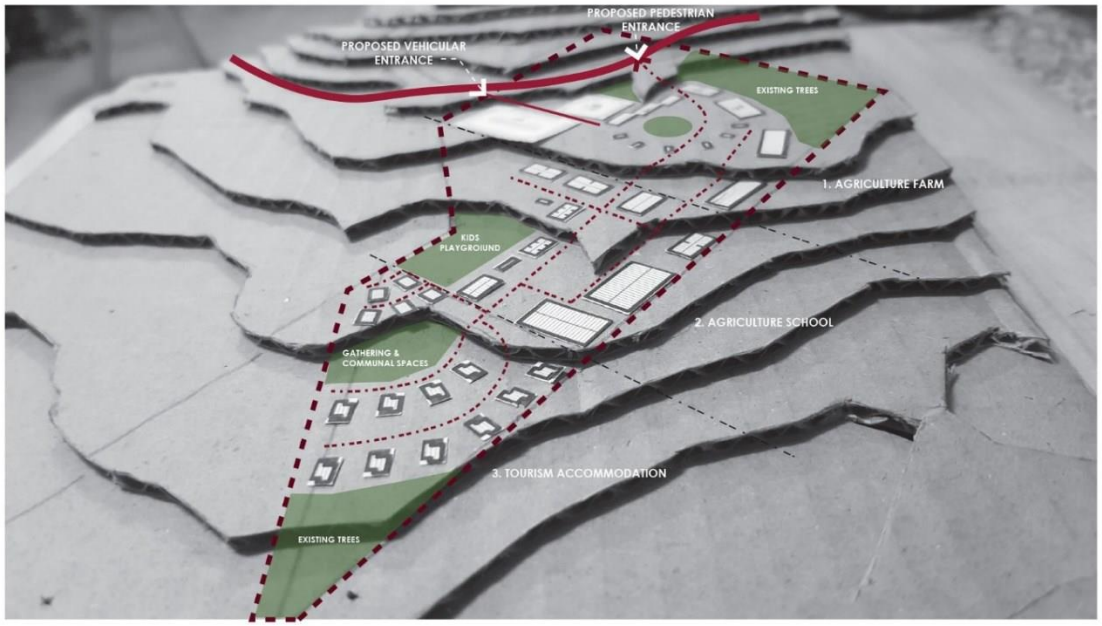
SPATIAL PLANNING BREAKDOWN

1 Parking
2 Visitors Center
3 Conference Hall
4 Fruit, Vegetables, Botanic Gardens
5 Kitchen Garden
6 Restaurant
7 Amptheatre Stage
8 Retail Plaza & Communal Space
9 Aquaponics Gardens
10 Animal Barn
11 Admin Block
12 Cafeteria/Dining Hall
13 Classrooms
14 Ablutions (Staff)
15 Agriculture Labs
16 Ablutions (Learners)
17 Kid's Playgrounds
18 Library (Indoor/Outdoor)
19 Computer Labs
20 Multi-purpose Hall
21 Forest Observatories
22 Communal gathering spaces
23 Cabins

SPATIAL PLANNING (PHYSICAL MODEL)



ATTEMPT 1



ATTEMPT 1

NOTES: ATTEMPT 1

The appraoch to this layout was inspired by the sequential program planning illustrated in the preceding diagrams. It is an illustrated that is further explored on a physical contour model as to also give an idea of how these spaces would communicate with eachother and the site as a whole.

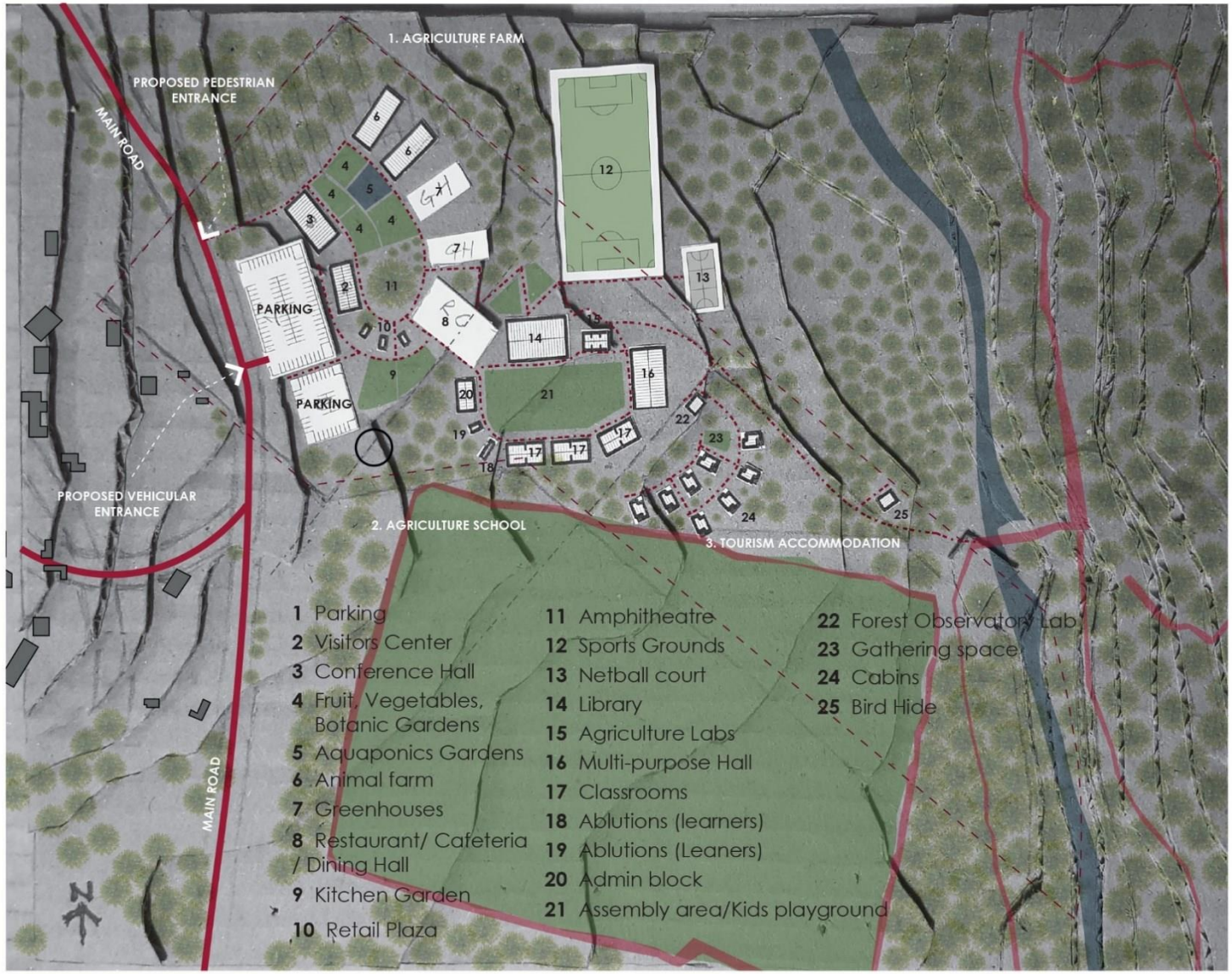
PROS -

- The approach of conserving the natural landscape, keeping the Sweet thorn and Wild Aloe trees that are found on site. Maintaining the existing natural landscape.
- Identifying a central spine and developing from the negative spaces, having kept the natural landscape undisturbed.
- Still communicating the land distribution and programme plan across.
- Organising spaces/programs to take advantage of the views and northen natural light.

CONS -

- The whole layout doesn't work out that well, spaces don't necessarily relate to each other effectively.
- The orientation of the buildings and inbetween spaces does not draw from the existing context .e.g. how the residential areas have been organised.
- Pedestrian movement inbetween buildings hasn't been clearly defined.

SPATIAL PLANNING (PHYSICAL MODEL)



ATTEMPT 2

NOTES: ATTEMPT 2

This layout draws from the previous attempt, it also seeks to establish a central circulation spine and also maintaining vehicular access and circulation to be kept at the top of the site...closer to the main road.

The program has expanded with the inclusion of a soccer field and a netball court.

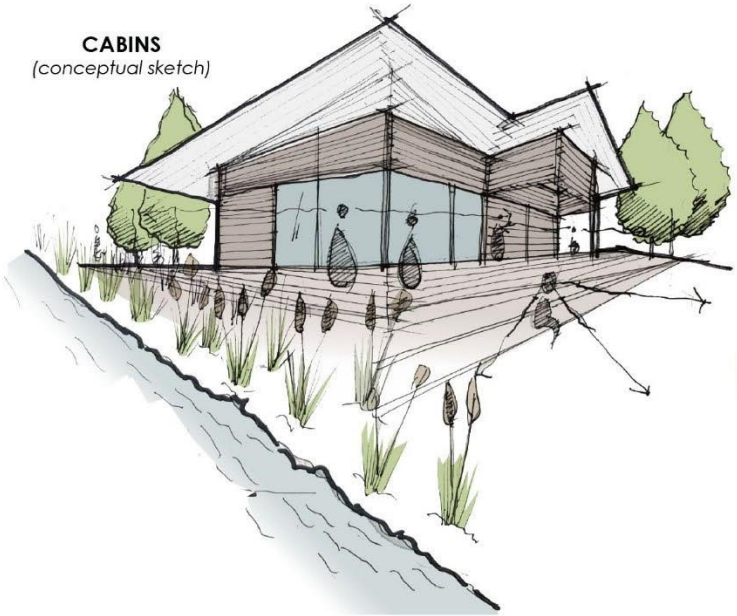
PROS -

- Buildings tend to relate a bit more effectively.
- Pedestrian circulation has been defined, however it is quite loose and does not necessarily draw from the existing context.
- The Kitchen (item 8) serves both the Dining Hall/Cafeteria of the School as well as the Restaurant of the Agricul ture Farm.

CONS -

- Vehicular access (Delivery and parking) hasn't been well considered defined. How does one park closer to the building they are visiting/using?
- There are too many open grand spaces between the programs.
- The relationship between the school and the Sports fields hasn't been defined properly.
- What influences or anchors the spatial arrangements, do courtyards anchor the surrounding spaces, do certain buildings with greater multi-functions anchor the organisa tion of spaces arround them?

CABINS
(conceptual sketch)



SCHEME
(conceptual sketch)





GREENHOUSES
(conceptual sketch)

8 CONSTRUCTION TYPOLOGIES

The following study addresses the different building typolgies that are found in the Keiskammahoek area, from the native cow-dung construction, indigenous African Hut (Rondavel) with multiple dwellings serving different function in the same site to the recent RDP construction. In this section I seek to highlight existing key features that can aid my choice of materials, roof style/construction, and further critique the shortfalls of these various material and building choices.

RESIDENTIAL:



01 Cow dung Construction

This form of native construction has been used for so many years by the locals of Keiskammahoek. It is the combination of a timber reed structural frame that shapes mostly the exterior walls of the dwelling and is then plastered and infilled with Cow-dung and mud.

The Cow-dung mixture is also used for the floor finishes. This type of construction is one that makes use and takes advantage of locally sourced materials .e.g. Timber reeds, Cow-dung, Mud etc. It's close to natural as possible and represents most of the indigenous construction methods of the African Hut (Rondavel).

A lot can be drawn from this construction method, also bearing in mind the properties of each individual material that is used here.



02 Zinc Construction

In most cases this form of construction is found in native units or informal settlements in South Africa. The use of Zinc to construct a dwelling is inexpensive, and can be a very quick process.

There are disadvantages relating to this type of construction and there are shortfalls in terms of material performance.

The illustration above is a typical representation of a simple dwelling space in this area that used locally available materials, observing from the typical representation of the rectangular structure with very few openings and a typical double-pitched roof construction.



03 Concrete Block

An example of a recently built Government Subsidy Housing, also commonly known as an RDP.

The Keiskammahoek area comprises of a variety of construction methods represented in the forms of residential to institutional facilities.

The concrete block construction can be cost effective, it does contain adequate thermal and structural properties, it also provides a sense of dignity for the locals.



04 Cow dung + Concrete Block

The composition of Concrete Block and Cow dung construction is quite common in most residential compounds in the Rural areas.

Here is an depiction of different materials being used for the different buildings within the same site. Highlighted above is a collapsing Rondavel that is constructed from Cow-dung, tmber reed frame and Mud mixture.

The structural longevity of this form of construction is questionable, as the image shows a collapsing structure. It would be interesting to experiment which locally sourced natural materials can be paired together to achieve structural resilience, appealing aesthetics and thermal performance.

INSTITUTIONAL:



05 Facebrick Construction

Illustrated above is the Institutional buildings of St Matthews High School, it is a mission school in Keiskammahoek that was founded in conjuction with St Matthews Missionary Church in the 1800s.

Facebrick seems to be the prominent choice of material in this construction. This element brings forth a modernised aesthetical feel of the campus, with the use of brick & timber columns to support the roof overhangs.

These material & structural elements I would like to draw from in moving forth with the design of my scheme and apply it mostly in the design development of the Educational entity of my proposal.



06 Water Harvesting

This sustainable design principle is relatively common in rural areas and moreso implemented in rural schools. The harvested water can be used for drinkable purposes (after being purified), irrigation and sanitation purposes.

It's one of the principles that will be implemented in the design development of my scheme for the above mentioned uses, and falls under a sustainable design approach.



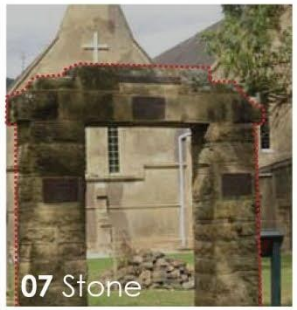
07 Baked bricks & Stone

St Matthews Mission Church was founded in 1854, by Bishop Armstrong and was built on land donated by local Xhosa Chief Socishe.

These early buildings were constructed out of well baked brics and stone, as one can identify from the illustration.

It communicates the English Reneissance architectural style, and was built at a period where the Keiskammahoek had a large population of British soldiers.

The structure has stood strong throughout the years, one can draw a lot from the types of materials used in this construction.



07 Stone

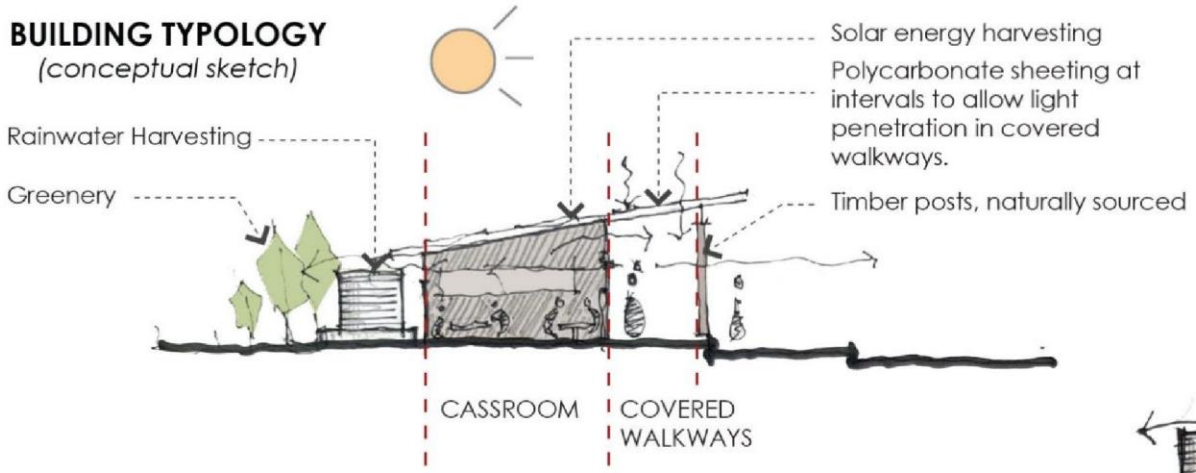
This is an image of the later constructed St Matthews Memorial Archway commemarating the founders, visionaries, land donors and fathers of St Matthews Mission.

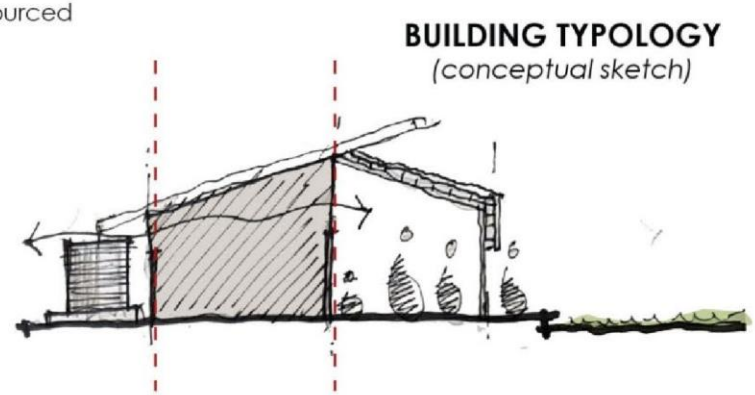
It is constructed out of historic stone, which is usually used in the construction of Historic Churches.

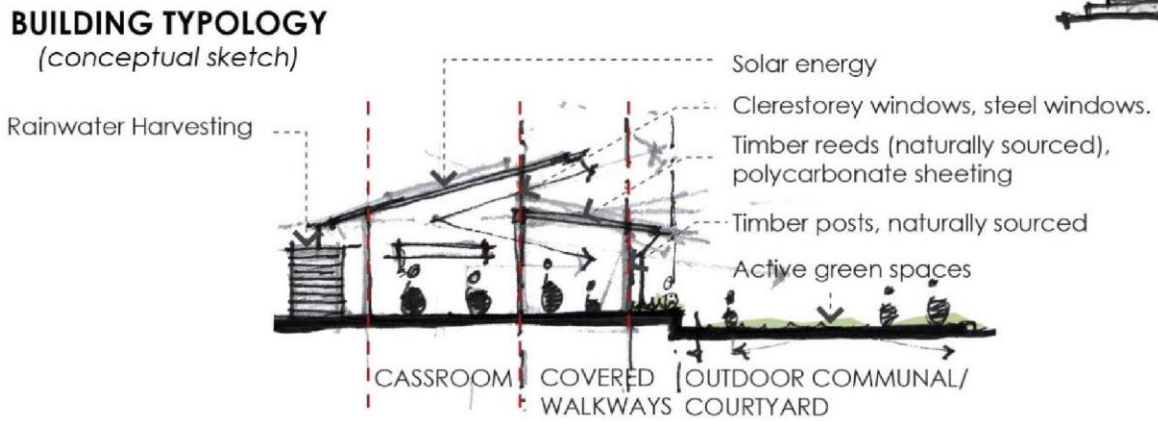
In the center of the image is a depiction of locally sourced stone, which can be used for new construction, cladding material or for restoration purposes.

The Keiskammahoek and neighbouring areas consist of different types of soils and sediments of rock, which are Dolerite, and Alluvial deposits. These natural materials can be used in the construction of certain building types, and local labour can be used in the process.

The following sketches are explorations of a building typology that is inspired by the existing typologies discovered in the context of Keiskammahoek. They are representations of the different building types that the scheme comprises of, mostly of the classroom typologies being explored.

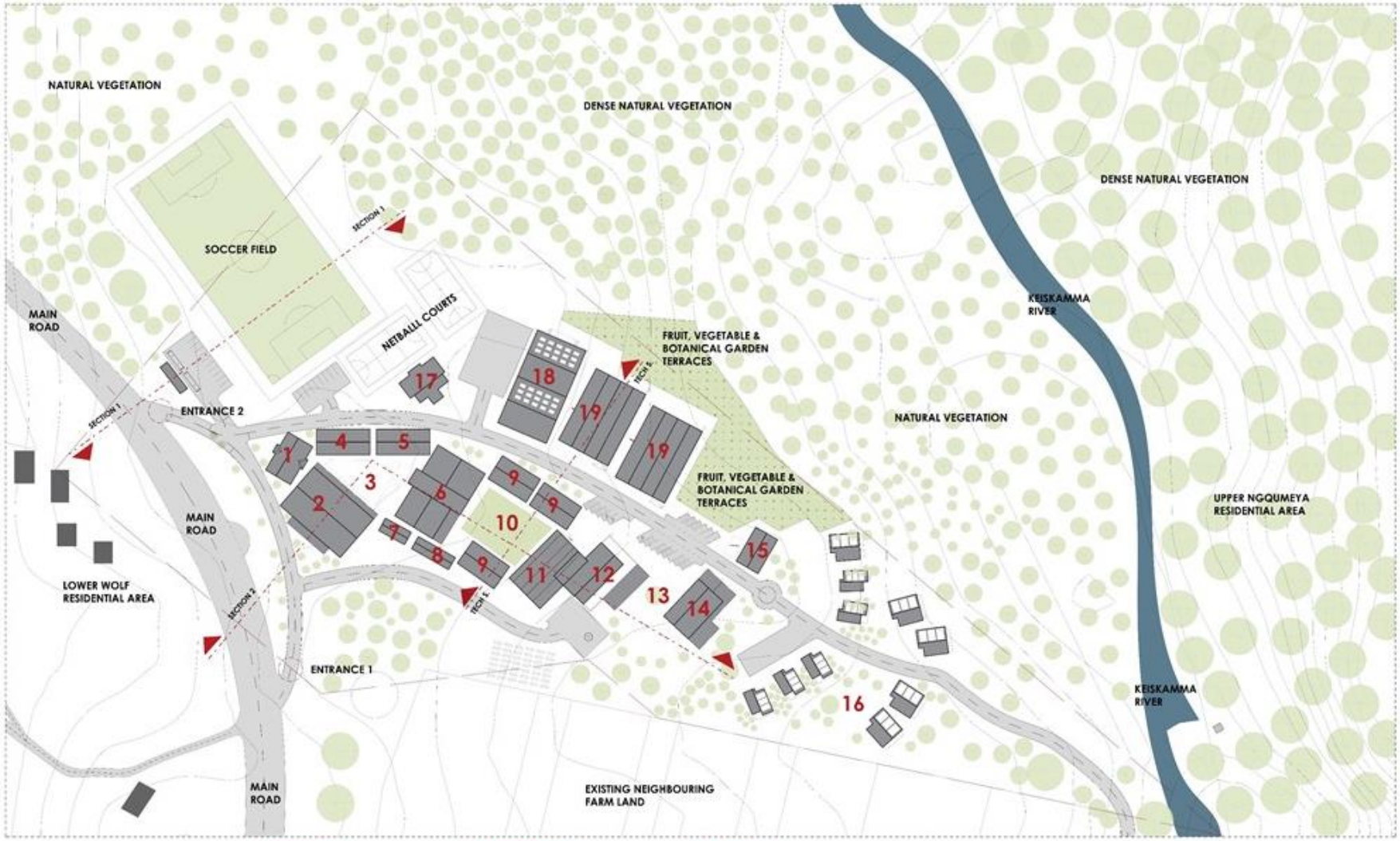






9 DESIGN DRAWINGS

9.1 Site plan



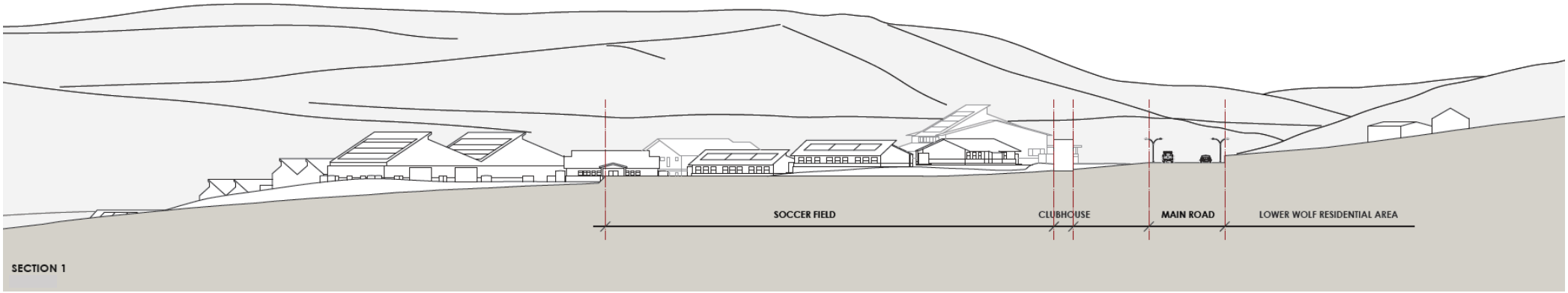
9.2 Floor plan



1:500 0 10 20 30 40 50 M

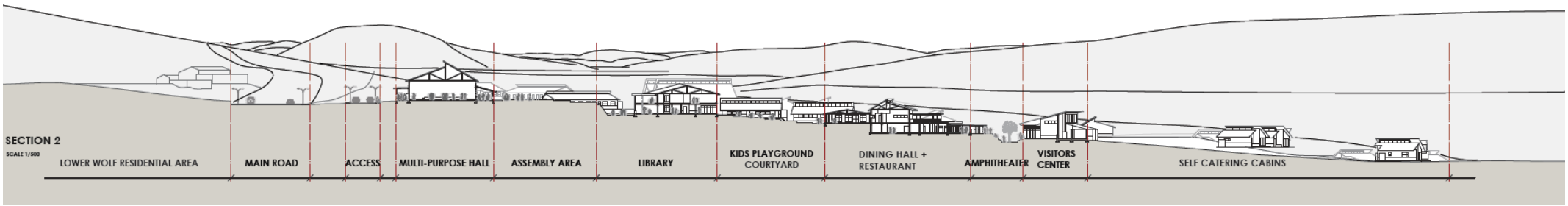
N

9.3.1 Section 1



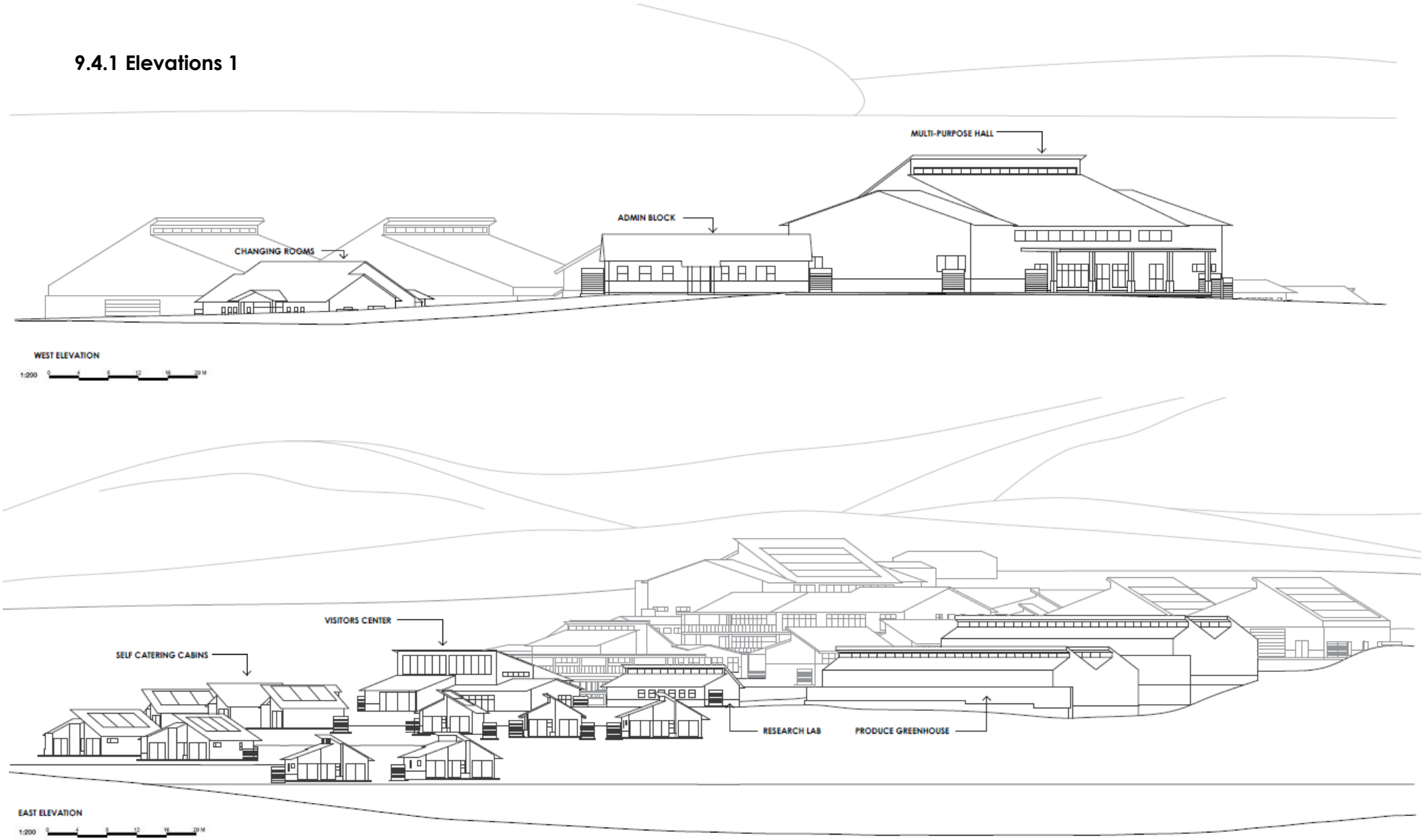
1:200 0 4 8 12 16 20 M

9.3.2 Section 2

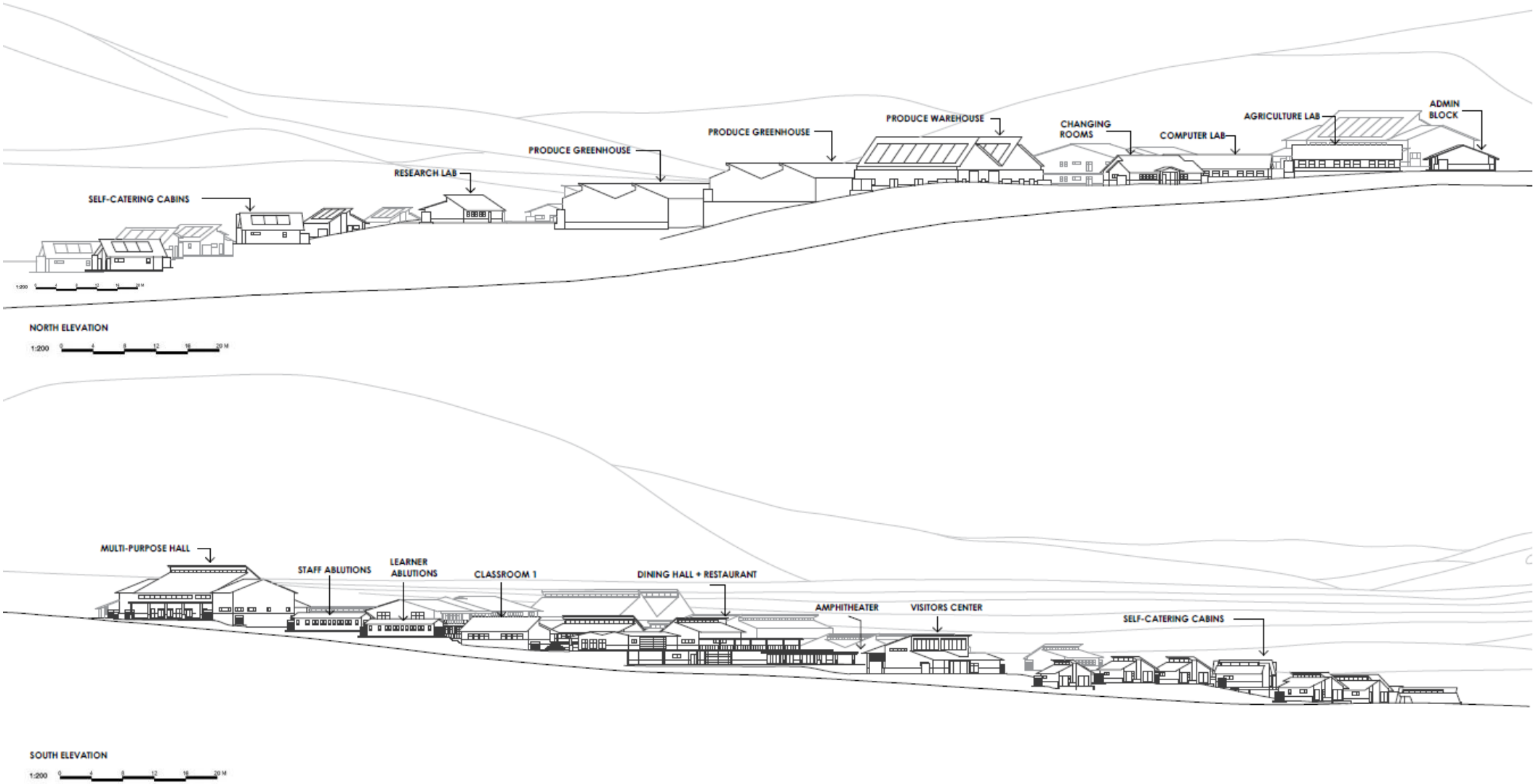


1:200

9.4.1 Elevations 1



9.4.2 Elevations 2



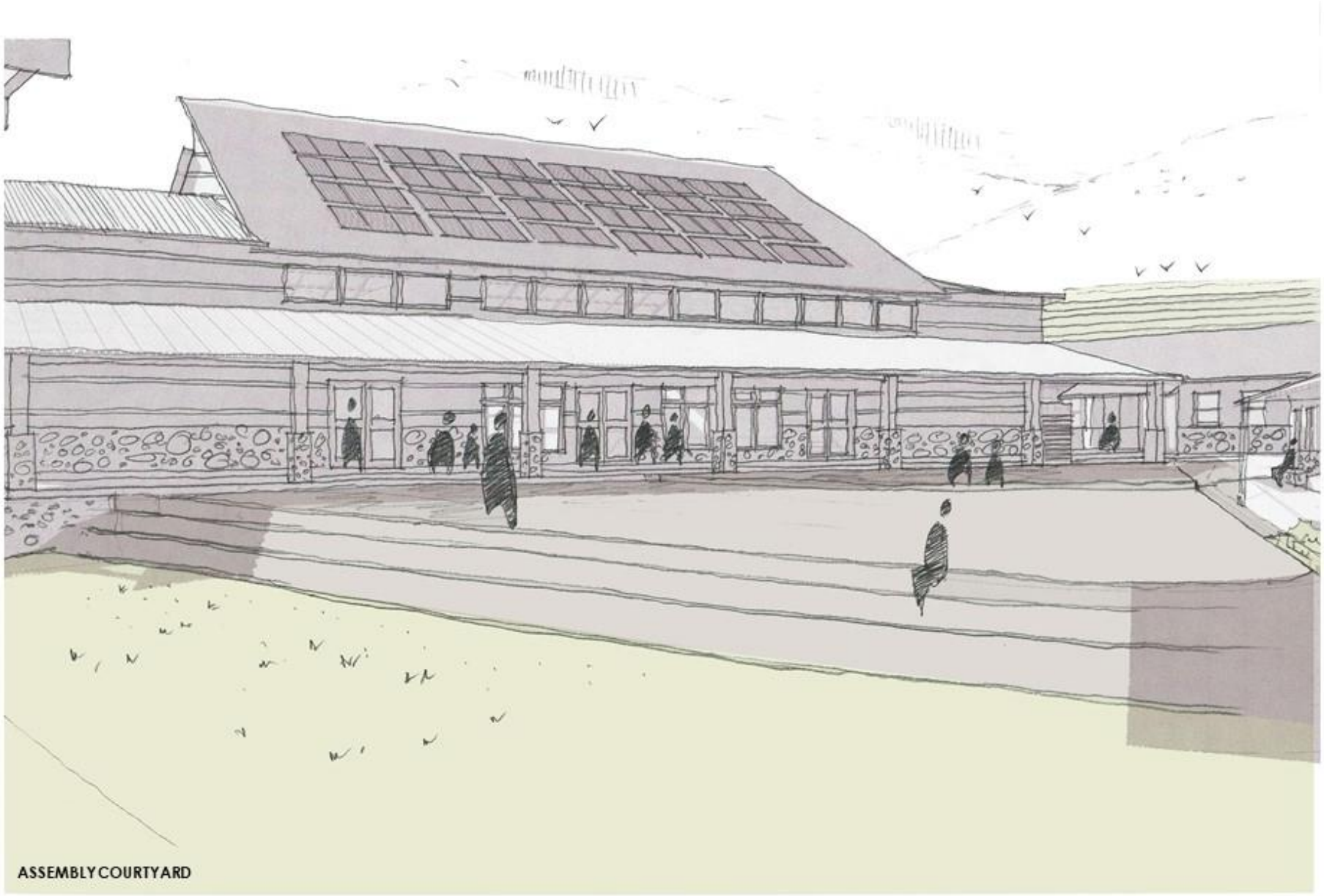
9.5 3d Perspectives



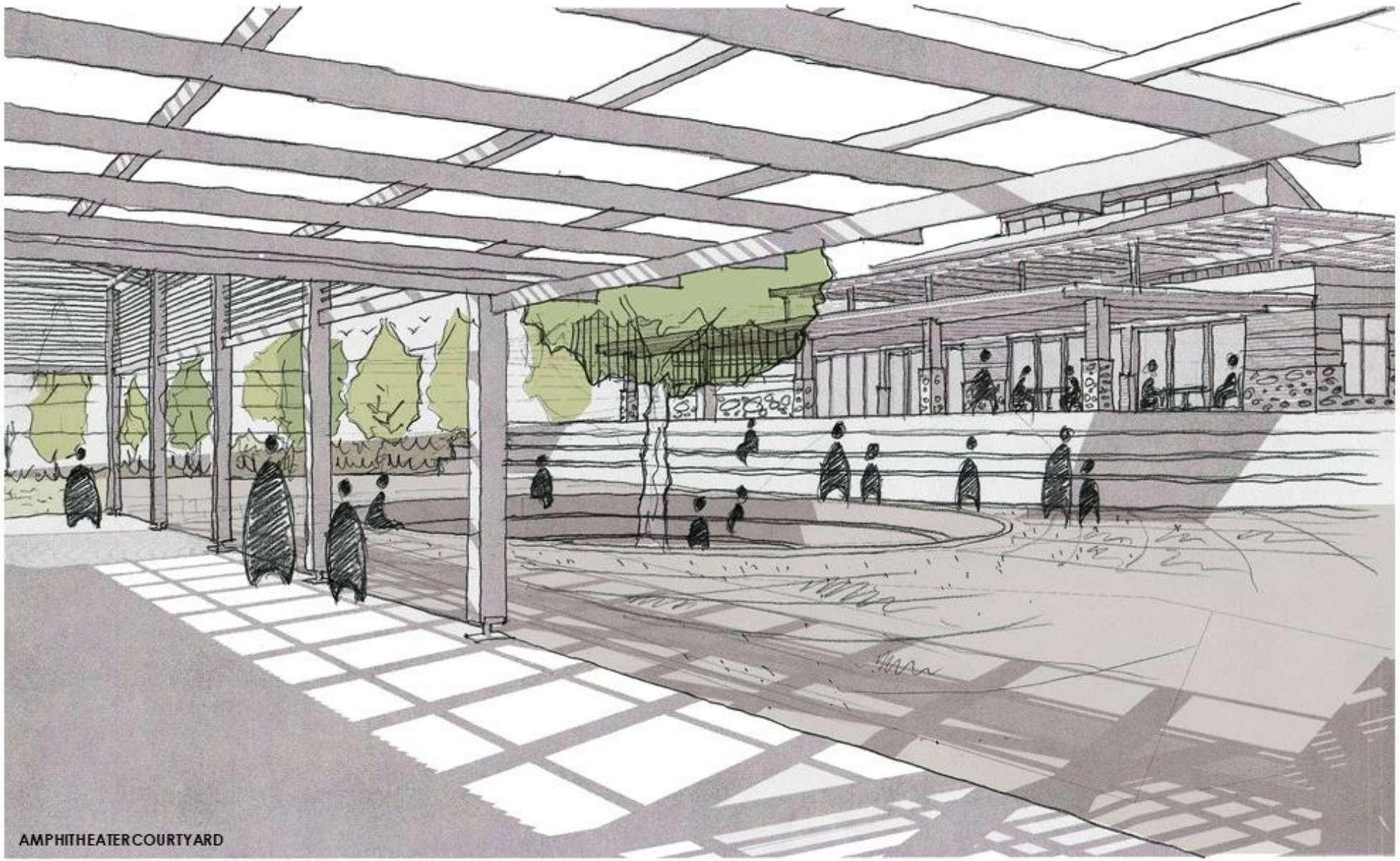
AERIAL VIEW 1



AERIAL VIEW 2



ASSEMBLY COURTYARD


AMPHITHEATER COURTYARD

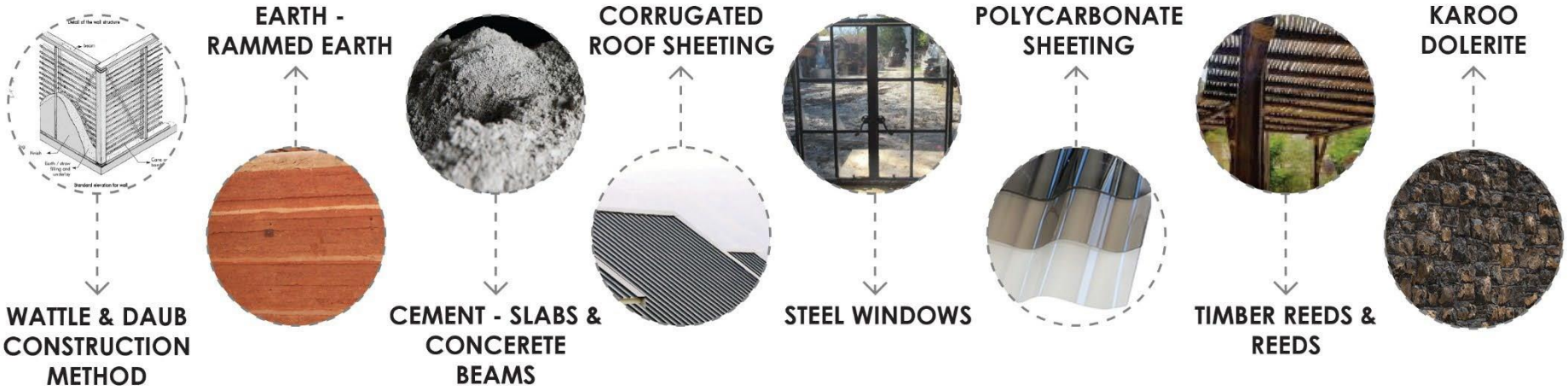
10 TECHNICAL SYSTEMS

10.1 Building materials chosen

The construction approach is to make use of locally sourced natural materials and indigenious/traditional building methods that are based on a sustainable approach that also greatly involves the assistance & participation (in construction) of the community.

The approach is to use Wattle & Daub as a building method for a portion of the development, this will apply to mostly to the building typology of the Classrooms (Educational aspect) of the complex entity. This indigenuous building method is relevant to the rural context of Keiskammahoek, as some of the residential buildings are constructed by the use of this method.

Rammed earth stabilised with lime, also a natural (sustainable) building material which will be used in the construction process of the majority of the buildings part of the development. Karoo Dolerite is found in the area and will be used to construct building plinths and ascladding for feature walls. Time reeds a posts are also accessible from the Keiskammahoek natural environment, polycarbonate sheeting to be used to allow natural light to penetrate the buildings at Clerestorey level and also cover the walkways. The community will be involved in the whole construction process of the development, from skilled artisans to inexperienced community members, to give the development a communal identity and significance.



10.2 Precedent studies - building methods & materials

The following precedent studies have assisted me in the design development stage and also in making pivotal logical design decisions based on their influence, the problems they solve and principles they possess.





(African Home for the JoreJick family) - Shane Kemp

Selected characteristcs:
- Radically simple design.
- Sustainable principles, energy harvesting.
- Use of locally sourced & sustainable materials, stone, earth, timber.





(Stone, Wattle & Daub House - Ichuta)

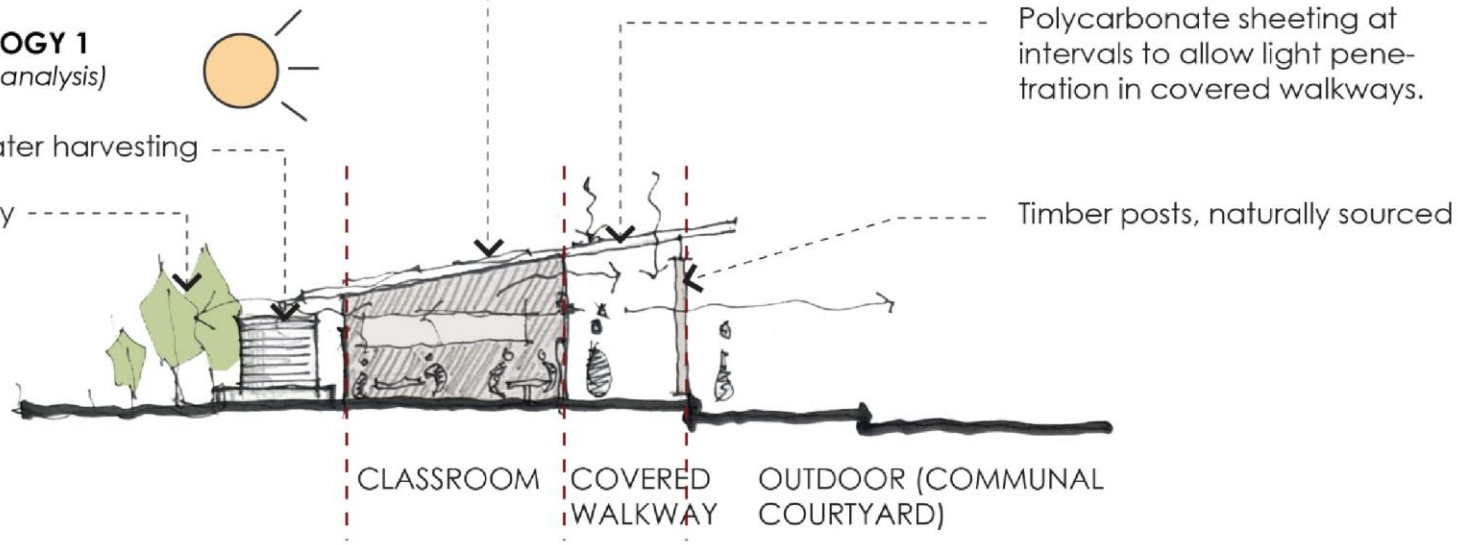
Selected characteristcs:
- Use of natural materials, stone, earth, timber.
- Wattle & Daub construction.
- Stone plinth, structural & aesthetical component.

Technical systems (Classroom design)

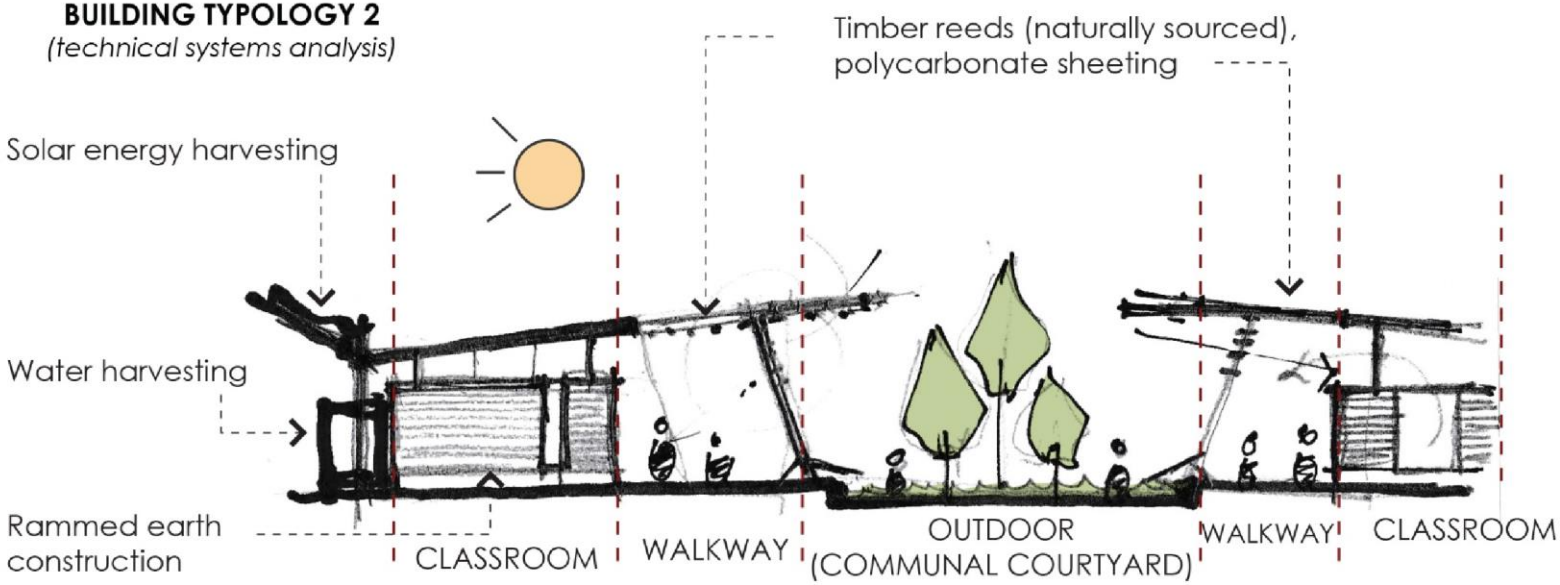
The following conceptual diagrams/sketches are explorations of a building typology that is inspired by the existing typologies discovered in the context of Keiskammahoek. They are representations of the different building types that the scheme comprises of, mostly a representation of the classroom typologies being explored. Sustainable principles such as water and energy harvesting, space conditioning and passive design are explored through these diagrams.

10.3 Classroom technical systems

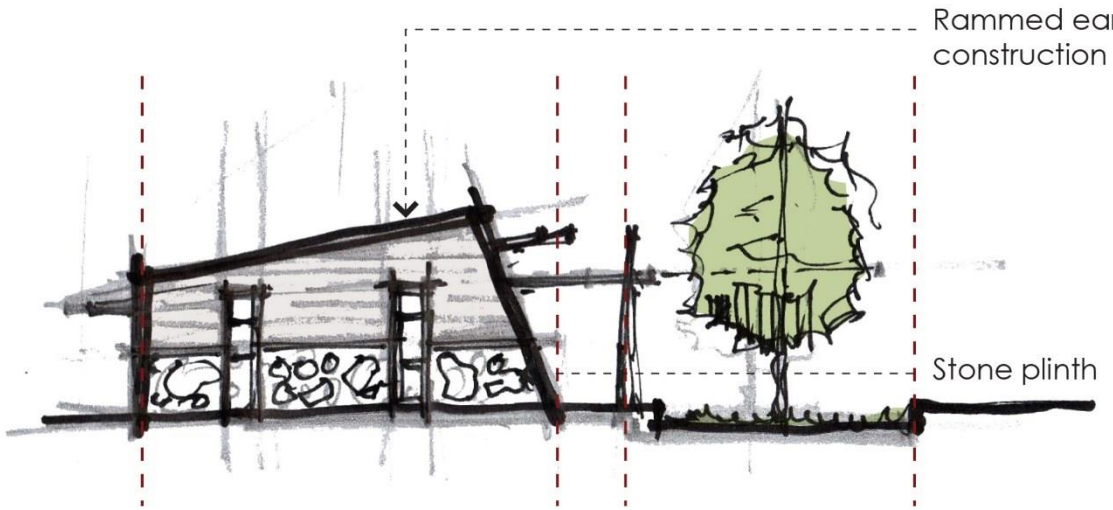
BUILDING TYPOLOGY 1
(technical systems analysis)



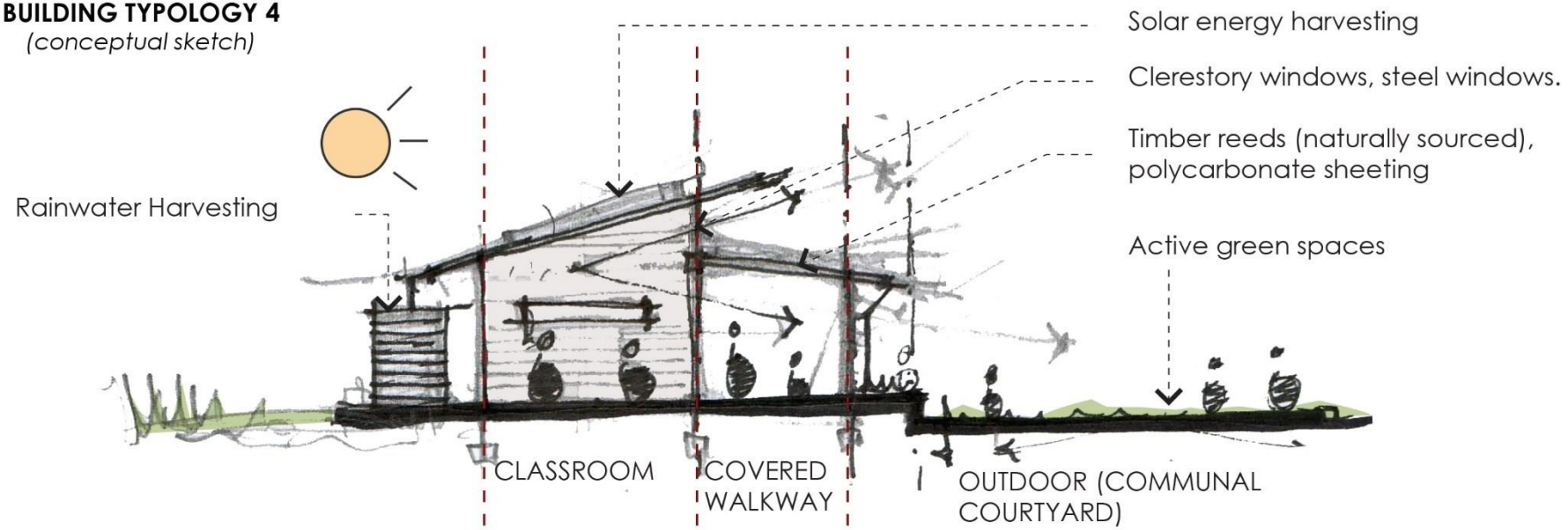
BUILDING TYPOLOGY 2
(technical systems analysis)



BUILDING TYPOLOGY 3
(technical systems analysis)



BUILDING TYPOLOGY 4
(conceptual sketch)

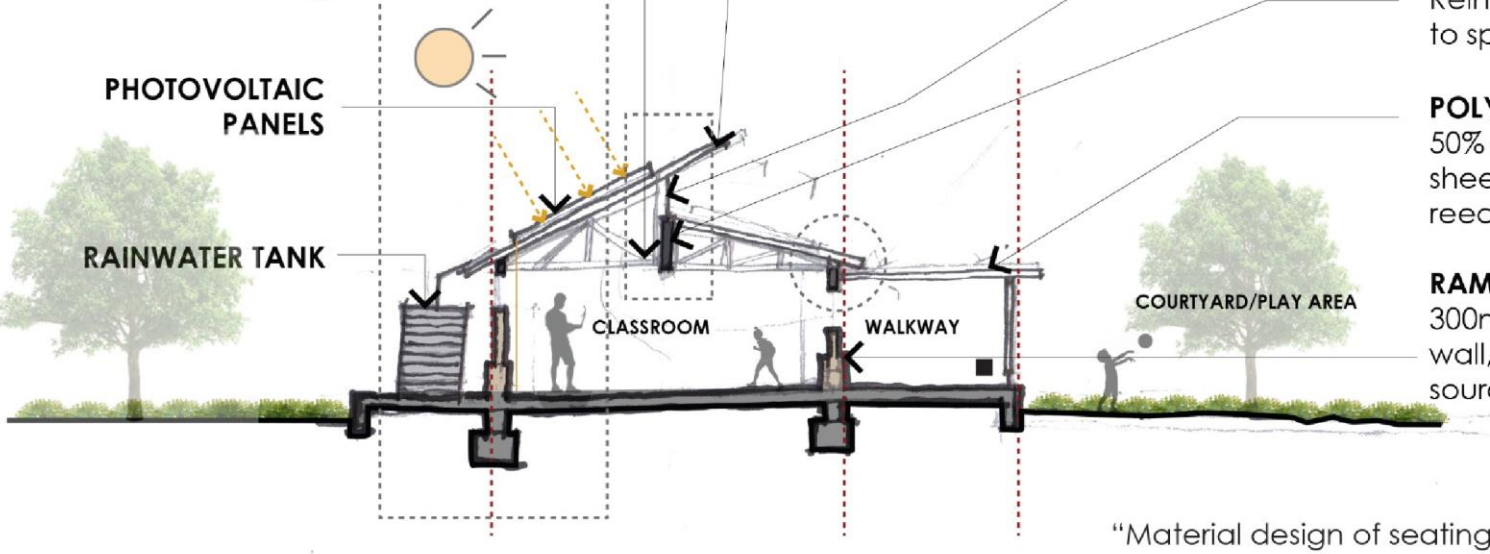


BUILDING TYPOLOGY 5
(technical systems analysis)

EXPOSED TIMBER ROOF TRUSSES
Exposed timber roof trusses with insulation and ceiling cladding

PHOTOVOLTAIC PANELS

RAINWATER TANK



ROOF SHEETING
Corrugated aluminium roof sheeting

CLERESTOREY WINDOW
Opal Polycarbonate clerestorey window

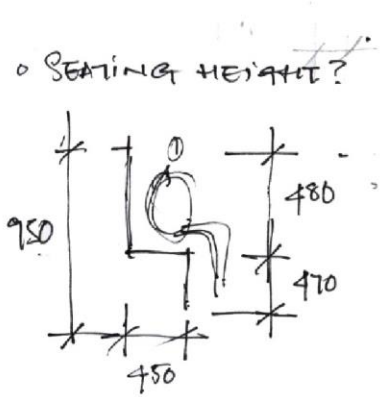
CONCRETE BEAM
Reinforced concrete beam to span from wall to wall

POLYCARBONATE SHEETING
50% Opal polycarbonate sheeting, fixe4d onto timber reeds.

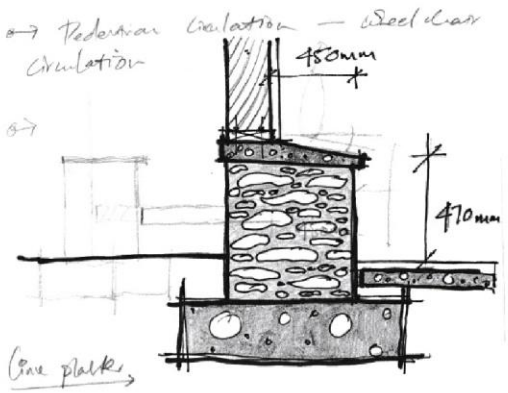
RAMMED EARTH WALL
300mm thick rammed earth wall, cladded with locally sourced Karroo Dolerite stone

GESTURES CONSIDERED
(conceptual sketch)

"Stone plinth also acting as a seating area for learners & teachers"



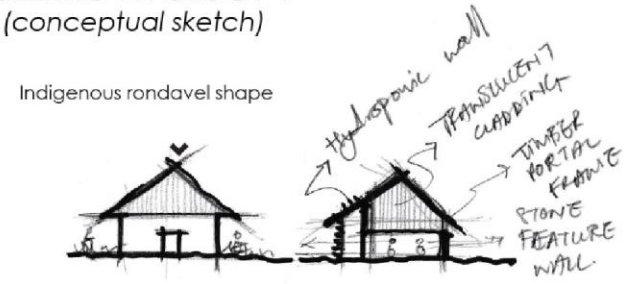
"Material design of seating area"



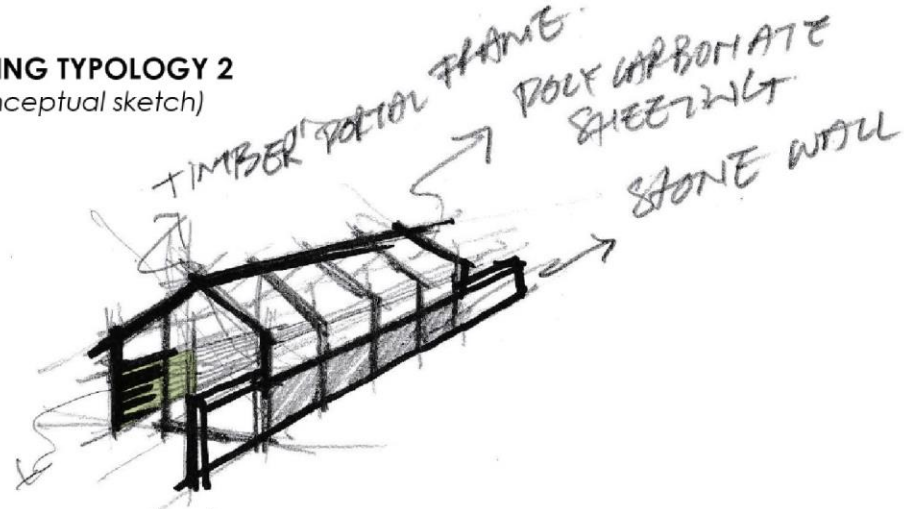
10.4 Produce Greenhouse technical systems

The following conceptual diagrams/sketches are explorations of a building typology for the produce greenhouse, it is greatly inspired by sustainable local materials i.e Dolerite stone wall that can is man made and acts as a feature wall, but also doubles as a seating area for tourists, locals, users of the scheme.

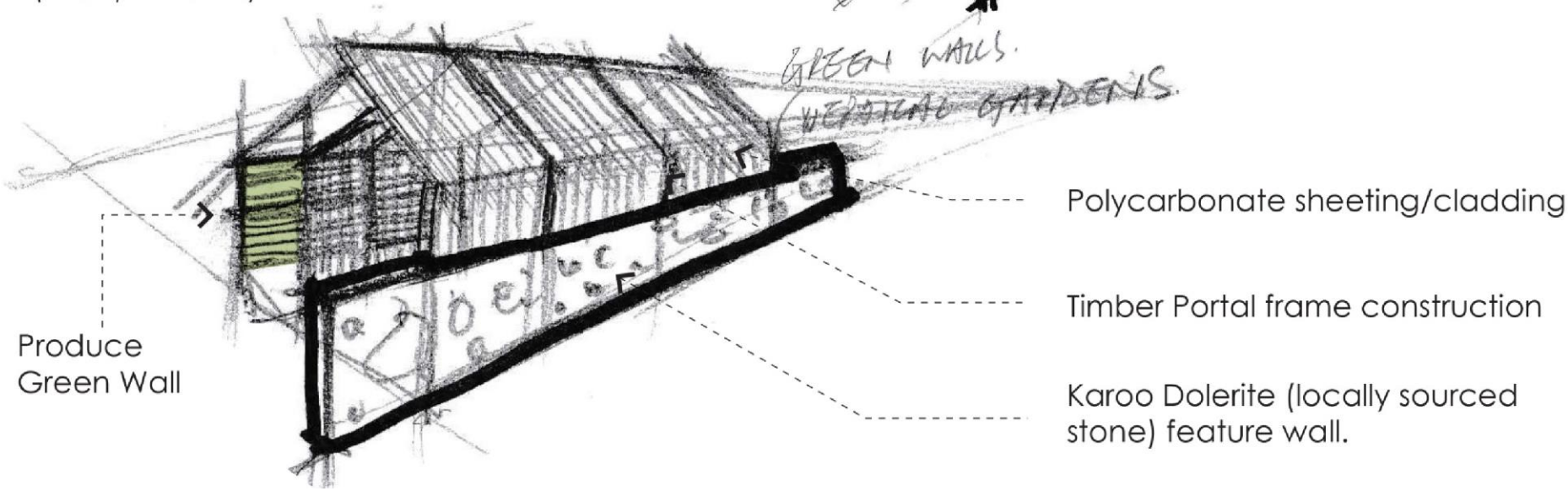
BUILDING TYPOLOGY 1
(conceptual sketch)



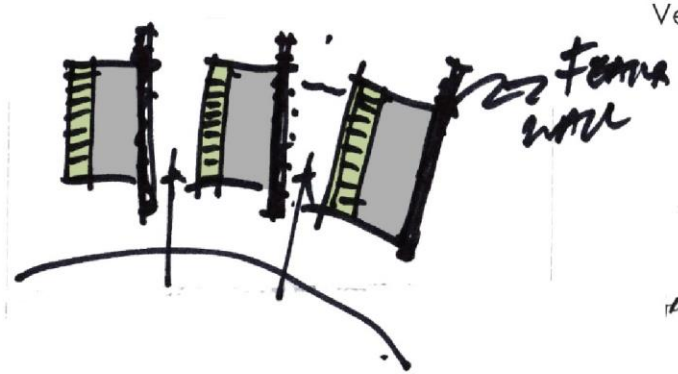
BUILDING TYPOLOGY 2
(conceptual sketch)



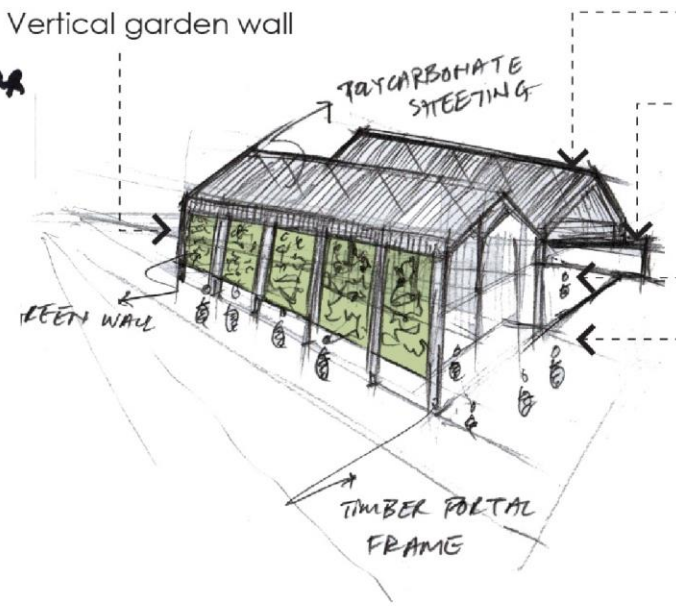
BUILDING TYPOLOGY 3
(conceptual sketch)



"Floor plan arrangement of Produce greenhouse(s) & manufacturing area"



BUILDING TYPOLOGY 4
(technical systems analysis)

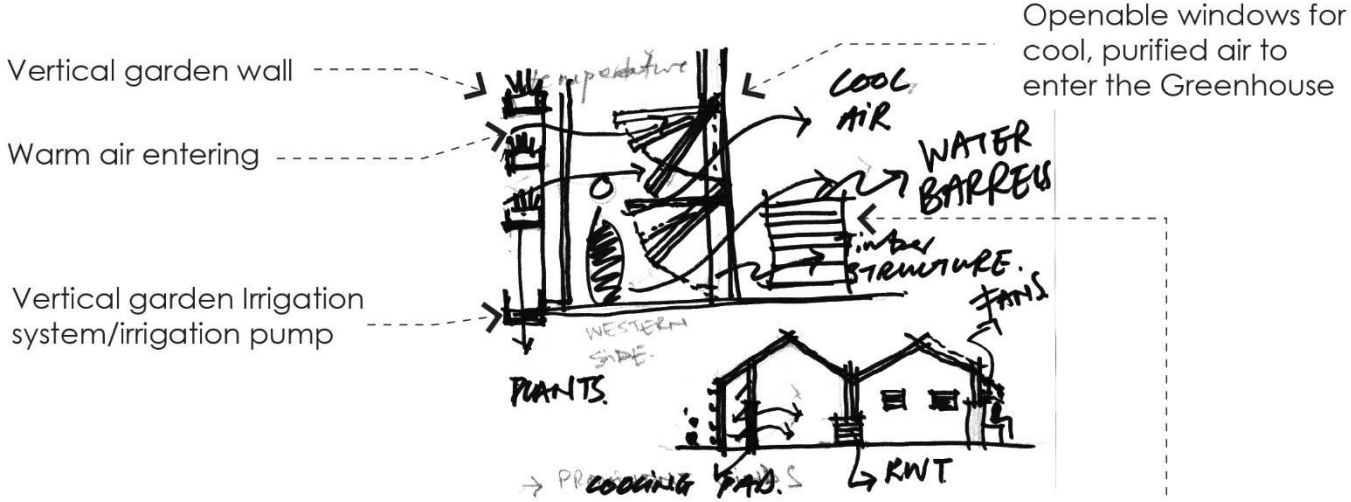


SYSTEMS EXPLORATION
(conceptual sketch)

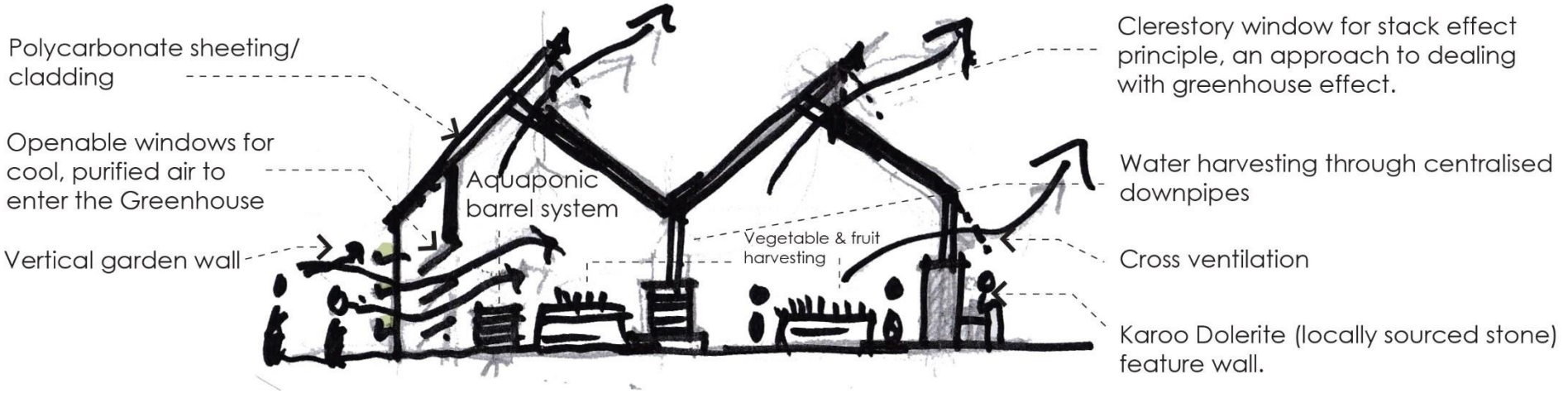


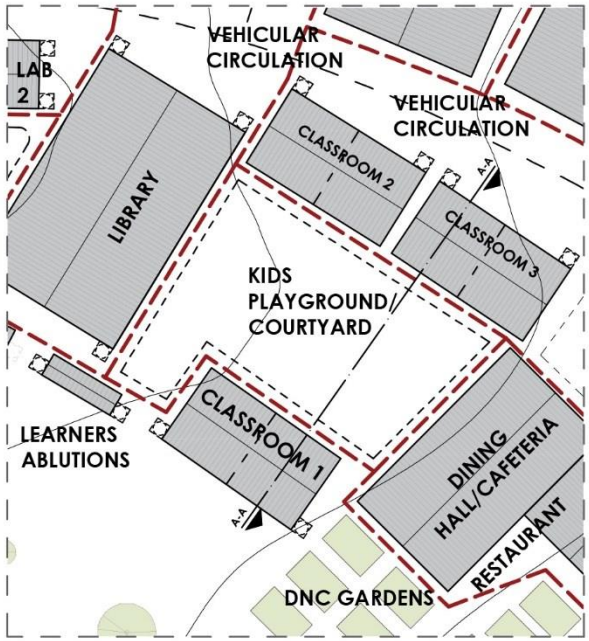


"How to keep the indoor temperature controlled?"

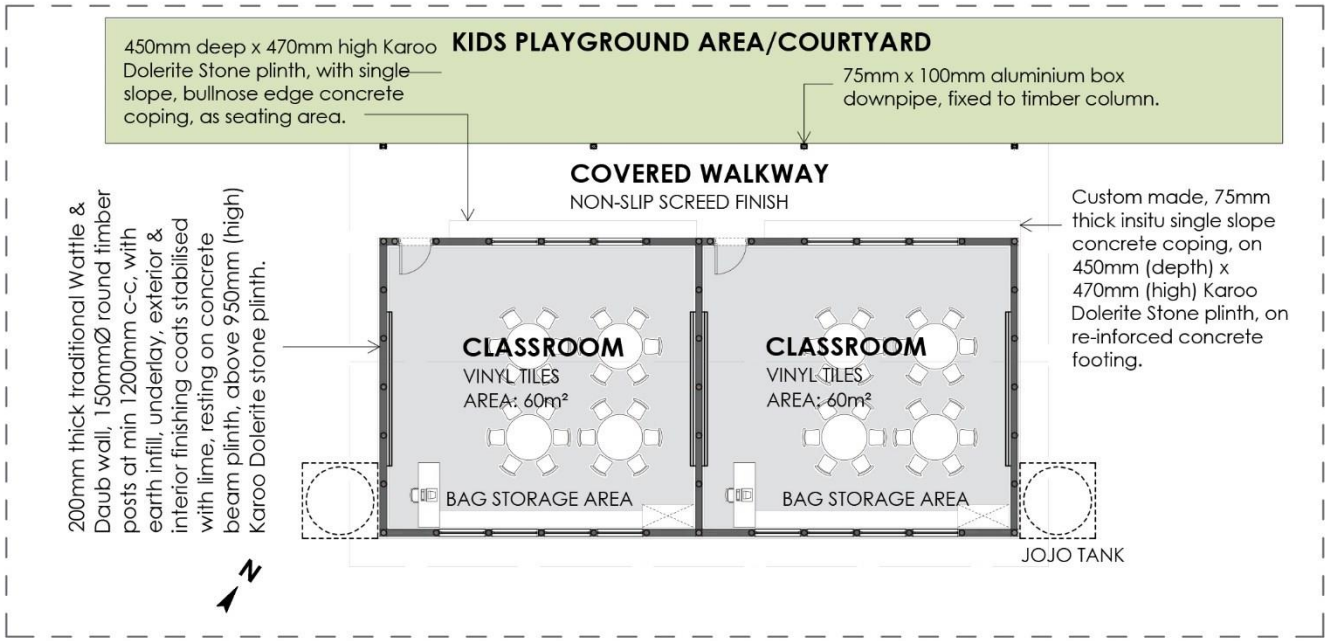


TECHNICAL SYSTEMS EXPLORATION
(conceptual sketch)

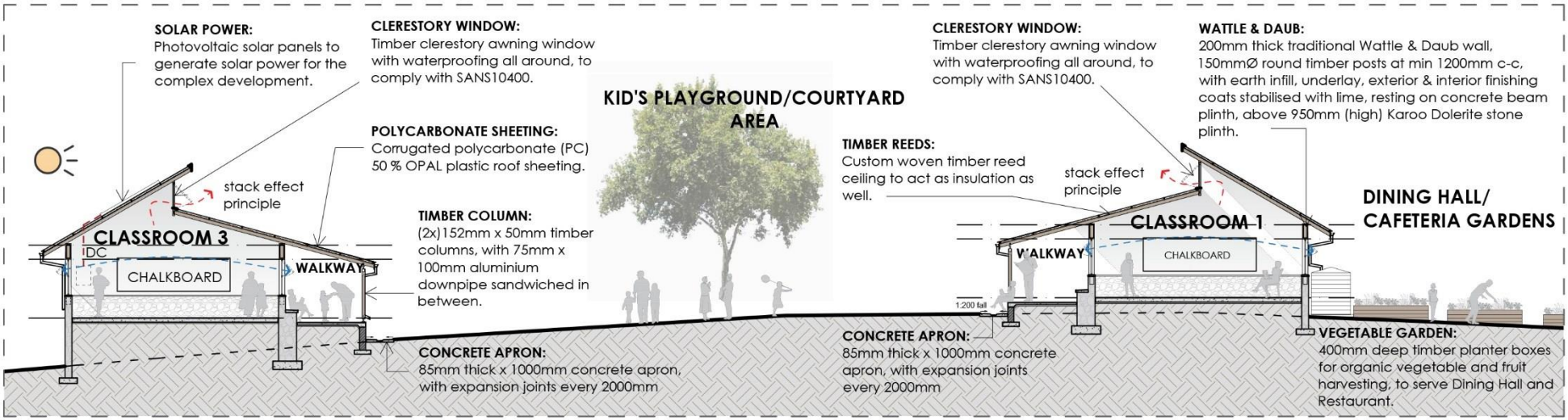




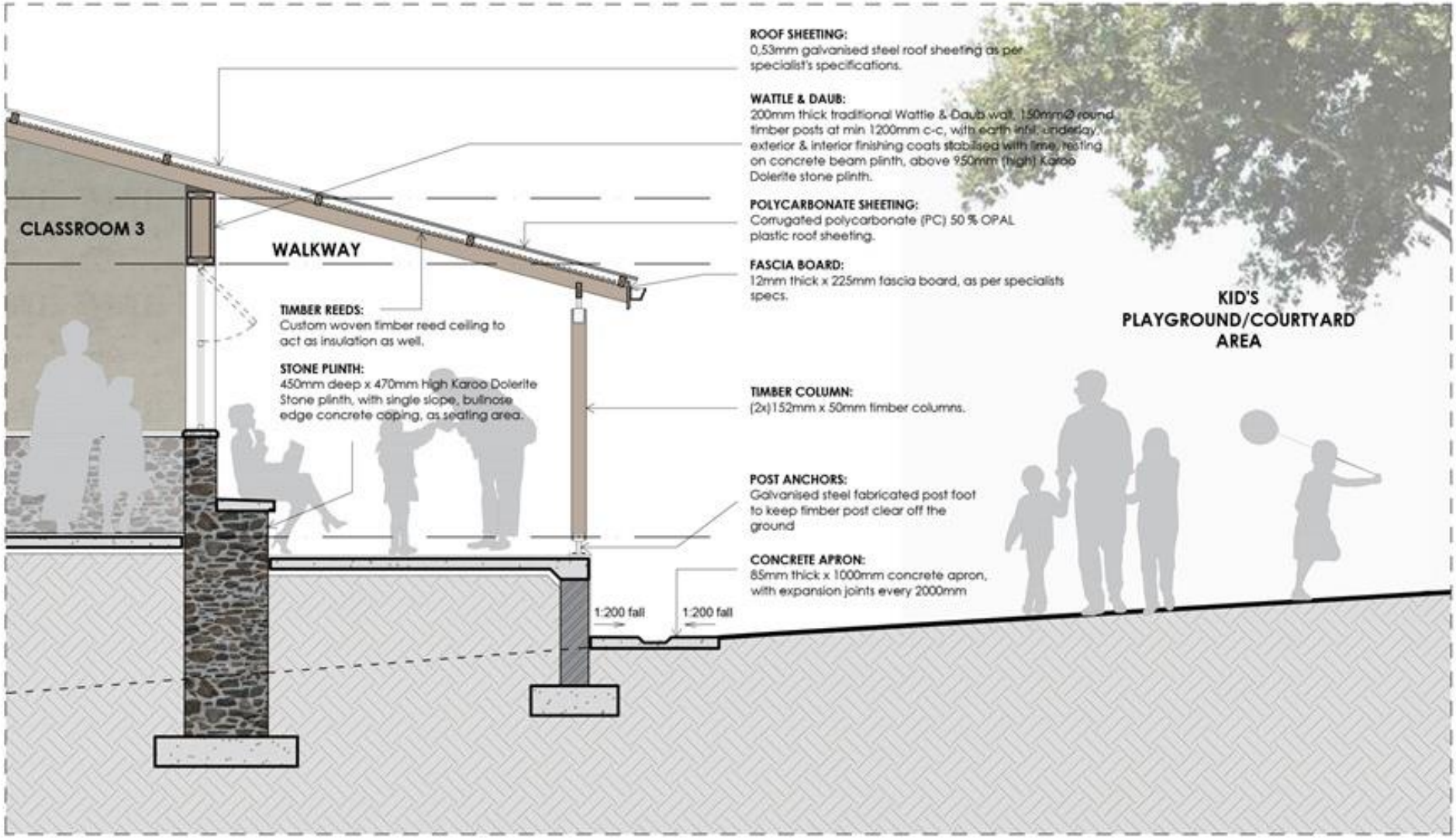
REFERENCE SITE PLAN 1:1000



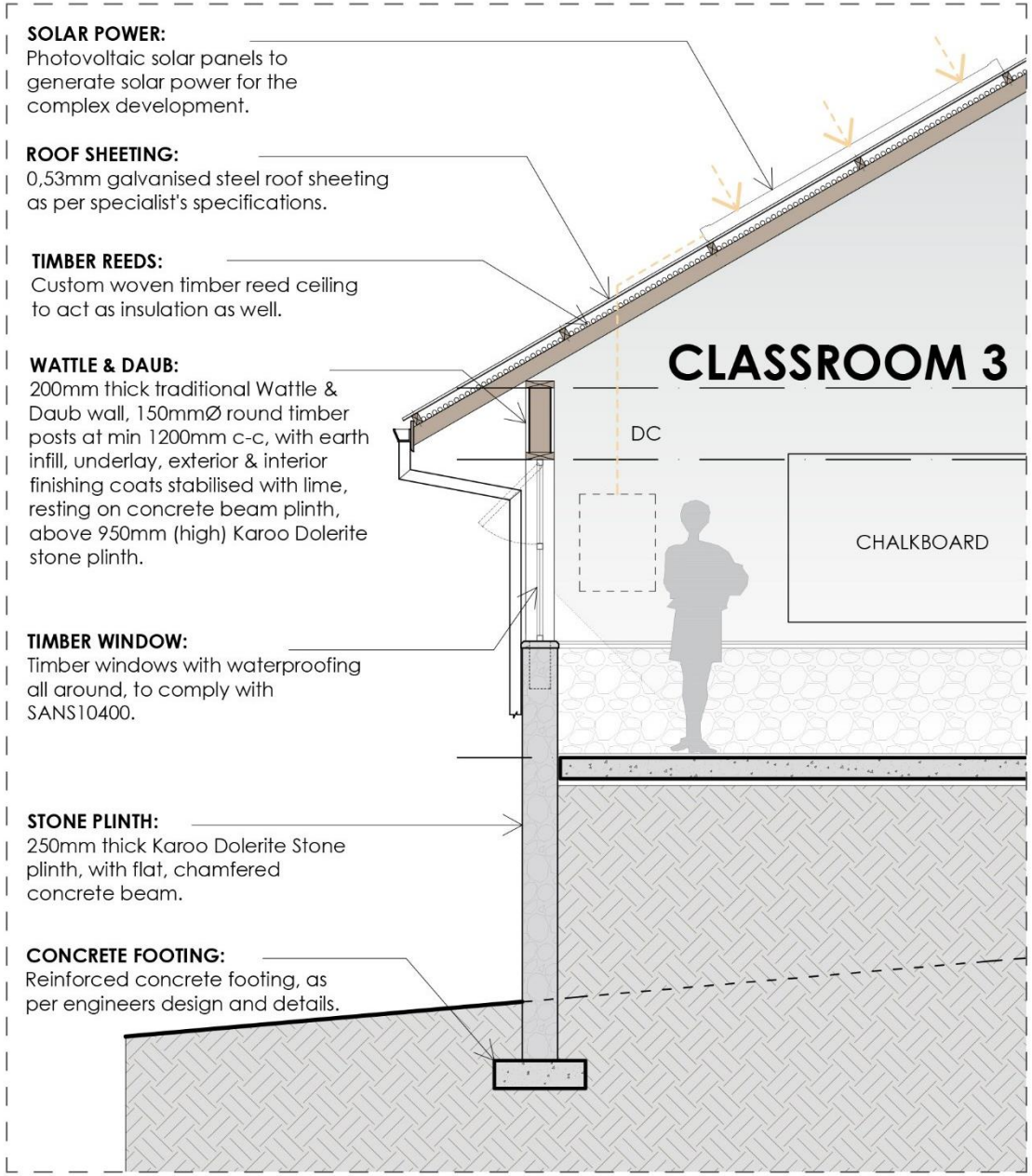
CLASSROOM 1 - FLOOR PLAN 1:200



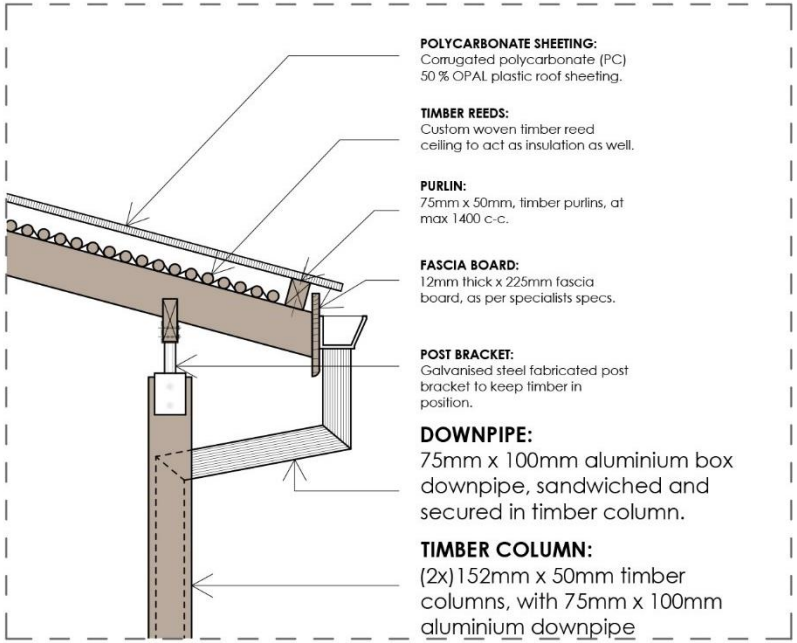
CLASSROOM 1 - SECTION A-A 1:200



PARTWALL SECTION 1 - 1:50



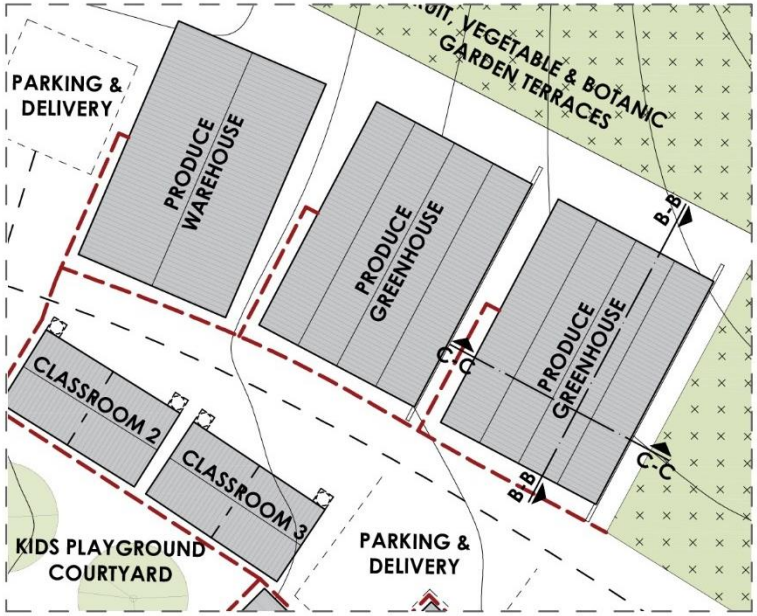
PARTWALL SECTION 2 - 1:50



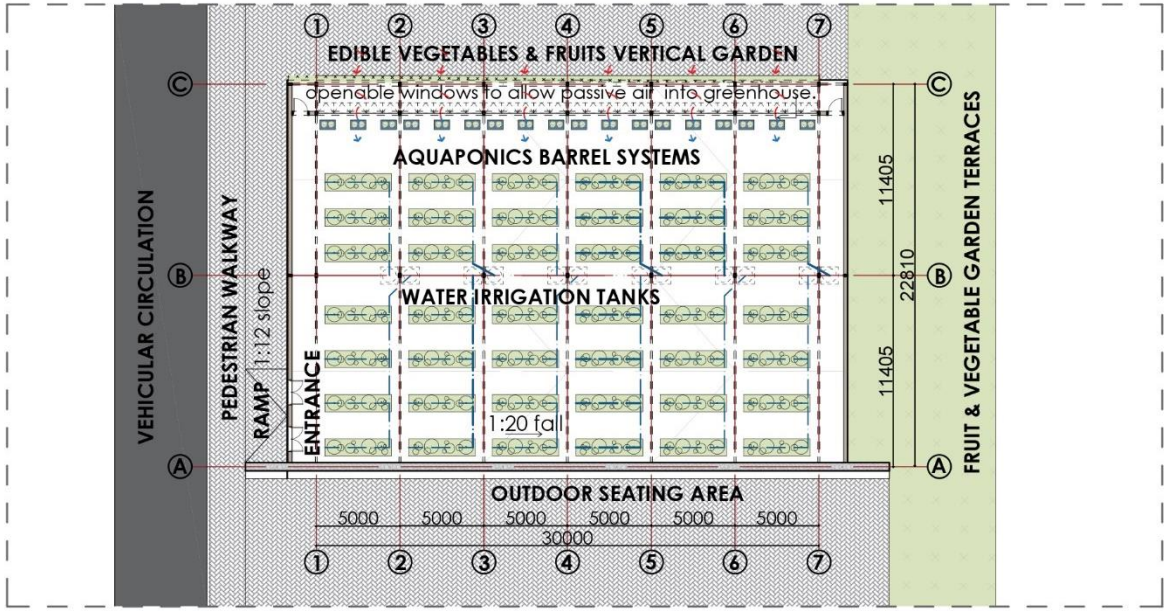
DETAIL 1 - ROOF OVERHANG - 1:20



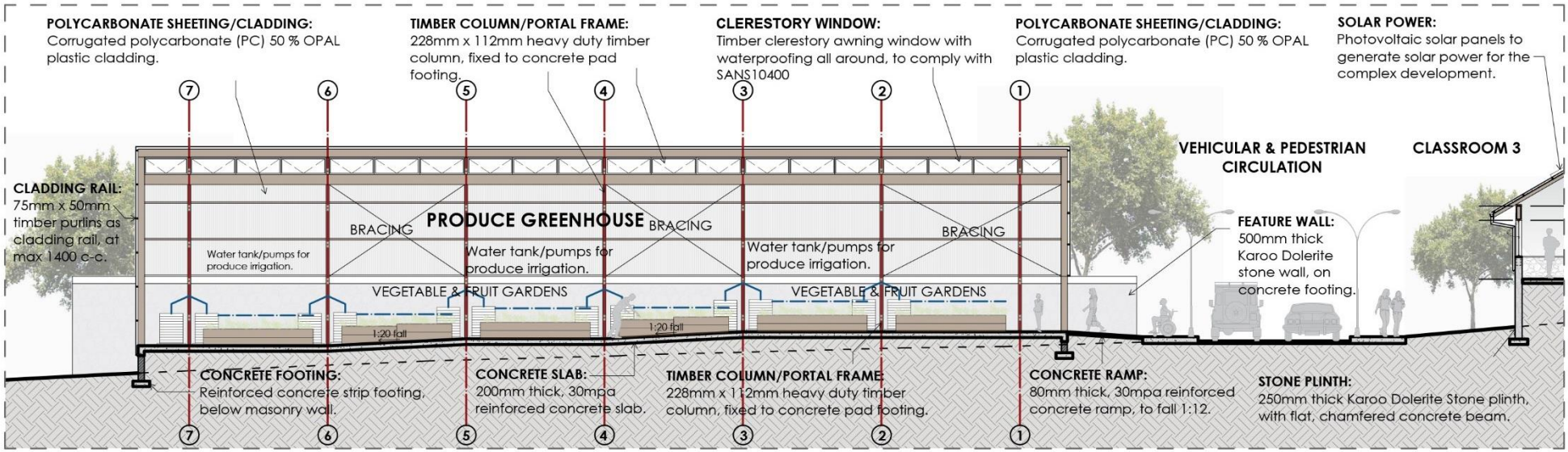
3D PART SECTION



REFERENCE SITE PLAN - 1:1000



PRODUCE GREENHOUSE FLOOR PLAN - 1:500



SECTION B-B - 1:200



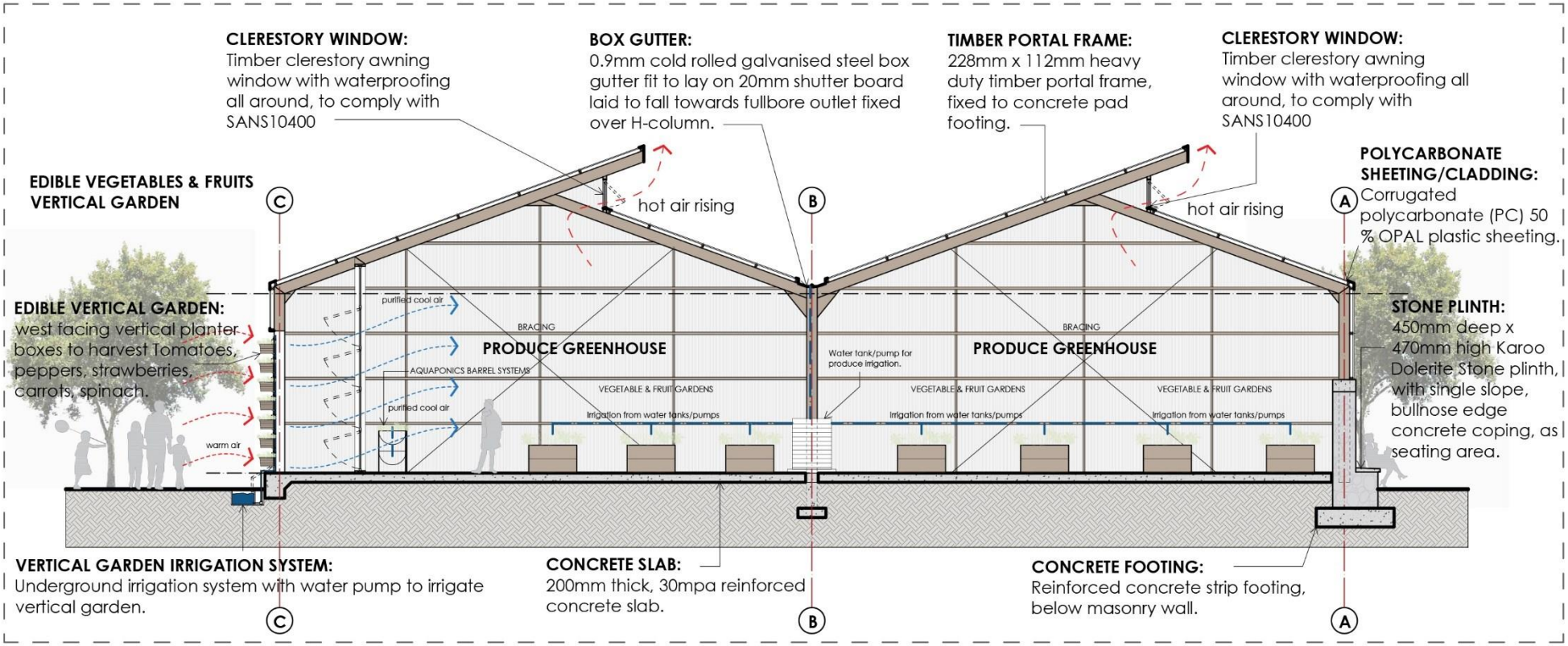
3D VIEW 01 - VERTICAL GARDEN



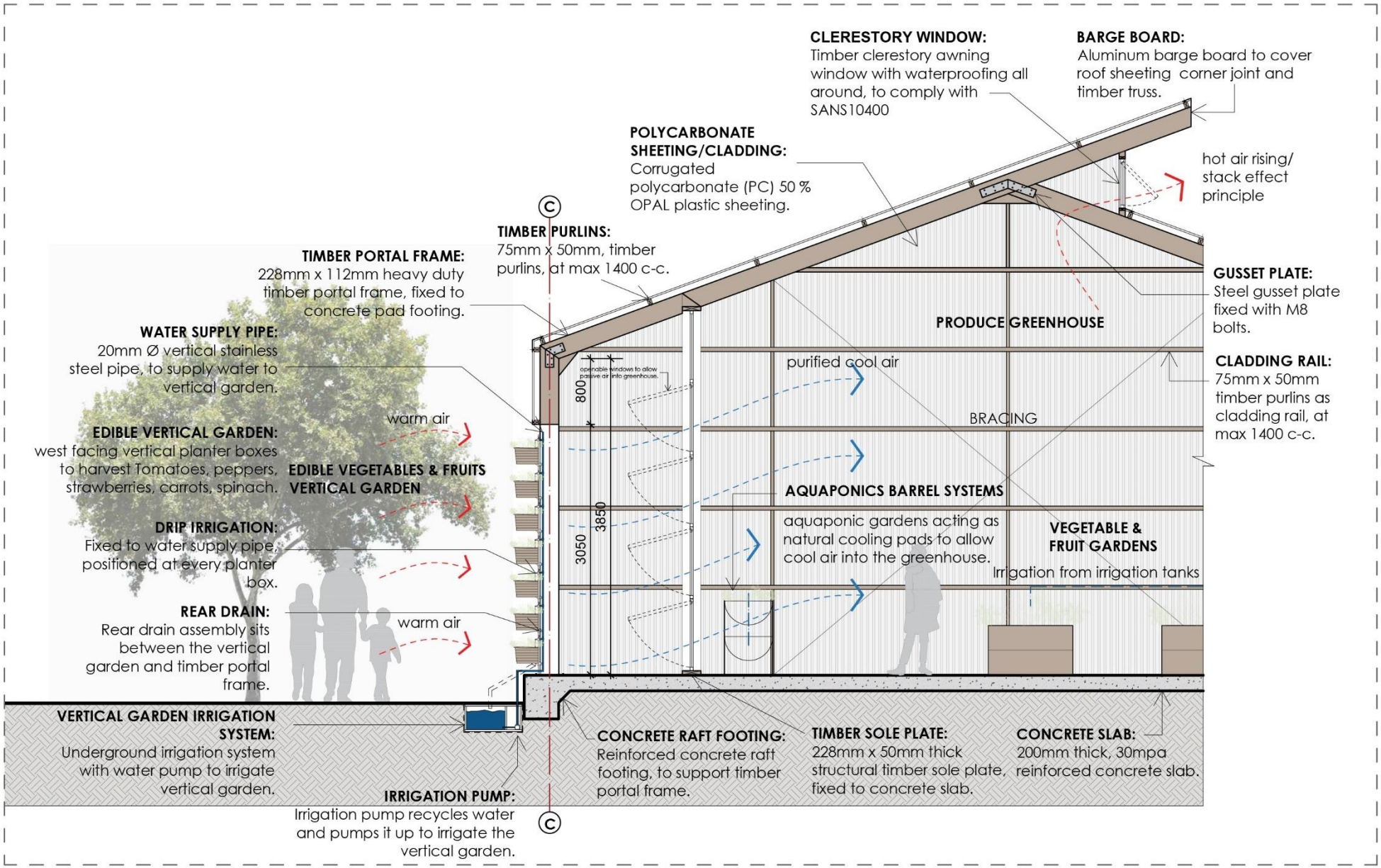
3D VIEW 02 - GREENHOUSE ENTRANCE



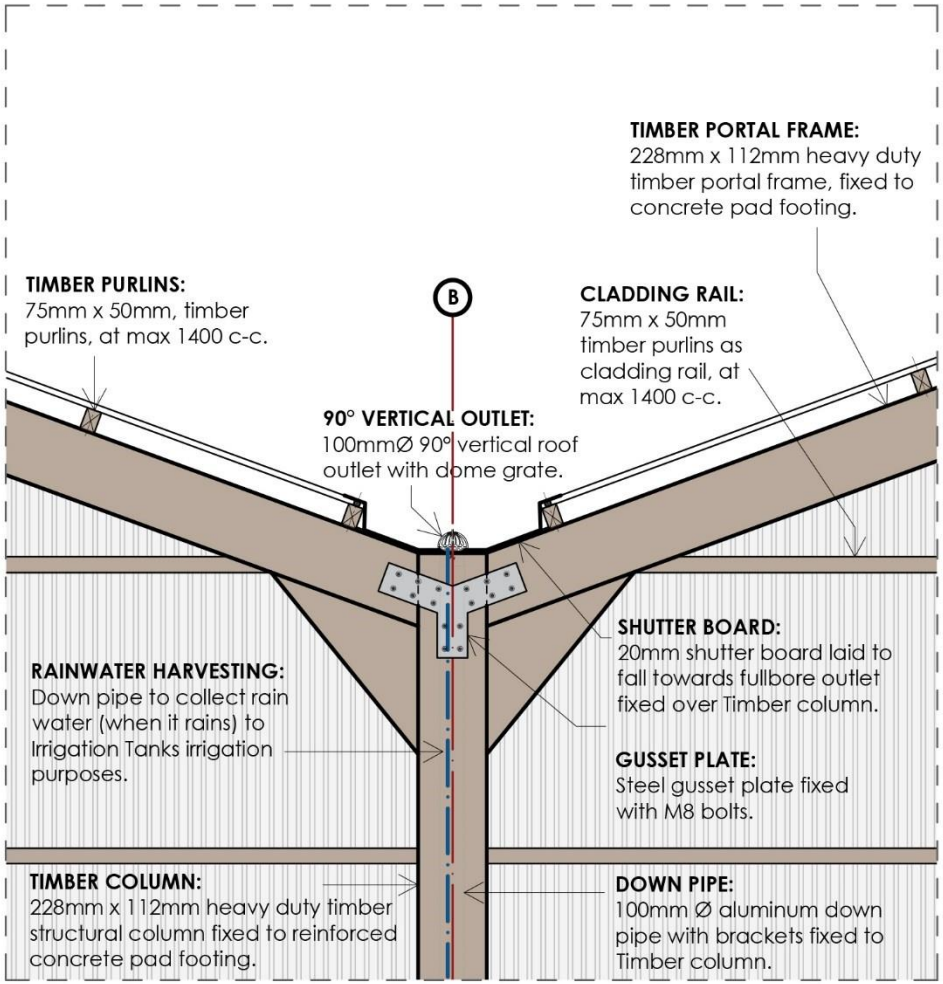
3D VIEW 03 - VEGETABLES & FRUIT GARDENS



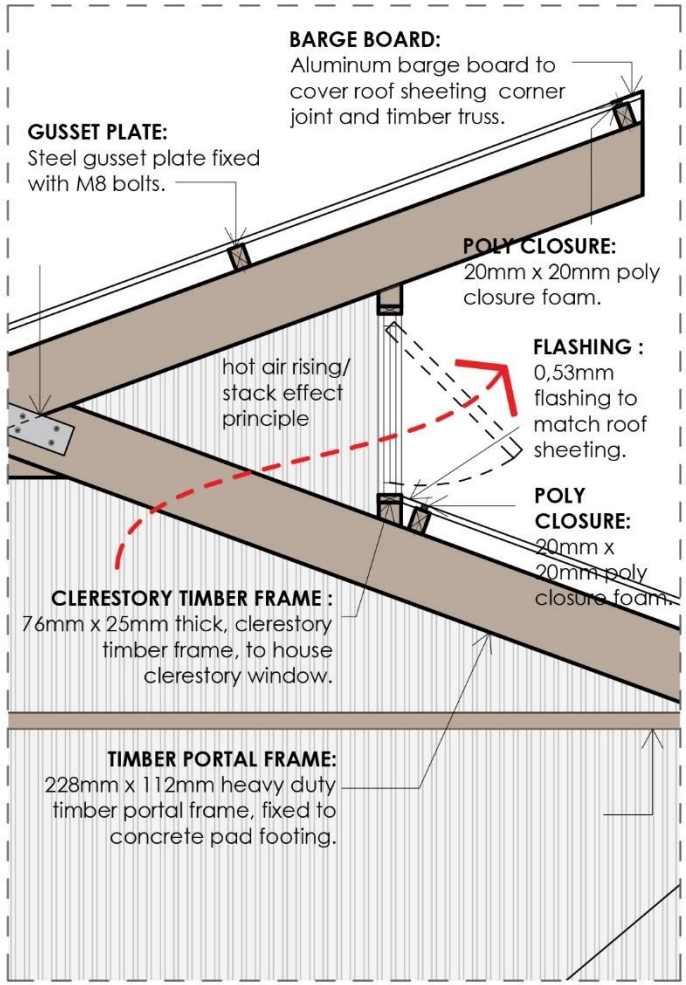
SECTION C-C - 1:100



PARTWALL SECTION 3 - 1:50



DETAIL 2 - 1:25



DETAIL 3 - 1:25

REFERENCES

Agyare-kwabi, P. 2003. Women and Food Security in West Africa, a paper presented at a seminar on Women, Integrated Farming Systems and Food Security in West Africa, held in Accra 25-28 November 2003, pp. 17

Altieri, M. 1987. Agroecology: The Scientific Basis of Alternative Agriculture. Westview Press, Boulder, Colorado.

Arch Daily. 2018. BIG Design Yi-Yang Shaped Panda enclosure for the Copenhagen Zoo. [ONLINE] Available at: https://www.archdaily.com/867991/bigs-design-yin-yang-shaped-panda-enclosure-for-the-copenhagenzoo?ad_medium=gallery. [Accessed 29 May 2020].

Arch Daily. 2020. Rural House #01/ Cristobal Vial Arquitectos. [ONLINE] Available at: https://www.archdaily.com?936503/rural-house-number-01-cristobal-vial-arquitectos?ad_medium=gallery. [Accessed 29 May 2020].

Arch Daily. 2020. InsideOut School/ Andrea Tabocchini & Francesca Vittorini. [ONLINE] Available at: https://www.archdaily.com/882665/insideout-school-andrea-tabocchini-andfransesca-vittorini. [Accessed 29 May 2020].

Arch Daily. 2018. Rural School Alto Mercado / Ana Elvira Velez + Juan B. Echeverri. [ONLINE] Available at: https://www.archdaily.com/893907/rural-school-alto-del-mercado-ana-elvira-velez-plus-juan-b-echeverri. [Accessed 29 May 2020].

Cohen and Garson Architects. 2000. Nelson Mandela Museum, Umtata, Qunu, Mvezo, Eastern Cape, SA 2000. [ONLINE] Available at: https://www.cohengarson.co.za/mandela-museum. [Accessed 29 May 2020].

E. Kadzamira, P. Rose. Can free primary education meet the needs of the poor? Evidence from Malawi. In: International Journal of Educational Development, 23, 5, 501-516. 2003

Engle, L. M. & Altoveros, N.C. Eds (2000). Collection, Conservation, and utilization of indigenous vegetables. Proceedings of a workshop. Asian vegetable Research and Development Centre: Tainan, Taiwan.

Falkernmark M, Rockström J & Karlberg L, 2009. Present and future water requirements for feeding humanity. Food security 1: 59-69.

Famine Early Warning System Network. Malawi food security outlook. October 2008 to March 2009. [ONLINE] Available at: http://www.fews.net/sites/default/files/documents/reports/Malawi_outlook_2008_10.pdf [Accessed 5 June 2020]

Famine Early Warning System Network. Malawi. Food security outlook update. Assistance is off to a slow start in some districts due to logistical challenges. [ONLINE] Available at: http://www.fews.net/southern-africa/malawi/food-securityoutlook-update/sat-2013-11-30 [Accessed 6 June].

FAO 1995. Planning for Sustainable use of land resources: Towards a new approach. [ONLINE] Available at: http://www.fao.org/docrep/Y8047EDD.htm [Accessed 4 June 2020].

FAO 1996. Food Security, Policy brief. World Food Summit. [ONLINE] Available at: http://www.fao.org/es/esa/policybriefs/pb-02.pdf [Accessed 4 June 2020].

FAO. 1998. Non-Wood Forest Products of Lesotho. Rome: FAO.

FAO, WFP, IFAD. The state of food insecurity in the world. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. FAO, Rome. 2012.

Feed the Future. Fact sheet: feed the future. [ONLINE] Available at: http://www.feedthefuture.gov/ [Accessed 5 June 2020].

Flavier, J. M., De Jesus, A. & Mavarro, S. (1995). "*The regional program for the promotion of indigenous knowledge in Asia*". Pp. 479-489 In Warren, D., L. J. Slikkerveer and D. Brokensha (eds.). The cultural dimension of development: Indigenous Knowledge Systems. London: Intermediate Technology Publications.

Google maps. 2020. Keiskammahoek – Google Maps/ [ONLINE] Available at: https://www.google.com/maps/place/Keiskammahoek,+5670/@-32.6835183,27.1200978,14z/data=32.6848602!4d27.1323579. [Accessed 9 February 2020].

Govinden, N. 1984. *Intercropping in the tropics: advantages and relevance to the small farmer.* Canadian Journal of Development Studies 5: 213-232.

Holt-Gimenez E, 2002. Measuring farmers' agroecological resistance after Hurricane Mitch in Nicaragua: a case study in participatory, sustainable land management impact monitoring. Agriculture, Ecosystems & Environment 93: 87-105.

Innis, D. 1980. *The future of traditional agriculture*. Focus 30(3): 1-8.

Lobell DB, 2009. Climate Extremes and Crop Adaptation. Summary statement from a meeting at the program on Food Security and Environment, Stanford, CA, held on June 16-18, 2009. [ONLINE] Available at: http://foodsecurity.stanford.edu/publications/climate_extremes_and_crop_adaptation/.

Makumba W, Janssen B, Oenema O, Akinnifesi FK, Mweta D & Kwesiga F, 2006. The long-term effects of the gliricidiamaize intercropping system in Southern Malawi, on gliricidia and maize yields, and soil properties. Agriculture, Ecosystems & Environment 116: 85-92.

McGranaham, G. et al (1999). *Environmental Change and Human Health in Countries of Africa, the Caribbean and the Pacific,* Stockholm Environment Institute, Stockholm, pp. 215.

Mertz, O., Lykke, A., and Reenberg, A. 2001. *Importance and seasonality of vegetable Consumption and marketing in Burkina Faso.* Economic Botany Vol.55 No.2, pp. 276-289.

Ministry of Agriculture, (1995). *Lesotho: Country Report to the FAO International Technical Conference on Plant Genetic Resources*, Leipzig, Germany.

Ministry of Education, (2007) Science and technology, MoEST, National Education Sector Plan 2007 – 2016. A statement, Lilongwe, Malawi.

Mnzava, A. N. And Chweya, J. A. 1997. *Promoting the conservation and use of underutilized and neglected crops II*. [ONLINE] Available at: http://pdf.usaid.gov/pdf-docs/PNACH.878.pdf [Accessed 7 June 2020].

Ministry of Agriculture and Food Security, (2008), MoAFS, Food Security Action Plan 2008, Lilongwe, Malawi.

Mountain, Edgar D, 1952. A Botanical Survey of the Keiskammahoek District, (Summary of a Botanical Survey Memoir No.27).
Keiskammahoek Rural Survey, The Natural History of the Keiskammahoek District, Volume 1, pp. 1-55.)

Nelleman C, Macdevette M, Manders T, Eickhout B, Svihus B, Prins AG & Kaltenborn BP, 2009. The environment food crisis – The environment's role in averting future food crises. A UNEP rapid response assessment. United Nations Environment Programme, GRID-Arendal, www.grida.no.

Notsi, L., 2012. African indigenous Farming methods used in the cultivation of African Indigenous vegetables. *African Indigenous Farming methods used in the cultivation of African Indigenous vegetables: A comparative study of Tsitas Nek (Lesotho) and Mabeskraal Village (South Africa),* Vol.1, 1 -19.

P. Moyi. Household characteristics and delayed school enrolment in Malawi. In: International Journal of Educational Development 30, 3, 236-242. 2010.

Reyes Tirado, Janet Cotter., 2010. Ecological farming. *Ecological farming: Drought-resistant agriculture, campaigning for sustainable agriculture,* GRL-TN, 1 – 16

Rutatora, D. F. And mattee, A. Z. 2000. Towards a farmer-centered extension service: The case of Uluguru Mountain Agricultural development Project (UMADEP) morogoro, Tanzania. [ONLINE] Available at: http://www.ajol.info/index.php/sajae/article/viewfile/3621/11602. [Accessed 7 June 2020].

S. Engler. Food (in)security and famine – Understanding the interconnection of vulnerability, perception of affected populations, and their adaptation capacities in times of food scarcity. Dissertation Zur Erlangung des Doktorgrades, Justus-Liebig-Universität Gießen, 2013.

S. Engler. Developing a historically based Famine Vulnerability Analysis Model (FVAM) – An interdisciplinary approach. In: Erdkunde – Archive for Scientific Geography, 66, 2, pp. 157-172. 2012.

S. Engler. Hungersnot – Bekannte Theorien und neue Analysemodelle. In: D. Collect, A. Schanbacher, T. Lassen (eds.): Handelin in Hungerkrisen. Neue Perspektiven auf soziale und klimatische Vulnerbalität. Universitätsverlag Göttingen, Göttingen, 67-83. 2012.

S. Makombe, P. Lewin., M. Fisher. The determinants of food insecurity in rural Malawi: implications for agricultural policy. In: IFPRI Policy Note, 4, 1-4. 2010.

Stats SA. 2011. Census 2011. [ONLINE] Available at: http://www.statssa.gov.za/?page_id=3839. [Accessed 9 February 2020].

T3 Architects. 2018. Eco Farm & Educative Park in Vietnam. [ONLINE] Available at: https://t3architects.com/tcportfolio/ecofarm-vietnam-green-building-saigon/. [Accessed 29 May 2020].

Vincent Ralph, Koanne Bentley, Anthony P. Dold, Vathiswa Zikishe, Nigel P. Barker, 2016. *The rediscovery of the Great Winterberg endemic Lotononis harveyi B. -E.van Wyk after 147 years, and notes on the poorly known Amathole endemic Macowania revoluta Oliv. (southern Great Escarpment, South Africa), PhytoKeys: 62, pp. 113 – 124.)*

Warren, D. M. 1991. Using indigenous knowledge for Agricultural Development. World Bank. Discussion Paper 127, Washington, DC: World Bank

Wikipedia. 2020. Keiskammahoek. [ONLINE] Available at: https://en.wikipedia.org/wiki/Keiskammahoek. [Accessed 9 February 2020].

WSFS, Declaration of the world summit on food security, [ONLINE] Available at: http://www.fao.org/docrep/013/a1936e/al936e00.pdf [Accessed 5 June 2020].

Zimmer, K. 1998. *The ecogeography of Andean potatoes BioScience 48*: pp. 455-464.