Hedges Against Extinction:

An Inner City Regional Riverine Botanical Park

By

Josias Potgieter

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Submitted in fulfilment of parts of the requirements for the degree
Masters of Landscape Architecture (Professional)
in the
Faculty of Engineering, Built Environment and Information Technology
University of Pretoria
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Declaration

In accordance with Regulation 4(c) of the General Regulations (G.57) for dissertation and theses, I declare that this thesis, which I hereby submit for the degree Masters of Landscape architecture (Professional) at the University of Pretoria, is my own work and not previously been submitted by me for a degree at this or any other tertiary institution.
I further state that no part of my thesis has already been, or is currently being, submitted for any such degree, diploma or other qualification.
I further declare that this thesis is substantially my own work. Where reference is made to the works of others, the extent to which that work has been used is indicated and fully acknowledged in the dissertation and list of references.

Josias Potgieter

Site location
The former Berea Park
597-577 Lilian Ngoyi Street
Pretoria Central, Pretoria, 0002
-25.758058, 28.193650

Function of the site: Historically a cricket club hosting several sports; now derelict.

Research field: Environmental Potential (EP)

Year Co-ordinator: Johan Prinsloo
Study Leader: Karen Botes

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Preface

Abstract

The central principle behind conserving river systems is to set aside a certain area of land to create representations of ecosystems that occur in the region to act as ecological or biodiverse depository. This is done to buffer against future modifications of the river systems in an effort to preserve the original biodiversity presence (Roux & Nel, 2013). There is a need for the conservation for the waterways of Pretoria to increase biodiversity and ecosystem service potential. The study site is in the Berea Park area, which are historic sportsgrounds that are now abandoned. The site sits adjacent to the Apies River within the 1:100 year flood line and can get completely flooded during such a flood event. The river was dechannelised and various flooding strategies where incorporated to mitigate and absorb the treat of a flood in the city.

Education plays an important role in conservation and developing the site. However, it has been shown that people have inherent biases to ignore the environment around them in favour of more active attention. This is known as plant blindness and is a major issue when trying to create awareness of ecological importance (Allen, 2003). The purpose of this dissertation is to test the viability of conserving regional river plant species in Pretoria through devising strategies to display plants in such a way as to counteract plant blindness. By placing the user in a phenomenological experience of a place such as a river, it is argued that plant blindness can be cured and create awareness. This in turn has positive consequences for riverine plant conservation.

Berea Park (Author, 2019).

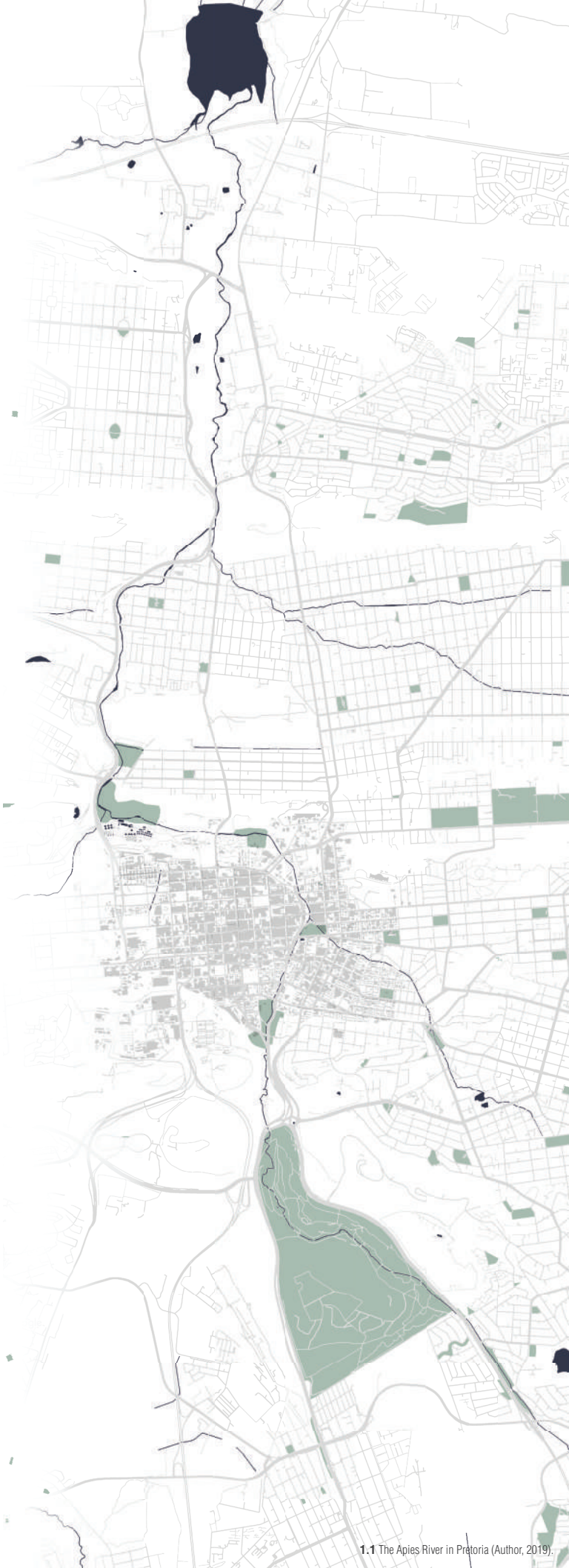
ACKNOWLEDGEMENTS

I would like to express my gratitude to my study leader Karen Botes who has been a positive force in my journey. She always gave me constructive comments and warm encouragement.

Furthermore, my deepest appreciation goes to Johan Prinsloo, who has been extraordinarily tolerant and always gave insightful comments and suggestions.

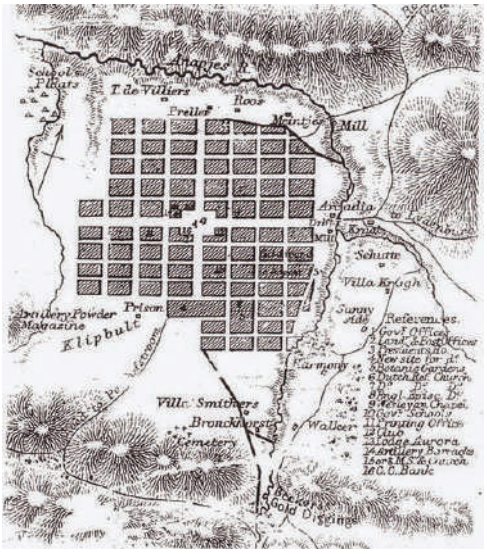
My parents I would like to thank for their generous support and tolerance of my temperament throughout the year.

Lastly, I am particularly grateful to my girlfriend who helped me with numerous grammatical errors.



1.1 The Apies River in Pretoria (Author, 2019).

1 INTRODUCTION



1.2 Map of Pretoria 1878 (SAHO, 2011).

1.1 A brief introduction to the Apies River and Berea Park's history

Prior to the arrival of the Dutch settlers, the fertile valley between the Magalies and Daspoort mountain ridges have been occupied since the stone age. Many tribes, such as the Bakwena and Matabele, settled in the valley. The first Voortrekkers arrived in 1836 and settled on farms in the Elandspoort and Groenkloof valley. The farms soon grew into a town which became a convenient trade location for travellers heading to Maputo, previously known as Delgoa bay (Sholtz, 2016).

Pretoria was officially established on the banks of the Apies River by the Voortrekkers who settled there in 1855. The location was chosen for the availability of water and rich soil in the valley between the protecting mountain ranges of the Magaliesberg. The name of the river means Monkey River, on account of the historic abundance of velvet monkeys present at the time (Show me, 2009). The city grew fast and was named the capital of the Zuid-Afrikaansche Republiek in 1877, which existed until the end of the second Boer war in 1902 (SAHO, 2011).

1.2 Background and Context

Water has always been a key factor in the development of human societies. Mesopotamia, Egypt and the Indus valley did not develop into flourishing civilisations until they mastered the control of water for irrigation. Control of the water created a centralised power through control of the food source and thus gave rise to governance. This can be validated and is evident in the Hammurabi's laws, written in 1771 BCE (Hill, 1915).

Civilisation still relies on the capacity of the natural environment to sustain social and economic development. Despite major technological and economic improvements in the well-being of mankind, freshwater is the bloodstream of the natural environment's capacity.

Two paradigms influence the management of natural resources, one of which is the development paradigm which allows water to work for the economic benefit of people. Ecosystems are essentially harvested for the production of social value. The former advocates water to benefit all, including the physical environment.

Rivers consist of complex multifunctional ecosystems with their own self-sustaining balance. Urban rivers also possess these complex ecosystem relationships, but modification of certain functions over others causes an imbalance in the ecosystem. These imbalances can lead to the degradation of the river environment and ecosystem in most urban rivers. The channelisation of urban rivers in concrete became prominent as measure to control and limit flooding, with some urban rivers even covered entirely and neglected. A recent increase in environmental awareness has led to urban streams being revisited and their aesthetic and environmental values appreciated (River Health Programme, 2005).

1.3 Pretoria's Urban Rivers: Identifying the Issue

The river systems of Pretoria are highly modified and channelised in areas. The natural state of these rivers has been severely compromised and most of these waterways are also polluted with sewage and other

pollutants such as floating litter which is carried into the river during storm events. Nonetheless, rivers in Gauteng such as the Hennops, Apies and Jukskei are still utilised by people for needs such as washing, leisure and food production. Consequently, this is problematic as the water quality can be a health risk to people especially young children and people with weakened immune systems (Moatshe, 2019). The most polluted areas in these rivers are close to wastewater treatment plants, animal farmlands and informal settlements as a result of the lack of proper sanitation infrastructure. The lowest concentration of pollutants was found to be in the river tributaries with little human interference (Abia, et al., 2015).

From 1906 to 1907, the British Municipal Administration who administered Pretoria for a short period prior to the unification of South Africa, appointed engineers to channelise the Apies River (Dipenaar, 2013). This was done to prevent damage to property from the river consistently flooding its banks in the rainy season (Jansen van Vuuren, 2019). The Apies River comprised wide shallow banks and was used often for watering animals and swimming prior to the channelisation.

To the vast majority of city goers today, the Apies River is unnoticed. Thus, the mindset of the city has shifted from relying on the river, to the river being ignored and considered a nuisance. The value of land for economic benefit outweighed the ecological benefits of the river. Therefore, buildings were constructed up to the edge of the river channel. This densification inadvertently contributed to more runoff from rainfall, which lead to more intense and faster flooding especially downstream where frequent damage has been recorded (River Health Programme, 2005).

1.4 Problem Statement

Pretoria's waterways need to be rehabilitated to increase biodiversity and provide green infrastructure potential. Education plays a key role in conservation and developing the site must satiate these needs and provide leisure, social and cultural benefits. The natural environment in and around Pretoria has significant cultural and natural heritage value. However, access to these nature areas is limited to vehicular transport.

The divide between people and nature is growing. This may be as a result of inherent biases of people who ignore the environment around them in favour of more active attention in the current busy world. This is known as plant blindness and is a major issue when trying to create awareness of ecological importance (Allen, 2003).

The site selected for the study is degraded, isolated and unused. Fragmentation is caused by the construction of Nelson Mandela Drive and the Lillian Ngoyi Avenue extension roads buildt in the nineties. The Nelson Mandela Drive roadway has also caused a divide between the city and its connection with nature by severing the pedestrian link to Groenkloof Nature Reserve physically and visually.

1.5 Research Questions

- How can Pretoria's regional river system ecology be conserved through a botanical garden in the inner city?
- How can the fragmented Berea Park parcels of land be joined to form a cohesive public space?
- How can the isolated suburbs, institutions and infrastructure surrounding the Berea area be stitched into the landscape fabric to reinvigorate this precinct?

1.6 Thesis Statement

The river system ecology in Pretoria can be restored through the creation of a botanical garden representing the river ecology and local vegetation types to provide an open space system connected to other open spaces in the city and to address plant blindness in order to promote river plant species conservation.

1.7 Project Aims and Objectives

The intention of this study is to implement a small-scale regional botanical garden in the Pretoria inner city to conserve and showcase the region's riverine and wetland plant species. The Apies River running through the site is the main driver for the intent of creating a riverine botanical garden which places emphasis on the regional riparian, aquatic and wetland plant life.

The river system will be rehabilitated with its natural ecology restored. The aim is not to return the river to its complete natural state, but rather create valuable amenities for city goers and condensed botanical displays of regional river systems. The botanical garden will include research facilities for the conservation of river habitats and to function as an educational facility managed by the University of South Africa (UNISA), the owner of the property to the east of the study site.

The botanical garden is conceptualised as a natural link bringing the natural environment from the Fountain's valley and Groenkloof Nature Reserve into the inner city. Nelson Mandela Road also serves as a prominent entrance to the city. The visual experience from a vehicle and exposure to the Apies River as natural and historic feature of Pretoria is therefore important for people living in the city as well

as tourists visiting the area.

1.8 Assumptions and Limitations

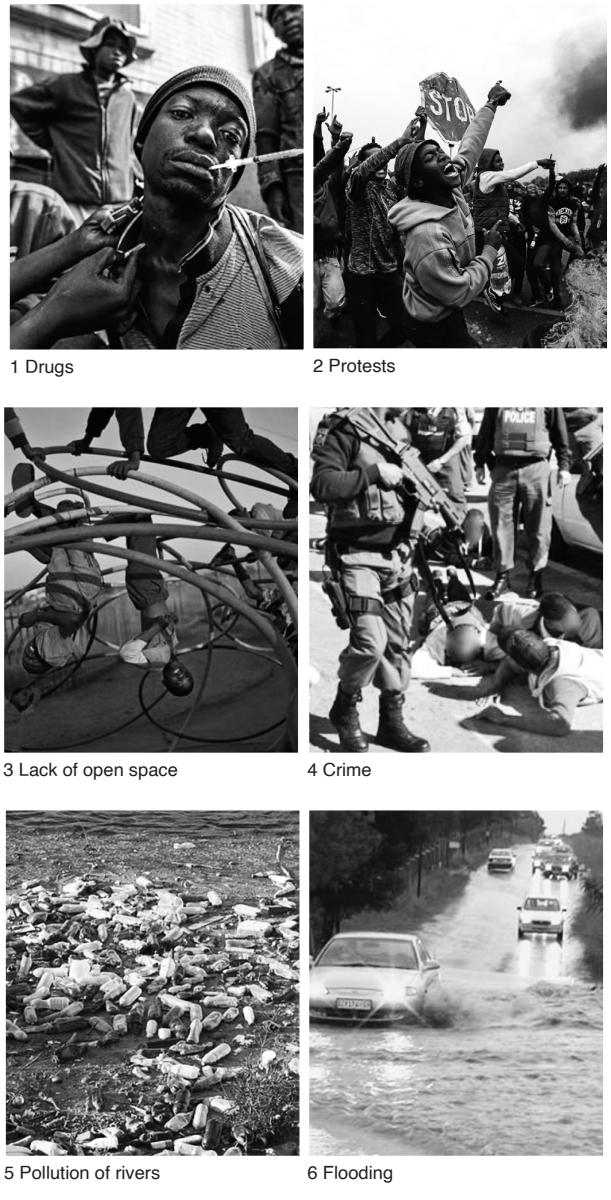
The Willow Road Bridge crosses the Apies River and is a declared heritage bridge. Any alterations to the channel should therefore be avoided or if proposed comply with the necessary legislation (National Heritage Resources Act, 1999).

The study focuses on the riverine vegetation and creating awareness of the of regional rivers. The physical conservation of regional rivers is excluded from this study.

Future possible pressures on natural water systems include the growing population in urban areas as well as pollution and other issues in developing countries are excluded.

1.9 Methodology

In-depth research will be conducted on the state and conservation of river systems and its link with plant blindness. Research sources will include: books, journals, articles, web pages, maps, photographs and interviews with professionals and will be referenced to gain a holistic understanding of the subject. Empirical studies will be undertaken in the Berea Park and surrounding area to determine the site conditions and existing programmes as well as the condition of the Apies River and its habitats. This research along with precedent studies will inform design decisions. The exploration of Landscape Architectural interventions will be done through the means of sketches and models. Hand drawn and computer-generated graphics and diagrams, as well as handmade and computer-generated models and simulations will be used as design tools.



1.3 Existing problems in the Berea Park area (Author, 2019).

2 BOTANICAL GARDENS

"God Almightie first planted a Garden and indeed it is the Purest of Humane Pleasures. It is the greatest refreshment to the spirits of man; without which Buildings and Palaces are , but grosse Handyworkes: and a man shall ever see that when ages grow to civility and elegancie men come to Build stately sooner than to garden finely as if gardening were the greater Perfection." Francis Bacon (Hill, 1915, p. 186)

2.1 Introduction

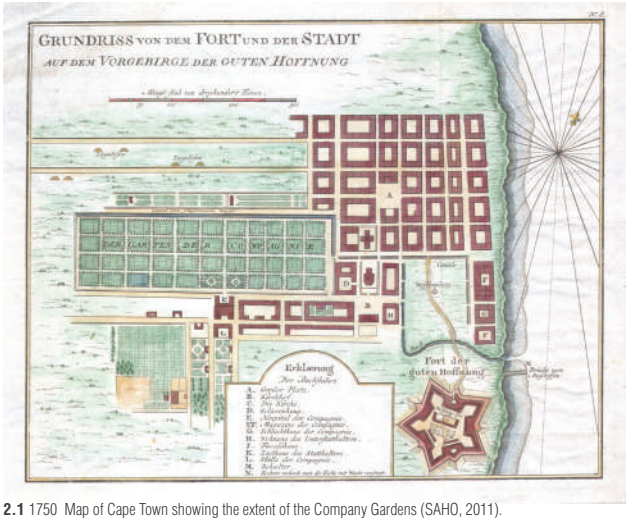
Through the ages, civilisations have strived to travel the globe in search of gold, spices and drugs. Spices and drugs may be the foundation of botanical gardens, with the value of spice being a driver for the development of gardens in the tropics and the need for drugs permeated into the physic gardens in Europe (Hill, 1915).

The history of botanical gardens is in a sense the history of gardens. The meaning and perception of botanical gardens have changed significantly through the ages.

The first documented mention of a garden was the Egyptian royal gardens of Tuthmose III designed by Nekht, head gardener of the gardens attached to the Temple of Karnak in 2055 BCE. The royal gardens were most likely used as pleasure gardens whereas the gardens at Karnak had more of an economic importance (Hill, 1915).

In the East, the Chinese are regarded as the founders of the first botanical gardens. In the 13th century BCE, the semi-mythical Chinese emperor, Shennong, was regarded as the father of medicine. He is generally depicted tasting a plant to test for its healing properties. This was also the first mention of herbal gardens in history. In 141 BCE, the Han emperor, Wu Ti, was known as the father of Botany because he ordered expeditions to collect plants from across the empire for agricultural production and to study their medicinal benefits (Unschuld, 1986).

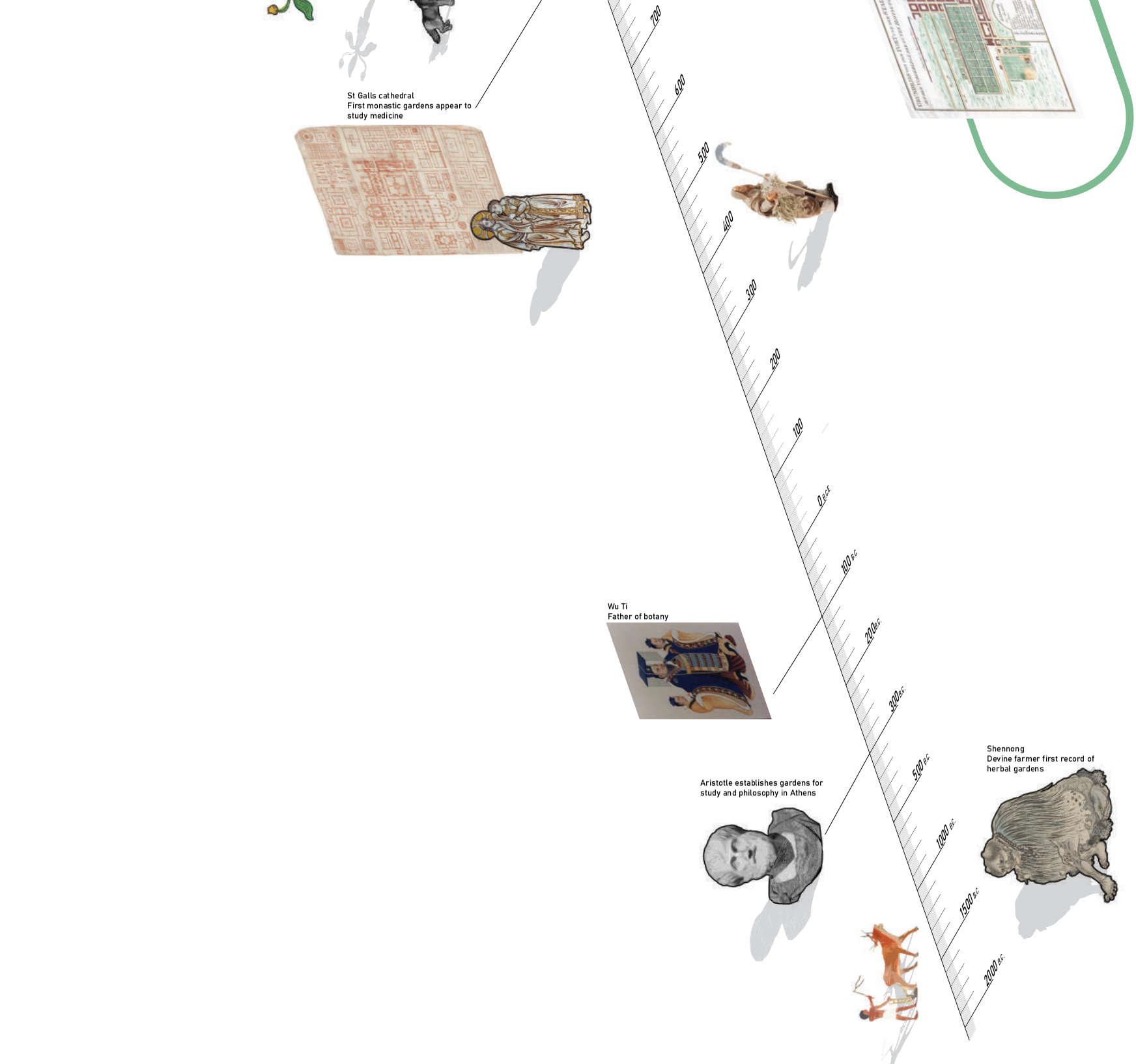
In the West, Aristotle created the first known western botanical garden in Athens. The garden was part of a philosophical school named the Lyceum. Alexander the Great collected plants and animals for Aristotle on his campaigns and also donated vast amounts of money towards the school and its gardens (NC State University, 2009).



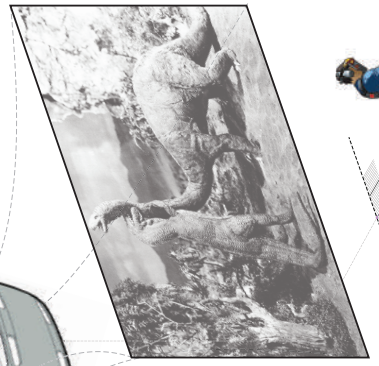
2.1 1750 Map of Cape Town showing the extent of the Company Gardens (SAHO, 2011).

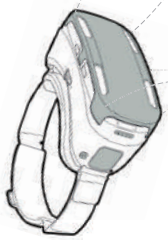
In 600 CE, during Emperor Charlemagne's reign, he constructed many monasteries which housed herbal gardens. The monastery of St Gall in France, which housed one of the largest Hortus and Herbularis in Europe. These gardens were known as physic gardens and were maintained by the monks living in the monastery. The physic gardens primarily grew medicinal plants for study and produced drugs and ointments (Hill, 1915). The ideas and knowledge gained from these monasteries later gave rise to universities. Physic gardens rose in popularity due to the need for medicinal herbs. It is speculated that superstitions such as the werewolves or vampires we know today were spread by herbalist and drug sellers to scare people away from collecting their own herbs in the wild, further driving the need for physic gardens. The Padua garden in Italy, dedicated to study of plants, was the first university to house a botanical garden for the study of botany specifically for medical applications (Hill, 1915).

Grand botanical gardens existed for centuries in South America. Moctezuma II, the emperor of the Aztec empire created the vast garden complex of Tenochtitlan as a paradise far more advanced than

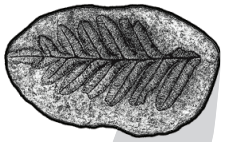

St Galls cathedral
First monastic gardens appear to study medicine
700
600
500
400
300
200
100
0 B.C.E.
100 B.C.
200 B.C.
300 B.C.
500 B.C.
1000 B.C.
1500 B.C.
2000 B.C.
Wu Ti
Father of botany
Aristotle establishes gardens for study and philosophy in Athens
Shennong
Devine farmer first record of herbal gardens

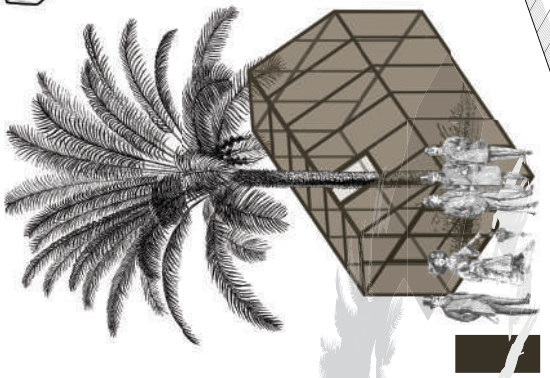
Virtual reality





First fossilised garden in Poland consisting entirley of fossilised plants



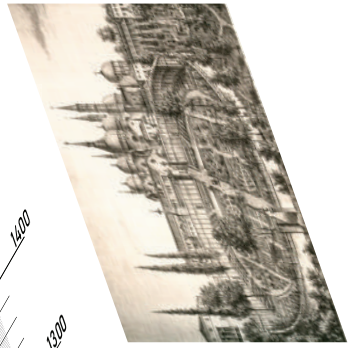


Superstitions grow among herbal merchants to protect their trade

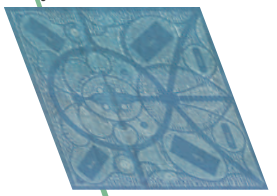
SOUTH AFRICA

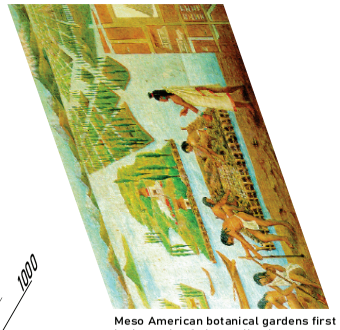
Heritage gardens

Padua Gardens in italy becomes the standard of ewducational gardens in europe



Burgers park
sharing and collection of seeds



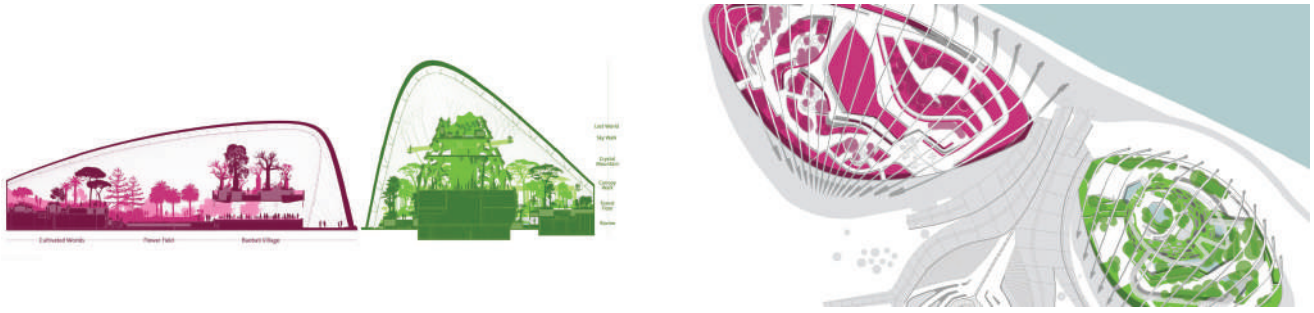


Meso American botanical gardens first in the scale of plant collections

1840
Botanical Gardens for collecting species

2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800

2.2 Time-line of the development of botanical gardens (Author, 2019).



2.3 Gardens by the Bay Conservatories diagram showing the representation of Mediterranean and rainforest biomes from across the world (Grant Associates, 2019).

anything in Europe at the time. The Aztecs studied medical botany and the qualities of their plants. Other gardens of Iztapalan and Chalco were said to have been arranged scientifically (Hill, 1915).

With the age of discovery, universities collected vast quantities of species from across the world. This created a friendly rivalry between universities as to who had the largest and most beautiful collections. It is at this point in history where botanical gardens, as we know them today, are defined. Living collections of plants from various parts of the world were collected and housed for the purpose of study and admiration, for similar reasons as zoological gardens housing animals (Hill, 1915).

The first garden in South Africa was the Vereenigde Oostindische Compagnie (VOC) Company Gardens. These gardens were originally planned for growing crops to supply the Cape colony and to resupply merchant ships, , but as the city grew and more farms became established, the Company Gardens started planting more exotic and indigenous ornamental plants (Brand, 2016).

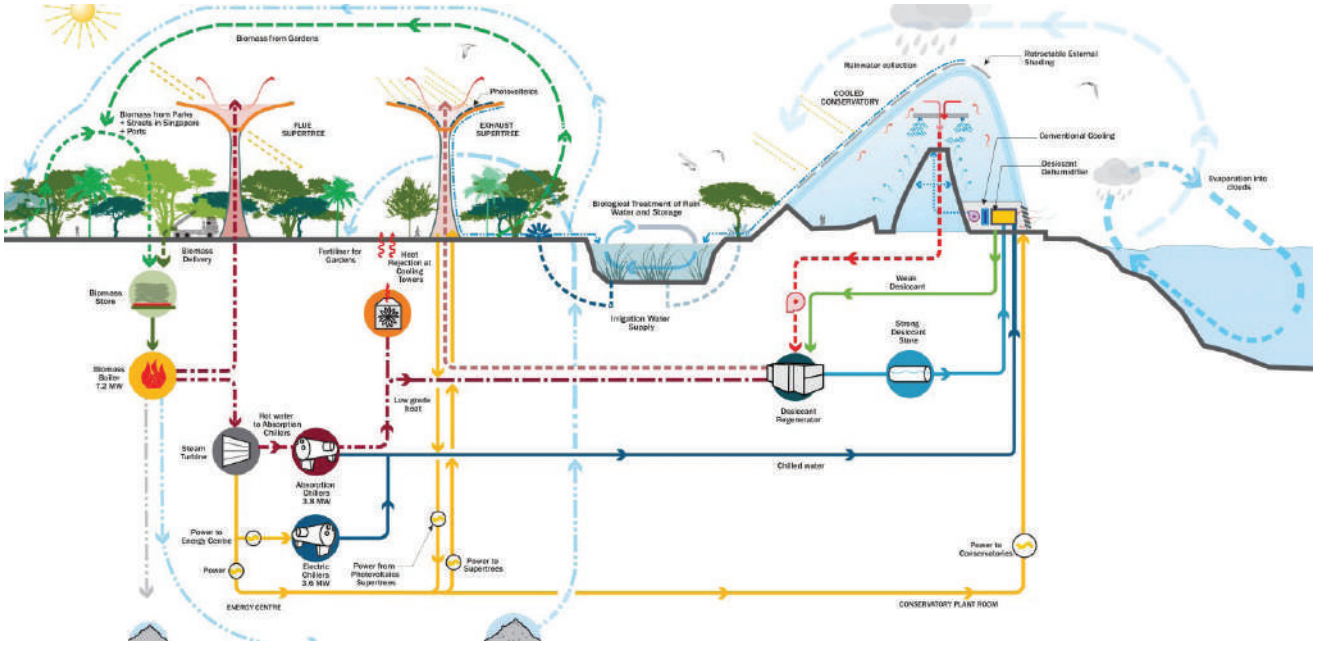
Kirstenbosch was established 1913 by the British botanist, Harold Pearson as a botanical garden to house collections of indigenous plants to ship samples from South Africa to Kew gardens in England. Similar gardens were also established in Port Elizabeth and Durban. During the late nineteenth century, botanical gardens became prestigious symbols for cities and thus most of the large South African towns at the time built their own gardens. These gardens were mostly arboretums and not true botanical gardens and functioned more like beautiful public parks (SANBI, 2016).

2.2 The Role of Contemporary Botanical Gardens

Today, the value of botanical gardens in society has been lessened as most botanical gardens have shifted their prerogative to conservation of plant species and ecosystems. A similar trend can be seen in South African botanical gardens, whereby the focus has shifted away from exotic collections towards collections of plants that are more endemic to the region of which the garden is situated (Maunder, 1994).

Botanic gardens are currently described as being outdoor collections of labelled living plants ordered in an aesthetically pleasing design. Avery and George argue that contemporary botanical gardens should be formulating their programmes toward more socially-slanted botany, for the enjoyment and education of society, increasing the responsibilities for botanists to live up to in their societies and communities (Avery & George, 1957). The role of botanical gardens in expanding their social roles in society is an emerging idea and not fully explored. There is an increase in awareness and concern on the impact humans have on the environment, which links to issues of social and environmental justice. More and more people are disconnected from nature, an area where botanical gardens can play a major role by connecting visitors to nature through programmes such as education, research and display (Krishnan & Novy, 2016). Botanic Gardens Conservation International (BGCI), the world's largest plant conservation network, defines Botanic gardens as institutions holding documented collections of living plants for the purpose of scientific research, conservation, display and education. The institution provides the following criteria for defining a botanic garden (Botanic Gardens Conservation International, 2019):

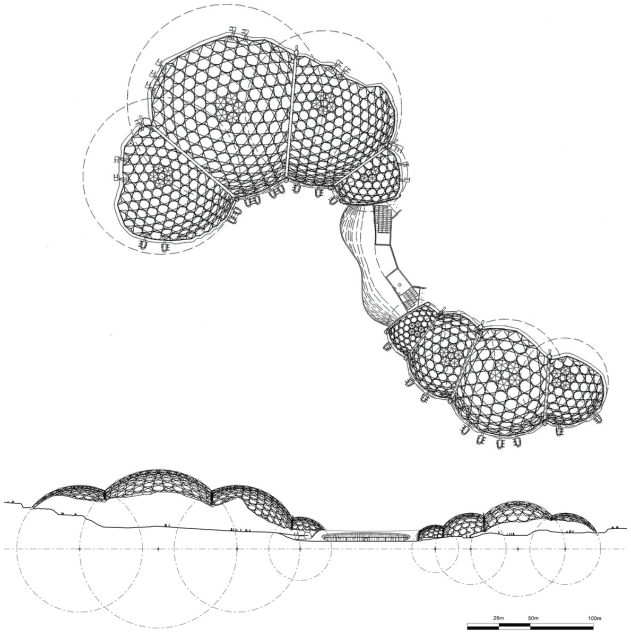
- A reasonable degree of permanence
- An underlying scientific basis for the collections
- Proper documentation of the collections, including wild origin
- Monitoring and long-term maintenance of plants in the collections
- Adequate labelling of plants
- Open to the public
- Communication of information to other gardens, institutions and the public



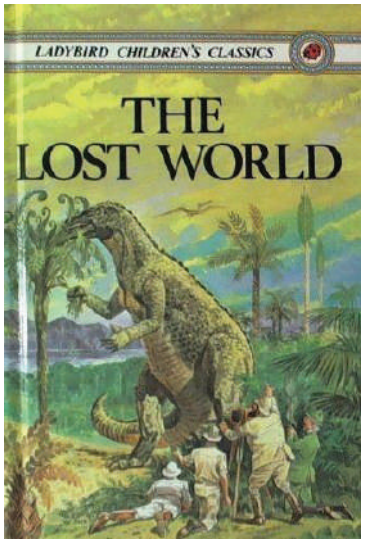
2.4 Schematic of the process, showing how the super tree structures are incorporated to vent hot air from the two conservatories (Grant Associates, 2019).

- Promoting conservation through extension and environmental education activities
- Exchange of seed or other materials with other botanic gardens, arboreta or research institutions
- Undertaking of scientific or technical research on plants in the collections including taxonomy, molecular biology, biochemistry, ecology, biodiversity conservation and other disciplines
- Conserving rare and threatened plants in ex situ collections (e.g. in the garden, seed banks etc.) and, wherever possible, in their natural habitats
- Compliance with international and national regulatory frameworks (e.g. the Convention on biological Diversity [CBD], the Convention on International Trade in Endangered Species of Wild Fauna and Flora [CITES], plant health, invasive species etc.)
- Adoption and promotion of sustainable practices such as renewable energy, water conservation and waste recycling

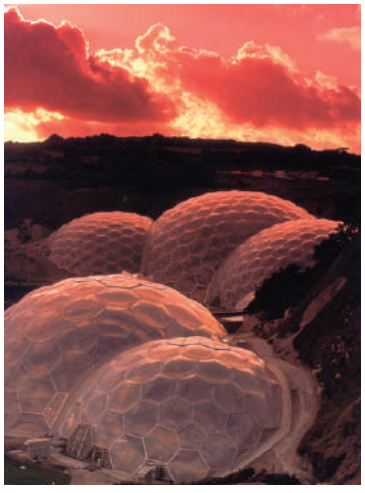
2.5 The Cloud Forest which displays mountain plant-life of the region (Grant Associates, 2019).



2.6 The Eden Project early conceptual designs (Grimshaw, 2001).



2.7 "The Lost World" by Sir Arthur Conan Doyle (Doyle, 1981).



2.8 The Domes are constructed with transparent 'windows' in each hexagon and pentagon are made of ethylene tetra-fluoroethylene copolymer plastic lining which is inflated (Grimshaw, 2001).

2.9 Master plan of the quarry in which Eden Project is situated (Grimshaw, 2001).

- Adoption and promotion of ethical standards related to knowledge, data sharing, procurement, commercialisation and employment.

2.3 Case Studies of Botanical Gardens

2.3.1 Gardens by the Bay | Grant Associates

Gardens by the Bay in Singapore is a 54-hectare garden featuring super tree structures up to 50 meters tall, with treetop walkways. The botanical garden contains two giant conservatories houses plants of the Mediterranean and tropical rainforests regions of the world respectively. The two conservatories offer a spectacular visual and spatial experience for visitors, telling the story of plants in all-weather 'edutainment' spaces.

The garden has heritage gardens linking plants to the people's cultural significance and spectacular night light shows and event spaces, and is also at the forefront of technology, with regards to the management of systems in the park, controlling it through intelligent environmental infrastructure. The vision for the garden was to combine nature, technology, environmental management and imagination to create a 21st century botanical garden with a focus on tropical plant life and habitats as well as being a spectacular destination to visit and experience (Grant Associates, 2019).

2.3.2 Eden Project | Grimshaw Architects

The Eden Project was an impressive feat of human ingenuity, with the botanical park built within a clay quarry consisting of a series of giant geodesic domes inspired by the American architect, Buckminster Fuller. The domes are linked together and comprise an interior rainforest biome of 16 000m² with a height of 50 meters and a Mediterranean biome covering 6540m² with a height of 30 meters. The park is Britain's second most visited tourist location, besides London. The inspiration for the park was the novel, "The Lost World" by Sir Arthur Conan Doyle (Grimshaw, 2001). In the novel, an island is discovered to contain all the unspoilt bounty of the earth. In a similar way, the Eden Project was a repository for plants of the world protecting species for future generation to enjoy.

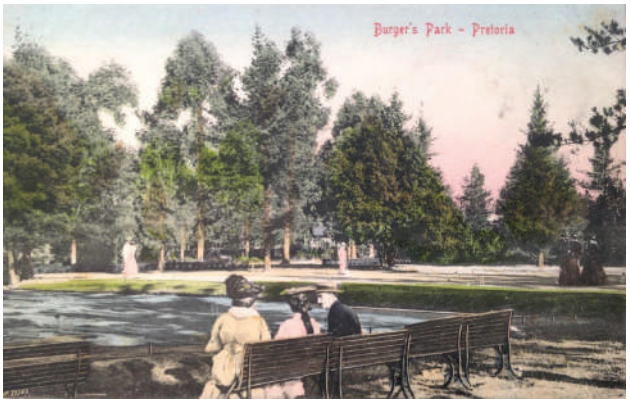
The programme of the park is an outdoor classroom, working closely together with teachers and the curriculum, to create a fun physical environment for learning (Eden Project, 2010).

2.4 Pretoria's Botanical Gardens

Pretoria has an interesting history of botanical gardens, with Burgers Park originally being the national botanical garden of the Zuid-Afrikaansche Republiek. After British occupation in 1877, the garden was moved as the current site was deemed unsuitable for a botanical garden due to poor soil. The garden was relocated to the area where Weskoppies Psychiatric Hospital is located today. Due to a lack of funds, however, the garden was never properly established, and it fell into disrepair. In 1946, the national botanical garden was established East of Pretoria (Hardijzer, 2018).

The Pretoria National Botanical Gardens were initially developed on the experimental farm of the University of Pretoria. The Department of Agriculture acquired the land from the University including some private properties along the northern part of the ridge. The botanical garden was constructed for the purposes of research under the Botanical Research Institute. The garden was officially opened on 23 October 1958. However, the botanical garden was closed to the public and could only be accessed by special arrangement. Only in 1984, was the garden was opened to the public. The Botanical Research Institute amalgamated with the National Botanical Gardens of South Africa to form the National Botanical Institute in 1989, which in turn became the South African National Biodiversity Institute (SANBI) in 2004.

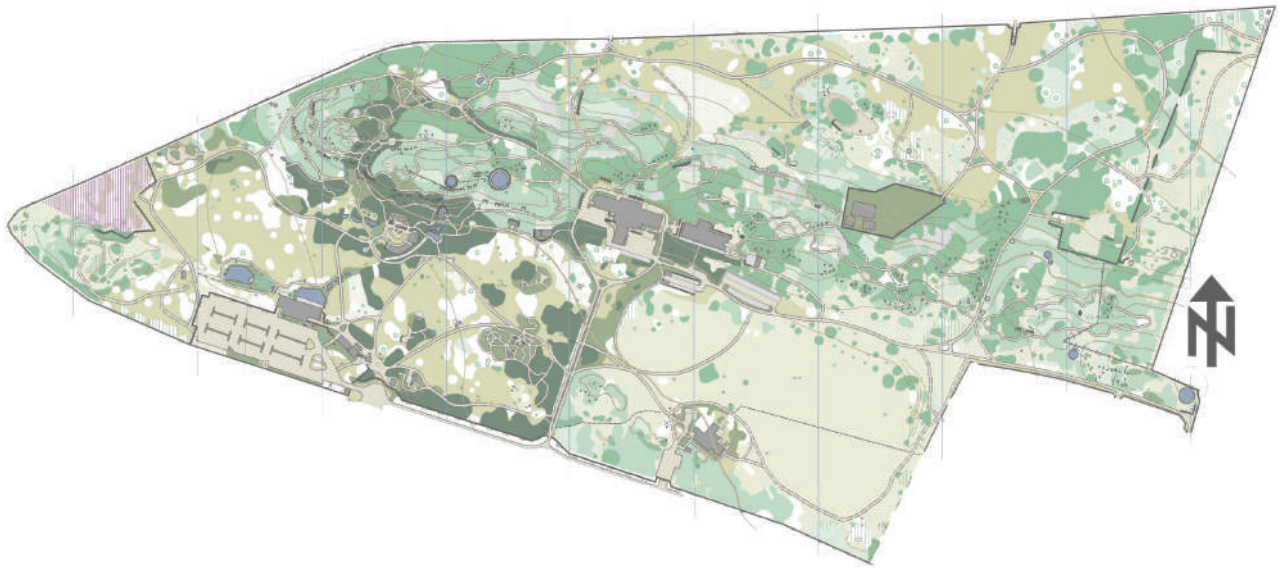
The Pretoria Botanical Gardens is well used today, with many events taking place such as festivals and markets on the weekends. However, its location requires the use of a vehicle to visit, this excludes



2.10 Coloured postcard dated 1908 showing two croquet fields in Burgers Park (Hardijzer, 2018).

2.11 Postcard of Burgers Park Pretoria 1907 (Hardijzer, 2018).

2.12 Coloured postcard dated 1907 Tennis Court in Burgers Park (Hardijzer, 2018).



2.13 Map of Pretoria Botanical Gardens (SANBI, 2016).

a large part of the city's population from visiting the garden often. With most activities happening over weekends the gardens are not adequately utilised on weekdays. (SANBI, 2016).

2.5 Relevance to this study

For this dissertation, a botanical garden is proposed in the Berea Park area, as the site is uniquely suited in conservation of the regional river ecosystems of the region through research and education, and will therefore provide opportunities for residents of the area to engage with plants and local habitats. The inherent value a botanical garden provides makes it suitable for river habitats of the region to be conserved through research and education. This botanical garden will house living collections that display regional river ecosystems and reintegrate natural systems into the river, regenerating the health of the river. The proposed botanical garden will house living collections that display regional river ecosystems and reintegrate natural systems into the river regenerating the health of the river. This garden will be utilised for research into the conservation of the local rivers. Moreover, the garden will educate the public on local riverine ecologies and their functioning, emphasising the importance of rivers.

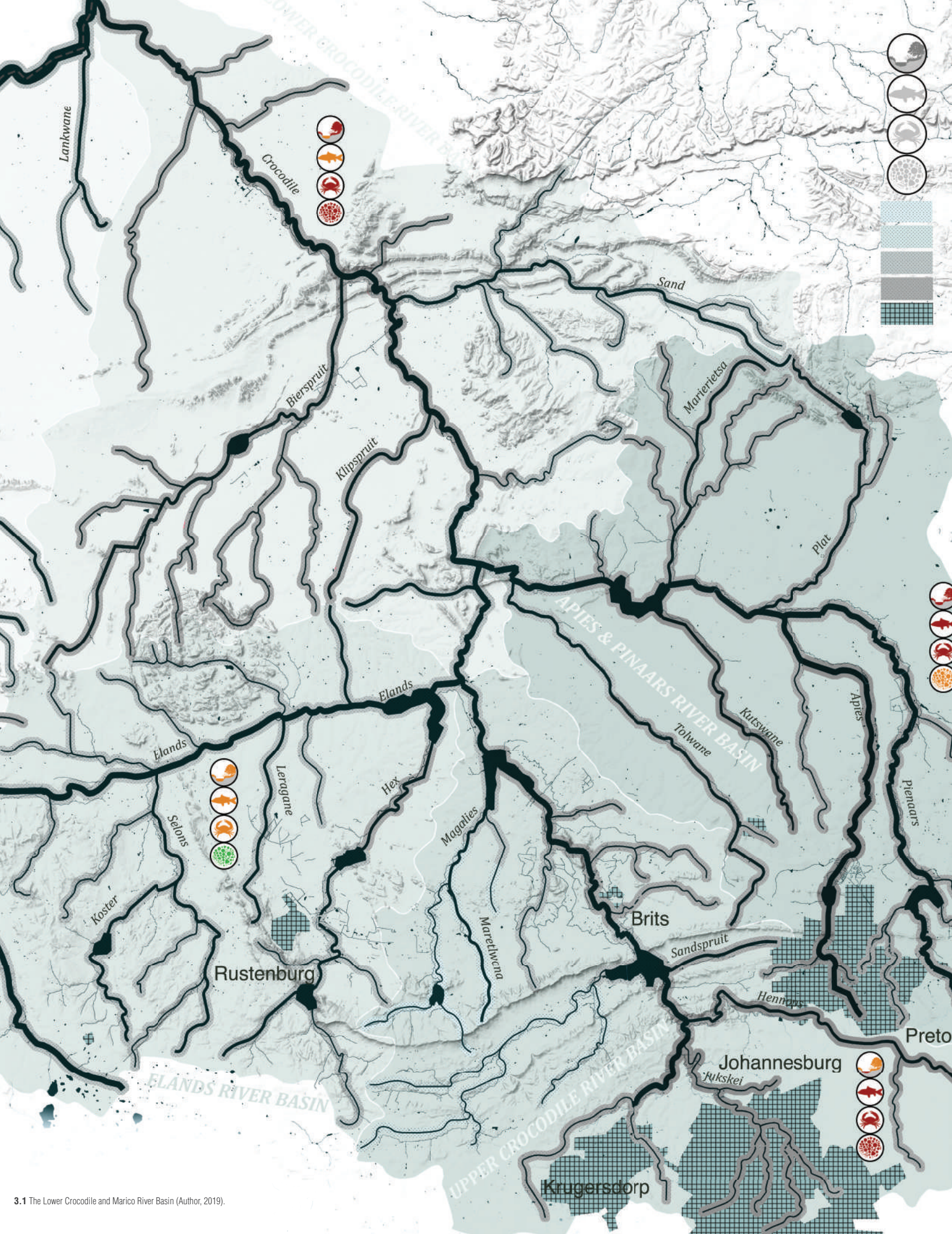
The Berea Park area can only partially address the problems of regional rivers. Conservation of regional river systems is necessary to preserve the ecological integrity of these rivers. The ecological state of regional river systems in Pretoria is highly degraded to non-existent, with exotic species prominent and local fauna populations depleted. Pollution in the rivers is present in the form of sewage and agricultural runoff.

The natural state of the Apies River has been severely compromised, through channelisation and development turning its back on the river.

2.14 The Capital Craft Beer Fest has become a popular annual festival held at the Pretoria Botanical Gardens.

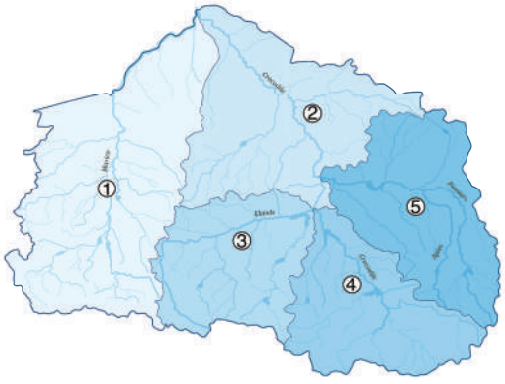
This contrasts with the establishment of the Pretoria where the river was a strategic resource for the people. The Apies River was the main reason for the founding of Pretoria.

However, the river is still useful to the city. Berea Park is isolated by roadways that enter the city. Landscape urbanism theories can be employed in transforming the isolated pockets of land and turning the area into a catalyst for development. Thus, it is argued that a botanical garden showcasing local river ecologies will create awareness of the conservation of these river systems, and together with research on these systems, drive the catalyst for conservation of rivers in danger of ecological collapse.

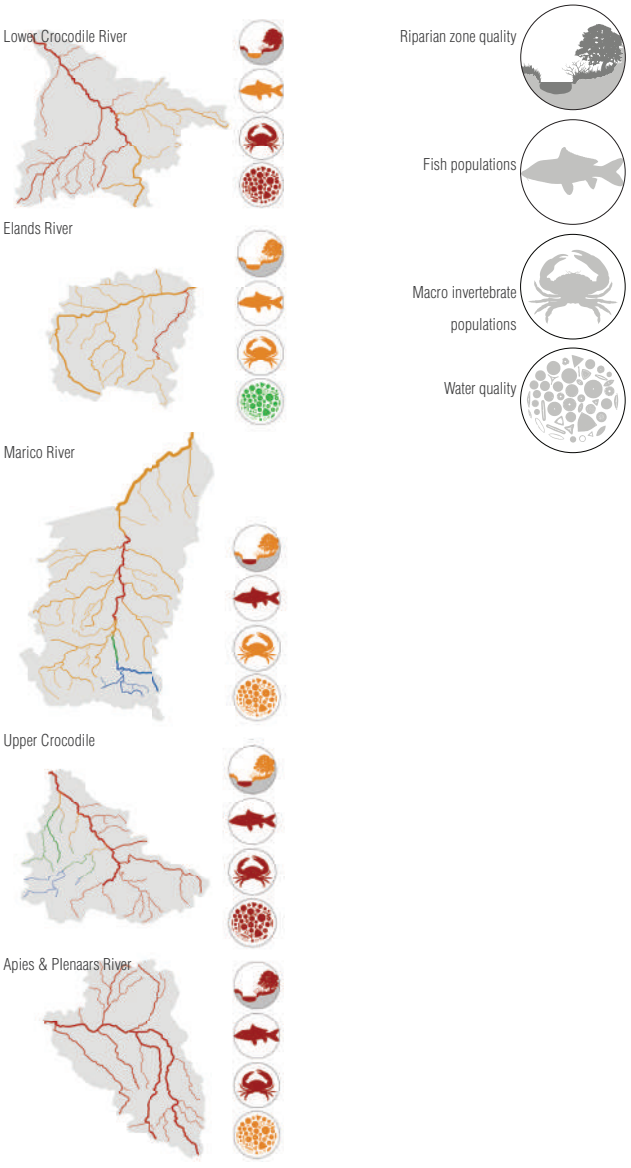


3.1 The Lower Crocodile and Marico River Basin (Author, 2019).

3 CONTEXT



3.2 The main tributaries of the Lower Crocodile and Marico River Basin (Author, 2019).

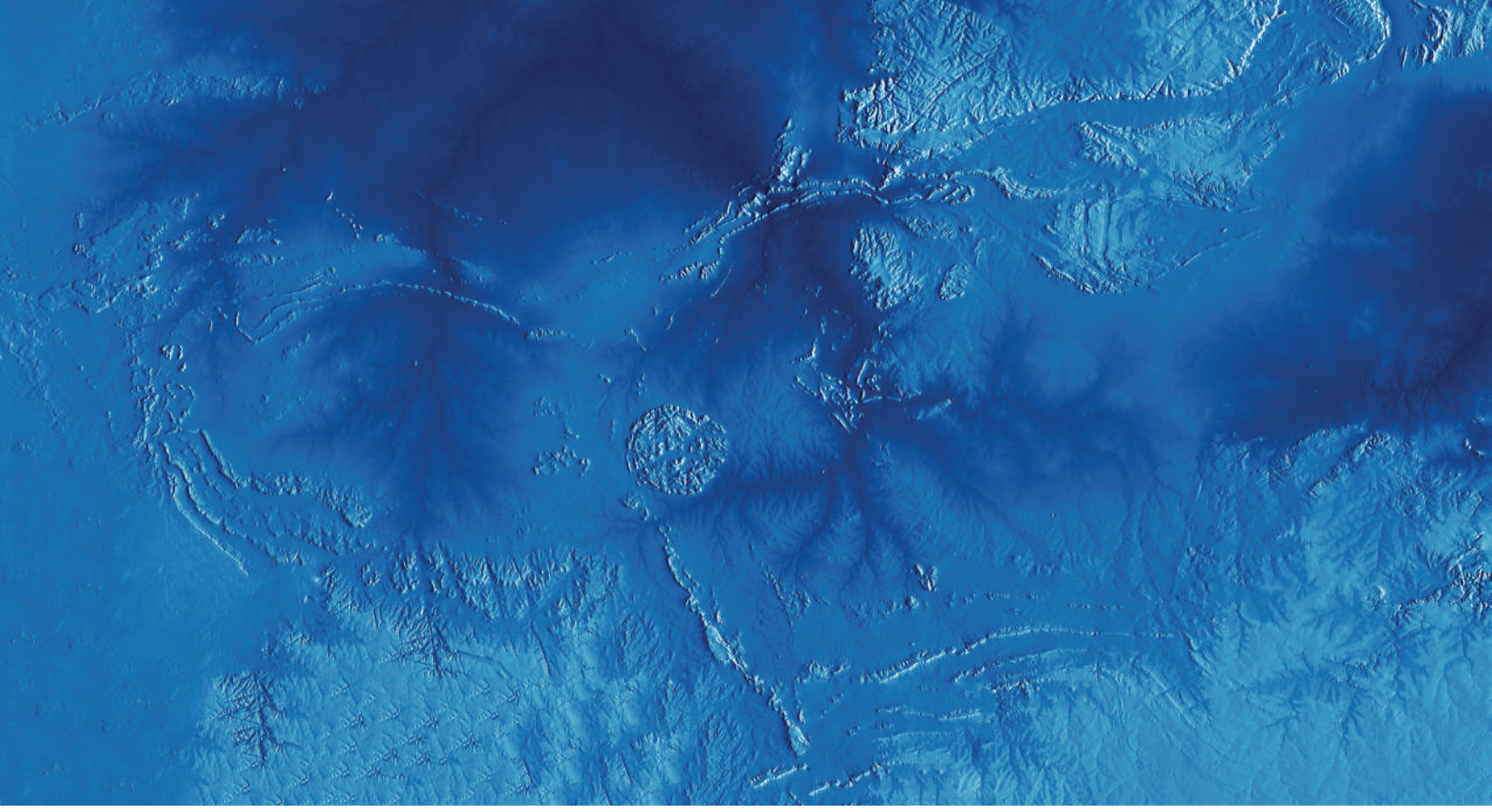


3.1 Introduction

The health of rivers in South Africa are at risk, mainly due to pollution through mining effluent, disposed waste, sewage and chemical fertilizers. The health of a river system refers to the amount of pollution and biodiversity present and can be described in a similar way one describes the health of a person or the health of the economy (Department of Water Affairs and Forestry, 2003). Extraction of water from rivers is also a growing problem, especially in areas prone to drought such as the Western Cape (Water Online, 2017).

Rivers provide the most basic needs to humans, namely drinking water. People also need rivers for physical and economic health. Rivers provide goods and services directly or indirectly such as fishing and the harvest of plants such as reeds, acts as resource for irrigation of farmlands and social uses such as baptisms and leisure activities.

The central principle behind conserving river systems is to set aside a certain area of land to create representations of ecosystems that occur in the region to act as ecological or biodiverse depository. This is done to buffer against future modifications of the river systems in an effort to preserve the original biodiversity presence (Roux & Nel, 2013). With the degradation of South African river systems currently happening, conservation of river systems has become an increasingly



3.3 Height Map of the Lower Crocodile and Marico River Basin (Author, 2019).

important topic. Furthermore, public awareness on the loss of biodiversity has also slowly become a more vocalised issue (Secretariat of the Convention on Biological Diversity, 2015). For people to engage in the issues of biodiversity loss in South Africa's river systems is really an issue of understanding the problems and effects of the loss of these river systems. Despite growing awareness and concern on the issue, environmental issues are regarded as a lower priority compared to problems prevalent in South Africa such as service delivery, housing and jobs. Furthermore, river system conservation and similar environmental issues are overshadowed by the issue of global warming. This is due to media and other sources discouraging the public from engaging with these seemingly smaller issues because of controversy, governments' lack of focus, and seemingly lack of benefit to the people (Novacek, 2008).

3.2 The Lower Crocodile and Marico River Basin

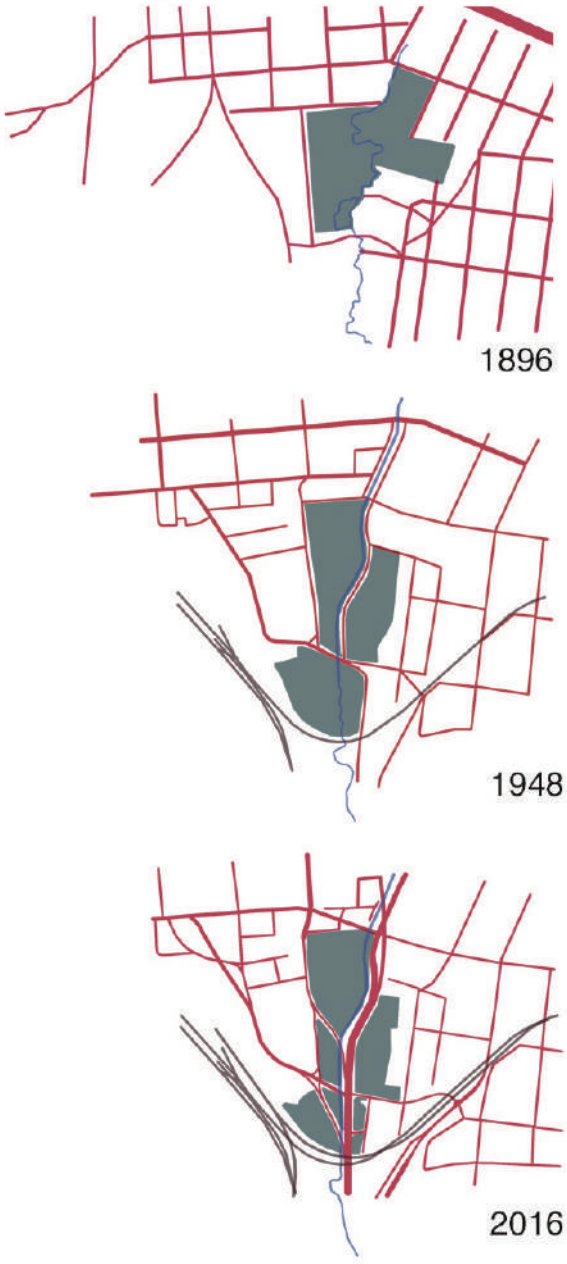
The Crocodile (West) and Marico water management area is situated mainly within the North West Province with some rivers in parts of Gauteng and Limpopo Province. The Crocodile and Marico rivers are the main rivers of the basin with their convergence forming the Limpopo river, which flows east into the Indian Ocean.

The region houses many important features including the Bafokeng tribal area, Pilanesberg Nature Reserve, the Cradle of Humankind Heritage sites, the dolomitic wetlands system at the source of Marico and Molopo rivers. There are also several large dams including Harbeespoort, Vaalkop, Roodeplaat, Rooikopjes, Klipvoor and Molatedi.

The annual runoff is 855 million cubic metres, with 75% of the total surface. Runoff flows down the Crocodile river. The Marico catchment contributes 20% and the upper Molopo catchment is 5% (Department of Water Affairs and Forestry, 2003).

Urban, industrial and mining water requirements contribute to more than half of the water use, a third is used for agricultural irrigation and the rest is used for rural supply and power generation. The water used in this water management area is far more than the area can provide. Consequently much of the water is imported mainly from the Vaal system (River Health Programme, 2005).

3.4 The Apies & Pienaars River basin regional analysis (Author, 2019)



3.5 Berea Park over time (Author, 2019)

3.6 One of the oldest relics of Pretoria's pioneering years. From 1860 to 1910, water from the fountains were supplied to the central part of Pretoria by means of a network of furrows. The furrows were covered with soil by approximately 1885 (Author, 2019).

3.7 Remaining segment of the original furrows which brought water into the city (Author, 2019)

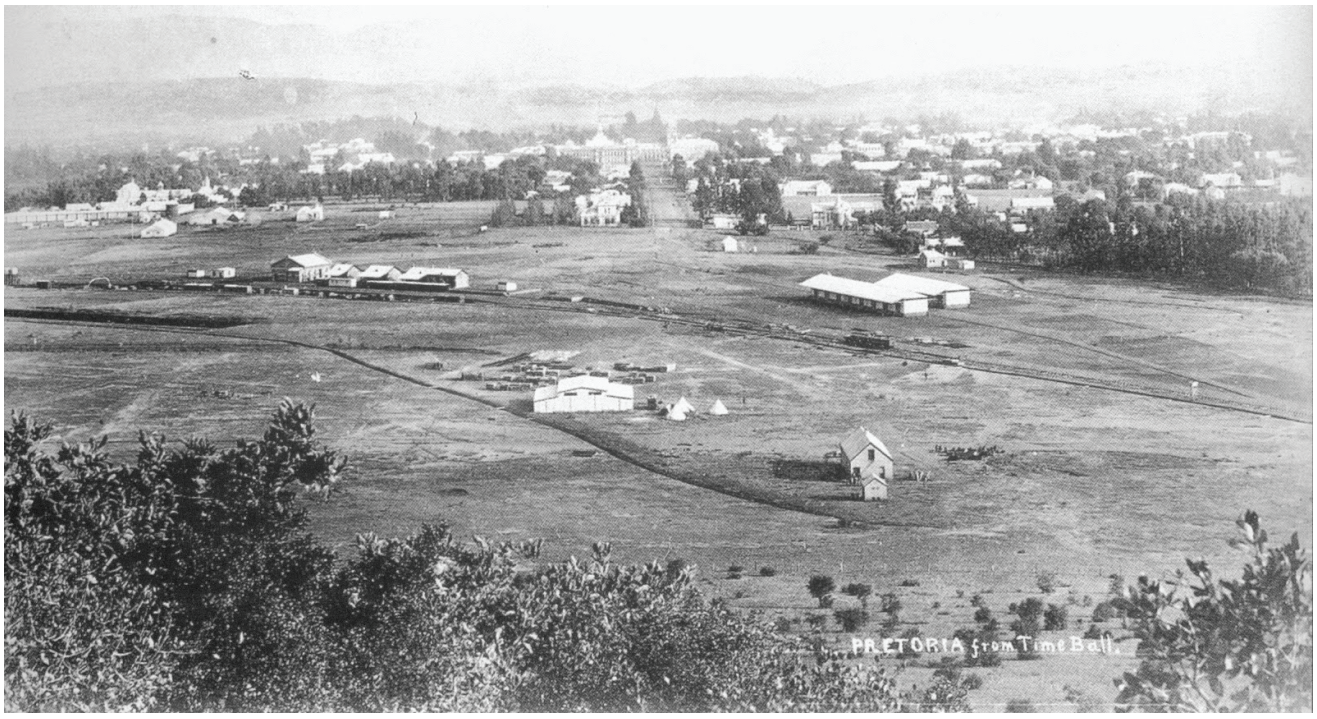
3.3 Development of Pretoria

In 1855, the first water furrows were constructed to provide water for household use and animals. However, as the city's population grew, sanitation worsened and waterborne diseases such as typhoid and cholera began spreading. After this, the furrows were abandoned and pipes were laid (Dipenaar, 2013).

As Pretoria grew, a higher demand for water developed and other methods had to be devised to attain sufficient water for the city. The British army built a concrete aqueduct from the river source to alleviate the need for water. This intercepted water from the river and decreased its base flow. This, together with the channelisation the river rendered the river redundant.

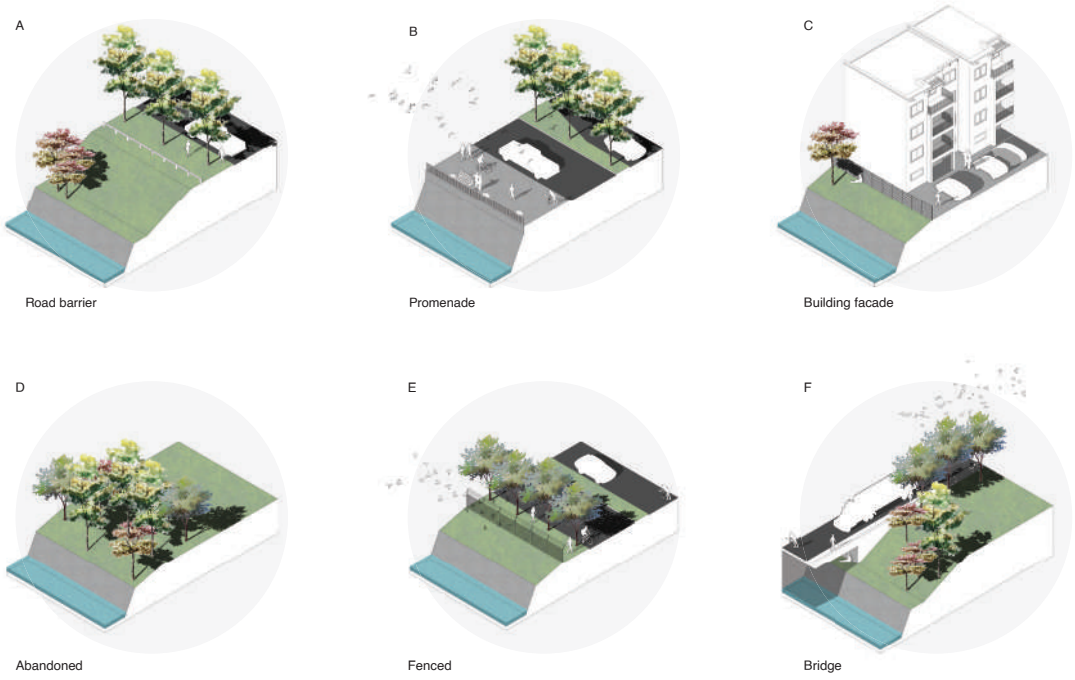
In 1923, a coal powered pump station was erected to provide the city with 21 million litres of water a day. The capacity of the fountain springs was 23 million litres a day. Demand surpassed the fountain spring's capacity and in 1927 other sources of water had to be sourced (Dipenaar, 2013).

The Apies River ultimately lost its significance as a natural river due to manmade modifications. The river ended up being reduced to a storm water channel, no longer providing cultural social or ecological benefits to the city.



3.8 Pretoria station with Berea Park visible to the right (Dipenaar, 2013).

3.10 The Apies river within Pretoria's Urban context (Author,2019)



3.11 The existing urban interface with the Apies River (Author, 2019)

3.4 The Current Urban Condition of Pretoria

3.5 Apies River

The Apies River, which runs through this city, is generally in a poor state. The in-stream habitats have been degraded almost to being extinct due to the channelisation. This results in higher flow velocity which alters the shape of the river bed. Urban runoff, sewage and litter from the city impact the water quality and integrity of the river drastically.

The riparian zone of the river has been altered by the modification of the river channel, compromising the habitat's integrity. Invasive species, such as Spanish reed (Arundo donax), dominate the river edge in some areas constituting up to 95% of the riparian foliage. According to the river health programme, published by the Department of Water Affairs, there is no sign of sensitive species of fish left in the river such as Chiloglanis sp. (rock catlet or suckermouth), Amphilius sp. (stargazer mountain catfish) and Aplocheilichthys sp. (topminnow) and even the hardier species occur less frequently than expected. Invertebrate diversity and abundance have been heavily impacted due to increased volumes and reduced lag times, as well as reduced water quality.

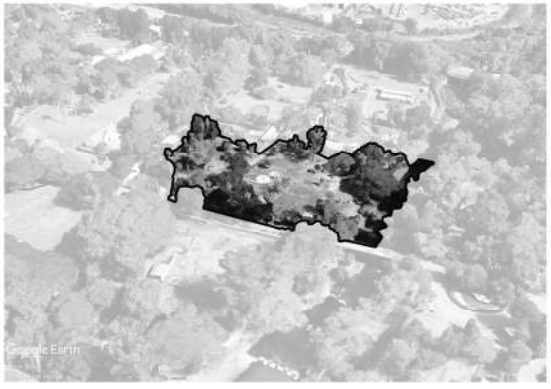
Some riffle and wetland habitats still existing along the river and sections close to the Bon Accord Dam have been under development to rehabilitate the river. The Wonderboom Nature Reserve also conserves some natural areas. The main drivers for the poor condition of the river are the high level of urbanisation and development and the channelisation and alterations of flow patterns (River Health Programme, 2005).

3.6 The Walking City

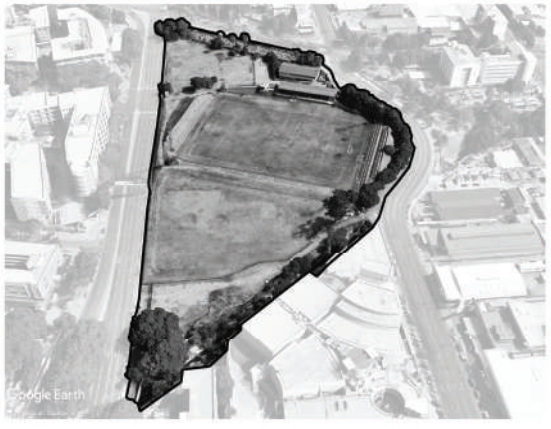
An urban analysis was done within the CBD group in early in 2019. The three areas we investigated were Mamelodi the CBD and the Berea residential blocks. The phenomena of cities within cities was investigated. The pheonomena of pockets of communities forming within the city and giving each part of the city a distinct feeling and character.

We analysed ecology, pedestrian movement, vehicle movement and public transport, as well as building edges and commercial activity. Through this analysis, we proposed a future urban vision of the city, developing the identified characteristic areas and enhancing the walk ability of the city by devising a scheme for a massive green belt looping around the city which will act as a pedestrian and cyclist highway.

3.12 Daspoort Wastewater Treatment Plant (Author, 2019)



3.13 The National Zoological Gardens (Author, 2019)



3.14 Caledonia Stadium (Author, 2019)

3.7 Selecting a site

While looking for a suitable location for a botanical garden that focuses on riverine ecologies, a set of parameters were set to which the site needs to adhere. Firstly, the site needs to be a large enough open piece of land. Secondly, the garden will need to be adjacent or have access to a river and thirdly, be accessible to pedestrians in the city.

Following these criteria, a few potential sites were identified.

Daspoort Wastewater Treatment Plant was identified for its large available area and interaction with the river, , but was deemed unsuitable for two reasons. One, its far location from the city core and two, its unsuitability for people due to the proximity of the sewage plant.

The Pretoria National Zoological Gardens has a river interface, but lacks space. The zoo itself would detract from the importance of the botanical garden.

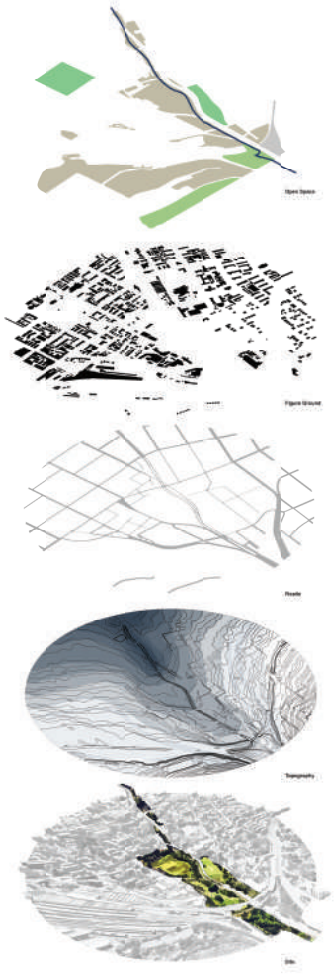
The Caledonia Sports Field is ideally located, but would be a difficult site because of the current programmes and because the two river edges are very close to a busy road. The site is surrounded by three busy roads and is thus unsuitable because of the noise and potential pollution.

Berea Park was selected for its large usable area, adjacency to UNISA and the presence of a dense residential population to the North of the site. The site is also the southern entrance to the city and a striking landscape implemented here can serve as the gateway into Pretoria.

The Apies River bordering the site has the potential of being utilised in creating a botanical riverine.

The site has rich heritage in its former sport grounds and has a few ruins and protected structures. Lastly, the site is close to the Groenkloof Nature Reserve and Fountain's Valley, which can benefit from a pedestrian linkage to explore the splendour of nature further.

3.15 Berea Park analysis (Author, 2019)



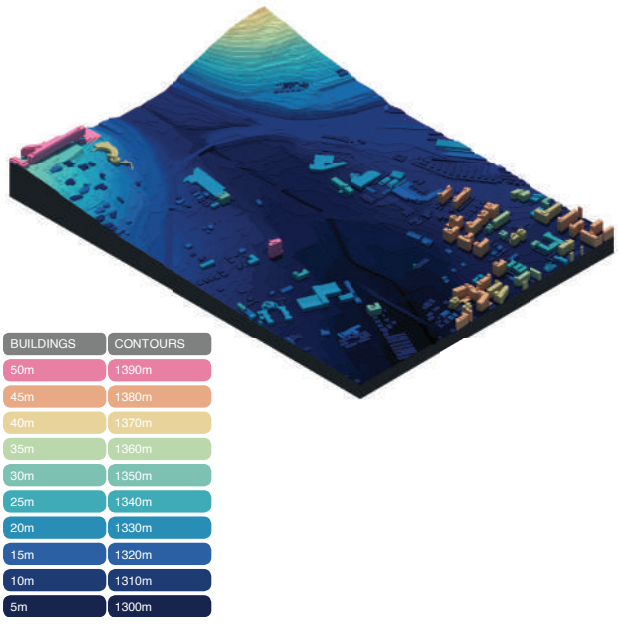
3.16 Isometric analysis layers of Berea Park (Author, 2019)

3.8 Site Analysis

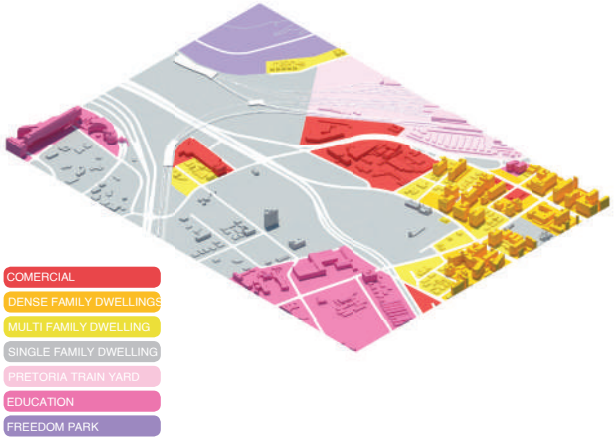
Berea Park lies at the southern entrance of the Pretoria from the neck between Freedom Park and UNISA. Due to the development and earthworks on the site over the years an anthropogenic layer of soil has been formed on top of the site. There is very little resemblance of soil profile one would expect in a floodplain in a riverine area, with little resemblance of riverine ecosystems.

No river plants grows in the concrete channel and no macro fauna can live in the fast flowing water of the river channel (River Health Programme, 2005). The vegetation on site consist of kikuyu grasses (Pennisetum clandestinum) and a patchwork of pioneer grasses; the trees are mostly clustered around the river and are dominated by White stinkwoods (Celtis africana) with some Karee trees (Searsias lancea) present and the iconic street trees Jacarandas (Jacaranda mimosifolia) are present on the northern parts of the site. Some invasive tree species are present, such as the Seringa tree (Melia azedarach).

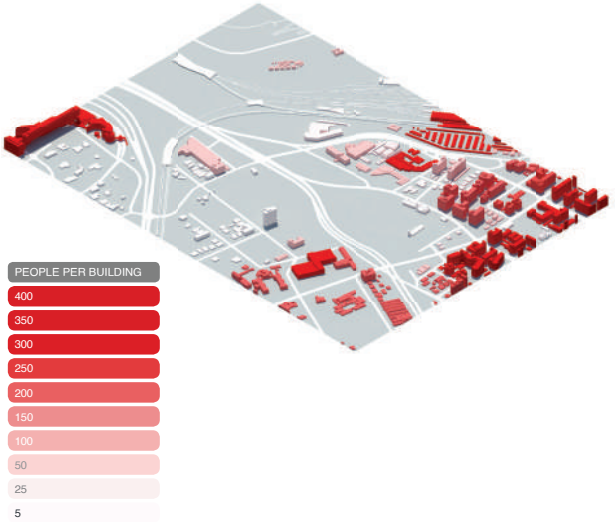
The topography of the area has been altered and the site is flattened due to the construction of the sports fields. However, the site naturally sloped downwards to the north with the flow of the river. This causes the north eastern edge of the site bordering the river channel to be approximately four metres higher than the top of the channel in a very steep gradient with the soil being held in place by Ficus trees.



3.17 Topography and building heights analysis (Author, 2019).



3.18 Land use analysis (Author, 2019).



3.19 Density analysis (Author, 2019).

3.20 The Berea Park Clubhouses (Author, 2019).

3.21 Willow Road Bridge (Author, 2019).

3.9 Historical Context of Berea Park

The site used to be a cattle ranch before it was bought by the city to be made into a cricket club. Since then, the club has hosted several sports including rugby, soccer, and bowling.

The club was the home of the northern Transvaal cricket club now known as the Titans and has since moved to Super Sport Park in Centurion (ESPN Sports Media Ltd., 2013).

The southern part of the site used to be a family cemetery, but the remains has been moved since. Willow Road Bridge and the clubhouse are declared heritage sites and are thus protected.

The main historic assets present on site are the two clubhouses. The southern clubhouse built in 1907 and the northern one added in 1926. These clubhouses have not been used since a fire destroyed the southern clubhouse in 2010.

There are several ruins scattered across the site of old stone grand stands and store rooms as well as the foundation of a small tennis clubhouse. Faint outlines of the sport fields are still visible, especially the rolling greens and tennis courts, because the site was flattened to accommodate the sports fields and old stone retaining walls were built across the site. The Willow Road Bridge is of historical value and may not be altered in any way.

The National Heritage Resources Act [No. 25 of 1999] states that: "(18) No person may destroy, damage, deface, excavate, alter, remove from its original position, subdivide or change the planning status of any heritage site without a permit issued by the authority of heritage resources who are responsible for the protection of such site."

Therefore, the approach to heritage assets on site would

3.22 The NZASM bridge ruin (Author, 2019).

3.23 The channelised Apies River today showing peak summer base flow (Author, 2019)

3.24 Hand coloured picture postcard dated 1908 showing a horse tramcar crossing the Tram bridge over the Apies River en route to Sunnyside (Hardijzer, 2018).

fundamentally be to retain as many elements as possible and incorporate these assets into the design. The burned down clubhouse will be retained as a ruin and fitted with a glass roof to function as a botanical hot house, subject to the necessary approvals in terms of the relevant legislation. The northern club house will be restored and used as a gallery and museum space including an Herbarium. The structure of the ruins across the site will be retained as far as possible and incorporated into the design of the garden. The stone retaining walls are of design value and the materiality of these walls will be drawn onto the design. The sports fields have been changed many times through the years from cricket to rugby, hockey and soccer and will not be retained. The rolling greens though, which have existed for many years and are defined by the stone retaining walls terracing the three greens, will be retained and incorporated in the design.

The building used to be occupied by vagrants as a base to operate from and crime in the area increased with drug dealing, hijackings, theft and rape. In 2010, the local residents protested against the increase in crime and out of frustration of no progress being made to stop this problem, they set the clubhouses alight to get rid of the criminals hiding there (Ngobeni, 2016). The Department of Public Works announced that the building will be restored and the area developed. At the beginning of 2019, the area was fenced and a barrier erected around the clubhouses with steel braces welded around the remaining central gables to protect them from further harm during the restoration. The current development is for the new head offices of the Department of Rural Development and Land Reform (Jansen van Vuuren, 2019). According to the plans, Berea Park will become a complex of office buildings with basement parking and will be fenced off to the public. There is also a berm that will be constructed to protect the site from a 1:100 year flood.

Currently the dilapidated Berea Park is used by vagrants and homeless as well as a few children who play on the remaining patches of sports fields. To the north of the site, there is an informal taxi layover where the drivers wait, during which they wash their vehicles and socialise at the local bar. In the southern area next to the Gautrain rail, an African Christian religious sect meets on Sundays to worship. At night, there are several fires burning across the site from homeless people trying to keep warm and settling in for the evening. As there are many tents and shacks set up next to the river channel amongst dense trees and shrubbery, the river is used for washing and drinking by the people living there.

3.10 Technical Considerations

The site sits within the 1:50 year flood line and can get completely flooded during a flood event. The severity of the flooding of the area is due to the flattened sports fields. To naturalise the river and create a shallower profile with vegetation, the river will need to be made 57metres wide as opposed to the current steep embankments which are an average off 13 metres wide. This is impractical for the current site, but not impossible. Other options include creating a naturalised wetland stream next to the river by pumping water out of the river or to create a kind of an artificial oxbow lake. Another major hurdle is the Willow Road Bridge which is a heritage protected structure and thus no alterations can take place near the bridge. The most viable option for a naturalised riverine in Berea would be to create a river that is not wider, but flood waters will then have to be offset through the use of a series of attenuation dams, most likely in the Groenkloof Nature Reserve.

3.25 The changing landscape as one moves towards the river (Author, 2019)

4.1 Early concept visions of Berea Park (Author, 2019)

4 THE CITY WITHIN A GARDEN

4.1 City Within a Garden

What does a botanical garden need to do for a city? Public green spaces are vital for all cities. It allows people a chance to wind down and manages the stresses of modern life. Botanical gardens create a pleasant environment to be in and above that, teaches people who are visiting, the value of natural spaces. A botanical garden does not just do all that, but it also restores the natural habitat of a region and assists in conservation of plant life through study and research. They are also often recreational spaces with events and many other activities taking place (Powledge, 2011).

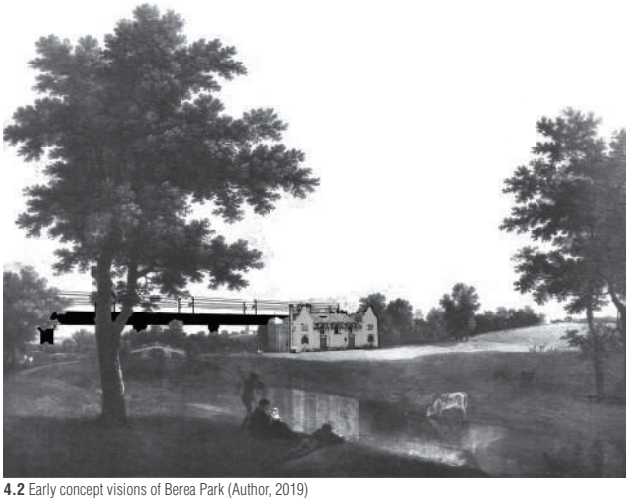
The programme of the site would thus be to create a botanical garden in the inner city focused on the regional river system plant life. This will serve educational purposes to the people of the city, communicating the importance of conserving our riverine plant habitats.

Linking regional aquatic, riparian and wetland conservation with human wellbeing will help conserve local and indigenous knowledge and create a strong localised identity.

The botanical garden will provide in-situ conservation potential, helping to strengthen existing natural river areas by providing plant species and horticultural expertise. As well as ex-situ conservation of plants through living collections that will provide genetic diversity and conservation research opportunities. A herbarium in the garden will function as a seed bank for the regions aquatic, riparian and wetland plant species will serve as a safeguard against species extinction and ensure maximum genetic diversity within species, strengthening resiliency of the plant species (Botanic Gardens Conservation International, 2010).

4.2 Defining a Contemporary Riverine Botanical Garden

Currently, most botanical gardens are expanding their programmes into conservation and plant biodiversity. This serves as a strong genetic repository for the long-term preservation of the species. Education and research into conservation topics have become the central theme around most botanical gardens in the world (Krishnan & Novy, 2016). It has been suggested that in a hundred years, botanical gardens will not be judged by the number of species in their collections , but rather by the number of viable species and ecologies surviving as a direct effort of the botanical garden and their contribution to economic and social development (Maunder, 1994).



4.2 Early concept visions of Berea Park (Author, 2019)

Social relevance is an increasingly important topic with many cultural organisations. Inevitably, a botanical garden needs funding to operate, which has led to many botanical gardens becoming entertainment venues – opening their doors to music concerts, weddings and festivals. The need to attract paying crowds seem to be a universal one among botanical gardens because these gardens are becoming increasingly short on funding as governmental support dwindles (Powledge, 2011).

4.3 Early concept visions of Berea Park (Author, 2019).

4.3 Programming a River

The overall programme of the park would be a botanical garden around the Apies River, displaying river habitats and biodiversity for people to visit, enjoy and from which to learn. The garden will have wandering paths throughout, with a few areas that catch one's eye. The main display garden will be a river landscape cutting through created hills and valleys which create a riverine labyrinth of sorts which people can experience the plant habitat and land forms created by a river. There will be assembly points for large groups. such as school groups, where one has a vantage point over the park which then can be explained by a guide. The groups can then be left to explore on their own.

Specifically, the garden will need to generate awareness in people of the need of South African rivers to be protected and show that natural systems and urban development can grow together and even benefit each other. The garden will also have horticultural research facilities which will help with the in-situ conservation efforts of rivers in the region, as well as, generate an understanding on how to better approach conservation of these habitats. There will be an event space in the garden that can host events of any kind from horticultural societies to music festivals; this will serve as an additional income to the botanical garden.

As homelessness and crime are prevalent in the area, realistically, much of the garden will be fenced and controlled. A small entrance fee will be required to enter the botanical garden for the upkeep of the garden as well as protecting and maintaining control over the area. However, there are large parts of the site which will be developed into public space for local residence and commuters to use.

Students from UNISA and other universities will be involved in the research – from undergraduates doing their practical to master and doctoral students working on their dissertations. The students will have free entry into the garden which also provides a convenient and safe way to travel to their campus when they travel from the city. The facility will cover many fields including horticulture, ecology, nature conservation, biology, botany. Most of the redeveloped river edge will remain public; however, some control will need to be maintained. A possible strategy could be devised to retire parts of the botanical garden in the future to increase the public space over a series of years as the city develops.

The proposed Department of Rural Development and Land Reform head offices will still be accommodated, , but instead of the proposed building layout which takes up much of the site, the buildings will be moved to the north of the site. This area will be designed as a public commercial space on the ground floor with offices occupying three or four storeys above.

The river will be dechannelised and naturalised to the original historic contours of the river where possible, within the extents of the site. It will not be possible to completely naturalise the river because

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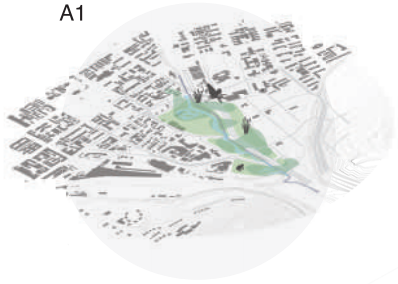
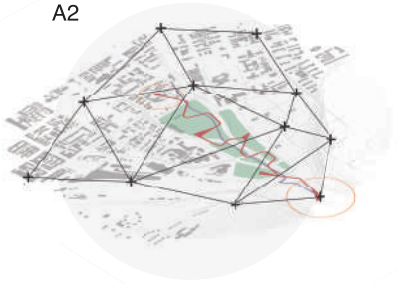


Reintroduce Floodplains

A2



Connect

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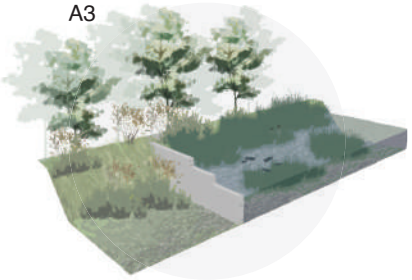
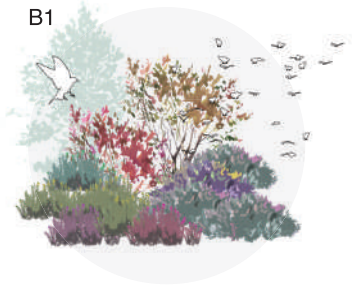


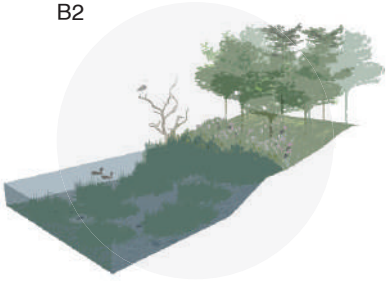
Control

B1



Biodiversity

B2



Water purification

B3

Reestablish the woodland

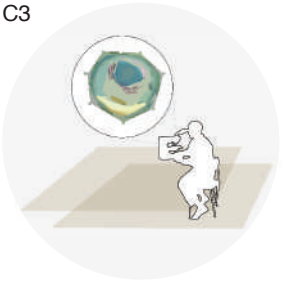
C1

Education

C2

Production

C3



Research

D1

Recreation

D2

Lifestyle

D3

Tourism

4.4 Programme of Berea Park Botanical Gardens (Author, 2019).

of the existing urban infrastructure and the needs of the city, , but a balance would be created between the natural landscape and the urban environment which will benefit both.

The river habitat will be restored naturally and, in some places, artificially created for the display of the botanical garden. This will create habitats for many species which will increase the biodiversity of the river system, making it more resilient to future pressures.

4.4 Connecting the city to its garden

The construction of Nelson Mandela Drive and Lilian Ngoyi Avenue has led to cars being the primary focus in the planning, with minimal care for pedestrians and their experience. The road construction has left residential areas isolated, surrounded by four lane roads. This is not a friendly environment for pedestrians. The Berea Park development will create pedestrian and cyclist-friendly north-south and east-west links, making it possible to safely walk from the Pretoria station to east in Muckleneuk, as well as, making Groenkloof Nature Reserve accessible by pedestrians from the city. Groenkloof Nature Reserve is a popular picnic spot over weekends and attracts many cyclists as well. Pretoria is fortunate to have this nature reserve right on the city's doorstep.

The proposed botanical garden will act as an aesthetic gateway and green corridor from the Groenkloof Nature Reserve area, increasing awareness of the Apies River.

4.5 Client identification

The site is currently owned by the City of Tshwane Metropolitan Municipality (CoT) and the restoration and preservation of the structures on site as well as the proposed developments are under the jurisdiction of the Department of Public Works. The head offices of the Department of Rural Development and Land Reform will be clients of part of this development. Generally, the CoT is expected to be the main client as this is a major development in the city as well as being a Gateway into Pretoria. UNISA owns the eastern stretch of land in the Muckleneuk area, where the research facilities will be located. UNISA will also be involved in the development of a means for pedestrians to access their campuses easily and develop facilities for study in botanical and horticultural fields which the university will benefit from greatly.

A pedestrian and cycling access gate is proposed to connect Groenkloof Nature Reserve and the Fountains Valley area to the city. The CoT who also owns Groenkloof Nature reserve may be consulted regarding the possibilities of the Apies River stormwater attenuation strategies to lessen the effect of flood waters downstream towards the site.

The Berea Park community has been very vocal towards the state of the park and has even developed an action plan for the area themselves. It will be crucial to obtain their input during the development of this project through a public participation process. The South African Biodiversity Institute (SANBI) will be the client for the development and operation of the botanical garden.

4.5 Logos of possible clients.

4.6 Conceptual collage of Berea Park Botanical Gardens (Author, 2019).

5 THEORY

5.1 Botanical gardens as a driver for conservation

Botanical gardens in South Africa have very particular programmes depending on the need of the organisation running the garden. By far, conservation is the utmost objective of botanical gardens. All of the national botanical gardens state conservation of local indigenous flora as their main concern. There are currently nine national botanical gardens, with two more currently being developed, one in Thohoyandou and another in East London (SANBI, 2019). These gardens are run by the South African National Biodiversity Institute (SANBI). SANBI's vision is to establish a botanical garden in every province of South Africa.

Some botanical gardens exist purely as living collections as an interest in plants from across the world. Most universities in the country have a botanical garden and these function for research purposes to the university, but also often house rare collections.

The botanical gardens in South Africa have been divided according to their function or programme. There are four major categories namely: Conservation, Living Collections, Research and Public aesthetic gardens. Most of the major botanical gardens in South Africa have been studied and compared. Smaller privately-owned botanical gardens have been deemed unnecessary to study as they provide very little information on public interaction.

Botanical Gardens in South Africa fulfil vital roles in the country, namely conservation, research, heritage and the provision of public open space.

Similarly, the botanical garden in Berea Park would focus on the conservation and the display of local river systems and their ecologies, which will provide research opportunities as well as public open space to the inhabitants of the city.

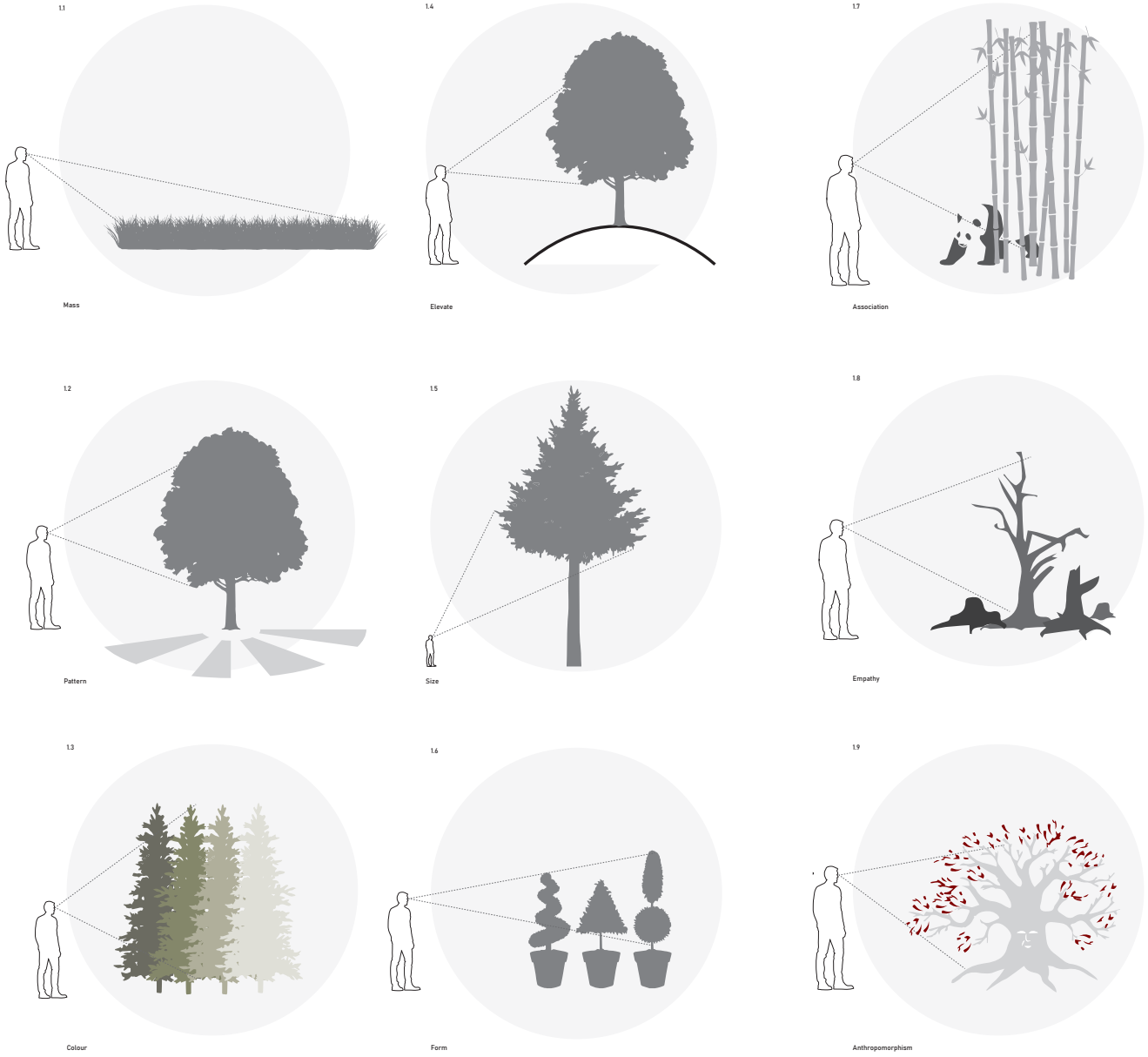
As mentioned previously, the nine National Botanical Gardens in South Africa focus on the conservation of local fauna, and educate people visiting the area on the local flora. These parks often have a small, maintained botanical garden area and then a larger protected natural reserve with hiking trails.

River systems in South Africa are being degraded by urban settlements and the engineering of river systems. Pollution and agricultural practices have also put these river systems and their ecologies at risk of being lost. These river systems and their bio regions consists of very biodiverse areas which hold a lot of research potential. Most urban cities could not have existed if they were not built close to a river to provide water and vital resources to the first settlers. Thus, the river is part of the city's history and is important to its heritage value. Urbanised rivers in Pretoria are rarely used as public space, but are instead being fenced off from the public. Thus, there exists an opportunity to develop the river edges to provide public amenities.

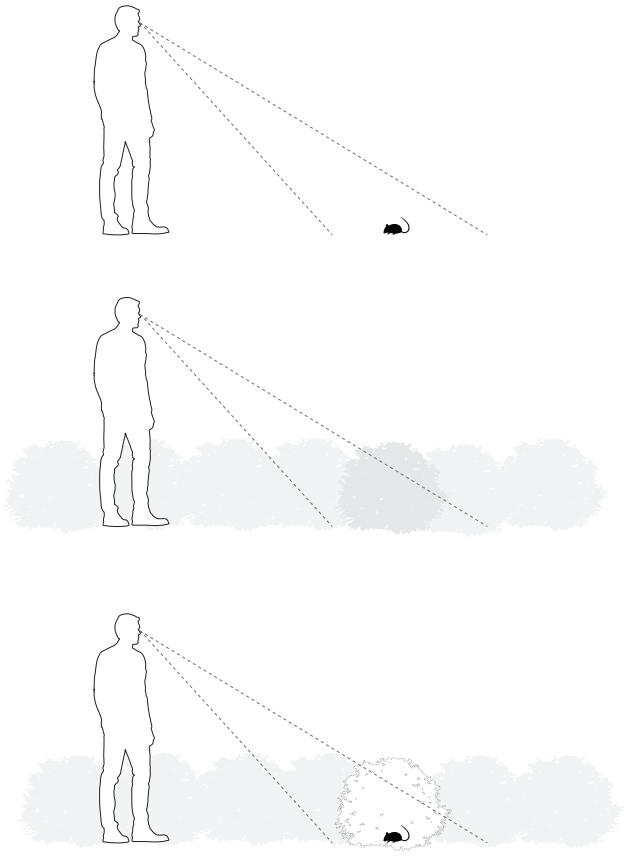
5.1 The first poster on plant blindness used to spread awareness of the issue (Wandersee & Schussler, 2001).

5.2 Plant blindness theory

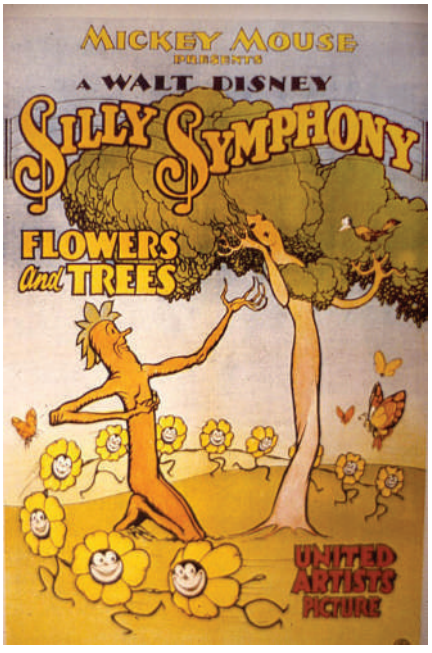
Plant blindness can be defined broadly as the inability to see or notice the plants in one's own environment, leading to the inability to recognise the importance of plants in the biosphere and in human affairs. This also includes an inability to appreciate the aesthetic and unique biological features of plants. Furthermore, many people view plants as inferior to animals leading to less human consideration (Allen, 2003).



5.2 Plant blindness design strategies (Author, 2019)



5.3 Active and passive attention when a animate object is within view a person will notice it and draw attention, however plants tend to not be noticed actively and are ignored when in view (Author, 2019)



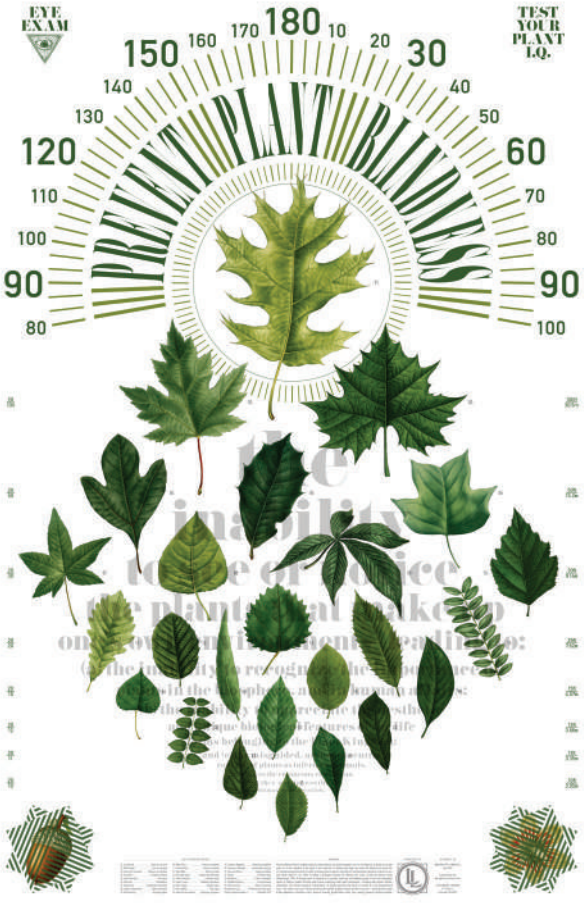
5.4 Silly Symphony Flowers and trees Promotional poster 1932 anthropomorphizing plants which creates empathy with the viewer (The Encyclopedia of Disney Animated Shorts, 1932).

The first mention of plant blindness was in 1998, by two botanists, Elisabeth E. Schussler and James Howard Wandersee. They identified the problem of people not noticing the plants in their environment. The term plant blindness was coined with the reasoning that most people were already familiar with the use of the word blind as a metaphorical adjective suggesting missing visual iinformation. Together with the word, 'plant', it means unable to or unwilling to visually perceive plants. Thus the definition of plant blindness is: "the inability to see or notice the plants in one's own environment—leading to:

- The inability to recognise the importance of plants in the biosphere, and in human affairs;
- The inability to appreciate the aesthetic and unique biological features of the life forms belonging to the Plant Kingdom;
- The misguided, anthropocentric ranking of plants as inferior to animals, leading to the erroneous conclusion that they are unworthy of human consideration" (Wandersee & Schussler, 2001).

In 1996, James Wandersee established the 15° Laboratory at Louisiana State University. The focus was on visual cognition research to improve biological and botanical learning. This later became the first campaign to increase awareness of plant blindness (Plant Science Bulletin, 2014).

Plant blindness is a real issue in contemporary botanical conservation. An example of this is conservation in the United States of America where 57% of endangered species are comprised of plants, yet only 3.68% of the total conservation funding goes to plants (Furness, 2018). Researchers are unsure about the reasons for plant blindness. Possible theories of its existence could be explained



5.5 Plant Blindness titled The Eye Exam Chart poster designed based on the research of Anna Kell and Jonathan Frey (LLoyd Library & Museum, 2018).

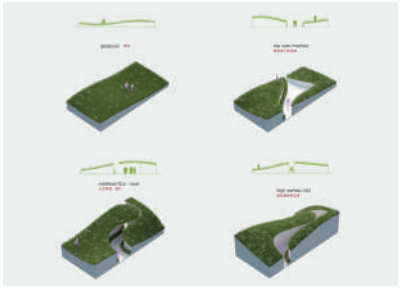
5.6 Plant Blindness titled The Panty poster designed based on the research of Anna Kell and Jonathan Frey (LLoyd Library & Museum, 2018).

by plants growing close together and they do not move, often amalgamating into one green mass visually, as well as that they usually go unnoticed when animals are present. Another possibility is that plant blindness is created culturally by not putting enough emphasis on plants. An example will be school biology textbooks devote very little pages to plants compared to animals, potentially leaving children with a lesser impression and perceived importance to plants (Furness, 2018).

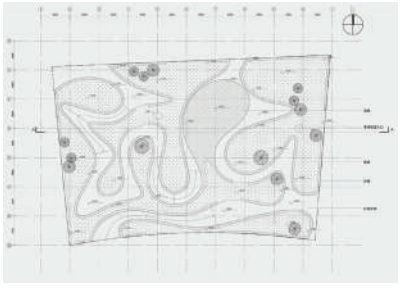
Ethnographic research has shown that many societies have strong bonds with plants. Aboriginal Australians, Native Americans and Maori communities all understand that plants are different from humans and animals, but that they are living things that share a common ancestry. Thus, this kingship relationship creates a mutual responsibility and dependence between man and plant. Although plant blindness is common, there are ways of diminishing or even reversing its effects (Mung & Williams, 1016).

On the surface, plants and humans are very different and research has shown that conservation funding goes towards species which are most human like. Plants are not perceived to move or have faces. Unlike humans and many animals, they also do not have emotions

5.7 The World Wildlife Fund logo which made the panda one of the most recognisable animals in the world (WWF, 2016).



5.8 Diagrams of the Where the River Runs landscape (Watkins, 2015).



5.9 Plan of the Where the River Runs landscape (Watkins, 2015).

or feelings. A way to value plants is by identifying the ways in which plants are similar. Plants communicate, take up food and young plants may share root systems with their parent plant. These recognisable behaviours can be easier to identify plants with human feelings. Rituals can be a strong method of identifying with plants. Many cultures across the world have festivals coinciding with plants such as spring blooms or harvest seasons. An example is the islanders of Nusa Pendina who value the coconut plant. When a child reaches a certain age, the father will plant a coconut tree for the child. The tree grows and is celebrated corresponding to the child's lifespan. The tree becomes a physical metaphor for the person's life (Williams, 2016).

By actively imagining the experience of plants, a person can feel more empathy for plants. Research found that people who are actively associated with plants were more likely to express greater concern and also tended to donate more to protecting this species. Art, literature and cultural rituals help people to imaginatively empathise with plants. Tending and caring for plants also create empathy. As one experiences the life and death of plants, one shares the joy and sorrow. A more controversial way to connect with plants is through anthropomorphism. Anthropomorphism is the attributing of human features and characteristics to plants, like describing plants as drooping or sunflowers facing towards the sun. Anthropomorphism in animals is commonly used in entertainment and conservation efforts, but not often used for plants. The anthropomorphism of plants is also considered by some to be unhelpful in that it misdirects the perception of plants or sentimentalises them in ways which belittle plants. However, experiments have shown that by anthropomorphising plants in stories and pictures can help people to emphasise with them and create a sensitivity towards protecting them (Williams, 2016).

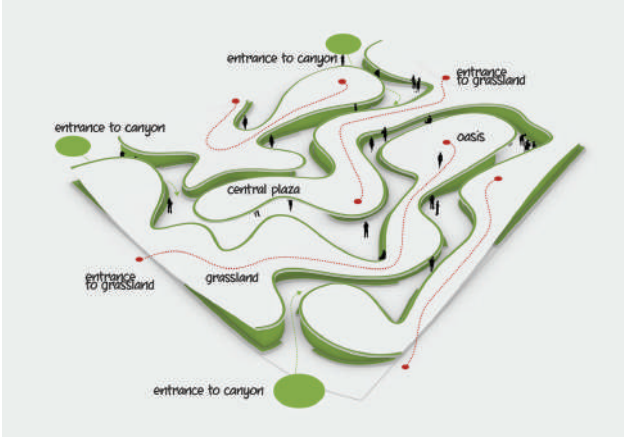
Visuals are an important factor in conservation. An example of this is the most recognisable animal in the world which is the giant panda. It has been the symbol of the World Wildlife Fund's logo for over 50 years. Today the giant panda is no longer endangered thanks to its millions of dollars of funding, which saved the species from extinction (WWF, 2016).

Similarly, plants can gain notoriety through smart visual campaigns. In 2018, artists Anna Kell and Jonathan Frey designed posters for the plant blind, based on research they conducted. They intended to bring awareness to the significance of plant education and identification (LLoyd Library & Museum, 2018).

Landscape Architecture can be used to communicate plant blindness through form making. wereby design language can be used to develop strategies to alleviate the issues of plant blindness and attempt to make the plants more noteworthy through form and placement. A design language will enhance certain aspects and

5.10 A render of the Where the River Runs landscape (Watkins, 2015).

5.12 Artistic representations of the Where the River Runs landscape (Watkins, 2015).



5.11 A diagram showing movement through the installation (Watkins, 2015)

5.13 Artistic representations of the Where the River Runs landscape (Watkins, 2015).

characteristics of the plants that are relevant to the botanical gardens programme and mission.

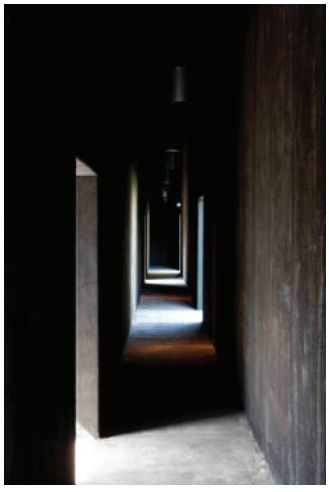
5.3 Theory Case Studies

5.3.1 Where the River runs | Penda

Where the River runs was a landscape that won the 10th international Garden Expo in Wuhan, China. The design brings to light the vital importance of clean water and protecting the environment. The show garden pavilion was designed to take the user through a series of hills and valleys on a pathway where the user is resembled as the river. The visitors are even given seeds to plant along the pathway to act as a functioning river would naturally. Water is used as the main design inspiration and is described as the 'main designer of our environment'. It is important to be made aware of the precious resource, on which all life on earth relies. The river is also important to the flourishing of Wuhan as it brought many goods from around the world, creating an important trade hub. The river also brought a wealth of flora and fauna of which the beauty inspired many poets and artists throughout history.

As people walk along the path and plant seeds, they fulfil the function of the river and bring life to the landscape. Just like a river, the user becomes the starting point of the lifecycle of plants. This action taken by the user creates a heightened sensibility towards the

5.14 The plants are specifically chosen to create interest in the garden throughout the seasons of the year (Frearson, 2011).



5.15 The entrance into the courtyards is through this narrow dark hallway removing the user from the outside busy world (Frearson, 2011).

importance of clean water and the protection of the river habitats.

This landscape provides users with different sensory experiences as one moves through, experiencing the landscape from the point of view of the river. The hills and valleys created along with the pathway cutting through these is a condensed abstract representation of the natural environment. This communicates a very large area in terms of an entire river into a garden expressed in a few abstract typologies meant to create the experience of such natural spaces. It is possible to explore the landscape through the pathway as well as walking up

5.16 The Serpentine Gallery Pavilion garden by Piet Oudolf with the courtyard framing the plants (Frearson, 2011).

the hills into the grassland meadows, creating different views and experiences (Watkins, 2015).

In the context of the rivers meant to be represented in this dissertation, it would be impossible to display everything realistically. Therefore, similar to this Penda landscape, the South African river typologies will be abstracted from landscape forms into a more condensed and realistic scale to the site's available space. Just like the Penda project, the goal would be to create the experience of the space rather than recreating the actual river realistically. The rivers of The Lower Crocodile and Marico river basin both possess similar plant and animal habitats. The differentiation of these rivers come from their form and the surrounding landscape such as high cliffs, flat grasslands, winding rivers and arid stony landscapes to name a few. It is these differences in river typologies that are explored in the design of the Berea Park Botanical garden. This is translated into a user experience with the ultimate goal of awareness and sensitivity to the importance of conserving these South African rivers.

5.3.2 Serpentine Gallery Pavilion 2011 | Peter Zumthor & Piet Oudolf

The Serpentine Gallery was conceived in 2000, and has become an international space for architectural experimentation. Each pavilion display lasts for three months throughout summer. The pavilion's provide a completely new experience each year and in 2011 Peter Zumthor and Piet Oudolf designed a contemplative room (Frearson, 2011).

It consisted of a dark structure enclosing a vibrant herbaceous garden reminiscent of a courtyard space. The intensity of the garden

colour, smells and forms are enhanced through the simple architectural enclosure functioning as a frame to the garden. The design aims to help users relax and take time to enjoy the garden and to engage in conversation about the garden and the experience or remain quiet and contemplative. The materials used in the architecture are significant in aiding the sense of place, emphasising the emotions and senses that play a role in the experience of the garden. The building acts a backdrop, a frame which focusses one's attention inward to the garden which is brightly lit with sunlight. Through the dark entrance ways and shadowed spaces, one enters into a whole new environment in which the user enjoys the garden, is able to sit down and rest and is isolated from the outside metropolis. This experience is intense, pure and memorable. The design aims to reconnect nature into human surroundings (Basulto, 2011).

The concept of the garden is Hortus conclusus which is Latin means enclosed garden. In the garden itself, the plants are used to convey their natural form, a form which evolves throughout the life of the plants. They are chosen for their structures, forms, textures and colours in a seemingly natural random distribution, yet in reality arethoughtfully curated to create the desired effect. Oudolf's approach to garden design is to embrace the full life-cycle of the plants, celebrating their change and beauty throughout the seasons (Frearson, 2011).

The theory of plant blindness states that humans tend to have a bias against plant life, ignoring their existence and processing them as background information. In this Serpentine Gallery pavilion, the Swiss phenomenological architect, Peter Zumthor places architecture as the background information and places the planted garden as the point of focus. The user cannot help, but actively focus on the garden, noticing all the different colours and textures. It is this focus that will be designed into landscape typologies, devising methods of creating areas of passive and active focus. Some of the ruined structures on site provide excellent opportunity to frame spaces and draw attention where it is needed. Furthermore, landscape forms, plant choices and placement will all directed by this simple mechanism of active and passive attention.

5.4 Unnoticed potential

The channelisation of the Apies River and the rapid development of the city led to the river to be viewed as less important to the city and considered a nuisance when developing around it. This is evident from the building orientations along the river. None of the buildings faces the river. Instead, most properties build walls on the river edge to keep out vagrants and occasional flooding. The value of the river system was enhanced in the Groenkloof Nature Reserve area, which was established in 1895 to the south of the city. With the construction of Nelson Mandela Drive and other roadways, the link between the city and the nature reserve was severed. Currently, access to the river is limited as a city dweller unless effort is made to drive to the reserve to experience the natural river. The roadways that were built created pieces of fragmented land, resulting in fallout pockets that are left bare and unusable.

5.5 Ecological design

Ecological design is primarily focused on the realistic or scientific representation of ecological form, function and processes. This is a branching of Landscape architecture concerned with fusing ecology, environmental planning and landscape architectural design.

In 1968 Ian Mc Harg published Designing with Nature a design manual describing in detail how to analyse a landscape ecologically, breaking down a region into appropriate data which is then used to inform a design course. Mc Harg promoted an ecological view in which the designer fundamentally understands the environment from the soil, climate, hydrology to ecosystems etc (Palmer, 2001).

The landscape architect James Corner affirms three areas of urgency in Landscape architectural design theory.

Firstly, Landscape architecture should resist the homogenising forces of globalisation.

Secondly landscape architecture should react to environmental challenges such as waste water treatment, diminishing biodiversity, and resource depletion.

Thirdly landscape architecture needs to shape the process and outcome of deindustrialisation and urban decay.

5.6 Conclusion

The north of the site is more active because of the informal taxi rank and a few street vendors. The historic Berea clubhouse itself has been occupied by vagrants who constantly commit crimes in the area, harassing the local residents. This makes the area extremely dangerous with reports of drug use and raping common (Ngobeni, 2016).

Trash pickers use the site for sorting through the trash they collected and various people move through the area, usually from the Salvokop side in the west over the railway lines through gaps in the railway fence. Some use the dilapidated green space for leisure, including school children who also play on the degraded sports fields after school. It is speculated that this only occurred recently because the site was cleared for construction, with the dangerous criminals removed. On Sundays, a religious sect worships on the site.

The approach to the design is to create a botanical riverine that houses the regional typologies of riparian, aquatic and wetland ecologies. This is known in the botanical garden world as an ecological

collection and is an exhibit of a specific ecology. The forms of the design will focus on the existing site features such as the river and the faint rectangular shapes of the old sports fields. Since the area floods periodically, the botanical garden will be designed to flood, simulating natural occurrences rather than simply building an embankment to stop the water.

It is speculated that the clubhouse may be converted into a herbarium or an open-air botanical museum on account of the structure missing a roof. The Apies River will be restored as close to natural as possible in certain sections, even re-introducing native fish species into the river.

The park will be a public park for recreation and leisure, with the botanical garden requiring paid admission. The park will also feature connections over Mandela Drive to connect the isolated Muckleneuk neighbourhoods as well as a pedestrian link to Groenkloof Nature Reserve.

5.17 The Serpentine Gallery Pavilion garden by Piet Oudolf (Frearson, 2011).

5.18 The entrance to the Serpentine Gallery Pavilion (Frearson, 2011).

6 CONCEPT

6.1 Vision

The project intention is to design a botanical garden which focuses on regional river habitats of the area. The garden will house collections of living plants which occur in water-bodies and on the banks of rivers as well as temporary and permanent flood plains. The collections will contain diverse specimens of these water body dependent ecologies with the purpose of educating visitors of the garden as well as research-based programmes run by the University of South Africa and the botanical garden themselves. This botanical garden will thus serve to conserve the water plant ecologies through in-situ and ex-situ cultivation of plants as well as provide a close by public open space for recreation and recharging the human spirit.

The study site is a collection of fragmented vacant land in the old Berea park area, which forms part of the southern entrance to the inner city of Pretoria, dominated by roadways fragmenting the space such as Nelson Mandela Drive and Lilian Ngoyi Roads. This has led to the leftover pieces of land to become isolated and unused. To address this, it is proposed to join these fragments to form a contiguous landscape which bridges the major roads and forms a blanket over existing infrastructure, comprising the proposed botanical garden. This will effectively allow a balance between pedestrians and vehicular traffic, to occupy the space.

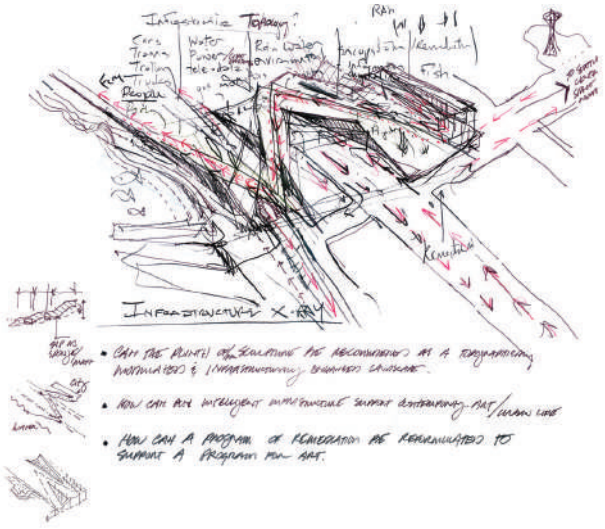
6.1 Concept of a contiguous landscape being morphed to span obstacles and still function as a contiguous landscape (Weiss/Manfredi, 2019).

6.2 Concept Case Studies

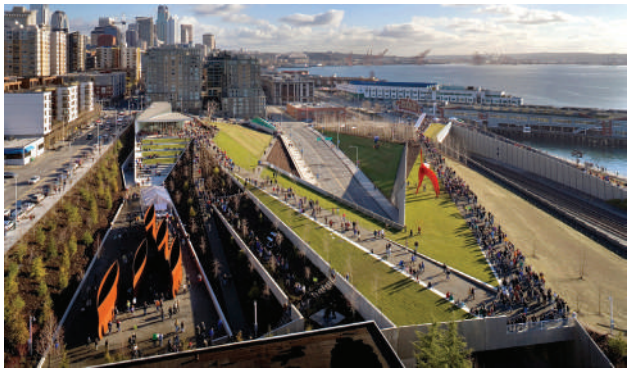
6.2.1 Olympic Sculpture Park | Weiss & Manfredi

The Olympic Sculpture Park in Seattle (2007) designed by New York based firm, Weiss and Manfredi faced similar problems. The site of the sculpture park was situated on three strips of land divided by a rail line and a road. The designers had to figure out a way to create a contiguous landscape as one of the largest obstacles to overcome.

The solution was a semi-elevated linear landscape which zig-zagged over the road and rail line. The landscape forms a linear path on a gradual slope, with the sculptures of the park placed on the path which terminates at the waterfront. The Olympic Sculpture Park rises over the existing infrastructure to reconnect the urban core to the



6.2 Concept of sketches of Olympic Sculpture Park (Weiss/Manfredi, 2019).



6.3 The Olympic Sculpture Park in Seattle, 2007 (Weiss/Manfredi, 2019)

6.4 The fractal formations of rivers (Lucy, 2016)

revitalised waterfront Elliot Bay waterfront (Weiss/Manfredi, 2019).

The river that runs through the site is a central element to the design of the botanic garden focusing on river and wetland ecologies. The river will be used to showcase these ecologies and species central to the conservation effort. The design of the river space will also seek to increase awareness and interaction of visitors with the river and its functions. The river currently goes largely unnoticed to the public and is a potential great asset to the city.

The ordering of plants within the botanical garden will be structured to combat plant blindness. Various techniques and strategies are proposed to increase the attractiveness and noticeability of a curated collection of plants. As a result, the memory of these species will be formed through the users' experiences of the space.

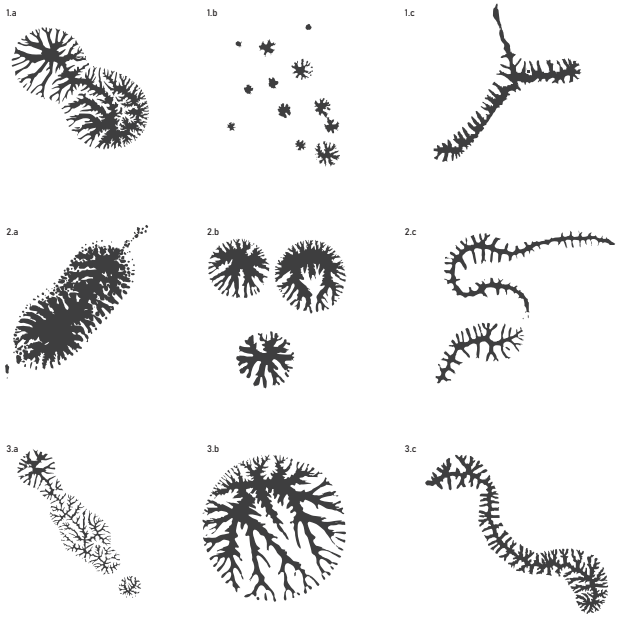
6.3 Conceptual Investigations

6.3.1 The Science of fractals

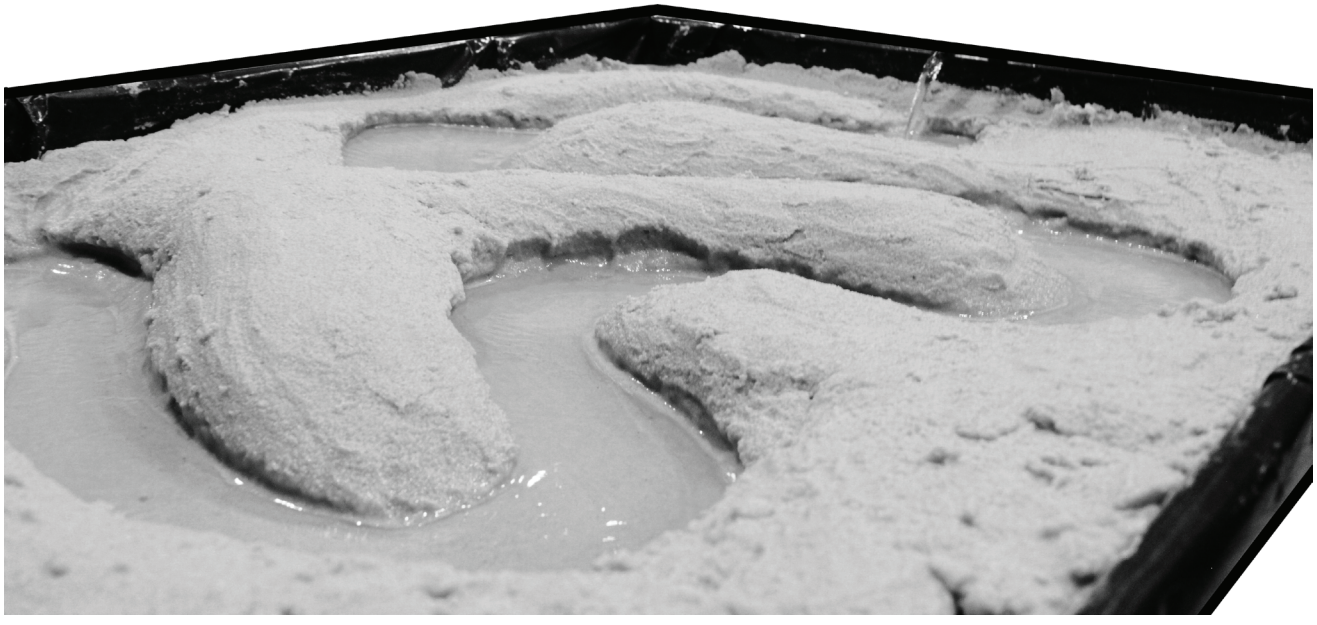
An exploration into fractals was conducted that involved experimenting with fractals and how these infinitely branching patterns form, inspired by the fractal patterns of rivers. Fractals are the phenomena of objects with continuously repeating patterns and each repetition reducing in scale. Perfect mathematical fractals, like the Mandelbrot set, infinitely repeats its patterns, with each pattern being a smaller copy of itself which in turn have smaller copies of itself, the pattern continuously repeating (Lucy, 2016).

Many natural phenomena are fractals to some extent which can be observed such as the veins on leaves or the branching patterns of rivers. Even cities can be viewed a fractal forms to some degree with highways branching into roads and avenues.

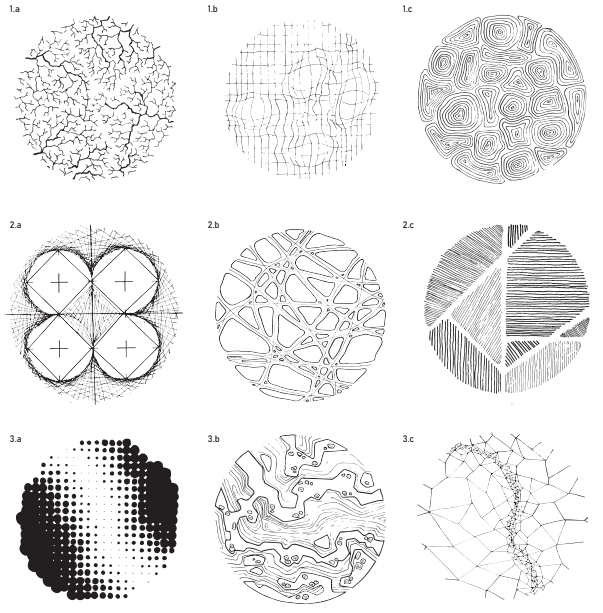
Architecturally fractal forms can be defined as hierarchical patterns starting as a main path which branches off into smaller and



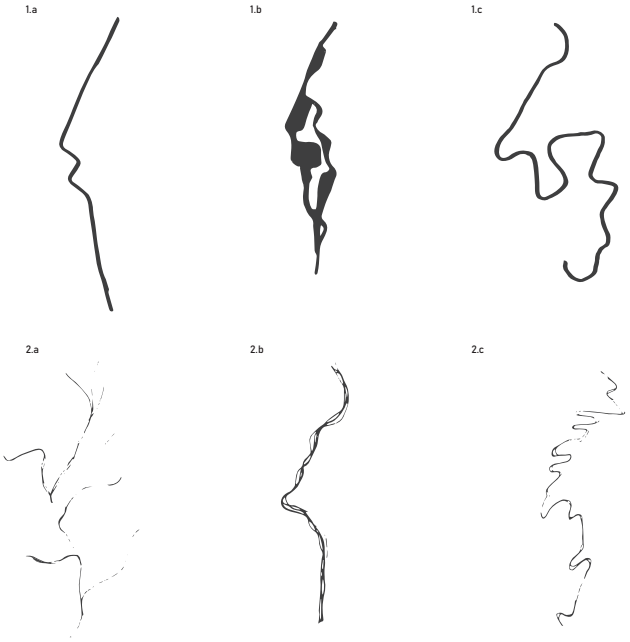
6.5 Fractal experimentation using two planes of glass and sandwiching droplets of paint (Author, 2019).



6.6 Form explorations using a sand model simulating a river (Author, 2019).



6.7 Pattern exercises inspired by the natural and manmade landscape and movement patterns (Author).



6.8 Form extracted from formations of rivers in different conditions (Author, 2019).

smaller paths. Fractal formation of rivers is different from the usual way fractals are formed. Rather than starting with a large pattern and then being repeated smaller and smaller, rivers start out at the smallest pattern and then the branches converge to form larger branches visually growing in hierarchy until the main river is formed. This happens because rain falls over a large area and the droplets then flow downhill eroding a small channel which creates paths for successive droplets to follow. Eventually, the droplets converge into larger and larger streams. This river network condenses a large area of rainfall into a small concentrated area (Fractal Foundation, 2013).

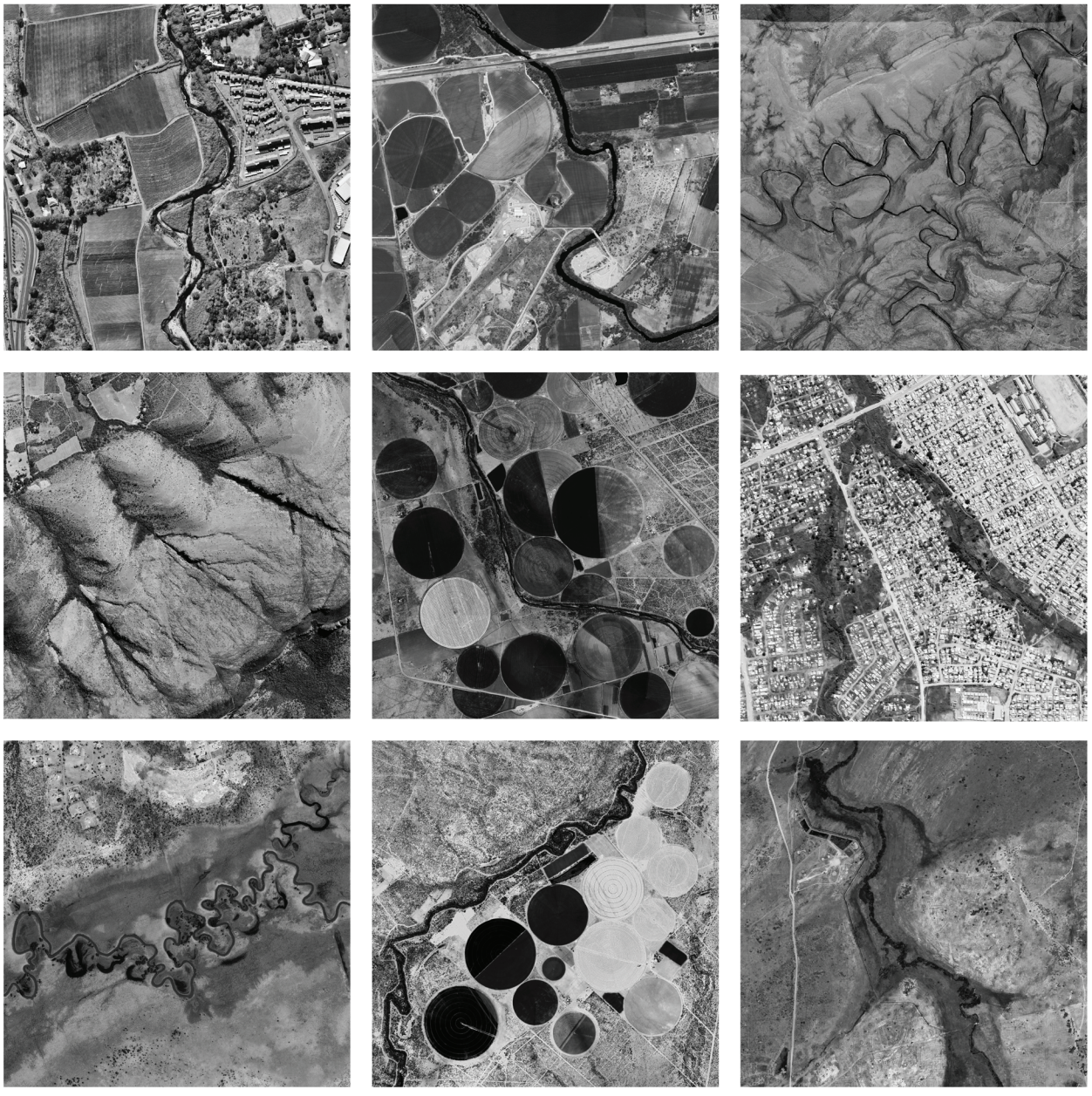
The branching patterns of rivers can inspire visual hierarchy as a concept to drive design. Fractal convergence was a concept translated into the park being the focus area drawing the city and nature into this point. No landscape exists independently from its environment and the energy, information and physical flows are visually reminiscent of the fractal convergence of a river network.

6.3.2 Landscape as pattern

Through the layering satellite images of the regional rivers, a form typology was devised, drawing inspiration from the natural and manmade land forms and patterns which exist. Human developments are huddled along the rivers with the inhabitants growing fewer the further from the river with most landscapes looking lifeless and barren without a river.

The patchwork of informal settlements built up to the river's edge, seemingly occupy every millimetre of available land with manmade structures, except for the occasional vegetable garden plot, visible between the checkerboard of gleaming corrugated iron roofs. In contrast to that, the river in the city is much more rigid and seems to have yielded its form to the organised patterns. The river is reduced to a simple line with no hint of its original path. Features which created striking impressions where the agricultural manipulation of the land, form lines squares and circles in various shades of colour. The agricultural landscape produced surprisingly beautiful patterns through the ploughing of fields; the pattern reminiscent of ancient labyrinths of Scandinavia and Celts. The planned rigidity of the fields is similar to the city form, but here the river still dictates the orientation and form of the patterns. The rivers are controlled by humans building dams and weirs amassing large bodies of water for irrigating the fields.

There is also a sense of ancientness when viewing the natural river landscape from above. It is evident as the river follows the landforms and creates a careful route around ancient mountains, and in other parts the river cuts through the mountain to form canyons moulding



6.9 Regional rivers from top left: Apies, Crocodile, Oliphants, Klipspruit, Crocodile,Pienaars, Marekele, Limpopo and Pienaars (Author, 2019).

the landscape to its will. In more flat landscapes, the river forms winding loops and branches spreading over larger areas forming a web of streams and greenery. All of these streams and rivers ultimately collects into one larger river and after a 1600-kilometre journey, ends up in the Indian ocean.

6.3.3 Hydrology as a form generator

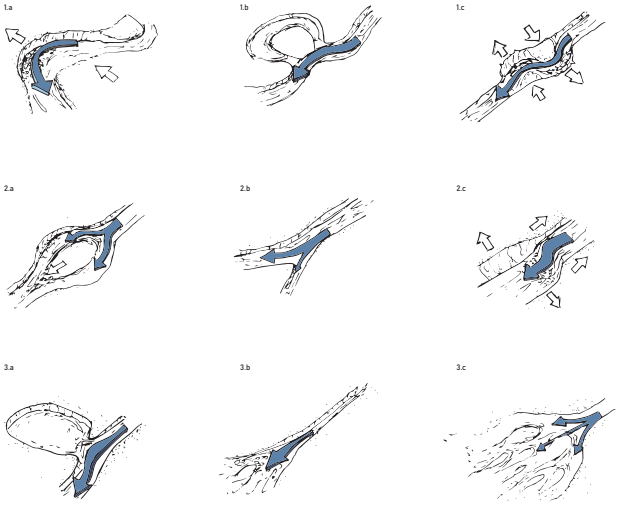
An experiment was conducted to understand the behaviour of flowing water and how rivers mould the landscape. The experiment was conducted by building a scaled-down river simulation model, using sand and a constant water-flow. The structure consisted of a wooden framework forming a 150 mm deep bed. This was waterproofed using pond liner and a drainage hole was placed at one end. The water drains into a bucket with a pump and then gets pumped back into the sand bed continuously. The sand used was play sand which has a light colour and very small sand grains, which was found to produce the best results.

Time-lapse footage was recorded of the simulation in 40-minute segments which were repeated several times. Close up photographs were taken of the interesting forms and behaviours being observed.

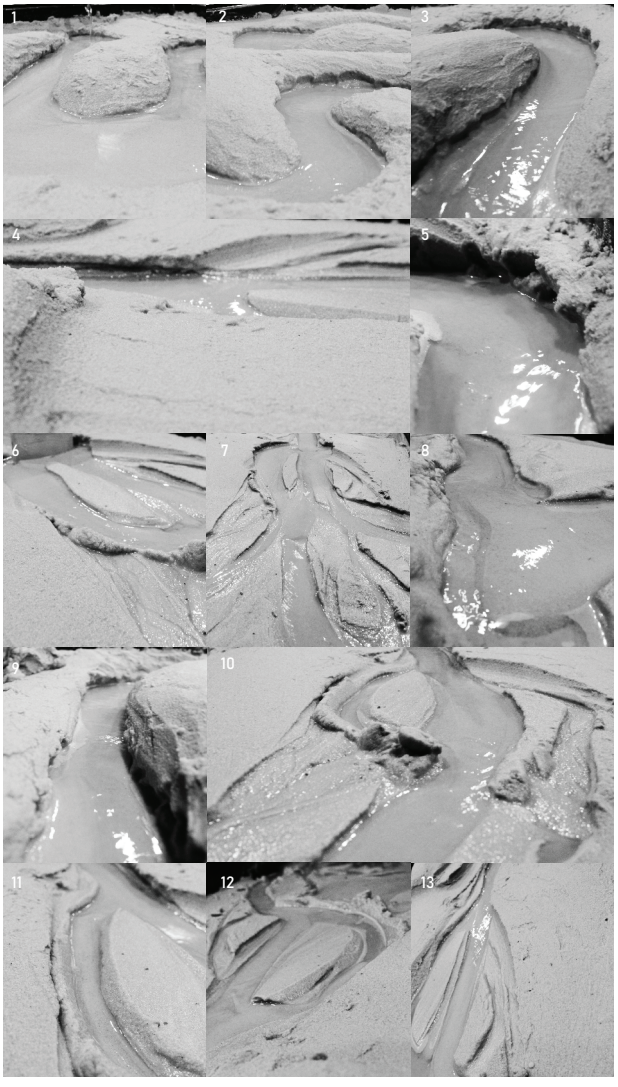
The water-flow always took the path of least resistance, cutting a straight line in the sand. The only way to get the river to change its course was to intervene and coax it by creating disturbances and blockages in its path. No matter the disturbance though, if the simulation was left to run long enough, the river would have returned to its original straight path.

The gradient of the sand bed was a major factor in the forms being generated. Steeper gradients produce fast-flowing water cutting deep canyons and create a thin stream, and the shallower gradients cause the water to move slowly and spread out much more creating a web of slow-moving streams eventually creating many islands.

The generation of these forms through water movement can be refined into two actions which are eroding and depositing. Fast-moving water tends to erode and pick up material which will then be carried until the water has too little movement or energy, in which case the material is deposited. This can happen at the same point in the river especially in river bends where the outer bend flows faster and erodes the inner bend which flows much slower, thus depositing material. One can then imagine the process the river is moving by cutting material away at one side and depositing it on the other. This process continues until the river reaches a state of equilibrium where either the river has slowed itself down and no longer possesses the ability to erode or the river has found the most ideal path, in which case the erosion is equal to the depositing of material and movement of the stream can no longer be observed.



6.10 The behavour of rivers and the creation of form through the two mechanisms of erosion and deposit (Author, 2019).



6.11 Form explorations using a sand model simulating a river (Author, 2019).

The typical forms that were observed being created by the river was a steep cliff or wall on the outer side of a bend and a gradual smooth bed on opposite side. Another interesting observation was when there was a height change within the river. The area where the height change occurred created a step which was gradually eroded, causing the step to seemingly move upstream until it dissipated. An island within the stream also tended to form into teardrop shapes with the rounded end facing into the stream and a pointed tail forming behind.

These observations of forms and behaviour were used to produce a design argument as well as a design language to build on the concept of the intervention.

Rivers in a natural landscape often form complex meandering paths which were difficult to reproduce for any length of time within the simulation. It is speculated that similar to the interventions required in the simulation to achieve these forms, actual rivers also react to interventions in the form of plant growth on riverbanks. Trees and thick plant growth can fix a riverbank in place and force the river to flow around, creating meandering forms. Other disturbances can be the materiality of the soil and rock the river flows over as well as human and even animal interventions. However, given a large enough timescale, the river will eventually triumph over these and continue creating a path of least resistance.

6.3.4 Phenomenology of a river

The design seeks to create experiences which engage the user through senses, focusing on the phenomenology of the space to form long-term memories of the subject in the user's mind. The German philosopher, Martin Heidegger suggested that if we read architecture through the phenomenological lens, we should realise that architecture is the way people connect to the world and so, it must help them centre themselves within it. Furthermore, he stated that architecture principles can be developed on the basic qualities of human experiences such as morality, value of human presence, mysticism, nostalgia and pin-pointing the limits of science and technology (Sharr, 2007, p. 3).

An example on the site is the river which goes unnoticed day by day and is considered more of a nuisance in the city. The only time the river is noticed is during a flooding of its banks, in which case the river is perceived in a negative way, warranting further action to remove people from the river. Plant blindness previously discussed also ties into this notion. Plants are ignored by people to the detriment of the plants and ultimately to the detriment of the people themselves.

6.12 Sketch of the Apies river in Groenkloof Nature Reserve (Author).

6.4 Conceptual approach

Early in the project, the river was identified as being ignored by the city whereas the city was established on the Apies river because of what it provides: water. Looking more into the idea of the ignored river, a pattern between the site, the community surrounding it and the plant life, began to emerge. They were in fact all ignored, isolated by roadways and railways. Existing on the fringes of the city forgotten and unimportant. A large inspiration for the design concept has come from the site itself. The idea of the river and what a river should be in a contemporary city was fundamental to this dissertation. When researching rivers, it was realised that an overwhelming number of these river habitats are either completely extinct or in severe danger of being lost. The main reason for that was that urban development was polluting and exploiting rivers. A solution was needed, one that would create sustainable urban development and also conserve rivers in their natural state. Not only was the river part of this issue, but it also began to be viewed as the solution. Instead of perceiving the river as a divider or nuisance, the river needed to be perceived as an asset, a connector of the city. The approach to the concept was to identify previous natural systems that have been lost through urban development, and then to ensure the important functions of the habitats are in place, and designing the intervention over that. Allowing for natural systems to remain functional will be vital to the future health and resilience of the city.

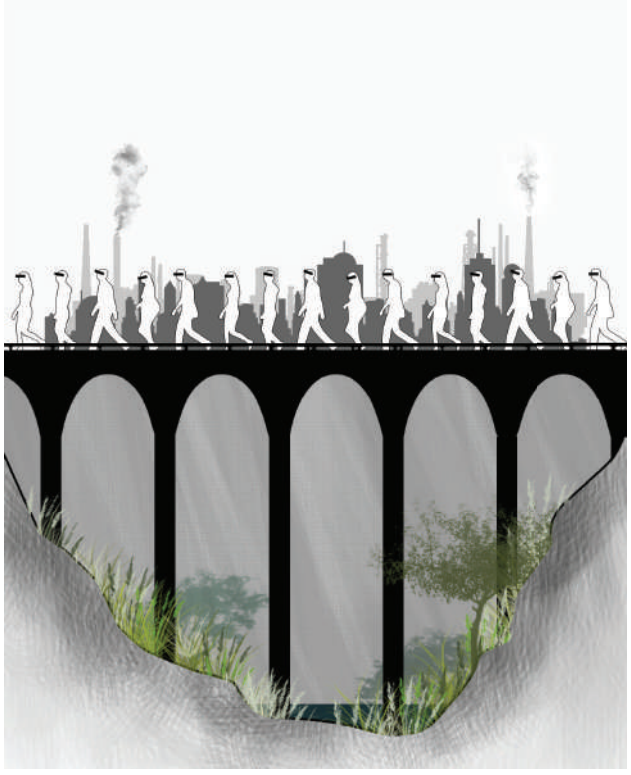
A conceptual approach was formed on the idea of ignoring an object either purposefully or subconsciously, and thus not recognising

the potential that one can benefit from by engaging with this, exploring the potential.

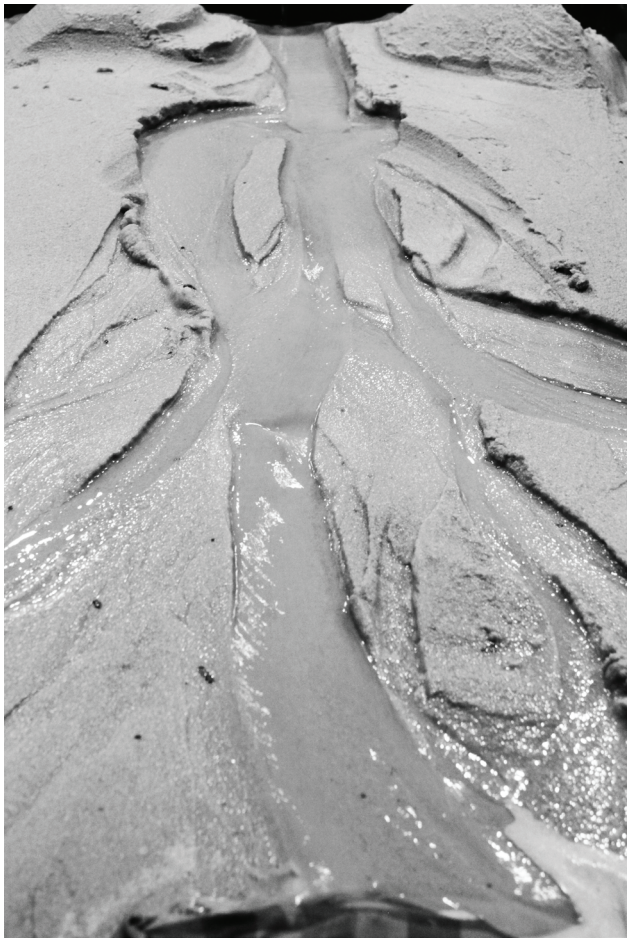
6.5 Unnoticed Potential

Perceiving the everyday for the first time

Unnoticed potential is a concept derived from the need to bring attention to previously ignored subjects. This concept is used as a driver to create an experience that will expose elements and characteristics of objects and the environment one is within. Perceiving everyday objects, such as plants from a new perspective, leads to consciously perceiving the benefits, positive outcomes and vital importance that these objects have. Like shining a light on a previously unperceived object, the aim is to create awareness and connection to the newly perceived object. Engaging with one's senses in a space to awaken emotions which previously were not realised.



6.13 Conceptualasation of unnoticed potencial (Author, 2019)



6.14 Form explorations using a sand model simulating a river (Author, 2019).

6.15 Form explorations using a sand model simulating a river (Author, 2019).

7 DESIGN DEVELOPMENT

7.1 Introduction

The method to developing a design was to approach the problem from a regional perspective using a Mc Harg approach of understanding the macro-regional ecosystems and functions. Thereafter, analysing the urban context, creating a more refined understanding of the issues present. Finally, the site would be analysed and human scale problems identified. Through this method of analysis, the issue would be understood holistically with each level of analysis being connected to the previous one. The would be approached in a opposite manner, starting at a more intimate level designing for the people's daily needs. Thereafter, moving up in scale and complexity, each level connected to the previous. This generated a system of support structures each connecting with the previous level. Approaching design in such a manner enables one to be able to pull a thread from the user all the way to having a affect on the regional context.

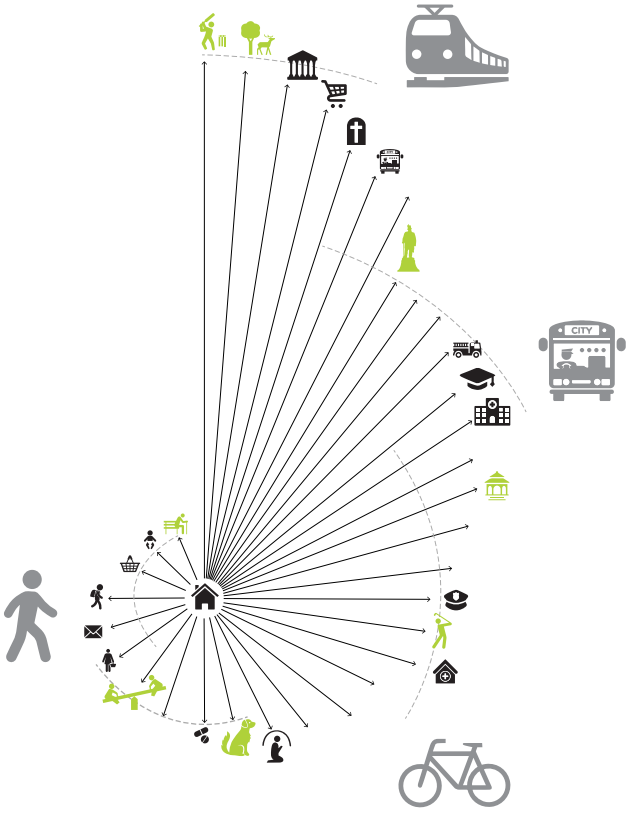
7.2 The system as a whole

Creating a walkable city

A framework for Pretoria was created. It set out to envision the river as a connection through the city. Through the use of urban design principles, an urban vision was generated to explore the possibilities of the city in the future.

One of the city's most widespread design issue is that there is a large emphasis placed on accommodating vehicles. The entire city has been adapted for the car and seemingly very little emphasis has been placed on accommodating pedestrians and other forms of transport. This has already become an issue with high amounts of traffic during peak times. This is due to the fact that many people only work in the city and not live there, but in the surrounding suburbs and townships.. Pretoria has a low density of people per square kilometre compared to other cities and this causes difficulties when planning for public mass transit. The running costs of public mass transit compared to the use are very poor. Also the costs in providing this infrastructure are higher because the required area of coverage is much larger due to urban sprawl, a leftover of apartheid city planning (Ludbrook, 2017).

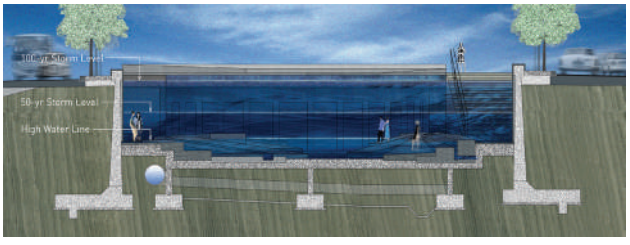
It was speculated that a possible solution to the issues Pretoria faces could be alleviated by densifying the city. People need to live and work in the city. This increase in city population will reduce costs and efficiency of service provisions and be. Also, this will make public transport more viable as there are more people using it, justifying further development of similar infrastructure. With the densified population of the city, more pedestrian amenities will need to be created, shifting the city planning focus from vehicles to pedestrian accessibility.



7.1 Walk able city diagram (Author, 2019)

7.2 ChonGae Canal is a highly used urban amenity (Cherry Wu, 2017).

7.3 Stepping stones across the stream (MikYoung Kim Design, 2019).



7.4 ChonGae Canal is still able to contain a 1:100-year flood mitigating the risks from floods (MikYoung Kim Design, 2019).

In the urban framework, three nodes or activity hubs were identified within the city. These were Marabastad, The Central Business District (CBD) and the Berea Park area. Marabastad mainly contributed commercial activities with informal markets and transport hubs being prevalent, it is one of the major access points into the city. The CBD is the best developed in terms of pedestrian infrastructure, with pedestrianised roadways and some open green spaces. This node focusses on government administration and legislative activities. The area also has the most pedestrian activities such as shops and markets. The Berea Park node is mainly a residential area with many churches, orphan homes and homeless shelters present. There are some green amenities available and overall this area had the least amount of pedestrian activity.

Transport hubs, shops and markets and residence are all vitally important to a person living in the city. The problem is that these amenities are located far apart, necessitating the use of a vehicle. The one thing all these nodes had in common was their adjacency to the river. IThe river thus became a connector through the city, and was designed as a green spine through the city which functions as a pedestrian highway and provides valuable open space amenities. The green spine will also increase property values along the river spurring development along this corridor. It is also vital that the city develops multi-faceted nodes which provide all necessary services and amenities within walking distance, such as schools, shops and parks.

7.3 Urban Vision Case Studies

7.3.1 ChonGae Canal Restoration Project | Mik Young Kim Design

The ChonGae Canal project is an eleven-kilometre greened urban river within the heart of downtown Seoul. The stream was enclosed with concrete in the 1960's over sanitation concerns. A highway was built over the enclosed stream to accommodate Seoul's traffic from the densely industrialised city centre. In the 90's, some damage to the canal could be observed and only light vehicles were allowed to use the highway, maintenance cost of the highway sky rocketed (Simrc, 2019).

In 2002, it was decided to demolish the highway and restore the river. This created vital green amenities in the city and significantly property values around the river. This linear park is now a vital part of the city's urban fabric and is a popular destination for locals and tourists alike, who can now pause and sit along the stream banks, as well as enjoy programmed civic events and artist installations. It has also restored the ecological systems, bringing native flora and fauna to this highly-urbanized environment (MikYoung Kim Design, 2019).

The linear river walk reduced traffic in the area despite the removal

7.5 Cycling bridges where created for cyclist which made it easier to travel via a bicycle as well as create interest and enthusiasm with cyclists (Singapore National Parks, 2013).

7.6 Scenic park connection along a waterways was found to be more used (Szubski, 2019).

7.6 A scenic park connection along a waterway (Szubski, 2019).

of the highway. The project has also eliminated the segregation between the North and South edges of the river and as a result has sped up traffic in the region. This phenomenon is known as Braess' Paradox which occurs when more closed roads lead to improved traffic.

The government of Seoul feared increased traffic with the removal of the highway and thus invested in a bus rapid transit system to work in conjunction with the city's subway. This has led to a 46% decrease of vehicles on the road.

The development led to further positive effects in the city such as cleaner air, reduced noise, reduced pollution and helped to mitigate the heat-island effect (Cherry Wu, 2017).

7.3.2 Park Connector Network | Singapore parks board

The Park Connector Network (PCN) in Singapore is a series of pathways and cycling routes which connect Singapore's parks. Singapore successfully achieved the goal of being a city within a garden through good political will and careful planning and strict development control (Singapore National Parks, 2013).

The Singapore National Parks Board (NPB) are responsible for maintaining the parks and the connector network. The NParks vision was to join the national effort creating the best environment for Singaporean and residents to live work and play in (Singapore National Parks, 2013).

The PCN was an integrated design approach of greening the city and providing recreational benefits to residents. The first park connectors were completed in 1995 and were merely pathways street lamps and a few benches, however as research was conducted on the use of these connectors, more activities and increased scenic routes were created.

7.7 Public street vision (Author, 2019).

This created a myriad of activities for people to take part in such as outdoor exercise equipment kids play areas, cycling routes, etc. People also preferred to use more scenic routes especially routed close to waterways. The increased greening of the PCN in turn increased biodiversity and created habitats for birds and other animals. This contributed to the environmental and social sustainability of the PCN (Szubski, 2019).

7.4 Pretoria's Urban Vision

Pretoria boasts various typologies activity of within the city. These areas have formed activity nodes focused on a specific programme. The problem identified in the urban analysis however was that these nodes were only connected via roads and hardly connected or completely isolated from pedestrian movement. Pavement widths are small and in peak traffic, they become congested and uncomfortable to manoeuvre.

The concept for Pretoria's urban vision was to look at landscape urbanism, which is a theory that believes cities should be planned through the design of their landscape and not the design of its buildings. The main focus of the vision was transit-oriented developments and human scale urbanism. The fundamental principles behind this urban vision was connectivity, walk ability, institutional services, densification, smart transportation, mixed use and recreational amenities.

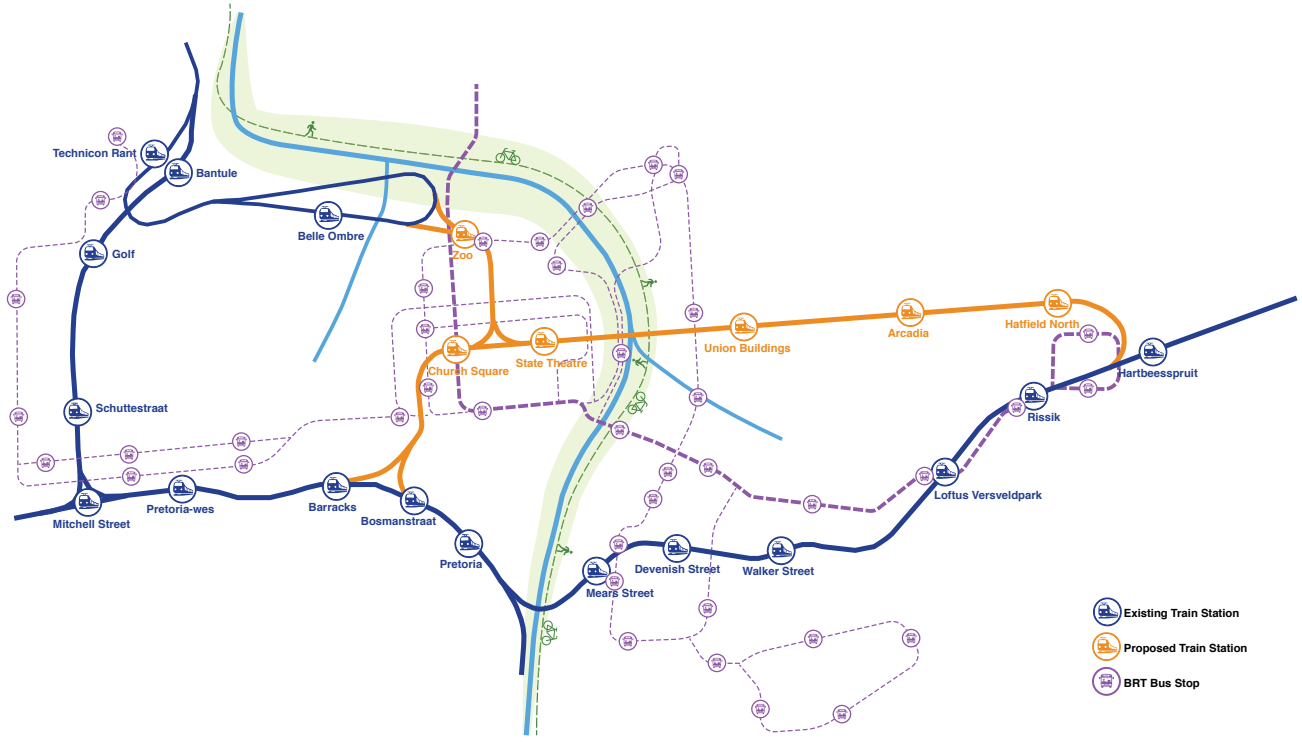
Following good urban design principles, a plan was devised to develop the Apies River as a public green space which forms a pedestrian highway across the city. This will link pedestrians and cyclists to the various nodes in the city. With the increase in pedestrians, there will be a decrease traffic, noise and pollution in the city. The pedestrian green corridor will form a loop around the city linking various parks and other public amenities.

Mass transit infrastructure such as rapid passenger trains and buses will be introduced, further reducing the need for vehicles in the city. These transit systems will complement the pedestrian highway emphasising the speed and convenience of transporting people across the city.

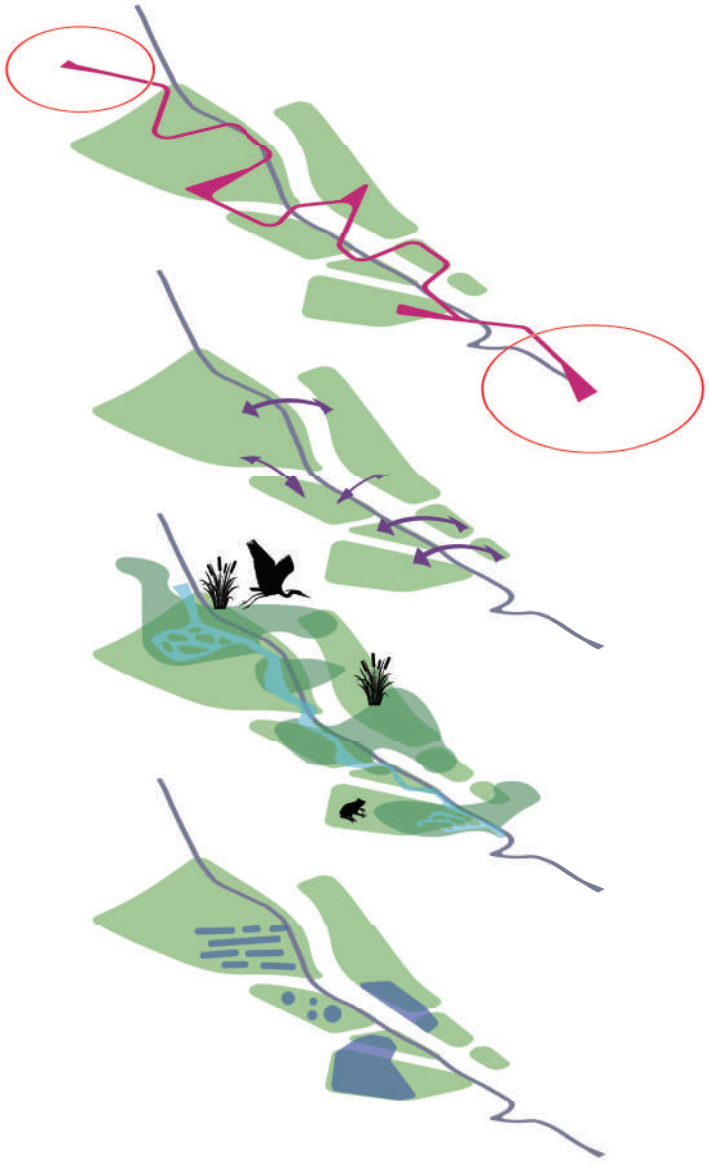
For the Transport systems to be sustainable, the cities population will need to be densified. Residential blocks will be developed in well-designed neighbourhoods, with all the amenities required within a convenient distance. Amenities such as shops, schools, parks and transport hubs. Developing the city with quality green spaces will increase the desirability for people to life there which in turn will increase property values, spurring further investment in the city.

Pretoria has a lot of vacant land that is unutilised. This land has the potential of becoming quality public spaces. The development of green spaces especially around the Apies River will increase biodiversity and create habitats for animals. This will generate a more resilient ecological system which can withstand shocks and pressures from the

7.8 The urban vision of Pretoria (Author, 2019).



7.9 An integrated transportation strategy for Pretoria (Author, 2019).



7.10 Design strategy for Berea Park Botanical Gardens (Author, 2019).

city or other external factors such as climate change. This system will provide passive ecological services such as cleaning the water of the river, providing oxygen and counteracting the heat-island effect.

Pretoria has organically developed activity nodes either through convenience or necessity. This urban vision does not seek to undermine this development, but rather to enhance its programming and encourage further sustainable development in the future.

7.5 Integrating the urban context

The Berea Park area has a mix of commercial and dense residential areas. The development of the design took into account the surrounding urban context. Many of the communities in the area are isolated by road-and-railways. Connection between these areas was a main design driver, specifically connecting the landscape in a pedestrian sense to other important amenities surrounding Berea Park. Intuitively, a series of pedestrian bridges and tunnels were designed to alleviate this issue. A simpler approach was also merely to design quality pedestrian walkways and cycle lanes, allowing for easier access throughout the area.

7.5.1 Public space

Developing a botanical garden adjacent to the Apies River in Berea Park is the primary design objective. However, the botanical garden will be a private garden as there is an entrance fee required for entry. Because of the need for public green space and to allow for access throughout the area, certain sections of the garden will be developed as public space and will be assessable during the day and closed during the evening to discourage nefarious activities and homeless people sleeping in the park.

Greenpoint Urban Park has a similar programme with free entrance to the park and it being open from 7h00 to 19h00 daily. They have security personnel patrolling the area and stationed at the entrances.

The local residence has a strong sense of community evident in their action plan for the Berea area, however the streets are quiet and seemingly abandoned due to the extreme levels of crime, drug use and prostitution in the area.

The Berea area surrounding the site will be rejuvenated by developing a well-designed street interface with safe and comfortable space for pedestrians.

7.5.2 The Department of Rural Development and Land Reform

The Department of Rural Development and Land Reform's new head offices are planned in Berea park. It is proposed in this dissertation that the buildings are positioned to the north of the site to create a street edge, with the buildings also creating a public square courtyard. The ground level of the new office building will be developed for commercial purposes with shops and cafés to spilling out into the public square. The building can also possibly house community amenities such as a community centre and child care facilities. Many of the government building in the city centre function successfully in this way.

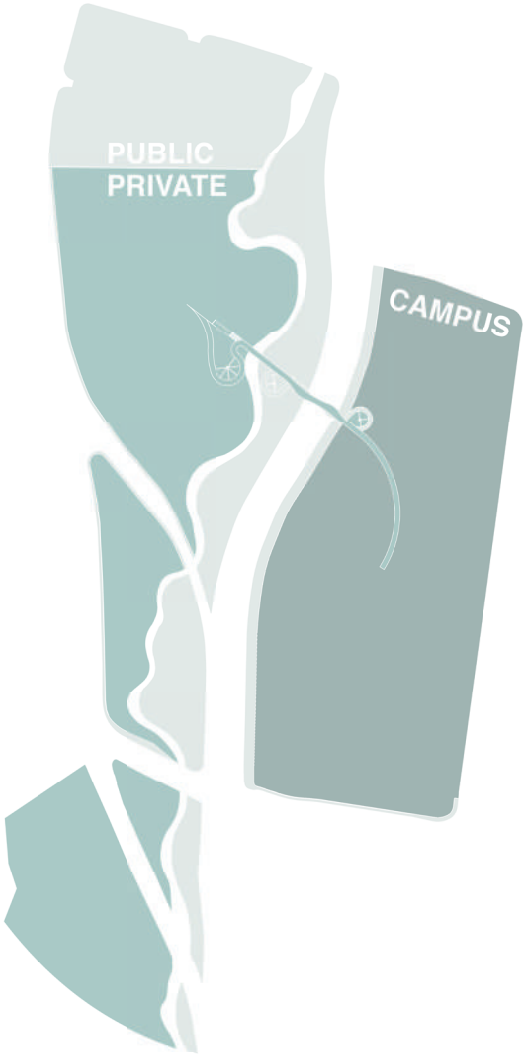
Rather than having an enclosed office building serving one purpose, this building will become a development anchor. This will provide many benefits in the area that will in turn attract more people to the Berea area, rejuvenating the community and allowing the streets to become safer and developing the area further.

7.5.3 University of South Africa

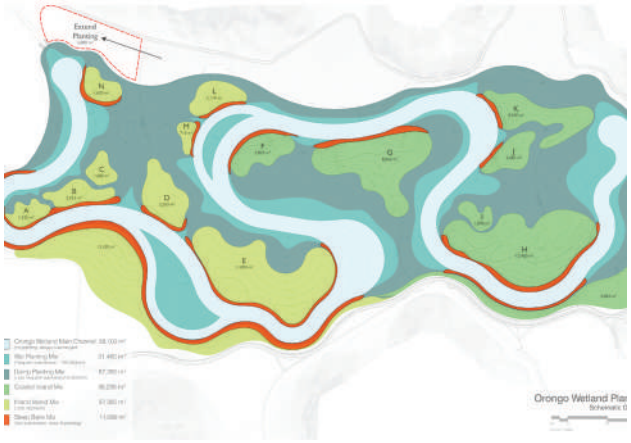
The UNISA Sunnyside campus to the east of Berea Park is a busy activity hub compared to the rest of the area. The Sunnyside Campus houses the Eskia Mphahlele Building which is UNISA's main registration hall. UNISA owns the entire area of the site east of Nelson Mandela Drive. The UNISA-owned property at the southern side of the Sunnyside Campus is not developed and has few derelict buildings. UNISA envisions to develop their campus further in the future.

For this dissertation, it is proposed to develop the area as a horticultural research facility for researchers and students to utilise for conservation research and student practicals. Furthermore, some residences are proposed for students and researchers to have the option of accommodation close by.

With Nelson Mandela Drive being one of the major entranceways into the city, it is important do design a gateway arrival experience. The gateway is meant to be viewed from a moving vehicle as one enters into the city. This is an important visual element as it provides the first impression of the city and welcomes people to Pretoria.



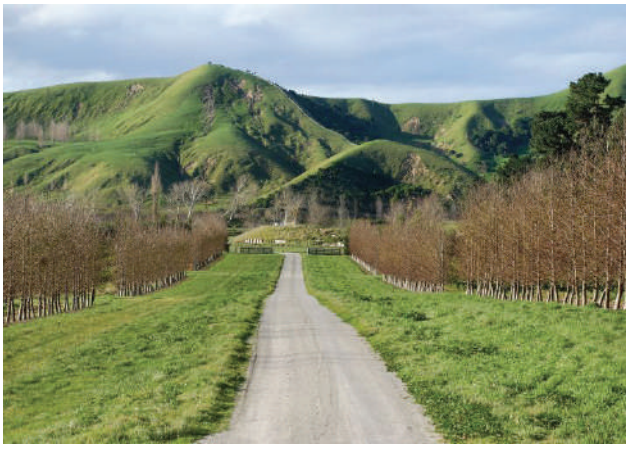
7.11 Diagram public and private locations (Author, 2019).



7.12 Wet land planting (NBW Landscape architects, 2019).

7.13 The sustainable farm at Orongo station (NBW Landscape architects, 2019).

7.14 Orongo station master plan (NBW Landscape architects, 2019).



7.15 Axis created too look onto a Maori burial ground (NBW Landscape architects, 2019).

7.6 Design Case Studies

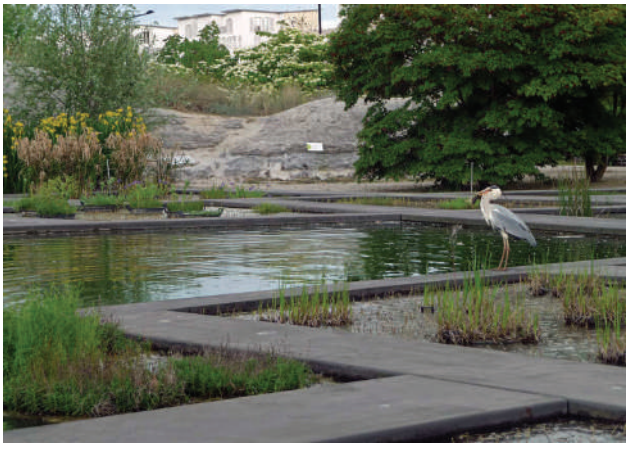
7.6.1 Orongo station | Thomas Woltz

Orongo station is a 3000-acre sheep farm on the East coast of the North Island of New Zealand. Colonisation and unrestricted sheep grazing have destroyed the natural habitat and native wildlife. Parts of the farm were rehabilitated to undo the 100 years of damage to the area. A massive reforesting effort planted over 500 000 trees on the previous sheep-grazed land, while still maintaining active agricultural activities which have become more productive. Also, 75 acres of fresh and salt water wetlands were restored and constructed. A major aspect of the project was the inclusion of local Maori tribes' people to restore the heritage burial grounds still in use on the site. Many Maori structures and earthworks where uncovered on site and incorporated into the design. Local people established nurseries to grow plants for the project contributing to the local economy. By integrating cultural and ecological landscape restoration with active, profitable agricultural operations, Orongo Station serves as a national model for

7.16 Bordeaux Botanical Garden (Landzine, 2019)

7.17 Bordeaux Botanical Garden master plan (Landzine, 2019)

7.18 The erodible soil embankments at Bordeaux Botanical Garden (Landzine, 2019)



7.19 The wetland at Bordeaux Botanical Garden (Landzine, 2019)

sustainable land management (NBW Landscape architects, 2019).

7.6.2 Bordeaux Botanical Garden | Catherine Mosbach

The typology of a botanical garden has been radically interpreted by Mosbach as a landscape only existing temporarily and always changing. The garden seeks not to have the user as merely an observer , but to have the user immersed in the experience of this garden. The garden represents the twelve environmental landscapes of the region, which were represented in miniature.

Mosbach Paysagistes interpreted, in a radical way the typology of a Botanical Garden. Rather than being a simple observer, the visitor is completely immersed in the experience of the garden. The rough cut-outs of different landscape typologies transcend their status of a 1:1 model of nature, placed on a deserted site they take the quality of an artistic sculpture. The pathways through the water basin bring the visitor into an intimate connection with the floating plants, and they brings them into the same environment and in the same situation of fragility (Landzine, 2019).

"Would a lover give an imitation gold jewel to their beloved? No. The same goes for landscape. I imitate nothing. I just try to be inspired with the power of what exists to look beyond what we know, because our life has a limited span and little time to discover its many 'treasures'" Mosbach.

7.7 Characteristics of the Design

The idea of the river being explorable by visitors to the garden is important to the design argument of this dissertation. Connection was not just important for people to get around, but it was also part of the argument that people need to be connected to the river, which can be more broadly expressed as a connection to nature. The experience of nature helps people to appreciate it more, building on the idea of plant blindness and making plants more noticeable.

The river interaction was designed to create a condensed experience of the phenomenology of a river. The objective thus is to immerse the viewer into a landscape which curates a display of living collections inspired by the river and its plant life.

The design of this experience was informed by the theory of plant blindness, creating a botanical garden which creates empathy and awareness towards the conservation of river habitats of the region. River habitat typologies where chosen to represent the rivers of the Lower Crocodile and Marico river basins within the botanical garden.

The river habitats were designed to mimic natural habitats, but a focus of the design was placed on the viewing of these habitats especially curating the display to highlight important aspects of these habitats and their plants.

Two possible approaches to this problem were explored. One approach would be to leave the channel in concrete and then using water from the river to create a riverine display next to the channel, effectively bringing the river to the user. The other approach was to dechannelise the river completely restoring it to a natural state, thus the user is then brought down to the river. The second approach was ultimately taken further as it provided the most benefits and design opportunities in regards to a botanical garden.

A final design driver was that of green infrastructure dealing with the flood. When a previously channelised river is naturalised, the issue of potential flooding arises as the channelised river was specifically engineered to handle certain storm events and transport the water away as quickly as possible. Many storm water strategies were employed to handle the storm water on site in an effort to reduce the amount of water flowing downstream and protecting the surrounding developments.

The Apies River on the site will be dechannelised and the embankments widened to return the river to its natural state.

This is done to create an aesthetic perception of the river. To create spaces which emulate the phenomenological experience of the river and to allow for interaction with the river.

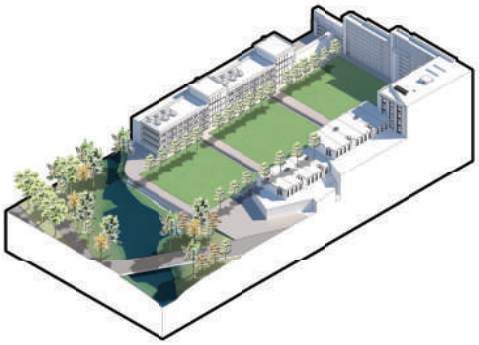
The historic form of the meanders of the river will be recreated where possible within the extent of the site, the original river flowed over a larger area than the site. This is done to lessen the danger of erosion as well as creating historical interest from a viewer's perspective.

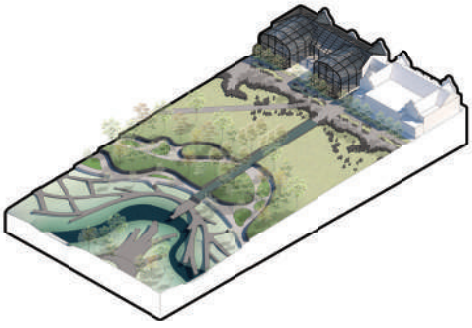
The benefits of naturalising the river above the ecological and aesthetic value are that flood risks are minimised when compared to a straightened concrete channel. The flood waters are slowed down and allowed time to infiltrate into the soil. The attenuation a natural flood system provides also reduces peak flows downstream (The Environment Agency, 2010).

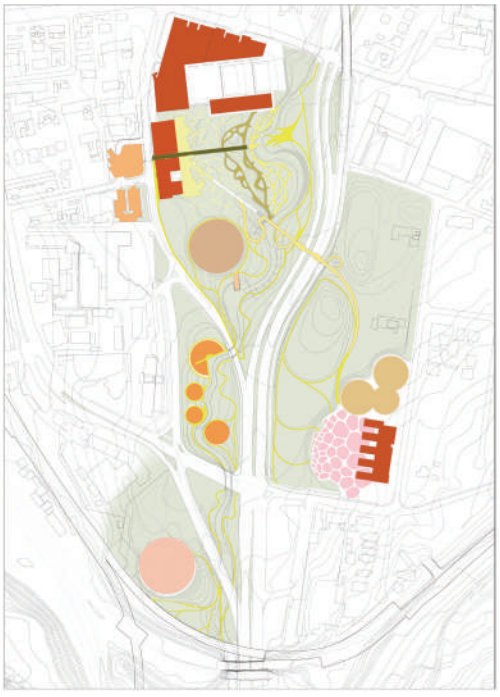
7.8 Sketch plans

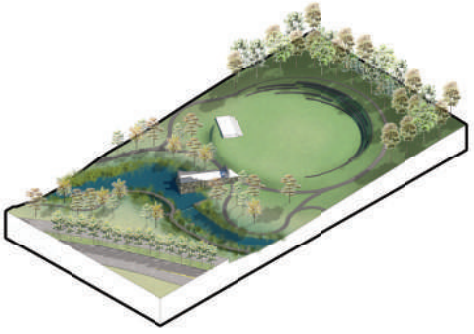
7.20 Creating plant awareness (Author, 2019)

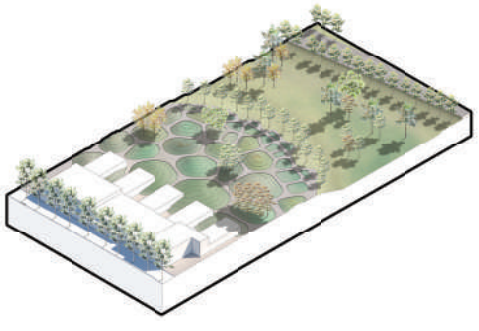
7.21 Berea Park Botanical Garden Master Plan (Author, 2019).

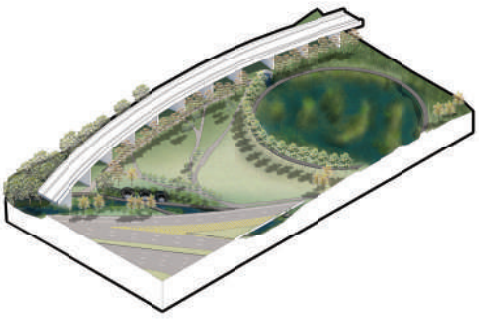




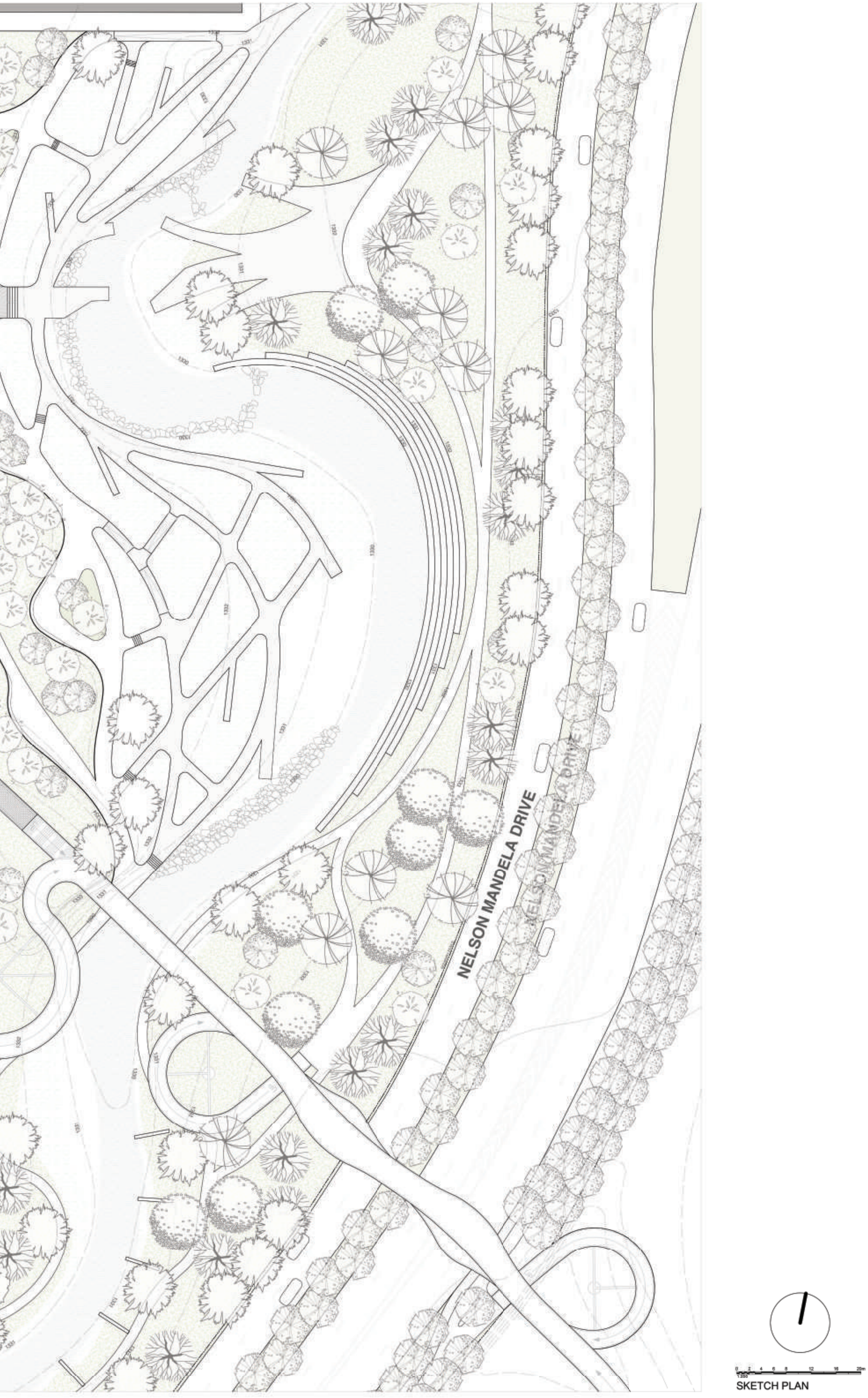






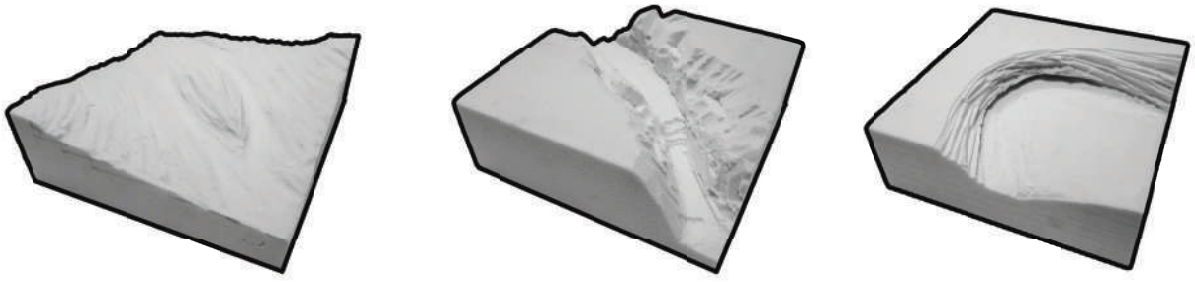


7.22 Berea Park Botanical Garden Sketch Plan (Author, 2019).



SKETCH PLAN

8 TECHNIFICATION



8.1 Foam model explorations (Author, 2019)

8.1 Technical approach

The technical approach draws from river forms, and the emphasis on the form generated by the explorations with the river simulation model. Form typologies are abstracted from the hydrological behaviour and dictate the design as a whole. This concept is used in the design of the garden and pulled through to the smallest design elements, for example, benches, lampposts, paving and fixings.

The experience of moving towards a river is important. Within the design, one moves from a harsh, exposed and hard-paved square to grasslands and meadows. As one moves further down on the journey, the pathways become meandering streams and the trees grow denser, leading into a woodland. As one exits the woodland, you find yourself suddenly confronted within a protected river with displays of riparian vegetation and the sounds of flowing water.

As a botanical garden, the design of spaces is focused on viewing plants. The design elements such as benches, walls, viewing decks and even materiality can potentially provide opportunities to view river habitats. Sensory engagements within these spaces are utilised to forward the phenomenological experience of the river's sense of place. All these concepts ultimately are drawn from the author's interpretation on counteracting plant blindness.

8.2 Technification of the river

8.2.1 Earth Works

The river will be dechannelised and the embankments worked down to a shallower gradient. Cut to fill will be balanced out with the creation of undulating hills and berms forming part of the design.

8.2.2 Erosion control

The concrete lining will be broken up into large pieces weighing an average of 150 kilograms. These pieces of concrete will then be used as erosion control along the river embankment in the form of submerged boulder groynes. The groynes will not be visible on the surface, but will still stabilise the embankment. The groynes are placed twenty meters apart, with the embankment in between being protected by a biodegradable geotextile pegged to the soil. This is to protect against erosion while the vegetation becomes established. Once the embankment vegetation has matured and filled out the entire river edge, the geotextile will decompose and the embankment vegetation will hold the soil in place.

In more high-risk zones where erosion is likely to damage structures or city infrastructure, a more robust erosion control strategy is necessary. These high-risk zones are usually on the outer embankment of the river curve where the flow velocity is highest thus causing more erosion. This should not be allowed to happen as the river will keep

8.2 Novartis Campus abradable walls (Vogt LA, 2019).

8.3 Novartis Campus abradable walls (Vogt LA, 2019).

eroding and creep towards structures like a road, potentially causing it to collapse.

To counter this, some of the outer bends will need to be completely erosion proof. This will be achieved through constructed concrete groynes with large boulders being placed around the groyne to break the water velocity and hide the concrete structure. The embankment between the groynes will be protected with a wire mesh weaved with a polymer matrix such as MacMat®R or similar. These geotextiles are specifically designed for steep embankments and high-risk erosion zones. The embankment will also be protected with placed boulders where the winter and summer base flow of the river comes in contact with the embankment. This creates a guard against erosion due to the constant flow of water. The wire mesh weaved with a polymer matrix geotextile is unaesthetic and will be below a mat of vegetation which alone will most likely be sufficient to hold the embankment. However, since it is a high-risk zone, the geotextile will be placed down for surety of erosion control.

In areas where people are encouraged to interact with the river high-risk erosion zones become a constructed embankment. The structure consists of a series of concrete beams stepping down into the river. The steps form a space for people to sit and enjoy the river and create vegetated terraces. The concrete beams completely prevent erosion and the terrace steps allow for a wider channel as the flood level rises allowing more water to move along the river.

8.2.3 Flood proof structures

The decked walkways in the riparian gardens are well within the rivers flood lines. This makes it crucial to design these structures to be floodable and not be damaged by the flood and associated debris. Firstly, the deck foundations are concrete footings which are installed one metre deep to provide stability in the saturated soil. Boulders are placed around the footing to protect against scouring of the soil. The whole deck structure is protected by a boulder berm which breaks the water velocity and causes the water to flood gently into the area. There are also strips of boulders under the deck walkways, placed perpendicular to the water flow to further break the water velocity. The riparian gardens will also be densely vegetated which will further reduce water velocity and scouring. The substructure of the deck walkway is galvanised steel which resists rust and is strong enough to take a hit from heavy floating debris. The decking material is grooved composite decking which is less prone to water damage and durable especially in a highly used area such as the riparian garden.

8.2.4 Retaining walls

Abraded embankment wall

The abraded embankment walls are a series of retaining walls required to lessen the slope gradient towards the river. The walls have a brickle texture that has been carved into patterns that are reminiscent of a river cutting into an embankment.

The walls create interest in the landscape as they seem to be naturally sculpted. The walls also focus the attention on the plants above it and opposite of the façade.

The walls are constructed by gradually reducing the cement content and increasing the coarseness of the material towards the face of the wall. This allows the outer façade to be sculpted with tools, but still have a structurally sound inner wall.

Rammed earth

Rammed earth walls are walls which consist of soil (usually locally sourced) which have been rammed or compressed in layers to form a solid structure. It is one of the oldest building techniques and examples that are more than a thousand years old still exist.

The rammed earth walls in the design are used only in the main axis walkway towards the river. Unlike the abraded embankment walls, the rammed earth walls have a contemporary look with a clean, even surface and sharp corners. This is to differentiate the main walkway from the wandering paths. Rammed earth was chosen because of the patterning of the layers being reminiscent of exposed soil horizons which reinforces the narrative of moving down to the river.

The rammed earth walls used in the design function like retaining walls, with a vegetated area being held in place. The retaining walls vary in height, but never exceeds 1,5 meters. As the walls are in contact with the soil, it is crucially important to keep excess moisture away from the wall, as rammed earth walls can lose structural integrity when absorbing large amounts of moisture.

To counter these weaknesses, a steel mesh is embedded into the wall to reinforce the integrity of the wall. The soil used in the construction will also be stabilised using cement mixed in a ratio of 1:7. It is possible not to add any stabilising material to the soil; however, the wall will be more abradable which is not desired in this instance.

The quality of the soil is also important as the soil cannot have a high clay content; a clay content of between 20 and 25% is ideal. If the clay content of the soil is higher than 25%, then sand may be added to compensate. The soil will also be mixed with waterproofing additive to create a hydrophobic material which will resist the absorption of moisture into the wall. Furthermore, the wall will have a standard retaining wall drainage system behind it to get rid of excess moisture.

The rammed earth wall will have a coping to guard against erosion from rain. The coping consists of a steel angle iron which allows soil to be held and vegetation to grow up to the edge of the wall.

8.2.5 Pathways

The Main River Walk

The main axis from the entrance of the park takes one down all the way to the river. The pathway seems to be cutting into the landscape with the rammed earth walls revealing the soil horizons. The materiality of the pathway consists of slate strips packed in an irregular flowing wave pattern. This is taken from the idea of the pathway becoming a river and the user experiencing the landscape as the river. The rough texture of the pathway is also in contrast to the smoother rammed earth walls, eluding to the idea of the stony riverbed. The pathway is constructed using rough slate strips tightly packed on top of a sand bed.

The Garden Pathways

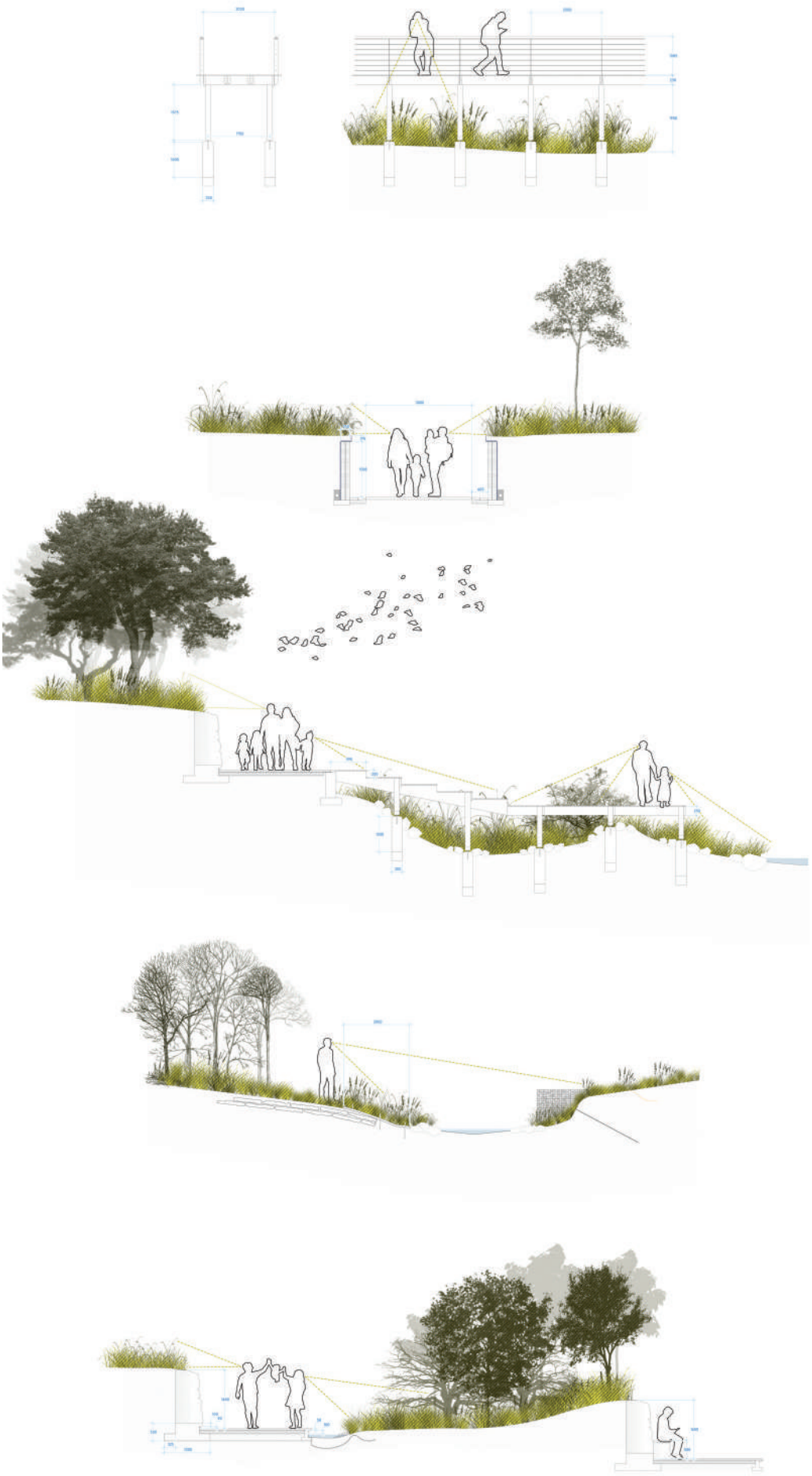
The garden pathways are meandering routes throughout the botanical garden, encouraging exploration between the different riverine zones and connecting to other parts of the botanical garden. The pathways are simple cast concrete that have been tined with an irregular wave pattern. The pattern is made by hand using a bullfloat. The subtle pattern emulates the ripples found in a sand bank at the bottom of a river. The patterning also provides a rougher surface to keep people from slipping when the surface is wet. It is necessary to use concrete paths as opposed to stabilised gravel (this was the original intent) because of the nature of downpours in Pretoria which are very heavy and fall in a short amount of time. This would have eroded the gravel pathways away over time. Concrete is also a good choice since it can be poured into a formwork to create neat flowing lines.

8.2.6 Rainwater management and Drainage

Pretoria receives most of its rain during the summer months (December to February). Downpours in the area are typically very heavy cloudbursts which fall in a short amount of time generating significant amount of runoff.

After the major earthworks are completed, the entire site would drain towards the river. Within the vegetation zones, a few retaining walls create terraces which slows down the runoff. There are a series of rain gardens on top of the terraces collecting rainwater and allowing for the precipitation to infiltrate into the soil. A rain garden is merely a vegetated depression in the ground where rain water can accumulate and slowly infiltrate into the soil. The water from the pathways are also diverted to these rain gardens. Each rain garden has an overflow pipe which drains excess water directly to the lower terrace. Once the second terrace is filled, the water drains to the river. These overflow drains are important to maintain control of the pooled water and to ensure that the water does not overflow onto the retaining walls.

The events space lawn will have a controlled agricultural drainage system. This is to allow for the lawn to drain and dry relatively quickly in case an event needs to take place there following shortly after a rain event. In a major flood event, the gate in the control structure can be lowered allowing the entire amphitheatre to flood and detain the flood water. After the flooding has passed, the gate can be lifted and the system will drain within a few hours releasing the flood water slowly back into the river.



8.4 Sections (Author, 2019)

8.3 Technology

8.3.1 Riparian Sods

Riparian sods are pre-planted biodegradable geotextiles which similar to turf, can be rolled out on a river embankment to have an instant vegetated area. The sods are submerged in water and planted with native emergent and submergent aquatic vegetation. Allowing the plants to grow in the biodegradable mats reduces stress to the plant. Hydraulic erosion is minimized because of the vegetated geotextile mat, which creates a biodegradable barrier for the substrate below.

These sods will be used on the river embankments where the summer and winter base-flow comes into contact with the embankment. The sods can be grown on site in an allocated location and after at least one growing season, they can then be transferred to the river embankment.

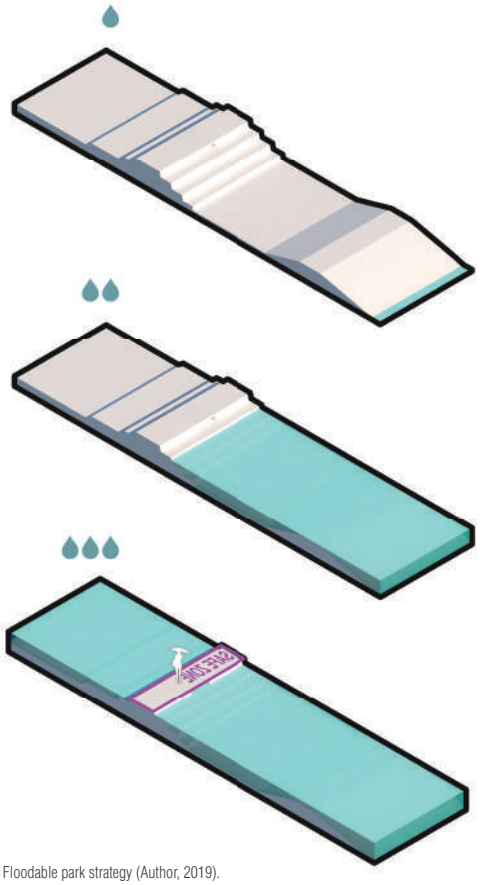
The mature plants can quickly establish their roots in the soil to prevent them from being washed away by the river.

8.4 Flooding of the river

The Berea park Apies River catchment area is 46.6 km² and includes Monument Park and Waterkloof to the East and Elardus Park, Zwartkop air force base and Littleton manor to the South.

To deal with a flood event, various strategies are employed to handle the flood event and prevent or at least minimise damage to property. The rehabilitated river has shallower embankments allowing for a larger section of the channel to flood. The velocity of the flood water is also much slower because of the river embankments being vegetated. This results in more infiltration into the soil and lessens the danger to people and animals. Detention and retention strategies are also used. This is done by creating depressed areas within the floodplain. When a flood occurs, the river fills up these areas which then holds the water either until it has all infiltrated into the soil or it is released back into the river at a controlled rate. The floodable event space and raingardens have been discussed in a section 8.2.6, but these are also included in the overall flooding strategy for the botanical garden.

The point downstream under the Justice Mahomed Street Bridge where the rehabilitated river converges with the concrete lined Apies River will cause a critical flow, which means the water level will rise at that point. This is because a substantial amount of water from the slow-flowing wide channel is suddenly transferred into a fast-flowing narrow channel. To counteract this, the critical flow will need to be



8.5 Floodable park strategy (Author, 2019).

calculated and the rate of convergence will be adapted to ensure the water level does not spill over the bridge. The end result will thus be to create a wide enough area of convergence by adding more culverts under the bridge.

To ensure these systems remain in peak performance, a flood maintenance plan will be necessary for the botanical garden. It is important to maintain the river stream and remove all obstructions and debris from the channel prior to a flood event. It is also important to keep drainage lines and culvers free of sediment and other debris.

8.5 Planting design

The planting choices in the botanical garden revolved around the endemic riverine habitats of the Lower Crocodile and Marico river basin. The objective is to display these plants in such a manner as to

generate a sensory experience which will draw attention towards the plants and riverine habitats. This is done to create awareness of the need to conserve the regional riverine habitats.

The endemic plant life of the region mainly consists of plants from the Lowveld bioregion.

The planting strategy is to create planting groups within their respective riparian zones, grouping plants according to their moisture preference. Based on the theory plant blindness, plants will be arranged so as to interact with the user's senses. Examples of these interactions would be:

Grasses brush past one's legs as you move through the field the wind gently swaying them forming ripples across the landscape. Trees creating dappled shade shining down rays of sunlight softly on the undergrowth. The sound of a stream flowing over a rocky riffle with reeds growing in between the stones.

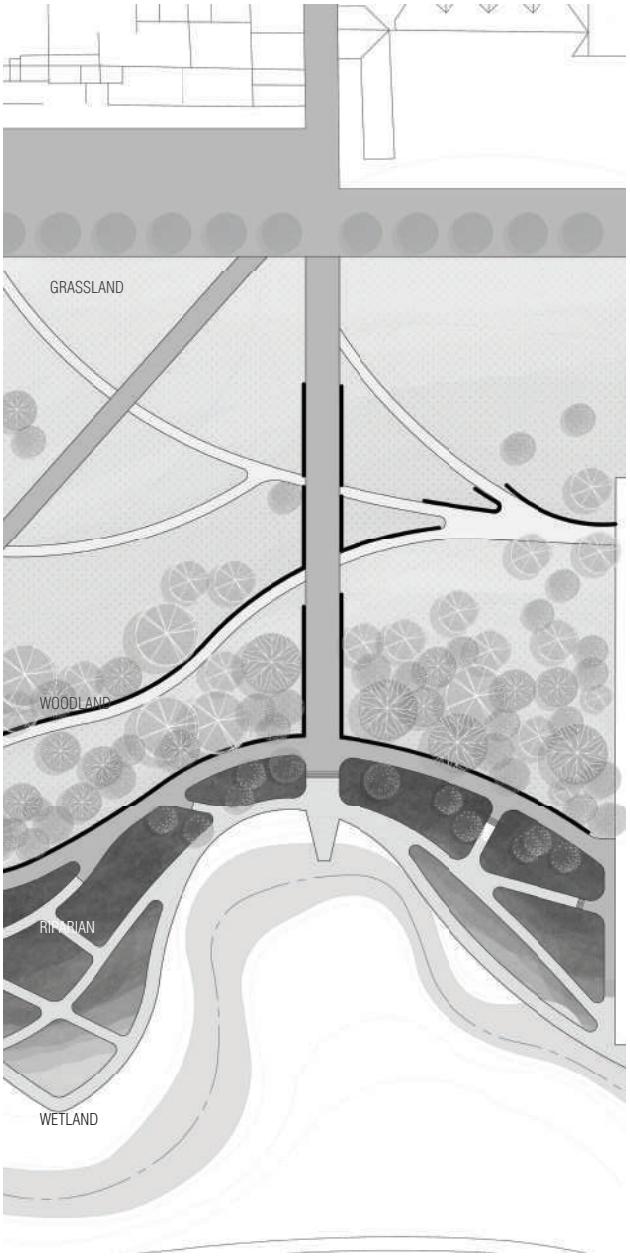
8.5.1 Riparian zones

The plant communities within river systems are categorised into riparian zones corresponding to wetness.

Zone 1: Permanently wet. The stream or channel-bed zone that is permanently or semi-permanently wet. It is flooded, at least part of the time every summer and supports largely hydrophytic (water-loving) vegetation. In some areas, the soils are often rocky and difficult to plant. Plant flood tolerant species. Plants that grow in this zone are sedges, reeds, various bulbs and irises.

Zone 2: Seasonal wet. The lower bank zone that is moist and is frequently waterlogged during the wet season. This may be a very narrow zone in a channelised or confined stream or a wide zone in an unconfined stream. Moisture usually decreases from the boundary of Zone 3. Shrub and weed competition may be intense. Soils are often sandy and/or rocky and droughty. Plant both flood and drought tolerant species. Plant communities include grasses.

Zone 3: Temporarily wet. The bank top zone that is usually wet or inundated for short periods during the wet season. This zone supports primarily upland vegetation, although some Zone 1 and 2 species may be found at the boundary of Zone 2 and 3. Plant drought tolerant species. This zone will be the buffer zone between development and the wetland/stream. This zone supports more woody plants such as perennial shrubs as well as trees (Wilken, 2019, p. 4).



8.6 Planting experience down to the river (Author, 2019).

Kirkia wilmsii

Erythrynum lysistemon

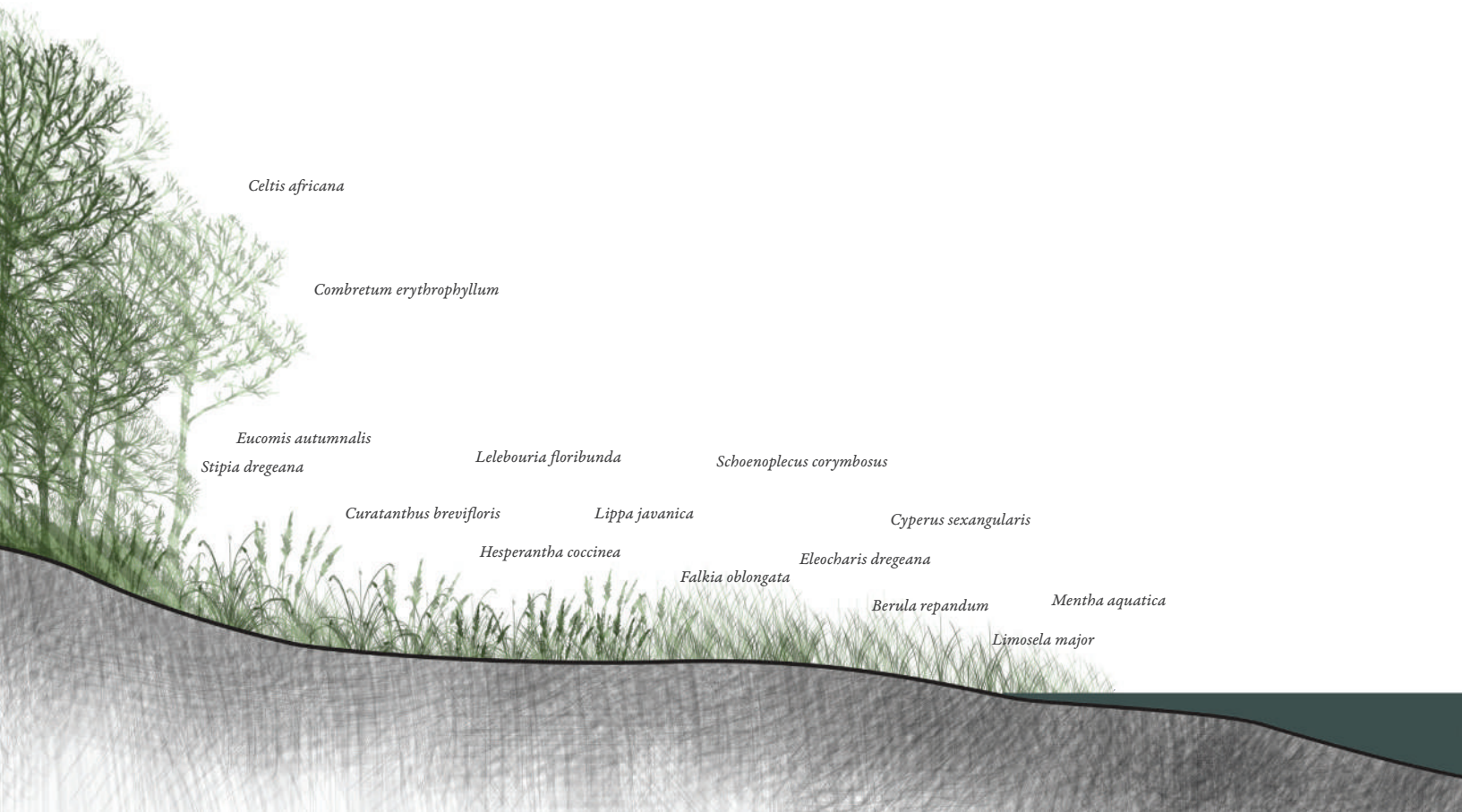
Setaria sphacelata

Melinis nerviglumis

Hyperthelia dissoluta

Kniphofia ensifolia

Gomphostigma virgatum


Celtis africana
Combretum erythrophyllum
Eucomis autumnalis
Stipia dregeana
Lelebouria floribunda
Schoenoplecus corymbosus
Curatanthus brevifloris
Lippa javanica
Cyperus sexangularis
Hesperantha coccinea
Eleocharis dregeana
Falkia oblongata
Berula repandum
Mentha aquatica
Limosela major

9 CONCLUSION

It was proposed that the river system habitat in Pretoria can be restored through the creation of a botanical garden, which represents the river ecology and local vegetation types, to provide an experience of the river. This generates awareness and empathy for river habitats and addresses plant blindness which in turn promotes the conservation of river plant species. It was also proposed that the fragmented pieces of abandoned land in the Berea area can be stitched together creating a green space connected to other parks in the city.

It is evident that Pretoria's waterways need to be preserved. Currently, river habitats are being lost to urbanisation and the divide between people and nature is growing. The natural environment in and around Pretoria has significant cultural and natural heritage value. However, access to these nature areas is limited to vehicular transport.

People have become ignorant about the perception of plants , with plants being perceived as a green backdrop. This is because of inherent biases of people to ignore the environment around them in favour of more active attention in the busy world. The intention of this study was to implement a small-scale regional botanical garden in the Pretoria inner city to showcase the region's riverine and wetland plant species. The Apies River running through the site was the main driver for the intent of creating a riverine botanical garden focussing on the regional riparian, aquatic and wetland plant life.

The river system was rehabilitated with its natural ecology restored. The aim was not to return the river to its complete natural state, but rather to create valuable amenities for city goers, researchers and tourists. The successful development of this botanical garden could be viewed as a new typology of small-scale botanical gardens. This typology could pioneer new ideas of what a contemporary botanical garden should be an ecologically rich environment stitched into the urban landscape which creates a symbiotic relationship for future development of both the human and natural environment.

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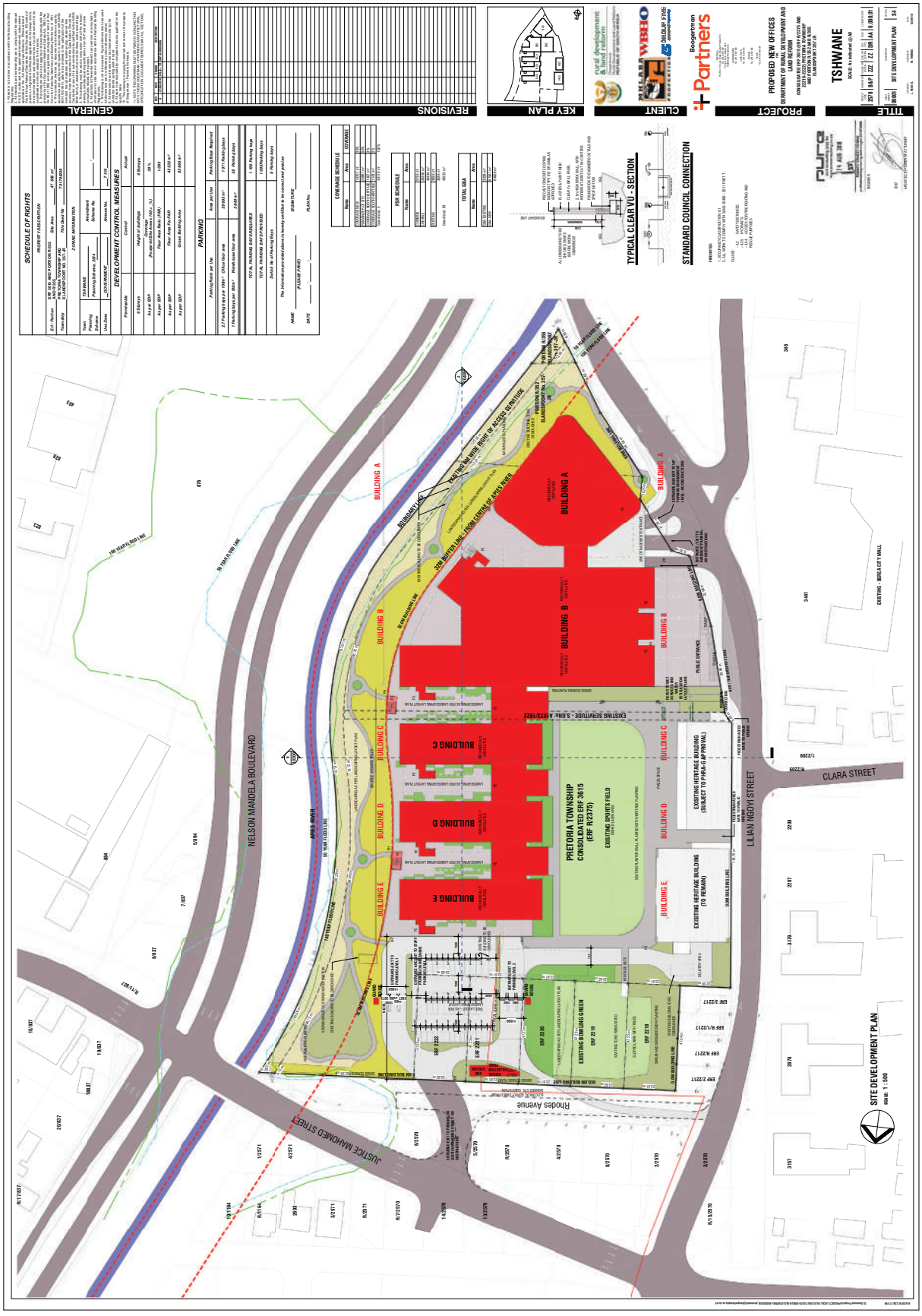
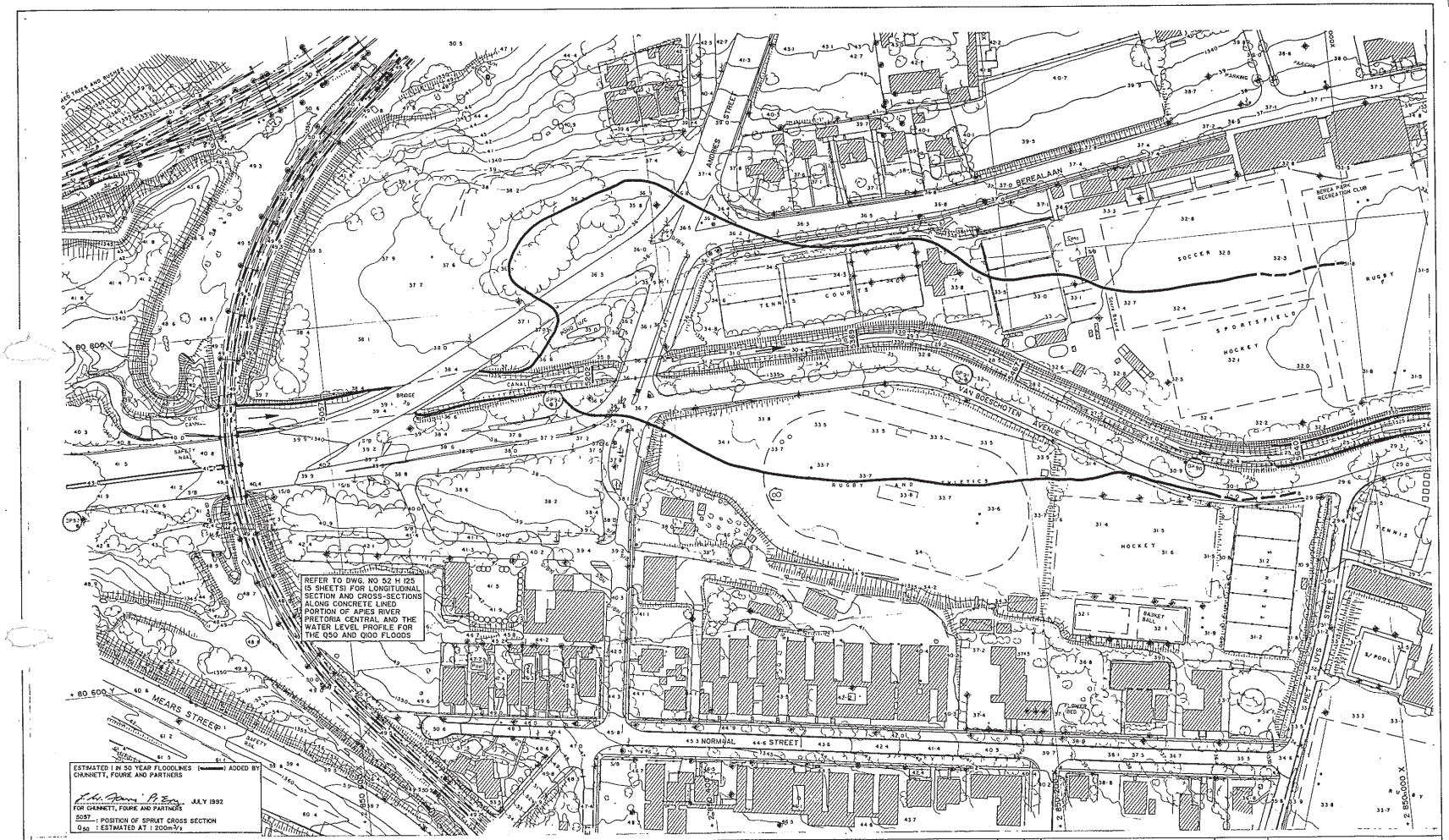
10 APPENDIX

10.1 Department of Rural development and land reform planned offices



Department of Rural Development and Land Reform new Head offices (Boogertman, 2019)



KOÖRDINAATLYS		Lo 29°	
	Y KONSTANTES	X	
PUNT NR	± 0,00	+ 2 800 000,00	HOOGTE
DP 90	+ 80 670,35	+ 50 108,34	1330,809
DP 91	+ 80 731,12	+ 50 229,32	1332,351
DP 92	+ 80 742,14	+ 50469,83	1337,089
DP 93			1342,509

NOTA :

KARTERING GEDOEN DEUR DEETLEFS EN VILJOEN VIR PREVIA KONSORTIUM GEDURENDE APR '87 TOT NOV '87.

0 10 20 30 40 50 100m
SKAAL 1 : 1 000

CONSULTING ENGINEERS / RAADGEWENDE INGENIEURS
CHUNNETT FOURIE & PARTNERS/VENNOTE
6th FLOOR, BANK LANE BUILDING, 269 ESSELEN STREET, SUNNYSIDE, PRETORIA 0002
6de VLOER, BANKLAANGEBOU, ESSELENSTRAAT 269, SUNNYSIDE, PRETORIA 0002
TEL: (012) 341-1535 FAX: (012) 341-1562 TELEX: 321468

No. Nr.	AMENDMENTS/WYSIGINGS	APPR. GDK.	DAT

	DATE	J.S. DRAWN/GETEKEN	DATUM 8.90
DESIGNED/ONTWERP			
CHECKED/NAGESIEN		P.B. TRACED/NAGETREK	8.90
DWG No / TEK. Nr		APPROVED/GOEDGEKEUR	9/92
SHEET VEL 4 OF VAN 4 SHEETS VELLE		SCALE SKAAL 1 : 1 000	

CITY COUNCIL OF PRETORIA
CITY ENGINEER'S DEPARTMENT

STADSRAAD VAN PRETORIA
DEPARTEMENT VAN DIE STADSINGENIEUR

CITY ENGINEER/STADSINGENIEUR	CHIEF ENGINEER (R&S)/HOOFINGENIEUR (P&S)	CONTRACT/KONTRAK
C C DURAND Pr.Eng	S J VAN AARTSEN Pr.Eng	

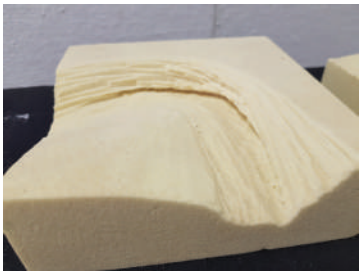
TITLE / TITEL
APIES RIVER CATCHMENT
CONCRETE LINED APIES RIVER CANAL THROUGH PRETORIA CENTRAL
ESTIMATED 1 IN 50 YEAR FLOODLINES FOR EXISTING CONDITIONS

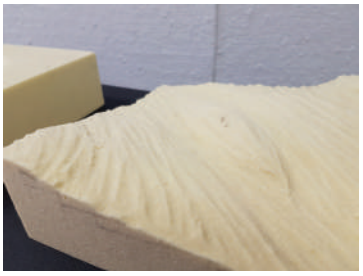
REFERENCES/VERWYSINGS	APPROVED/GOEDGEKEUR	DATE/DATUM	DWG. No. / TEK. Nr.

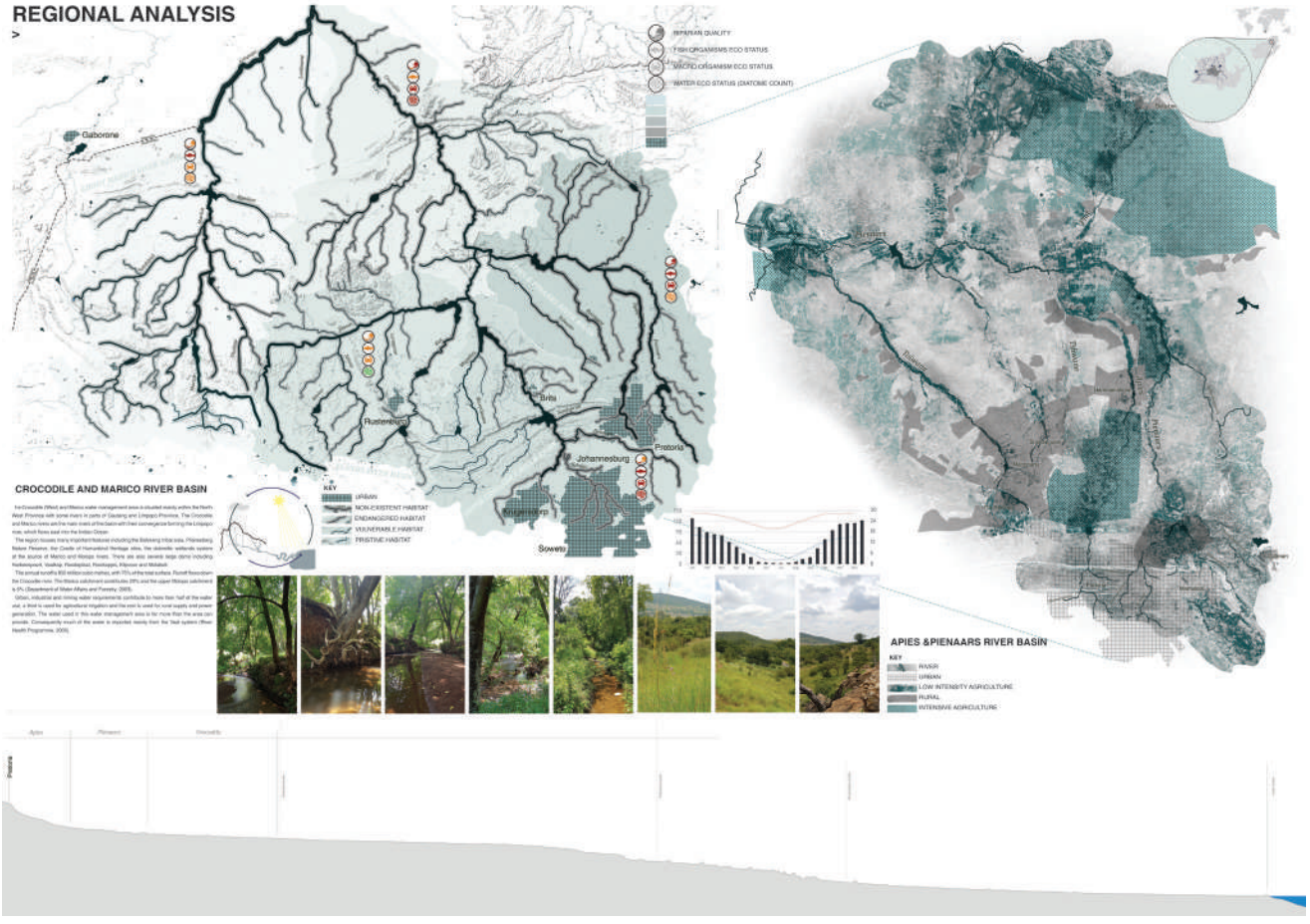
P 4116/3 A29

1990 flood-lines Berea Park (DAF, 2019)

10.3 Presentation






REGIONAL ANALYSIS
Gaborone
Rustenburg
Brits
Johannesburg
Pretoria
Sowetu
CROCODILE AND MARICO RIVER BASIN
KEY
URBAN
NON-EXISTENT HABITAT
ENDANGERED HABITAT
VULNERABLE HABITAT
PRISTINE HABITAT
APIES &PIENAARS RIVER BASIN
KEY
RIVER
URBAN
LOW INTENSITY AGRICULTURE
RURAL
INTENSIVE AGRICULTURE


RIVER DESIGN STRATEGY
MASTER PLAN
DETAIL SECTIONS
SKETCH PLAN

URBAN ANALYSIS

>

SITE ANALYSIS

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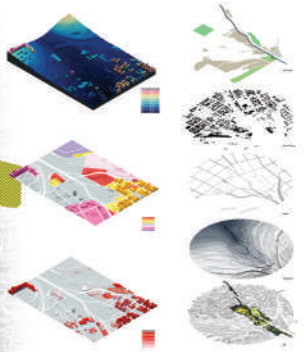
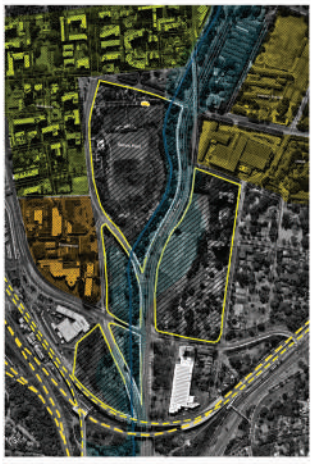
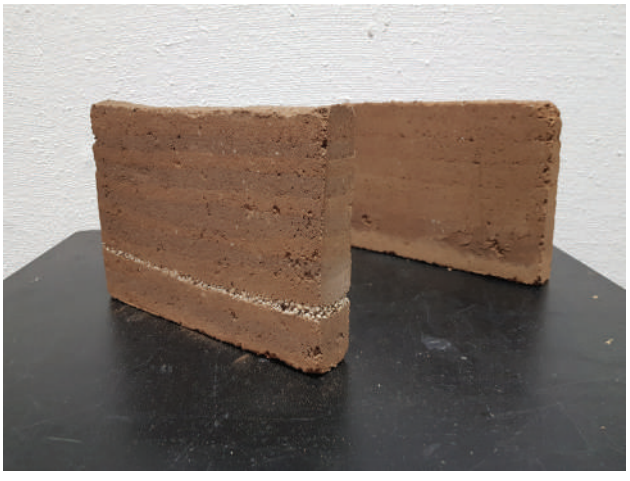
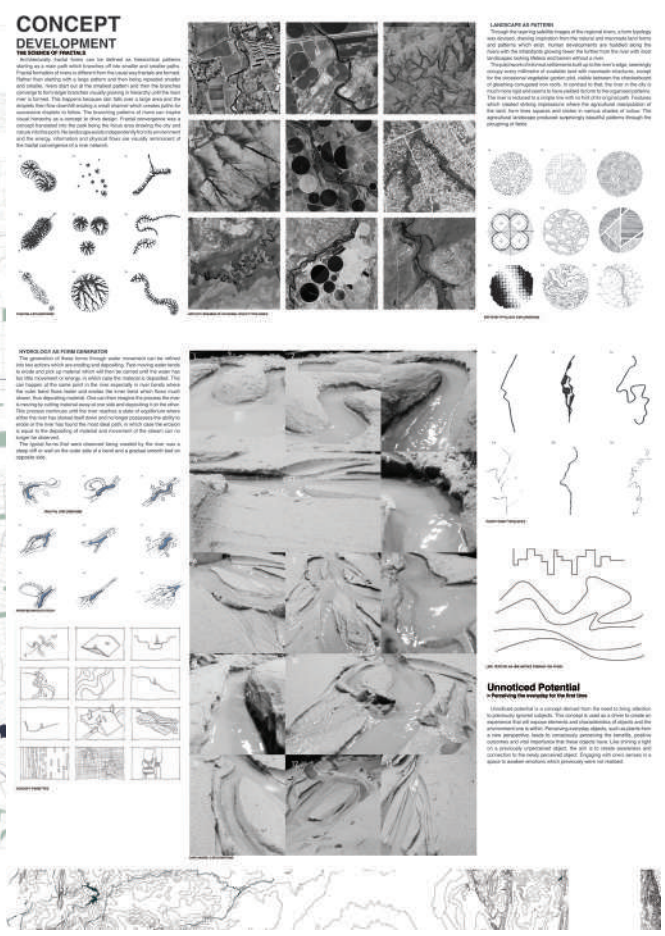


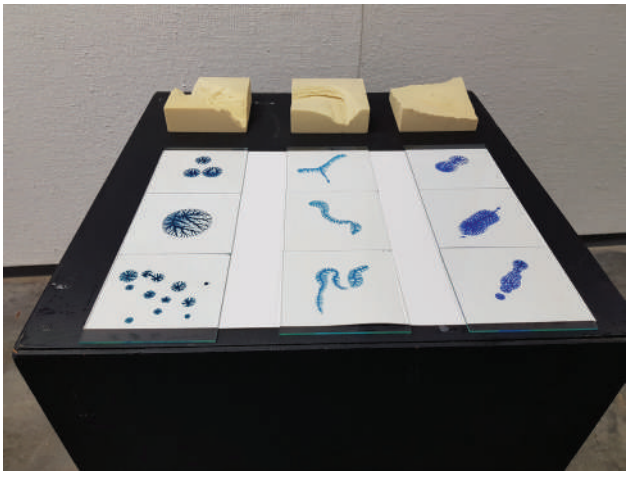





PROGRAMME
POPULATION
2,472612 inhabitants
86,670 m² city park space
0.98 m² per person
Curitiba

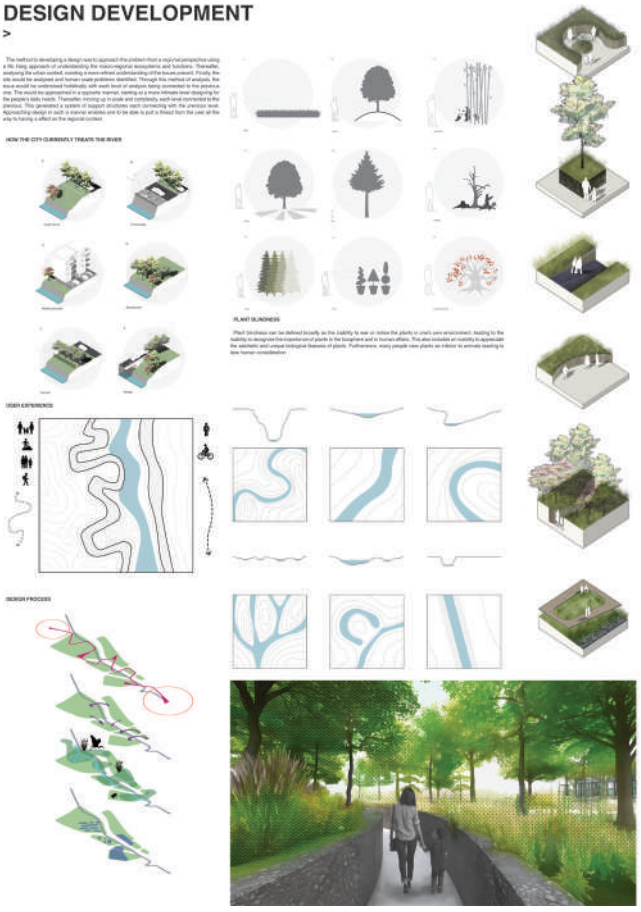

CONCEPT
DEVELOPMENT
Unnoticed Potential


Hedges Against Extinction



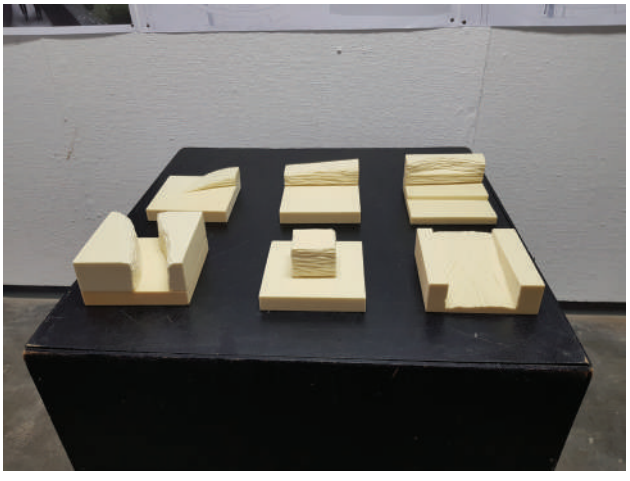
DESIGN DEVELOPMENT

>



MASTER PLAN

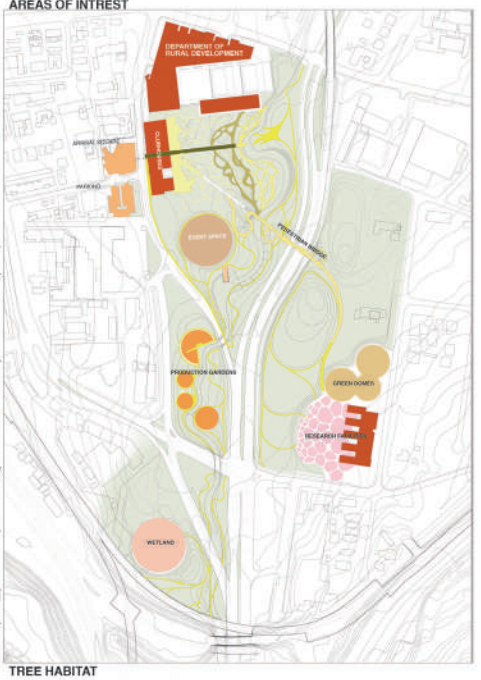
>



MASTER PLAN

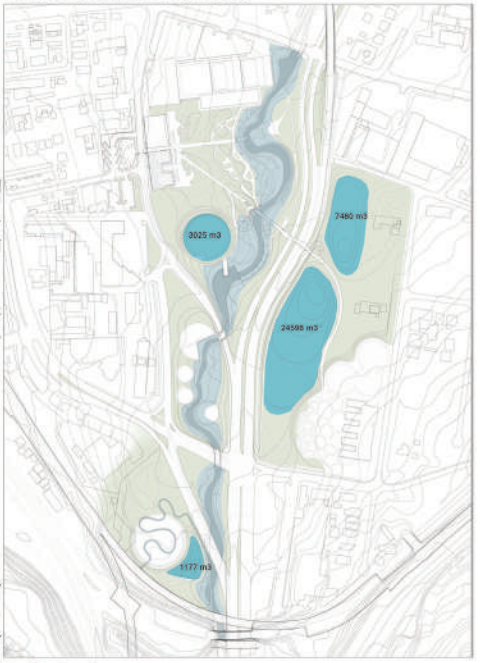
>

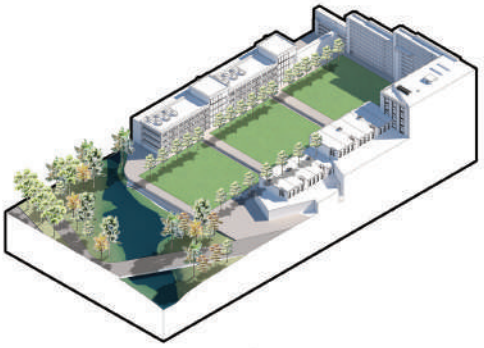
AREAS OF INTREST



TREE HABITAT

ATTENUATION AND RETENTION ZONES

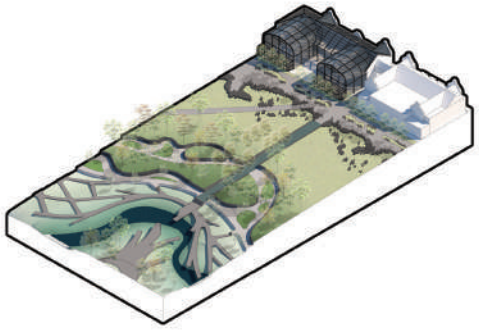




1 BOWLING GREENS

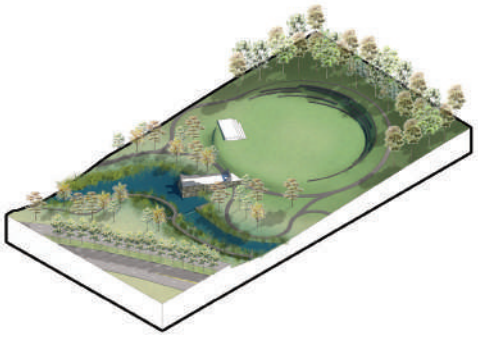
The Department of Rural Development and Land Reform's new head offices are planned in Berea park. It is proposed in this dissertation that the buildings are positioned to the north of the site to create a street edge, with the buildings also creating a public square courtyard. The ground level of the new office building will be developed for commercial purposes with shops and cafes to spilling out into the public square. The building can also possibly house community amenities such as a community centre and child care facilities. Many of the government building in the city centre function successfully in this way.

Rather than having an enclosed office building serving one purpose, this building will become a development anchor. This will provide many benefits in the area that will in turn attract more people to the Berea area, rejuvenating the community and allowing the streets to become safer and developing the area further.



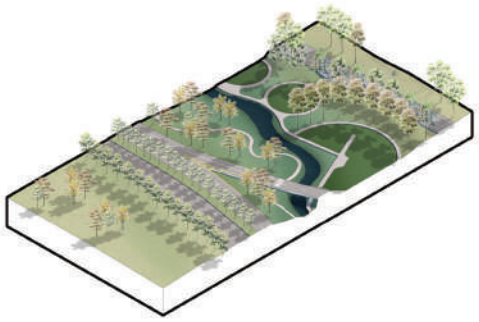
2 RIVER WALK

The main axis from the entrance of the park takes one down all the way to the river. The pathway seems to be cutting into the landscape with the rammed earth walls revealing the soil horizons. The materiality of the pathway consists of slate strips packed in an irregular flowing wave pattern. This is taken from the idea of the pathway becoming a river and the user experiencing the landscape as the river. The rough texture of the pathway is also in contrast to the smoother rammed earth walls, eluding to the idea of the stony riverbed. The pathway is constructed using rough slate strips tightly packed on top of a sand bed.



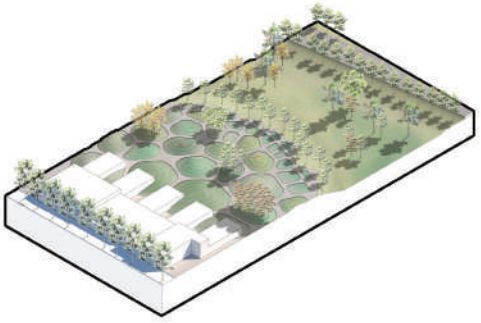
3 EVENT SPACE

An event space in the garden that can host events of any kind from horticultural societies to music festivals; this will serve as an additional income to the botanical garden.



4 PRODUCTION GARDENS

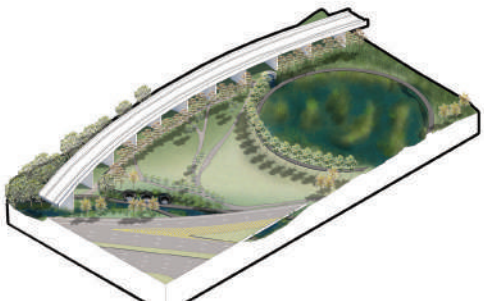
Botanical displays of cultivated crops traditionally grown by the people of the region.



5 WETLAND WALKWAY

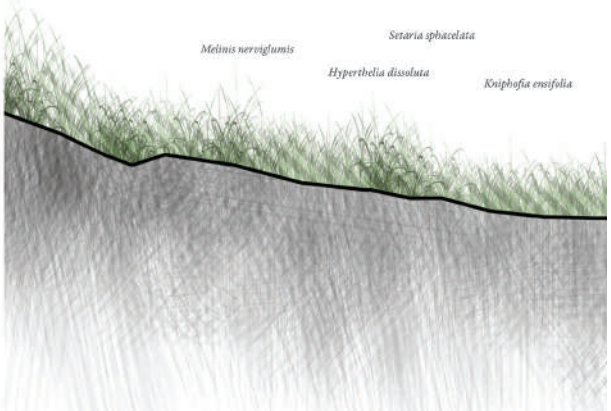
The UNISA Sunnyside campus to the east of Berea Park is a busy activity hub compared to the rest of the area. The Sunnyside Campus houses the Eskia Mphahlele Building which is UNISA's main registration hall. UNISA owns the entire area of the site east of Nelson Mandela Drive. The UNISA-owned property at the southern side of the Sunnyside Campus is not developed and has few derelict buildings. UNISA envisions to develop their campus further in the future.

For this dissertation, it is proposed to develop the area as a horticultural research facility for researchers and students to utilise for conservation research and student practicals. Furthermore, some residencies are proposed for students and researchers to have the option of accommodation close by.



6 WETLAND WALKWAY

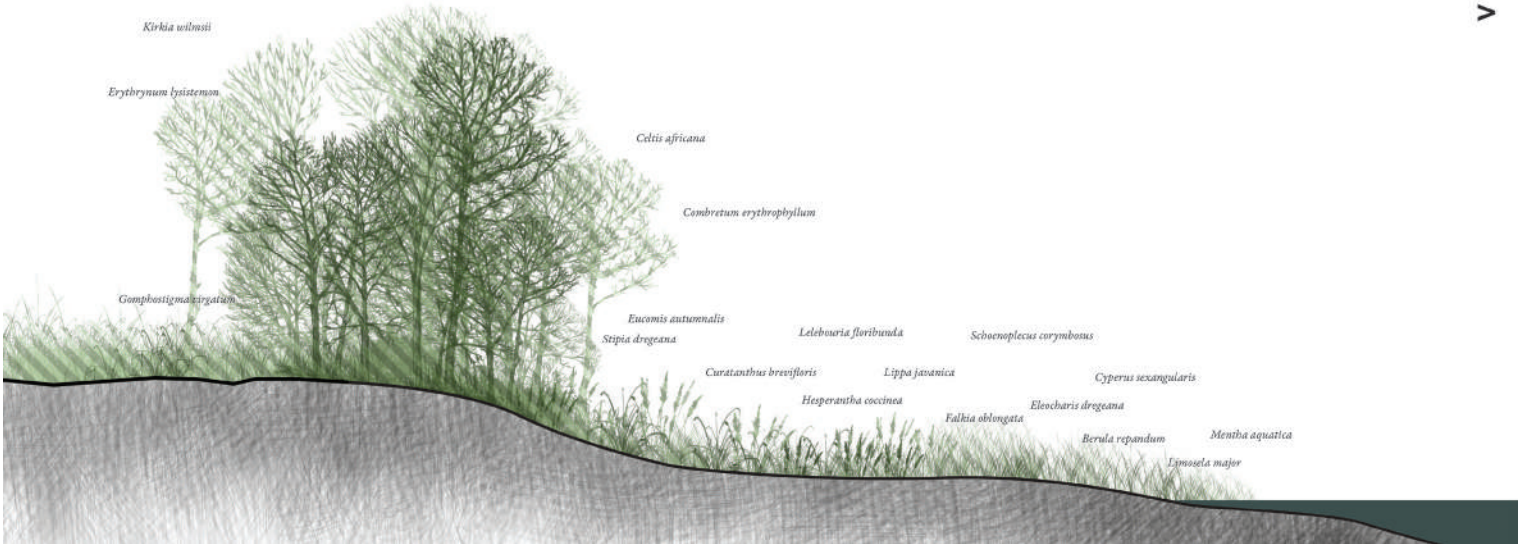
A 2m high circular walkway which gods the wetland. The wood used in the decking is a wood and plastic composite which is highly durable and long lasting in weather and higly trafficed areas. The walkway has signage along the way which informs users of intresting elements in the wetland.



SKETCH PLAN

SKETCH PLAN

>



DETAIL SECTIONS

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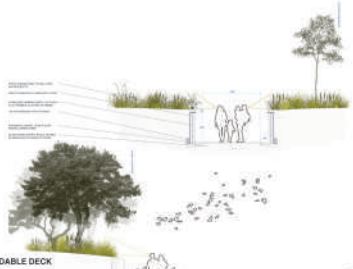
1 WETLAND WALKWAY

2 RAMMED EARTH WALL



3 FLOODABLE DECK

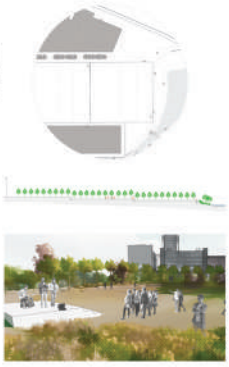
4 EMBANKMENT STABALISATION

5 ABRADABLE WALLS

1 RIVER WALK

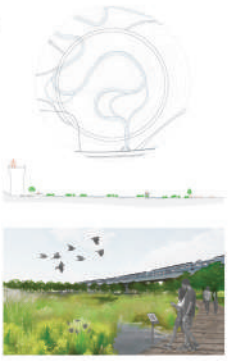
2 RESEARCH CENTRE

3 BOWLING GREENS



4 EVENT SPACE

5 WETLAND



6 BRIDGE