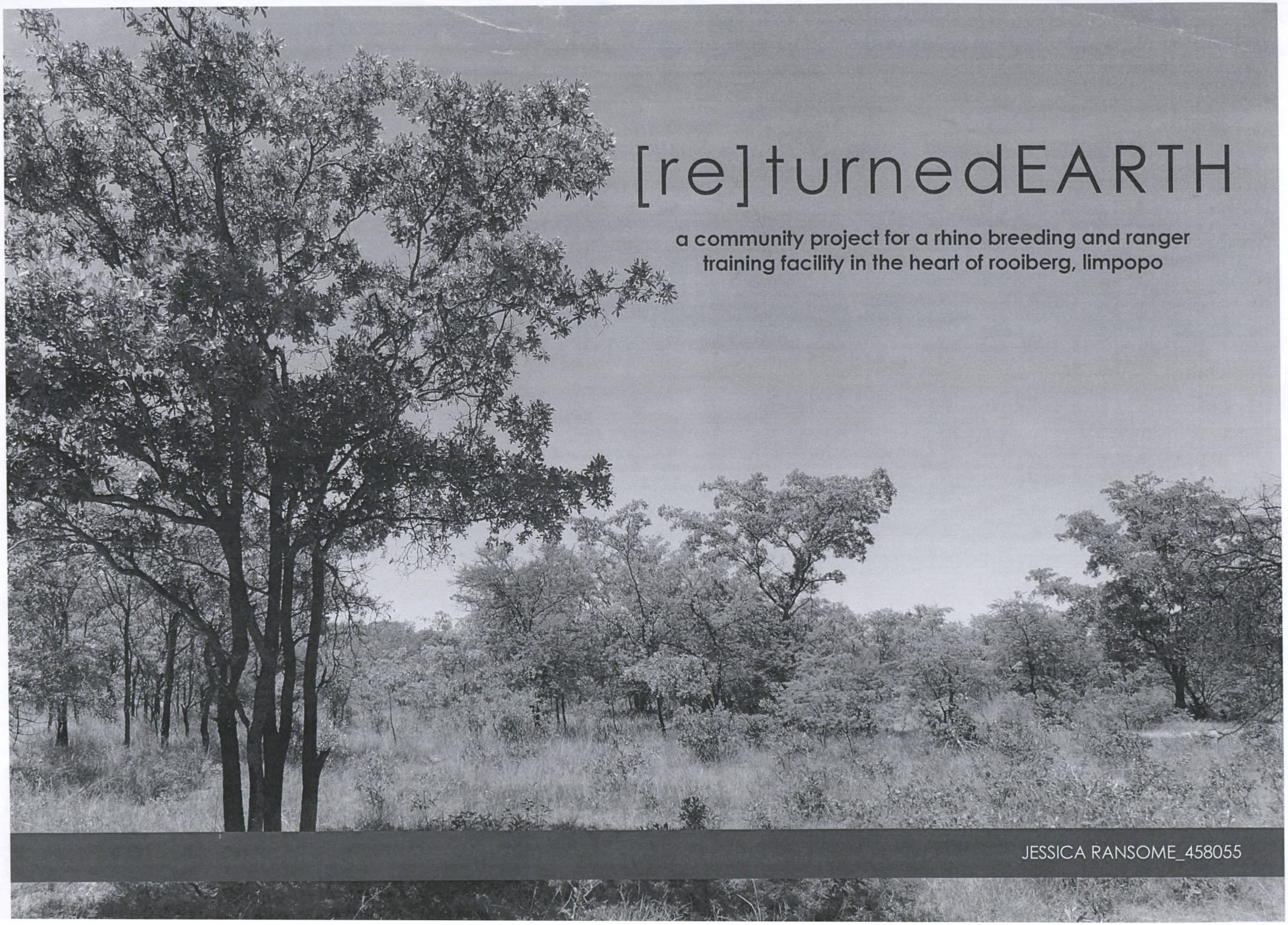


[re]turnedEARTH

a community project for a rhino breeding and ranger training facility in the heart of rooiberg, limpopo

JESSICA RANSOME_458055

[re]turnedEARTH

a community project for a rhino breeding and ranger training facility in the heart of rooiberg, limpopo

Jessica Ransome_458055

DECLARATION

I, Jessica Ransome, 458055, am a student registered for the course Master of Architecture (Professional) in the year 2016.I hereby declare the following:

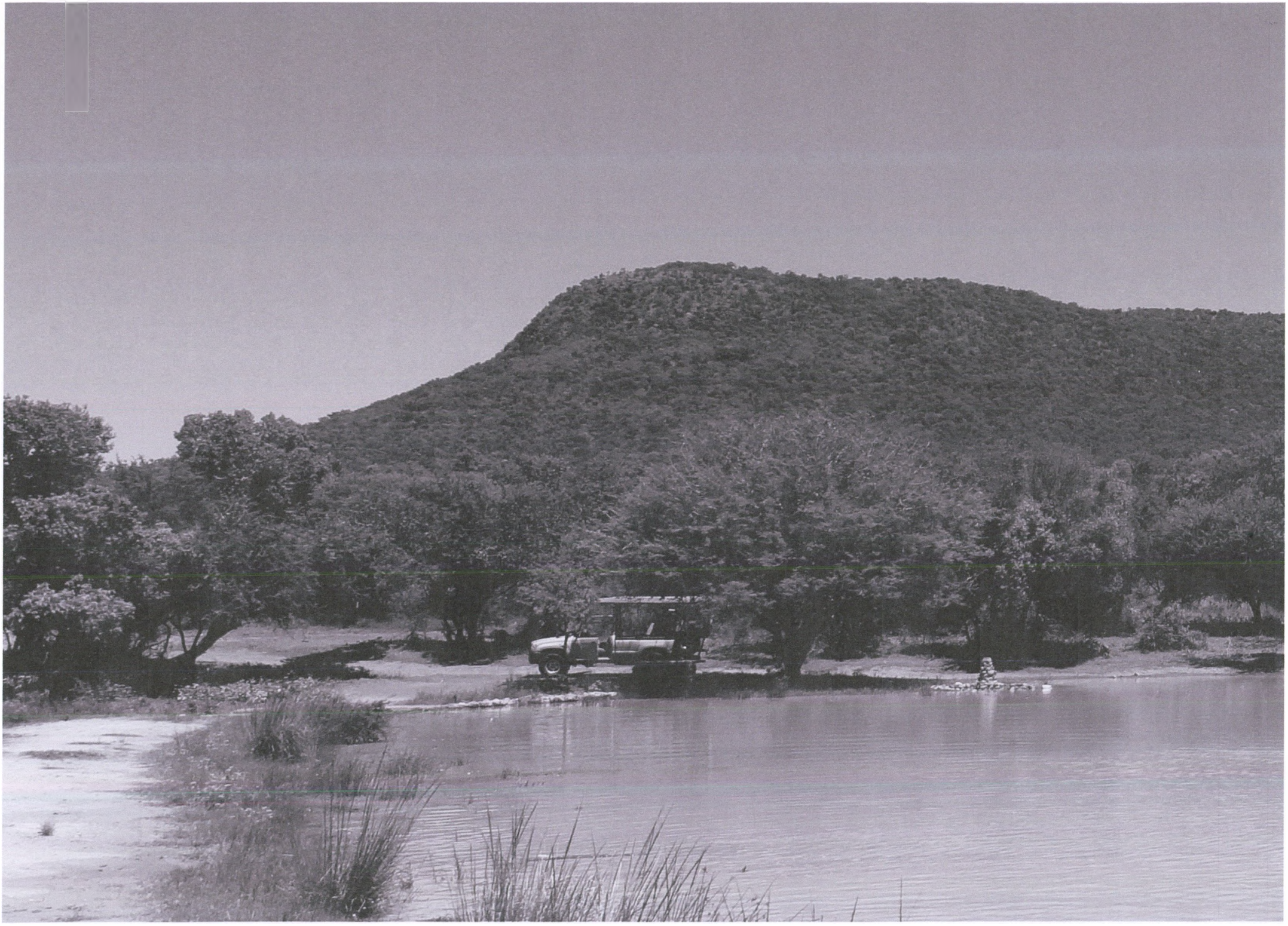
I am aware that
plagiarism [the use of someone else's work without permission and/or without acknowledging the original sources] is wrong. I confirm that the work submitted for assessment for the above course is my own unaided work except where I have stated explicitly otherwise. I have followed the required conventions in referencing thoughts, ideas, and visual materials of others. For this purpose, I have referred to the Graduate School of Engineering and the Built Environment style guide. I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my unaided work or that I have failed to acknowledge the source of the ideas or words in my own work.

Signed Author: Jessica Ransome_458055

Date: 26 February 2017

Supervisor: Brigitta Stone-Johnson

This document is submitted in partial fulfilment for the degree: Master of Architecture (Professional) at the University of the Witwatersrand, Johannesburg, South Africa, in the year 2016.



ACKNOWLEDGEMENTS

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My fiance, Dave who has been going through this journey with me from the first year in 2010. We've both had a fair amount of ups and downs throughout our architectural studies, but we've supported each other non-stop along the way. Always taking the time to give our opinions to each other and advice and help where needed. Dave, you've been by my side through all the late nights and stress as well as all the good times, discussing design ideas and sharing creative knowledge. I can't wait to see what the future holds for us.

To my grandparents, Olliver, Robin and Valerie, you have always shown a great interest in my studies and have given me an immense amount of support and encouragement along the way. Grampie, thank you for always proofreading my essays and taking the time to give me such good advice over the years.

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Lastly, thank you to all the staff at WITS University, the Architecture Department and my supervisor, Brigitta. For the help, advice and facilities to have had the opportunity to study and gain these qualifications. It's been a long journey, but I am so grateful to have done it!

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QUESTION

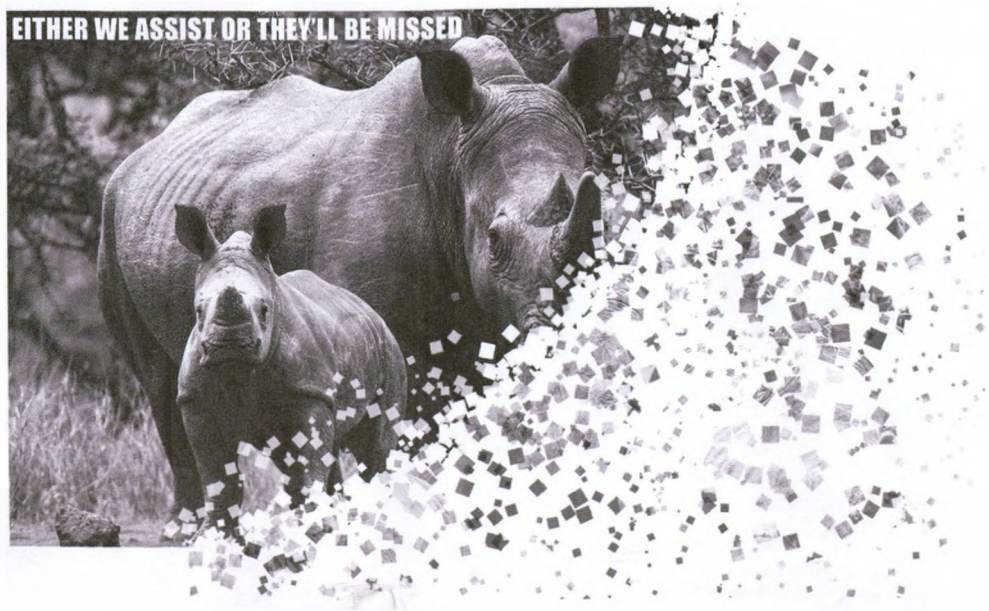
[re]turnedEARTH

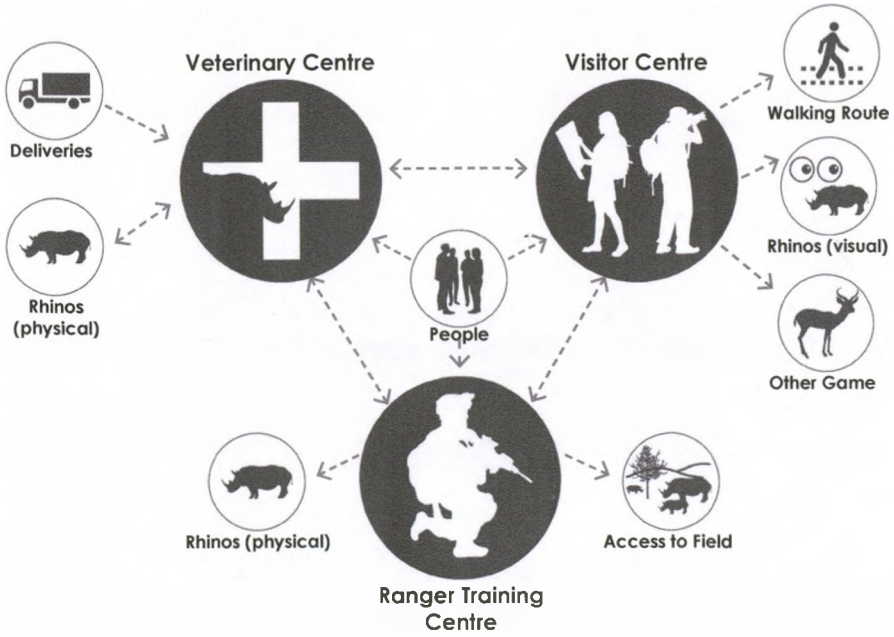
a community project for a rhino breeding and ranger training facility in the heart of rooiberg, limpopo

Jessica Ransome_458055

There are many threats facing South Africa's wildlife, the White Rhino being one of the most threatened species, said to be facing extinction due to the drastically depleting population figures as a result of poaching.

This project does not attempt to provide a solution to the Rhino poaching epidemic in South Africa, but rather to focus on dealing with the challenges of Rhino reproduction and protection. Allowing the architecture of the proposed centre to house the facilities that bring Rhinos and humans together to assist in breeding, education and exposure to the species.





The diagram above shows the three main programmes in the proposed centre, the ***Veterinary Centre***, the ***Visitor Centre*** and the ***Ranger Training Centre***, and certain elements they need to relate to. This diagram helped influence the programmatic placement in the design of the centre, and how a cohesive project was formed therefrom.

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1.1 ABSTRACT

"Animal constructions serve the same fundamental purposes as human constructions; they alter the immediate environment for the benefit of the species by increasing the level of order and predictability in the habitat." *[Atkin, T & Rykwert, J. 2005]*

There are many threats facing South Africa's wildlife, the White Rhino being one of the most threatened species, said to be facing extinction due to the drastically depleting population figures as a result of poaching. Rhinos are being targeted all over the world with the bulk of the White Rhino poaching occurring in South Africa. As a result, the Waterberg district of Limpopo has been chosen as the broader area of which the site is situated to partially eliminate the poaching threat. The Waterberg's tourism industry has grown exponentially over the last few years, and the greater area has many tourist attractions including both public and private game farms and lodges. However, despite the increasing number of tourists visiting the area annually, there are still high levels of unemployment and poverty in the area.

This research report does not attempt to provide a solution to the Rhino poaching epidemic in South Africa, but rather to focus on dealing with the challenges of Rhino reproduction and protection. Allowing the architecture of the proposed centre to house the facilities that bring Rhinos and humans together to assist in breeding, education and exposure to the species. It is essential that the approach to the design of this centre does not interfere with the natural habitat of the Rhinos and how they exist in the landscape. The project has thus been treated as both a landscape and architectural design to ensure that the user experience through the site is equally important to the Rhino as it is to the human occupants and visitors.

1.2 INTRODUCTION & STRUCTURE

Introduction:

Commonly known to most, the White Rhino species faces the threat of extinction due to the drastically depleting population figures. This statement has been elaborated upon and researched further in the bulk of this research report and a proposed solution to some the challenges associated with the epidemic are outlined by showing how architecture can bring humans and Rhinos together to aid in the repopulation of this endangered species.

After many years of visiting the Waterberg area and specifically the area of the site, it has become apparent that while tourism is growing in the area, wildlife conservation, game breeding and hunting dominate most of the farms in the area. Tourism has been linked with many of these activities already and thus the inclusion of eco-tourism in the project has been made.

The nature of this research report is to investigate how architecture can bring humans and Rhinos together in a community integrated project to boost Rhino populations past the point of extinction. The aim is to achieve this while still maintaining a natural landscape and adhering to the conservation of both the animals as well as the landscape.

In this way, the research report proposes a building complex including a community led Rhino breeding facility and ranger training centre with the inclusion of a visitor and volunteer programme to the Rooiberg area of the Waterberg District in Limpopo.

Structure of the Research Report Document:

Chapter 2_Theory:
The research report document opens with a theoretical essay. This explores the proposed programmatic elements of the research report and how they came together to form a cohesive body of information which influenced the design to the point of completion.

Chapter 3_Site Location, Context & Analysis:
The proposed site for the project has been researched at depth, providing an insight of information which informed various design decisions that were made. Furthermore, this section outlines the context of the area, the user groups as well as the available materials on site. Climatic data has also been analysed for the design to respond to not only the site but the climate too.

Chapter 4_The Project Brief:
Through an understanding of the sections above, the project brief and programmatic requirements were developed for the design of the proposed centre. In addition to this, the accommodation schedule was developed and then used to start the conceptual space planning.

Chapter 5_Design Concept Development:
This section highlights the start of the design process, in addition to showing connections to the theoretical essay a further analysis of materiality and building processes is included. The concept was derived from models, sketches and exploration, all of which are shown and elaborated on in this section.

Chapter 6_Sketch Design & Development Process:
This section reveals the evolution of the design, from conceptual drawings, through to the design development process. Various informants are expressed and explained, including design decisions and the development of details that are illustrated and explained.

Chapter 7_Technical Resolution:
The technical study in this chapter reveals the construction process and how the proposed building is to be built. Perimeter sections, construction details as well as building performance are all included in this chapter.

Chapter 8_Final Design Drawings:
The final drawings and models of the project are presented within this section and reveal the overall design and aesthetic, and thus is a culmination of the research and design processes completed throughout the year.

Chapter 9_Viability & Feasibility Report:
The final chapter and conclusion to the research report indicate the viability of the research report including a business plan proposal for projected clients, operations & funding.

THEORY

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2.1 INTRODUCTION

The nature of this chapter is to introduce the underlying theory on which the design of the proposed centre was based. This has been broken down into various subsections, providing the reader with an overview of each of the contributing elements. Each subsection will discuss these elements, motivating and providing a reason for the inclusion of them in the research report project. Additionally, the chosen location will also be accounted for and analysed.

In addition to the other Rhino species, the White Rhino is under threat and, not only in South Africa but worldwide. As a result of poaching and lack of breeding programmes, the number of White Rhino worldwide has fallen below 20 500. Due to the White Rhino being native to South Africa, *[WWF. 2016]* and the evidence that the species is under a huge threat of extinction, the repopulation of this particular Rhino species is the focus of this research report.

"Conservation has long been a cornerstone of South Africa's wildlife management strategy. South Africa was one of the first countries to take the lead in conservation tourism with nature reserves and game parks." *[Simm, C. 2015]* "Limpopo is dedicated to wildlife conservation, with three national parks, including a large part of the Kruger National Park, Mapungubwe, and Marakele, more than 50 provincial nature reserves managed by Limpopo Tourism and Parks as well as some private game reserves practising both nature and wildlife conservation." *[Simm, C. 2015]* The proposed centre and research report will not only deal with animal conservation with the White Rhino breeding programme but also with nature conservation on and around the site.

The chosen site lies within the foothills of the Waterberg mountain range in the Waterberg District in Limpopo on a privately owned farm called Rotavi Private Game Reserve. Within this region, there has been a significant increase in the conservation of wildlife over the past few years. The majority of farms are privately owned, and many specialise in the game breeding industry. Although there has been an awareness of conservation in the area and the tourism industry thrives in the Waterberg, there are still a large number of local communities experiencing high levels of unemployment and poverty. As a result, these communities have been forced into subsistence farming, and reports of poaching have been made and could be a result of the high unemployment rate, although this is pure speculation of the farmers in the area. While the farming does not affect the area negatively, poaching is something that needs to be eradicated. It has been shown that engaging local communities in conservation strategies enable them to feel a sense of ownership over a project. Additionally, providing an ongoing source of income, which in return removes the need to poach for additional income and food. The Vingerkraal community, located just 12km via sand road from the proposed site, is one of the oldest remaining communities in the immediate area. Established in 1994, it consists of a few hundred former 'Koevoet' members. *[Ap, Sapa. 2012]* Unemployment and poverty rates are high in this village, and thus the inclusion of these community members has been worked into various aspects of the proposed centre.

The purpose of this essay is to prove the viability of the research report topic and provide a background of knowledge and information to the reader on each of the proposed elements of

the programme before delving into the concept and design of the proposed centre.

In addition to this conclusion, a viability and feasibility study has been completed and can be found later on in the document in Chapter 9.

2.2 THE WHITE RHINO

An introduction and motivation for the proposal of a White Rhino breeding facility.

"The White Rhino is a major conservation success story, having been brought back from the very brink of extinction. However, the current surge in poaching for their horns, particularly in South Africa, has seen record numbers killed in recent years. Urgent efforts are now underway to stop the poaching and end the illegal trade." *[WWF. 2016]* In the last eight years 5 048 White Rhino have been poached in South Africa alone. That is more than 19 times the number (261) that were poached for their horns in the 27 years between 1980 and 2007, leaving only about 20 000 Rhino in Southern Africa. *[Rademeyer, J. 2013]* With reference Figure 2.2.1, it is evident that the population of the Rhino species as a whole is under a huge threat of extinction. Although the White Rhino has the highest remaining population, its nativity to Southern Africa, as well as its origin to the region, prove viability for a breeding facility of this particular species within South Africa.

The human race is so lucky to have special connections with the earth, nature and other species yet so many people in this world take this for granted and instead of preserving the Earth's beauty, resources, and animals, destroy them. We are in a global crisis with Rhino populations dropping well into the endangered category and some species, like the Northern White Rhino, classified to be extinct in the wild with only three remaining worldwide. *[WWF. 2016]* Illustrated in Figure 2.2.2, poaching has seen an exponential rise over the last seven years in Southern Africa, with an exception to the slight drop in number from 2014 to 2015. However, these numbers are also only based on reported deaths and in fact could

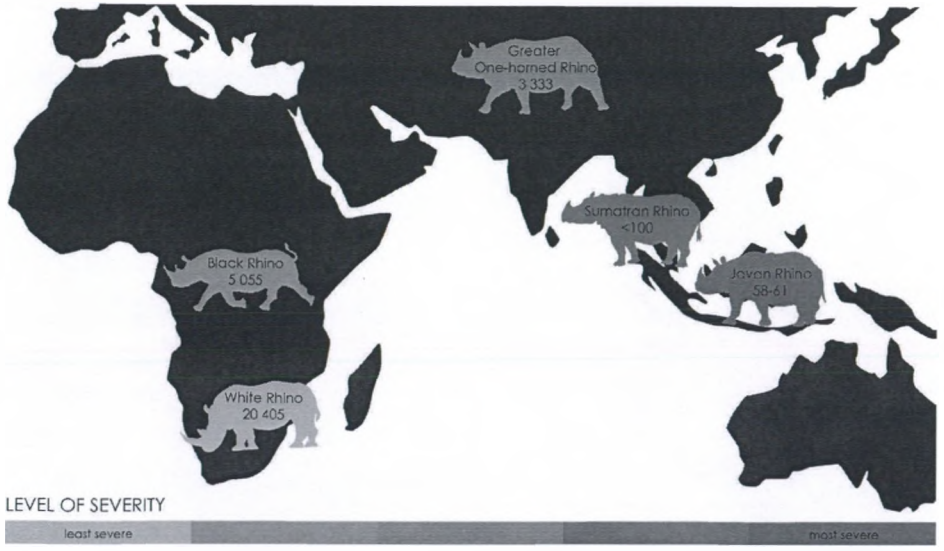


Figure 2.2.1: Worldwide Rhino Population Figures *[Save the Rhino, 2016]*

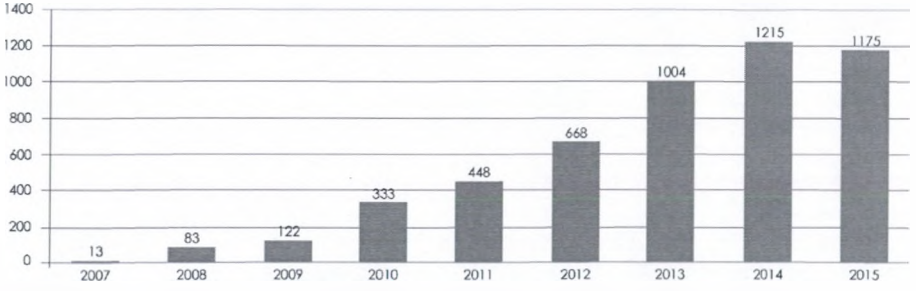


Figure 2.2.2: Recorded Number of Rhinos Poached *[Save the Rhino, 2016]*

be much higher.

"The killing only stopped when there were no Rhinos left," said Ian Player, the author of *The White Rhino Saga*, referring to the Rhino poaching epidemic of the Black Rhino in Zambia and Zimbabwe in the early 1970s. After the first near extinction of the Rhinoceros species in the 19th century, legal hunting of White Rhino was resumed in 1968 in South Africa and, at the time, there was a headcount of approximately 1 800 White Rhino in the country. *[Rademeyer, J. 2013]* While some consider it to be a cruel sport and others a challenging hobby, it has been proven that the economic incentive hunting creates is critical to the sustenance of many animal species. Statistics prove that wildlife populations have increased dramatically over the last 50 years with the lift of the trophy hunting ban in South Africa. The country went from a 500 000 head count of game to a head count of over 20.5 million animals today. Opposite to this, a ban on hunting was imposed in Kenya in the 1970s, and they have since lost 85% of their game due to a huge poaching problem. *[African Sky Hunting. 2015]*

As written by Rhino conservationist, and author Ian Player, "The great irony is that Rhino were nearly wiped out because of hunting in the 19th century, but it is through hunting in the 20th century that Rhino populations have exploded. When Rhino were put back on the hunting list, it was the beginning of the game ranching industry. The industry, at the time, were buying Rhino for a few thousand Rand, selling them on to European or American hunters for USD $25 000 and then putting that money back into conservation and buying more land and more Rhino. I am very, very emotional about Rhino, but I am not sentimental. The fact remains that through death there is life." *[Player, I. 2013]* In 2008, 40 years after the lift of the Rhino hunting ban in South Africa the White Rhino population had a head count of about 19 000, with roughly 5 000 on privately owned land/farms. That is an increase of 17 200 Rhino since the lift of the hunting ban in 1968. *[Rademeyer, J. 2013]* Since then not only has the hunting ban been reintroduced but the legal trade of Rhino horn was also banned. As a result, the world population figures have dropped, and the poaching statistics have risen. Thus, the reason for addressing the issue of the near extinction of the White Rhino as opposed to other threatened or endangered species in South Africa. Not only has it been considered an international disaster but also due to the nature of the animal and the different requirements for housing such animals. After analysing other animal conservation projects it is a common trend for the facilities to focus on one, maybe two, species as their main goal. This results in a concentration of research, facilities, and care for that particular species or animal.

In Figure 2.2.3 below, two projected outcomes for the future of the White Rhino have been illustrated. Either poachers will get the better of them and they will only be known through photographs and skeletons in museums, or with the intervention of a breeding facility and increased game ranger support and skills they will continue to live on in the wild where they belong. This emphasizes the importance of the introduction of such a breeding facility in Limpopo.

The nature of the proposed centre is, however, to breed Rhino and not to hunt them. The controversial topic of Rhino dehorning is something that also needs to be considered and is under investigation in South Africa. The ban on domestic Rhino horn trade was lifted in November 2015 by a judge of the Pretoria High Court; however, it has since been appealed by the South African Minister of Environmental Affairs. *[Save the Rhino (2). 2016]* It is not known to many that if the Rhino's horn is trimmed without damaging the skull of the Rhino, it will grow back, the same way one's finger or toenails grow back once trimmed. Should the ban on legalised Rhino horn trade be lifted, the horn would no longer cost a Rhino's life and African people would benefit more from saving a Rhino than from poaching it. *[Hume, J. 2015]* When a Rhino's horn is trimmed without damaging the skull it grows back within 3 years and the 2kgs of horn one Rhino can produce in a year could provide finances for food and education for 5 families per annum in our communities. *[Hume, J. 2015]*

"San Francisco-based start-up, Pembient, plans to bioengineer fake Rhino horn. They hope that the synthetic horn, priced at about one-eighth of the reported $60 000 per kilogramme for the

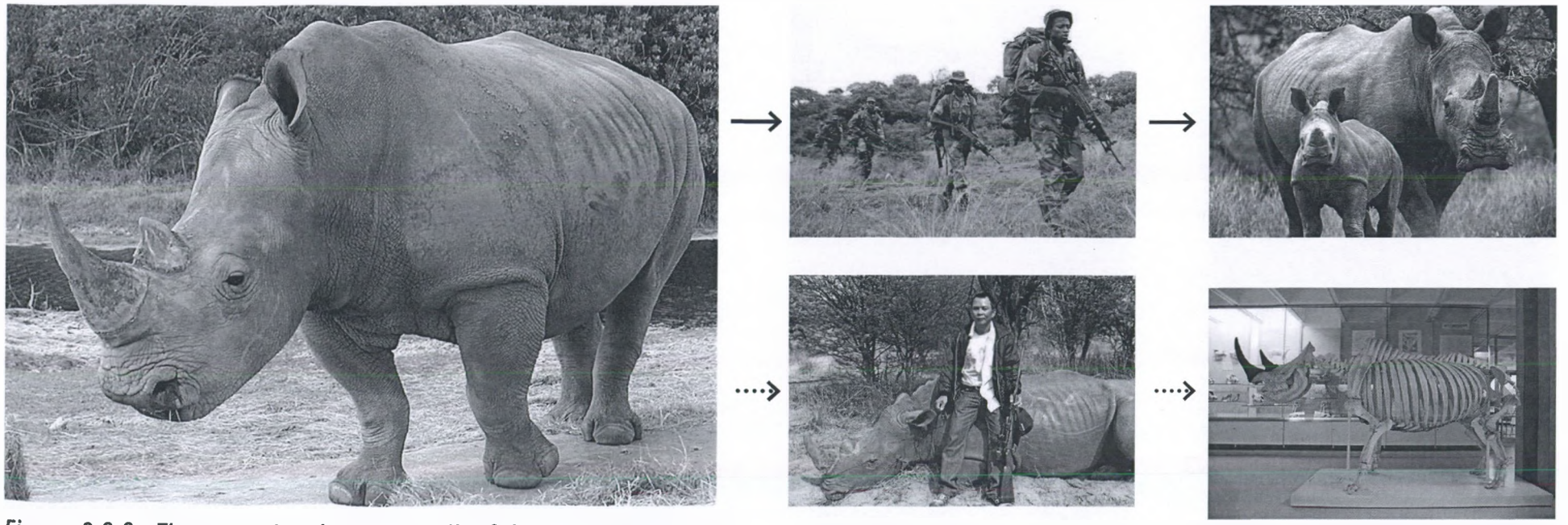


Figure 2.2.3 - There are 2 outcomes for the future of the White Rhino. *[Illustration by author]*

real horn, thus kerbing the economic incentive for poachers. The hope is that this will dissuade poaching in Africa for the Rhino's horn." *[Actman, J. 2015]*

"The engineer's at Pembient have figured out a way to turn keratin powder and Rhino DNA into a substance that is genetically similar to natural Rhino horn." [Seeker. 2015] While many believe this may be a solution to the huge Rhino poaching problem, many wildlife groups are sceptical. "There is no evidence that selling synthetic or biofabricated horn would reduce the demand for Rhino horn or dispel the myths around Rhino horn and could indeed lead to more poaching because it increases demand for "the real thing"." *[Save the Rhino. 2016]*

International Rhino horn trade has been banned since 1977, so some may ask why the peak in Rhino poaching from 2008 onwards? Was there a sufficient leakage in illegal Rhino horn trade to satisfy the demand? What about the fact that 60 Rhino were exported from South Africa to China in 2007 to start a Rhino breeding farm there as well as the massive rise in budget, USD $130 million - five times more than the previous year, from the Chinese Government in 2007 for traditional Chinese medicine research. *[Saving Rhinos. 2010]* It is a well-known fact that Rhino horn is used in Chinese medicine for various purposes and the fact that the rise in poaching happened directly after the year in which these two critical events happened in China is hard to believe to be a coincidence.

The future demand for Rhino horn can only be speculated upon, and while there are many opinions on the matter, there is no hard evidence for what the future holds. For this reason, the main focus of the centre has been placed upon the breeding and protection of the Rhinos at the centre. While provision has been made for secure storage of horns trimmed, this is common practice amongst Rhino owners to ensure the animals are less desirable to poachers. These horns can either be kept and sold later on should legal trade become available, or they can be burned and disposed of.

2.2.1 SUCCESS OF OTHER RHINO BREEDING PROJECTS

"In almost all Rhino conservation areas, there are other valuable plants and animals. The protection of Rhinos helps protect other species. Rhinos contribute to economic growth and sustainable development through the tourism industry, which creates job opportunities and provides tangible benefits to local communities living alongside Rhinos." *[WWF. 2016]* There is thus more benefit than just the expansion of the Rhino species by introducing such centres or projects.

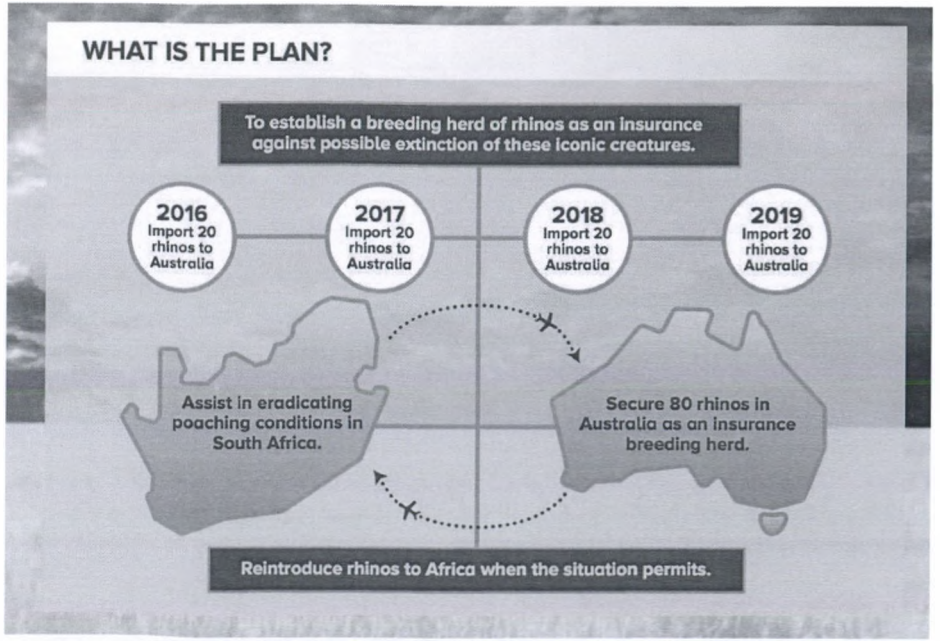


Figure 2.2.4 - The Proposed Plan *[The Australian Rhino Project. 2015]*

The Australian Rhino Project is a relatively new project having started with their viability study in 2013. "Their mission is to fly 80 African Rhinos 11 000kms from South Africa to Australia to establish an insurance population and ensure the survival of the species." *[The Australian Rhino Project. 2015]* Figure 2.2.4 illustrates their plan over the next four years by flying 20 Rhino across each year and then re-introducing them back to South Africa when the situation permits. *[The Australian Rhino Project. 2015]*

""It is our absolute goal that, once conditions permit, we will reintroduce the Rhinos into the wild, anywhere in Africa, not necessarily South Africa. I believe passionately that Rhinos must be available to the world in the wild." - Ray Dearlove, Patron and Founder, The Australian Rhino Project." *[The Australian Rhino Project. 2015]*

This organisation has come about because the number of Rhino killed per year is greater than the number of Rhino being born each year, and they believe if we do not act now Rhino will become extinct by the year 2024. *[The Australian Rhino Project. 2015]* This then begs the question - why Australia? As seen in Figure 2.2.5, the reasons stated for Australia being a good place for the project are shown. *[The Australian Rhino Project. 2015]*

The concept of the project may sound like a good idea, and they have got some conservationists and naturalists backing them, including, the late Dr Ian Player, Sir David Attenborough, as well as Investec Australia. The project is only due to send over their first 20 Rhino this year should they get the funding so the success of the actual project cannot be determined yet. In the words of Ian Player, "It is impossible to overemphasise the importance of

having a decent White and Black Rhino population surviving in Australia, particularly as the habitat in certain parts of Australia, thanks to the African exotic introductions, is ideal for the Rhino." *[The Australian Rhino Project. 2015]* While most species can adapt to new environments, and Australia does have a similar climate to South Africa, if the same operation could take place in South Africa, thousands of Rands and/or Dollars would be saved – or could be put into the project in other ways.

In the North West province, farm owner, John Hume, runs a successful Rhino breeding farm with above average population

Figure 2.2.5 - Why Australia? *[The Australian Rhino Project. 2015]*

growth and excellent reproduction indices. Since its inception six years ago, 518 calves have been born from 373 cows. *[Hume, J. 2015]* Hume has also been encouraging the legalisation of Rhino horn trade to encourage more communities, government and commercial farmers around South Africa to start breeding programmes of their own. While many say he is backing this for his own financial gain due to his huge stockpiles of Rhino horn, he has completed a viability report on the costs involved in running a 100-cow Rhino breeding facility to justify the legalisation of Rhino horn trade. The 2 charts shown in Figure 2.2.6, on the following page, done by Hume himself, show that a Rhino breeding farm of this scale (100 cows) without legislation of Rhino horn trade is not feasible. No one will ever be able to borrow the kind of money needed for starting a project like this from a bank. He explains in a TEDx talk that it is simply not sustainable in the private sector and that it cannot be done in the public sector alone. *[Hume, J. 2015]* However, after further investigation into the intricacies of Rhino breeding, it is not necessary to start off with 100 cows. According to the Rhino Husbandry Manual, 2-3 Rhino is all that is needed to start a breeding herd. *[Metrione, L & Eyres, A (Eds). 2014]* The legalisation of Rhino horn trade would merely bring in more money and allow the breeding farm to expand quicker.

Should the Rhino farms be allowed to sell the horn, that gets trimmed from the Rhino for safety reasons anyway, it would be a way of sustaining the massive running costs of such a farm. Especially if they don't have any other source of income generation, and thus make this type of breeding more appealing to more game breeding farms. Hume has done the calculations,

as seen in the chart, Figure 2.2.7, and the total investment amount per year drastically decreases with the sale of Rhino horn instead of drastically increasing as seen in the charts in Figure 2.2.6 where this factor has not been accounted for.

The annual financial difference made by the sale of Rhino horn is massive when looking at a 100-cow breeding farm. However, when starting off on a smaller scale and including other means of income generation through tourists, education, etc., the sale of Rhino horn is not imperative on the justification of such a project. For the viability and feasibility report developed for the proposed centre in specific, please see Chapter 9.

As often attributed to Albert Einstein, "Insanity: doing the same thing over and over again and expecting different results". If the industry does not make some drastic changes the extinction of the Rhino is probable. Relying on donations and government funding to keep these breeding farms going is not sustainable and nor is it constant. When the costs are so high each year, a farm cannot afford to be a few million Rand short of what they need. The conservation of this magnificent species will rely on some different methods combined, including anti-poaching schemes, breeding projects, additional income through fundraising, tourism, and possibly the legalisation of international Rhino horn trade.

RUNNING COSTS FOR 100 RHINO COW BREEDING PROJECT

	2015	2016	2017	2018	2019	2020
livestock expenses	1,200,000.00	1,320,000.00	1,452,000.00	1,597,200.00	1,756,920.00	1,932,612.00
bank charges computer expenses electricity	84,600.00	93,060.00	102,366.00	112,603.00	123,863.00	136,249.00
fuel	70,000.00	77,000.00	84,700.00	93,170.00	102,487.00	112,736.00
herbicide	44,000.00	48,400.00	53,240.00	58,564.00	64,420.00	70,862.00
insurance	78,000.00	85,800.00	94,380.00	103,818.00	114,200.00	125,620.00
licenses postage printing & stationery	11,200.00	12,320.00	13,552.00	14,907.00	16,398.00	18,038.00
protective clothing	15,600.00	17,160.00	18,876.00	20,764.00	22,840.00	25,124.00
repairs & maintenance	164,000.00	180,400.00	198,440.00	218,284.00	240,112.00	264,124.00
salaries	440,000.00	484,000.00	532,400.00	585,640.00	644,204.00	708,624.00
staff recruitment	8,000.00	8,800.00	9,680.00	10,648.00	11,713.00	12,884.00
telephone	27,200.00	29,920.00	32,912.00	36,203.00	39,824.00	43,806.00
wages	460,000.00	506,000.00	556,600.00	612,260.00	673,486.00	740,835.00
professional fees	104,000.00	114,400.00	125,840.00	138,424.00	152,266.00	167,493.00
safe custody fees	34,000.00	37,400.00	41,140.00	45,254.00	49,779.00	54,757.00
security expenses	1,080,000.00	1,188,000.00	1,306,800.00	1,437,480.00	1,581,228.00	1739351
TOTALS + 10% P.A	**3,820,600.00**	**4,202,660.00**	**4,622,926.00**	**5,085,219.00**	**5,593,740.00**	**6,153,115.00**

CAPITAL COSTS FOR 100 RHINO COW BREEDING PROJECT

	2015		2016		2017		2018		2019		2020	
	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT
carry over from prev. year		0		81,654,807.00		91,604,926.37		102,418,473.34		114,169,290.61		126,935,225.77
purchases cows	105	52,500,000.00	5	2,500,000.00	5	2,500,000.00	5	2,500,000.00	5	2,500,000.00		
purchases bulls	21	5,250,000.00	1	250,000.00	1	250,000.00	1	250,000.00	1	250,000.00		
births	34		34		34		34		34		34	
deaths females 5+2	7		7		7		7		7		7	
deaths males 1+2	3		3		3		3		3		3	
sales females + 10% P.A	9		9	-2,700,000.00	9	-2,970,000.00	9	-3,267,000.00	9	-3,595,700.00	9	-3,953,070.00
sales males + 10% P.A	15		15	-2,250,000.00	15	-2,475,000.00	15	-2,722,500.00	15	-2,994,750.00	15	-3,294,225.00
replace future female	5		5		5		5		5		5	
replace future male	1		1		1		1		1		1	
SUB TOTAL	**57,750,000.00**		**79,454,807.00**		**88,909,926.37**		**99,178,973.34**		**110,328,840.61**		**119,687,930.77**	
TOTAL RUNNING EXP + 10%	3,820,600.00		4,202,660.00		4,622,926.00		5,085,219.00		5,593,740.00		6,153,115.00	
1000ha @ R10 000	10,000,000.00		0		0		0		0		0	
fences	2,000,000.00		0		0		0		0		0	
equipment	1,000,000.00		0		0		0		0		0	
TOTAL INVESTMENT	**74,570,600.00**		**83,657,467.00**		**93,532,852.37**		**104,264,192.34**		**115,922,580.61**		**125,841,045.77**	
INTEREST @ 9.5%	7,084,207.00		7,947,459.37		8,885,620.97		9,905,098.27		11,012,645.16		11,954,899.35	
TOTAL INVESTMENT	**81,654,807.00**		**91,604,926.37**		**102,418,473.34**		**114,169,290.61**		**126,935,225.77**		**137,795,945.12**	

Figure 2.2.6: Running & Capital Costs for a 100 Rhino Cow Breeding Project *[Hume, J. 2015]*

CAPITAL COSTS FOR 100 RHINO COW BREEDING PROJECT WITH LEGAL HORN TRADE

	2015		2016		2017		2018		2019		2020	
	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT
carry over from prev. year		0		68,154,807.00		61,972,426.37		53,635,885.84		42,783,857.30		29,002,826.29
purchases cows	105	52,500,000.00	5	2,500,000.00	5	2,500,000.00	5	2,500,000.00	5	2,500,000.00		
purchases bulls	21	5,250,000.00	1	250,000.00	1	250,000.00	1	250,000.00	1	250,000.00		
births	34		34		34		34		34		34	
deaths females 5+2	7		7		7		7		7		7	
deaths males 1+2	3		3		3		3		3		3	
sales females + 10% P.A	9		9	-2,700,000.00	9	-2,970,000.00	9	-3,267,000.00	9	-3,595,700.00	9	-3,953,070.00
sales males + 10% P.A	15		15	-2,250,000.00	15	-2,475,000.00	15	-2,722,500.00	15	-2,994,750.00	15	-3,294,225.00
replace future female	5		5		5		5		5		5	
replace future male	1		1		1		1		1		1	
SUB TOTAL		**57,750,000.00**		**65,954,807.00**		**59,277,426.37**		**50,396,385.84**		**38,943,407.30**		**21,755,531.29**
TOTAL RUNNING EXP + 10%		3,820,600.00		4,202,660.00		4,622,926.00		5,085,219.00		5,593,740.00		6,153,115.00
1000ha @ R10 000		10,000,000.00		0		0		0		0		0
fences		2,000,000.00		0		0		0		0		0
equipment		1,000,000.00		0		0		0		0		0
TOTAL INVESTMENT		**74,570,600.00**		**70,157,467.00**		**63,900,352.37**		**55,481,604.84**		**44,537,147.30**		**27,908,646.29**
INTEREST @ 9.5%		7,084,207.00		6,664,959.37		6,070,533.47		5,270,752.46		4,231,028.99		2,651,321.40
TOTAL INVESTMENT & INTEREST		**81,654,807.00**		**76,822,426.37**		**69,970,885.84**		**60,752,357.30**		**48,768,176.29**		**30,559,967.69**
return 90kg horn @ R150 000 inc. 10%		-13,500,000.00		-14,850,000.00		-16,335,000.00		-17,968,500.00		-19,765,350.00		-21,741,885.00
TOTAL INVESTMENT		**68,154,807.00**		**61,972,426.37**		**53,635,885.84**		**42,783,857.30**		**29,002,826.29**		**8,818,082.69**

Figure 2.2.7: Running & Capital Costs for a 100 Rhino Cow Breeding Project WITH Legal Horn Trade *[Hume, J. 2015]*

2.2.2 HATHIGAON ELEPHANT VILLAGE - PRECEDENT STUDY

Project:	Hathigaon Elephant Village
Date:	2010
Architect:	Rahul Mehrotra of RMA Designs
Location:	Jaipur, Rajasthan, India

"Indian architect, urbanist and educator, Rahul Mehrotra's firm RMA won a competition organised by the Rajasthan Government for a housing project for Mahouts, the Hindi term for elephant riders, as well as their elephants and families. They have recently been awarded the gold medal prize for sustainable architecture (organised by the Italian University of Ferrara). Rahul Mehrotra spoke @WhatDesignCanDo about his most recent work including the Elephant Village, or Hathigaon." *[Designboom: Chin, A. 2013]*

Because there are no 'building or design standards' for Elephant design, a spatial study was done to determine the minimum size area the elephants would need to live and move comfortably while in their 'rooms' - see Figure 2.2.9 below.

Although the White Rhino will be allowed to 'roam free' to a certain extent in the proposed centre, a spatial study has also been done. There are certain spatial requirements for territory and space in enclosures, bomas and pens for sick or injured Rhino. Please refer to page 36 for the White Rhino spatial study for the proposed centre.

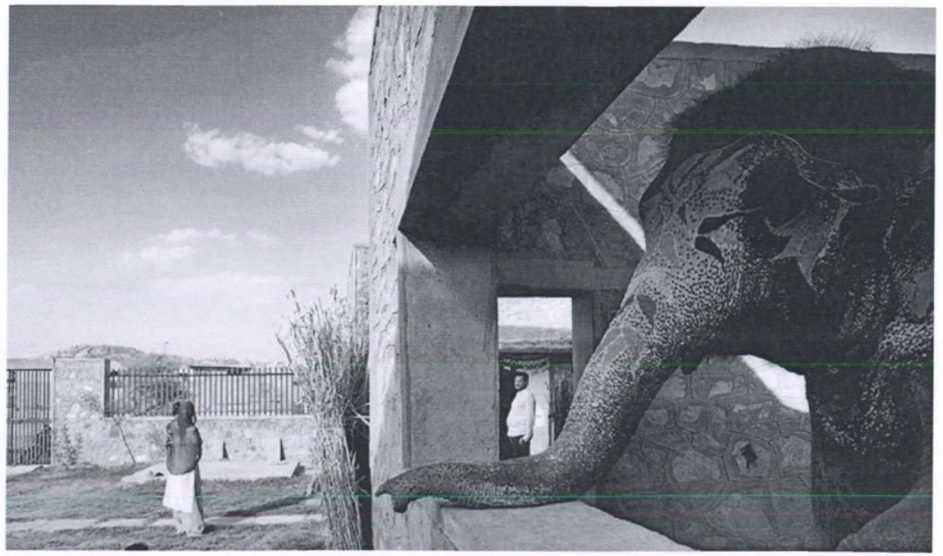


Figure 2.2.8 - Elephant Housing in Garage-like rooms. *[RMA. 2013]*

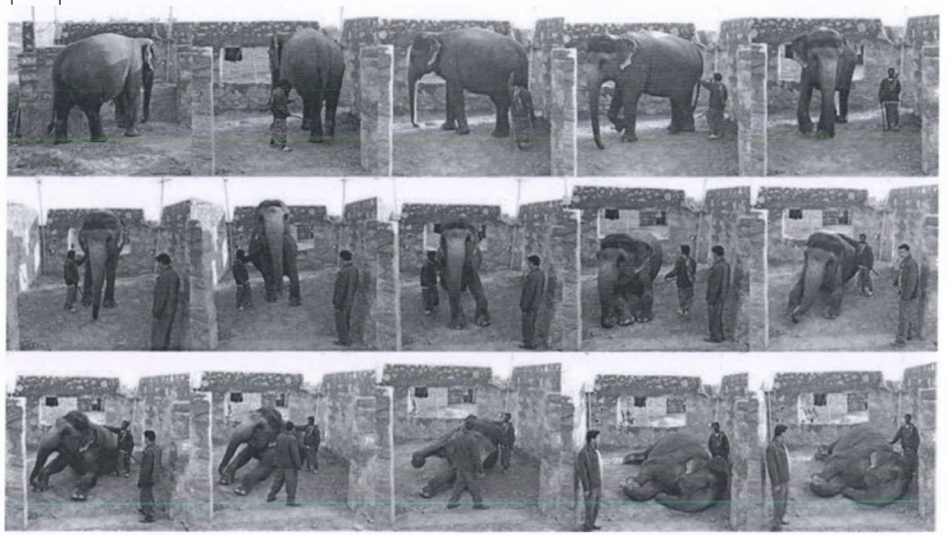


Figure 2.2.9 - Minimum Spacial Requirement for Elephant Research.
[Chin, A. 2013]

The plan designed for the elephant village can be seen below in Figure 2.2.10.

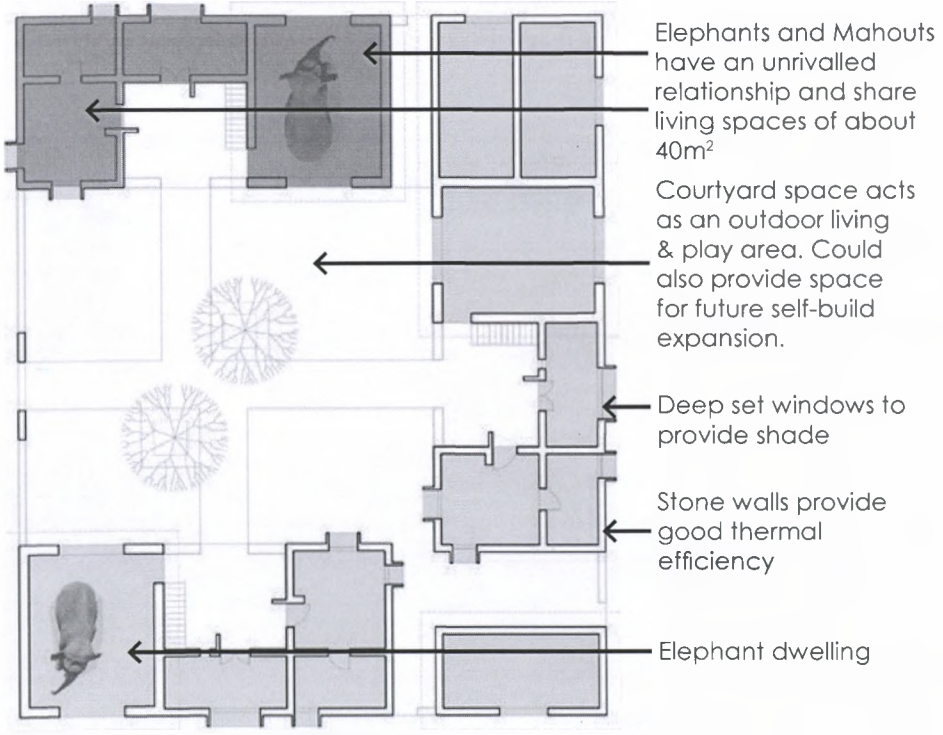


Figure 2.2.10 - Ground Level Plan and Spatial Analysis *[RMA. 2013]*

This project was undertaken as a landscape regeneration rather than an Architectural project. As seen Figure 2.2.11 in just 3 and a half years the landscape transformed from a barren site to a lush and green scape where water is plentiful.

Figure 2.2.11 - A radical change can be seen in the landscape just 3 ½ years later *[RMA. 2013]*

The design strategy was to use the artificial topography created by the sand quarry to capture rainwater and revive the immediately devastated environment and micro-climate. Indigenous species of plants and trees were planted to restore the natural biodiversity of the area. *[Designboom: Chin, A. 2013]*

"The Mahouts' previous accommodation, in an urban setting without a water source nearby, made for sick and sad elephants. Elephants require 300 liters of water per day; therefore, 100 elephants x 365 days x 300 liters = 10,950,000 liters. As of 2013, due to the successful implementation of the design strategies, the approximate quantity of water retained on the site per year is 20 million litres, roughly double the yearly requirement for one hundred elephants at Hathigaon." *[Designboom: Chin, A. 2013]*

"The landscape process required an acute understanding of the history of the site as well as the needs of the elephants. Local knowledge was also vital in selecting the material palette and establishing building systems throughout the complex." *[Designboom: Chin, A. 2013]*

As part of the landscape regeneration the housing clusters, arranged in sets of 4 units per cluster, were only situated in positions on the site that were not being used as part of the landscape regeneration. Unlike most architectural projects, the landscape was the centre of the project and the architecture evolved around and was informed by it. *[Designboom: Chin, A. 2013]*

The adjacent image, Figure 2.2.12 clearly shows the placement of the housing units, as well as the introduction of the man- made water catchment ponds to collect rainwater runoff.

Although this project differs from the proposed Rhino breeding facility, the key elements remain import to take note of. Hathigaon was built on a limited budget as it was Government funded and thus the design had to make use of simple building techniques and materials available on site. The rural location of the centre has also encouraged the inclusion of passive design as an effective response to the need for a high level of natural ventilation. *[Designboom: Chin, A. 2013]* It is estimated that the centre will grow through local population involvement as well as the inclusion of a visitor centre as a means of additional income to assist with the running costs.

"Over the years, as an architect, Rahul Mehrotra of RMA has become less concerned with controlling all details; instead, he is fascinated by the way the residents' contributions become part of the final product." *[RMA. 2013]*

Personal Conclusion:

Like this project, the proposed centre also focuses on the living conditions and habitat creation of animals, in this case, the White Rhino. In addition to this, both projects are sensitive to their location and site, and as a result, the landscape and vegetation have been considered in the design along with the spatial requirements of Hathigaon. A similar approach has been taken in the design of the proposed centre.

Figure 2.2.12 - Site Plan and Figure Ground showing Placement of Housing Units *[RMA. 2013]*

2.2.3 BACKGROUND OF THE WHITE RHINO

Both the Northern White Rhino and the Southern White Rhino, more commonly known to man these days, are indigenous to Southern Africa. South Africa being the country that has the majority of the White Rhino population. "The White Rhino is the only grazer of the five Rhino species, feeding almost exclusively on short grasses." *[WWF. 2016]* They are shade-loving creatures, and a crash (the plural term for a group of Rhinos) of up to 14 may form, mostly females with calves while the adult male defends a territory of roughly 1-3km², with which they mark with vigorously scraped dung piles. *[WWF. 2016]* A size analysis has been done as seen in Figure 2.2.13, and this has been used to determine the spatial requirements within the facility where the Rhino need to be contained and/or examined.

There are many contributing factors for designing a facility for any animal to be kept in captivity and considering the size of the Rhino; these will largely influence the design of the centre. While the aim is to have the majority of the Rhino roaming 'free', or rather in designated breeding camps, there will need to be bomas for the receiving and delivery of Rhino as well as recovery bomas for any Rhino that may have been injured or is in need of medical attention. The sizing guidelines in addition to the information obtained from the document "Transportation and Boma Management of Rhinos" by P S Rogers regarding the catchment of Rhinos has determined the size of said bomas, Rhino movement on site as well as the location of the different holding pens and/or breeding camps.

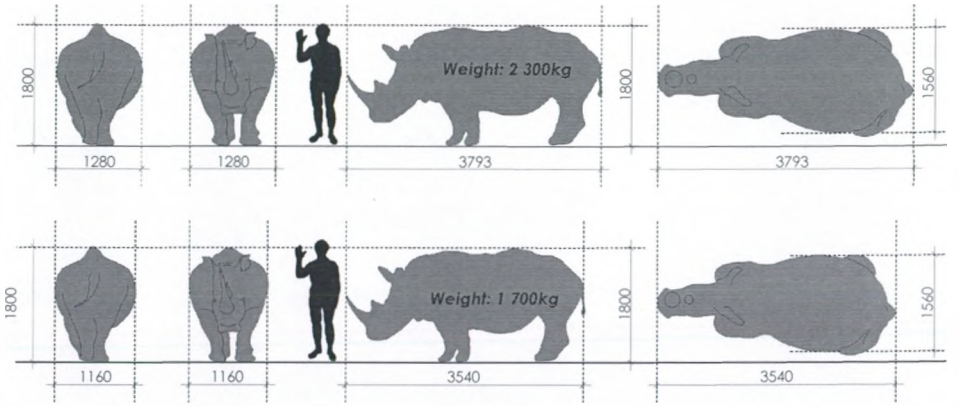


Figure 2.2.13: White Rhino Size Analysis, Male Top, Female Bottom
Scale 1:100 [Graphic by Author]

Habitat & Ecology:

Possibly the largest pure grazer that ever lived, the White Rhino's wide square mouth enables them to graze most efficiently. "A good habitat includes trees and ample water as well as open grassland. They often drink twice daily but can go 2-4 days without drinking if water is distant." *[Estes, R.D. 1991]* While the farm's natural landscape is suitable for the eating requirements, water sources are not close to the site, as shown in Figure 2.2.15, the closest dam

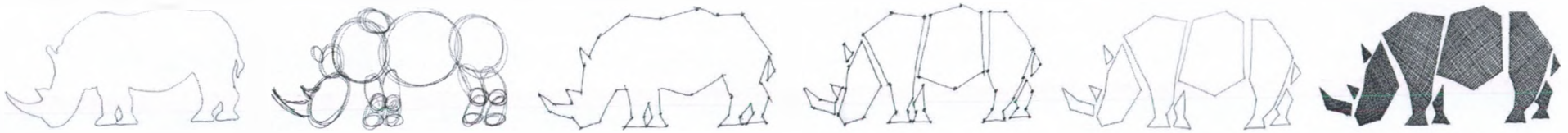


Figure 2.2.14: White Rhino Geometric Sketches *[Graphic by Author]*

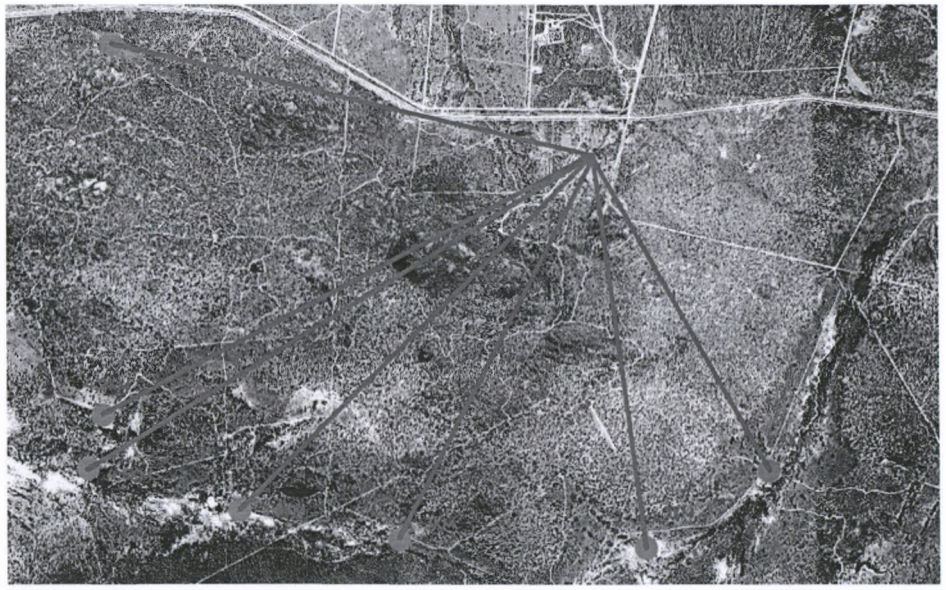


Figure 2.2.15: Dam Distances from Site
Not to Scale [Graphic by Author]

is 2.5km from the site. Hence the proposal for an additional dam on site. Location of the smaller holding pens was also determined by the existing trees, for shade, and reasonably flat, grassy terrain.

Social Organization:

Both White and Black Rhino use dung and urine to mark their territory, however, among the White Rhinos, only the males are territorial and make use of dung middens and spray urine to demarcate. *[Carnaby, T. 2005]*

White Rhinos are mostly encountered in small groups called a 'crash', females with young usually live alone but often associate with other females. "Sub-adults sometimes band together after being sidelined by their mothers upon the arrival of a new calf." *[Carnaby, T. 2005]* Crashes of up to 14 in high-density areas could consist of a combination of sexes and ages. These groups occupy home ranges which are not defended but overlap with those of other groups and some dominant male territories. *[Carnaby, T. 2005]* Adult bulls prefer to be alone, but they do spend time associating with groups, especially those that have oestrous females. This does not mean that lone bulls are necessarily territorial; territorial bulls also tolerate single males, called satellite males, in their territories if they behave submissively and do not make advances towards females. *[Carnaby, T. 2005]*

Physical Characteristics:

"Rhinos may have thick skin, but it can be quite sensitive, especially to sunburn and insect bites. That is why Rhinos like to wallow in mud, it not only cools them down but when the mud dries it forms a protective layer over the skin." *[Save the Rhino (3). 2016]* They sleep lying down with their legs tucked in underneath them and lie under trees for shade and weather protection.

The Rhino's horn is made up of a protein called Keratin, the same substance fingernails and hair is made from. Their horns are not hollow like that of an elephant's tusk but rather a solid mass of hairs that continue to grow throughout the animals life. *[Save the Rhino (3). 2016]* The reason the horn is pointed is due to the Rhino rubbing the horn on trees and rocks which grinds it down into the

pointed end. As previously illustrated in Figure 2.2.13, there is a size difference between male and female Rhinos, with the male being bulkier and heavier. However, this is not readily noticeable unless seen in a mixed group of adults.

Relationship with Humans:

The relationship between humans and Rhinos is one that is not productive for either species. The Rhino has long been considered one of the most dangerous animals in the world. The thrive on instinct alone and will only attack when they feel threatened or in danger. *[Rhino Worlds (1). 2014]*

A Rhinoceros attacking a human being is a very rare event. In fact, there are fewer than two attacks every year and these are, for the most part, not fatal. Although the Black Rhino of Africa is notorious for being aggressive, it is not often that it needs to inflict such aggression on people, since Rhinos are, by their very natures, loners. *[Rhino's Info. 2015]*

Due to the Rhinos inherently poor vision, they often cannot distinguish the difference between a human and other animals in the wild. It is this, and the desire to survive, that they may challenge anything that may be of threat to them. For this reason, humans and Rhinos have been kept separate in the design of the centre, only allowing access to veterinary staff and game rangers into the Rhino enclosures to keep the public visitors safe.

Methods of Self Protection:

Due to the size of the White Rhino, there are not many associated predators for it to worry about. Young Rhinos have the biggest risk involved with dangers from predators. "The young are often curious, and they may venture too far from their mothers. When certain predators including large cats, wild dogs, and crocodiles see this, they may spring into action and feed before the mother can do anything to prevent it." *[Rhino Worlds (2). 2014]*

"Oxpeckers perch on the bodies of the Rhino to feed off ticks among other insects. These birds are also believed to be able to warn the Rhino of approaching danger." *[Rhino Worlds (2). 2014]* In addition to this, their omnidirectional ears are continuously flicking and rotating listening for sounds or warning calls while they sleep and they can be up and on their feet in seconds. *[Carnaby, T. 2005]*

Another result of the poor vision of the Rhino is enhanced hearing and smell. Rhino may be caused to charge when they recognise a smell that is foreign to them. The smell and/or sound point them in the direction of the danger.

2.3 THE IMPORTANCE OF GAME RANGERS

"The challenges facing Africa's game rangers are greater than ever before in the face of a poaching epidemic that threatens the very existence of our continent's remarkable wildlife." *[Game Ranger Association of Africa. 2016]* The importance of well-equipped and highly trained ranger teams has been recognised to be crucially important in the combating of Rhino poaching as well as the protection of other wildlife species. Many don't realise that "Rangers are the guardians of our planet's most precious natural assets and that every day they go to work, their lives are at risk as a result of human greed and cruelty." said Director General Julia Marton-Lefèvre, who leads the *International Union for Conservation of Nature, IUCN*. *[Game Ranger Association of Africa. 2016]* In the past year alone the death toll of Rangers reached 102, with poachers responsible for 69 of those deaths that were accounted for. *[Game Ranger Association of Africa. 2016]*

"Wildlife rangers endure similar ordeals to soldiers in combat. They routinely face death, injury, or torture from poachers, and the wild animals they protect can kill them too." *[Neme, L. 2014]* "According to Sean Willmore, president of the *International Ranger Federation* and founder of the *Thin Green Line Foundation*, worldwide, about two rangers are killed every week, and that is only partial data, it could be double that." *[Neme, L. 2014]* Figure 2.3.1 shows a ranger in patrol in Zakouma Nature Park, n southwestern Chad, where, in 2013, 90 elephants were killed by poachers. This is just one of many examples that demonstrate the need for game rangers anywhere in the world where protected or targeted wildlife resides. *[Neme, L. 2014]*

"Even 'successful operations' can end traumatically for Rangers. Whether it be an injured or killed ranger or animal, even if the poachers are caught, these experiences are not good for either party." *[Neme, L. 2014]* Many may not realise that there is an extremely emotional side to the job of a ranger – this is something that has been considered in the design of the proposed training facility. Counselling and help where needed are crucial for the wellbeing of game rangers.

Figure 2.3.1 - An anti-poaching team patrols in Zakouma National Park, Chad, in February 2014 *[Longari, M. 2014]*

"Many who become game rangers go into it knowing that the position comes with many dangers of wild animals, dehydration, irritating insects, never mind the poachers. Most are the type of tough personality that can handle the rigours of the job," says Kevin Bewick, head of the Anti-Poaching Intelligence Group of Southern Africa. *[Neme, L. 2014]* Even with the high death toll and extreme risks there are many people still keen to do the job, while the attraction is often the security of a job it is not the only residing factor.

Figure 2.3.2 - A South African soldier participates in a night patrol exercise against Rhino poachers in Kruger National Park in July 2011. *[De Sakutin, S. 2011]*

"Being a ranger was not a choice but a calling," says Stephen Midzi, whose base is Shangoni Post in the Kruger National Park. "I was born for this, so I had to fulfil what has already been written in my book of life." *[Neme, L. 2014]*

2.3.1 BECOMING A GAME RANGER IN SOUTHERN AFRICA

In Southern Africa, there is a certain protocol that needs to be followed to become a game ranger. There are also different levels of game ranger qualifications. The various qualifications are done through the *Field Guide Association of Southern Africa* (FGASA), and there are many facilities where one can obtain this training, of which the proposed Rhino Breeding and Ranger Training Centre will be one of them.

Due to the nature of the project and the White Rhino being classified as a 'dangerous animal', the training facility will have to offer courses up to level 3, being the highest level of qualification in the Game Ranger industry. In addition to this, it will need to offer an Advanced Rifle Handling course. While there are many steps to go through to obtain these qualifications, the demand for Rangers in Southern Africa is high. The addition of this service will not only benefit the local community by providing them with the opportunity to gain new skills and thus jobs, but it will also draw both local and foreign people to the centre that are passionate about wildlife and conservation. *[FGASA. 2016]*

After speaking with some of the farmers and staff from the surrounding farms, it became knowledge that many staff members already have basic ranger training qualifications but are instead working as labourers on various farms. This centre will provide them with the opportunity to further their studies and continue along the path they initially set out for, should this still be an aspiration of theirs.

In addition to the main qualifications, levels 1 - 3, there is an entry level qualification. The "local guide" qualification which allows people who may not be competent to qualify for level 1 onwards and/or may be illiterate to obtain a qualification in the industry which then opens doors for jobs in their futures. With this and some industry experience, they would then be able to go on to level 1 and onwards to become a 'dangerous game' game ranger. *[FGASA. 2016]* After speaking to *Bush Wise*, a FGASA accredited company, many "bush-goers" are also interested in this course. These people often want to expand their knowledge in the field for personal gain, thus bringing in more revenue for the centre.

As outlined above, becoming a game ranger entails vigorous training, both mental, physical, and intellectual and someone would need to have the drive to adhere to these high standards of training to succeed in the job. It is for this reason that the proposed Ranger training facility is closely linked to the visitor and information centre. This will provide people with a better knowledge of what the job entails, not only so they can support it, but also so that people considering the job can acquire a better understanding before committing.

2.4 COMMUNITY INTEGRATION

The concept of community participation and integration has been put in place to ensure the active involvement of community members in the surrounding area. In this case, the Vingerkraal community as well as the local farming community. "It is a means of empowering people by developing their skills and abilities to enable them to negotiate and make appropriate decisions for their development." *[Seah, L. 2014]* While this is not a proposed housing solution, creating a community aided project whereby the existing community can get involved in all aspects, from the building and maintenance to the running of the centre while learning new skills along the way. It is an opportunity for employment and skills upliftment which, by association, would improve the lives of the community members, as well as eradicate the need to poach in the area. The involvement of the local farmers and their managers would be on a much smaller scale, hosting information classes or seminar and group learning rather than active involvement in the building and running of the centre.

Involving any large group of people in any form of decision-making leads to difficulties. Material studies have been done to inform the building methods that have been proposed. This will ensure that community members will be able to be involved in the building of the centre, rather than creating high expectations that can't be met, resulting in demotivated people. There are obviously some factors that will be determined by specialists, for example, the veterinary and lab requirements for the breeding facility as well as the boma sizes for the Rhino. However discussing building techniques with the local community would be crucial. First to find out if they know how to do certain building techniques, and secondly, if they don't, would they be willing to learn new forms of building. A general outcome from informal chats with people from the area showed a positive mindset on learning new techniques to improve skill sets. Especially where it involves learning to build with site-specific materials such as earth from the site for rammed earth building.

For the design of the proposed centre, the relationship of animal to human needed to be assessed, in living conditions, hierarchy as well as spatial needs. "Architecture, which is the exact artistic and technical discipline for which human biological and psychological life are a necessary precondition, must always be, at some level, indifferent to the life within it. Moreover, life, for its part, privileges itself above all else and seeks continuously to expand it a field of expression. This is true of both animal and human life, although animal life has rarely been of architectural interest." *[Ingraham, C. 2006]* The precedent study of Hathigaon Elephant Village on pg 32 is a good example of how the design lent itself to the coexistence of animals and humans. Due to the nature of the White Rhino's natural habitat being out in the open, the design of the centre will not facilitate permanent 'housing' of the Rhino except in the case of sick or orphaned Rhino(s). These spaces have been designed according to the spatial study and general requirements of a Rhino's natural habitat. Creating a form of integration and connection between humans and Rhinos is also crucial in the design of this centre. The aim of the project is to bring the two together, to aid in a solution to the depopulation of the White Rhino and thus they have been considered together rather than two separate elements during the design and planning process.

Community participation is considered as an imperative feature for the successful development of rural areas. While the majority of the farms in the area are privately owned, the Vingerkraal community was established in 1994, and it is thus very important to include this community in any non-private development of the area. Participation has a different meaning to different people and the way in which it is defined largely depends on the context and background to which it is applied. *[Kumar, S. 2002]* "Participation in any project requires the voluntary and democratic involvement of people in three ways, namely: Contributing to the development effort, sharing equally in the benefits derived and decision making in respect of setting goals, formulating policies, and planning and implementing economic and social development programmes." *[Midgley, J. 1986]*

Through the analysis of various community-based project precedent studies, the significance of The Cassia Co-Op Training Centre (see pg 46) in relation to the proposed Rhino breeding facility has outlined community involvement and utilisation of natural materials. Through a further site analysis of the proposed site, available materials have been investigated further and their structural properties determined

The Oppi Koppi Community Crèche (see page 48) also emphasised the fact that "teaching the locals the skills they require to build the new techniques that are introduced through these types of projects is the correct approach. Not only does it allow them to maintain the new community building but they can also use the skills obtained in other applications which lead to opportunities created in the future." *[Ransome, J. 2015]*

By observing the vernacular of Vingerkraal Village, very basic methods of building have been adopted. From using corrugated iron to a few simple brick structures. "By teaching the community members new skills for building methods that utilise local materials while being durable and thermally efficient at the same time will not only allow them to provide a better standard of life for themselves but also, will save them money in the long run." *[Ransome, J. 2015]*

The temperature and rainfall analysis (see page 66), shows that the temperature fluctuations are quite vast throughout the year, from extremely hot summers to very cold winter's nights. Thus a thermally efficient building and design approach is essential in this setting. This will not only maximise comfort in the building but also reduce heating and cooling costs for the inhabitants.

2.4.1 CASSIA COOP TRAINING CENTRE - PRECEDENT STUDY

Project:	Cassia Coop Training Centre
Date:	2012
Architect:	TYIN Tegnestue Architects
Location:	Sungai Penuh, Kerinchi, Sumatra, Indonesia

The initiation of the Cassia Co-op Training Center started with a French businessman, Patrick Barthelemy, who travelled to *TYIN Tegnestue Architect's* office in Trondheim from Sumatra with a briefcase full of cinnamon. *[Cifuentes, F. 2012]* Sumatra supplies 85% of the world's cinnamon and has a large amount of wood from the trunk of the tree left as a by-product of cinnamon production. This was not the only deciding factor for developing the cinnamon factory within the cinnamon forest of Sumatra, poor working conditions including unsafe and unsanitary factories, underpaid and long working days and workers without rights were the greater concern.

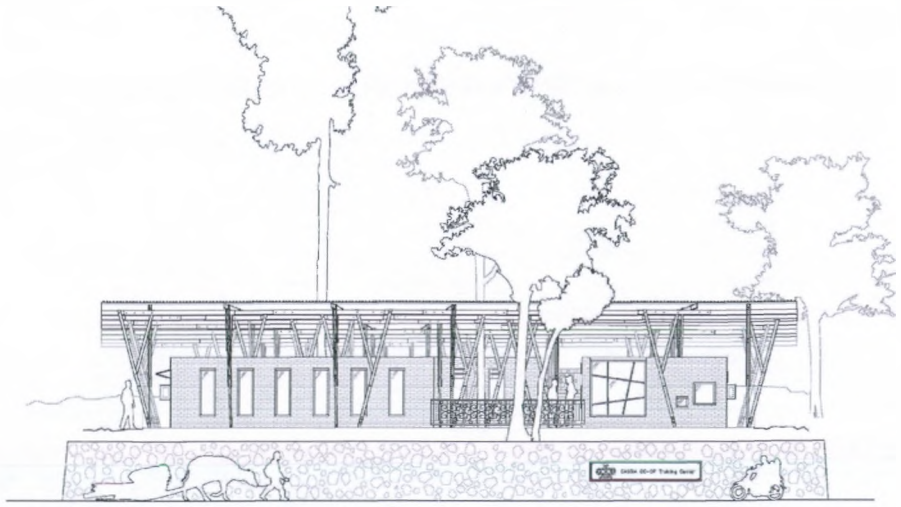


Figure 2.4.1 - Cassia Co-op Front Facade *[TYIN. 2012]*

"The Cassia Co-op Training Centre has become a unique centre with ambitions of being better than its competitors, not only in quality but first and foremost in ethics. The centre wishes to set a new standard in how to run a socially well-functioning enterprise; local farmers and workers will receive proper payment, a decent healthcare program and have access to schools and education. Also, the factories of Cassia Coop will be sanitary and safe." *[Cifuentes, F. 2012]*

"The project is mainly constructed from the use of two materials, namely locally crafted brick and the trunk of the cinnamon tree. As mentioned, the trunks are a by-product from the cinnamon production and they have a low status among the locals. *TYIN* decided that the 'low status' seemed undeserved, and so they chose to utilise the trunks in everything from the main construction to the interior of the centre. The finesse of craftsmanship found on, amongst other things, the doors and windows of the centre, is said to be some of the most impressive they have witnessed during their projects." *[TYIN tegnestue Architects. 2011]*

As illustrated in the photos in Figure 2.4.2, "the local community was quite involved in the construction of this project. Local skills amongst the community were utilised as well as expanded upon in the skills development part of the project." *[Ransome, J. 2015]* See Figure 2.4.2 where the team leaders are showing the locals how

to do a certain job. "Construction may take longer in the greater scheme of things. However, the skills learned will be used to develop their own homes or maintain the building." *[Ransome, J. 2015]*

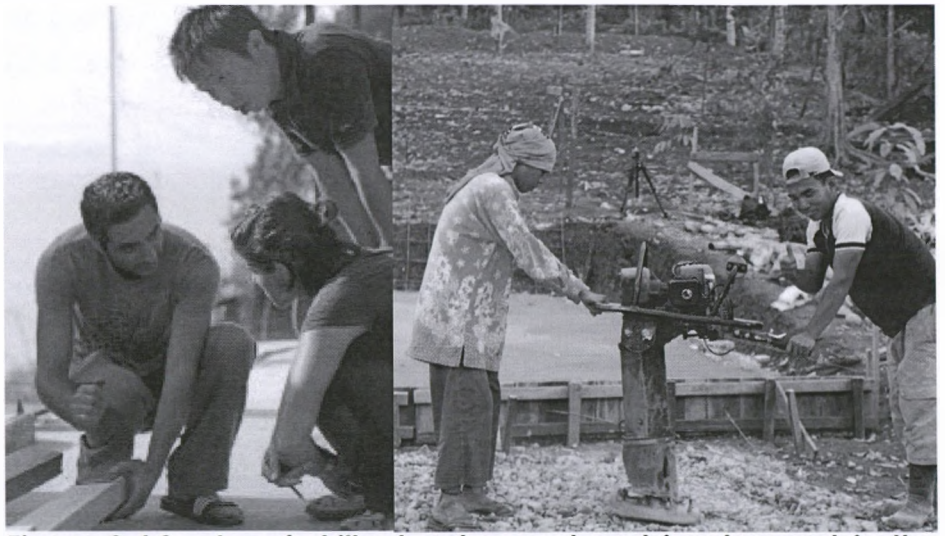


Figure 2.4.2 - Local skills development and involvement in the construction process *[TYIN tegnestue Architects. 2011]*

"The main idea behind the project was the classic concept of a light wooden construction on a base of heavy brick and concrete. The wooden construction gives a feeling of being within a cinnamon forest. The Cassia Co-op Training Centre is built around a pair of mighty Durian trees, with a scenic view of the beautiful Kerinci Lake in the front and with its back towards the lush cinnamon forest. A major challenge was to create a naturally ventilated climate beneath a roof surface of no less than 600 square meters. Knowledge and experience gained in former projects greatly aided the design team in achieving this, through the use of thermal mass, reduction of sun rays and maximised eaves." *[Cifuentes, F. 2012]*

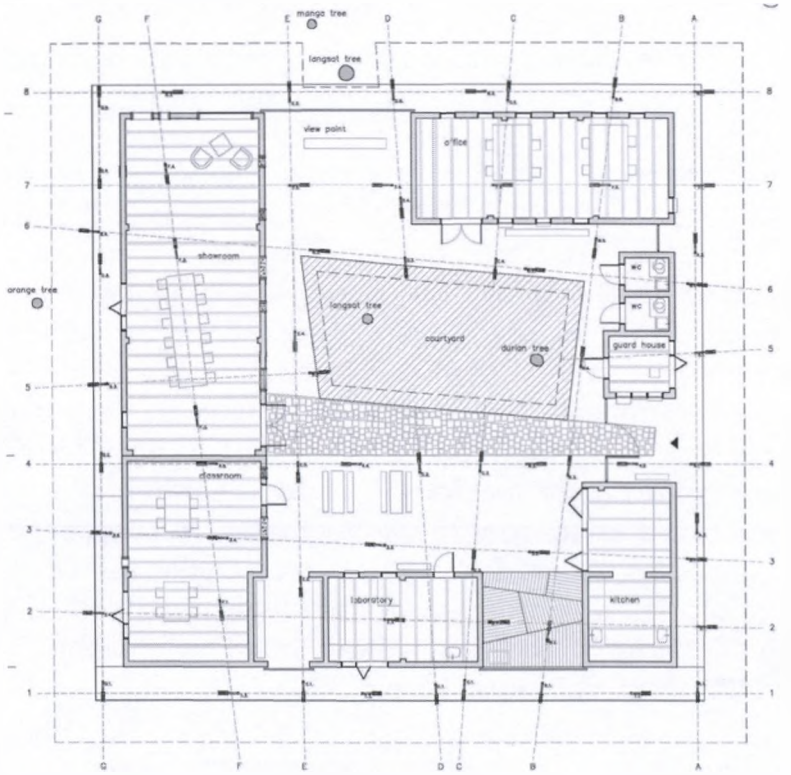


Figure 2.4.3 - Cassia Co-op Floor Plan *[TYIN tegnestue Architects. 2011]*

As seen in the plan above, Figure 2.4.3, the centre has been designed with a courtyard; that is big enough for the water buffalo to walk around in, as these animals are frequently used in the industry. The design also promotes the natural ventilation of the buildings by allowing the flow of air in between them.

2.4.2 OPPI KOPPI COMMUNITY CRECHE - PRECEDENT STUDY

Project: Oppi Koppie Community Creche
Date: 2011
Architect: Design.Develop.Build
Location: Prince Alfred Hamlet, Western Cape, SA

"One of the enduring and commonly recognised legacies of South Africa's apartheid system is its spatiality. Implemented as an armature of the Afrikaner nationalist government, this effectively rewrote the configuration of human settlement according to principles of racial segregation." *[LOW, I. 2011]* As in the case of many cities, towns and farm areas across South Africa, the divide created then is still visible now. As previously stated the Vingerkraal community originated as a result of the forced segregation and the people have remained there since. In this case, the location of the community creche is within a poor, rural area with access to only basic services, the design team came together, working with the community the programme realised unique encounters between people of difference, seemingly separated by continents, class and professional ability. *[LOW, I. 2011]* Using a Design Build Research (DBR) approach where design and production are directly linked forced the design team to interact with their 'clients' in the decision-making process of the project.

"The design relies on a strategic assessment of materials, labour and community needs" *[LOW, I. 2011]* "This project considered these three aspects in the design and employed the same concepts that have also been considered in the design and development of the proposed centre." *[Ransome, J. 2015]*

"This project was built largely by a group of German students that volunteered to come over to South Africa and work with *Design.Develop.Build*. They did involve the community members to a certain point. However, it can be argued that the inclusion of largely prefabricated elements in the build (such as the roof as shown in Figure 2.4.4) not be all that beneficial to the rural community." *[Ransome, J. 2015]*

Figure 2.4.4 - The Oppi Koppi Community Creche *[DIGEST. 2011]*

"While the community will benefit from the creche when it is finished, without the skills and knowledge of the building materials and methodology, they will not be able to maintain the building correctly when the *Design.Develop.Build* group has left." *[Ransome, J. 2015]* This very important factor is often overlooked in these

community projects, especially when foreigners come into an environment they are not familiar with, take over for a few months and leave a state of the art building behind, feeling very proud of themselves for helping the poor in Africa. This is not always the case and while many of these associations have good intentions, without the knowledge of maintaining such buildings the community often can't fix things that break as they simply do not know how to.

"Teaching the locals the skills they require to build the new techniques that are introduced through these types of projects is the correct approach. Not only does it allow them to maintain the new community building but they too can use those skills in other applications, and this too opens doors in the future." *[Ransome, J. 2015]*

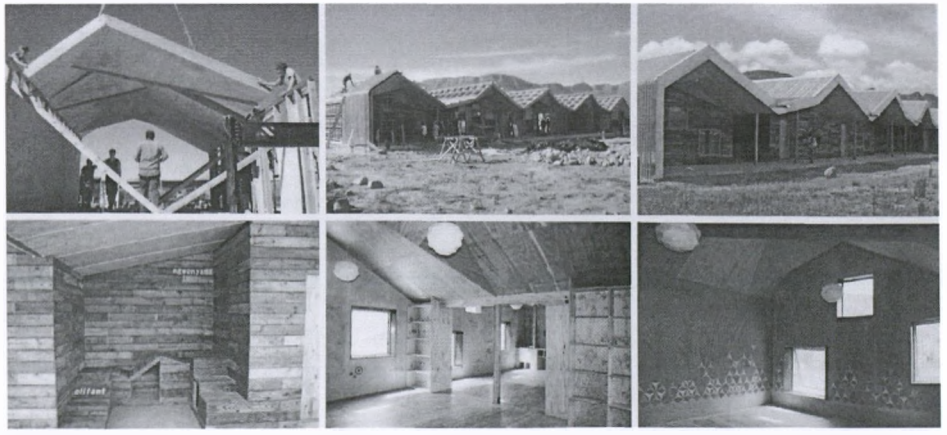


Figure 2.4.5 - The Oppi Koppi Community Creche Building Process
[DIGEST. 2011]

Personal Conclusion:

As with the Cassia Coop Training Centre, this project has also emphasised the great importance of community built projects and the right way to go about achieving them. The emphasis lies on the fact that construction methods used must be able to be done by the community and not have to be outsourced.

2.4.3 THE VINGERKRAAL COMMUNITY

Vingerkraal is an informal settlement which is situated within the Bela-Bela Municipality of the Waterberg District. It is isolated from economic activity and basic infrastructure within the municipal area. *[Waterberg Government. 2014]* Due to this, there has been a proposal for the relocation of this community to one of the existing economically viable nodes. The outcome of this proposal will be determined and considered by Council. While some residents may be open to the idea of relocation, many may not want to move. For this reason, a proposal for community inclusion has been included in this research report.

As shown in Figure 2.4.6, the relationship between Vingerkraal Village and the proposed site can be seen. Only 12km from the site via sand road, a relationship with this village will be easy to establish.

The municipality has said, "Development at Vingerkraal must be considered very carefully due to the high development costs at the present location. The high costs of service delivery to this area will have a meaningful impact on the development process. Water supply is also inadequate for the existing community." *[Waterberg Government. 2014]* For this reason, alternative building methods have been researched and included in the design of the proposed centre and the aim is for this information and associated skills development to be passed onto the local community so that they can use them to better their circumstances. There are many ways to provide an area of the village with basic service that are not brought in from the municipality.

As it stands, the services provided for Vingerkraal's residents are as follows:

- Electricity - 4%
- Sanitation - 0%
- Water - 63%
- Refuse - 2%

As outlined in Chapter 8, *Technical Documentation,* methods and construction details have been outlined for achieving some of these basic services using natural methods and available materials.

About Vingerkraal:

Area: 1.14km²
Population: 827 (728/km²)
Households: 147 (129/km²)

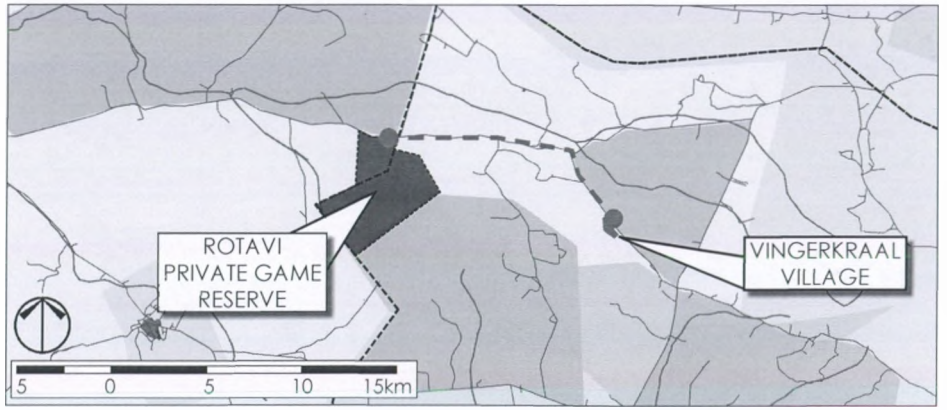


Figure 2.4.6: Vingerkraal Village in Relation to the Site *[Graphic by Author]*

Figure 2.4.7 - The Vingerkraal Village and Figure-ground Illustration

[Graphic by Author]

2.5 SECTION CONCLUSION

From the research outlined in this chapter, it can be deduced that a project such as a community led Rhino breeding and ranger training facility would thrive in the proposed area. The various components of the project will work well together to form a rich, community-based project. By combining community, Rhino breeding, game ranger training as well as a passive building approach to the architecture, the community will be enriched in all spheres and the knowledge of the community members will grow drastically.

As explained in section 2.1, the reason for designing this centre around the breeding of White Rhino specifically is not only due to the poaching epidemic but also because of the lack of Rhino breeding in the country as a whole. It would be ideal for a successful Rhino breeding farm to thrive in South Africa than for the Rhino to all be flown to Australia to start a similar project there.

While breeding the Rhinos will increase the population numbers, other measures of protection and conservation need to be accounted for to ensure the safety and well-being of the animals. Game Rangers play an important role in the conservation of all wildlife throughout the world and thus introducing a facility whereby anyone, not only the community, can come and get their qualifications to become a game ranger and protect our wildlife is necessary. Not only will this facility provide training for people to become game rangers, but it will also bring in income from the fees paid by those who wish to do their training at this facility. These can then be put back into the running of the centre and account for some of the high fees associated with Rhino breeding.

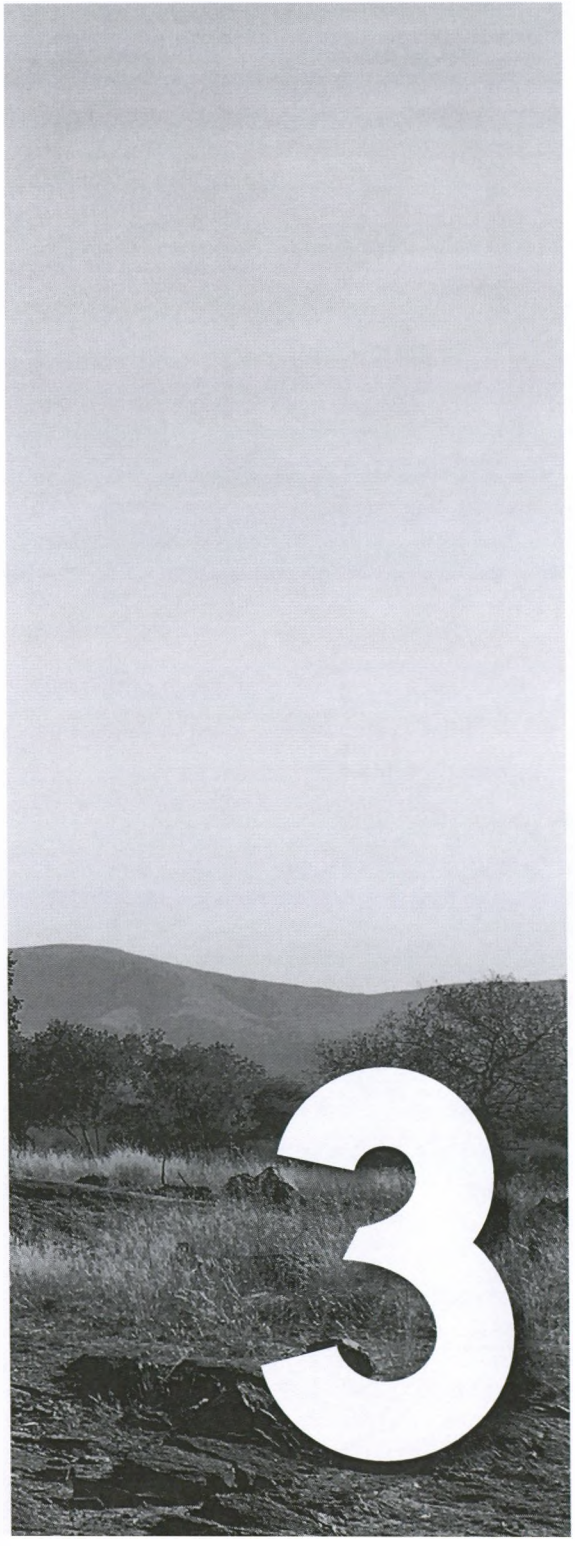
The community will play a large role in the development of this centre, not only has it been proven that community involvement from the start of a project leads to a sense of worth and ownership but it will also open doors for many of the community members that are currently without jobs. As outlined, there are many skills to be learned in the development of this project, from building techniques to an expanded knowledge of the wild and how to conserve it.

Overall, the viability of the project is positive, while the site is rural and municipal resources are in place, it is still important to design for the conditions that come with the location. Electricity to the area can be unreliable at times and thus using alternative building methods so that the comfort levels and lighting rely on natural sources rather than electrical supply is important. By using the natural materials available and a passive design approach, the building can function optimally with little or no outside input.

Is it possible for architecture to bring Humans and Rhinos together to repopulate the endangered White Rhino species and, in the process, create a community project that enriches the community of the Waterberg District in Limpopo?

INTRODUCTION

SITE LOCATION,
CONTEXT & ANALYSIS



CHAPTER INDEX

An Introduction to the Site pg 56

Understanding the Context pg 58

Section Conclusion pg 72

3.1 AN INTRODUCTION TO THE SITE

Introduction and Overview of the Site Location:

Due to the nature of the animal dealt with in this project, the White Rhino, the site choice was important and had to lend itself to the occupancy of this animal. For maximum breeding success, the Rhino needed to be in its natural habitat, or as close to as possible. As previously mentioned, the architecture will be the medium for which the world of the human and the world of the Rhino will meet. This centre will give the opportunity for the users to experience nature and the White Rhino within an existing natural landscape that attracts different user groups to move through the site and experience a different journey.

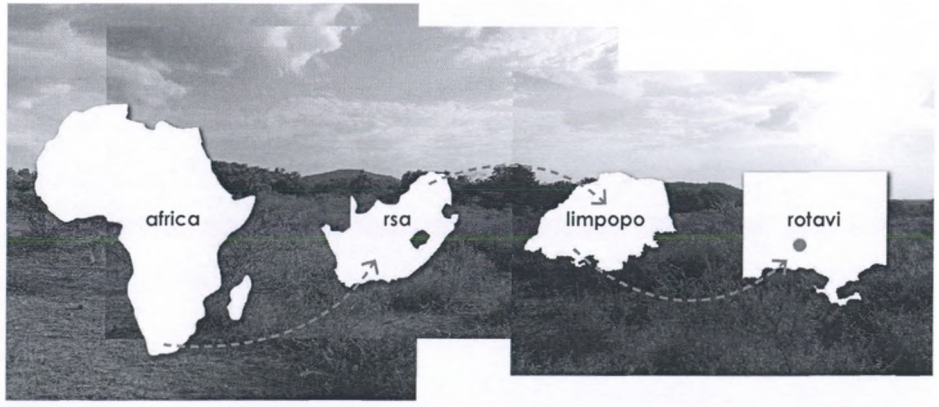


Figure 3.1.1: Existing "Conservation Belt" (Highlighted in Green, Outlined in Red) in the existing context. *[Graphic by Author]*

The centre is proposed to be on *Rotavi Private Game Reserve* in the Waterberg district of Limpopo, South Africa. This farm specifically was chosen not only due to the readily available access to the site but also because of its location. As seen in Figure 3.1.2, the

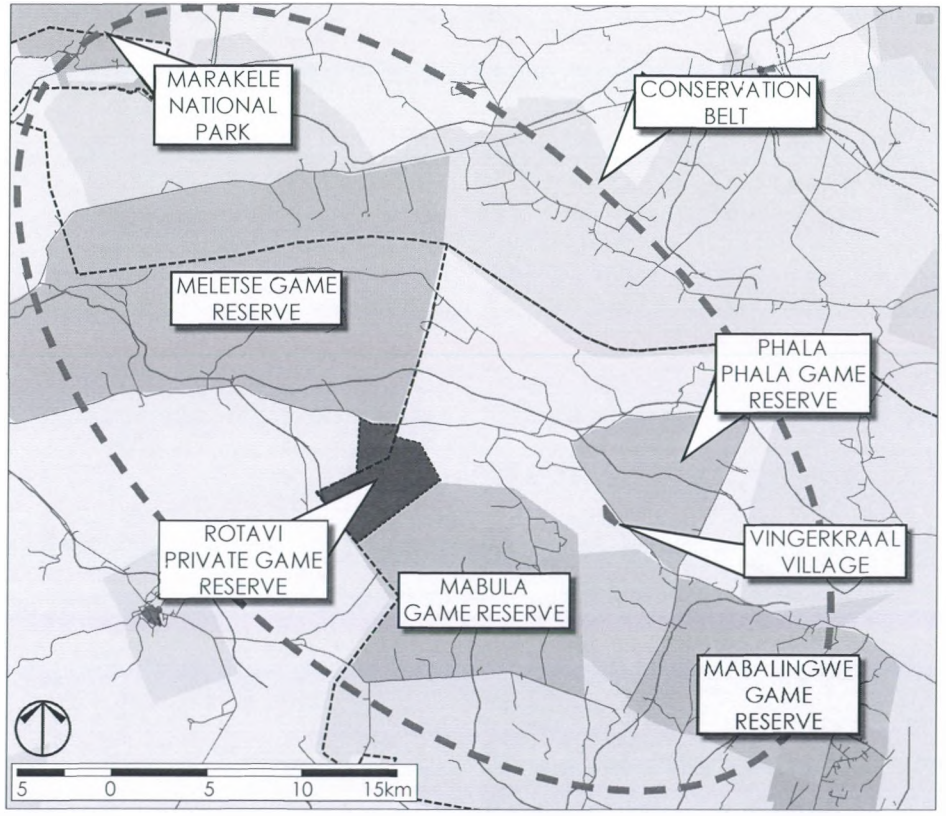


Figure 3.1.2: Existing "Conservation Belt" (Highlighted in Green, Outlined in Red) in the existing context. *[Graphic by Author]*

location of the farm lies in the middle of a "conservation belt," the conservation areas outlined in green. The Waterberg was the first region in the northern part of South Africa to be named as a "Biosphere Reserve" by UNESCO and thus contributing

to the conservation of the area is an important design factor. *[SA Venues. 2015]* "The main characteristics of Biosphere reserves include the interconnection of conservation, development, and logistical support. Traditionally confined conservation zones are outpaced through appropriate zoning schemes, combining core protected areas with zones where sustainable development is fostered by local dwellers and enterprises with often highly innovative and participative governance systems. The focus of these areas is on a multi-stakeholder approach with particular emphasis on the involvement of local communities in management as well as fostering dialogue for conflict resolution of natural resource use and the integration of cultural and biological diversity, especially the role of traditional knowledge in ecosystem management. A Biosphere Reserve demonstrates sound sustainable development practices and policies based on research and monitoring as well as acting as sites of excellence for education and training and participating in the World Network." *[UNESCO. 2014]* Other factors contributing to the choice of the site location are that the natural habitat of the area matches the requirements for the White Rhino's habitat and White Rhinos are already indigenous to the area. In addition to this, this area is not associated with the Kruger National Park, which is where the majority of the Rhino poaching in South Africa has been recorded.

The exact location of the site on the farm was chosen due to a number of reasons. The proximity to the main road and existing separate entrance to the farm was the first reason. This provided the opportunity to create a separate entrance from the private game farm while still being close enough to the main road for ease of access to the site. The chosen site is punctured with an existing road the leads directly from the farm's entrance gate. This means no additional road infrastructure will need to be incorporated into the design, thus imposing on the natural landscape less. The topography of the site has a gentle slope and lies within a catchment area of the rainwater runoff from a nearby 'koppie'. Thus allowing the incorporation of a small holding dam to be included in the design to provide a water source for the Rhinos and other animals in the vicinity. Lastly, the site is relatively clear of trees, allowing the buildings to have been designed around the existing fauna and flora and thus approaching the design with a sense of sensitivity to the landscape.

3.2 UNDERSTANDING THE CONTEXT

"Limpopo is South Africa's northernmost province, lying within the great curve of the Limpopo River. It is a region of contrasts, from true bushveld country to majestic mountains, primaeval indigenous forests, unspoilt wilderness and patchworks of farmland." *[South Africa Info. 2015]*

Limpopo is slowly becoming increasingly popular among tourist destinations in Southern Africa. There is an abundance of wildlife as well as many different tourist attractions and destinations. These include some of the countries best game farms and lodges, both public and private, as well as many conservancies dealing with animal conservation and awareness. Visitors to Limpopo can expect to experience a range of cultural, traditional and historical activities and sites. Making it even more popular amongst Gauteng residents as many of the destinations are only one to three hours drive from Johannesburg or Pretoria. The Government of Limpopo makes it a mission to create an economic environment "conducive to sustainable economic growth, environmental justice and an improved quality of life for all" by becoming a preferred eco-tourism destination. It, therefore, practices responsible tourism according to the principles of the *Fair Trade in Tourism Charter. [Simm, C. 2015]*

"When it comes to agriculture, Limpopo is very rich, from vast quantities of fruits, vegetables, cotton and citrus plantations in the eastern and northern areas respectively to livestock farming and hunting in the drier western and northern region." *[South Africa Info. 2015]*

The Waterberg Biosphere is a unique wilderness area of South Africa yet to be fully discovered. The ecosystem is characterised as a dry deciduous forest or 'Bushveld' and within the district, many game reserves, both national parks, and private farms, can be found. With a bonus of being a Malaria-free area, it has become one of Limpopo's most popular eco-tourism attractions.

Figure 3.2.1: Waterberg, Limpopo Locality Map. *[Graphic by Author]*

The Waterberg, or *Water Fountain* in English, is a mountainous area of approximately 15 000km² and is the north-east district in the Limpopo Province of South Africa. *[South Africa Info. 2015]* "A large portion of the Waterberg's bushveld country has been given over to the Conservation of Elephants, White Rhino, Leopard and Buffalo. Landowners have restored land overgrazed by cattle, to attract and protect antelope, giraffe, hippo, and other species, with an accompanying rise in the trend of eco-tourism, and the marketing of the Waterberg as prime game country." *[SA Venues. 2015]*

3.2.1 CONTEXT SITE MAPPING

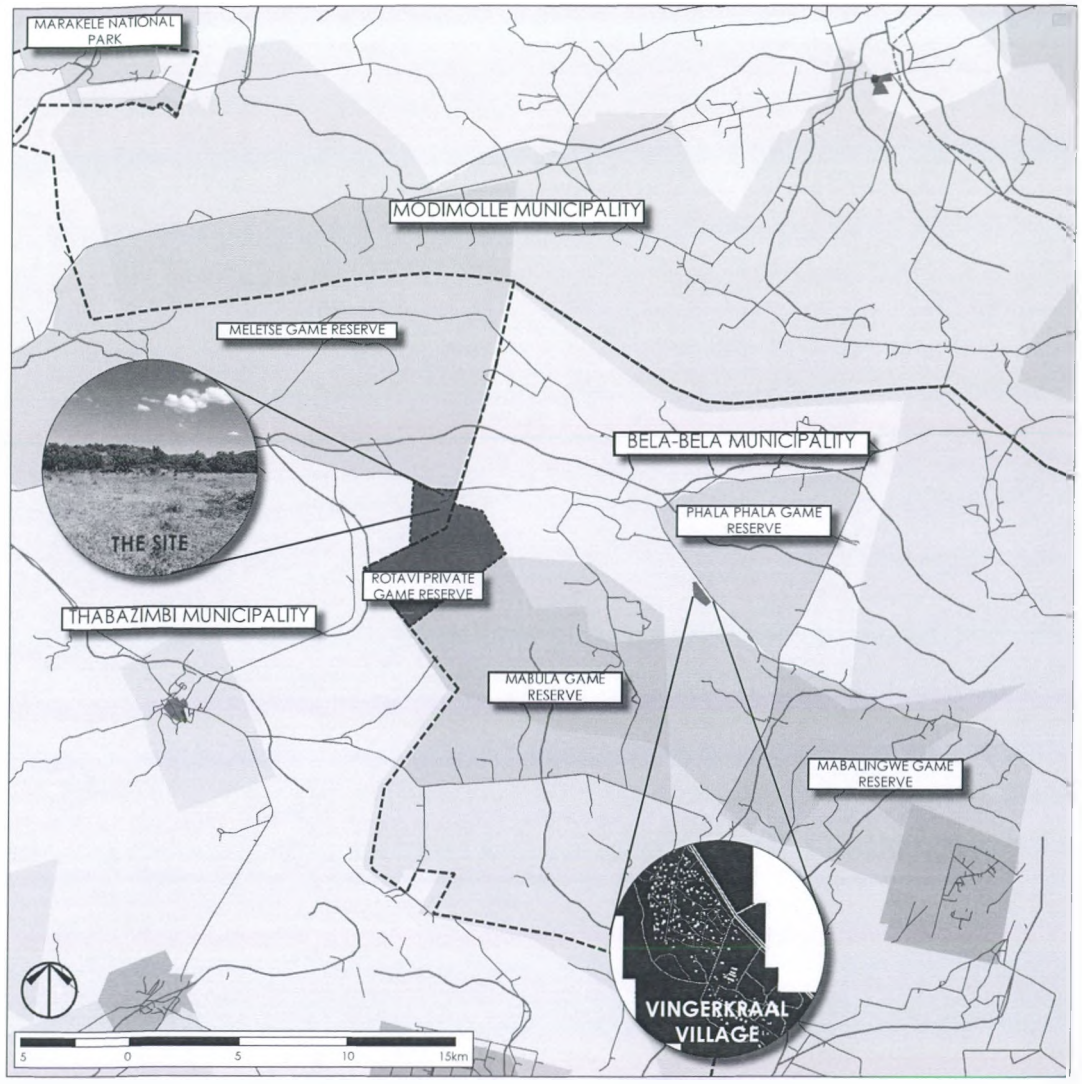


Figure 3.2.2: A Map Highlighting the Conservation Areas & Population Density Around the Site *Scale as per scale bar [Graphic by Author]*

The map illustrated in Figure 3.2.2 specifically highlights the conservation areas as well as the population density of the surrounding area. Both of these factors led to the choice of site placement. As mentioned previously, the site was placed in the middle of a "conservation belt" (see green areas on the map) within the Waterberg District and in an area where the population density is extremely low resulting in much lower noise levels which are beneficial for Rhino breeding. *[Webb, J. 2014]*

Vingerkraal Village is shown in red on the map, and it is evident that it is close enough to the site to create a link to the proposed centre. This was explored further on pg 50 in the previous chapter.

LEGEND_

- RIVERS
- CONSERVATION AREAS
- MAIN ROADS
- ARTERIAL ROADS
- DISTRICT MUNICIPALITY BOUNDARY
- RAILWAYS

POPULATION (inhabitants/km²)

<1	100-300
1-3	300-1000
3-10	1000-3000
10-30	>3000
30-100	

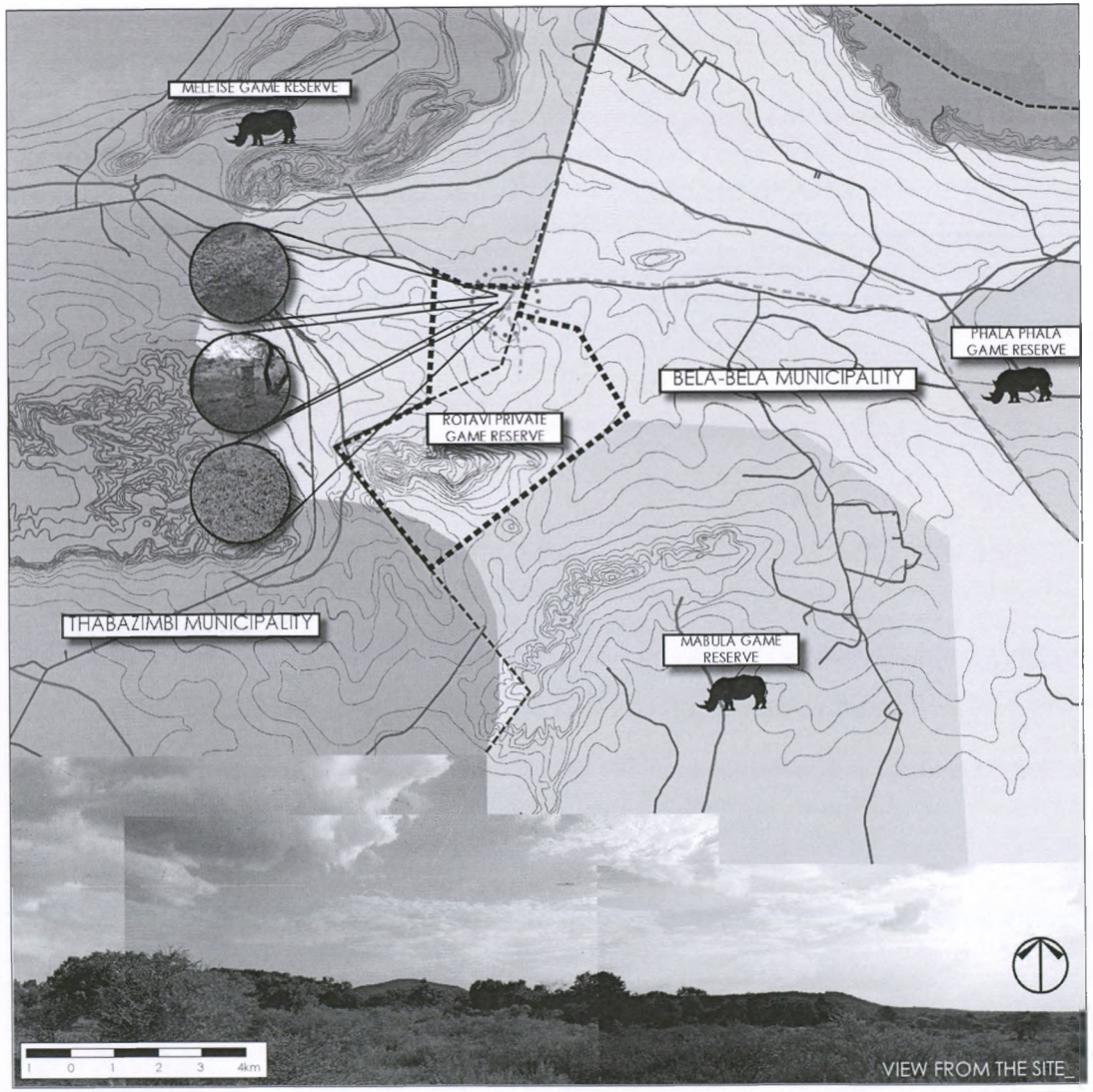


Figure 3.2.3: A Map Highlighting the Vegetation Types & White Rhino Presence Around the Site *Scale as per scale bar [Graphic by Author]*

Due to the nature of the proposed project and the emphasis placed on the breeding of White Rhino, it was necessary to indicate their presence in the surrounding area to show that the species is not foreign to the Waterberg. The map in Figure 3.2.3 illustrated this presence, however, due to the sensitivity of the species and current poaching, numbers for the amount of Rhino on each farm are not available, and the farm owners were not willing to give out this information.

The different vegetation types in the area have also been shown, placing importance on the soil types and whether or not they are suitable for building. The layer shown, that was taken from the *Limpopo GIS* website, indicate soils with a high clay content over and around the site, including the area of Vingerkraal Village. The importance of this layer has been further explained on page 84, concerning material choices for the building of the centre.

LEGEND_

- RIVERS
- CONSERVATION AREAS
- ARTERIAL ROADS
- DISTRICT MUNICIPALITY BOUNDARY
- CONTOURS (20m INTERVALS)
- ESKOM ELECTRICAL CABLES
- Rhino PRESENCE*

VEGETATION TYPE

- soils - high clay content
- well drained soil
- soils - strong texture
- rocky areas

*Due to sensitivity, numbers are not available

The contours illustrated in the map are at 20m intervals, depicting a gradual slope at the point of the site.

3.2.1 IDENTIFYING THE USER GROUPS

VETERINARY STAFF:

According to a few of the farm owners in the area, the nearest wildlife vets are either in Rooiberg or Thabazimbi and the specialist vets are called out from Pretoria.

There are many farms in the area with vast amounts of wildlife species, especially dangerous animals. As a result, a vet would be highly utilised in the area, whether it be for general check ups and vaccinations or emergency procedures. Many farmers even said they would be willing to pay a premium for this convenience.

The inclusion of facilities for on-site veterinary staff would allow for immediate treatment should there be any emergency. The opportunity also arises for research and monitoring of the Rhinos to ensure that breeding occurs at the optimum rate for the greatest success of the species.

The farm has existing housing that can accommodate these staff members to live on site with their families.

GAME RANGERS:

As mentioned previously in Chapter 2, the presence of game rangers goes hand-in-hand with dangerous animals, such as White Rhinos. The proposed centre includes a training facility, equipped to train up new Rangers, allow existing Rangers to increase their skill level and for people to come and get their certification in game management.

The game ranger training centre will be an integral part of the centre as a whole. Visitors will have the opportunity to move through this facility and learn about what game rangers do regarding the protection of the Rhino species. It will also educate them on the importance of these people in the wildlife conservation industry.

An on-site dormitory has been included in the design for Rangers that are on call or on duty for a close range of access to the Rhinos. The farm also has various types of existing housing that can accommodate some the Rangers to live on site, either alone or with their families.

LOCAL COMMUNITY:

The local community, both the farm owners, as well as the community members of Vingerkraal Village, will be involved at the centre to a certain extent.

The centre will provide jobs for some of the local community members as there will be various roles and positions that will need to be filled. Those that want to get involved with the building of the centre will also take part in the skills development programme.

The aim for the involvement of the local farmers is intended to be for gatherings and information seminars monthly. The local farmers that were spoken to all agreed that workshops or seminars based on snakebite protocol, fire break burning strategies, etc. would be highly beneficial and that they would be willing to host these occasionally, providing information that they specialise in to enrich the community.

VISITORS, TOURISTS AND VOLUNTEERS:

The tourism industry is booming in the Waterberg area. Not only does the centre provide people with the opportunity to view White Rhinos in their natural habitat but it also allows them to learn about the species while they are there. The centre is a destination and thus provides facilities for people to come and spend the entire day or weekend.

It is becoming increasingly popular for people with a passion for the wild to volunteer at various wildlife centres around Southern Africa. The majority of these people come in from overseas countries, and thus there is a huge opportunity to gain an income off this as well as getting people in to do valuable work and thus spreading the awareness.

There are two existing lodges on the farm, and thus these will be used for visitor and volunteer accommodation. The financial figures for these elements have been outlined in the viability and feasibility study in Chapter 9.

RHINOS AND OTHER WILD ANIMALS:

While this centre is aimed at the breeding of White Rhinos, there are many other wild animals that are indigenous to the area of the site. As a result, careful planning needs to be put in place to ensure that these habitats are not destroyed.

There are specific regulations and guidelines for the transportation and housing of White Rhinos. These have all been incorporated into the design of the centre to ensure that the habitat is kept as close to natural as possible for the Rhinos.

Herd, or "crash", social behaviour has also been assessed and designed for. Not only to ensure that the Rhinos are happy and healthy but also to maximise the breeding success rate.

BIRDLIFE:

There is a large amount of existing bird life on and around the site. While the centre has not been designed for the birds, they need to be considered, and their habitats need not be destroyed.

Attracting birds to the site using water, food or desired vegetation will add to the visitor experience gained by the tourists and volunteers. Many people enjoy birding as a hobby and thus birding hides have been incorporated into the design.

3.2.2 THE ENVIRONMENT

The Terrain:

Figure 3.2.4 [Ransome,

Solid and loose rock on site:

This large rocky outcrop largely influenced the placement of the chosen site and the northern border. Rhinos do not like steep slopes and/or loose rocky surfaces. The majority of this rock face is hard, solid rock with small brittle pieces lying loosely on top of it. It is therefore not suitable for use in the building.

Figure 3.2.5 [Ransome,

Veld Grass Coverage:

The majority of the site is well covered with veld grass that is plentiful and in good condition. These are optimum conditions for the White Rhino's habitat as they are grazers. The Rhino holding pens thus are placed within the grassy landscape.

Figure 3.2.6 [Ransome,

Eroded Soil with Minimal Grass:

Due to previous overgrazing from cattle and the presence of staff housing in the area, some of the ground has suffered minor erosion. While this is not an extreme case and the erosion is only surface level, the placement of the site dam and water troughs in the Rhino pens has been influenced by this.

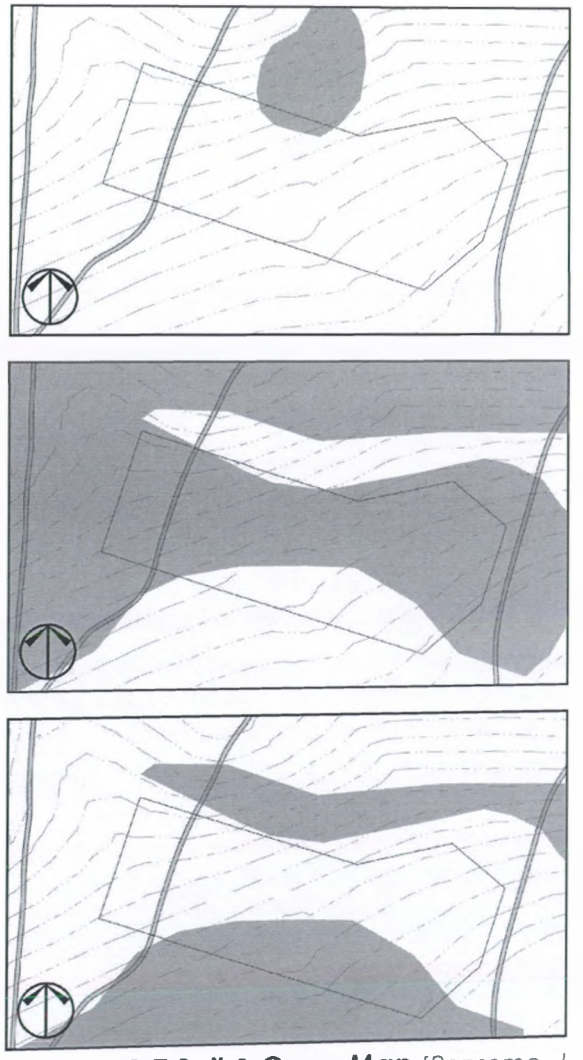


Figure 3.2.7 Soil & Grass Map [Ransome, J.

The Fauna and Flora:

Figure 3.2.8 *[Ransome,*

Small Shrubs:

While the ground is scattered with many small shrubs and bushes, these have not influenced the design. The approach has rather been to landscape the outdoor areas and transplant or put in new plants and shrubs where they are desired. While the courtyard area has been designed to maintain the natural "bushy" feel, movement paths and gathering areas have dictated the placement of garden beds.

Figure 3.2.9 *[Ransome,*

Big Trees:

There are a number of established trees on the site. Careful placement of the buildings has been made to ensure the preservation of these trees by addressing the design as a landscape-sensitive project. Rhinos are shade-loving animals due to their sensitive skin, for this reason, the placement of their pens has also been determined by the existing trees on the site. Additional trees have also been added where needed. The height of the trees on site also determined the height of the buildings, with a stealth design approach, the buildings fit into the landscape and predominantly below the tree line.

Figure 3.2.10 *[Ransome,*

Medium Sized Thorn Shrubs:

As with the large trees, many of the established shrubs on the site have been maintained and kept where they are. A range in plant size keeps the natural look and feel of the bush evident in the new centre and preserves the habitats for small creatures living within these plants.

3.2.3 THE CLIMATE

The Climate:

As illustrated in the graph below in Figure 3.2.11, the average rainfall on the site is during the summer months with little or no rain in the winter months. The high volume of rainfall versus the relatively low number of rainy days in the summer months indicated heavy rainfall. This result in high surface runoff, with little seepage, often contributing to erosion. That being said, the veld and bush in the summer months are extremely lush and plentiful for the game on the farm to feed off.

Due to the lack of rainfall during the winter months, a site dam has been proposed as part of the design to catch surface runoff from a nearby "koppie". This will not only provide a water source for the animals but has been used for evaporative cooling in the design. There is an existing borehole near the site that can provide drinkable water for use within the centre.

Figure 3.2.12 indicates the average monthly temperatures showing that the site experiences very hot summer days, warm summer nights, warm winter days and very cold winter nights. This is a contributing factor for the approach of passive design within the building. Electricity is unreliable in the area due to the rural location and thus achieving comfort levels within the building have been met through thermal massing and evaporative cooling in the design.

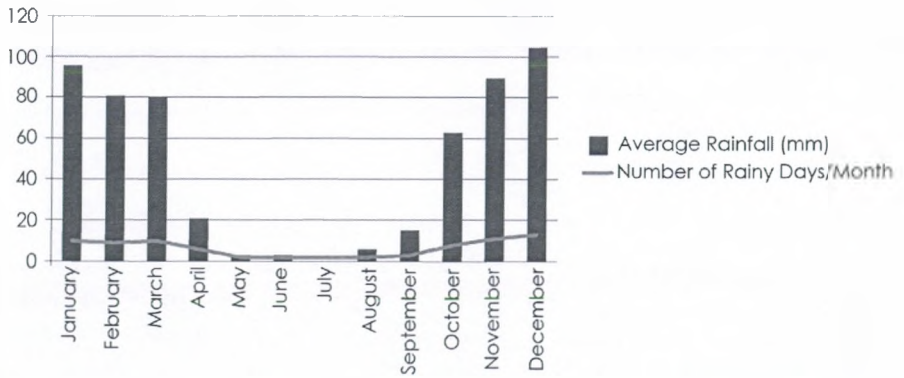


Figure 3.2.11: Average Monthly Rainfall and Number of Rainy Days in Rooiberg, Limpopo *[World Weather Online, 2012]*

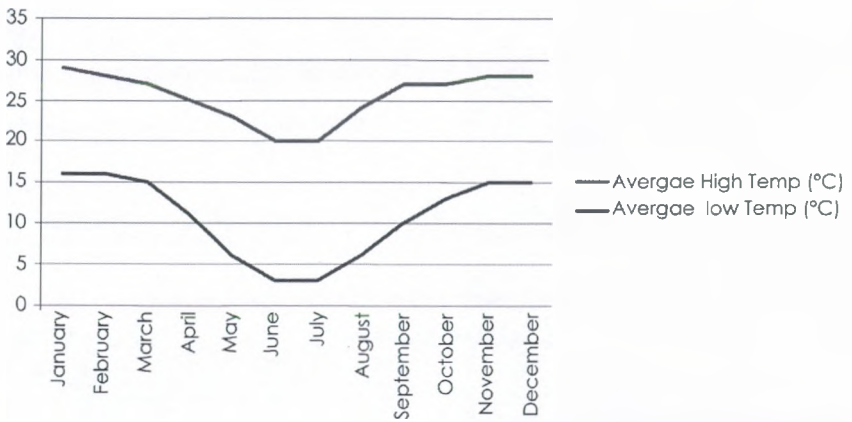


Figure 3.2.12: Average Monthly High and Low Temperatures in Rooiberg, Limpopo *[World Weather Online, 2012]*

The Sun:

The thermal mass design relies on the sun, in both the winter months when warmth is required at night and summer months when cooling is needed during the day. For this reason, the sun angles and sun paths for the site have been documented as per Figures 3.2.13 and 3.2.15. This information has assisted in the placement of thermal mass walls, overhangs and shading devices and window openings in the design. Existing established trees on site have also been considered in the design, where some lose their leaves in winter, like the Marula tree in Figure 3.2.14 and some don't.

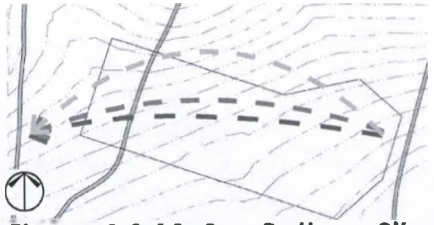


Figure 3.2.13: Sun Path on Site *[Graphic by Author, Information: JALOXA. 2011]*

As the design was especially sensitive to existing trees, their effect on the building performance needed to be assessed. More specific calculations can be found in Chapter 8, Technical Resolution.

Figure 3.2.14: A Marula Tree on Site: The Difference Between Summer and Winter *[Ransome, J. 2016]*

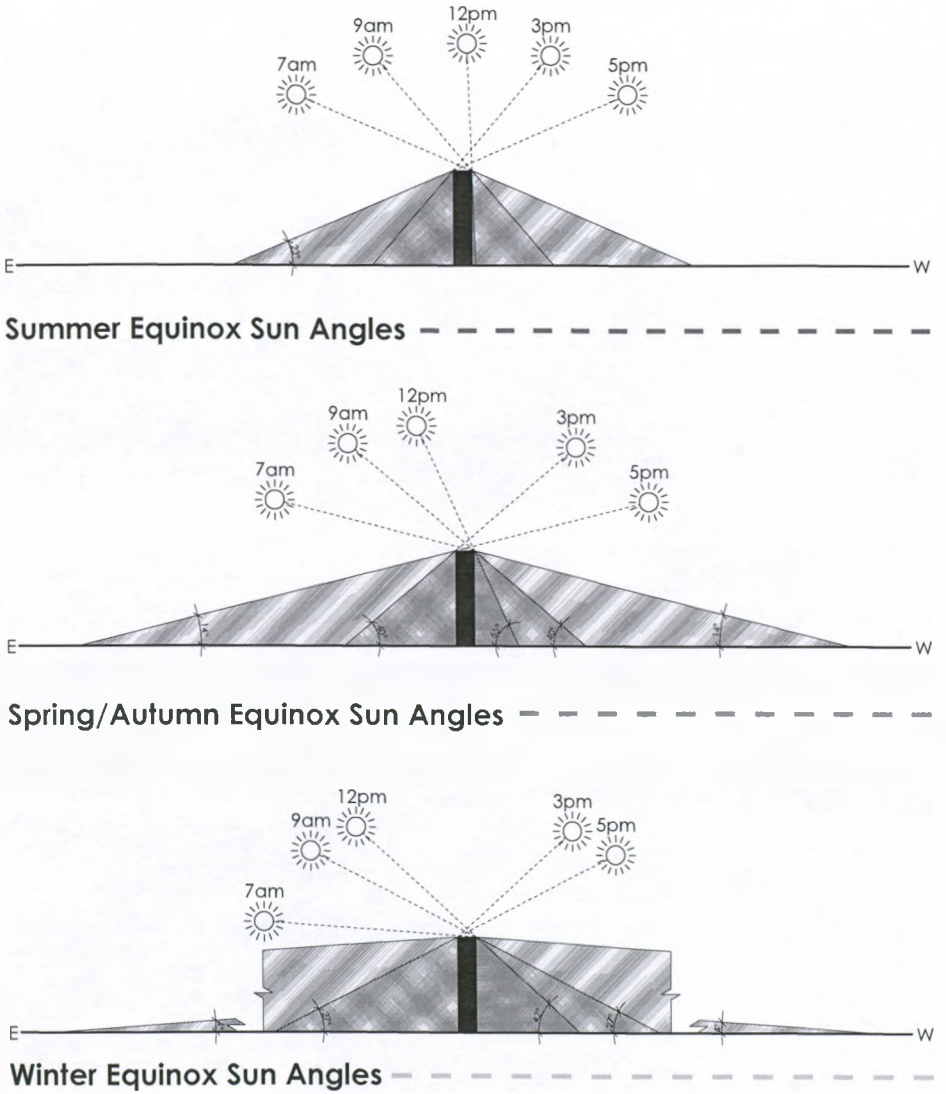


Figure 3.2.15: Quarterly Equinox Sun Angles and Shadows *[Graphic by Author, Information: JALOXA. 2011]*

3.2.4 SITE PANORAMAS

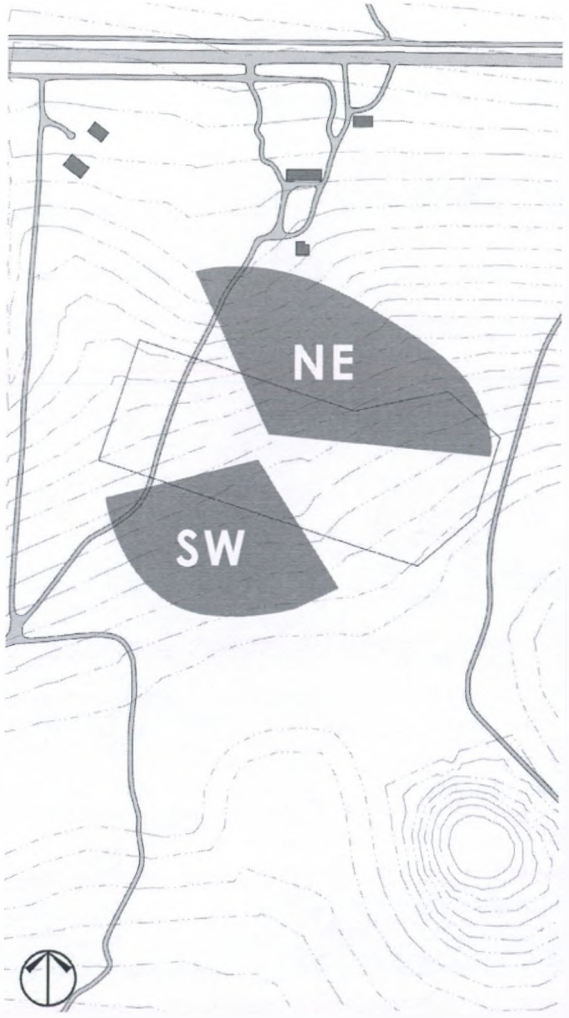


Figure 3.2.16: Location of NE and SW Panoramas *[Ransome, J. 2016]*

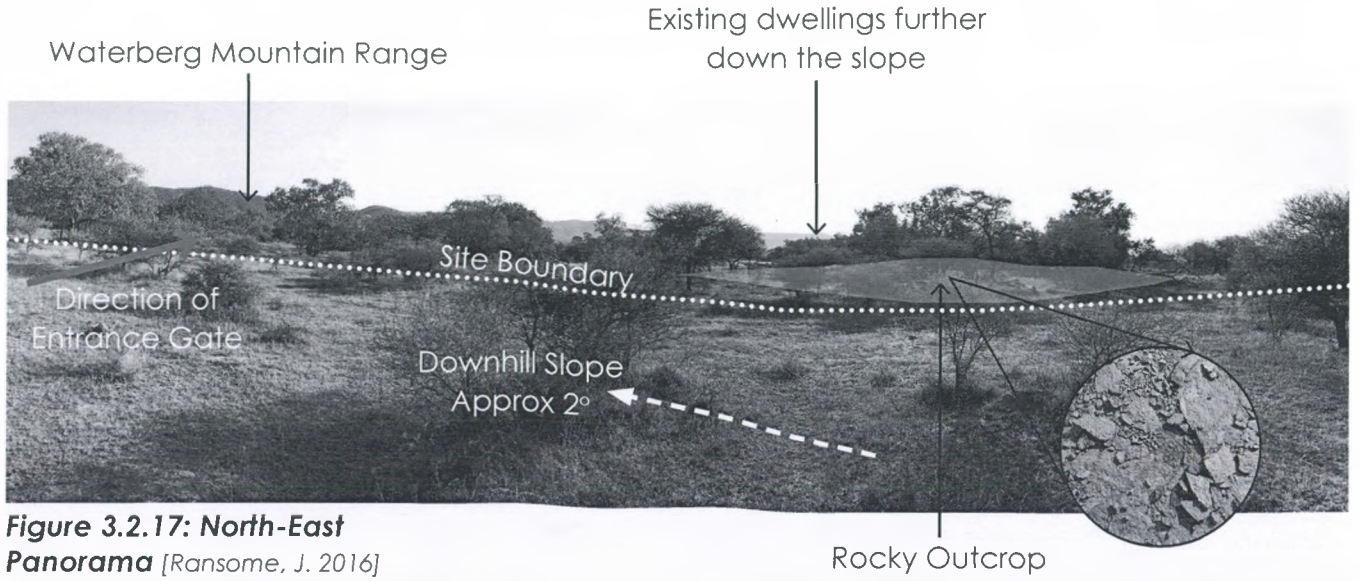


Figure 3.2.17: North-East Panorama *[Ransome, J. 2016]*

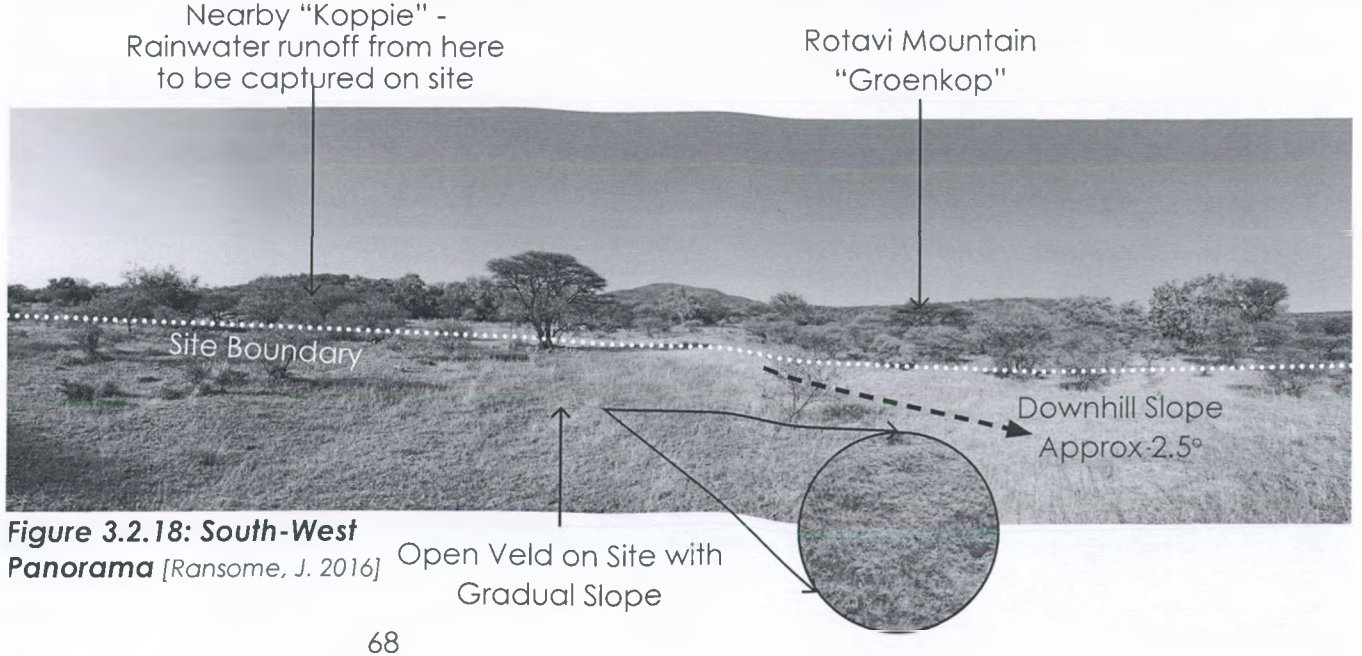


Figure 3.2.18: South-West Panorama *[Ransome, J. 2016]*

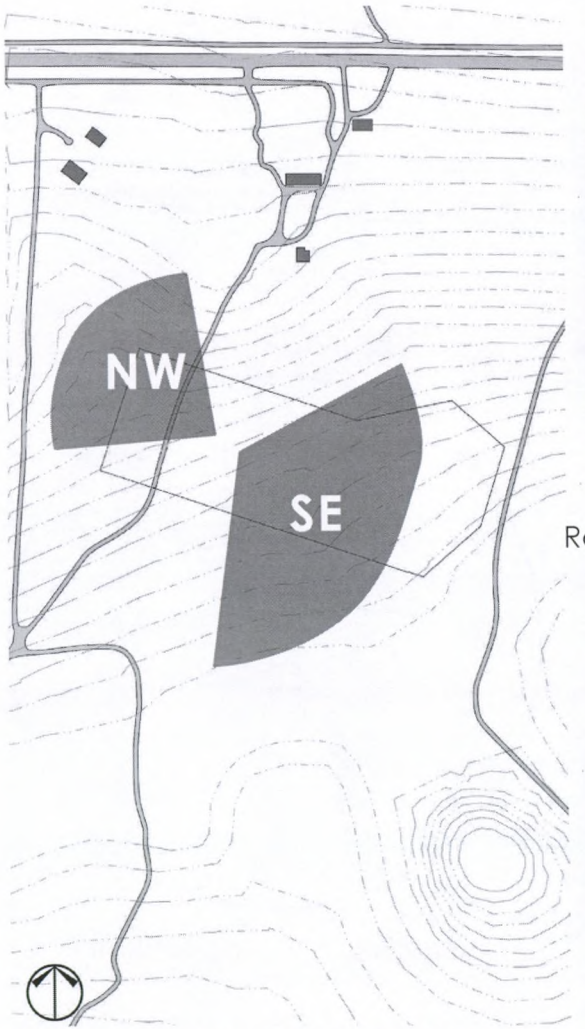


Figure 3.2.19: Location of NW and SE Panoramas *[Ransome, J. 2016]*

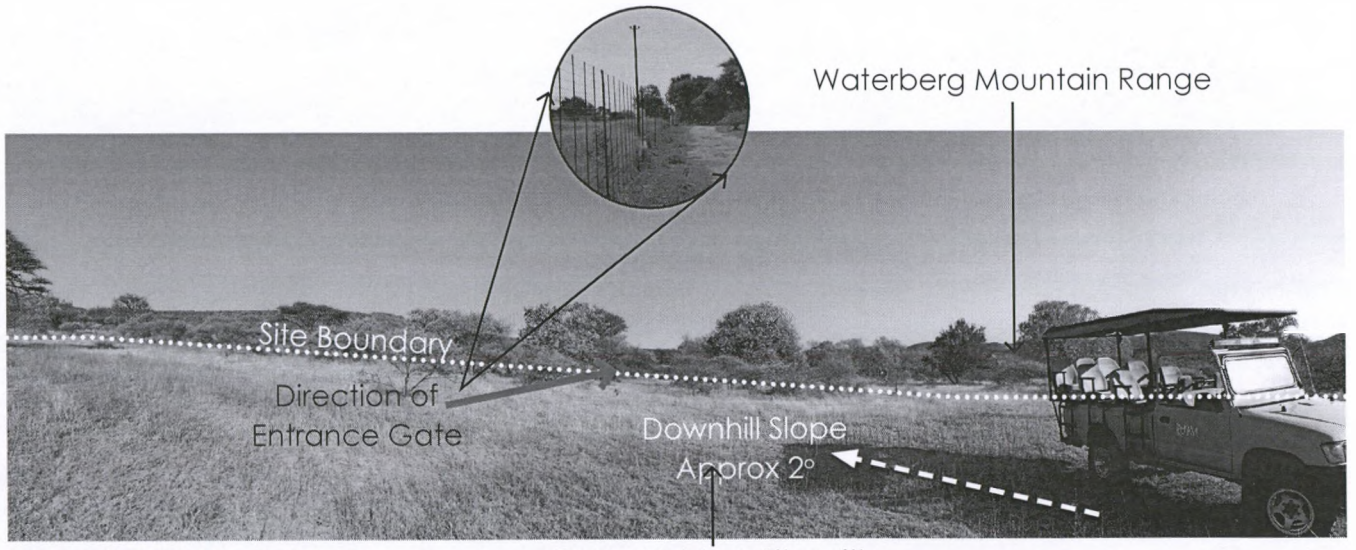


Figure 3.2.20: North-West Panorama *[Ransome, J. 2016]*

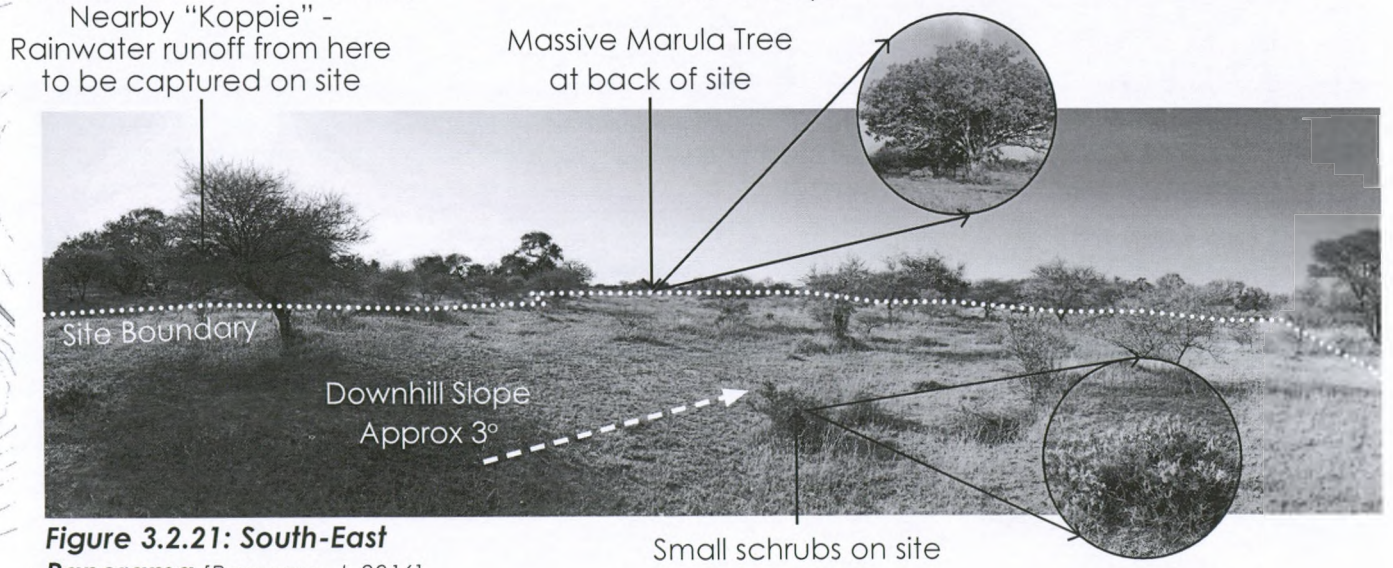


Figure 3.2.21: South-East Panorama *[Ransome, J. 2016]*

3.2.5 EXISTING BUILDINGS AROUND THE SITE

Figure 3.2.22: The Old 'Ommi Draai Winkel' Shop *[Ransome, J. 2016]*

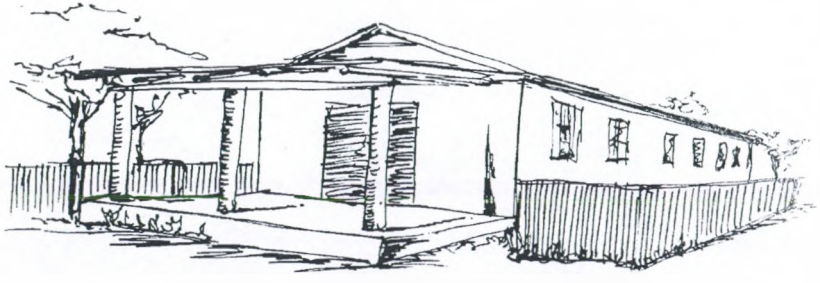


Figure 3.2.23: The Old School *[Ransome, J. 2016]*

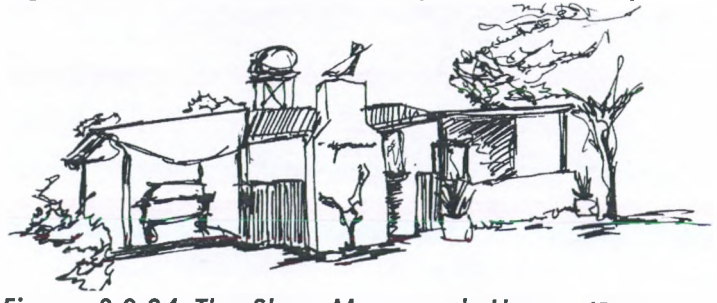


Figure 3.2.24: The Shop Manager's House *[Ransome, J. 2016]*

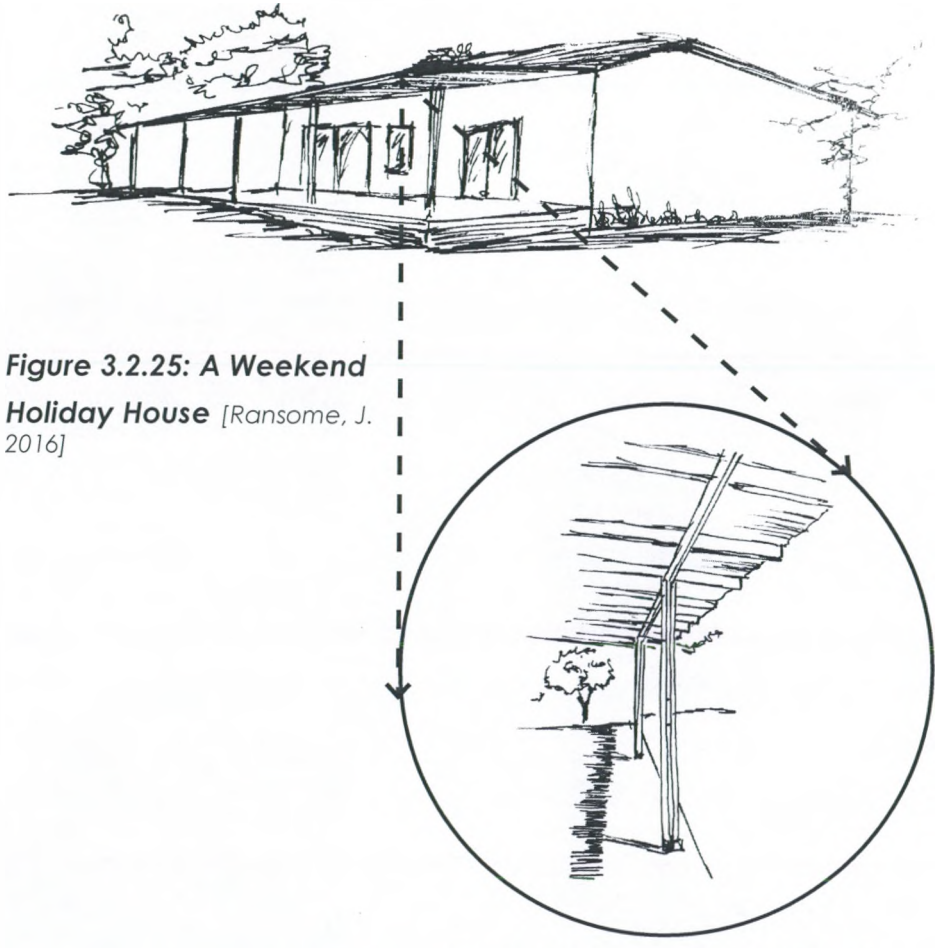


Figure 3.2.25: A Weekend Holiday House *[Ransome, J. 2016]*

Figure 3.2.26: Patio Roof Detail *[Ransome, J. 2016]*

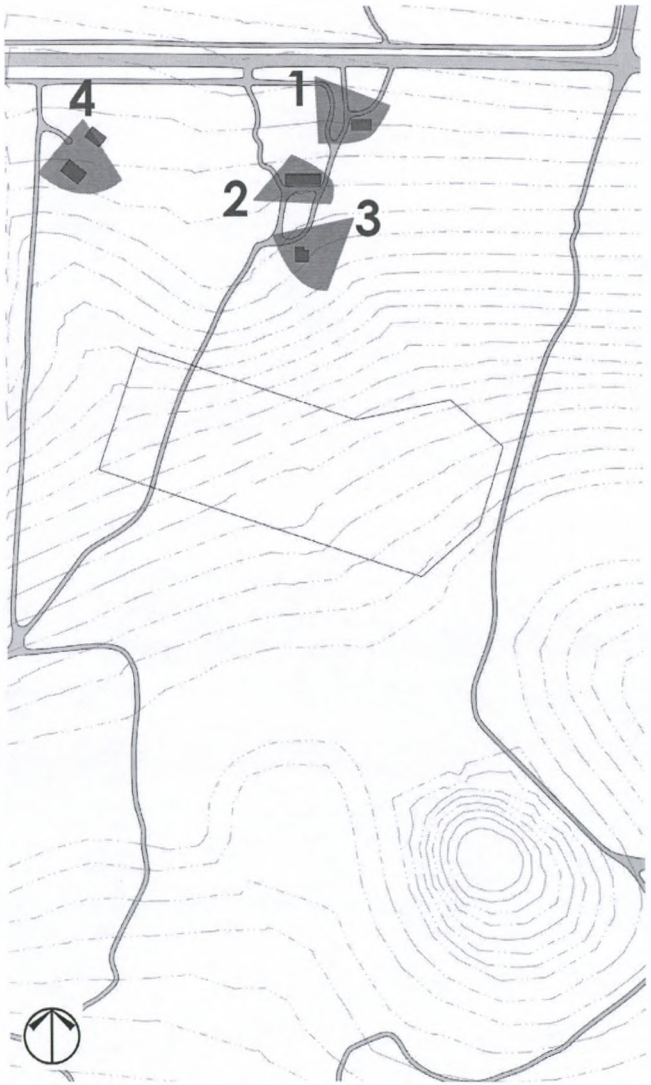


Figure 3.2.27: Site Map Indication Position of Sketches *[Ransome, J. 2016]*

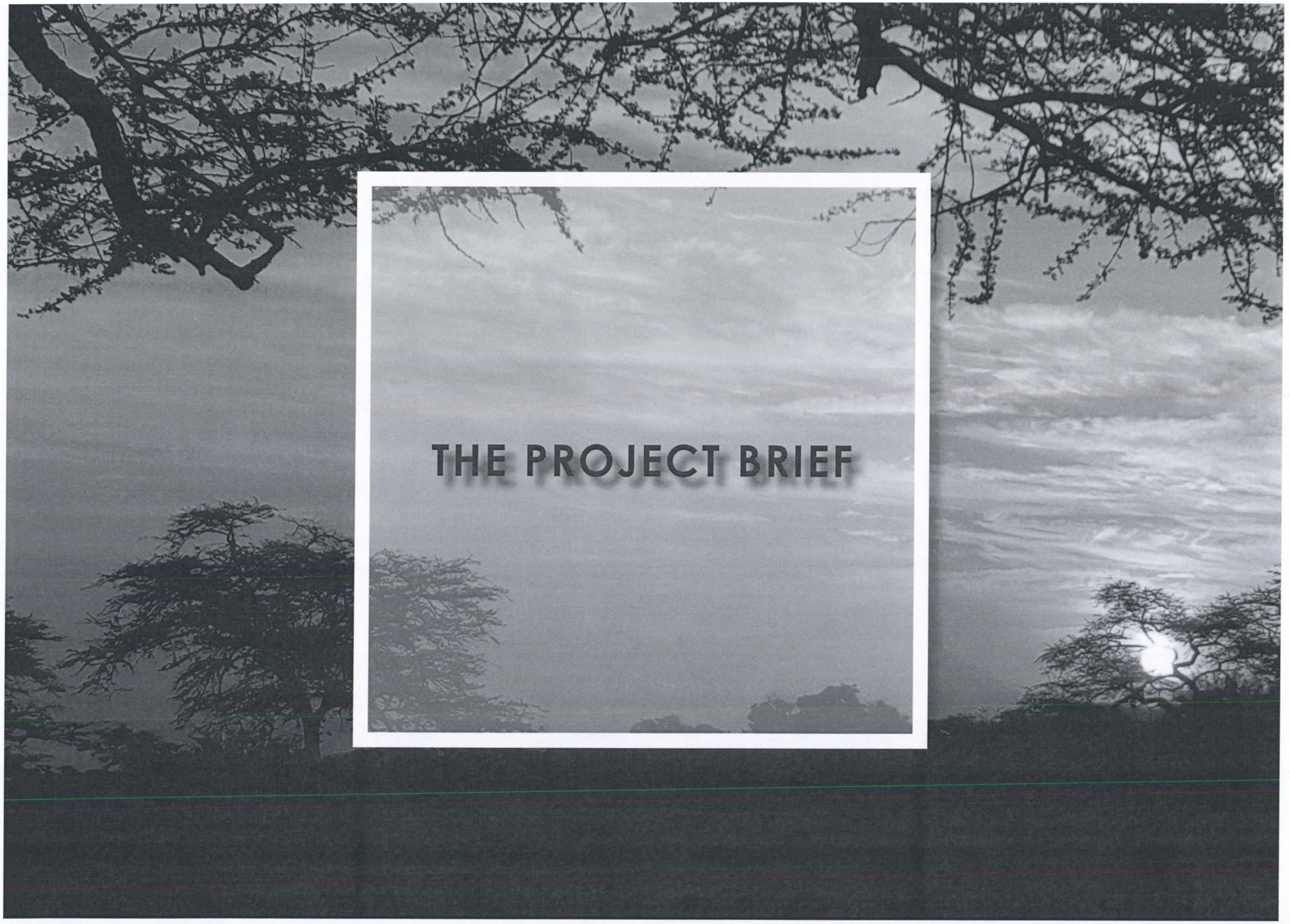
The sketches shown are of buildings around the chosen site, they all represent a similar style of building, brick walls with dual pitched corrugated iron roofing. The farm, *Rotavi Private Game Reserve*, has a brick making press, and most of these buildings have been built using these concrete block bricks.

Gum poles and latte fencing are also evident in most of the buildings. The building of these structures was done by people that live and work on the farm as permanent staff so their skills were utilised.

Overall, they are simple structures that have been built well. The vernacular of many buildings in the area is similar to these with the addition of thatch roofing. Thatch is extremely popular in the greater area, especially in bush lodges, although it comes with a huge fire risk.

3.4 SECTION CONCLUSION

From the research outlined in this chapter, it can be deduced that a project such as a community led Rhino breeding and Ranger training facility would thrive in the proposed area, the Waterberg District in Limpopo. The facts have been stated that the location of the site is ideal for the centre. Although this same project could be done at numerous locations throughout Southern Africa, the high volume of game, farms, and communities in the Waterberg make for an ideal setting. The best outcome of such a project is that it would expand to other areas of Southern Africa, increasing the breeding of Rhino to numerous locations and allowing the species to thrive in the wild. However, the start of the project is proposed to be in the Rooiberg area of the Waterberg District.


THE PROJECT BRIEF

4

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4.1 PROGRAMME VISUALISATION

The nature of the project is such that it demands a connective approach to the joining of the different programmes involved in the centre. The brief was developed in response to the theoretical research, outlining what needed to be incorporated in this centre and further, how the different programmes can come together to form a cohesive project.

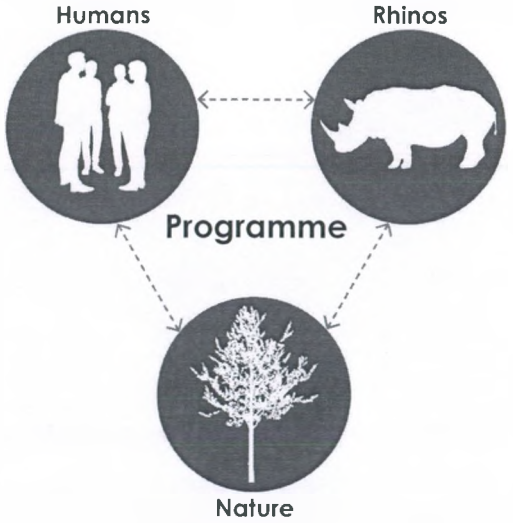


Figure 4.1.1: Programmatic Links *[Ransome, J. 2016]*

As mentioned previously, this research report seeks to find a link between humans, Rhinos and nature, see Figure 4.1.1, and how they can coexist in one place, forming the programme of the centre. The inclusion of community and visitors has further strengthened this link. While the various programmes, the Vet, the Ranger training centre and the Restaurant may function alone. Linking them through an 'experiential walking journey' through, around, and above the buildings allows the user and/or visitor to experience and learn about the different programmes of the centre.

While these connections have been made, various thresholds have also been put in place to ensure the safety of both the humans and the Rhinos. Only qualified staff and Game Rangers will have physical access to the Rhinos. Visitors and other members of the community and/or staff will only have visual access to the Rhinos. The programme has also been arranged in such a way so that various areas are kept private, for staff access only. Other areas are incorporated into the 'experiential walking journey' through the site. This allows the visitors to view into certain rooms and experience different exhibits and views along their way.

The aim of this journey is for the user to gain an experience and understanding of nature. To further educate them on the life of the Rhino and the threats faced as well as to highlight the importance of Game Rangers in the wildlife industry. To enhance this experience, nature has been brought into the design of the building. The earth reused in the rammed earth construction, as well as on the outer northern side, bermed to connect to the existing landscape and instil a sense of stealth in the design. The climate and environment have been considered in the incorporation of macro systems to create thermally efficient and comfortable buildings. In addition to this, the journey allows the visitor to discover nature on a magnified scale, exposing them to the various conservation practices that have been outlined in this research report.

4.2 ACCOMMODATION SCHEDULE

VETERINARY FACILITIES:

Surgical Suite 170m²
- secure access
- Rhino prep area
- vet prep area
- viewing windows
- Rhino moving "trolley"
- external access for Rhino
- X-ray area
- X-ray viewing room
- a post-mortem examination area
- computer station
- Rhino disposal
- access to recovery pen

External Exam Area 300m²
- covered area
- work top
- Rhino crush
- food and water trough
- fenced

Recovery Pens x2 740m²
- food and water
- mud baths and shade
- vet access
- fenced

VETERINARY ADMIN FACILITIES:

Reception 70m²
- orientation and circulation

Office Areas 140m²
- open plan researchers offices
- main vet private offices x2
- kitchenette and break area
- meeting rooms
- general storage
- staff toilets

Pharmacy 80m²
- stock room
- distribution
- secure access
- public waiting area

Public Vet Facilities 80m²
- exam area/room
- helipad and hangar
- field storage room

General Requirements 80m²
- linen storage
- laundry and sterilization
- maintenance closets

RESEARCH FACILITIES:

Laboratory x2 80m²
- secure access
- workstations
- separate office access
- general storage
- viewing windows
- wash up areas
- computer stations

Rhino Horn Secure Vault 40m²
- safe door
- secure access
- ventilated room
- shelving system
- scale
- inventory computer

Resource Centre 50m²
- mini library area
- study spaces
- computer stations
- workstations
- joined with Ranger training

GAME RANGER TRAINING CENTRE:

Indoor Gym 60m²
- male and female locker room/showers
- uniform storage lockers
- cardio training area
- weight training area

Field Exit Room 48m²
- access to breeding camps
- game viewer vehicle parking
- gun safe and storage
- secure access

Recreation Room and Kitchen 55m²

Workshop 80m²
- external access
- vehicle parking
- work top benches and storage

Lecture and Seminar Spaces 140m²
- discussion style room with tables
- seated lecture venue

Counseling Facilities 40m²
- councillors meeting room
- private office

TOURIST CENTRE:

Reception and Arrival Area 150m²

Interactive Exhibition - Rangers 80m²
- game ranger related exhibition and interaction space
- circulation through ranger training facility

Toilets 150m²

Restaurant & Bar 330m²
- bar with seating
- internal table seating
- external table seating
- kitchen
- food storage
- scullery

External Walkway and Circulation
- paths and walkways around the site highlighting different views
- viewing decks
- gathering areas - fire pit etc.
- water level hide over dam
- viewing windows into various areas (labs, operating room, etc.)

Rhino REQUIREMENTS:

Food 80m²
- food storage
- food preparation
- inventory and logging system
- access to holding pens
- wet and dry storage

Delivery Bomas 1600m²
- walled boma - Rhino can't see out
- delivery ramp into boma
- truck access
- food and water troughs
- mud baths
- shade
- secure access
- surveillance tower

Calming Pens 600m²
- fenced - Rhino can see out
- food and water troughs
- mud baths
- shade
- secure access
- surveillance tower

ACCOMMODATION:

Vet Accommodation
- existing accommodation on the farm for vets and their families

Ranger Accommodation on Site 60m²
- dorm room
- 4 x bunk beds
- communal living area
- joined to the training facility
- for rangers on duty only

Ranger Accommodation off Site
- existing accommodation on the farm for rangers and their families

Visitor and Volunteer Accommodation
- existing lodges on Rotavi to be used

WATER INFRASTRUCTURE:

Site dam 800m²
- rainwater runoff from nearby "koppie" caught in this dam
- Rhino and other animal water source
- viewing deck for visitors

Rainwater Collection Ponds 300m²
- rainwater runoff from site and roofs
- various ponds
- pump system
- integrated into the design

Borehole Water Supply
- additional water source
- existing borehole close to the site
- clean, drinkable water
- pump system to circulate water

COMMUNITY INVOLVEMENT:

Community build
- skills development programme
- using local materials
- utilising local skills
- education
- alternative building methods

Community run
- job creation
- game ranger training
- general staff
- farm labourers
- maintenance and general upkeep

SITE CONSERVATION:

Sensitivity to site
- large trees and shrubs kept and designed around
- the slope of the site used in the design of berm structure
- thermally efficient building
- reusing excavated earth - returning the earth to the build
- rainwater harvesting
- additional fauna and flora added

Geothermal HVAC system
- using the earth's constant ground temperatures to regulate the internal temperatures
- closed loop system - requires no addition input of material

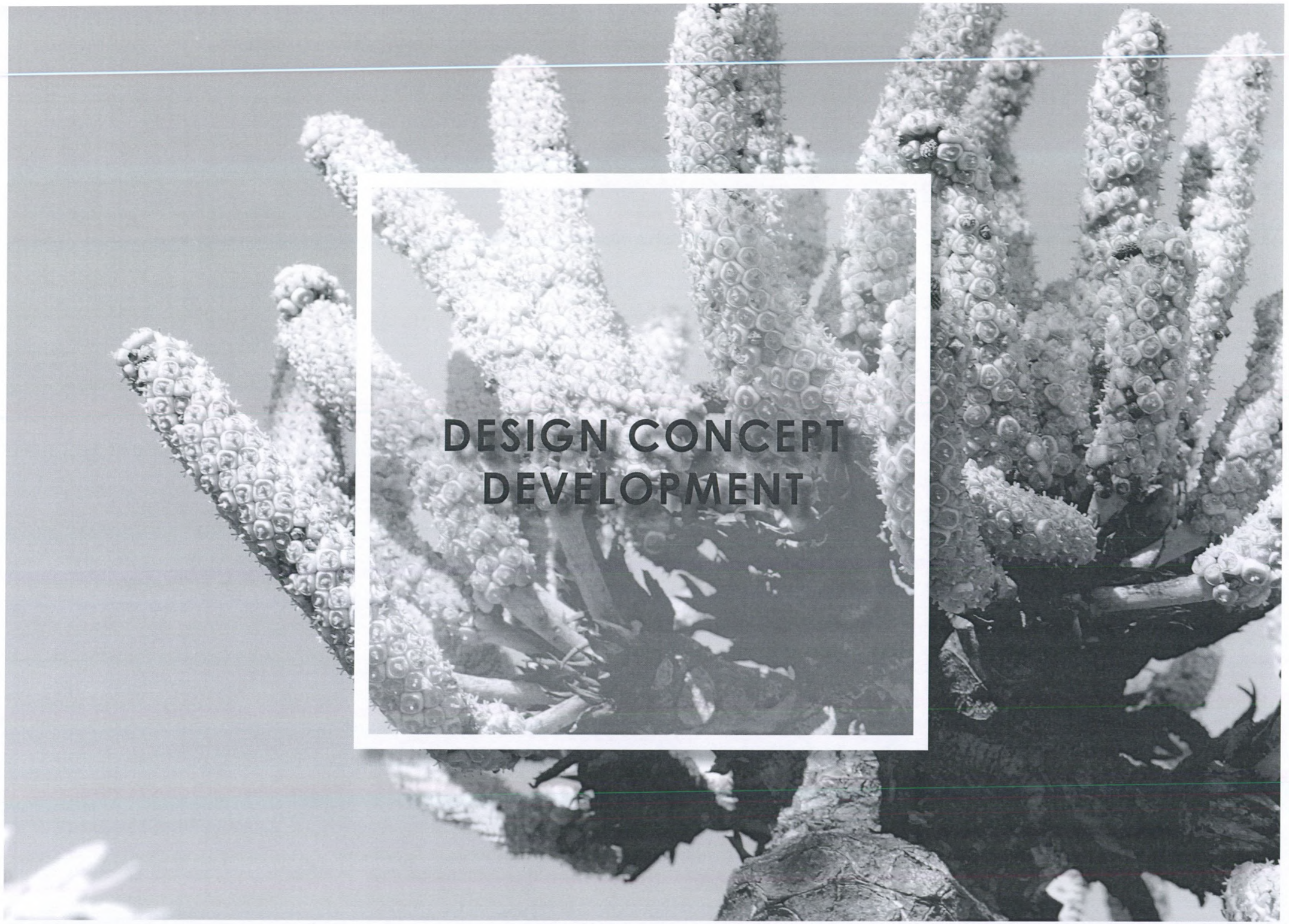
Solar power generation
- supplied for backup for unreliable existing supply
- aesthetically pleasing installation on flat roofs

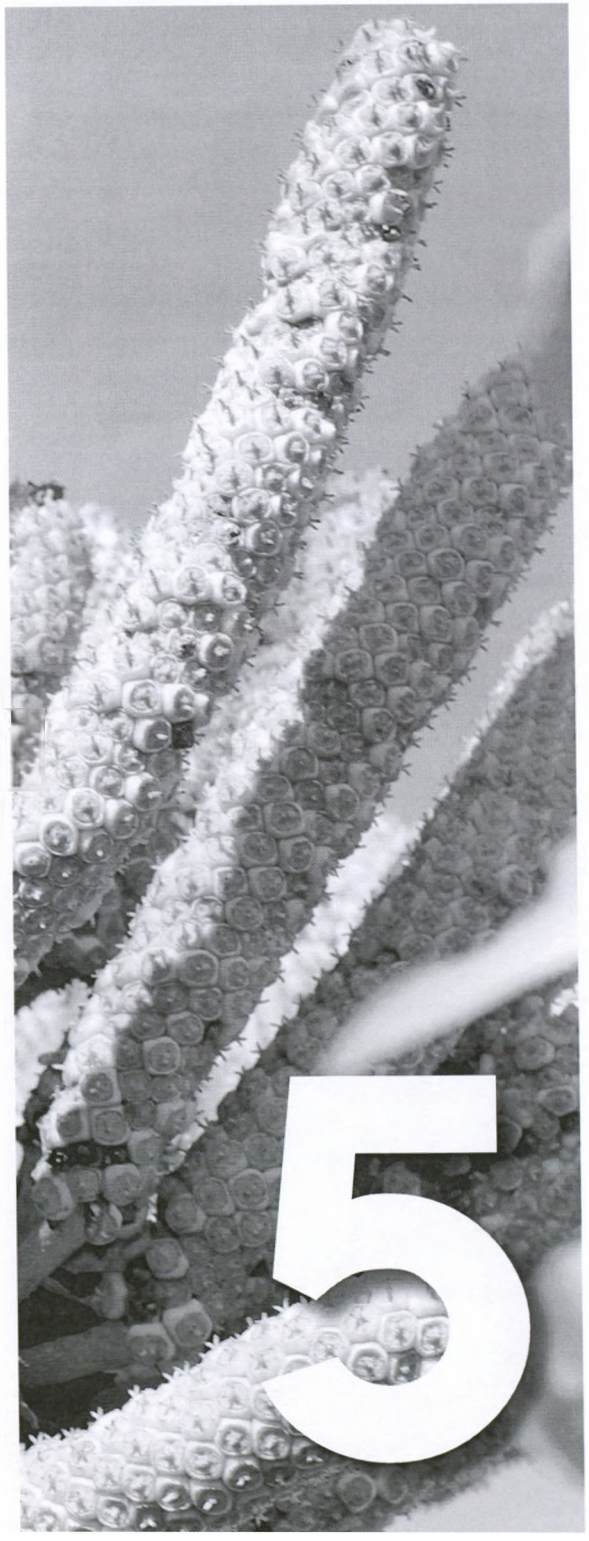
MISCELLANEOUS:

Parking 250m^2
- 20 bays

Access points
- separate staff access
- main visitor access
- entrance gate

Lookout towers
- points of elevation for watching Rhinos
- ranger and visitor access
- cooling system - planted facade, still permeable for sight, provides shade and cools air moving through
- point of reference for vertical circulation within the buildings


DESIGN CONCEPT
DEVELOPMENT



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Materials pg 84

Design Concept Theory pg 96

5.1 MATERIALS

Using Earth as a Building Material:

As illustrated in Figure 5.1.1 below, there are many benefits to using earth as a building material in the proposed centre. As shown in Figure 3.2.3 on page 61, "A map highlighting the vegetation types and White Rhino presence around the site," the soil on and around the site indicates a high clay content which is one of the most important factors for using soil in earth construction. Rammed earth construction is not the only application in which the earth from the site would be used, earth berm construction has also been incorporated into the design, both of which have been researched further and elaborated on in the rest of this chapter.

The main points benefitting the use of earth include manual labour and as a result skills development. This means that the local community members will be provided with the opportunity to learn about a material that is readily available in the area and how to build thermally efficient and structurally sound buildings with it.

Other earth, excavated from the site during the building stages or from the digging of a dam can also be used in the earth berms in the design as well as on the planted, green roof. Top soil and/ or soil with a high content of organic matter is perfect for planting and use in the top layers of the berms as it is more permeable, allowing for sufficient drainage.

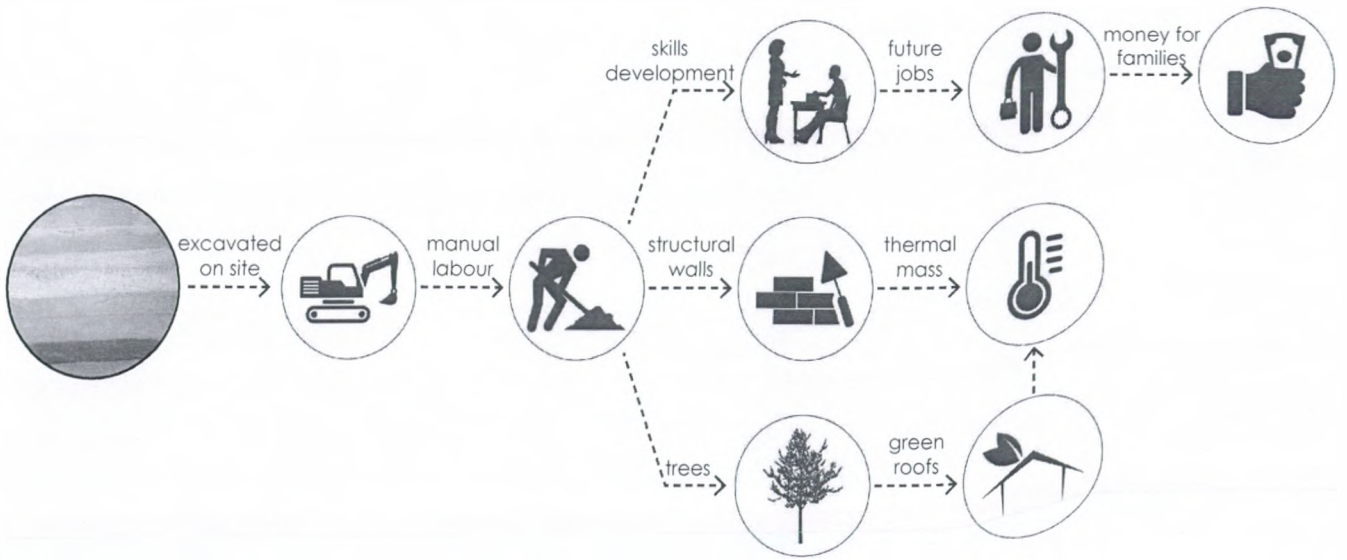


Figure 5.1.1 Building with Earth *[Ransome, J. 2016]*

Using Concrete as a Building Material:

While concrete may not be as eco-friendly as earth in the building process, there are still many benefits to using this material in the design and construction of the proposed centre; these have been illustrated below in Figure 5.1.2. By bringing in the raw ingredients for the concrete mix and using the available borehole water on site, which is suitable for drinking, allow for the concrete to be mixed on site by the building team. Many of the locals spoken to said that they have experience in building with concrete as it is such a common material used in this area.

The material has been proposed to be used for a number of different things in the construction of the proposed building. These include foundations, floor slabs, roof slabs and both berm retaining walls as well as other walls in the building, excluding the rammed earth spine walls. There is an existing cinder block press on the site that can be used for making concrete cinder blocks for use in masonry wall construction. Due to the majority of the flat roofs being planted, trafficable roofs, the structural capabilities of concrete is required. This then, in conjunction with the earth and planting on the roofs adds to the thermal mass of the building. Rammed earth walls also require concrete footings where the wall meets the ground as rammed earth does not weather well if water sits and/or pools on it.

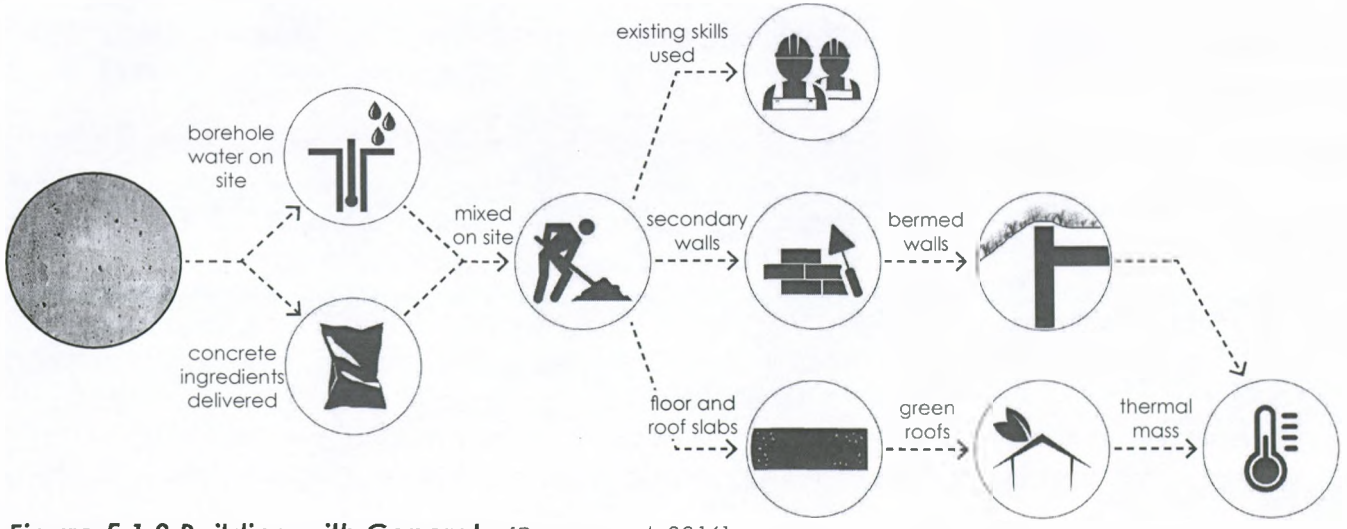


Figure 5.1.2 Building with Concrete *[Ransome, J. 2016]*

5.1.1 RAMMED EARTH CONSTRUCTION

"A rammed earth wall is made up of a compact mixture of sand, gravel, silt and clay earth. Because of the unique characteristics of each soil in each unique location, the proportions of the mix used for making the wall will differ according to the soil's clay content." *[McIntosh, P. 2016]*

As previously mentioned, the soil on and around the site is suitable for use in earth building techniques due to its composition. Modern soil mechanics are used to identify the exact composition of the soil which then indicates whether or not additives are needed and if the soil needs to be treated in any way before its used, such as sifting or removal of organic matter. If there is too little clay in the earth available, cement or lime might be used as a stabiliser. The addition of a stabiliser helps to make the wall more water resistant and durable. The ideal percentage of the stabiliser will depend on the specific characteristics of the available soil. *[McIntosh, P. 2016]* Due to the modernisation of the material it is now possible to specify rammed earth construction in almost any situation and receive the benefit of this beautiful construction technique. *[Muskoka. 2015]*

Rammed earth construction can be done in two ways, either manually or mechanically. Reinforced formwork is used in the construction and is designed to resist the outward forces created by the compaction of the soil. It also defines the structure's shape and width, which is a minimum of 300-400mm, as well as allowing for the creation of openings in the wall. *[Rael, R. 2009]*
Figure 5.1.3 below shows the basic 5 step process used to build a rammed earth wall. The ramming process begins by filling a formwork with a small amount of soil and compacting it with a tamping device. As stated previously, this process can be done manually with a tamper that is typically constructed of wood or steel with a thick, heavy base, or a more modern approach makes use of a pneumatic tamper that is operated by hand and can compact large volumes of earth at once. *[Rael, R, 2009]*
Due to the rural location of the proposed centre and the intention of including the local community in the build of the project a manual

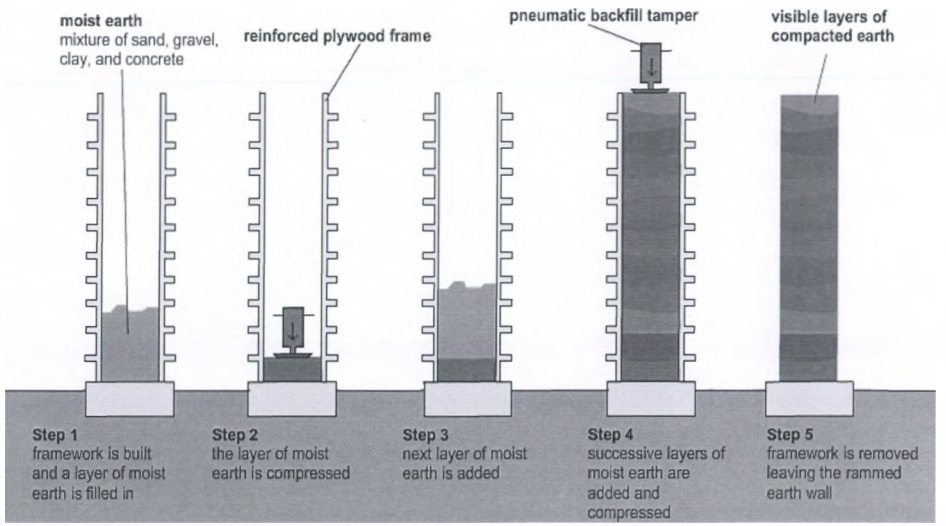


Figure 5.1.3 Rammed Earth Construction Process *[Sustainable Building Design. 2014]*

build approach will be used, this will aid in skills development and thus allow the community members to use this method of building without the need of specialised tools and machinery. Rammteck owner and developer, Mike Beukes, has developed a method

of stabilised rammed earth wall construction and has used this technology very successfully on a variety of social community projects across South Africa. *[McIntosh, P. 2016]*

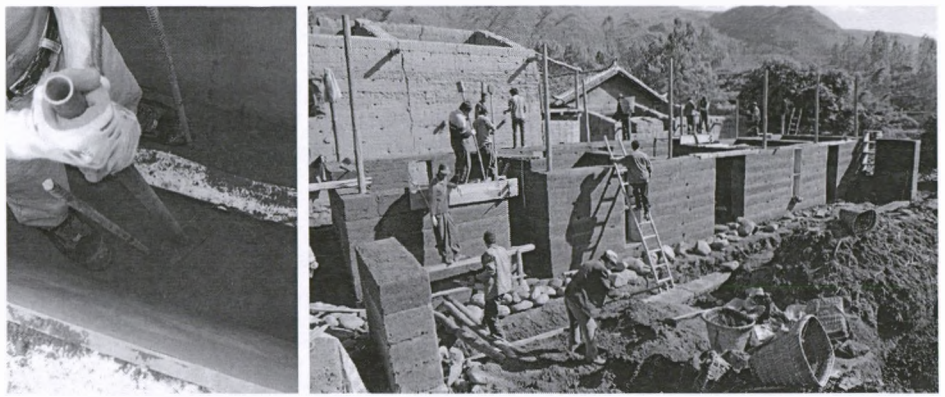


Figure 5.1.4 Rammed Earth Construction in Progress by Community Members *[Sustainable Building Design. 2014]*

Rammteck's core vision is to go to underprivileged and mostly rural areas and train people to use the rammed earth technology. Members of the local community, both men and women, volunteer to work for a low income, during which time they are trained in basic building construction techniques and receive a certificate at the end. This not only brings in a small amount of income but also provides them with the skills to become financially self-sufficient in the future. *[McIntosh, P. 2016]* As stated in previous chapters, Vingerkraal Village, which is located only 12km by sand road from the site, is poverty-stricken, and many of the inhabitants have been unemployed for some months and even years. With the exponential growth in tourism in the area, construction is happening all the time, and this would provide many opportunities for the locals to get involved in construction in the future.

Not only would this building technique benefit the local community, both financially and for self-gain, but it is extremely eco-friendly. The majority of the composition would be made up of sand from the site, reducing material delivery and procurement costs drastically and using these walls together with semi-underground structures and green roofs, the entire building will be one big thermal mass, aiding in the intended approach of passive design. The natural aesthetic and texture of the material lends itself well to the context of the proposed site. Earthy colours will add to the stealth effect, and the wall's texture is somewhat similar to that of the Rhino's skin.

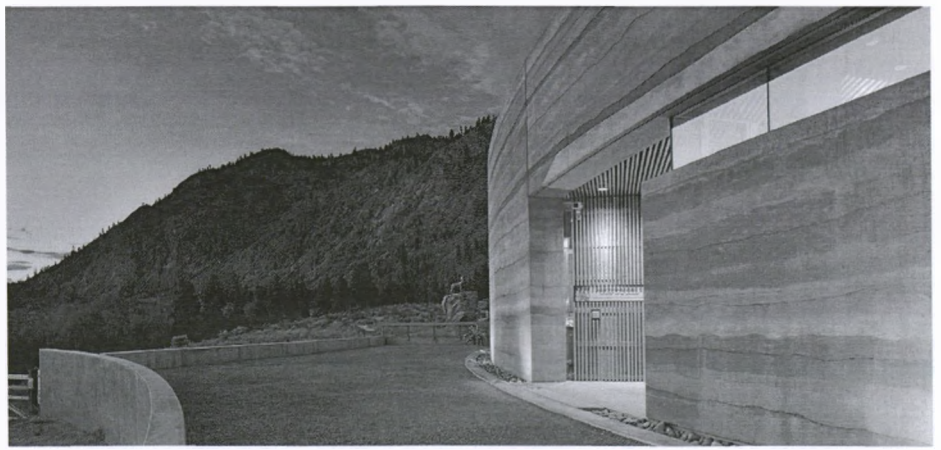


Figure 5.1.5 Nk'Mip Desert Interpretive Centre by Hotson Bakker Boniface Haden Architects *[Rael, R. 2009]*

Benefits of Building in Rammed Earth:

"The many advantages of building with rammed earth include superior thermal mass, temperature and noise control, strength and durability, low maintenance, fire proofing, load bearing and pest deterrence, as well as its beauty and the pleasure of building with a natural and environmentally sound material." *[Rammed Earth Constructions. 2014]*

Thermal Mass

The large thickness of the walls, at a minimum of 300-400mm, allows for a slow release of heat (or cold) into the building. Resulting in internal temperatures remaining pretty constant, with the outcome that buildings are warmer inside in winter and cooler inside in summer. *[Rammed Earth Constructions. 2014]*

Noise Reduction

Both the thickness and density of rammed earth walls result in a vast degree of noise reduction. This is not a relevant feature for the design of the proposed centre as there won't be noisy activities happening inside or outside. However it is more beneficial in the building of houses in high-density areas. "*CSIRO* tests quoted in *Bulletin 5 Earth-Wall Construction* indicate a sound transmission rating of more than 50 decibels for a rammed earth wall of 250mm. Thicker walls, such as the minimum thickness of 300-400mm load bearing walls, provide even better sound insulation." *[Rammed Earth Constructions. 2014]*

Strong and Durable

"As *CSIRO* research (and centuries of years of use worldwide) has proved, rammed earth is extremely durable and weather resistant." When paired with modern technologies, building methods and design, along with certain additives, these walls ensure maximum strength and durability.

Low Maintenance

Once rammed earth walls are built and sealed they should not require much attention for 10-20 years. Exposed walls, however, which all of the walls are in the proposed centre, do require additional coats of sealer now and then. The beauty of the wall lies in its appearance, thus additional renders, plaster or paints are not required. Although should a different finish be desired; they can be treated the same as masonry walls. *[Rammed Earth Constructions. 2014]*

Fire Proof

This is the most important factor in the choice of rammed earth walls for the proposed project. There is an extremely high risk of veld fires in the general area of the site, and thus precautions needed to be accounted for. Earth does not burn. Tests have shown that a 250mm thick rammed earth wall sustained a fire rating of 4 hours. *[Rammed Earth Constructions. 2014]*

Load Bearing

At 300mm plus in thickness, rammed earth walls are load bearing and thus the need for additional support and bracing falls away.

Versatile

Throughout the ages, rammed earth has been used in many applications, ranging from commercial to residential along with a number of different finishes and variations. *[Rammed Earth Constructions. 2014]* Different colours, patterns and finishes are achieved through the soils used, their colours and the method of ramming. Layers can be made up in a variety of thicknesses and colours, adding texture and diversity to the appearance of the wall. The colours are a result of different soils used, and this may

require soils to be sourced from different locations to achieve this desired aesthetic. This aesthetic is shown in Figure 5.1.6.

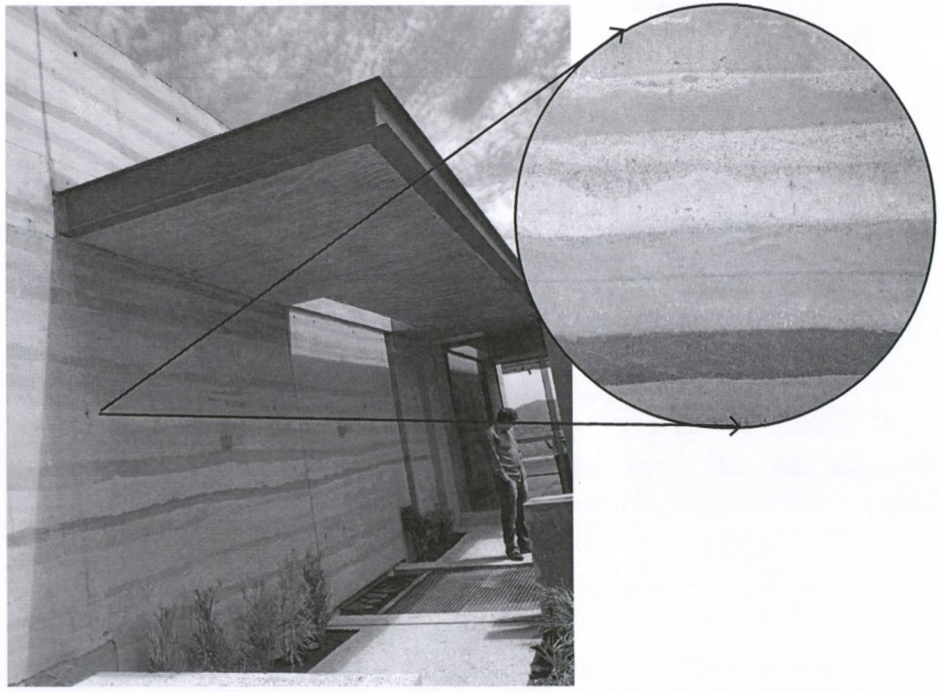


Figure 5.1.6 A Rammed Earth House *[Monaghan Farm. 2014]*

Pest Proof

Studies have shown that termites and other pests are not interested in rammed earth. There are no cavities in rammed earth walls for pests to live in, or to use as a route to the roof or other timbers. *[Rammed Earth Constructions. 2014]*

Healthy and Environmentally Friendly

Rammed earth is non-toxic, non-polluting and breathable. This creates safer, more comfortable buildings. It is very low in embodied energy and extremely comfortable habitable spaces. *[Rammed Earth Constructions. 2014]*

Disadvantages of Rammed Earth Building:

While there are many favourable properties of rammed earth, there are a few disadvantages associated with this building technique too. Some of these include compromised durability, only certain types of soil can be used, longer construction process, increased Carbon emissions due to additives. *[Walsh. 2012]*

Compromised Durability

While in ideal conditions rammed earth is extremely durable, should the wrong soils be used or stabilisers not added where needed, durability is compromised.

Soil Types are Limited

Not all soil is suitable for rammed earth. As previously mentioned, the soils used in rammed earth construction need to have a certain composition to avoid vast amounts of additives.

Build Time Increased

Due to the amount of formwork needed and especially when done with manual labour as opposed to using pneumatic compressors, the build time for rammed earth structures can be quite lengthy. However, when used in a community build and skills development project, such as the proposed centre, a longer build time is a minor setback when compared to the skills learnt and possibilities created for the future of the construction workers.

Increased Carbon Emissions

When stabilisers are needed to be added to the mixture for rammed earth, the associated Carbon emission level increase. This is however not nearly as high as the Carbon emissions associated with other, more conventional building techniques.

5.1.2 THE GREAT WALL OF WA - PRECEDENT STUDY

Project:	The Great Wall of WA
Date:	2012
Architect:	Luigi Rosselli
Location:	Western Australia, Australia

"Boasting the longest rammed earth all in Australia, and probably the Southern Hemisphere, at 230m long, the rammed earth wall meanders along the edge of a sand dune and encloses twelve earth covered residences, created to provide short-term accommodation for a cattle station during mustering season." *[Rosselli, L. 2015]*

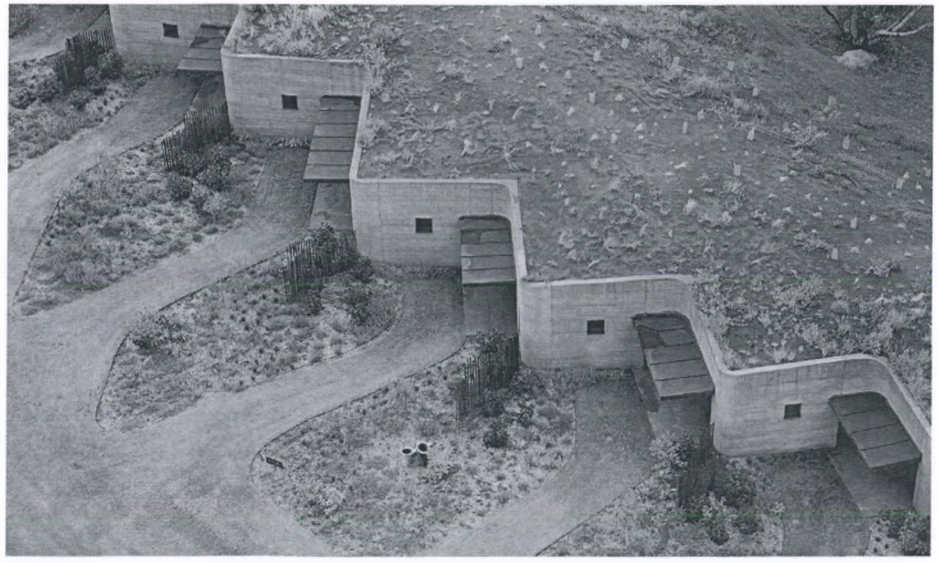


Figure 5.1.7 The Great Wall of WA *[Birch, E. 2015]*

The units are made up of a 450mm thick rammed earth wall to the front with a sand dune to the rear, encapsulating the building and covering the roof, resulting in the best thermal mass available, making them naturally cool in the subtropical climate. *[Rosselli, L. 2015]* Like many other rammed earth construction projects, the sand used for this wall was also located on site, gravel was used from the adjacent river and water from a local borehole. "Corten steel canopies have been inserted into each undulating fold in the wall, providing ample shade for the floor-to-ceiling glazing at the front of each residence." *[Keskeys, P. 2015]*

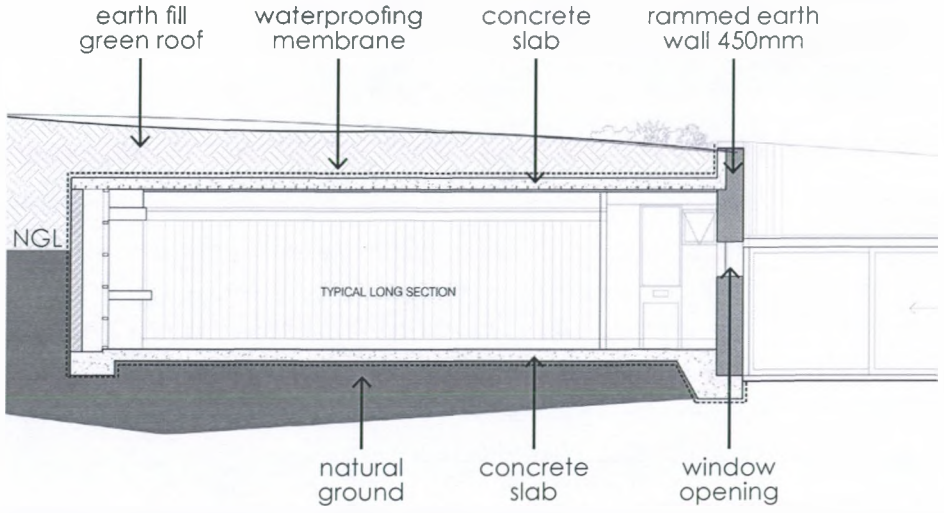


Figure 5.1.8 Typical Section Through a Unit *[Rosselli, L. 2015]*

The rich brown colour and texture of both the Corten steel and terra cotta shades of the Great Wall itself allow the building to meet the landscape harmoniously, blending the earthen colours of the Australian Outback. Landscaping has also been used to enhance the natural look and feel of the area further. *[Keskeys, P. 2015]*

Figure 5.1.9 Aerial View of The Great Wall of WA *[Birch, E. 2015]*

Personal Conclusion:

This project is a perfect example of how rammed earth construction can be combined with 'underground' or berm architecture, allowing the building to sink into the landscape rather than impose upon it. The rammed earth gives the illusion of a structural member, holding the earth back with a retaining wall, but in fact, as can be seen in Figure 5.1.8, the concrete construction of the building's shell holds the structure. A similar approach has been taken in the design of the proposed centre, using rammed earth walls to 'slice' the landscape and bury the building in places adding to the feeling of stealth.

5.1.3 BERM CONSTRUCTION

"When an entire earth-sheltered house is built below the natural ground level or completely underground, it's called an underground structure. A bermed house may be built above the natural ground level or partially below, with earth covering one or more walls." [Energy (2). 2011]

Figure 5.2.10 Building into the Earth *[Ransome, J. 2016]*

While many bermed structures may look like a normal building from one side, and as one moves around to the other side of them, they become hidden in the landscape. As seen in Figure 5.1.11, concerning the precedent study on the following page, the Edgeland House is almost completely hidden in the landscape

Figure 5.1.11 Edgeland House: Back of House vs Side of House
[Bardagiy, P 2013]

from each side, whereas from the front and back it is quite visible. Earth-bermed structures are built mostly above ground. Piles of soil are pushed up, bermed, against the side of the walls and often over onto the roof of the building. This creates a 'protective cocoon' of earth and vegetation, forming a barrier between the inside of the building and the open air outside. [Nathan, F. 2012] Earth sheltered buildings are designed most commonly in three different ways: atrium, penetration, and elevational. The design choice between these depends on the outcome and building performance desired by the user. The atrium style, see Figure 5.1.12, is most suitable for buildings wanting maximum protection from the elements, sun, wind, heat and cold. All rooms are built around a central 'atrium' facing out into the courtyard to allow light to filter in fro above. [Nathan, F. 2012]

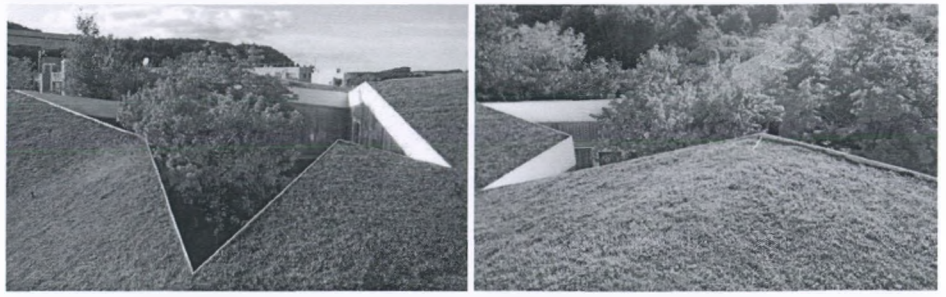


Figure 5.1.12 Loop House: Atrium Style Bermed House
[NL Architects. 2009]

In a penetration style berm design, see Figure 5.1.13, the entire building is covered in earth except the position of doors and windows. The building is most often built at natural ground level with earth bermed up around and over it, creating an earth 'dome'. This design allows the building to have natural cross ventilation

and lighting from more than one side of the house. [Energy (2). 2011]

Figure 5.1.13 The 'Culata Jovai' or 'House of Confronted Rooms: Penetration Style Bermed House *[BAUEN Architecture Studio. 2013]*

"An "elevational" bermed design exposes one elevation or face of the house and covers the other sides, and sometimes the roof, with earth to protect and insulate the house." [Energy (2). 2011] This approach is both shown in the precedent study on the previous page, The Great Wall of WA. It is most common for the exposed side to face North, in the Southern hemisphere, for maximum natural sunlight. Strategically placed skylights are often incorporated in this form of bermed design to allow for natural ventilation and lighting in from the north to parts of the building that don't have direct access to this orientation.

The design of the proposed centre utilises a combination of elevational berm design and penetration berm design. The addition of lightwells has been included in the design of the centre in the veterinary and visitor wing where the exposed wall faces predominantly south. There are also parts of the building that puncture out through the berm to provide visual access through to the Rhino enclosures on the Northern side.

Advantages of Earth Bermed Buildings:

Earth sheltered buildings are less susceptible to the impact of extreme outdoor air temperature fluctuations due to their thermal mass. They require less external maintenance and can be treated along with the rest of the surround garden or landscape. Like rammed earth, sound proofing is also an advantage of bermed buildings and in addition to this; they blend into their surrounding landscape more naturally. [Energy (2). 2011] "Earth-sheltered buildings are a practical and cost-efficient option in many circumstances, as long as careful thought and effort are put into the design, site selection, and construction stages of the projects." [Nathan, F. 2012]

Disadvantages of Earth Bermed Buildings:

The initial build cost for these structures is considerably higher, up to 20% than conventional building techniques. This, in addition to the extreme need for careful consideration and planning for waterproofing, both during the construction phases and when the building is habitable, are the two main disadvantages, or concerns, for earth bermed building. [Energy (2). 2011] Structure also needs to be properly considered as there is a great amount of earth pressure associated with such large mounds of earth and thus retaining wall design needs to be able to withstand these pressures to avoid failure. [Nathan, F. 2012]

5.1.4 EDGELAND HOUSE - PRECEDENT STUDY

Project:	Edgeland House
Date:	2012
Architect:	Bercy Chen Studio
Location:	Austin, Texas, USA

"In an increasingly generic and de-natured world, we are interested in producing architecture tuned to the specificity of a place." *[Chen, B. 2013]* The aim of this project was to design a house, based on the vernacular of the "pit house", one of the oldest housing typologies in Northern America. Causing minimal disturbance to the site in an effort to heal the land, restore the slope and bring back wildlife.

Figure 5.1.14 Front Entrance to House *[Bardagiy, P 2013]*

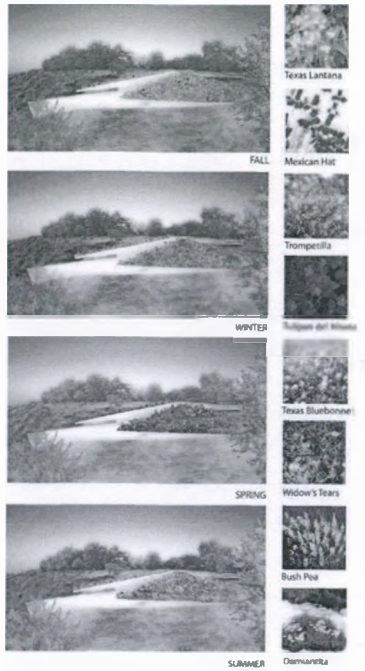


Figure 5.1.15 Flowers in season *[Chen, B 2013]*

"The approach addresses the climate of central Texas and utilises thermal capacity of the earth to regulate temperature, while the linear courtyard down the centre allows fresh air to flow between the bluff and the river below. The courtyard is a theatre for observing migrating hummingbirds, monarch butterflies and, even ant colonies, heightening one's awareness of nature in an urban setting." *[Chen, B. 2013]* Flower species were carefully selected based on the seasons of the year to ensure the roof was always in bloom (See figure 5.1.15) and over 40 native species of wildflowers and grass were reintroduced in this way to preserve the local ecosystem.

The roof on both sides forms a continuation of the two slopes on either side of the house, adding to the feeling of stealth in the architecture. These contrast the high glass walls that line the inside of the house, bringing in maximum light and natural ventilation as well as opposing the heavy bulk of the roof above.

The house uses the earth's mass to maintain a moderate temperature inside the residence, while the green roof also aids in natural insulation. *[Nothingam, S. 2014]* This approach adopts the same principles of passive design, using thermal mass to keep the house cool in summer and warm in winter by using the earth's constant ground temperatures.

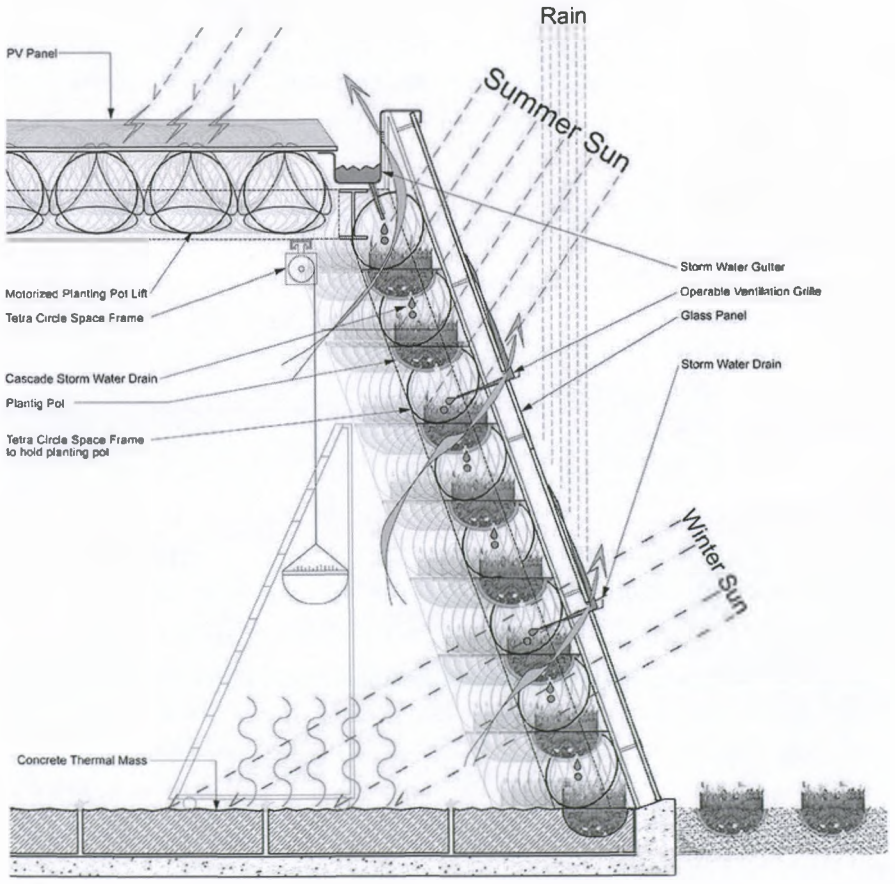


Figure 5.1.16 Sustainable Skin System Section *[Chen, B 2013]*

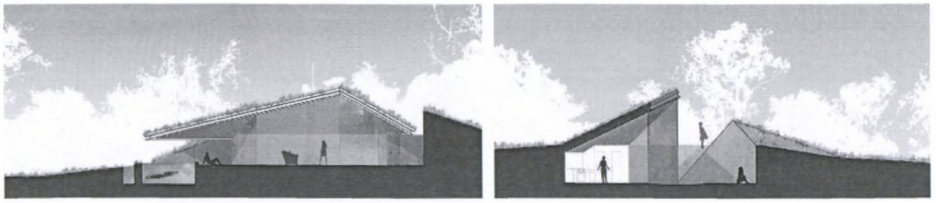


Figure 5.1.17 Sections through the house *[Chen, B 2013]*

Personal Conclusion:

By using similar design approaches in the design of the proposed centre, has not only resulted in the landscape undergoing less damage but vantage points have been created for visitors to view down into the Rhino enclosures while still enjoying a natural landscape. Figure 5.1.18 below is an exploration of this vernacular. This project also adopts a similar approach to the use of thermal mass in the building design to what has been anticipated in the proposed centre.

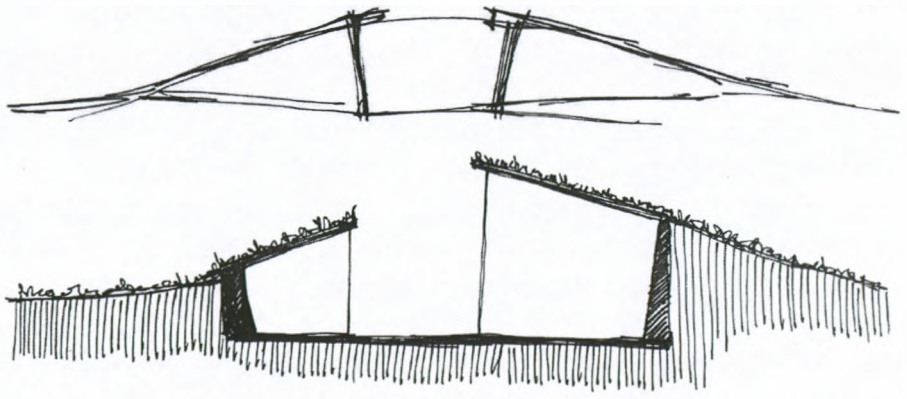


Figure 5.1.18 Sketches of the design approach *[Ransome, J.*

5.2 DESIGN CONCEPT THEORY

It is evident that the structures which various animal species build for themselves and their offspring are just as essential for their survival as architecture is for human existence. *[Atkin, T & Rykwert, J. 2005]*

As stated previously, the main question of this research report is: How can architecture bring Rhinos and Humans together in one place and still maintain a natural habitat? While Rhinos do not necessarily 'build' themselves structures like many other animal species do, they still rely heavily on certain features in their habitat for survival, like mud, for example, to coat their skin. There are five main functions of 'animal architecture' that, in turn, relate directly to 'human architecture', these will be discussed below and elaborated upon how they have been incorporated into the design of the proposed centre.

Protection from the Physical Environment:
This includes temperature control, water management, humidity control, gas exchange and ventilation, and waste management. *[Atkin, T & Rykwert, J. 2005]* A passive design approach has been used in the design of the proposed centre. As mentioned previously, statistics show that earth from the site is suitable for earth building and will thus be used for the construction of thermal mass spine walls, as well as bermed construction. Sun angles and orientation have been considered in the design (see pg67), and water capturing has formed a prominent part of the design as water is a scarce resource in this area. The Rhino enclosures have been designed to have plenty of shade and shelter from the harsh elements as well as water and mud to ensure maximum comfort.

Protection from Predators:
In the animal world, this is done through avoidance, detection or recognition, mechanical protection, and protective nesting. *[Atkin, T & Rykwert, J. 2005]* The biggest threat will be that of the poacher, and maximum protection has been incorporated to ensure the safety of the Rhinos within the centre. Protection and communication also work hand in hand, look out points, providing elevation for surveillance over the enclosures have been carefully placed on the site to create a connection link to the ground staff to communicate possible threats.

Food Gathering:
This includes cultivation, feeding, prey capture, leaf rolling, and food storage. *[Atkin, T & Rykwert, J. 2005]* Due to White Rhinos being grazers, the majority of their feed will come from the natural landscape. However, food storage for additional Lucerne and supplements has been provided for, and feeding areas will be controlled and protected, especially in areas of confinement.

Communication:
This is done by assisting transmission, signal structures, mate selection, and reproduction. *[Atkin, T & Rykwert, J. 2005]* As the site is located on a private game farm, signage and communication to the outside world are key in encouraging tourists and volunteers to visit the centre. The project is intended to work with the surrounding community and not on its own. The social structure of the Rhino has also been considered in the design of the centre as this is fundamental in the breeding success rate. Specific thresholds have been put in place regarding public and private access to

the Rhinos and how connections are made. The Vet staff and Game Rangers in training are connected with the Rhinos on both a visual and physical level while the visitors only connect through visual means, not only for their protection but for the protection of the Rhino too.

Decoration:
This focus lies not only on the aesthetics of the building but also how it speaks to its users. A careful selection of materials can assume a poetic quality in the context of the architecture, by looking at the composition, tangibility, smell and acoustic properties to bring out a specific meaning. "What the use of a particular material could mean in a specific architectural context." Succession in this leads to materials in architecture to be made to shine and vibrate. *[Zumthor, P. 1998]*

The approach that has been taken to create connections between Humans and Rhinos can be seen in the sketches below in Figure 5.2.1. By encapsulating the centre with the Rhino enclosures allowing the Rhinos to move freely while still giving the staff and visitors the opportunity to interact and view them on different levels. The journey of the Rhino starts at the arrival into the delivery bomas and then they move on through the site. From the boma to the calming pen and then out into the breeding camps on the farm. While there is some level of control, as there needs to be at such a facility, the Rhinos habitat will be as close to 'natural' as possible. The concept of a journey of movement through the site has also been translated into the circulation of staff and visitors in the centre. The concept of movement through the centre includes an "experiential journey" through the different programmes of the centre. This will allow the user to experience different encounters and sites or views along their journey.

The concept, 'returned earth' has transpired through the vast amount of earth used in the design, in both the rammed earth and bermed construction. This adds to the thermal mass but also creates a vantage point for viewing down into the Rhino enclosures and eliminating the need for fences and barriers. The buildings and earth will act as the barriers, thus taking advantage of the site and merging the habitat of the Rhino with that of the Human.

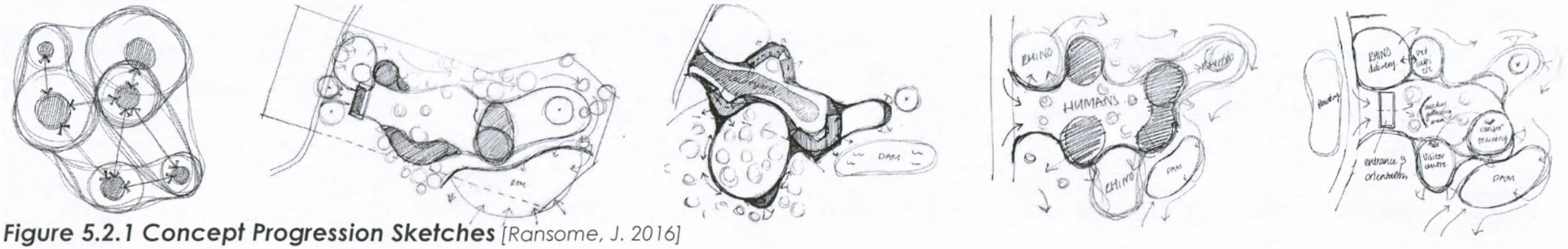


Figure 5.2.1 Concept Progression Sketches *[Ransome, J. 2016]*

Movement Through the Site.

Analysing how both the Rhinos and the Humans would move around the site influenced the placement of buildings and services as well as enabled the creation of connections between the two at various points on the site, whether it be visual or physical.

Figure 5.2.2 illustrates the movement of the Rhino and the journey they would experience as they move through the site.

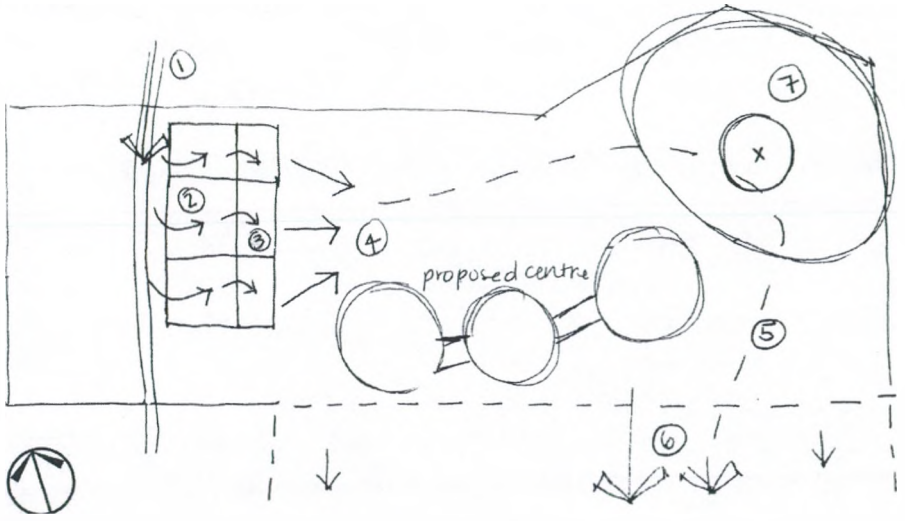


Figure 5.2.2 Rhino Movement Diagram *[Ransome, J. 2016]*

1. Arrival to the site from the existing road, coming in from the gate off the main road.
2. Delivery into a confined delivery pen where they cannot see out past the solid walls. This pen is large enough for the animal to calm down in after it's journey.
3. From here they are moved into a calming pen, this pen is slightly smaller and is fenced with permeable fences so the Rhino can become accustomed to its new surroundings.
4. The Rhinos are released into the main enclosure which surrounds the site and allows them to be monitored for a few days as they begin to interact with each other.
5. In this main enclosure, they will move around the site to the dam to get water and their movement is restricted to the north-eastern part of the site, allowing them to be viewed from the centre.
6. Finally, the Rhinos are released into the breeding camps on the main farm. These are large areas of farm fenced off and controlled to ensure breeding occurs at a maximum rate.
7. This area has been reserved as an isolation enclosure, either for sick Rhinos or calving mothers that need assistance.

This analysis of movement played a large role in influencing how the design evolved on the site, from both the Rhino's perspective as well as the Human's.

5.2.1 FRACTAL GEOMETRY & RHIZOME THEORY

"Symmetry develops into a rhythm when entities are replicated along a line or rotated around a point." *[Bovill, C. 1996]* Both the concept of Fractal Geometry and Rhizome Theory relate closely to the shapes and forms found in nature. While these may seem random to the naked eye, there are many theories and mathematical explanations for the formations found in nature.

"Fractal geometry is the study of mathematical shapes that display a cascade of never-ending, self-similar, meandering details as one observes them more closely." *[Bovill, C. 1996]* They appear almost everywhere in nature, in leaves, tree branches, mountain ridges and rivers. As per Figures 5.2.4 and 5.2.5, this notion was explored and the geometries of the fractal thus became apparent.

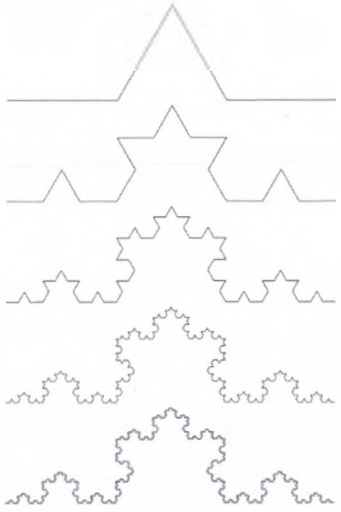


Figure 5.2.3 - The Koch Curve. *[Abel, Z. 2012]*

Fractal Geometry:

As seen in Figure 5.2.3, "The Koch curve is usually constructed as the limit of the following sequence of paths, where each iteration is made by stitching together four copies of the previous curve." *[Abel, Z. 2012]*

As said by mathematician, Ron Eglash who studies fractals at the heart of African designs, the line segment decreases as the total distance increases as these patterns are repeated over and over again. *[Eglash, R. 2013]*

Figure 5.2.5 Ink Stamp of a the Fractal Geometry in the Veins of a Leaf *[Ransome, J. 2016]*

Figure 5.2.4 Fractal Illustration of the Marula Tree on Site *[Sketched and Photos by Author]*

Rhizome Theory:

"Rhizome Theory is a concept that was developed by Deleuze and Guattari and can be described as an A-centered multiplicity. The limits to its magnitude and dimensions mean that it cannot increase in number without completely changing its nature. This theory provides us with a way to see how everything can be multiple and inter-related." *[Kerr, S.B. 2014]*

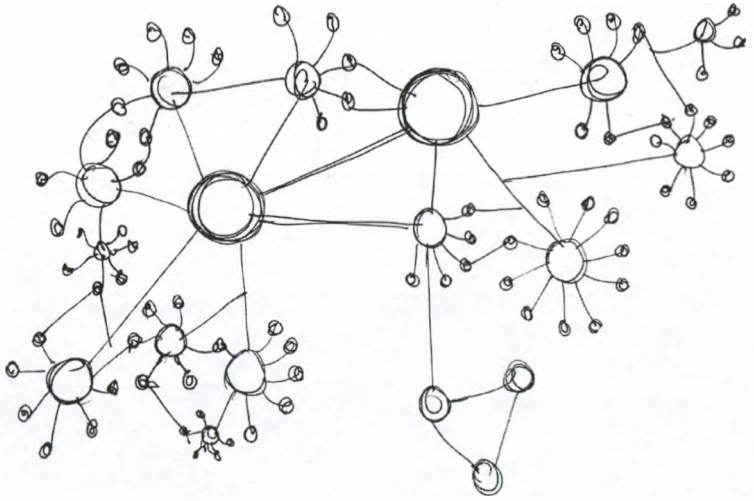


Figure 5.2.6 - Rhizome Exploration & Illustration *[Diagram by Author]*

There are six typical characteristics of the Rhizome: Connection and heterogeneity, meaning any point can be connected to another no matter how similar or different. Multiplicity, as mentioned before, it cannot increase in number without completely changing its nature. Asignifying rupture, a Rhizome can be broken off at any point, but it will always start up again. Lastly, Cartography and Decalcomania which make us think of a Rhizome as a map, something that is always open and can be entered at any point. *[Kerr, S.B. 2014]*

As seen in Figure 5.2.57 below, Rhizome theory is also evident in many forms of nature. While the notion of a fractal may still be evident in some ways, like the patterned formation of the desert rose petals, the way in which the plant grows imitates Rhizome theory with the "random" branching off, and the ability to regrow into an individual plant once snapped off or broken in places.

Figure 5.2.7 - Rhizomes in Nature *[Photographs by Author]*

"The Rhizome is not a thing but rather a process, an imminent process that allows us to question hierarchy or organisation." *[Kerr, S.B. 2014]*Rhizomes do not have a start or an end, they are always in the middle and can be entered from many places, like the notion of a map. *[Kerr, S.B. 2014]* While the theory of the Rhizome may not have transpired into the form of the building, it has influenced the way in which its users circulate. To create an experimental journey through the site that can start or end in different places and be experienced in a different way each time round reflects the notion of the Rhizome.

5.2.2 MASSING MODEL EXPLORATION

The annotated photographs below in Figure 5.2.8 illustrate the start of a massing model exploration by adopting the notion of building within the earth and replacing the earth.

Instead of creating a ground level courtyard surrounded with a combination of fences and buildings to keep the Rhinos out, this concept utilises the approach of raising the earth and setting the proposed buildings into the earth. This results in creating a raised "natural" landscape for visitors to view down upon the Rhinos without needing fences to keep them safe. This has allowed the design to evolve by using passive building methods from the thermal mass created by the earth as well as enhancing the connections created between Human and Rhino.

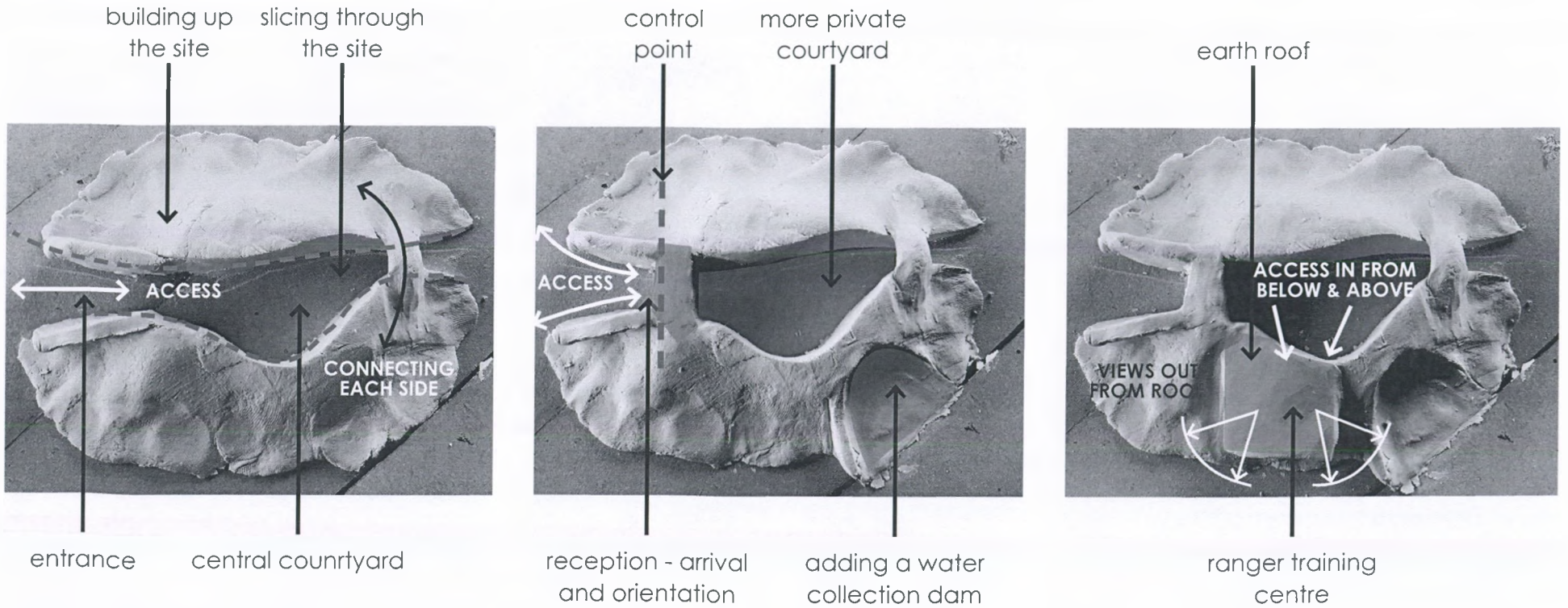
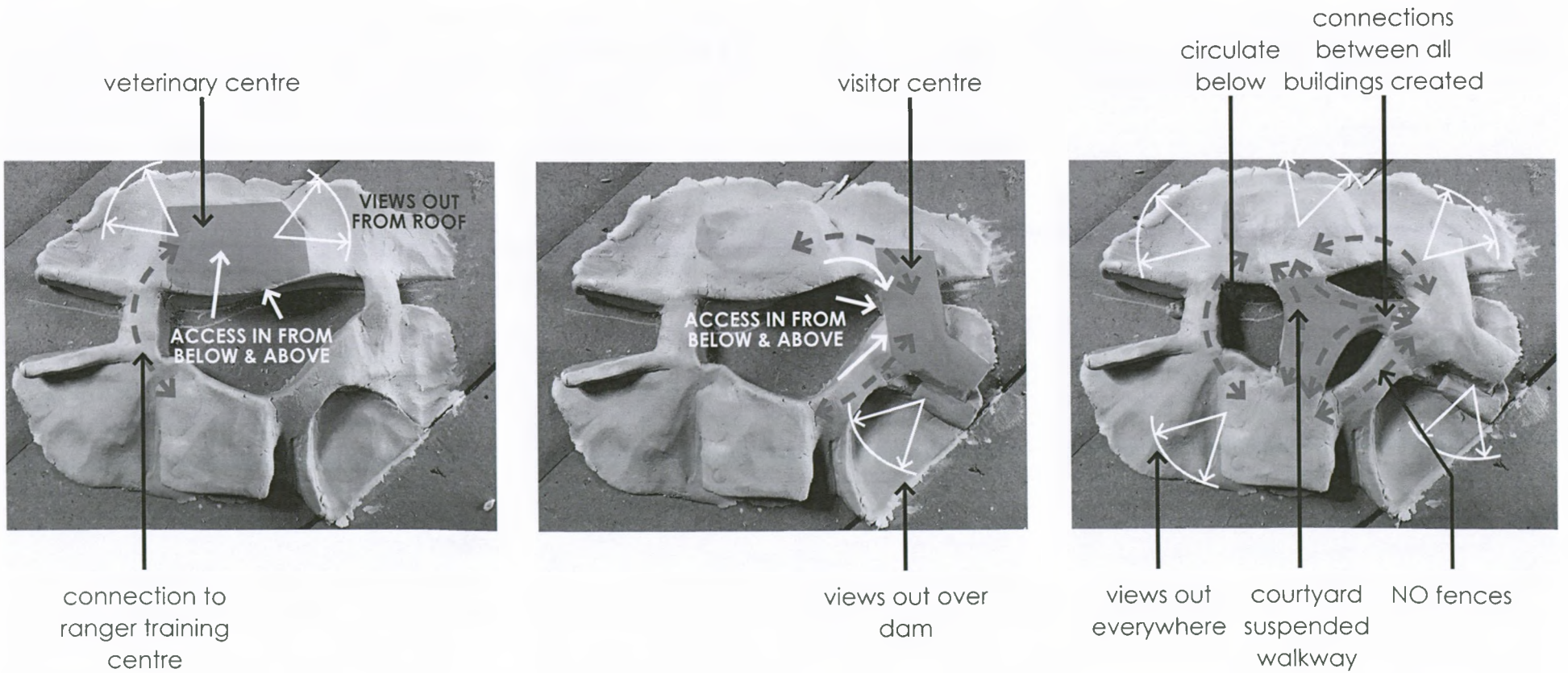


Figure 5.2.8 Concept Progression Sketches *[Ransome, J. 2016]*

Views and connections through circulation are the most important design features. These have been carefully designed to create the best experiential journey possible for the visitor, allowing them to experience every aspect of the centre as well as its surrounds.

As seen over the next few pages, as well as in the next chapter, this concept has been explored in a few ways to reach the final design.



5.2.3 BUILDING IN THE EARTH

The annotated photographs below in Figure 5.2.9 illustrate a continuation of the massing model exploration on the previous page. By adopting the notion of building within the earth, utilising spine walls as retainers and strong design elements as well as replacing the earth.

As explored in the precedent study, Edgeland House on page 94, building within the earth results in a stealth kind of architecture. This relates directly to that of the animal watching hide. The idea behind an animal watching hide is for the viewer to observe out and watch the animals in their natural habitat with them not knowing they are there. Hide design differs based on the requirements and location of the hide. Common design features include elevation to maximise the view range and narrow viewing slots to keep the viewers concealed from the animals. Sound proofing so that the animals do not scare off from the sound of the people, and lastly, camouflage, often hides are camouflaged into their setting to maximise detection avoidance as well as not to damage the natural habitat of the animals in the area. [Rewilding Europe. 2012]

This same approach has been taken in the design of the proposed centre, to allow Humans and Rhinos to coexist without hindering the habitat of the Rhino.

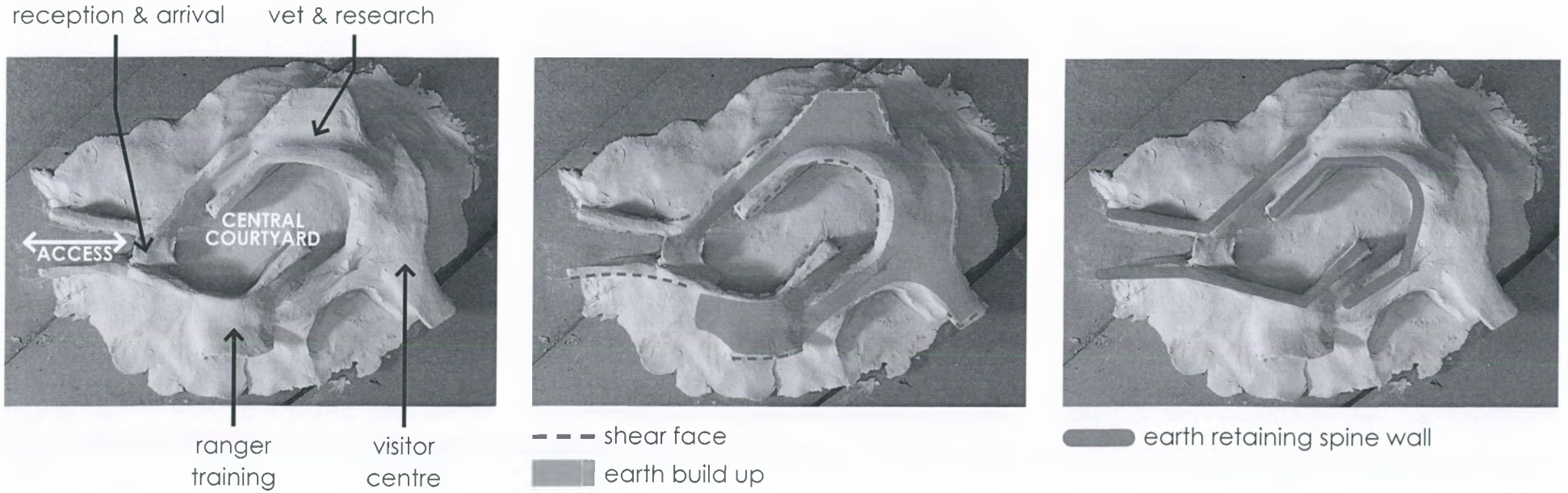
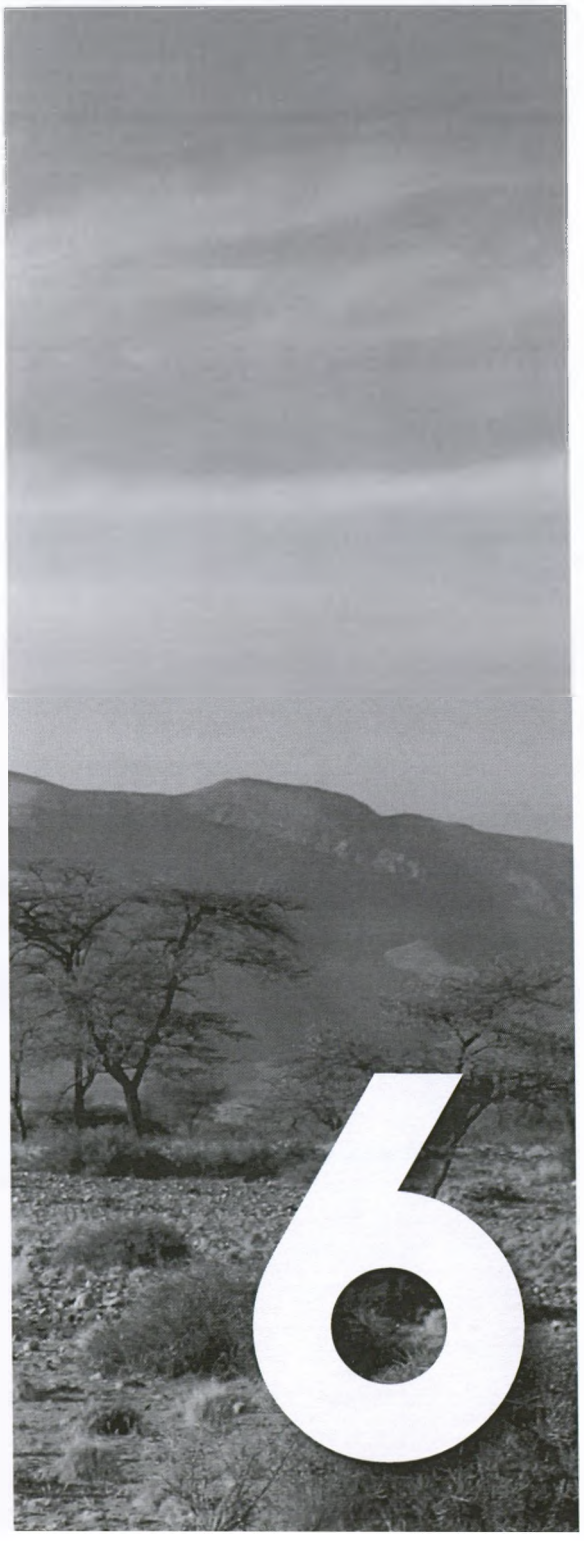


Figure 5.2.9 Clay Massing Model Exploration *[Ransome, J. 2016]*

SKETCH DESIGN
& DEVELOPMENT
PROCESS



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6.1 PROGRAMME LAYOUT

As explained throughout the previous chapters, the concept of the design was to bring Humans and Rhinos together in a way that maintained a natural landscape and habitat for the Rhinos. The programme layout on the site evolved quite a bit from the first iteration, and this will be explained further in the next section, 6.2 Sketch Design on the following page.

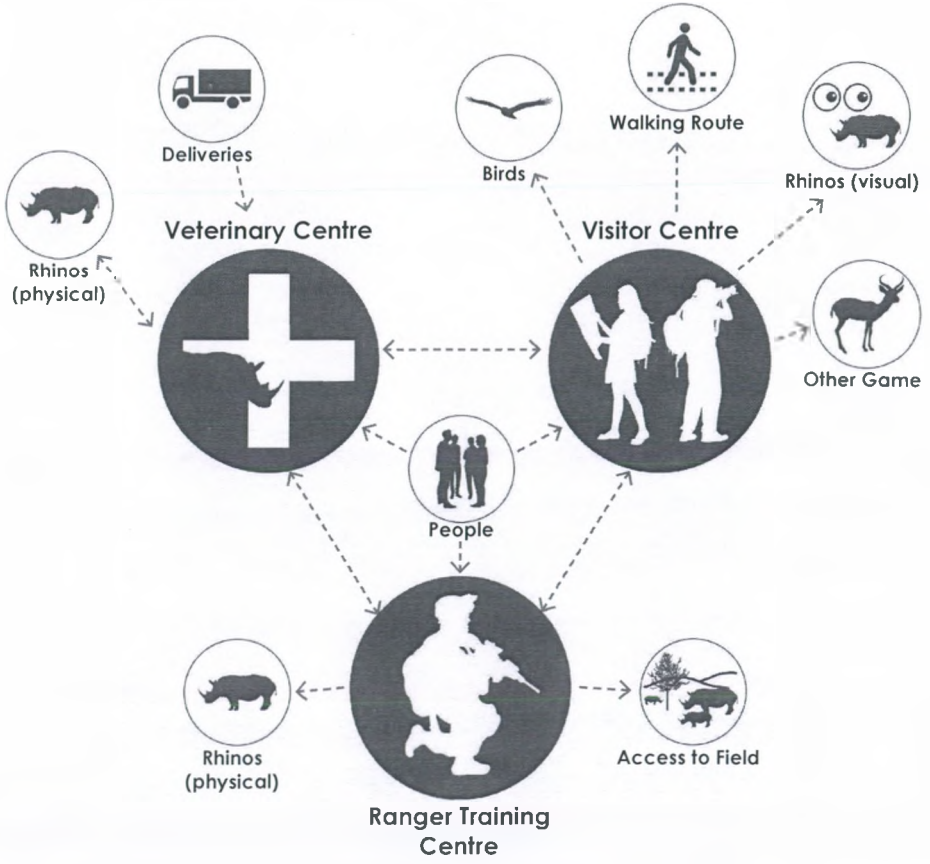


Figure 6.1.1: Links to Main Programme *[Ransome, J. 2016]*

The diagram in Figure 6.1.1 shows the three main programmes in the proposed centre, the Veterinary Centre, the Visitor Centre and the Ranger Training Centre, and certain elements they need to relate to. This diagram helped influence the programmatic placement in the design of the centre, and this evolution is explained in this chapter.

As seen in Figure 6.1.2, the programme layout went through 3 iterations before the sketch design evolved. As per the key, the dashed line represents the divide between Human and Rhino; the light red indicated the 'Rhino's area' and the dark red indicated the 'Human area'. The layout started off with a more prominent divide between the Humans and Rhinos, with the only connections being visual from the centre into the Rhino enclosure. This design approach started with the centre surrounding the Marula tree on site, hence the buildings being to the north of the site. The design then evolved, with the buildings in the centre of the Rhinos so that views and connections could be made with the Rhinos the whole way around the centre, both visual and physical. The third iteration shows a less organic form, this responded to the building technologies that have been used as well as to the circulation and movement of both human and Rhino.

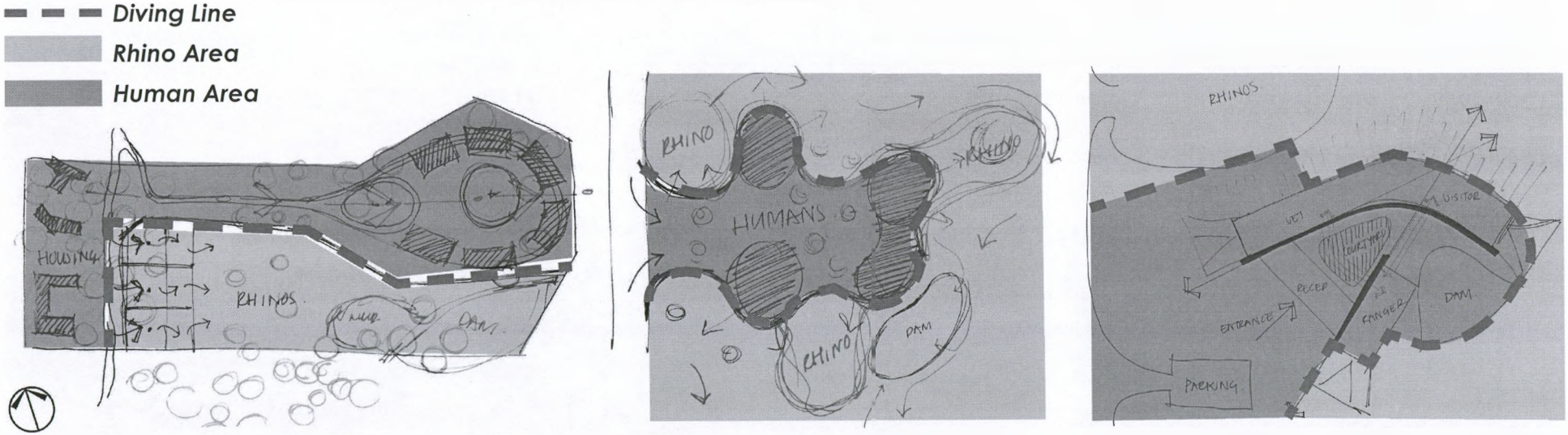


Figure 6.1.2 Programme Layout Development Sketches *[Ransome, J. 2016]*

6.1.1 WITS RURAL - PRECEDENT STUDY

Project:	WITS Rural Training and Research Facility
Date:	2015
Architect:	Kate Otten Architects
Location:	Klaserie, Limpopo, South Africa

"The Wits Rural Campus (WRC) project is a phased upgrade of an existing environmental research facility on the borders of the Kruger National Park, intended to create a Rural Knowledge Hub." *[Otten, K. 2015]* It provides the opportunity for both local and international students to come and engage with the community members as well as the opportunity for the community to benefit from training programs and interactions with researchers. *[Otten, K. 2015]*

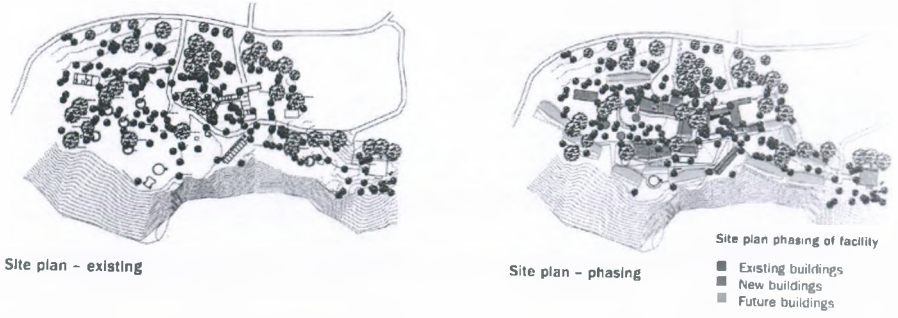


Figure 6.1.3 - Site Plan Existing vs. New Phased Site Plan
[Otten, K. 2015]

The location of the WRC is in an environmentally protected area, and this proved to be a key driver in the design process. Parts of the site that were already developed were used, see Figure 6.1.3. By adapting existing building facilities where possible, the architects decreased the expansion into the surrounding bush. *[Otten, K. 2015]*

Phase 1, as seen in Figure 6.1.4, is also a pedestrian-only zone which relied on existing vehicle access roads to prevent the need for including more roads and thus less maintenance and undestroyed landscape. *[Otten, K. 2015]* Once a road has been graded through the veld with a TLB grader it takes years for the earth to recover and grow back should one no longer wish to use the road.

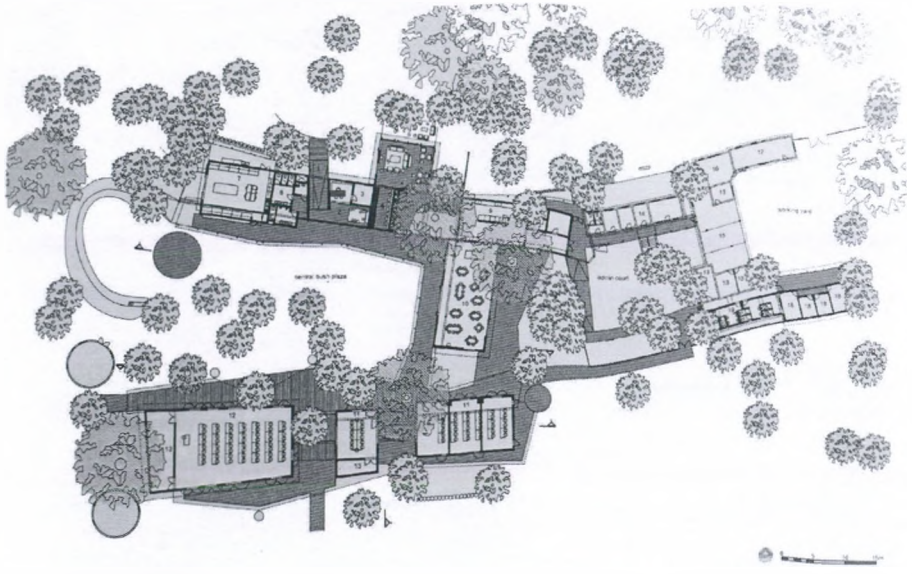


Figure 6.1.4 - Phase 1 Plan *[Otten, K. 2015]*

The design team also took this principle of minimal site disruption into the design of the buildings themselves, having individual units linked by covered walkways allowed them to preserve the existing terrain and protected trees. In addition to this, the shifting geometry of the buildings also created the formation of courtyards and gathering places as well as views out into the surrounding bushveld. *[Otten, K. 2015]*

The scale of the buildings is another important factor in the design. The WRC utilised careful use of colour and scale and the buildings were designed to be intentionally quiet and recede into the landscape. *[Otten, K. 2015]* When designing for conservation purposes, it is critical to take this approach in all aspects. The Hathigaon Elephant Village project also emphasised landscape rejuvenation and preservation.

"The design approach took cognisance of economic, social and environmental sustainability." *[Otten, K. 2015]* As with the proposed research report this project also made design decisions based on materials and skills available and well as passive climate control and rainwater collection. The plan, as seen in Figure 6.1.5, shows the project at completion, with an emphasis on the existing trees notable as well as the covered walkways, highlighted in grey. *[Otten, K. 2015]*

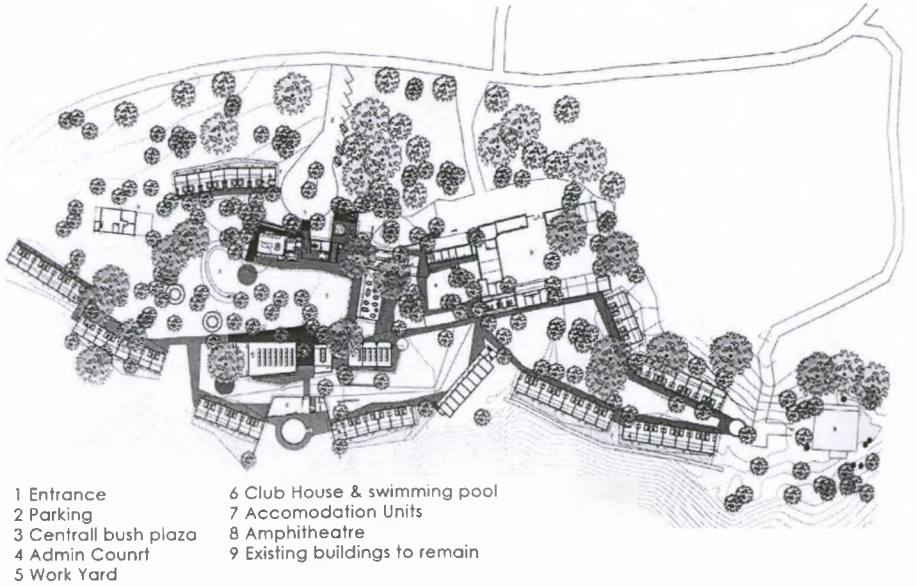


Figure 6.1.5 - Site Plan at Completion *[Otten, K. 2015]*

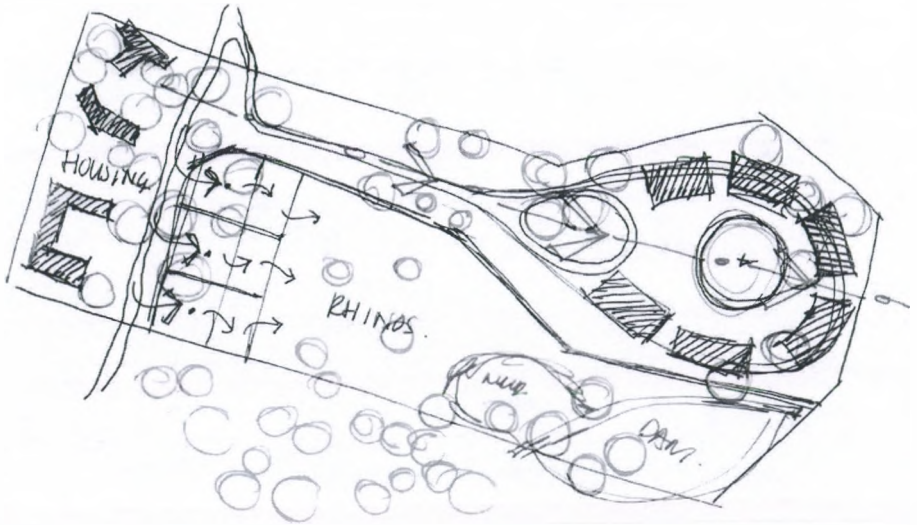
Personal Conclusion:

This approach to design in the wilderness is the same approach the proposed centre has adhered to. Maximising on the surrounding views and allowing the natural lay of the land to inform design decisions, resulting in an eco-friendly, aesthetic design. The existing trees on the site have also largely informed placement and design decisions as all of the established trees and large shrubs have been preserved in the design.

6.2 SKETCH DESIGN

The sketches below in Figure 6.2.1 illustrate how the design initially started. All the buildings circulated around the Marula tree on the axis formed by the existing road on the site. A 'fractal' form was created from the road's loop, which determined the placement of the buildings. Views were captured all round, of the Waterberg to the north, Rotavi mountain and the Rhinos within the enclosure to the south and all the circulation between the buildings was around the central tree. As mentioned previously, the divide between human and Rhino was too prominent and thus led to further exploration of the site placement.

The idea of adding a dam to the site was introduced at this early stage. The placement was determined by the nearby "koppie" and the direction of its runoff as per the site contours.



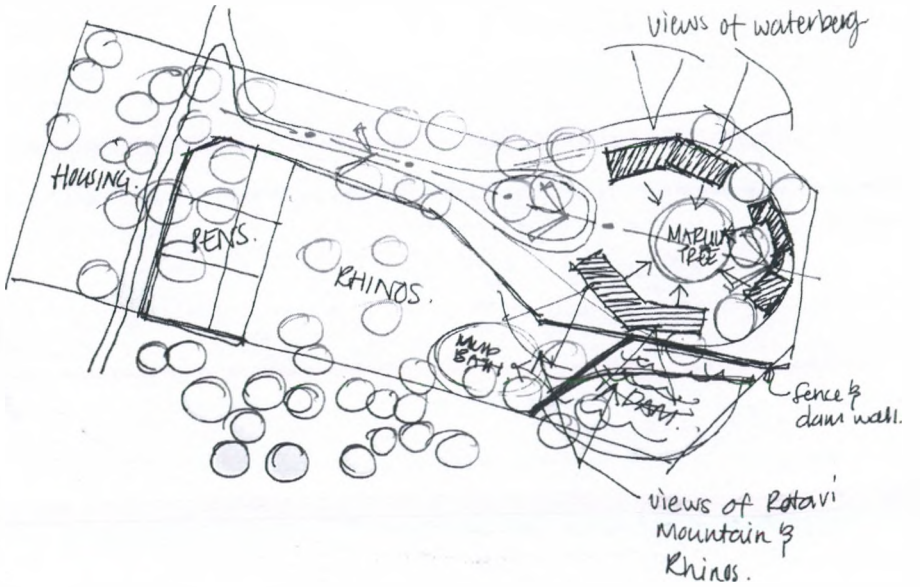


Figure 6.2.1 Programme Layout Development Sketches *[Ransome, J. 2016]*

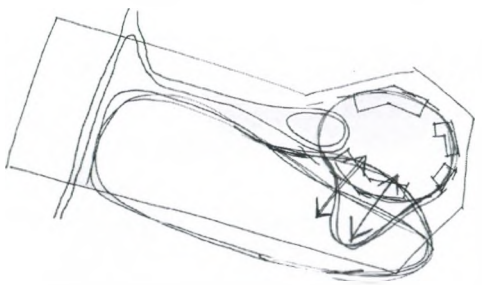


Figure 6.2.2 Blurring the Line
[Ransome, J. 2016]

Figure 6.2.2 illustrates the thought process of blurring the line between human and Rhino and how the two could merge. Either the humans 'spilling' out into the Rhino enclosure or visa verse. From here the idea of a walkway or experiential journey developed.

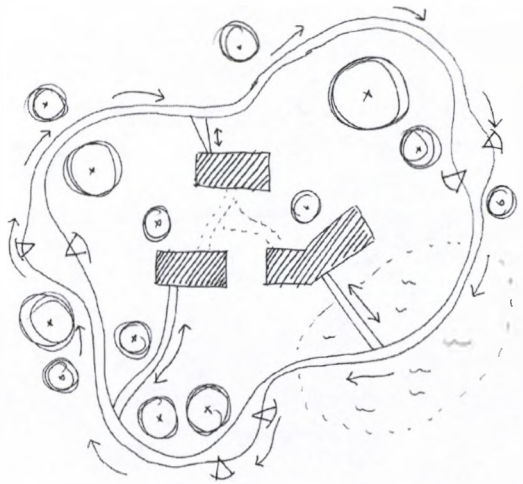


Figure 6.2.3 Infinity Loop - Walking Journey *[Ransome, J. 2016]*

The concept of an experiential journey walkway started off as an "infinity loop", as seen in Figure 6.2.3. The idea was based on the notion of Rhizome theory, where the user could enter or exit the loop at various points but continue walking around for as long as they wanted. In this iteration of the walking journey, the walkway is disconnected from the built form, creating a separate entity which surrounds the buildings. Many of the ideas developed at this stage have remained constant throughout the design process although the concept of the journey has since been interpreted in a different way which will be explained later on in the chapter.

The sketches in Figure 6.2.4 illustrate some of the experiences that are incorporated into the walking journey. These include:

1. Viewing from above: Looking down through an opening onto the animals passing by below.
2. Viewing at eye level: Seeing the animals through a ha-ha fence at close a distance and eye level.
3. Concealed viewing: Whether it be from an enclosed walkway or a viewing hide, this allows the viewer to see the Rhino but the Rhino not to see the viewer.
4. View from a suspended walkway: Safely viewing the Rhino from above in their natural habitat, the walkway not obstructing their path in any way allowing them to move under it.
5. Drinking: Both sketches 5 and 6 show different ways in which the viewer can observe the Rhino while they are drinking. Their line of sight level with the top of the water providing a unique experience, the Rhino not aware they are there as the place of viewing would be completely hidden and sound proof.

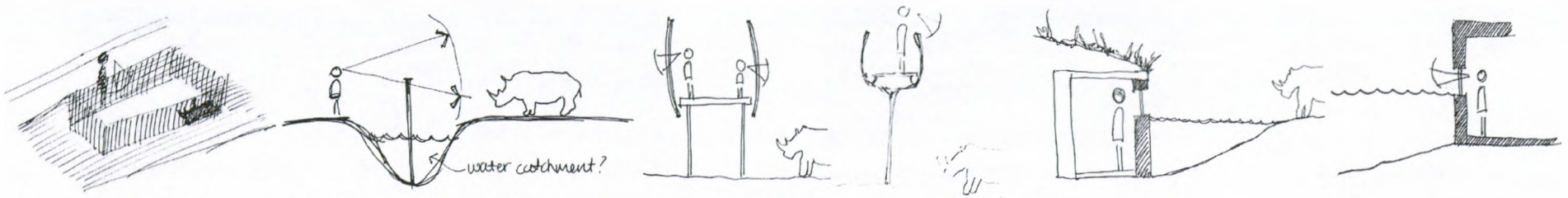


Figure 6.2.4 Visual Connections and Experiences on Walking Journey *[Ransome, J. 2016]*

6.2.1 SKETCH DESIGN REVISION A

As seen in the sketches in Figure 6.2.5 and the model in Figure 6.2.8, the design started off as a series of fragmented buildings. These buildings were joined by walkways, creating connections between them and adhering to the concept of a walking journey.

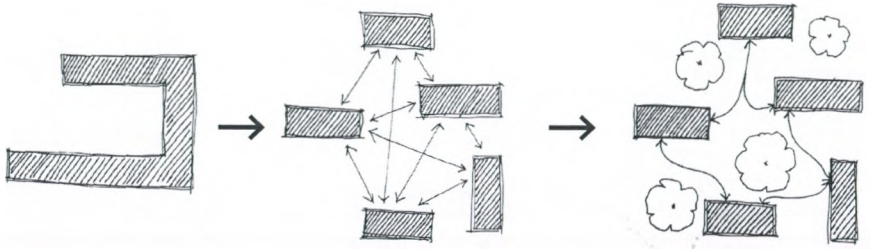


Figure 6.2.5 Creating Connections between the Buildings *[Ransome,*

The models shown in the photos in Figure 6.2.7 illustrate the idea of a suspended walkway, connecting the buildings and winding through the site, respecting the existing trees. This idea was adopted from the Boomslang walkway in Kirstenbosch Botanical Gardens, by Cape Town architect, Mark Thomas and engineer, Henry Fagan. *[Griffiths, A. 2014]*

While the idea of an experiential walkway works well on the site, the suspended walkway does not. The raised walkway had to have fence underneath it to keep the Rhinos out of the internal courtyard and this then instilled a sense of incagement from within the courtyard.

Figure 6.2.6 Boomslan Walkway
[Griffiths, A. 2014]

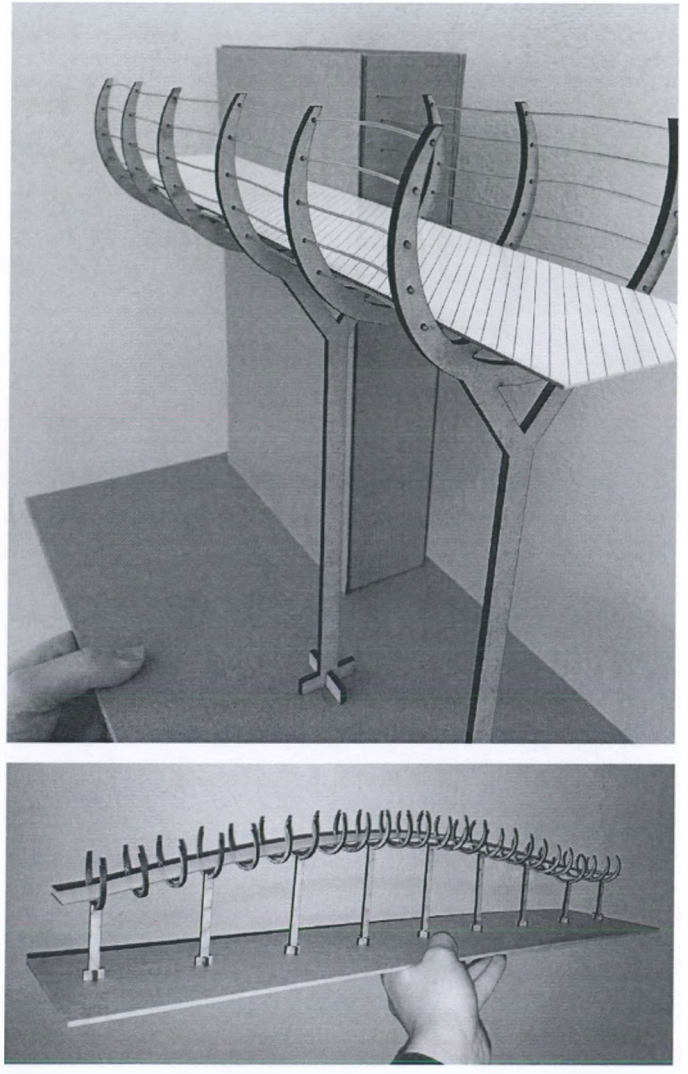


Figure 6.2.7 Suspended Walking Bridge Model
[Ransome, J. 2016]

Figures 6.2.8 and 6.2.9 illustrate this sense of being trapped. Views out into the Rhino enclosures are inhibited and blocked by the suspended walkways and fencing when viewing out from the central courtyard and thus taking away from the beauty of the place. The next design iteration explains the response to this and how the design evolved from this revision.

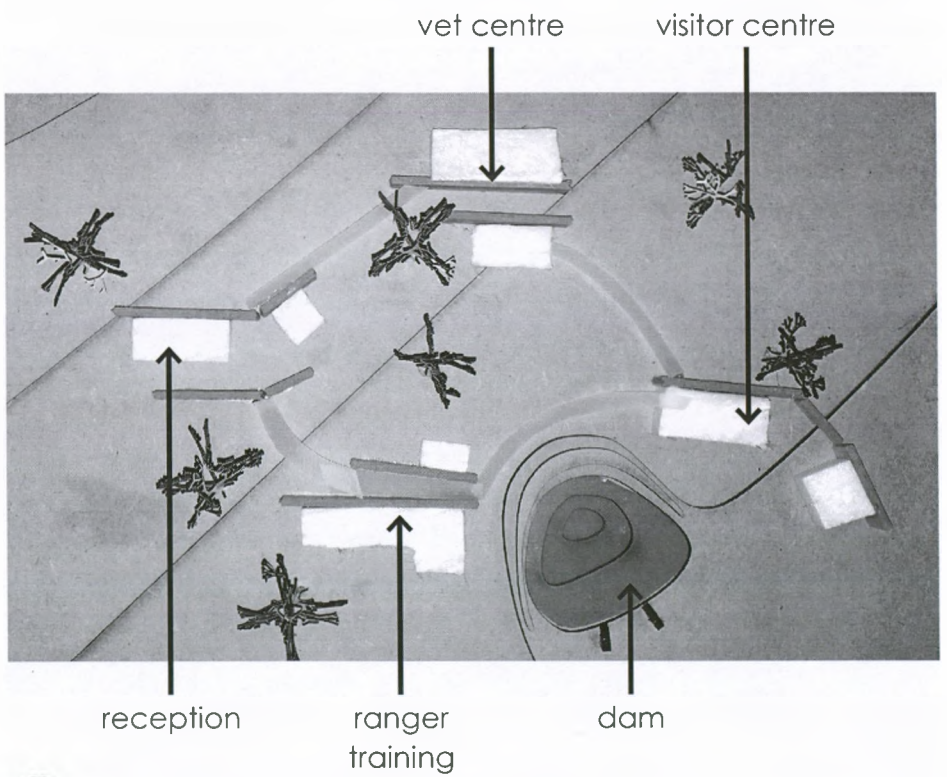


Figure 6.2.8 Sketch Design Rev A Massing Model *[Ransome, J.*

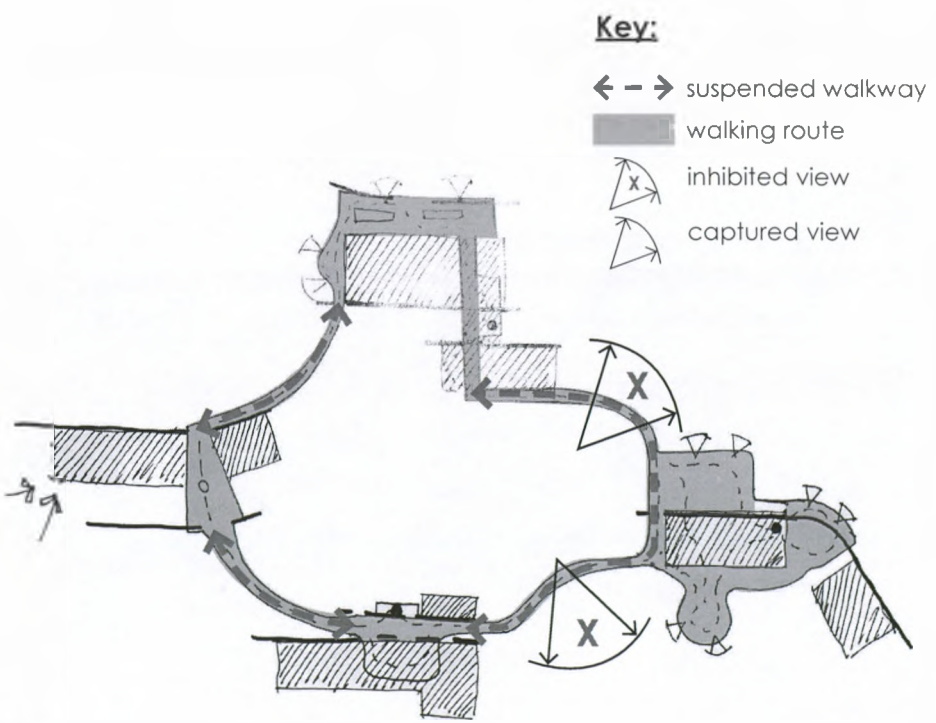


Figure 6.2.9 Sketch Showing Walking Route *[Ransome, J. 2016]*

6.2.2 SKETCH DESIGN REVISION B

To create a sense of logic in the building layout for the design, the placement of the Rhino pens and site dam were used as place-making elements. These divide the site into two zones, namely the "safe zone" and the "unsafe zone", for human access, see Figure 6.2.10 below.

The position of the Rhino pens was determined by the existing road, as well as the predicted movement route of the Rhinos through the site, as seen previously on page 98. As the animals will be delivered in big trucks, ease of access was important regarding delivery and the movement route of the Rhinos determined the safe and unsafe zones on the site as shown below in Figure 6.2.11.

While still wanting to include the majority of the natural landscape in the design, the proposal of a courtyard evolved and was determined by the axis as shown below. These axes were aligned as such to create an opening on the entrance side to draw the visitor in upon arrival.

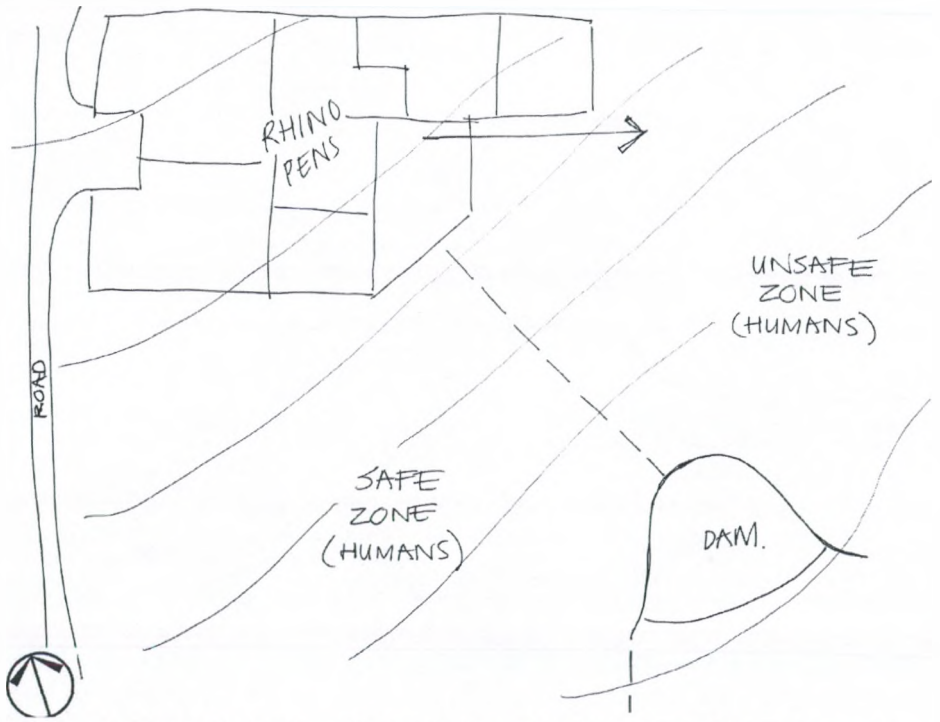


Figure 6.2.10 Illustration Safe & Unsafe Zones on Site *[Ransome, J.*

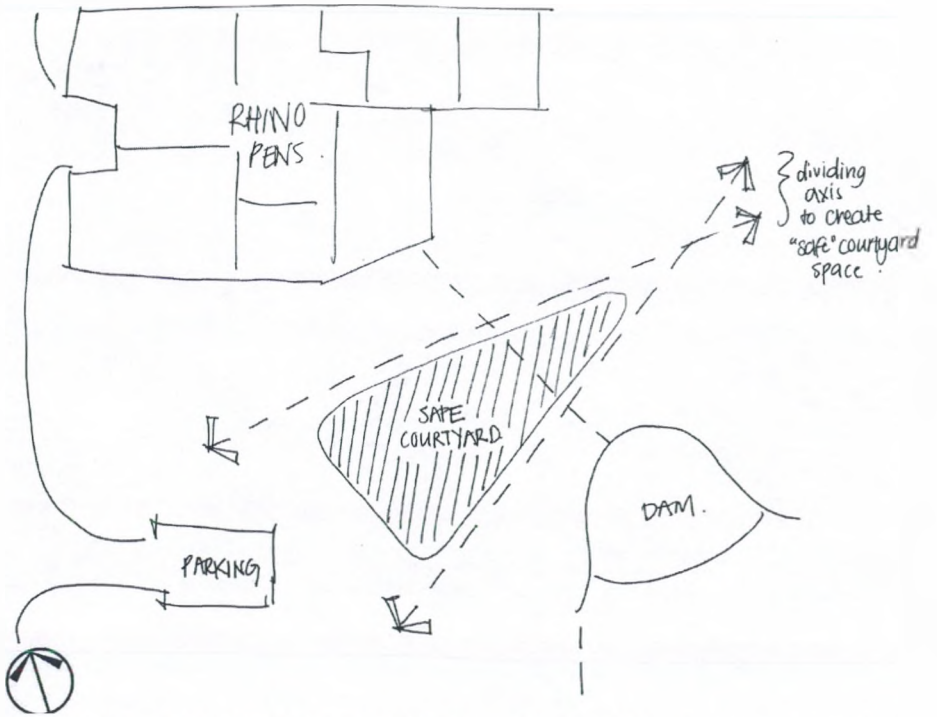


Figure 6.2.11 Illustration of Axis Created on Site *[Ransome, J. 2016]*

The sketches below in Figure 6.2.12 illustrates how the design started along the axis developed in the previous sketch, Figure 6.2.11. Rammed earth spine walls have been placed along these axes, creating a strong, heavy front for the building mass and outlining the courtyard created in the middle. This concept has been taken further in Figure 6.2.13, whereby the earth berm is clearly shown (in green) and how portions of the building puncture out through this. The roof of the vet and visitor centre is a planted roof and will form part of the walking journey experienced by the user as they move through the site. Points of vertical circulation have been included in the buildings to allow access up onto the planted roof as wall as bring light in from above. Breaks in the rammed earth wall illustrate points of entry and will also allow for the penetration of natural light into the buildings.

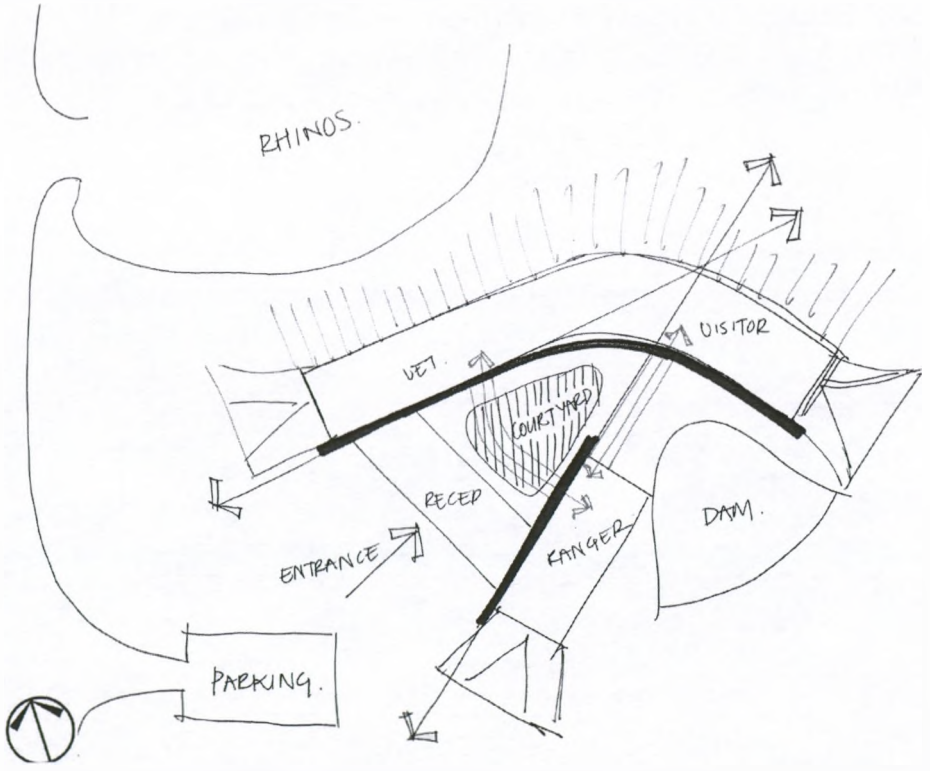


Figure 6.2.12 Sketch Design Informed by Axis *[Ransome, J. 2016]*

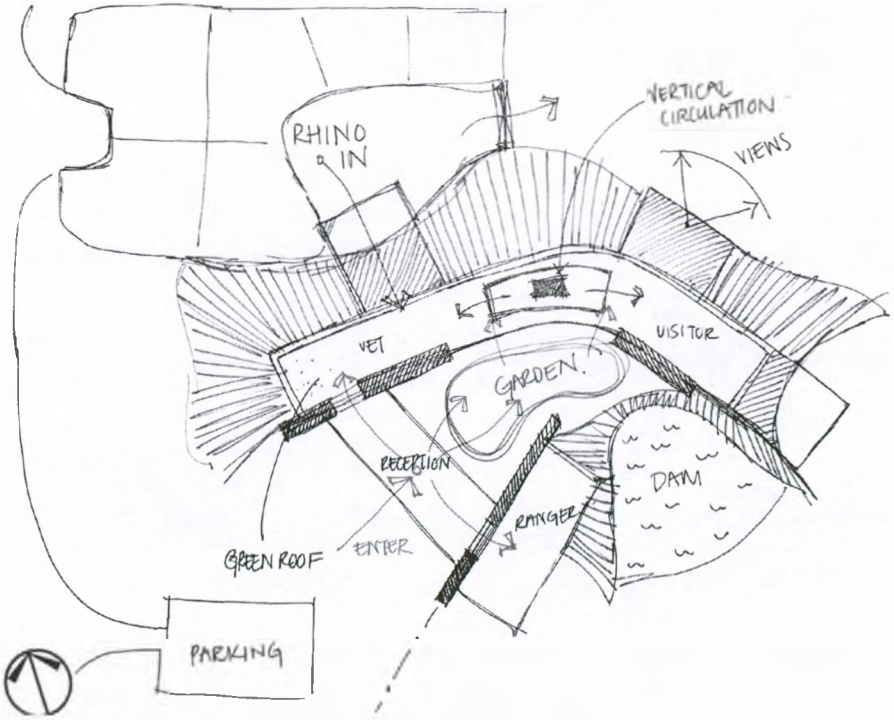


Figure 6.2.13 Sketch Design Development *[Ransome, J. 2016]*

The sketches below in Figures 6.2.14 and 6.2.15 illustrate design exploration in the early stages of this design iteration. The berms are clearly seen in both, with the planted roof and rammed earth walls lining the central courtyard.

Instead of having a walkway as a separate entity as in design revision A, the planted roofs have become the walkway in the design development. This design is less fragmented and forms a cohesive building development, linking spaces both internally and externally. Giving use to the roof of the buildings as opposed to including additional walkways allows the building to engage with the user in more ways, it becomes multifunctional and a more integrated design as a whole.

The sketch in Figure 6.2.16 illustrates the walkway on the planted green roof, specifically where it connects to the berm below. This will give an illusion of a seamless transition between the earth roof and earth berm. Hiding the building below and thus giving the illusion of being in nature, adding to the stealth approach and creating a stronger connection to the surrounding landscape. The slope of the berms has been designed to be too steep an incline for the Rhino to be able to get up. The walkway is also situated far enough from the edge, with a planted, non-trafficable garden to keep people away from the edge and unable to go down the berm. In places where the trafficable area is close to the edge, sufficient railings and safety measures have been designed for.

As one of the main concepts around the design of the centre is the experiential journey and thus movement in the buildings, and around the site, way-finding points were important to include. Within the design, there are various features and design elements that aid in persuading certain movement paths as well as public

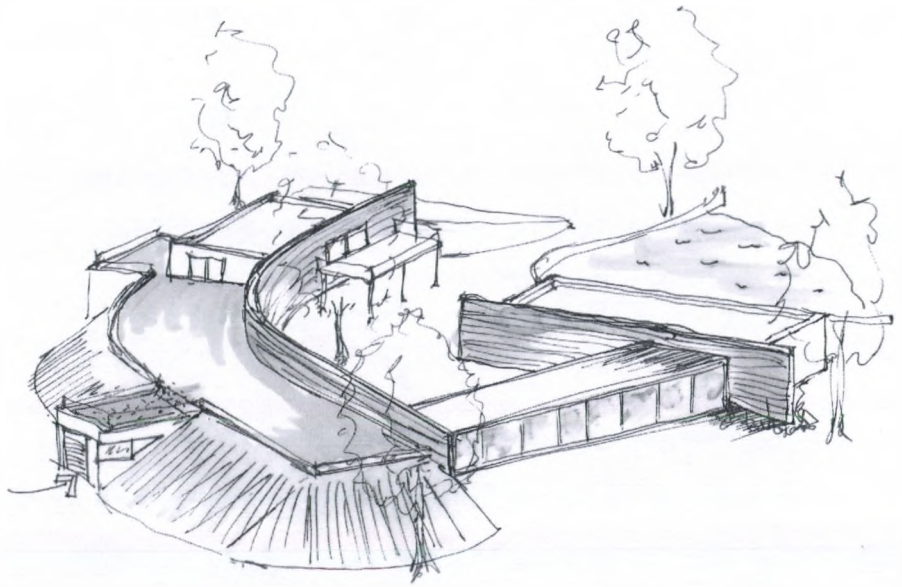


Figure 6.2.14 Design Revision B Initial Sketches *[Ransome, J. 2016]*

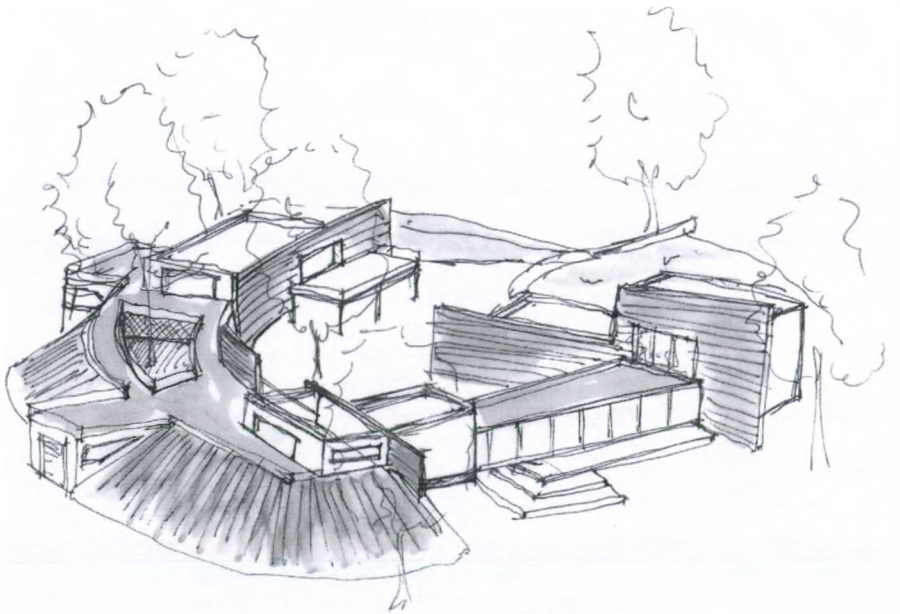


Figure 6.2.15 Design Development - Revision B *[Ransome, J. 2016]*

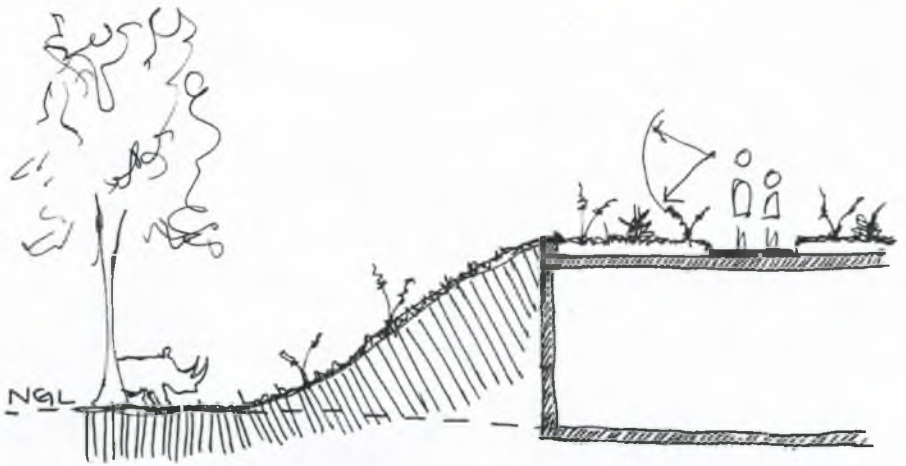


Figure 6.2.16 Rooftop Walkway on Green Roof *[Ransome, J. 2016]*

and private thresholds within the building. While this is a public building, the programme deals with sensitive topics and thus certain areas need to be kept inaccessible to the general public and visitors.

The diagram in Figure 6.2.17 shows the development of the placement of the vertical circulation nodes. These are designed to be way-finding elements within the design as well as light wells. As mentioned previously, the concept of the experiential journey is for the user to be able to repeat the journey a few times, taking a different route each time. Having various nodes of vertical circulation not only allows the user to move between floors easily but also for the user to be able to enter and exit the journey at different points.

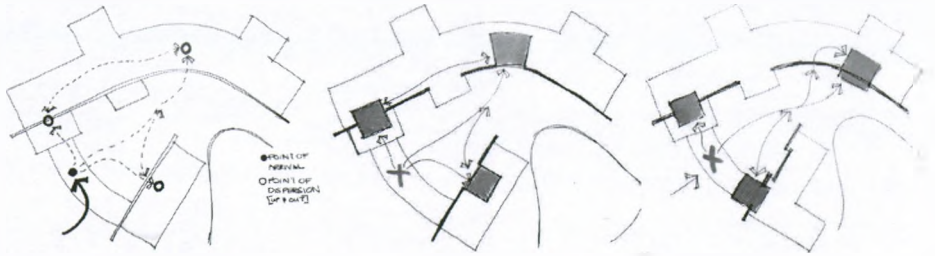


Figure 6.2.17 Points of Vertical Circulation *[Ransome, J. 2016]*

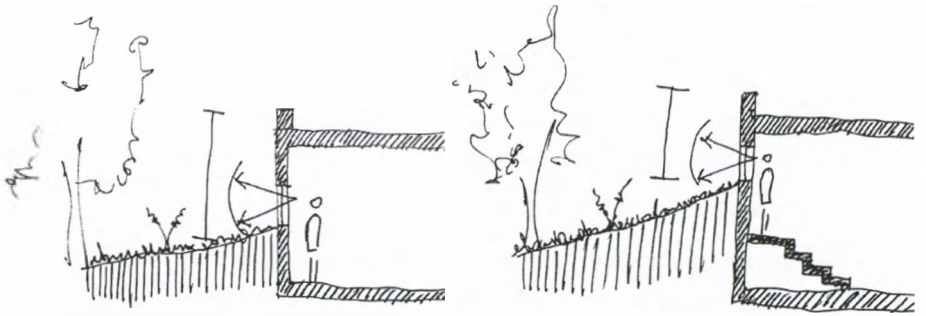
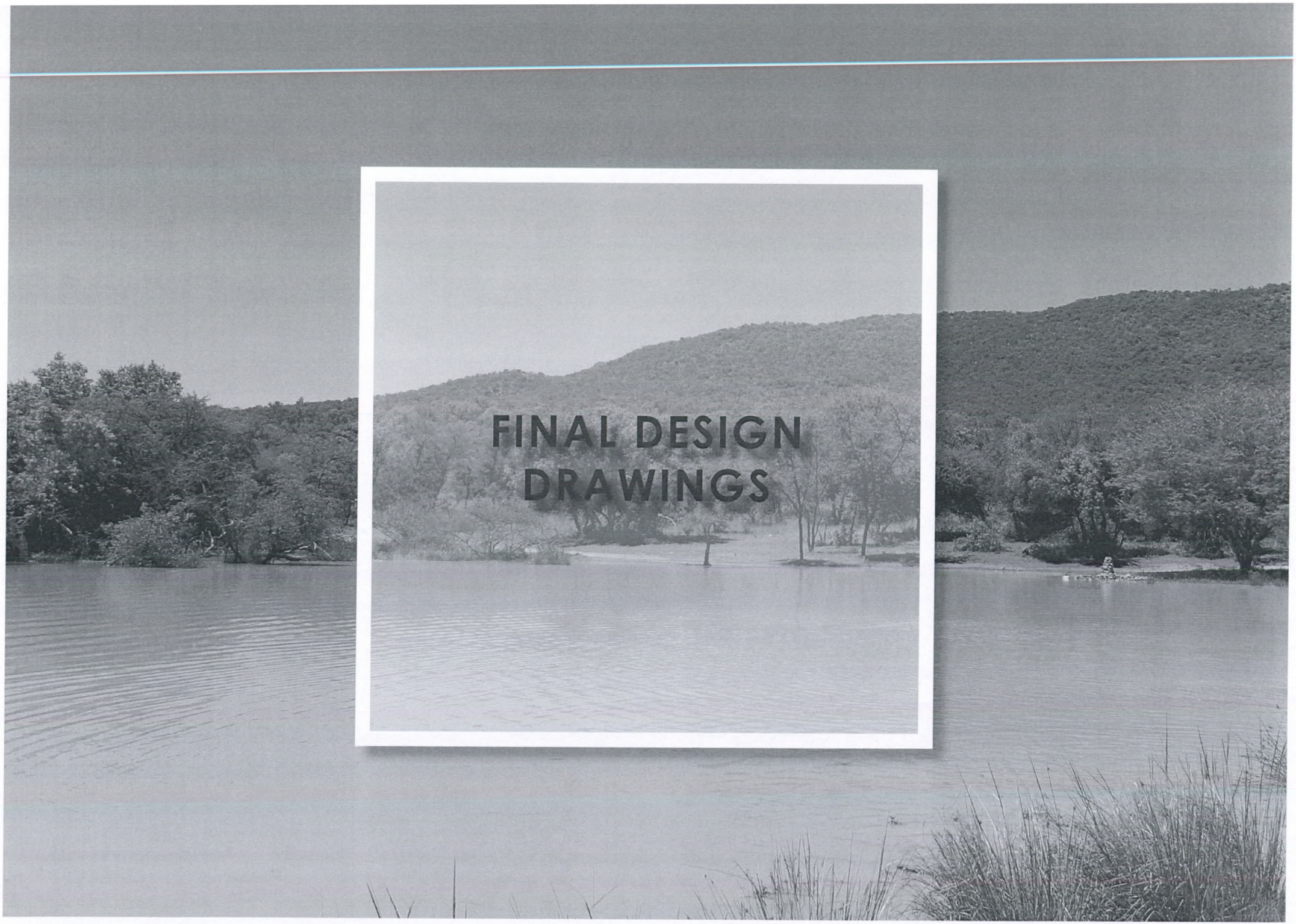
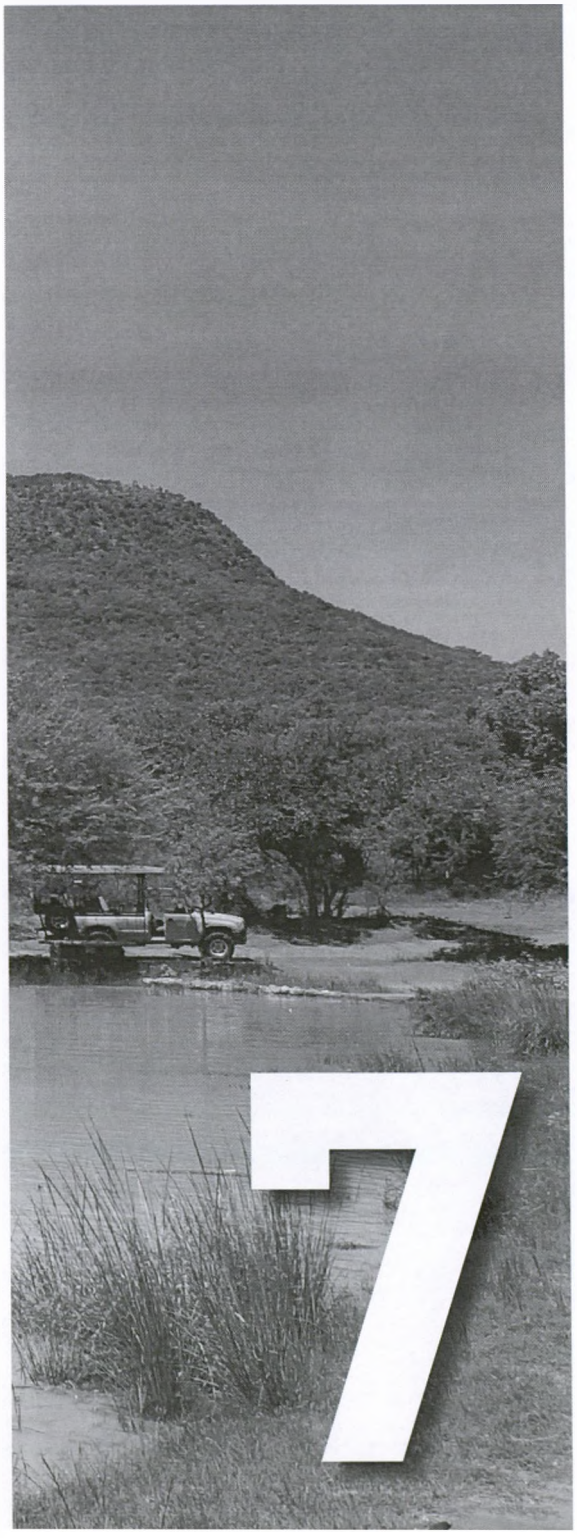


Figure 6.2.18 An Animal Viewing Hide in the Earth *[Ransome, J. 2016]*

There are various points along the 'journey' where the user will experience different elements of the centre. Figure 6.2.18 shows the design of the animal viewing hide protruding through the berm, looking out over the Rhino enclosures. To maintain the concept of stealth through the design, the aim was for as little of the building to pop out of the land as possible. Creating raised platforms inside the hide allowed for the windows to be higher and thus the berm to be higher, making the hide almost invisible from the outside. The earth berm's sound proofing properties also aid in the design of the hide as one of the main features of an animal viewing hide is for it be as quiet as possible so as not to scare off any animals outside of it.

The following chapter, *Final Design Drawings*, highlights and shows more of the design in more detail in plan, section, elevation and three-dimensional renders.


FINAL DESIGN
DRAWINGS



7

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Site Plan	pg 122
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Elevations and Sections	pg 128
Perspectives and Renders	pg 142

7.1 SITE PLAN

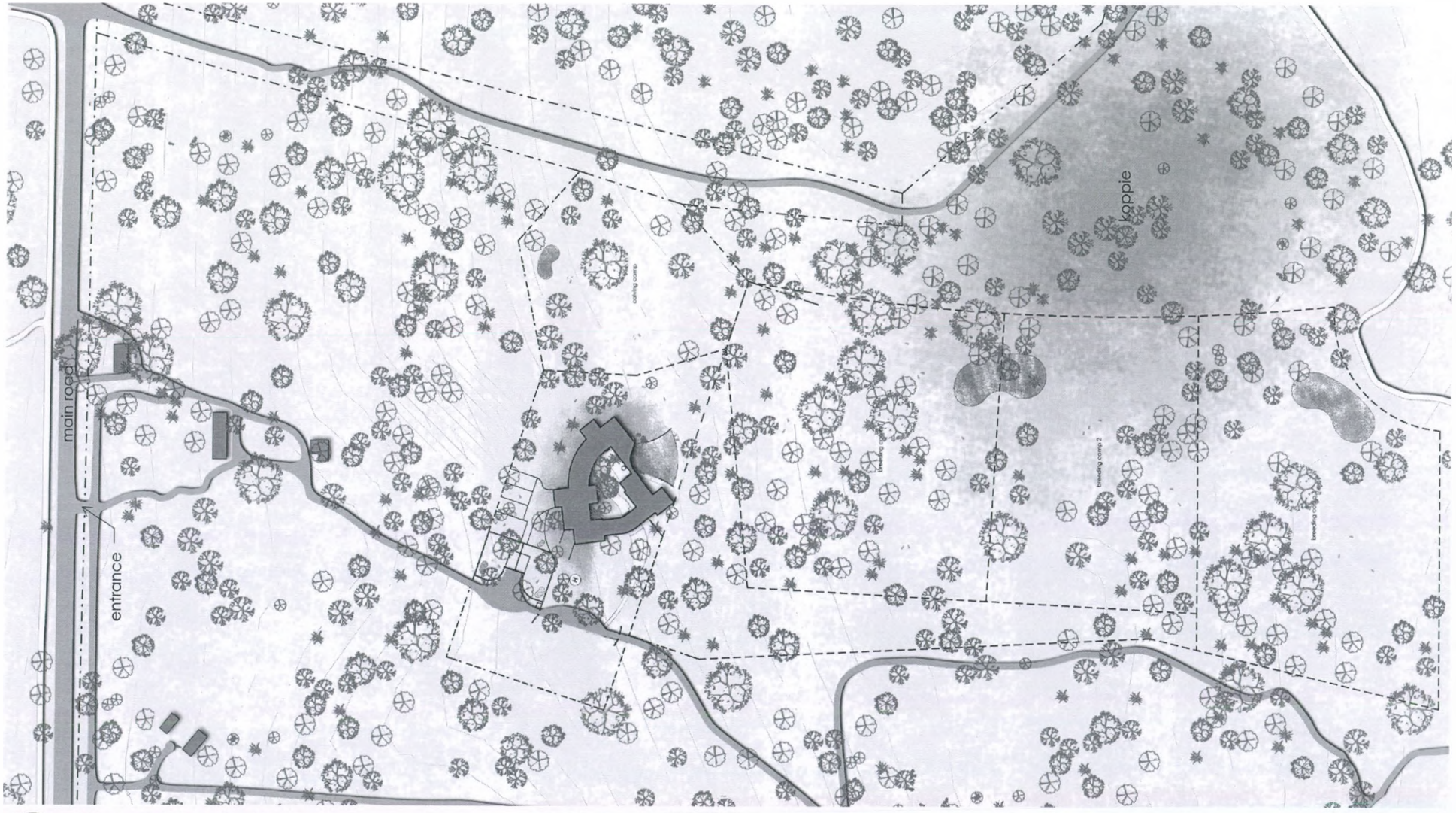


Figure 7.1.1 Locality Plan
Not to Scale [Ransome, J. 2016]

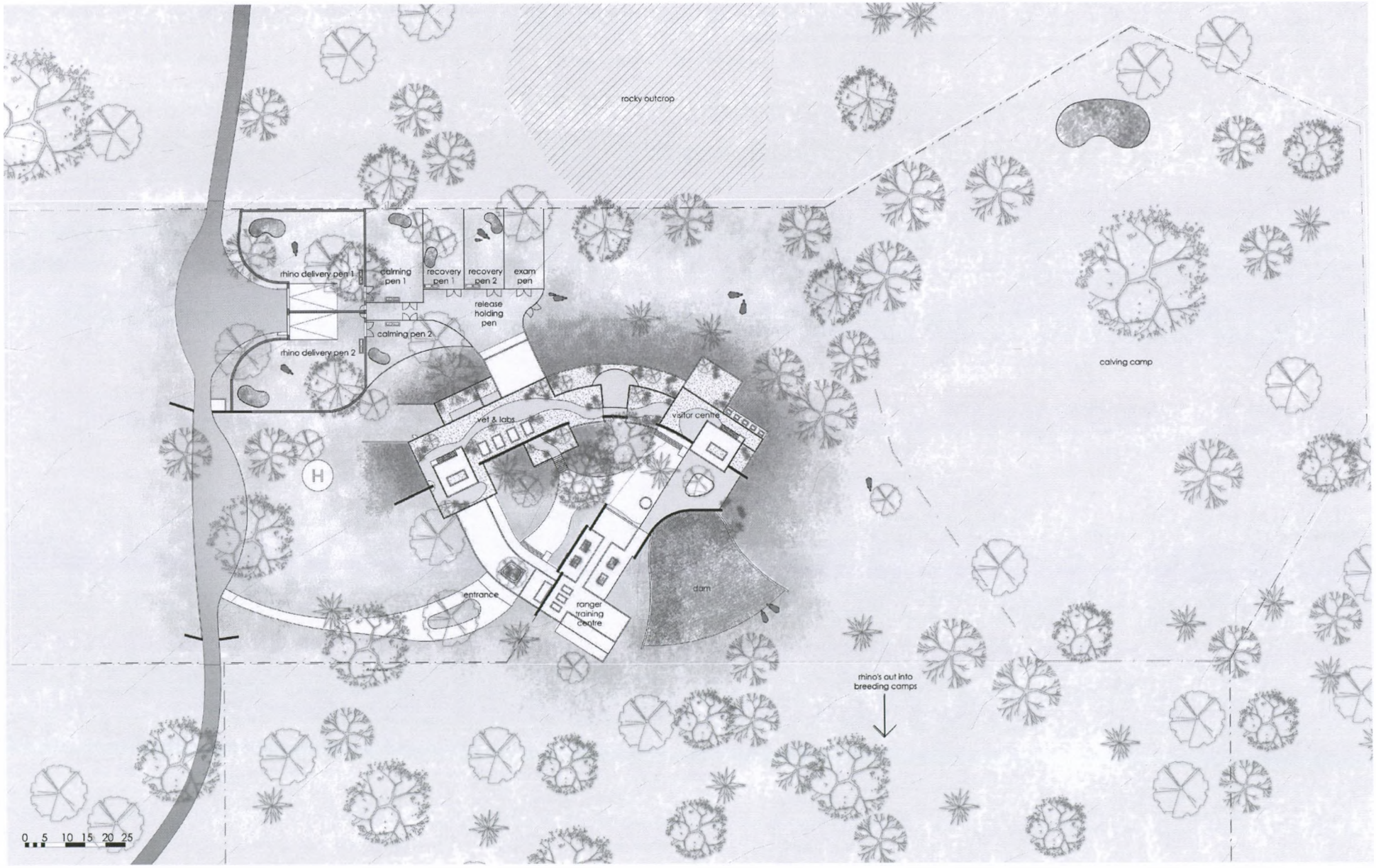


Figure 7.1.2 Site Plan

Scale as per scale bar [Ransome, J. 2016]

7.2 BUILDING PLANS

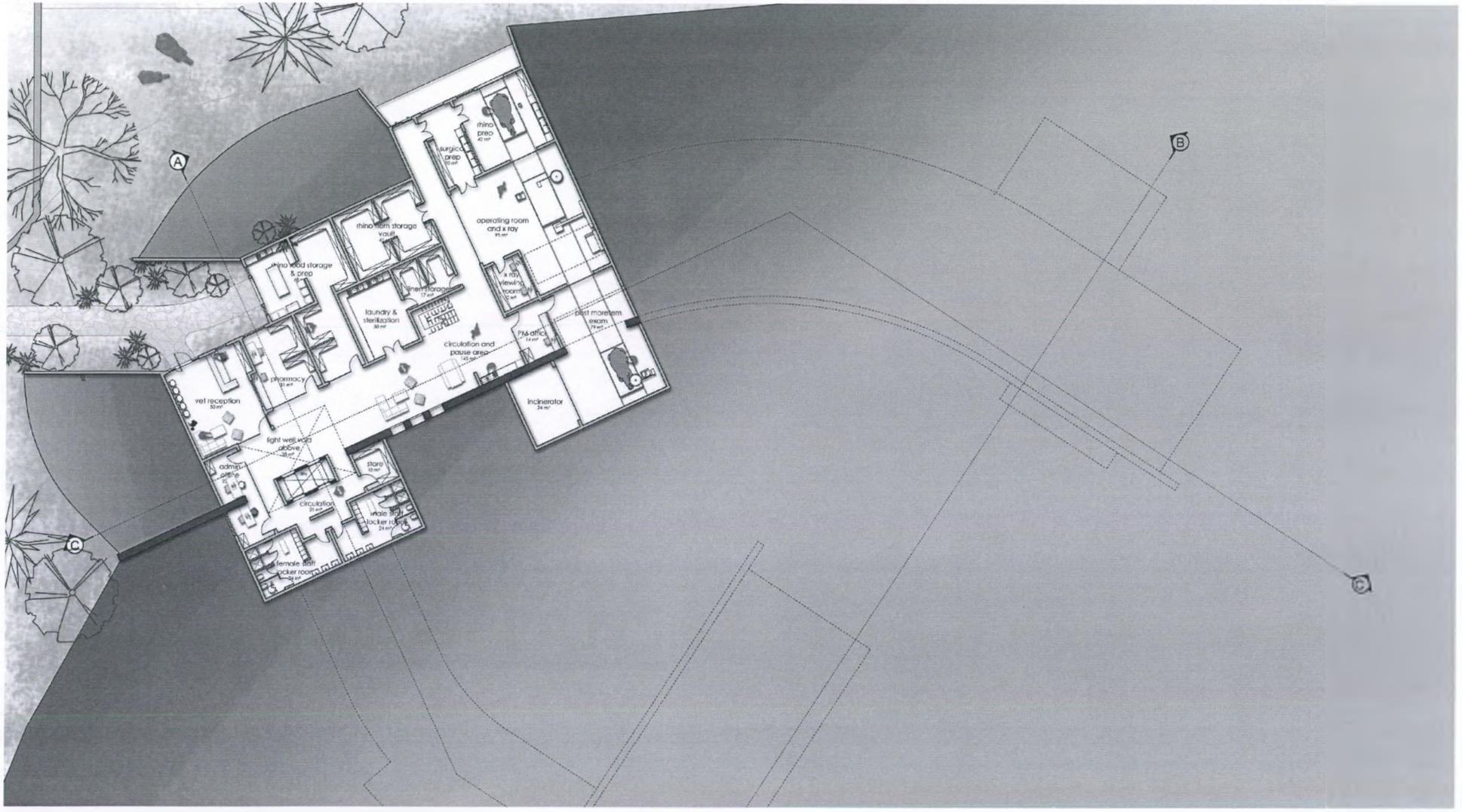


Figure 7.2.1 Lower Ground Floor Plan

Not to scale [Ransome, J. 2016]

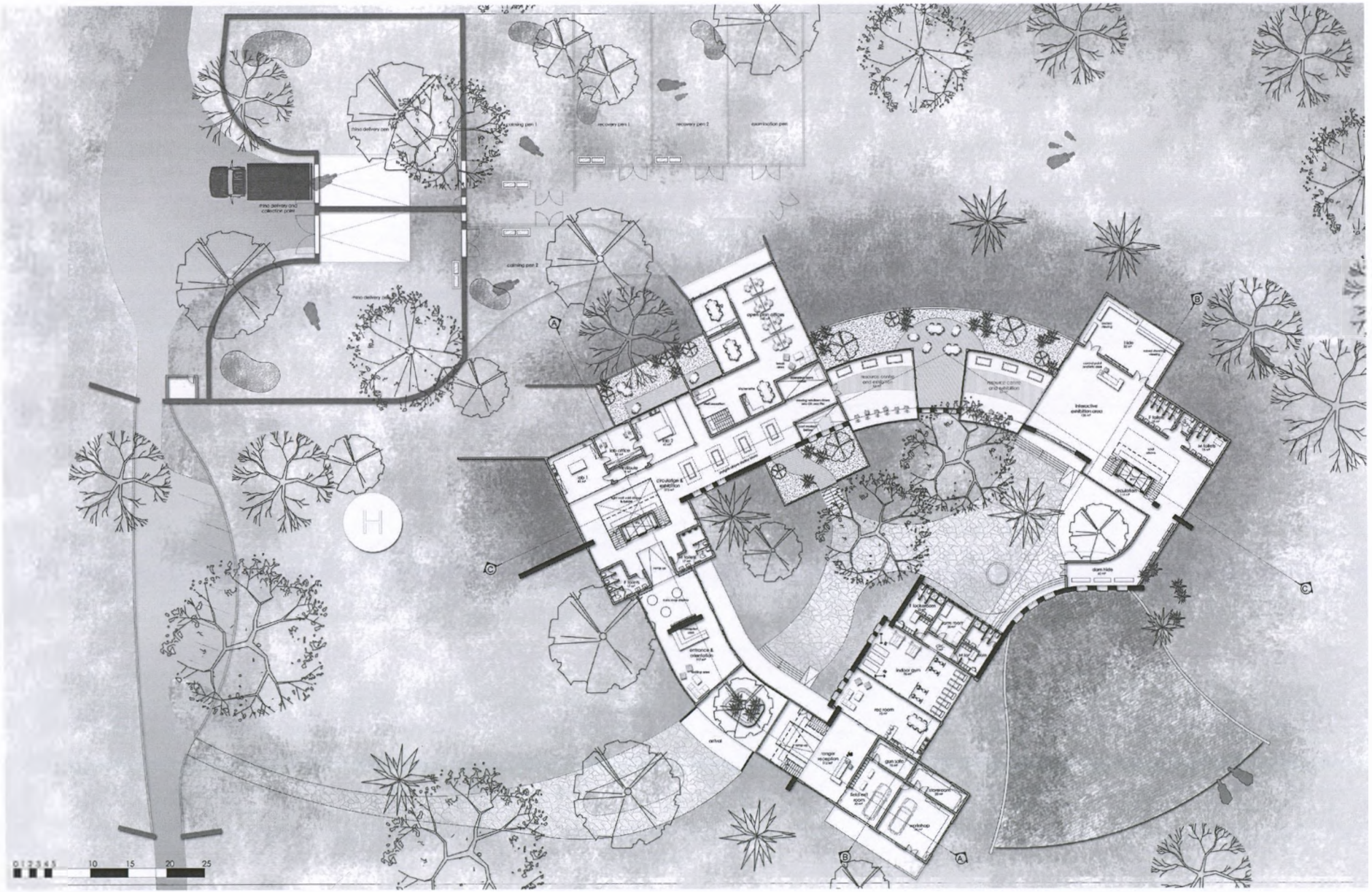


Figure 7.2.2 Ground Floor Plan

Scale as per scale bar [Ransome, J. 2016]

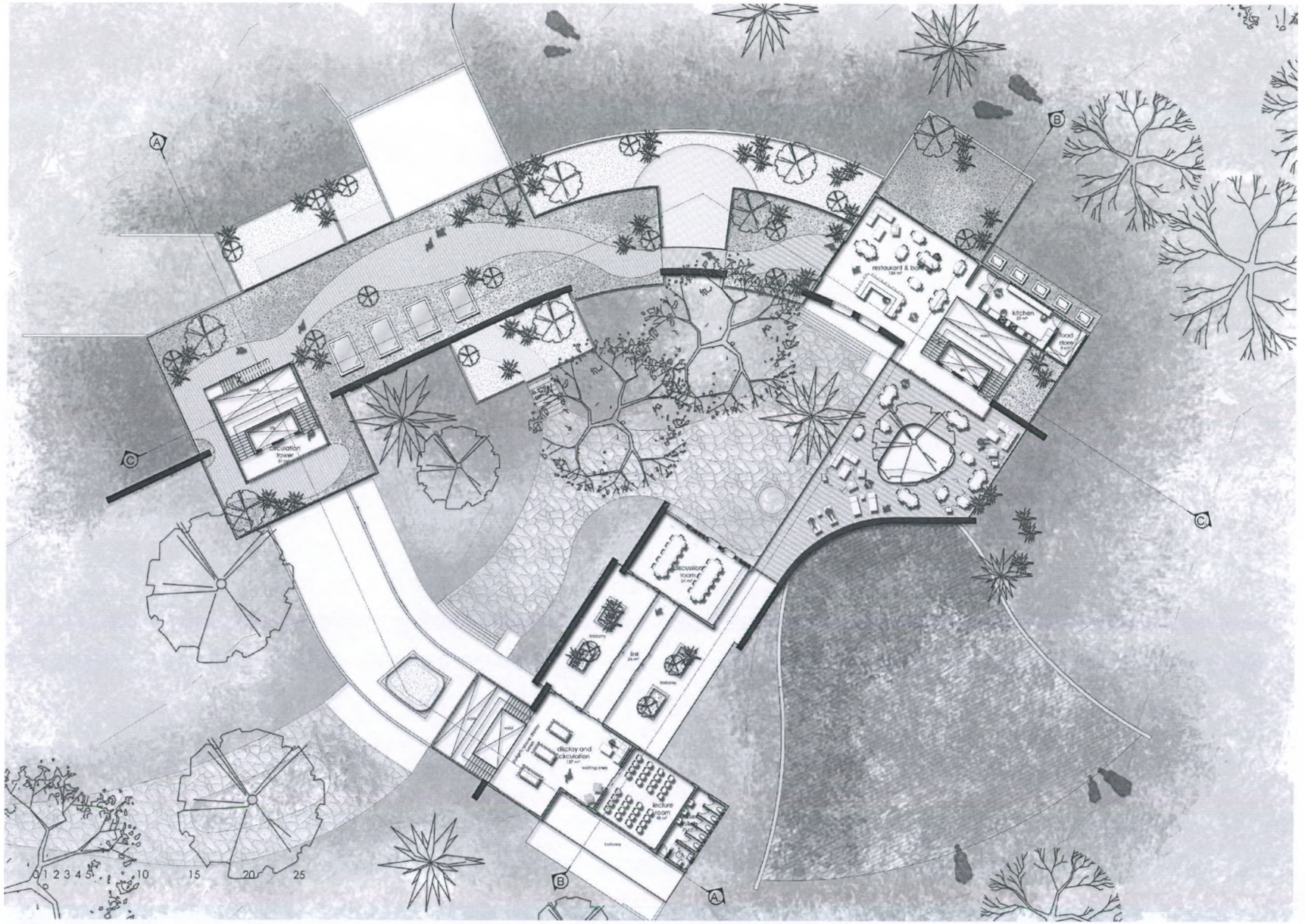


Figure 7.2.3 First Floor Plan

Not to Scale [Ransome, J. 2016]

7.3 ELEVATIONS AND SECTIONS

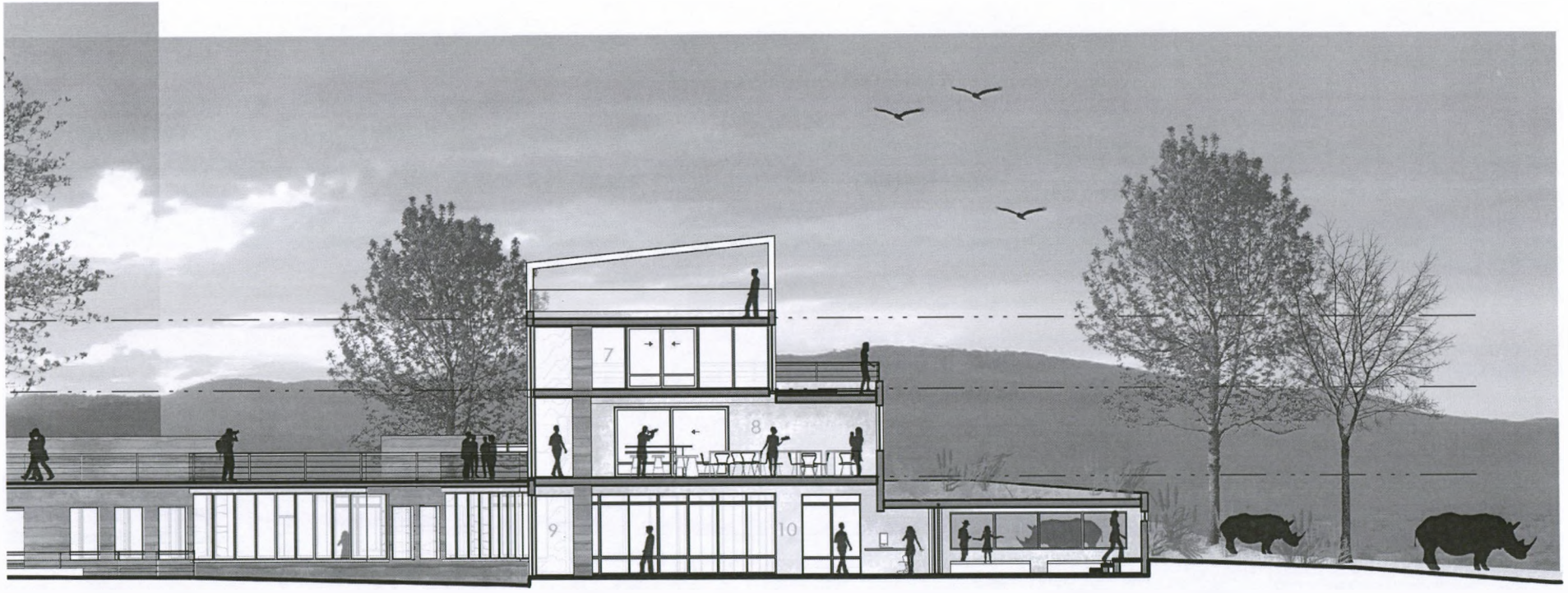
Figure 7.3.1 Section A

Not to Scale [Ransome, J. 2016]

1. lab office
2. vestibule
3. pharmacy
4. circulation and pause are
5. lifts
6. circulation and exhibition
7. circulation
8. circulation tower
9. male staff lockerroom
10. entrance and orientation
11. display and circulation
12. ranger reception
13. field exit room
14. workshop

Figure 7.3.2 Section B

Scale 1:200 [Ransome, J. 2016]



1. lecture room
2. field exit room
3. gun safe
4. recreational room
5. indoor gym
6. male lockerroom
7. circulation lobby
8. restaurant and bar
9. circulation
10. interactive exhibition area
11. animal viewing hide

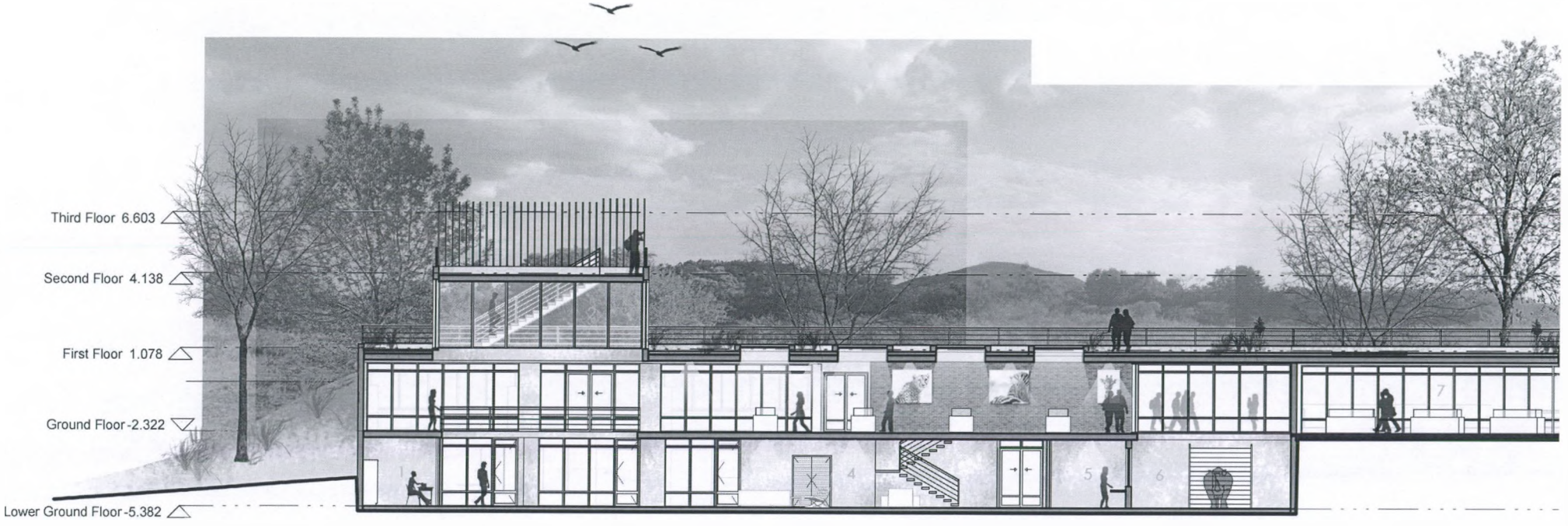
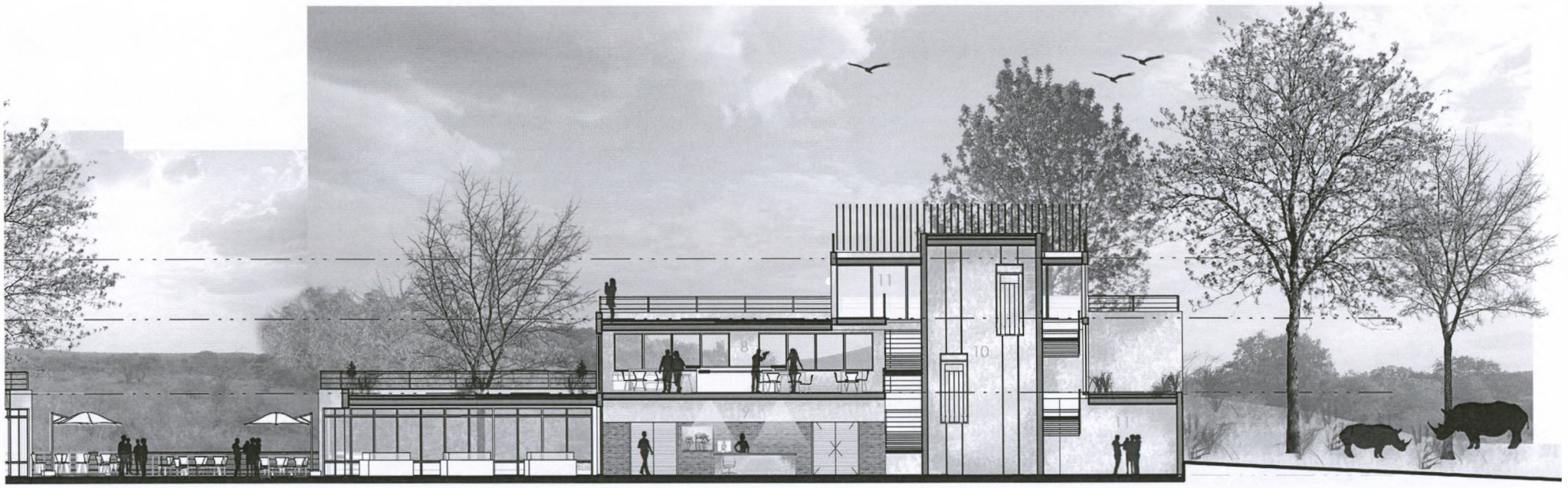


Figure 7.3.3 Section C

Not to Scale [Ransome, J. 2016]



1. admin office
2. circulation tower
3. circulation and exhibition
4. circulation and pause area
5. post mortem office
6. post mortem exam
7. resource centre and exhibition
8. restaurant and bar
9. interactive exhibition area
10. lifts
11. circulation lobby

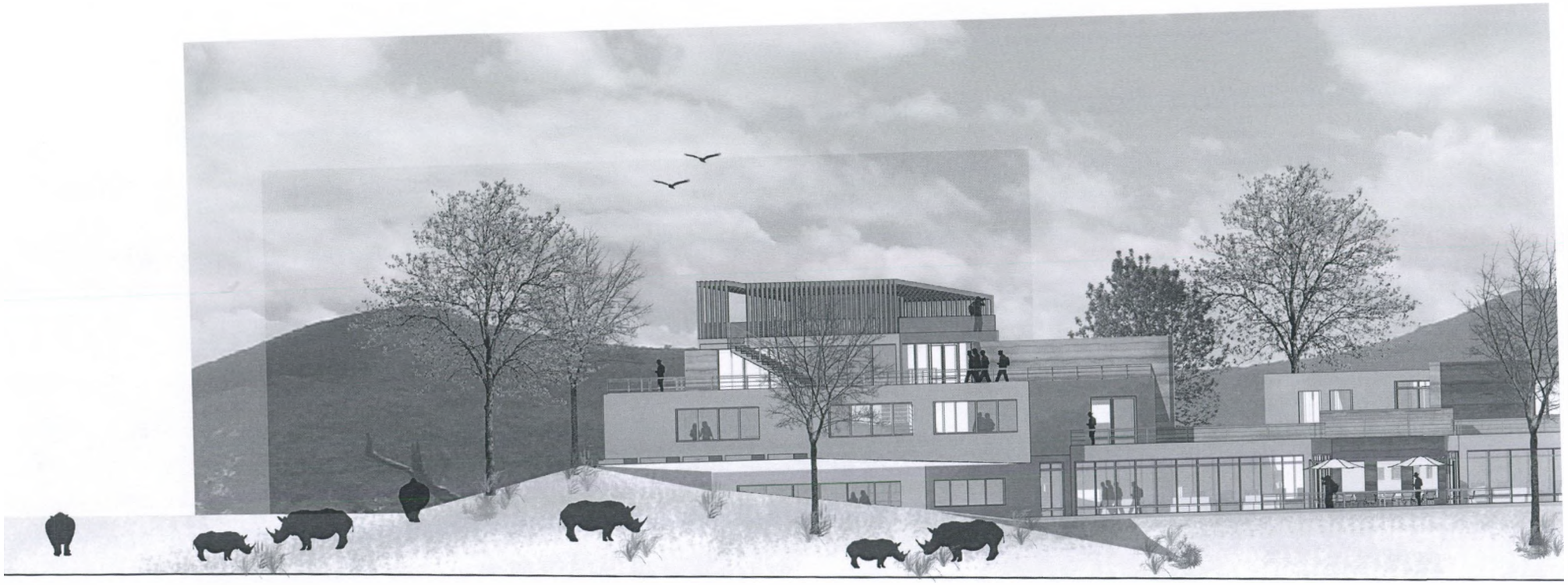
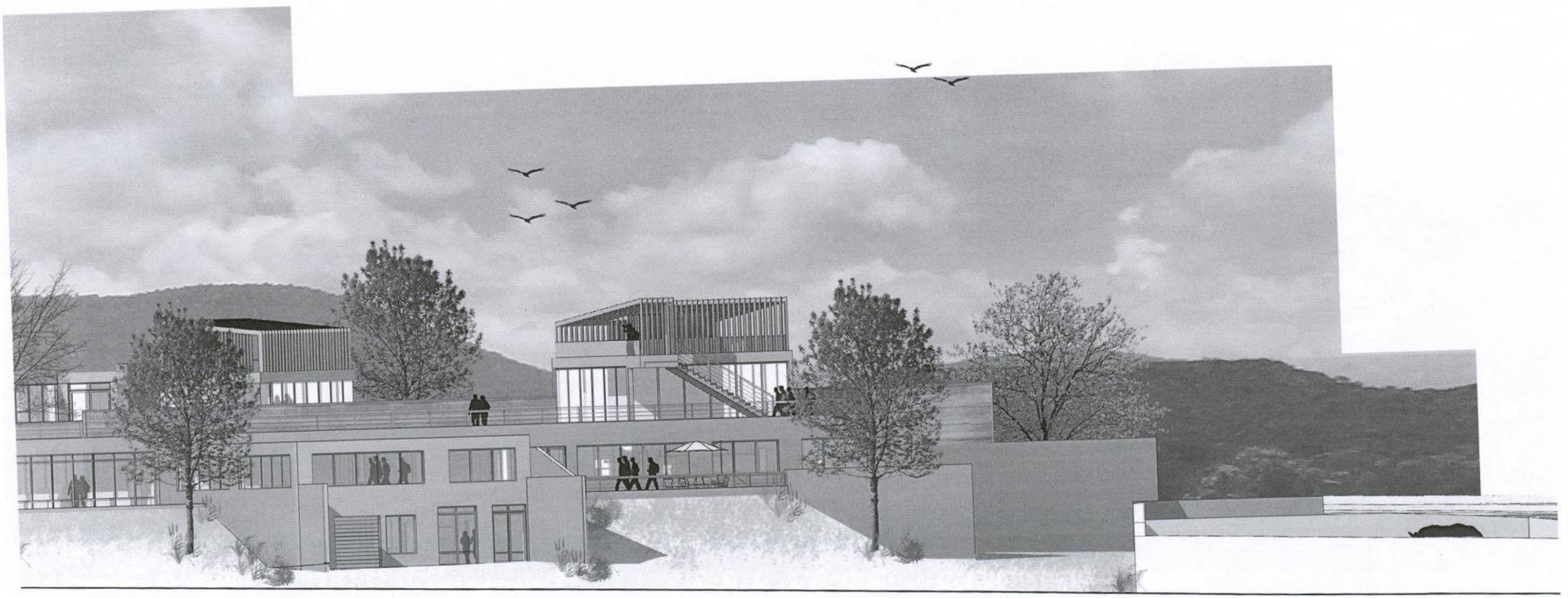


Figure 7.3.4 North Elevation

Not to Scale [Ransome, J. 2016]



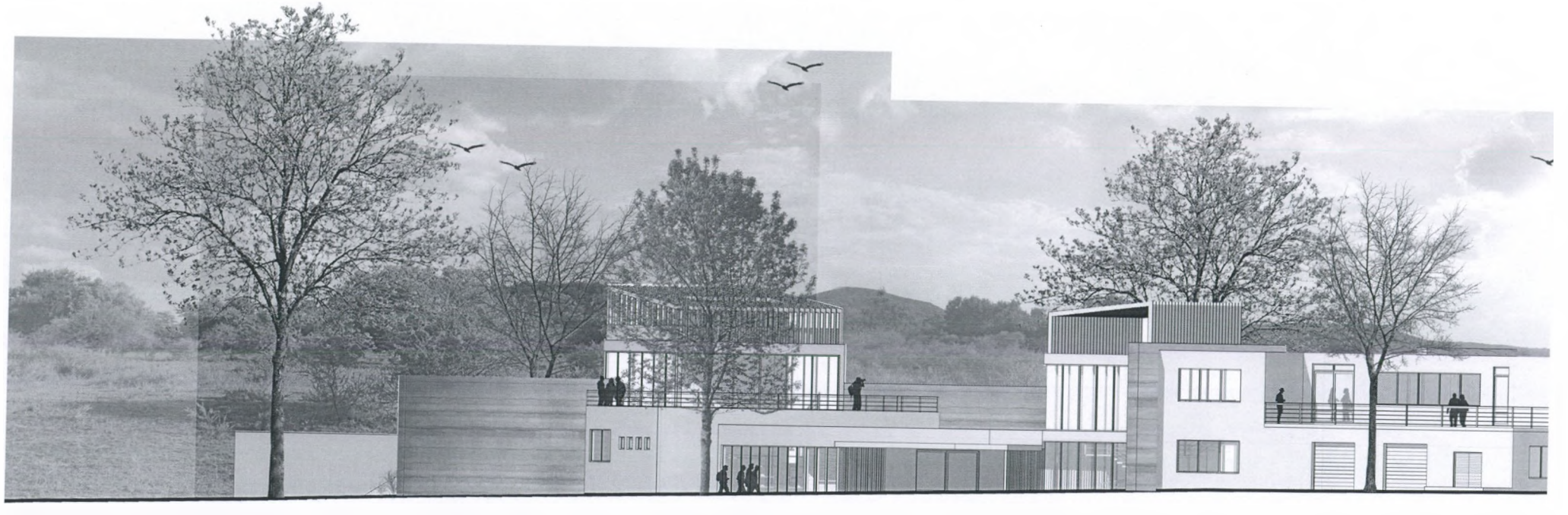
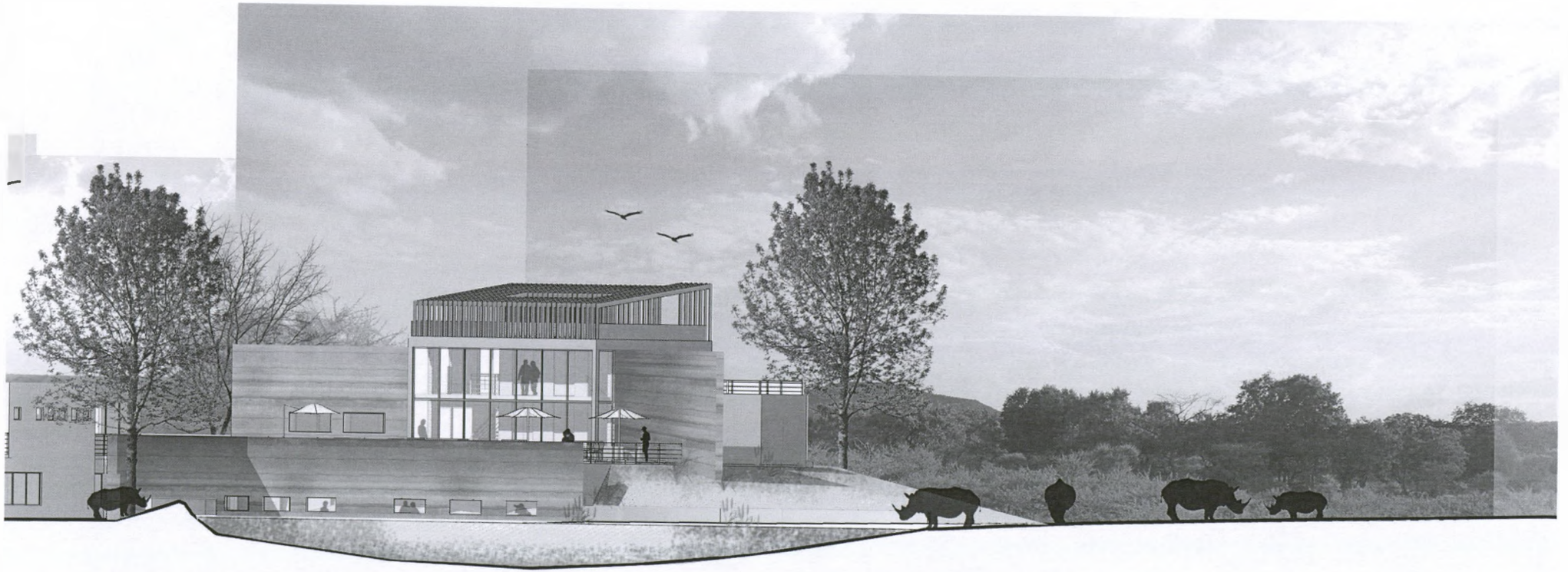


Figure 7.3.5 South Elevation

Not to Scale [Ransome, J. 2016]



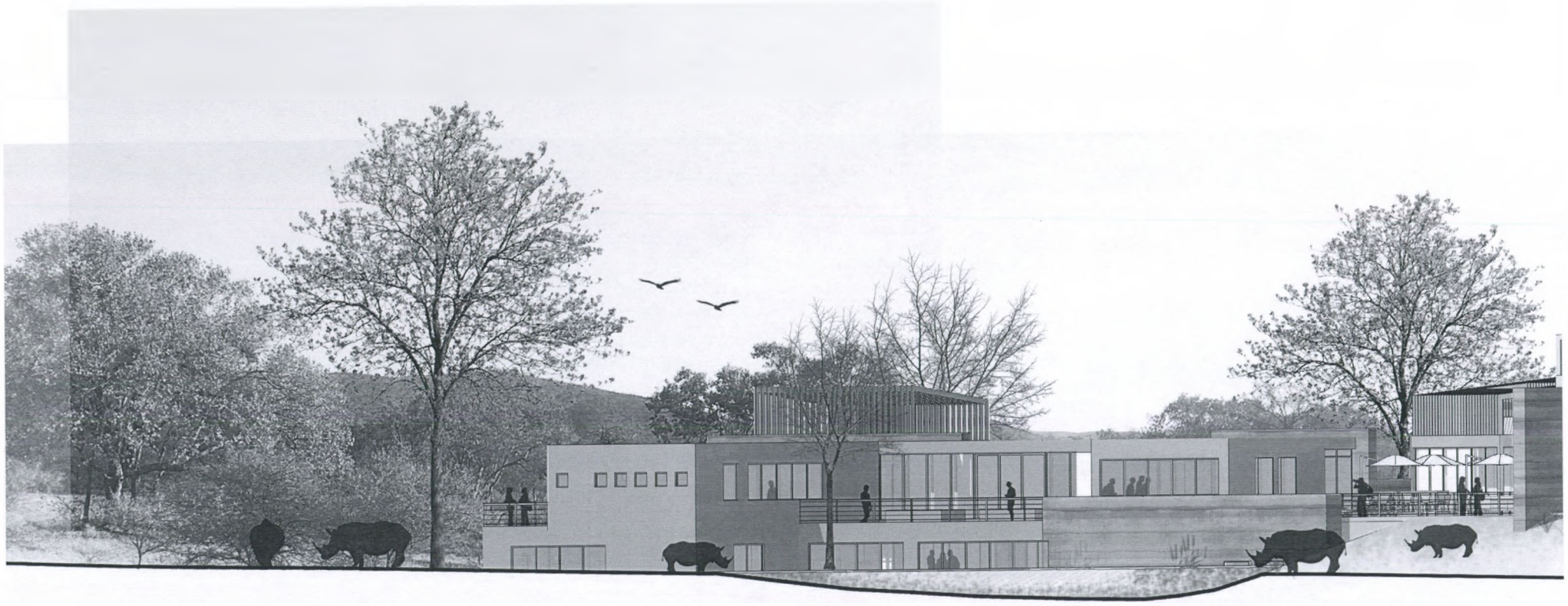


Figure 7.3.6 East Elevation

Not to Scale [Ransome, J. 2016]

Figure 7.3.7 West Elevation

Not to Scale [Ransome, J. 2016]

7.4 PERSPECTIVES AND RENDERS

Figure 7.4.1 Entrance Perspective

Not to Scale [Ransome, J. 2016]

Figure 7.4.2 Internal Exhibition Walkway and View into Vet's Lab

Not to Scale [Ransome, J. 2016]

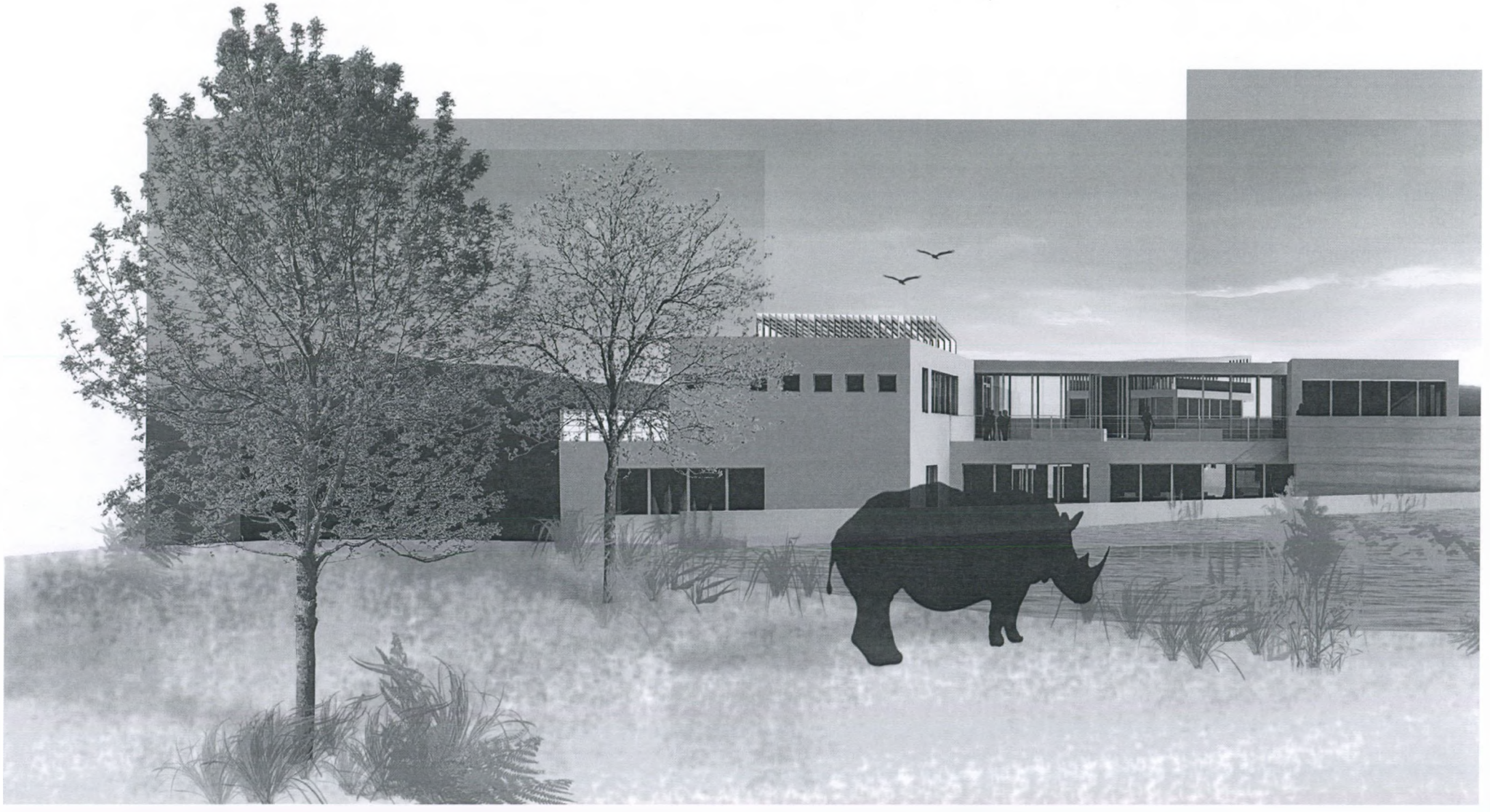


Figure 7.4.3 Rhino's View From Dam

Not to Scale [Ransome, J. 2016]

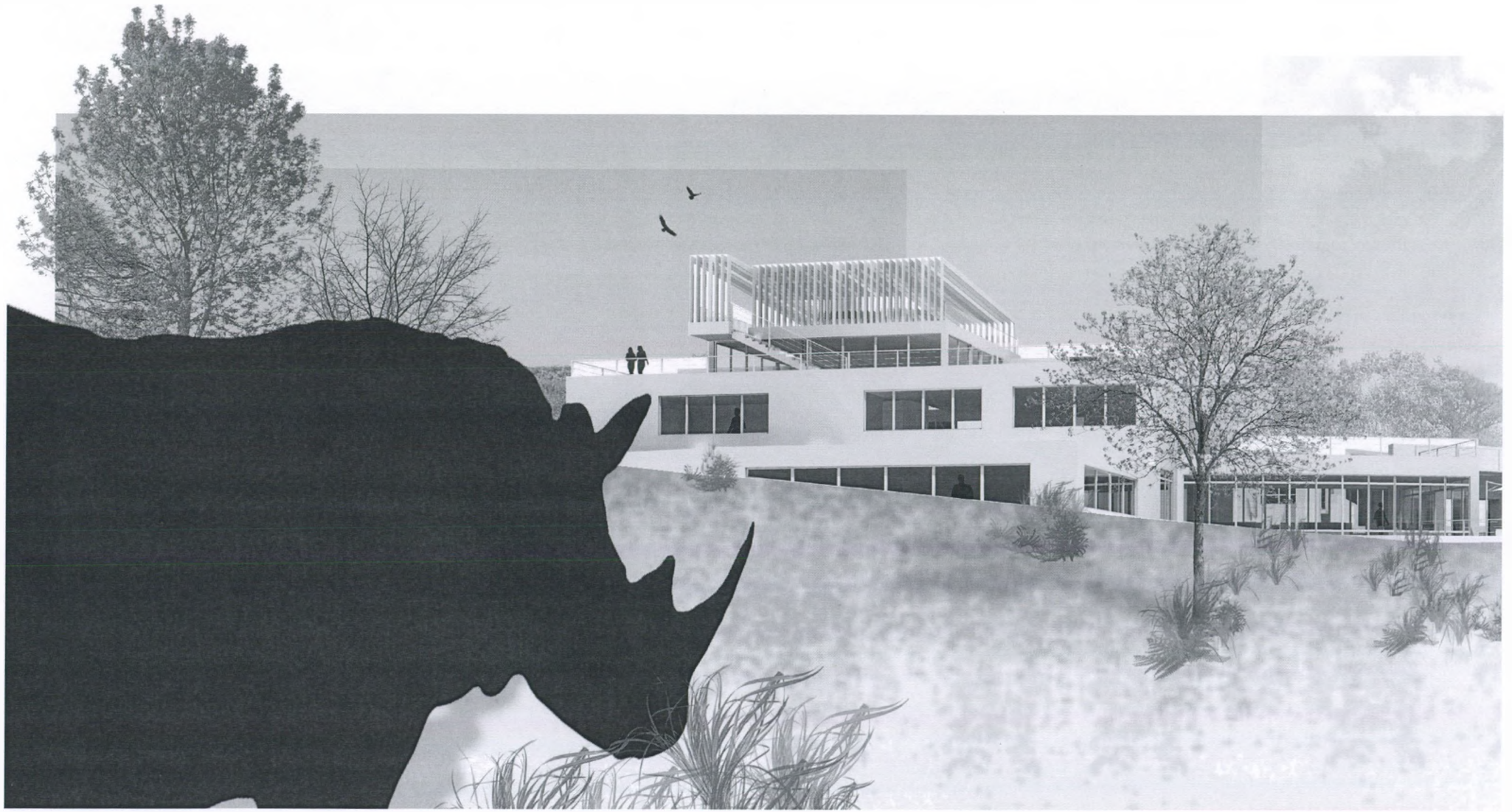


Figure 7.4.4 Rhino's View From Enclosure

Not to Scale [Ransome, J. 2016]

Figure 7.4.6 View From Deck into Courtyard Below

Not to Scale [Ransome, J. 2016]

Figure 7.4.7 Animal Viewing Hide, Looking Out

Not to Scale [Ransome, J. 2016]

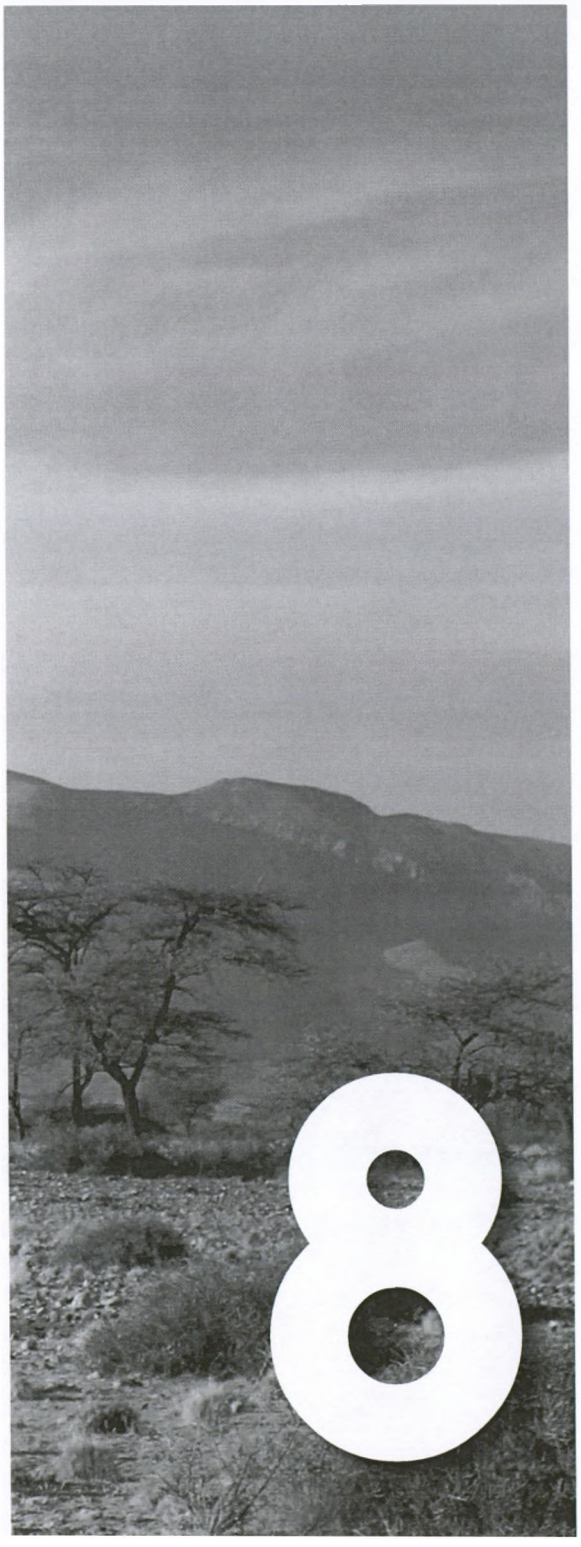
Figure 7.4.8 View Towards Ranger Training Centre and Entrance

Not to Scale [Ransome, J. 2016]

Figure 7.4.9 From Lookout Tower 1 to Green Roof and Courtyard Below

Not to Scale [Ransome, J. 2016]

TECHNICAL
RESOLUTION



8

CHAPTER INDEX

Building Performance pg 154

Response to the Sun pg 156

Rainwater Harvesting pg 162

Geothermal HVAC System pg 164

Perimeter Sections and Details pg 168

8.1 BUILDING PERFORMANCE

As mentioned in the previous chapters, the aim for the architecture of the design was to create a thermally efficient building that hardly relied on outside sources of heating, cooling, lighting and water.

The diagrams below in Figures 8.1.1 to 8.1.4, highlight the different aspects of the design that will be explored in this chapter and the various approaches that were taken to achieve thermal efficiency in the building as well as a water-wise strategy for capturing and storing rainwater. Together with the building technologies outlined in chapter 5, details and perimeter sections have been developed to show the overall building performance and the construction methodology used.

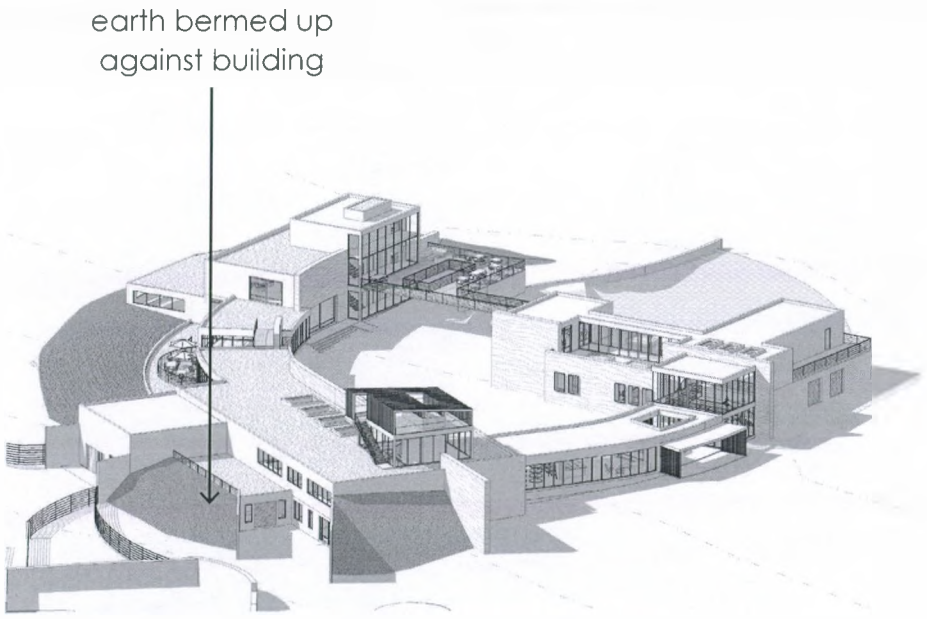


Figure 8.1.1 Axonometric Highlighting the Earth Berms
Not to Scale [Ransome, J. 2016]

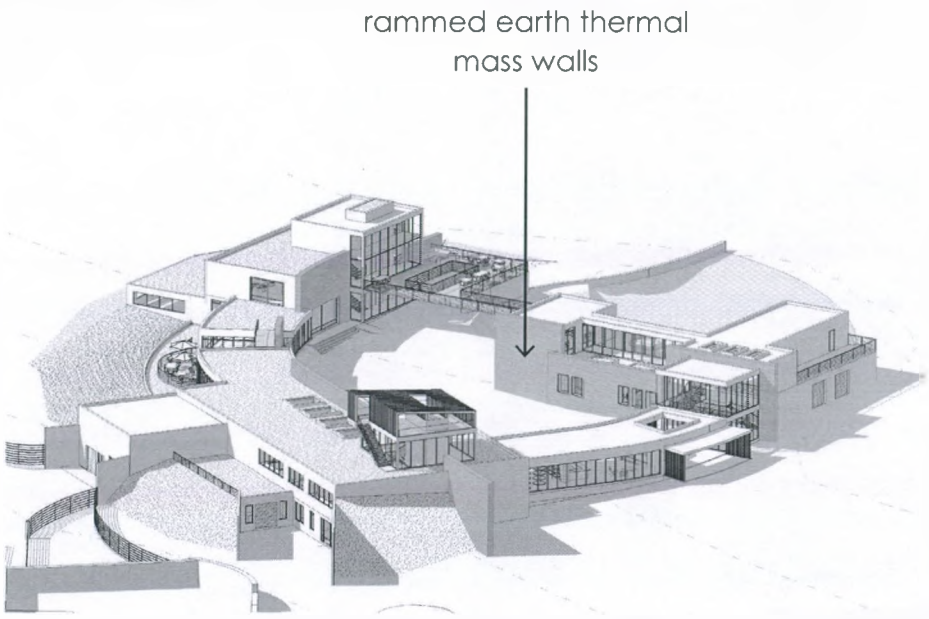


Figure 8.1.2 Axonometric Highlighting Rammed Earth Walls
Not to Scale [Ransome, J. 2016]

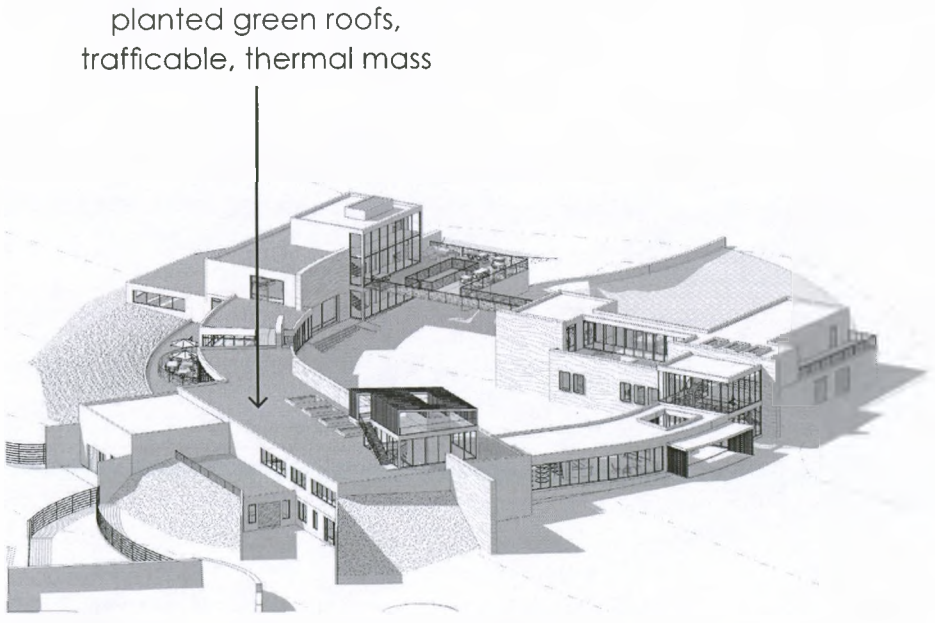


Figure 8.1.3 Axonometric Highlighting Green Roofs
Not to Scale [Ransome, J. 2016]

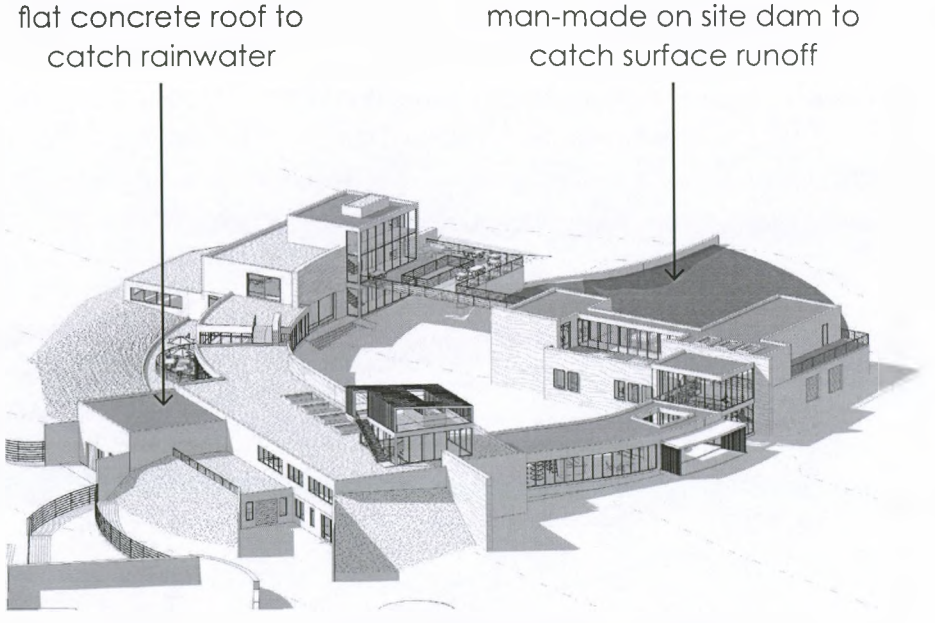


Figure 8.1.4 Axonometric Highlighting Water Catchment
Not to Scale [Ransome, J. 2016]

8.2 RESPONSE TO THE SUN

As seen in Figure 8.2.2 below, the stereographic sun angles, as shown in the site analysis chapter on page 67, have influenced the placement of the rammed earth spine walls. This ensures that they receive maximum sunlight in the winter months for them to absorb as much heat as possible during the day and slowly release it into the building for maximum comfort. The same goes for the summer months, as seen in Figure 8.2.3, the existing trees on the site are deciduous. They regain their leaves in the summer months, allowing the rammed earth walls to be shaded in most parts as the buildings require cooling in these months.

This combined with the thermal massing from the bermed earth on some of the external walls and the geothermal HVAC system (see page 160 for a detailed study) results in a passively heated and cooled building. With indoor temperatures fluctuating around 18.7oC, the constant ground temperature 3-6m below the natural ground level.

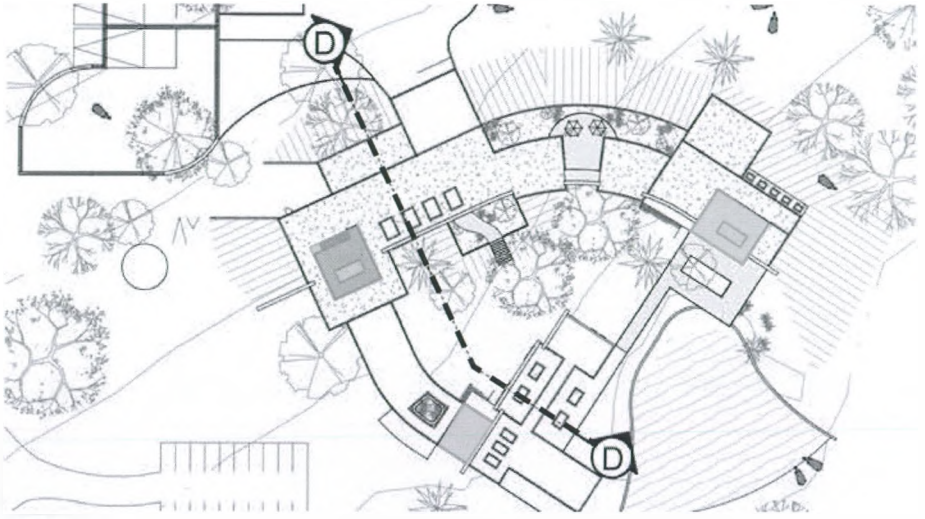


Figure 8.2.1 Site Plan Showing Section Location
Not to Scale [Ransome, J. 2016]

Figure 8.2.2 Section D - Winter Daily Sun Study
Not to Scale [Ransome, J. 2016]

The inclusion of light wells in the design has been made in the main vertical circulation nodes. The location of these light wells are highlighted in yellow in Figure 8.2.1. These were included to bring light down into the building in various areas, especially where the bermed earth has not allowed for northern light penetration. See Figure 8.2.4 showing a sketch of the light well concept. These void light wells also allow for visual connection between the floors of the building.

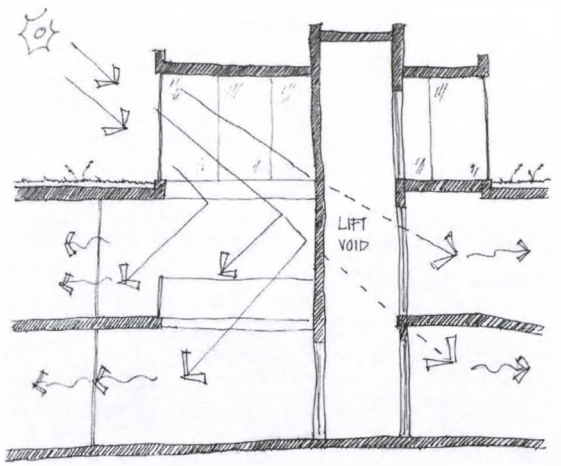


Figure 8.2.4 Light Well Diagram

[Ransome, J. 2016]

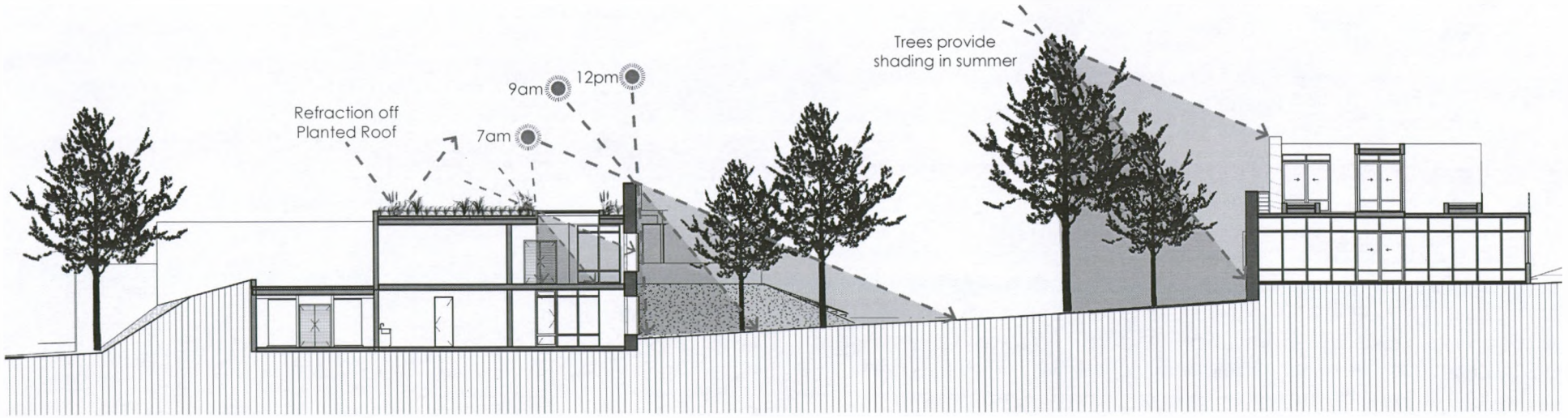


Figure 8.2.3 Section D - Summer Daily Sun Study

Not to Scale [Ransome, J. 2016]

8.2.1 SOLAR POWER

'River House' by *26'10 South Architects* is a good example of a building that was designed around the sun. Maximising solar gain and northern views due to the well-orientated site consideration led to the final design of this South African house. The picture and diagrams in Figure 8.2.5, illustrate simply how the sun paths were taken into consideration to achieve the best possible design.

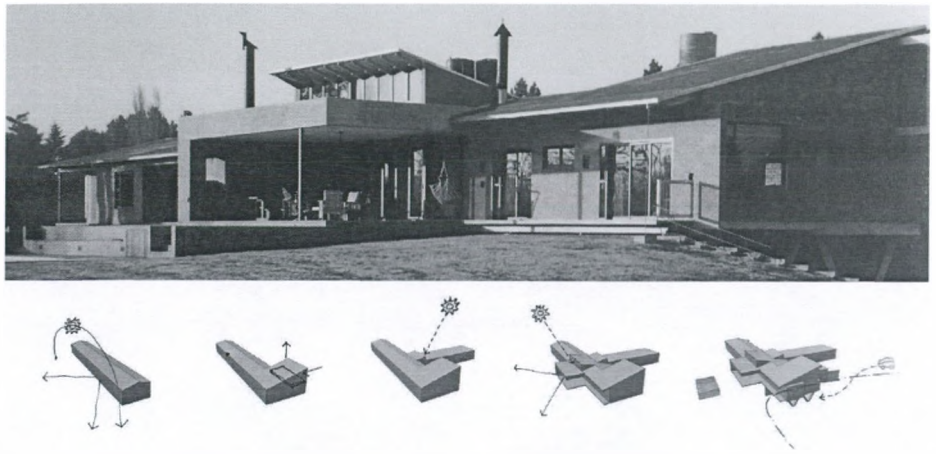


Figure 8.2.5 River House *[Deckler, T. 2010]*

While the sun's angles have influenced various parts of the design, the embodied energy in the sun's rays has also been unitised in the inclusion of solar power within the building. This will not supply the entire building but rather act as a backup power source when the power supply is unreliable. It will also take some of the load off the municipal connection as there is a large area of flat roof that is not planted and therefore capable of taking solar panels. Figure 8.2.6 shows the flat roofs, highlighted in yellow, that will have solar panels on them, this adds up to approximately 660m^2 of area to accommodate these solar panels.

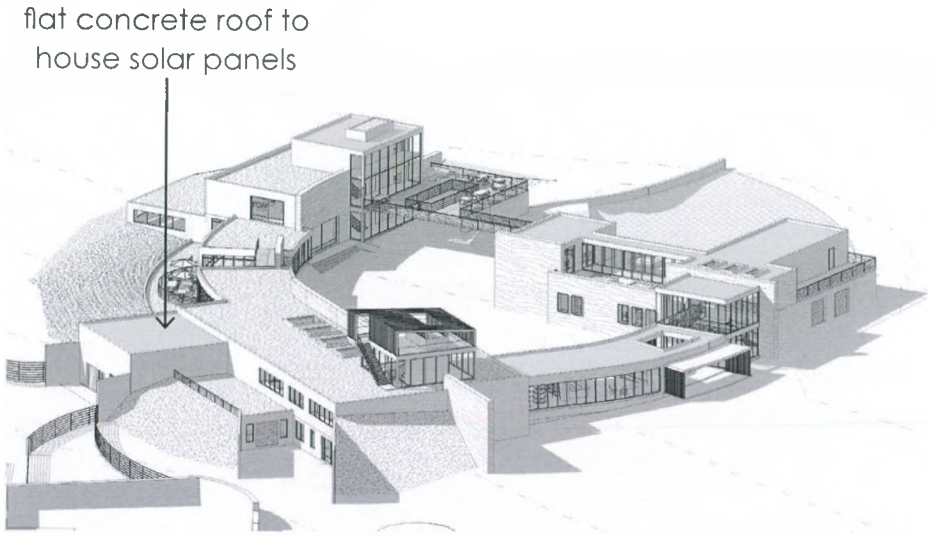


Figure 8.2.6 Axonometric Highlighting Solar Panels on Flat Roofs
Not to Scale [Ransome, J. 2016]

A commercial solar power system is a great way to utilise the sun's energy to provide a building with clean, renewable and cost-saving electricity. The diagram in Figure 8.2.7 illustrates how one of these systems works. *[Solar Craft. 2016]*

Solar or photovoltaic, panels have an array of solar cells that are connected. These panels generate electricity by converting solar radiation into electrical energy, and this process is a clean and environmentally friendly way of generating electricity from the earth's largest natural element, the sun. *[BauderSOLAR. 2014]*

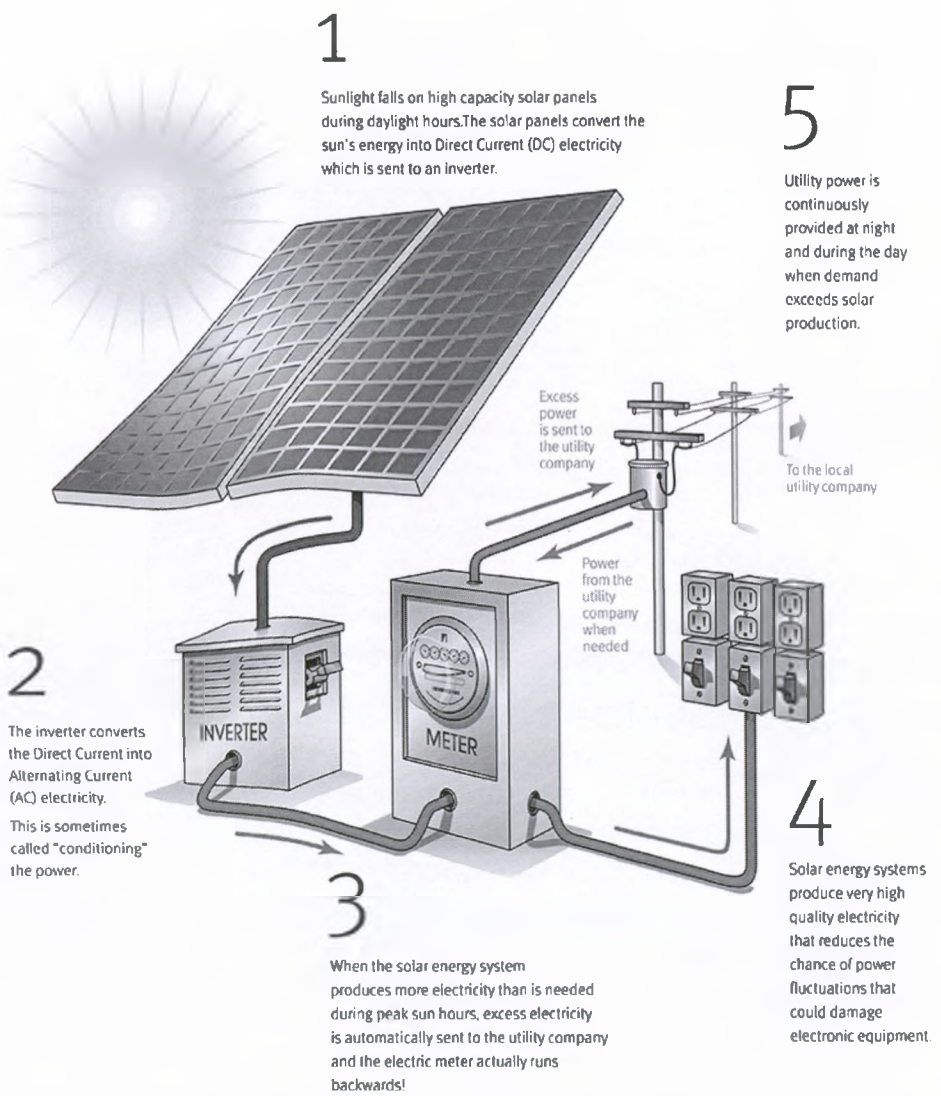


Figure 8.2.7 Diagram Showing How a Solar Power System Works
[Solar Craft. 2016]

"Not surprisingly, a flat roof is the ideal place for a photovoltaic installation as it provides an unobstructed space that is perfectly positioned to catch as much sunlight as possible." *[BauderSOLAR. 2014]*

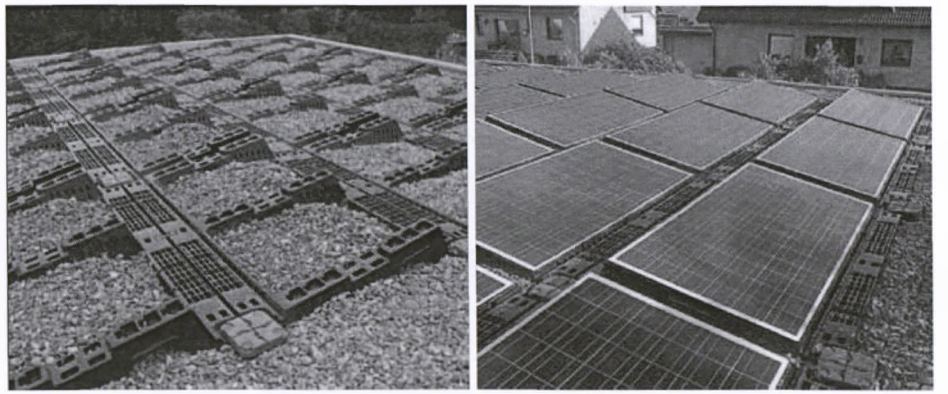


Figure 8.2.8 Solar Panels on a Flat Roof *[BauderSOLAR. 2014]*

While the solar panels may be mounted to the entirety of the flat roof surface, the substructure of the units ensures that efficient rainwater drainage still occurs. This particular system by *Bauder SOLAR* has a non-penetrating installation design to ensure that waterproofing membranes are not damaged and that the system does not interfere with the roof structure. "The polypropylene substructures are filled a specified ballst to hold down the units from wind forces and stabilise the photovoltaic panels. The base units are designed to create a 10° angle on to which each photovoltaic module is secured. This allows for optimum energy generation per square metre across the roof area and reduces the impact of wind load." *[BauderSOLAR. 2014]*

7.2.2 GENERATED SOLAR POWER

The specifications for the Solon Black 280 Solar Panel can be seen in Figure 8.2.9. Together with the average monthly number of sunny days and installation area, this information has allowed the average monthly power output to be calculated.

"On average, your solar system is going to lose some energy due to wiring, power, inverter efficiency, so you end up using 80% of your solar system's capacity." *[Osman, N. 2015]* The following formulas can be used to work out the amount of kilowatt-hours (kWh) the solar panel system puts out on average per month.

AC Rating (kW) = Average kWh per month / sunny days / average sun hours per day

DC Rating (kW) = AC rating / derate factor (0.8)

Solon Black 280 Solar Panel:
660 (roof area) / 1.96 (panel size) = **336 panels**
1 panel = 196W = **0.196kW**

0.196 (panel output) x 336 (number of panels) x 9 (average sun hours per day in summer)
Average kWh per month (summer) = **594kWh**

0.196 (panel output) x 336 (number of panels) x 7 (average sun hours per day in winter)
Average kWh per month (winter) = **462kWh**

SOLON BLACK 280 / 17 SOLAR PANEL

Dimensions (H x W x D)	1,973 x 993 x 5.3mm
Weight	23.8 kg
Junction box	1 junction box with 3 bypass diodes
Cable	Solar cable, length 1,500mm, 3.2mm², prefabricated with MC4-combinable plug
Application class	Application class A (according to IEC 61730)
Front glass	Transparent toughened safety glass, 4mm
Solar cells	72 cells, monocrystalline Si 6.2" (156 x 156mm)
Cell encapsulation	EVA (Ethylene Vinyl Acetate)
Underside	Composite film
Frame	Frameless
Backrails	6 backrails reinforced with glassfibre PA (290 x 50 x 38mm)

SYSTEM SPECIFICATIONS

System weight	12.9 kg/m²
Output per area	100 W/m²
Suction (4mm ESG/ optional 5mm safety glass)	1.3 kN/m²
Windload/snowload (4mm safety glass)	1.3 kN/m²

Figure 8.2.9 Solon Black 280 Specifications *[BauderSOLAR. 2014]*

AC Rating (summer) = 594 / 21.5 (ave. sunny days summer) / 9
= 3.07kW AC

DC Rating (summer) = 3.07 / 0.8
= 3.84kW DC

AC Rating (winter) = 462 / 28.75 (ave. sunny days winter) / 7
= 2.3kW AC

DC Rating (winter) = 2.3 / 0.8
= 2.87kW DC

As seen in Figure 8.2.10, the annual incoming shortwave solar radiation lies in the 8001-8500 MJ/m^2 zone for the area in which the proposed site lies. "The amount and intensity of solar radiation that a location or body of water receives depends on a variety of factors. These factors include latitude, season, time of day, cloud cover and altitude." [Fondriest Environmental, Inc. 2014] Due to these factors, not all radiation from the sun reaches the earth's surface. The illustration in Figure 7.2.9 shows that a high percentage of incoming solar radiation reaches the area of the site as the darker the colour, the more concentrate the amount. This means that the use of solar power in the proposed centre would not only be hugely beneficial, but it would also be highly effective.

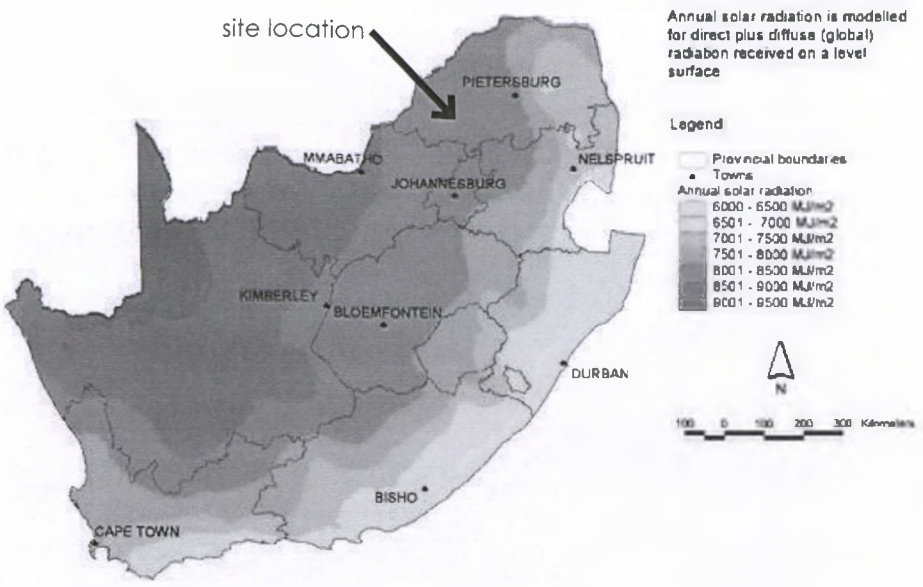


Figure 8.2.10 South African Renewable Resource Database - Annual Incoming Shortwave Radiation *[Energy Intelligence. 2015]*

8.3 RAINWATER HARVESTING

The diagram in Figure 8.3.1 shows the flat concrete roofs (highlighted in light blue) and the planted roofs (highlighted in green) where rainwater will be captured. Additionally, there is a site dam (highlighted in dark blue) that will catch surface runoff from the nearby 'koppie'. Rhinos require a lot of water for both drinking and mud baths, and as shown previously on page 37, the closest dam is 2.5km away. For this reason, water capturing and storage is a big part of the design scheme.

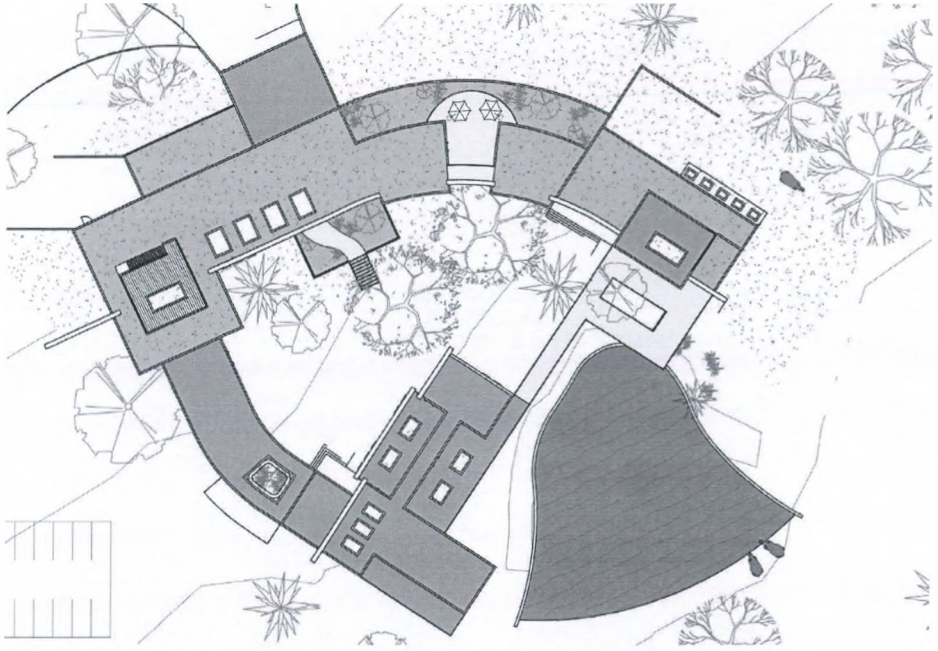


Figure 8.3.1 Site Plan Showing Rainwater Capturing
Not to Scale [Ransome, J. 2016]

Rainwater captured from the flat roof surfaces above will be brought down onto the ground floor of the building via uPVC pipes cast into the concrete columns where it will be stored in storage tanks. These tanks will be connected to a pump that services a number of water supply pipes to provide water to the Rhino holding pens for drinking and mud pits as well as irrigation to the flat, planted roofs and on-site gardens. Any additional, or overflow, water will be pumped into the site dam to ensure that it stays full all year round. Keeping the planted roof surfaces damp will not only ensure that the plants grow to their full potential, but evaporative cooling from the evapotranspiration off the plants and the prevailing winds will aid in naturally cooling the building in the hot, summer months.

Flat Roof Catchment Area = 868m²
Planted Roof Catchment Area = 874m²
Dam Catchment Volume = approx. 800kl

	Wet Season October - March	**Dry Season** April - September
Average monthly rainfall (mm)	86	8
Average Rainy Days per month	10	2
Flat Roof Catchment (kl / month)	74.65	6.9
Planted Roof Catchment (kl / month)	37.58	0
Total Storage (kl / month)	112.23	6.9

Figure 8.3.2 Monthly Rainfall Storage *[Ransome, J. 2016]*

Approx. Monthly Usage in Rhino Pens - Drinking:
6 (rhinos) x 12 (average litres per day) x 30 (days in a month)
= 2.16kl / month

Approx. Monthly Usage in Rhino Pens - Mud Baths:
6 (rhinos) x 10.8 (3.6m^3 mud bath filled 3 times per day) x 30 (average days in a month)
= 1.9kl / month
Total Rhino Pen Usage = 4.06kl / month

Due to the scarce amount of rain in the dry months, from April to September, water will need to be stored from the wet season to accommodate for some of the usages. Only 50% of the water that falls on the green roofs has been added into the amount captured, as the plants themselves will absorb a lot of the rainwater in these areas. There is still roughly 108kl of water left over from the catchment in the months of the wet season, and this can be distributed evenly over the dry months as well as used for other needed water sources on site. Some of these would include topping up the dam levels, additional mud pits for Rhinos that are not in the pens, as well as watering the planted roofs and gardens should they require more water than what the rain provides. As the temperatures in the wet season are very hot, the rate of evaporation will also be high and thus these figures are purely an average, and additional water will be needed from the borehole source on the site.

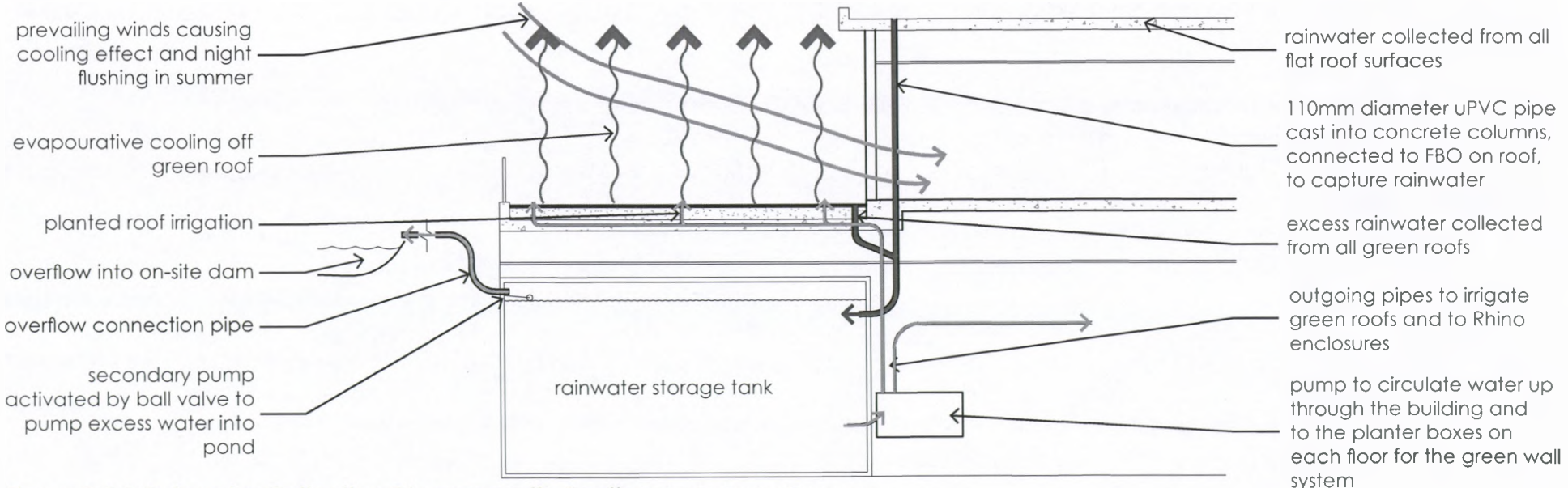


Figure 8.3.3 Rainwater Collection Diagrammatic Section *Not to Scale [Ransome,*

8.4 GEOTHERMAL HVAC SYSTEM

"The ground absorbs nearly half of the solar energy our planet receives. As a result, the earth remains at a constant, moderate temperature just below its surface all year round. However, air temperature varies greatly from summer to winter, making air source heating and cooling least efficient when you need it the most." *[Climate Masters. 2015]*

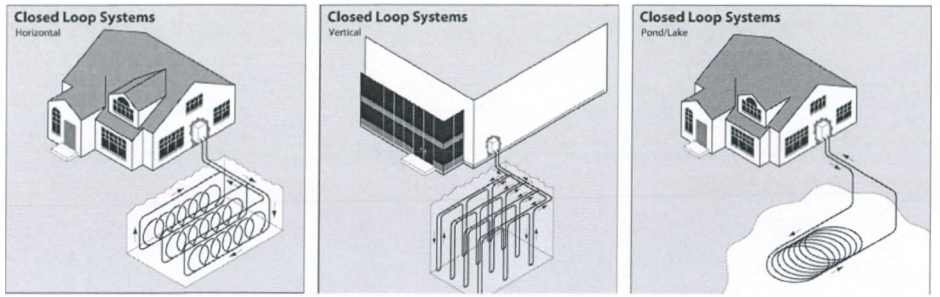


Figure 8.4.1 Horizontal, Vertical and Pond-like Closed Loop HVAC Systems *[Energy. 2011]*

As illustrated in Figure 8.4.1, "Most closed-loop geothermal heat pumps circulate an antifreeze solution through a closed loop (usually made of plastic tubing) that is buried in the ground or submerged in water. A heat exchanger transfers heat between the air in the heat pump and the antifreeze solution in the closed loop. The loop can be in a horizontal, vertical, or pond/lake configuration." *[Energy. 2011]*

By using the equation as shown in Figure 8.4.2, with a depth of 4m below ground, the average soil temperature on the Summer Equinox (21 December) is 22.2°C and the average soil temperature on the Winter Equinox (22 June) is 15.2°C. The yearly average is

$$T\,(soil\ D, tyear) = T(mean) - T\,(amp) * \exp\left(-D\sqrt{\frac{\pi}{365x\alpha}}\right) * \cos\left(\frac{2\pi}{365}\,(\text{t(year)} - \text{t (shift)} - \frac{D}{2}\sqrt{\frac{365}{\pi * \alpha}}\right))$$

		Constant	Summer	Winter
T (soil D, tyear)	Soil Temperature at depth D and Time of year		x	y
T (mean)	Mean surface temperature (average air temperature). The temperature of the ground at an infinite depth will be this temperature		20.63	13.13
T (amp)	Amplitude of surface temperature [(maximum air temperature - minimum air temperature)/2]		6.75	8.63
D	Depth below the surface in m (surface=0)	4		
α	Thermal diffusivity of the ground (soil)	0.001		
t (year)	Current time (day)		355	173
t (shift)	Day of the year of the minimum surface temperature		173	173
π	PI	3.14159265		
exp	Air turbulance constant	0.002		

Figure 8.4.2 Numerical Equation for Average Ground Temperature at a Certain Depth *[Equation - Florides, G & Kalogiriu, S. 2011]*

thus 18.7°C at this depth for this area. *[Florides, G & Kalogiriu, S. 2011]*

The geothermal HVAC system for the proposed centre utilises a series of pipes laid in the ground at 4m below the natural ground level. As stated, the constant average temperature is roughly 18.7°C. The piped system is a closed loop system containing an antifreeze solution.

In summer the water runs from the ground into a coil within a heat pump unit (located on the ground floor), as the water travels up through this coil it cools the incoming air to roughly 18.7°C. As it is cooling the warm air, the water itself heats up, and by the time it reaches the top of the coil, it will have warmed considerably. The warm water then travels back into the coils in the ground to cool back down to 18.7° and start the cycle again. While this is the

water part of the cycle, the air that is conditioned in this system enters the heat pump unit at a warm temperature, it is then cooled and blown back up through the building to be expelled through the aircon outlet vents on each floor. The inlet vents on each floor suck in the stale, warm air from the space as it is displaced by the cool incoming air and expel it from the building at each floor. There is an additional heat pump unit at this point where the warm stale air runs through a coil on its way out so that the hot outside air can be cooled by a few degrees before it is blown to the heat pump unit in the basement to be cooled again. This is the fresh air intake for the system.

Then in winter the system is reversed, the water runs in the opposite direction in the closed loop geothermal pipe, cold water is pumped into the ground loop and a warmer 18.7° exits into the heat pump coil. Here cool air from the outside of the building enters and is warmed by the warm water in the coil before being expelled into the building. Cool air is then sucked out the outlet vents and dispersed outside through the same method as in summer; the cool air warms the cold fresh outside air by a few degrees before it enters the system. The location of the site does not experience freezing winter's days, and the temperatures remain quite moderate. Thus this system is used to maintain a level of comfort rather than heating up the space.

Diagrams illustrating this system can be found in Figures 8.4.3 and 8.4.4 on the following page.

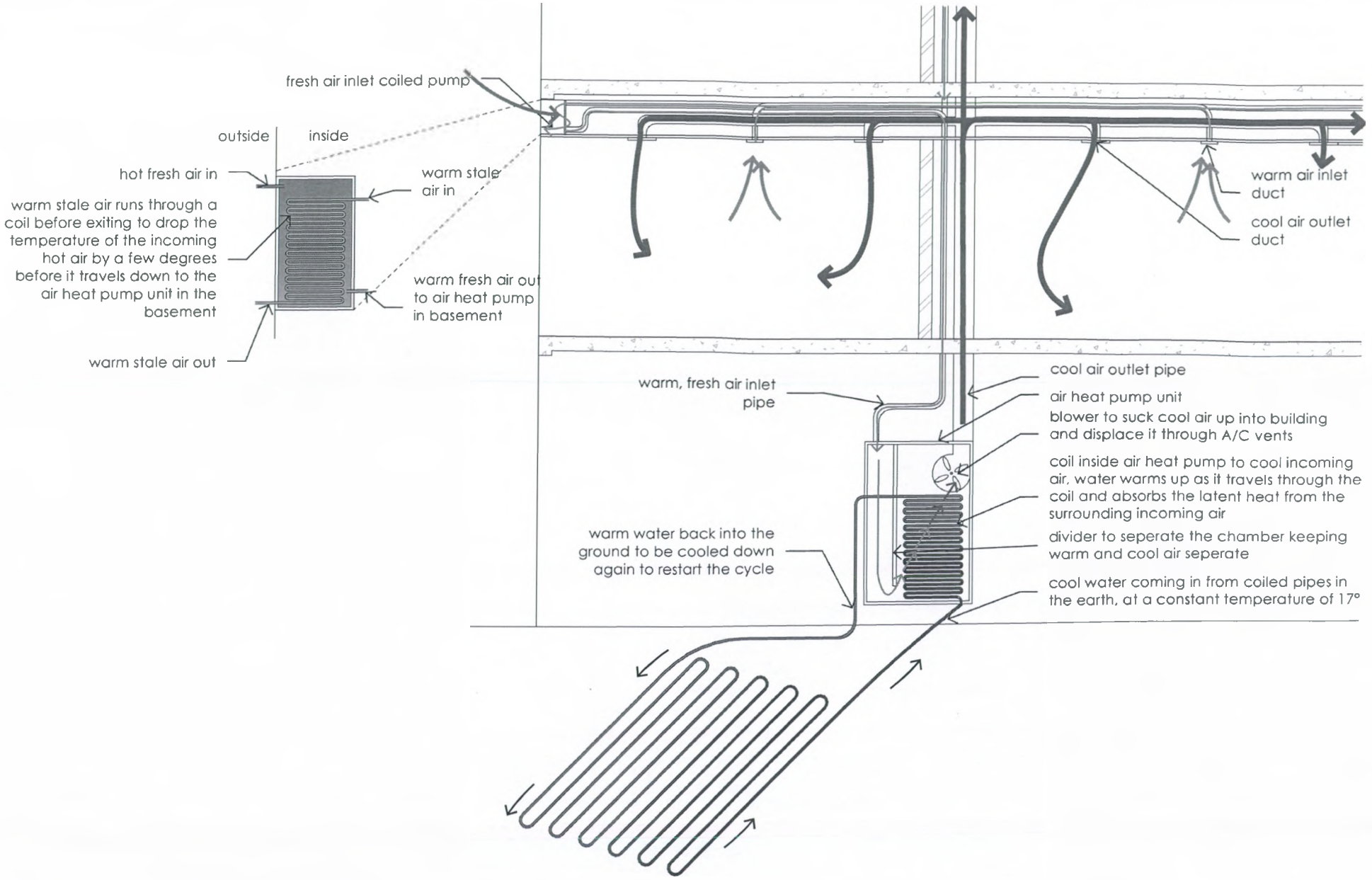


Figure 8.4.3 Geothermal HVAC System in Summer *[Ransome, J. 2016]*

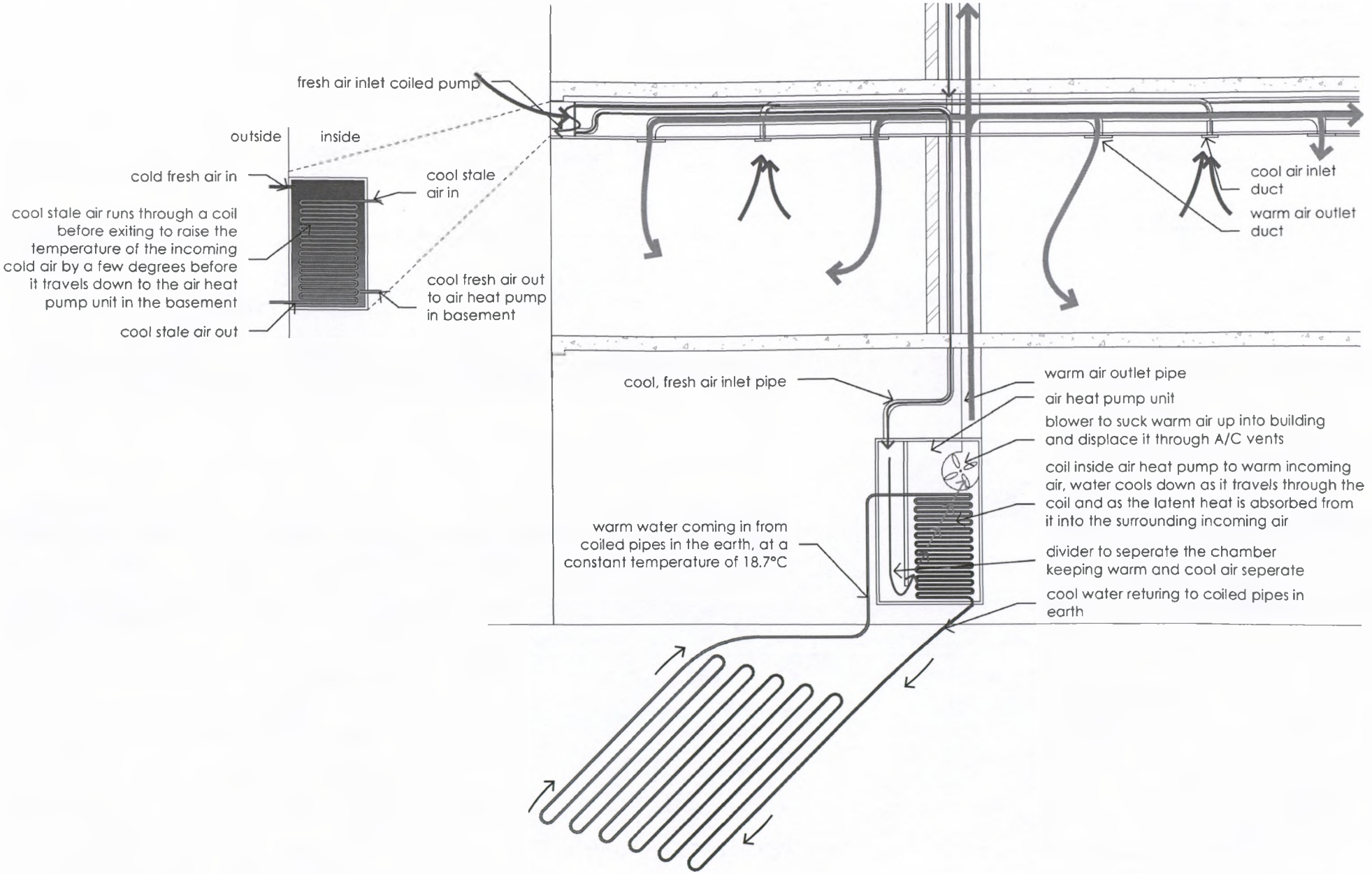


Figure 8.4.4 Geothermal HVAC System in Winter *[Ransome, J. 2016]*

8.5 PERIMETER SECTIONS AND DETAILS

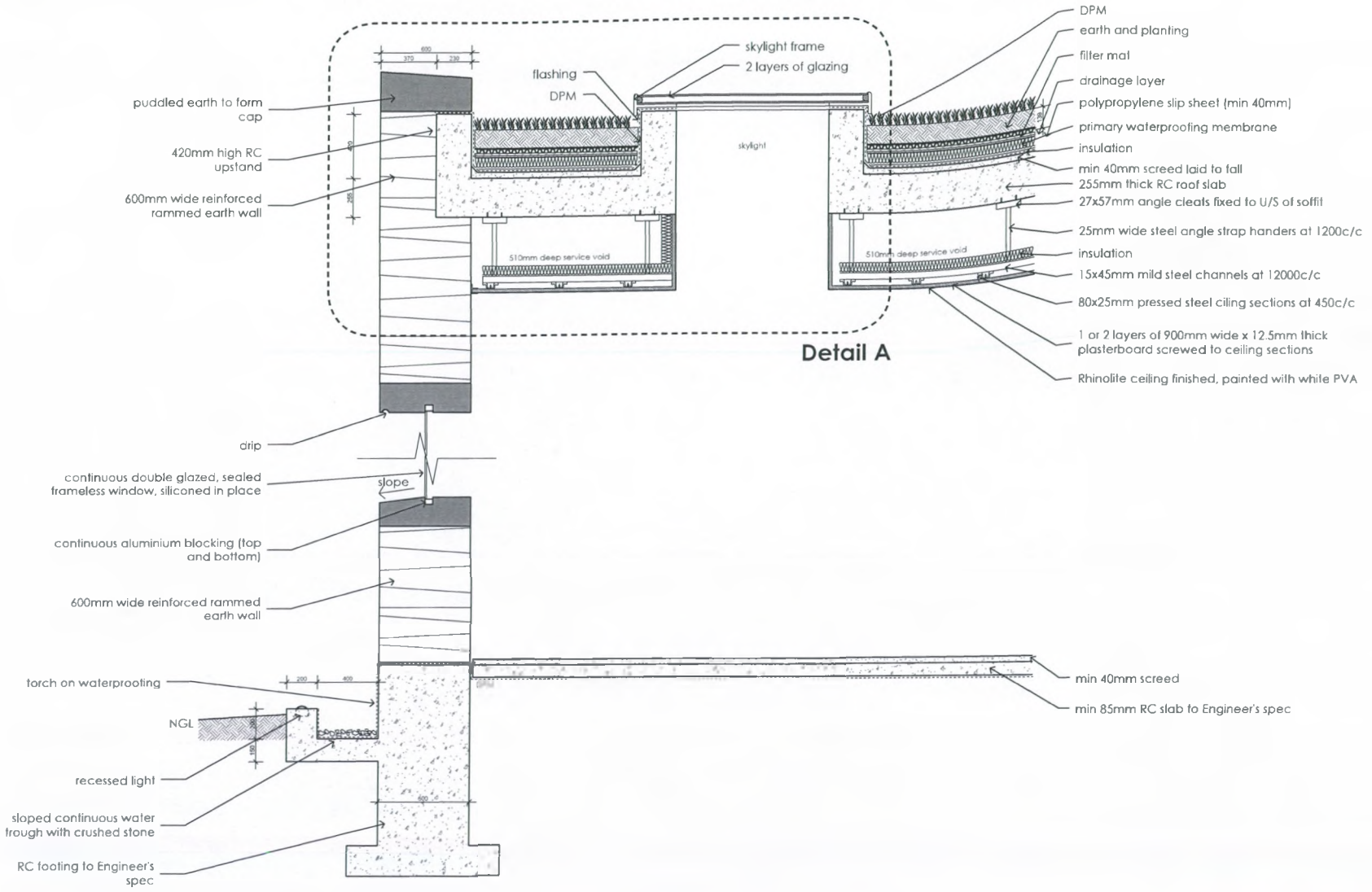


Figure 8.5.1 Perimeter Section Through a Rammed Earth Wall and Green Roof

Not to Scale [Ransome, J. 2016]

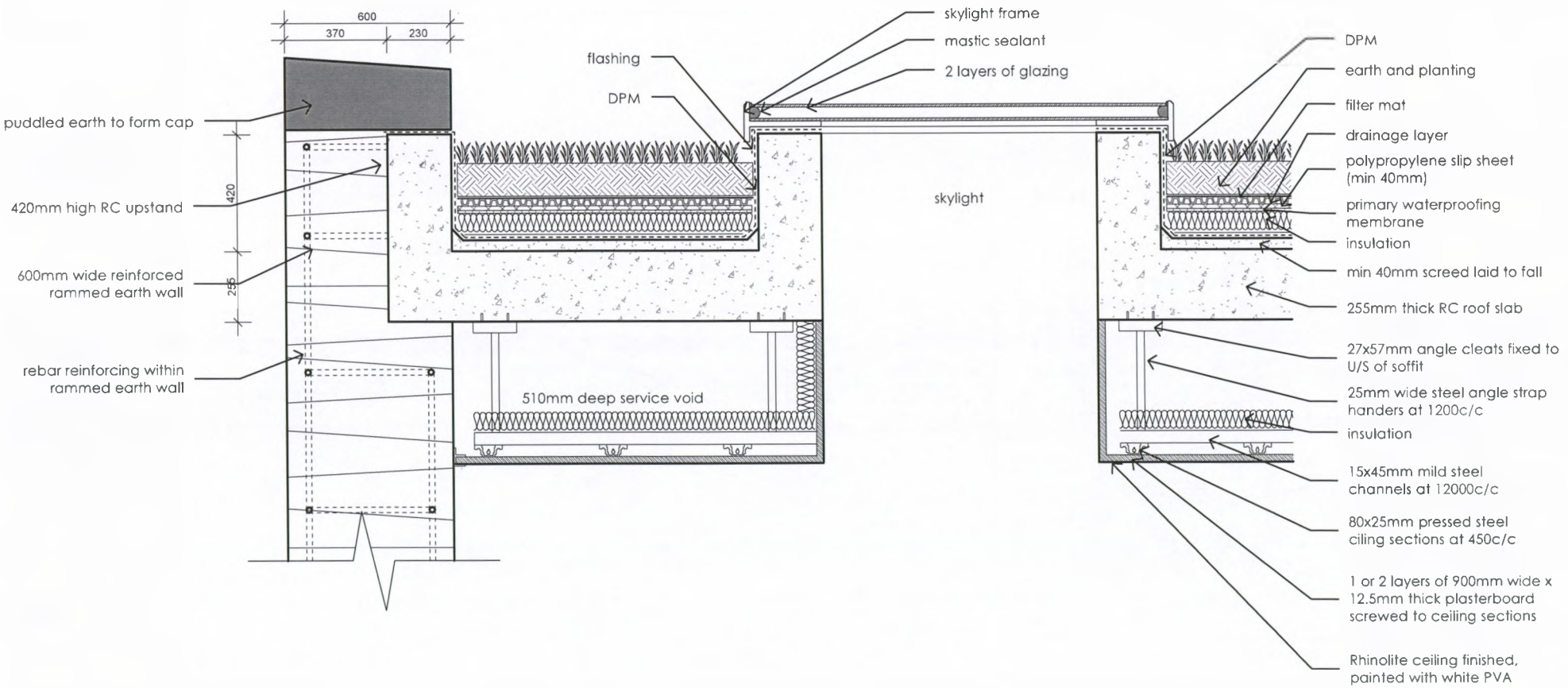


Figure 8.5.2 Detail A

Scale 1:20 [Ransome, J. 2016]

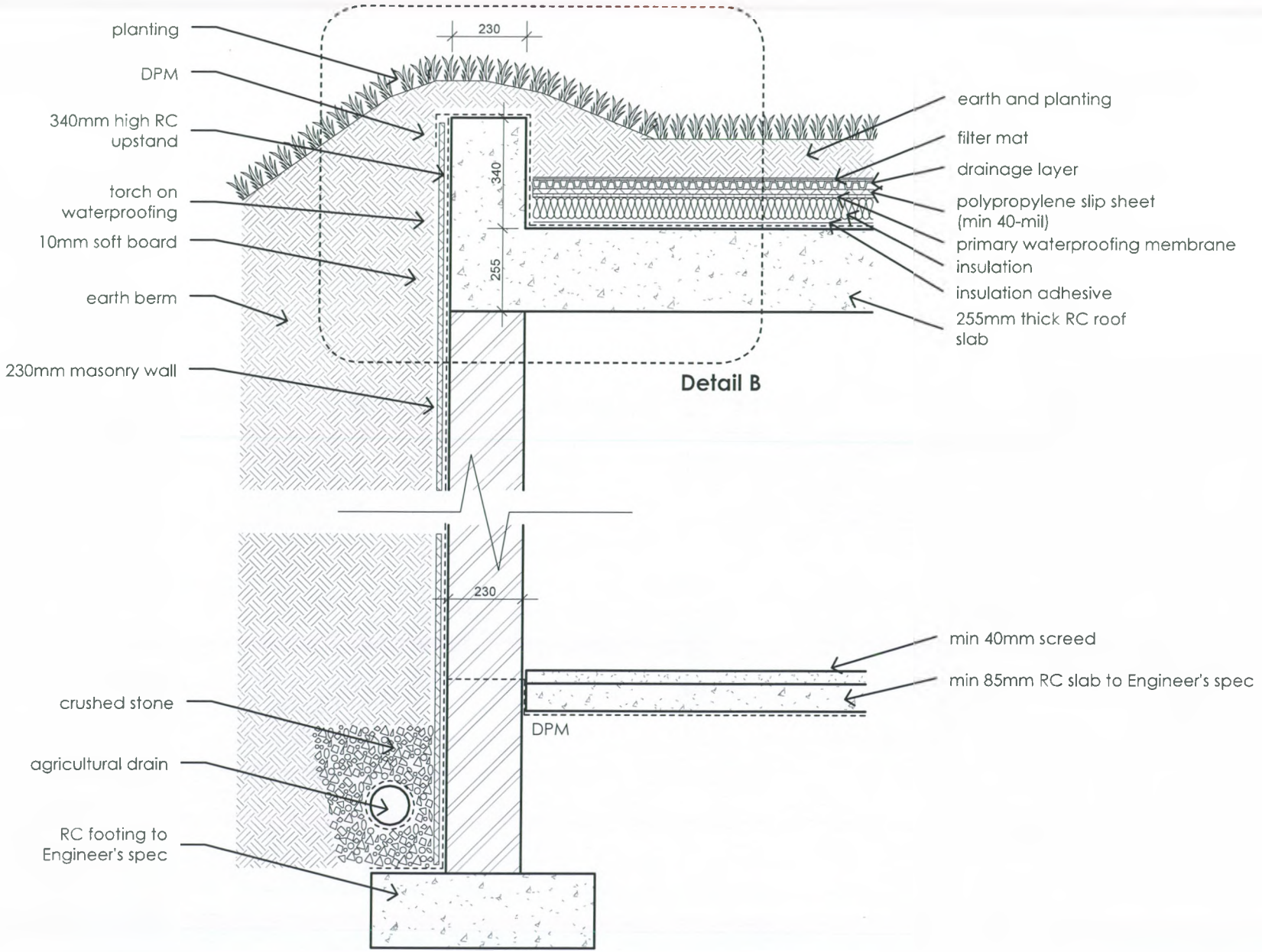


Figure 8.5.3 Perimeter Section Through an Earth Berm and Green Roof

Not to Scale [Ransome, J. 2016]

In order to create the illusion of the building being underground, the bermed earth continues over the upstand beam to connect with the planted roof. This allows the building to be hidden underneath and the edge concealed in the earth.

The walls that the earth is bermed up against have been treated like a basement wall. The torch on waterproofing with an agricultural drain below to disallow water from seeping into the building.

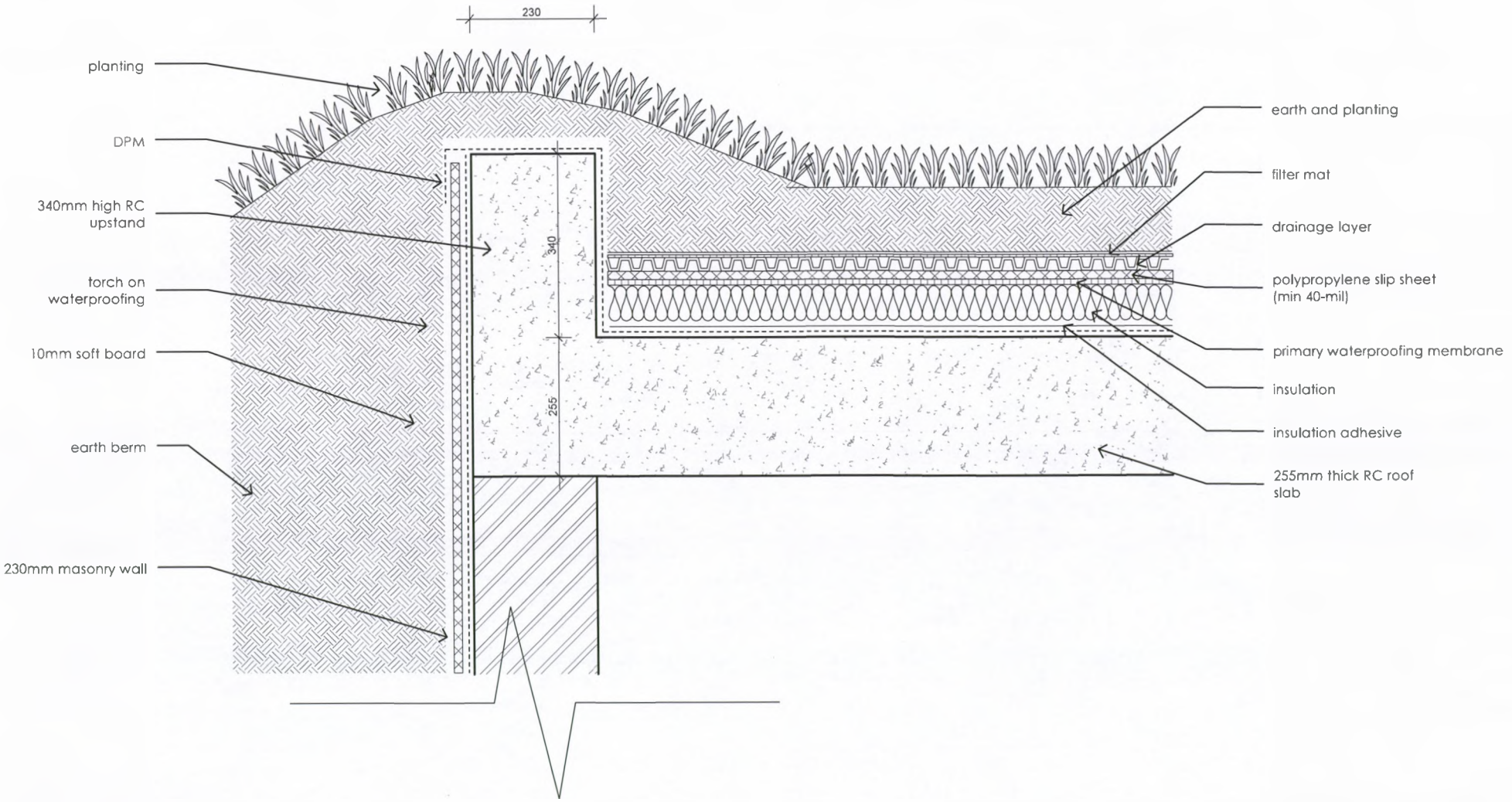


Figure 8.5.4 Detail B

Scale 1:10 [Ransome, J. 2016]

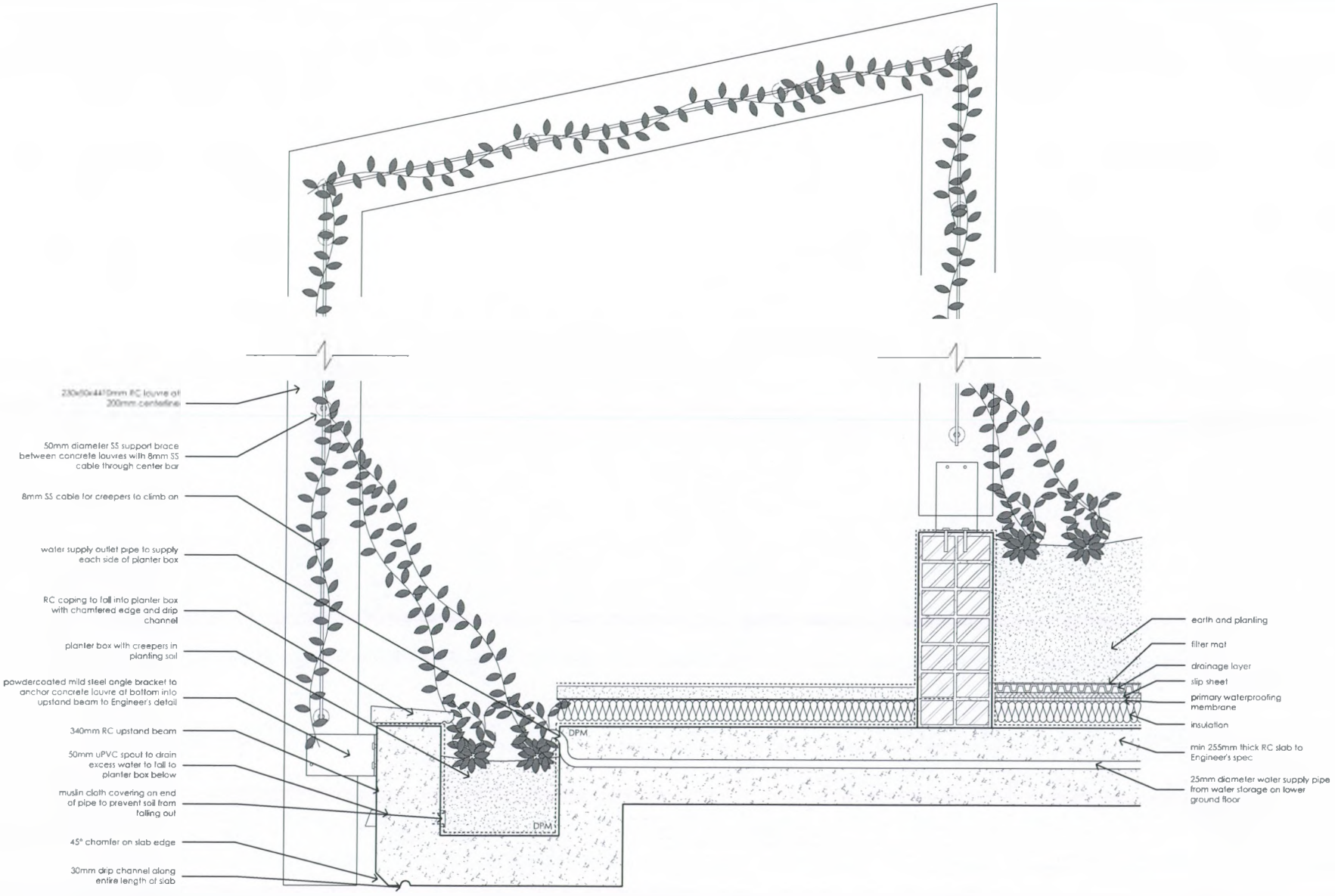


Figure 8.5.5 Planted Pergola Detail

Not to Scale [Ransome, J. 2016]

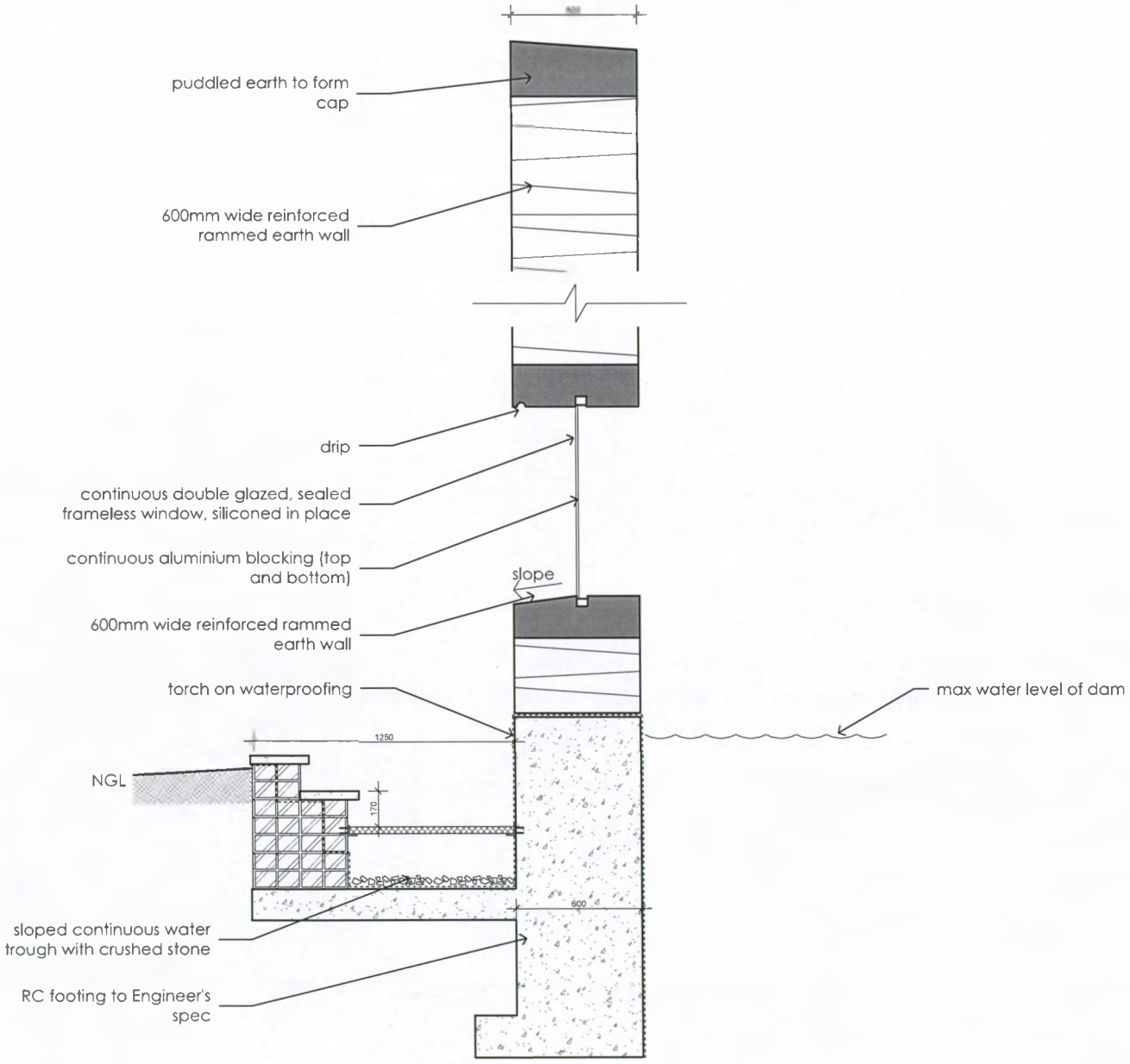


Figure 8.5.6 Viewing Window and Trough Over Dam Through Rammed Earth Wall

Not to Scale [Ransome, J. 2016]

VIABILITY &
FEASIBILITY REPORT

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The Proposed Client and the Community	pg 184
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9.1 PROJECT SCOPE AND SUMMARY

1.1.1 The Brief:

As mentioned previously in the document, the White Rhino is under threat, not only in South Africa but worldwide. As a result of poaching and lack of breeding programs, the number of White Rhino worldwide has fallen below 20 500. It is one of South Africa's largest mammals, second to the African Elephant, and with the species under huge threat, the re-population of these animals is the focus of this research report and the main goal to which the brief for this project arose.

Anyone can provide a facility for others to operate. However, teaching the locals the skills they require to build these facilities and the new techniques that may be introduced through these projects is the correct approach. Not only does it allow them to maintain and take ownership of the new community building but they too can use those skills in other applications, and this then provides opportunities in the future.

The brief outlines the proposal to design a *Community-led Rhino Breeding and Ranger Training Centre* to the Rooiberg area of the Waterberg District of Limpopo to boost Rhino populations past the point of extinction. The inclusion of the community has also been made clear in the brief. Not only to involve the community but to educate them and provide a means of enhancing their current living situations by providing skills training and interaction with the centre and the conservationists, volunteers and students that will be working there.

1.1.2 Site Selection:

The nature of the White Rhino and its need to be in the African bushveld has led to the decision of placing the centre out in the rural area of Rooiberg in the foothills of the Waterberg Mountains in the Limpopo province of South Africa. The brief has thus become quite dependent on the placement of the site and its specific conditions of the area. The brief outlines the inclusion of the community and the development of an interface between the community, White Rhino and the various visitor/user groups as well as the need for conservation to play a large role, both in the future of the White Rhino and the site itself. For future reference, when referring to 'the community' throughout the chapter, that is referring to the Vingerkraal community village, located 12km by sand road from the site.

Physical Interface: As mentioned previously, the project site is located on the private farm, *Rotavi Private Game Reserve*, in the Rooiberg area of the Waterberg. As seen in Figure 9.1.1, the site lies directly in the middle of the major conservation zones in the Waterberg District, and will thus add to the overall conservation of the area.

Social Interface: The aim of this project is to create a link between the existing community and the Rhino breeding industry. The facility will thus become a physical interface that connects the local community to the Rhino breeding and Ranger training industry. As seen in Figure 9.1.1, the closest community village, Vingerkraal, is just 12km via the sand road from the site. After speaking with the

locals, both farmers and community members, it became known that there is a severe lack of jobs in the area and that most of the people that reside in this village are unemployed. It was this fact that led to the inclusion of the community, not only in the building of the centre but the running of it too.

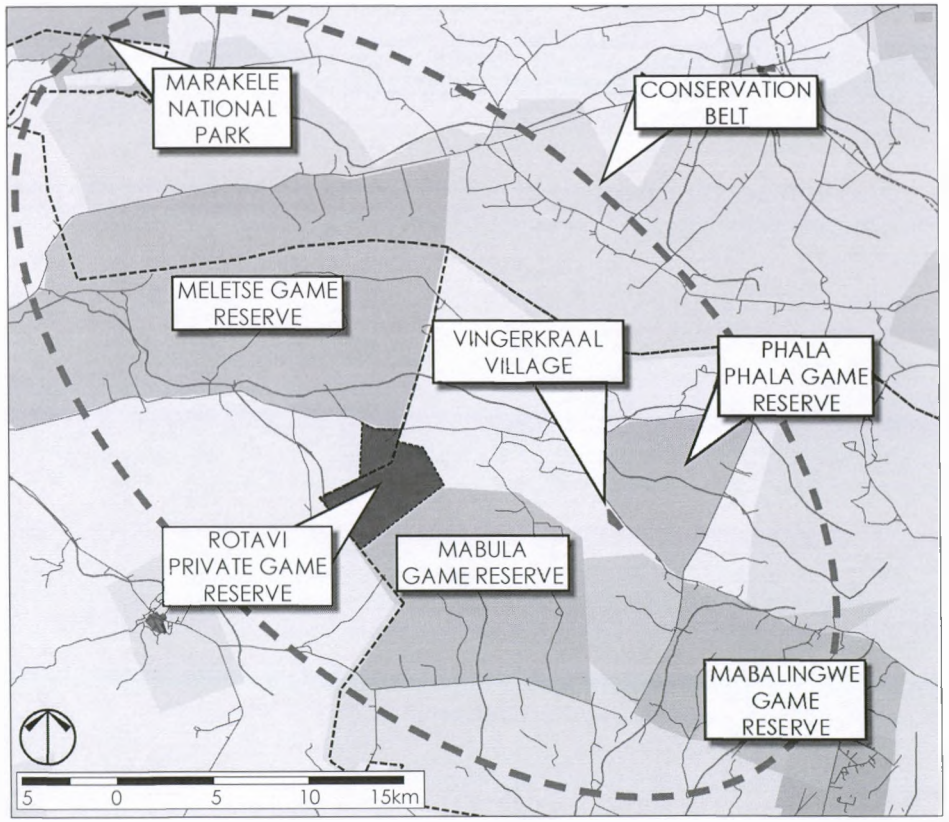


Figure 9.1.1: Existing "Conservation Belt" (Highlighted in Green, Outlined in Red) in the existing context. *[Graphic by Author]*

1.1.3 Financial Considerations:

Due to the locatio of the proposed centre being in a rural setting, there are various aspects that need to be taken into account during the design process as well as the implementation and funding of the project. Below, these items have been listed, and their impact on the design and funding of the building has been analysed.

INFRASTRUCTURE:

Due to the location of the site being within a rural area, many services and infrastructural elements are limited. The infrastructure that is in place will be utilised within the project and maximised upon. However, there will be some elements that will need to be implemented and that will come at a cost.

Roads: The *Rooiberg Bewaria* Road runs directly past the proposed site, and while it may be a sand road it is well maintained throughout the year and can be driven on with any vehicle. This road would therefore provide access to the site during construction from both the Rooiberg town side and the Bela Bela town side. Delivery of materials and access for builders as well ease of access for post project completion for staff or visitors coming from any direction would be via this road. The existing roads on the site are also in good condition and are maintained by the farm, these have been considered in the placement of buildings and services to minimise the need for new roads and access paths on site.

Electricity Supply: The owners of Rotavi Private Game Reserve paid to have power lines from Eskom installed along the main sand roads when they bought the farm in 2004. This is thus the main power supply for the site. There are additional Diesel generators that have the capacity to run the entire farm's operations should there be a power outage. Electricity is therefore not an issue on the site. However, alternative means of electrical generation has been explored, such as the implementation of solar power within the facility, as illustrated on in Chapter 8, *Technical Documentation*. By using solar power, the facility could significantly reduce its running costs.

Water Supply: The water on the farm is obtained from boreholes as there are no municipal connections. This is the case with many of the other farms in the area too. The rainfall can, however, be erratic and thus water saving schemes always play a big role in these areas. The utilisation of rainwater harvesting storage tanks is an absolute necessity, especially during the construction phase when large volumes of water will be needed for the building. Rhinos also consume a lot of water, both in drinking and their requirement for muddy dams to wallow in so it is vital that the centre is water conscious, both before and after completion. Chapter 8, *Technical Documentation,* has outlined the strategy for rainwater harvesting.

MATERIALS AND EXISTING MACHINERY AND SKILLS:

Some of the existing natural materials on the site include earth and stone (there is a vast amount of loose stone and rock in the surrounding area). There is also a Cinder block press on the farm that produces concrete blocks 320x160x160mm in size, this is used for the majority of the building and costs a lot less than getting ready-made bricks delivered to the farm.

Due to the lack of architecture in the area, there aren't many clues as to what the 'general typologies' are, and thus the architecture for the proposed centre cannot be derived from this. Using the approach of utilising what is on site and available regarding skill and materiality is thus very important and new skills can be taught in this way of design and building.

In addition to this, passive design methodology has also been researched and incorporated into the design in order to maximise the effectiveness of the materials used and to create a thermally efficient building design. This is also another way the centre can respond to the site conditions to create a sustainable and conservation aware design.

9.2 IMPLEMENTATION OF PROJECT

This section focuses on the the implementation of the proposed centre. Varous aspects have been considered, such as start up costs, funding, and the requirements for the centre. Proposed funding as well as a potential client is discussed, as well as the fee proposal for the scope of services that would be provided by the architectural professional.

2.1 Fee proposal:

The associated build costs for the proposed centre are based on estimated areas for the programme of the centre that were determined for the sketch design phase of the design process. These include the proposed fees for the services of an architectural professional based on the building costs and the recommended fee structure as per the SACAP guidelines.

The build cost breakdown is shown in Figure 9.2.1. The rates per square meter and the programme sizes provide the estimated total costs. It is important to note that the costs associated with the building in this table are general and could vary based on the source of the materials as well as the labour costs. Figure 9.2.1 shows the professional architect's fee's based on the estimated build cost as per the recommended project cost-based fee by SACAP.

Project Cost	**24,920,000.00**
Cost Bracket 7	R13 000 001 - R40 000 000
Total Fee (recommended):	**2,242,800.00**
	Based on 9% of consturction cost
	As per Table 1: Project Cost-based Fee by SACAP

WORK STAGE	PERCENTAGE OF TOTAL FEE	ESTIMATED COST (ZAR)	CUMULATIVE TOTAL
1	5%	112,140.00	5%
2	15%	336,420.00	20%
3	20%	448,560.00	40%
4.1	20%	224,280.00	60%
4.2	10%	224,280.00	70%
5	27%	605,556.00	97%
6	3%	67,284.00	100%

Figure 9.2.1 Professional Architects Fees Based on the Estimated Build Cost *[Ransome, J. 2016]*

Development Costs	Area (m²)	Cost Rate (R/m²)	Total
Admin & General:			
reception	80	9,000.00	720,000.00
food prep area	8	5,000.00	40,000.00
linen & material prep	8	5,000.00	40,000.00
laundry & sterilization	8	5,000.00	40,000.00
pharmacy stock & distribution	10	9,000.00	90,000.00
offices (incl kitchen & break areas)	200	9,000.00	1,800,000.00
meeting rooms	100	9,000.00	900,000.00
male & female staff toilets	15	9,000.00	135,000.00
visitor toilets	30	9,000.00	270,000.00
maintenance closets	8	5,000.00	40,000.00
general storage	8	5,000.00	40,000.00
loading and delivery	100	7,000.00	700,000.00
workshop	50	10,000.00	500,000.00
restaurant and kitchen	200	8,000.00	1,600,000.00
			6,915,000.00
Rhino Breeding Facilities:			
surgical suite	90	18,000.00	1,620,000.00
labs (x2)	80	18,000.00	1,440,000.00
x ray	30	18,000.00	540,000.00
post mortem exam	36	12,000.00	432,000.00
rhino horn secure vault	36	12,000.00	432,000.00
rhino recovery pen (x5)	432	1,000.00	432,000.00
external exam area	73	1,000.00	73,000.00
rhino holding boma - big (x2)	800	1,000.00	800,000.00
rhino holding boma - small (x3)	216	1,000.00	216,000.00
			5,985,000.00
Ranger Training Facilities:			
reception	25	9,000.00	225,000.00
lecture rooms (x2)	40	12,000.00	480,000.00
indoor gym	60	16,000.00	960,000.00
field training	200	500.00	100,000.00
			1,765,000.00
Accomodation:			
staff houses (x2)	500	5,000.00	2,500,000.00
individual housing units (x6)	216	5,000.00	1,080,000.00
communal areas for housing units	108	5,000.00	540,000.00
			4,120,000.00
Infrastructure:			
water infrastructure & rain water collection	1200	2,800.00	3,360,000.00
parking (20 bays)	250	1,500.00	375,000.00
landscaping	2000	1,200.00	2,400,000.00
			6,135,000.00
		TOTAL:	**24,920,000.00**

Note:
- This amount excludes the costs to procure professional services for the project development.
- These amounts are based on estimated building costs
- The square meters of the building is preliminary and was completed prior to final design completion as an estimates

Figure 9.2.2 Estimated Building Cost Breakdown and Overall Total *[Ransome, J. 2016]*

2.2 Income Generation at the Facility:

In order to assess the viability of the research report topic, an exploration of the possible income generation sources has been outlined in the tables below. These figures are based on similar projects and/or centres that run similar programmes. Due to the existing lodge facilities at Rotavi Private Game Reserve, the design of the centre will not include a full lodge for visitors and/or volunteers. It has been suggested that the two existing lodges will be used for this purpose, adding to the income generation of the farm while minimising the building footprint and thus build costs. The other two sources of income will come from day visitors as well as short-term volunteer programmes.

INCOME GENERATION AT SIMILAR CENTRES

ORGANISATION	TYPE OF INCOME	AMOUNT	AVERAGE QTY		MONTHLY TOTAL	COMMENTS
De Wildt Shingwedzi Cheetah Reserve, Waterberg Limpopo	day visitors on tours (twice daily)	220.00	8	per day	53,680.00	guided tour through the cheetah reserve on a game viewer
Wilderness Conservation & Wildlife Research in South Africa	conservation volunteers	16,240.00	12	every 2 weeks	389,760.00	includes all food, accomodation, training, equipment, airport transfers, laundry and activities
Wildlife Act: Field Research and Learning, Zululand South Africa	conservation volunteers	16,750.00	12	every 2 weeks	402,000.00	includes all food, accomodation, training, equipment, airport transfers, laundry and activities
Adventures with Elephants, Zebula, Limpopo	day visitors on tours (twice daily)	265.00	10	per day	80,825.00	interactions, safaris and swims with elephants

Figure 9.2.3: Reference Pricing for Income Generation at Similar Centres *[Generated by Author]*

Due to the inclusion of the Ranger training programme being for the benefit of the community members, the 'income' for the Game Ranger training has been omitted and will be subsidised by the profits of the centre as well as outside funding. As seen in the table in Figure 9.2.5, the income of the first year '2016' assuming the building is up and running is just over R6.4 million and increases according to South African inflation rates each year. This income has been included in the start up costs involved with the centre that can be seen on the following page.

INCOME GENERATION PREDICTION AT RHINO BREEDING AND RANGER TRAINING CENTRE

TYPE OF INCOME	AMOUNT	AVERAGE QTY		MONTHLY TOTAL	YEARLY TOTAL	COMMENTS
Rotavi Lodge	7,000.00	12	nights per month	84,000.00	1,008,000.00	sleeps 14 people, self catering lodge
Daily tour	240.00	8	per day	58,560.00	702,720.00	guided tour of the breeding facility and game drive though the farm
Conservation Volunteers	16,500.00	12	every 2 weeks	396,000.00	4,752,000.00	includes all food, accomodation, training, equipment, airport transfers, laundry and activities
				TOTAL:	6,462,720.00	

Figure 9.2.4: Monthly Income Generation at the Proposed Rhino Breeding and Ranger Training Centre *[Generated by Author]*

INCOME GENERATION PREDICTION AT RHINO BREEDING AND RANGER TRAINING CENTRE

TYPE OF INCOME	2016	2017	2018	2019	2020
Rotavi Lodge	1,008,000.00	1,074,528.00	1,145,446.85	1,221,046.34	1,301,635.40
Daily tour	702,720.00	749,099.52	798,540.09	851,243.73	907,425.82
Conservation Volunteers	4,752,000.00	5,065,632.00	5,399,963.71	5,756,361.32	6,136,281.16
TOTALS:	**6,462,720.00**	**6,889,259.52**	**7,343,950.65**	**7,828,651.39**	**8,345,342.38**

Figure 9.2.5: Income Generation at the Proposed Rhino Breeding and Ranger Training Centre *[Generated by Author]*

2.3 Start-up Costs Involved with a Rhino Breeding Centre:

Outlined in the two tables in Figure 9.2.6, are the costs involved in starting up a six cow Rhino breeding farm, the figures are based on the numbers for starting a 100 cow farm as estimated by Rhino breeder John Hume. *[Hume, J. 2015]* He has completed a viability report on the costs involved in running a Rhino breeding facility to justify the legalisation of Rhino horn trade. As per these two tables, it can be seen that the annual profit for the centre for the first few years is quite low and thus would only cover the build cost outlined on the previous page in Figure 9.2.3 as R24.92 million by mid-2020.

RUNNING COSTS FOR 6 RHINO COW BREEDING PROJECT

	2016	2017	2018	2019	2020
livestock expenses	79,200.00	87,120.00	95,832.00	105,415.20	115,956.72
bank charges computer expenses electricity	93,060.00	102,366.00	112,603.00	123,863.00	136,249.00
fuel	77,000.00	84,700.00	93,170.00	102,487.00	112,736.00
herbicide	48,400.00	53,240.00	58,564.00	64,420.00	70,862.00
insurance	5,148.00	5,662.80	6,229.08	6,852.00	7,537.20
licenses postage printing & stationery	12,320.00	13,552.00	14,907.00	16,398.00	18,038.00
protective clothing	8,580.00	9,438.00	10,382.00	11,420.00	12,562.00
repairs & maintenance	180,400.00	198,440.00	218,284.00	240,112.00	264,124.00
salaries	242,000.00	266,200.00	292,820.00	322,102.00	354,312.00
telephone	29,920.00	32,912.00	36,203.00	39,824.00	43,806.00
wages	506,000.00	556,600.00	612,260.00	673,486.00	740,835.00
professional fees	114,400.00	125,840.00	138,424.00	152,266.00	167,493.00
safe custody fees	37,400.00	41,140.00	45,254.00	49,779.00	54,757.00
security expenses	71,280.00	78,408.00	86,248.80	94,873.68	104361.06
TOTALS + 10% P.A	**1,505,108.00**	**1,655,618.80**	**1,821,180.88**	**2,003,297.88**	**2,203,628.98**

CAPITAL COSTS FOR 6 RHINO COW BREEDING PROJECT

	2016		2017		2018		2019		2020	
	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT
carry over from prev. year		0.00		-257,612.00		-2,576,252.72		-6,308,132.49		-10,835,097.26
purchases cows	6	3,000,000.00	5	2,665,000.00	5	2,840,890.00	5	3,028,388.74	5	3,228,262.40
purchases bulls	2	500,000.00	1	250,000.00	1	250,000.00	1	250,000.00	1	250,000.00
births	5		3		4		4		7	
deaths females	0		0		1		0		1	
deaths males	0		0		0		0		1	
sales females + 10% P.A					2	-1,300,000.00	2	-1,320,000.00	2	-1,360,000.00
sales males + 10% P.A							1	-660,000.00	1	-680,000.00

SUB TOTAL	**3,500,000.00**	**2,657,388.00**	**-785,362.72**	**-5,009,743.75**	**-9,396,834.86**
TOTAL RUNNING EXP + 10%	1,505,108.00	1,655,618.80	1,821,180.88	2,003,297.88	2,203,628.98
LESS INCOME GENERATION	6,462,720.00	6,889,259.52	7,343,950.65	7,828,651.39	8,345,342.38
fences	200,000.00	0	0	0	0
equipment	1,000,000.00	0	0	0	0
TOTAL INVESTMENT	**-257,612.00**	**-2,576,252.72**	**-6,308,132.49**	**-10,835,097.26**	**-15,538,548.27**
TOTAL PROFIT:	**257,612.00**	**2,576,252.72**	**6,308,132.49**	**10,835,097.26**	**15,538,548.27**

Figure 9.2.6: Running & Capital Costs for a 6 Rhino Cow Breeding Project *[Table by Author based on Hume, J. 2015]*

In the table in Figure 9.2.7, the annual profit of the proposed centre is outlined should the lift on the ban of legal Rhino horn trade be lifted. It is clearly evident that the profits of the centre rise exponentially with the sale of Rhino horn included on an estimated 2kgs of horn per Rhino per year. The price of the horn has also been estimated to decrease over the years as should the demand be met, and the illegal trade risk factor removed the horn will be worth a lot less as the year's pass.

CAPITAL COSTS FOR 6 RHINO COW BREEDING PROJECT WITH LEGAL HORN TRADE

	2016		2017		2018		2019		2020	
	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT
carry over from prev. year		0.00		-257,612.00		-2,576,252.72		-6,308,132.49		-10,835,097.26
purchases cows	6	3,000,000.00	5	2,665,000.00	5	2,840,890.00	5	3,028,388.74	5	3,228,262.40
purchases bulls	2	500,000.00	1	250,000.00	1	250,000.00	1	250,000.00	1	
births	5		3		4		4		7	
deaths females 5+2	0		0		1		0		1	
deaths males 1+2	0		0		0		0		1	
sales females + 10% P.A					2	-1,300,000.00	2	-1,320,000.00	2	-1,360,000.00
sales males + 10% P.A					0		1	-660,000.00	1	-680,000.00
SUB TOTAL		**3,500,000.00**		**2,657,388.00**		**-785,362.72**		**-5,009,743.75**		**-9,646,834.84**
TOTAL RUNNING EXP + 10%		1,505,108.00		1,655,618.80		1,821,180.88		2,003,297.88		2,203,628.98
LESS INCOME GENERATION		6,462,720.00		6,889,259.52		7,343,950.65		7,828,651.39		8,345,342.38
fences		200,000.00		0		0		0		0
equipment		1,000,000.00		0		0		0		0
TOTAL INVESTMENT		**-257,612.00**		**-2,576,252.72**		**-6,308,132.49**		**-10,835,097.26**		**-18,788,548.27**
return 12kg horn @ R150 000 inc. less 10% PA		-2,400,000.00		-3,818,181.82		-4,958,654.55		-5,860,210.91		-6,556,916.36
TOTAL INVESTMENT		**-2,657,612.00**		**-6,394,434.54**		**-11,266,787.03**		**-16,695,308.17**		**-22,345,464.63**
TOTAL PROFIT		**2,657,612.00**		**6,394,434.54**		**11,266,787.03**		**16,695,308.17**		**22,345,464.63**
ACCUMULATIVE NO. OF RHINO ON FARM (INCL. DEATHS, EXCL. SALES)		13		22		31		41		52
TOTAL NO. OF WHITE RHINO ON FARM (INCL. CALVES)		**13**		**22**		**29**		**36**		**44**

Figure 9.2.7: Running & Capital Costs for a 6 Rhino Cow Breeding Project WITH Legal Horn Trade *[Table by Author based on Hume, J, 2015]*

In Hume's calculations for a 100 cow breeding project, the difference in the total investment in the year 2020 is nearly R129million less with the legalisation of Rhino horn trade should these figures be calculated accurately. Hume went on to calculate the figures up to the year 2025, and by then a Rhino breeding farm would be making a profit of roughly R169million. [Hume, J. 2015] This money could be pumped back, not only into the Rhino conservation industry but conservation in general and where ever it is needed. Hume explains that trimming a Rhino's horn is a non-consumptive sustainable use of one of our natural products which the Rhino rubs away anyway - that is why its point it sharp, it has been rubbing the horn away. *[Hume, J. 2015]* As seen in Figure 9.2.7, the figures for a six cow start up project in 2020 are also a lot higher by 2020. While it is not as drastic as Hume's calculations, secondary income generators have also been factored into this calculation and R5 mill extra in one year will go a long way regarding community skills development and upliftment.

The legalisation of Rhino horn trade is, as explained previously in the document, a very controversial topic. For this reason, other means have been outlined to prove the viability of this centre, with, or without it.

9.3 THE PROPOSED CLIENT & COMMUNITY

The proposed client for the funding of the centre is currently Rhino breeder and farm owner John Hume. The reason for choosing a private investor is due to the existing farm Hume owns in the North West province of South Africa. He already owns over 1000 White Rhino and his breeding project is a huge success. The only downfall is that by having so many Rhino so closely confined when they are used to masses of space, there is a higher rate of disease and infection. It is this reason that relocating some of the Rhino to another farm would not only be beneficial to the Rhino themselves but also to the communities in the other areas. The costs of buying Rhino could also then be omitted from the calculations and rather include costs of transporting Rhino from his existing farm which would be a lot less than buying new Rhino from elsewhere. This would result in the start-up costs being a lot less and thus the turnover being a lot higher. The table in Figure 9.3.1, shows the annual profits should he relocate his Rhino to the new facility. The cost of relocating is roughly R31 000 per Rhino [Save the Rhino. 2014]. This clearly shows that the cost of the facility would be able to be paid off a lot quicker and the addition of outside investors or donations would be minimal.

Another major aspect of the proposed project is community involvement. Available materials on site that can be used to build with have been incorporated into the design, and the overall aim is to involve the community in the project from start to finish. Whether some are involved in the building and construction, others in the running of the centre and skills development as well as those that already have jobs and are not interested in being involved in the project at all.

CAPITAL COSTS FOR 6 RHINO COW BREEDING PROJECT WITH RELOCATION

	2016		2017		2018		2019		2020	
	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT	NR	AMOUNT
carry over from prev. year		0.00		-3,509,612.00		-5,828,252.72		-9,560,132.49		-14,087,097.26
relocate cows	6	186,000.00	5	2,665,000.00	5	2,840,890.00	5	3,028,388.74	5	3,228,262.40
relocate bulls	2	62,000.00	1	250,000.00	1	250,000.00	1	250,000.00	1	250,000.00
births	5		3		4		4		7	
deaths females	0		0		1		0		1	
deaths males	0		0		0		0		1	
sales females + 10% P.A					2	-1,300,000.00	2	-1,320,000.00	2	-1,360,000.00
sales males + 10% P.A							1	-660,000.00	1	-680,000.00

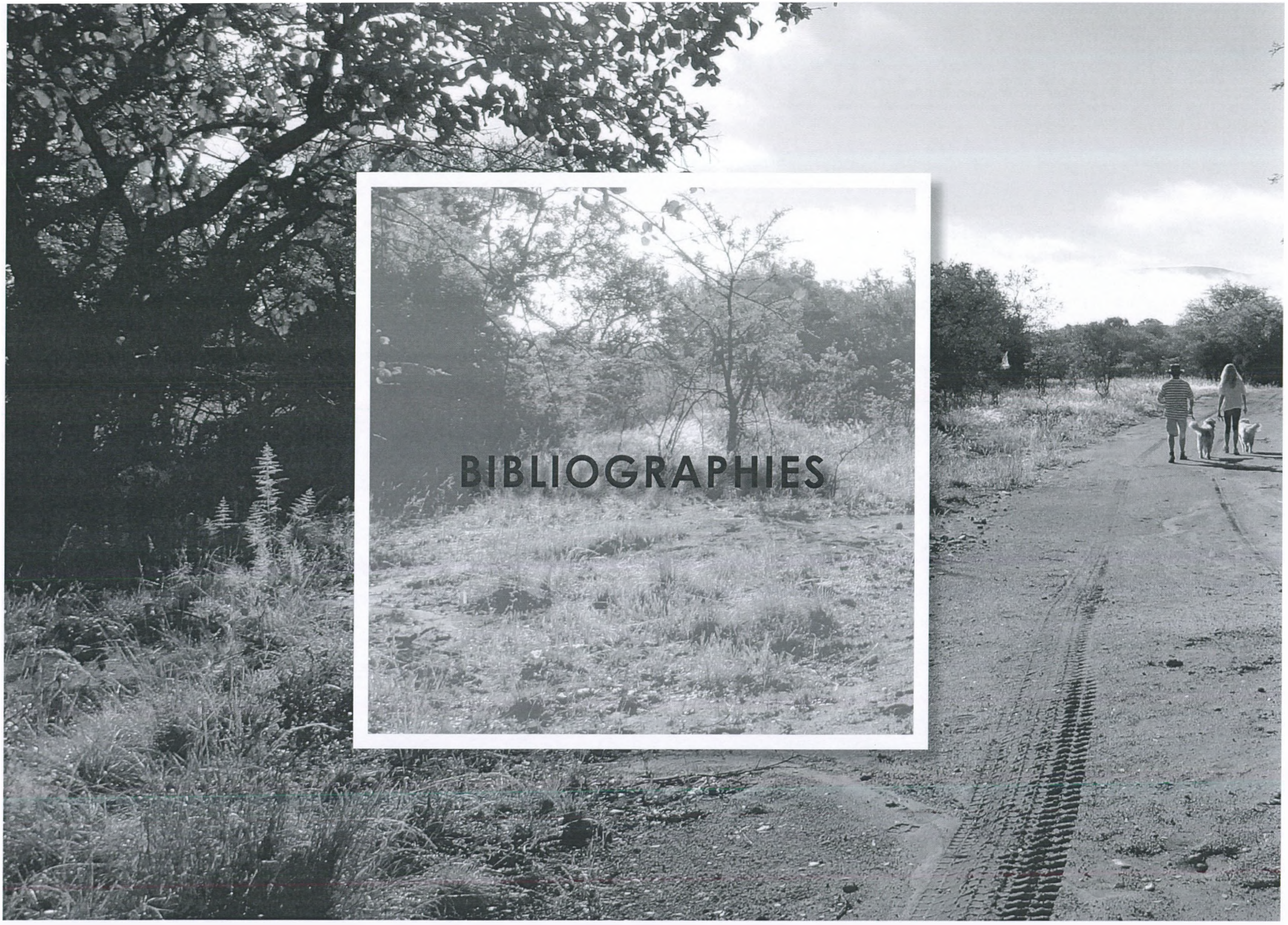
SUB TOTAL	**248,000.00**	**-594,612.00**	**-4,037,362.72**	**-8,261,743.75**	**-12,648,834.86**
TOTAL RUNNING EXP + 10%	1,505,108.00	1,655,618.80	1,821,180.88	2,003,297.88	2,203,628.98
LESS INCOME GENERATION	6,462,720.00	6,889,259.52	7,343,950.65	7,828,651.39	8,345,342.38
tences	200,000.00	0	0	0	0
equipment	1,000,000.00	0	0	0	0
TOTAL INVESTMENT	**-3,509,612.00**	**-5,828,252.72**	**-9,560,132.49**	**-14,087,097.26**	**-18,790,548.27**
TOTAL PROFIT:	**3,509,612.00**	**5,828,252.72**	**9,560,132.49**	**14,087,097.26**	**18,790,548.27**

Figure 9.3.1: Running & Capital Costs for a 6 Rhino Cow Breeding Project with Relocation from Existing Farm *[Table by Author based on Hume, J, 2015]*

9.4 CONCLUSION

As outlined in all of the information provided throughout the document it can be concluded that the proposed project is both viable and feasible on the proposed site. Whether the ban on the legal trade of Rhino horn is lifted or not, the centre will still make a profit each year allowing it to grow exponentially and use the profits to put back into the conservation of the White Rhino as well as of the area and the upliftment of the community.

The proposed client, John Hume, is a feasible option for the funding of the project and depending on the bond taken out for the build cost of the centre, third party funding would more than likely not be needed. It could be proposed that a few fundraising events be hosted in the initial stages to boost the initial cash flow into the project. However, when starting off on a small scale breeding project, the start-up costs are not very high, and the centre should have a positive turnover from year one should the additional income be generated accordingly.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9.1 BOOKS, JOURNALS AND MAGAZINES

ATKIN, T & RYKWERT, J. [2005] *Structure and Meaning in Human Settlements.* Philadelphia: Unversity of Pennsylvania

BOVILL, C. [1996] *Fractal Geometry in Architecture and Design.* Boston: Birkhauser

CARNABY, T. [2005] *Beat About the Bush.* Houghton Johannesburg: Jacana Media

DECKLER, T. [2010] River House. *DIGEST of South African Architecture. Volume 15.* (Pages 176 - 177)

DELEUZE, G & GUATTARIS, F. [1987] *A Thousand Plateaus Capitalism and Schizophrenia.* Minneapolis & London: University of Minnesota Press

DOCZI, G [1981] *The Power of Limits - Proportional Harmonies in Nature, Art & Architecture.* Boulder & London: Shambhala Publications.

ELIZABETH, L & ADAMS, C (EDS.) [2005] *Alternative Construction: Contemporary Natural Building Methods.* New Jersey: John Wiley & Sons Inc.

ESTES, R.D. [1991] *The Behaviour Guide to African Mammals.* South Africa: Russel Friedman Books

HAGGARD, K, ET. AL. [2005] *Alternative Construction: Contemporary Natural Building Methods: Chapter 3: Natural Conditioning of Buildings.* New Jersey: John Wiley & Sons Inc.

INGRAHAM, C. [2006] *Architecture, Animal, Human: The Asymmetrical Conditions.* Routledge: New York City

KUMAR, S. [2002] *Methods for Community Participation: A Complete Guide For Practitioners.* London: ITDG Publishers

METRIONE, L & EYRES (EDS). [2014] *Rhino Husbandry Manual.* Fort Worth, TX: International Rhino Foundation

MIDGLEY, J ET. AL. [1986] *Community Participation, Social development and the State.* London: Methuen

MITLIN, D & SATTERTHWAITE, D. [2004] *Empowering Squatter Citizen: Local Government, Civil Society and Urban Poverty Reduction.* Earthscan: London

OKAFOR, F. [1982] *Community Involvement in Rural Development: A Field Study in the Bendek State of Nigeria.* Community Development Journal, Vol 17, No. 2

PALLASMAA, J. [2005] *The Eyes of the Skin.* Great Britain: Wiley-Academy

PLAYER, I. [2013] *The White Rhino Saga.* Johannesburg & Cape Town: Jonathan Ball Publishers

RAEL, R. [2009] *Earth Architecture.* New York: Princeton Architectural Press.

TAYLOR, W. ET. AL. [2003] *The Waterberg: The Natural Splendours and the People.* Cape Town: Struik Publishers

VAN LENGEN, J. [2008] *The Barefoot Architect - A Handbook for Green Building*. English edition. California: Shelter Publications Inc.

ZUMTHOR, P. [1998] *Thinking Architecture.* Germany: Birkhauser

9.2 WEBSITES

ABLE, Z. [2012] *Thue-Morse Navigating Turtles.* [Online] Available: http://blog.zacharyabel.com/2012/01/thue-morse-navigating-turtles/ [Accessed 19 July 2016]

ACTMAN, J. [2015] *National Geographic: Can Fake Rhino Horn Stop the Poaching of an Endangered Species?* [Online] Available: http://news.nationalgeographic.com/2015/12/151203-pembient-synthetic-Rhino-horn-vietnam-poaching/ [Accessed 20 September 2016]

AFRICAN SKY HUNTING. [2015] *Hunting and Conservation in South Africa.* [Online]. Available: http://www.africanskyhunting.co.za/articles/hunting-and-conservation.html [Accessed 2 March 2016]

AP, SAPA. [2012] *Apartheid's black-on-black divide slower to heal.* [Online] Available: http://www.timeslive.co.za/local/2012/01/22/apartheid-s-black-on-black-divide-slower-to-heal [Accessed 14 March 2016]

ARONS EN GELAUFF ARCHITECTEN. [2008] Animal Refuge Centre. *ArchDaily* [Online] Available: http://www.archdaily.com/2156/animal-refuge-centre-arons-en-gelauff-architecten [Accessed 23 April 2016]

BAUDERSOLAR. [2014] *Flat Roof Photovoltaic Systems* [Online] Available: http://www.bauder.co.uk/assets/b/a/baudersolarbrochure_lowres.pdf [Accessed 19 September 2016]

CASSIA CO-OP. [2015] *Training Center.* [Online] Available: http://www.cassia.coop/ [Accessed 23 April 2016]

CENSUS 2011. [2011] *Vinaerkraal.* [Online] Available: https://census2011.adrianfrith.com/place/981001 [Accessed 14 March 2016]

CHIN, A. [2013] Hathigaon Elephant Village. *Designboom* [Online] Avaialble: http://www.designboom.com/architecture/rahul-mehrotra-of-rma-designs-hathigaon-elephant-village/ [Accessed 4 April 2016]

CIFUENTES, F. [2012] Cassia Coop Training Centre. *ArchDaily* [Online] Available: http://www.archdaily.com/274835/casia-coop-training-centre-tyin-teanestue-architects [Accessed 23 April 2016]

CLIMATE MASTERS. [2015] *Geothermal Heating & Cooling – How Does Geothermal Energy Work?* [Online] Available: http://www.climatemaster.com/residential/how-geothermal-works/ [Accessed 3 October 2016]

EGLASH, R. [2013] *TED Talks: Ron Eglash: The fractals at the heart of African designs.* [Online] Available: https://www.youtube.com/watch?v=EPjSjNRwdEw [Accessed 19 July 2016]

ENERGY. [2011] *Geothermal Heat Pumps.* [Online] Available: http://energy.gov/energysaver/geothermal-heat-pumps [Accessed 3 October 2016]

ENERGY (2). [2011] *Efficient Earth-Sheltered Homes.* [Online] Available: http://energy.gov/energysaver/efficient-earth-sheltered-homes [Accessed 7 October 2016]

FGASA. [2016] *Becoming a Game Ranger.* [Online] Available: http://www.fgasa.co.za/default.asp?CPH_ID=98 [Accessed 30 April 2016]

FLORIDES, G AND KALOGIROU, S. [2011] *Annual ground temperature measurements at various depths.* [Online] Available: https://www.researchgate.net/publication/30500353_Annual_ground_temperature_measurements_at_various_depths [Accessed 3 October 2016]

FONDRIEST ENVIRONMENTAL, INC. [2014] *Fundamentals of Environmental Measurements: Solar Radiation and Photosynethically Active Radiation.* [Online] Available: http://www.fondriest.com/environmental-measurements/parameters/weather/photosynthetically-active-radiation/ [Accessed 17 October 2016]

GALLIERS, C. [2015] *Current Rhino Poaching Stats.* [Online] Available: http://wessa.org.za/get-involved/Rhino-initiative/current-Rhino-poaching-stats.htm [Accessed 14 March 2016]

GAME RANGER ASSOCIATION OF AFRICA. [2016] *Support Africa's Rangers.* [Online] Available: http://www.gameranger.org/what-we-do/projects/107-support-africas-rangers.html [Accessed 28 April 2016]

GOING SOLAR. [2015] *How Many Solar Panels Will I Need?* [Online] Available: https://us.sunpower.com/blog/2015/07/23/how-many-solar-panels-do-i-need-my-home/ [Accessed 16 October 2016]

GO LIMPOPO. [2016] *Waterberg Region.* [Online] Available: http://www.golimpopo.com/waterberg [Accessed 14 March 2016]

GRIFFITHS, A. [2014] *Boomslang walkway by Mark Thomas and Henry Fagan extends over a forest canopy.* [Online] Available: http://www.dezeen.com/2014/06/30/boomslang-walkway-kirstenbosch-national-botanical-garden-mark-thomas-henry-fagan/ [Accessed 22 Septemebr 2016]

HUME, J. [2013] We have to legalise trade in Rhino horn: John Hume at TEDxJohannesburg. *YouTube.* [Online] Available: https://www.youtube.com/watch?v=3uGkQWJBe_Y [Accessed 4 April 2016]

HUME, J. F. [2015] *Rhino Breeding Project in the North West Province, South Africa.* [Online] Available: https://www.environment.gov.za/sites/default/files/docs/Rhinobreedingproject_jfhume.pdf [Accessed 23 March 2016]

JALOXA. 2011. *Stereographic Sunpath Diagram for 24°S.* [Online] Available from: http://www.jaloxa.eu/resources/daylighting/docs/sunpath_24_south.pdf [Accessed: 2 March 2016]

KERR, S.B [2014] Three Minute Theory: What is the Rhizome?. *YouTube.* [Online] Available: https://www.youtube.com/watch?v=anteiRO-XfU [Accessed 30 June 2016]

MCINTOSH, P. [2016] *Rammed earth on the rise.* [Online] Available: http://earthworksmagazine.co.za/features/rammed-earth-on-the-rise/ [Accessed 31 August 2016]

MUSKOKA. [2015] *Rammed Earth.* [Online] Avaialbe: http://www.muskokasustainablebuilders.ca/Rammed_Earth.html [Accessed 31 August 2016]

NATHAN, F. [2012] *Off the Grid News: How to Build an Underground, Off-Grid, Virtually Indestructable Home.* [Online] Available: http://www.offthegridnews.com/grid-threats/the-surprising-facts-about-earth-sheltered-living/ [Accessed 7 October 2016]

NATIONAL GEOGRAPHIC. [2016] *White Rhinoceros.* [Online] Available: http://animals.nationalgeographic.com/animals/mammals/white-Rhinoceros/ [Accessed 15 March 2016]

NEME, L. [2014] *For Rangers on the Front Lines of Anti-Poaching Wars, Daily Trauma.* [Online] Available: http://news.nationalgeographic.com/news/2014/06/140627-congo-virunga-wildlife-rangers-elephants-Rhinos-poaching/ [Accessed 30 April 2016]

OL PAJETA CONSERVANCY. [2016] *Rhinos. Witness the Mighty Vulnerable.* [Online] Available: http://www.olpejetaconservancy.org/wildlife/Rhinos/ [Accessed 15 March 2016]

OSMAN, N. [2015] *Calculating the Kilowatt Hours Your Solar Panels Produce (Solar Panel Output)* [Online] Available: http://understandsolar.com/calculating-kilowatt-hours-solar-panels-produce/ [Accessed 16 October 2016]

PIETERSE, DU TOIT & ASSOCIATES. [2014] *Waterberg Spatial Development Framework.* [Online] Available: www.waterberg.gov.za/docs/other/GA36%20Phase-1%20Final.doc [Accessed 4 April 2016]

RAMMED EARTH CONSTRUCTIONS. [2014] *Benefits Of Building In Rammed Earth.* [Online] Available: http://www.rammedearthconstructions.com.au/rammed-earth-info/ [Accessed 21 June 2016]

RHINO'S INFO. [2015] *Rhino Attacks on Humans.* [Online] Available: http://www.Rhinosinfo.com/Rhino-attacks-on-humans.html [Accessed 21 September 2106]

REWILDING EUROPE. [2012] *Wildlife Watching Hides.* [Online] Available: https://www.rewildingeurope.com/assets/uploads/Downloads/Rewilding-Europe-Wildlife-Watching-Hides-Best-Practice-Guidelines-Dec-2012.pdf [Accessed 12 August 2016]

RHINO WORLDS (1). [2014] *Rhinoceroses and Humans.* [Online] Available: http://www.Rhinoworlds.com/Rhinoceroses-and-humans/ [Accessed 21 September 2016]

RHINO WORLDS (2). [2014] *Rhinoceroses Predators.* [Online] Available: http://www.Rhinoworlds.com/Rhinoceros-predators/ [Accessed 21 September 2016]

SAVING RHINOS. [2010] *In Plain Sight: China's 'Rhino Horn Scheme' : Another inconvenient truth.* [Online] Available: http://www.savingRhinos.org/2011/06/12/in-plain-sight-chinas-Rhino-horn-scheme/12859 [Accessed 1 May 2016]

SAVE THE RHINO. [2014] *Plans to move up to 500 Rhinos from Kruger National Park.* [Online] Available: https://www.savetheRhino.org/latest news/news/1066 plans to move up to 500 Rhinos from kruger national park [Accessed 26 May 2016]

SAVE THE RHINO. [2016] *Synthetic / bio-fabricated Rhino horn: Will it save the Rhino?* [Online] Available: https://www.savetheRhino.org/Rhino info/thorny issues/synthetic Rhino horn will it save the Rhino [Accessed 20 September 2016]

SAVE THE RHINO (1). [2016] *Poaching Statistic.* [Online] Available: https://www.savetheRhino.org/Rhino info/poaching statistics [Accessed 14 March 2016]

SAVE THE RHINO (2). [2016] *Domestic trade in Rhino horn* [Online] Available: https://www.savetheRhino.org/Rhino info/thorny issues/legalising the horn trade/domestic trade in Rhino horn [Accessed 22 April 2016]

SAVE THE RHINO (3). [2016] *Fun Rhino Facts.* [Online] Available: https://www.savetheRhino.org/Rhino info/for kids/everything Rhino [Accessed 21 July 2016]

SA VENUES. [2015] *The Waterberg Region.* [Online] Available: http://www.sa-venues.com/north province bushveld.htm [Accessed 3 October 2016]

SEAH, L. [2014] *Evaluating community participation in rural development projects : the case of Mokaalwaneng Village.* [Online] Available: http://uir.unisa.ac.za/handle/10500/18824 [Accessed 1 May 2016]

SEEKER. [2015] *3D-Printed Synthetic Rhino Horns Could Save Rhinos.* [Online] Available: http://www.seeker.com/3d-printed-synthetic-Rhino-horns-could-save-Rhinos-1769963373.html [Accessed 20 September 2016]

SIMM, C. [2015] *Ecotourism in Limpopo Province.* [Online] Available: http://traveltips.usatoday.com/ecotourism-limpopo-province-27615.html [Accessed 14 March 2016]

SOLAR CRAFT. [2016] *Commercial Solar Power – How it Works.* [Online] Available: http://solarcraft.com/commercial-solar-power-how-it-works/ [Accessed 16 October 2016]

SUSTAINABLE BUILDING DESIGN. [2014] *The Beauty of Rammed Earth.* [Online] Available: https://sustainablebuildingdesign.wordpress.com/2014/09/02/the-beauty-of-rammed-earth/ [Accessed 31 August 2016]

SOUTH AFRICA INFO. [2015] *Limpopo Province, South Africa.* [Online]. Available: http://www.southafrica.info/about/geography/limpopo.htm#.VubHIJx9670 [Accessed 14 March 2016]

THE AUSTRALIAN RHINO PROJECT. [2015] *Help us relocate the first Rhinos to Australia.* [Online] Available: http://theaustralianRhinoproject.org/ [Accessed 23 March 2016]

TYIN TEGNESTUE ARCHITECTS. [2011] *Cassia Co-op Training Centre.* [Online] Available: http://www.tyinarchitects.com/works/cassia-coop-training-centre/cctc-projectdescription/ Accessed: 23 April 2016]

UNESCO. [2014] *Introducing UNESCO.* [Online] Available: http://en.unesco.org/about-us/introducing-unesco [Accessed 18 March 2016]

WALSH. [2012] *Pros and cons of rammed earth.* [Online] Available: http://www.swalsh.com/h/blog/pros-and-cons-of-rammed-earth/bp6/ [Accessed 5 October 2016]

WATERBERG GOVERNMENT. [2014] *Annexure 1 - Settlement Priorities - Vingerkraal, Bela Bela.* [Online] Available: http://www.waterberg.gov.za/docs/plans/ANNEXURE%201-SETTLEMENT%20PRIORITIES.pdf [Accessed 5 Spetember 2016]

WEBB, J. [2014] *Could sound design help captive Rhino breeding?* [Available] Online: http://www.bbc.com/news/science-environment-29846902 [Accessed 4 April 2016]

WORLD WEATHER ONLINE. [2012] *Rooibera Monthly Climate Average, South Africa.* [Online] Available: http://www.worldweatheronline.com/rooibera-weather-averages/limpopo/za.aspx [Accessed 21 March 2016]

WWF. [2016] *White Rhino.* [Online] Available: http://wwf.panda.org/what we do/endangered species/Rhinoceros/african Rhinos/white Rhinoceros/ [Accessed 15 March 2016]

9.3 PRECEDENT STUDIES

Cassia Coop Training Centre:

CASSIA CO-OP. [2015] *Training Center.* [Online] Available: http://www.cassia.coop/ [Accessed 23 April 2016]

CIFUENTES, F. [2012] Cassia Coop Training Centre. *ArchDaily* [Online] Available: http://www.archdaily.com/274835/casia-coop-training-centre-tyin-tegnestue-architects [Accessed 23 April 2016]

TYIN TEGNESTUE ARCHITECTS. [2011] *Cassia Co-op Training Centre.* [Online] Available: http://www.tyinarchitects.com/works/cassia-coop-training-centre/cctc-projectdescription/ Accessed: 23 April 2016]

Edgeland House:

BARDAGIY, P [2013] Edgeland House. *ArchDaily* [Online] Avaialble: http://www.archdaily.com/331677/edgeland-house-bercy-chen-studio [Accessed 31 August 2016]

Chen, B. [2013] Edgeland House. *ArchDaily* [Online] Avaialble: http://www.archdaily.com/331677/edgeland-house-bercy-chen-studio [Accessed 31 August 2016]

NOTHINGAM, S. [2014] *Underaround House Encased in Glass Offers a Modern take on Native American Pit House.* [Online] Available: http://www.decoist.com/2013-02-21/underground-house-encased-in-glass/ [Accessed 31 August 2016]

Hathiagon Elephant Villaae:

CHIN, A. [2013] Hathiagon Elephant Villaae. *Designboom* [Online] Avaialble: http://www.designboom.com/architecture/rahul-mehrotra-of-rma-designs-hathiagon-elephant-villaae/ [Accessed 4 April 2016]

RMA. [2013] Hathiagon Elephant Villaae Images. *Designboom* [Online] Avaialble: http://www.designboom.com/architecture/rahul-mehrotra-of-rma-designs-hathiagon-elephant-villaae/ [Accessed 4 April 2016]

Oppie Koppie Community Creche:

LOW, I. [2011] Design. Develop. Build: Oppie Koppie Community Crèche. *DIGEST of South African Architecture.* Volume 16. (Pages 168 – 171)

The Great Wall of WA:

BIRCH, E. [2015] The Great Wall of WA - Photographs. *ArchDaily.* [Online] Available: http://www.archdaily.com/771780/the-great-wall-of-wa-luigi-rosselli [Accessed 31 August 2016]

KESKEYS, P. [2015] *The Great Wall of WA: 12 Rammed-Earth Dwellings Emerge from the Australian Wilderness.* [Online] Available: http://architizer.com/blog/the-great-wall-of-wa/#.Vo1O0MyHZsg.pinterest [Accessed 31 August 2016]

ROSSELLI, L. [2015] The Great Wall of WA. *ArchDaily*. [Online] Available: http://www.archdaily.com/771780/the-great-wall-of-wa-luigi-rosselli [Accessed 31 August 2016]

WITS Rural Training and Research Facility:

OTTEN, K. [2015] WITS Rural Training and Research Facility. *DIGEST of South African Architecture*. Volume 20. (Pages 64-65)

9.4 IMAGES, PHOTOS & DIAGRAMS

BAUEN ARCHITECTURE STUDIO. [2013] *Modern Earth Shelter: Homes Built into the Hillside.* [Online] Available: http://dornob.com/modern-earth-shelter-homes-built-into-the-hillside/ [Accessed 7 October 2016]

BELOMLINSKY, A. [2012] *Tree Growth Life Cycle.* [Online] Available: http://www.istockphoto.com/vector/tree-growing-growth-life-cycle-royalty-free-vector-icon-set-gm165811726-19638696 [Accessed 31 July 2016]

DE SAKUTIN, S. [2011] *A South African soldier participates in a night patrol exercise against Rhino poachers in Kruger National Park in July 2011.* [Online] Available: http://news.nationalgeographic.com/news/2014/06/140627-congo-virunga-wildlife-rangers-elephants-Rhinos-poaching/ [Accessed 30 April 2016]

DESIGN BEEP. [2015] *Cracked Mud.* [Online] Available: http://designbeep.com/2012/08/23/45-free-cracked-mud-textures-for-your-designs/ [Accessed 12 July 2016]

ENERGY INTELLIGENCE. [2015] *Solar PV projects of plenty in South Africa*. [Online] Available: http://www.energyintelligence.co.za/solar-pv-projects-of-plenty-in-south-africa/ [Accessed 16 October 2016]

HD WALLPAPER. [2015] *White Rhinoceros 7.* [Online] Available: http://hdwallpaperia.com/white-Rhinoceros-7.html [Accessed 20 March 2016]

LONGARI, M. [2014] *An anti-poaching team patrols in Zakouma National Park, Chad, in February 2014.* [Online] Available: http://news.nationalgeographic.com/news/2014/06/140627-congo-virunga-wildlife-rangers-elephants-Rhinos-poaching/ [Accessed 30 April 2016]

NL ARCHITECTS. [2009] *Loop House (re)Visited.* [Online] Available: https://nlarchitects.wordpress.com/2009/09/11/loop-house-revisited/ [Accessed 7 October 2016]

RHINO SOURCE CENTRE. [2006] *White Rhino.* [Online] Available: http://www.Rhinoresourcecenter.com/images/White-Rhino_i1195751305.php?type=tax_images&taxon=5&sort_order=desc&sort_key=year [Accessed 15 March 2016]

ZOOLOGO MUSEUM. [2015] *Here's our magnificent White Rhinoceros skeleton (male), with replacement horns. [Photograph]* At: The University of Cambridge. [Online] Available: https://twitter.com/zoologymuseum/status/646313424637534209 [Accessed 15 March 2016]

123RF. [2014] *Rhino Skin.* [Online] Available: http://www.123rf.com/photo_27082601_Rhino-skin-texture.html [Accessed 12 July 2016]

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ETHICS CLEARANCE

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11.1 ETHICS CLEARANCE

SCHOOL OF ARCHITECTURE AND PLANNING
HUMAN RESERCH ETHICS COMMITTEE

SCHOOL OF ARCHITECTURE PLANNING

CERTIFICATE OF RETROSPECTIVE ACKNOWLEDGEMENT
PROTOCOL NUMBER: SOAP21/12/05/2016

PROJECT TITLE:	[re]turned EARTH - A community led Rhino breeding & ranger training facility in the heart of Rooiberg, Limpopo
INVESTIGATOR/S:	Jessica Ransome (Student no# 458055)
SCHOOL:	Architecture and Planning
DEGREE PROGRAMME:	Master of Architecture Professional (MArch Prof)
DATE CONSIDERED:	22 August 2016
EXPIRY DATE:	22 August 2017
DECISION OF THE COMMITTEE:	Retrospective Acknowledgement

CHAIRPERSON
(Professor Daniel Irurah)

DATE: 24-09-2016

cc: Supervisor/s: Brigitta Stone-Johnson

DECLARATION OF INVESTIGATORS
I/We fully understand the conditions under which I am/we are authorized to carry out, the abovementioned research and I/we guarantee to endure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

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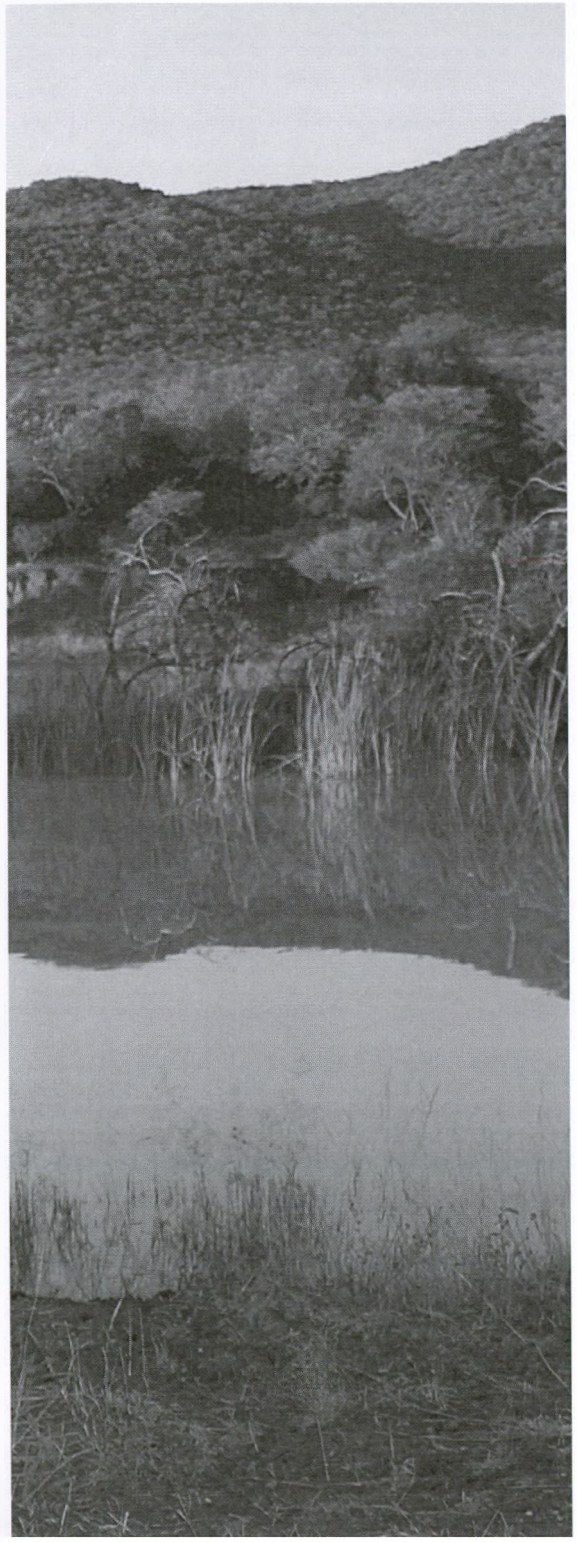
THANK YOU



[re]turnedEARTH

a community project for a Rhino breeding and ranger training facility in the heart of rooiberg, limpopo

JESSICA RANSOME_458055

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