Living Drosscape

Remediating urban disconnections

Living Drosscapes

remediating urban disconnections

By

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requirements for the degree
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Declaration

In accordance with Regulation 4(c) of the General Regulations
(G.57) for dissertation and thesis, I declare that this thesis, which I hereby submit for the degree Master of Landscape Architecture (Professional) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

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.

Gareth Faul

Site Location
Linbro Park Landfill Site
Portion 1 of the Farm Bergvallei 37 IR and
Portion of the Farm Lombardy 36 IR
Gauteng Province
-26.082610, 28.117989

Current operation of the site: Closed landfill site, currently undergoing final capping processes

Research Field: Environmental Potential (EP)

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

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Abstract

"Adaptively re-using waste landscapes has become one of the twenty-first century's great infrastructural design challenges" - Alan Berger

The study of this dissertation aims to understand how the principles of landscape architecture and the theory of urbanisation can be used to reprogram the "waste landscapes" in South Africa.

Growth, in all manner and forms, creates waste. In the urban environment, these "waste landscapes" create fragmentation within the city, acting as "holes and barriers" in urban development. In South African cities, the effects of Apartheid urban planning has led to purposeful "waste landscapes" to deliberately separate social groups through the use of mine dumps, landfill sites and enclosed communities. Therefore, there is a need to remediate the past and create socially justified connections for communities that are cut-off from economic urban nodes.

Johannesburg, which is one of the provincial capital cities in South Africa, has a goal to become the "Future African city" in 2040 as set out by the City of Johannesburg Metropolitan Municipality, in their report, Spatial Development Framework 2040. As part of this framework, an area along the N3 and N1 highways that links Johannesburg and Pretoria, has been dubbed the "N3 development corridor." A section of this corridor will be used to explore an intervention that relates to landscape urbanism and its principles of adapting and re-using a "waste landscape". The "waste landscape" in question is the Linbro Park Landfill Site which is currently undergoing its final capping process as the site closed in 2005. The landfill and the N3 act as barriers between the previously disadvantaged community of Alexandra and the future development and economic potential of Linbro Park.

The design objective is to adaptively reuse the landfill into a public green space that contributes to reconnecting urban fragmented communities within the region, while also providing ecologically sound solutions for the remediation of a landfill site.

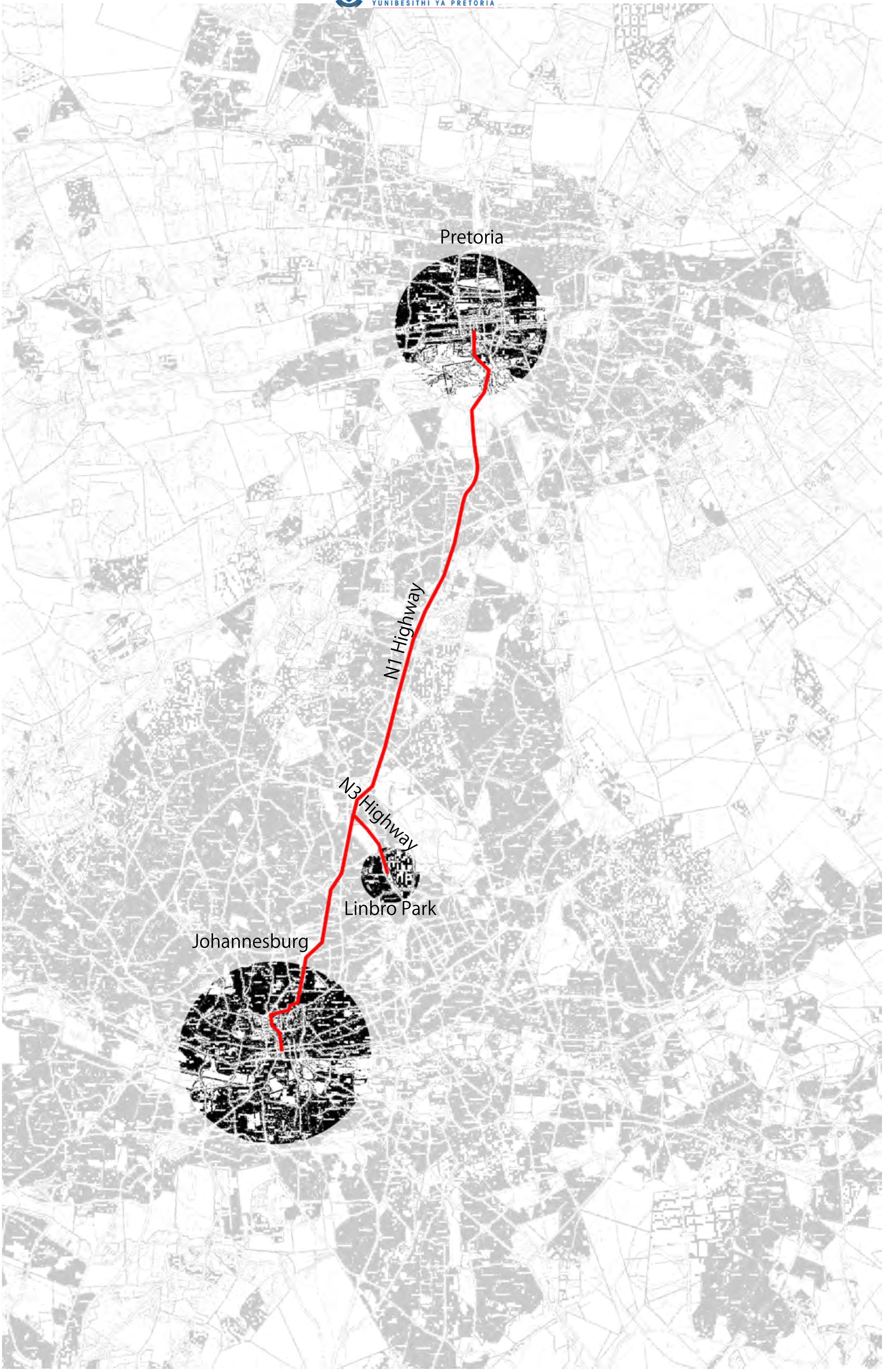

Fig *i*: Site location (Author, 2020)

Acknowledgement

The year of 2020 was a trying year as Covid-19 gripped the world. Therefore, I wish to express my gratitude to my lectures, Karen Botes and Johan Prinsloo, for encouraging me throughout the year.

Special thanks to my family for keeping me motivated and to my best friend, Josias Potgieter, for his guidance.

Abbreviations

MAP: Mean annual precipitation

APCV: Annual precipitation coefficient of variation

MAT: Mean annual temperature

MFD: Mean frost days

MAPE: Mean annual potential evaporation

MASMS: Mean annual soil moisture stress

CAD: Computer-aided design

Definitions/ Terminology

"Waste landscapes": A term referring to spatial areas or land that is considered to be either, or both, a wasteland caused by urbanisation, industrial processes or pollution, or a space that is considered to be wasteful and does not contribute any beneficial factors to the urban condition.

Drosscape: A drosscape is a term coined by Alan Berger. It refers to a "waste landscape" that has been developed into a *"new condition in which land surfaces are modelled following new programs or new sets of values"*. The new development remediates the wasteland and changes the perception of its wasteful characteristics (Berger, 2006).

Datascapes: Layers of information that may relate to physical, social, cultural, urban, ecological and intangible systems which can emphasise a design response or guide it (Wellner, 2006).

B-Class landfill: A B-Class landfill is a type of landfill site that falls into this particular category in terms of its construction and allowed waste types. B-Class landfills only accept non-hazardous, domestic waste products (Butler, 1998).

Landscape urbanism: Landscape urbanism is a branch of landscape architecture knowledge that aims towards incorporating elements ranging from the built environment to the ecological process of nature, into a harmonious and sustainable system within the urban environment (Waldheim, 2006).

Hydrophytes: Plants that only grow in aquatic conditions.

Homeostasis: Maintaining a suitable environmental condition by responding to external influences.

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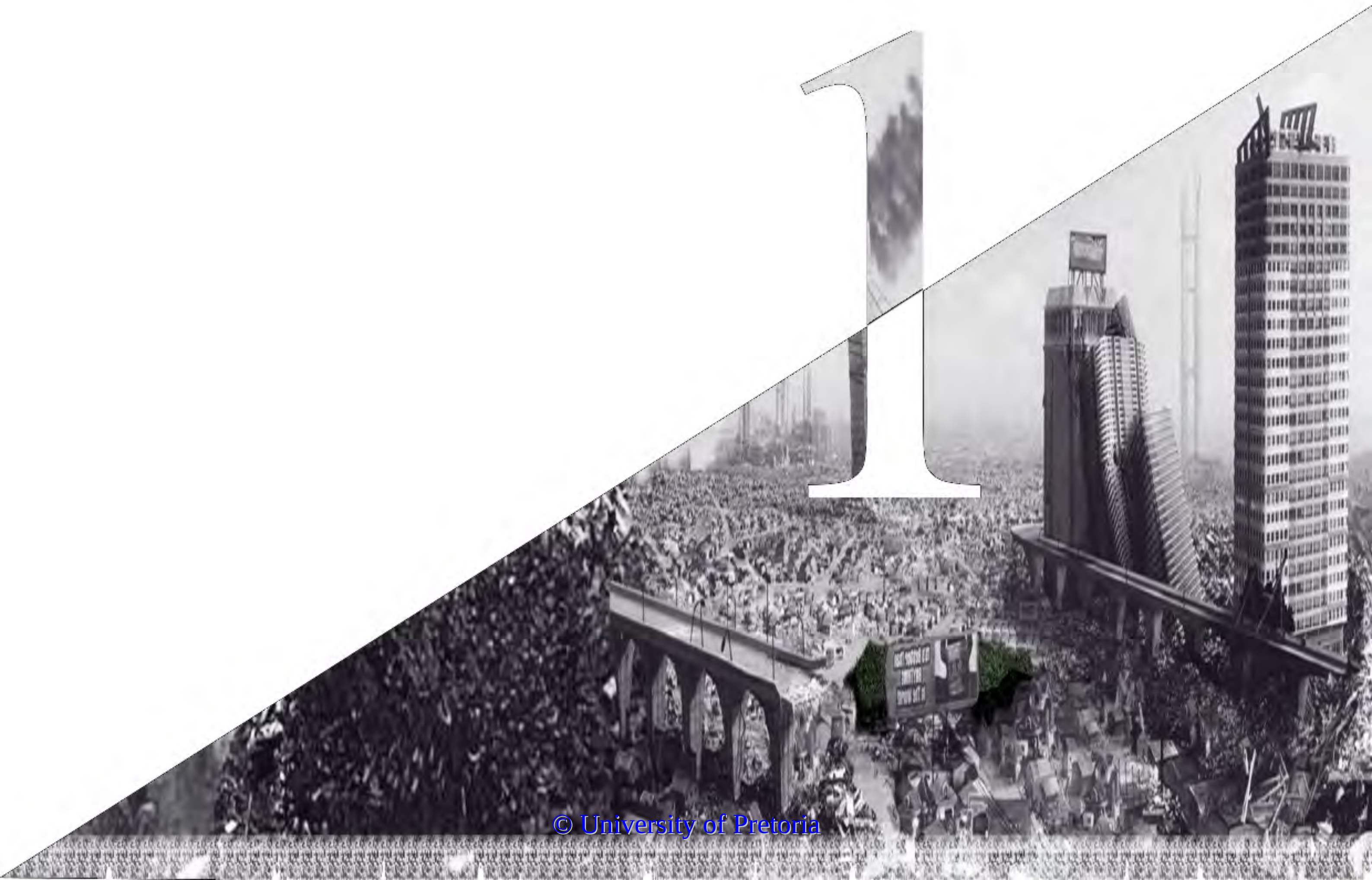

Chapter 1: Introduction

1.1 Preamble

The point of departure for this dissertation shall begin with understanding the development of the urban environment and its effects on the landscape from ancient times through to the modern period, which has lead to the rise of landscape urbanism. It is important to understand the dynamic nature and influences that cause changes in the morphology of the urban environment, which resulting in the formation of "waste landscapes".

Cities have become the main habitat for humanity, as people move away from rural settlements in favour of cities. This migration has drastically increased over time. It has been recorded that during the 1800s, London and Beijing were the only two cities to have a population of over a million people. In 2016, 436 cities were recorded to have also reached this milestone and an estimated 559 to 731 cities will have reached this populace by 2030 (Martinez, 2015).

The growth of urban environments and natural ecosystems have shown a similar pattern in terms of development. One common characteristic is that waste is an inevitable by-product of growth. Therefore, the formation of urban wastes or "waste landscapes" are inevitable and will cause spatial holes within the urban environment. The idea that an urban environment can become "wasteless" or develop without producing "waste landscapes", is impossible. "Waste landscapes" often lack infrastructure, investment value and may be contaminated by toxins which creates the challenge of adaptive reuse of these areas beyond simple rehabilitation (Berger, 2006).

1.2 The chosen study area: Linbro Park Landfill Site and surrounding communities

Within the South African context, the issues of fragmentation are greater due to the past legislations of the Apartheid era. Social groups were deliberately separated into suburban regions by using "waste landscapes" as a buffer zone between "white" economically rich neighbourhoods and the "African" neighbourhoods. Currently, the effects of past urban segregation planning are still present as often the isolated communities have little access to economic urban nodes, infrastructure and quality green spaces (City of Johannesburg: Department of Development Planning, 2016). The township of Alexandra can be seen as an example of a fragmented community. The N3 and the Linbro Park Landfill Site act as barriers between Alexandra and Linbro Park. This prevents Alexandra residents benefiting from the new proposal for the development of Linbro Park.

Landfill sites are a primary example of "waste landscapes" in that they are both physically and metaphorically a "waste landscape". Landfills such as Roberton's Landfill and Linbro Park Landfill area becoming engulfed by urban expansion.

Landfill sites present unique opportunities to create regional parks due to their location within urban environments as seen in Figure 1.1. However, interventions are limited due to unstable earth, leachate, methane gases, soil erosion of landfill sites and the decomposition of waste. The differing decomposition rates make predicting soil movements difficult.

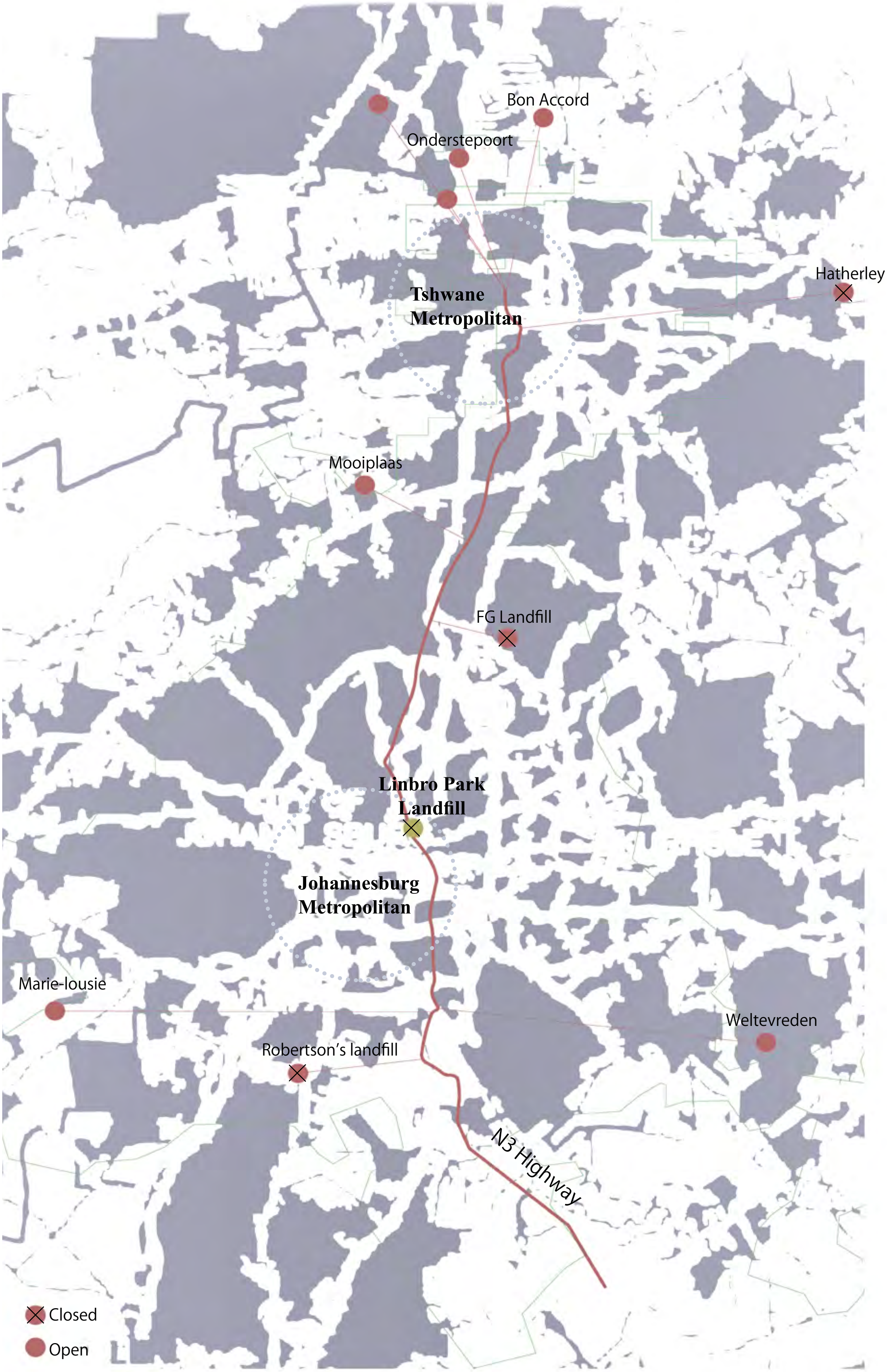

Fig 1.1 Landfill site in Gauteng Province (Author, 2020)

The scope of the dissertation aims to incorporate "waste landscapes" into the urban environment through the principles of landscape urbanism. The dissertation will address issues that are present on multiple levels and dynamic categories that are found in an urban environment. This relates to:

1.2.1 The contemporary urban issue

The rapid development of urban environments and urban sprawl growth has lead to "waste landscapes" being developed. These spaces cause "spatial holes" within the urban environment. These "waste landscapes" can be described as barriers and cause urban fragmentation between communities (Berger, 2006).

1.2.2 The South African urban regional issue

The segregation of communities in South Africa is not only caused by the natural growth of the urban environment. The Apartheid urban planning regime had deliberately created urban environments that divided social groups and caused the formation of inverted polycentric city layouts. This layout has lead to certain areas to be deprived of having access to economic growth hubs and other issues such as lack of infrastructure investment.

1.2.3 The site issue

Landfill sites are the most convenient method of waste disposal globally, however, the operations and site management are expensive such as leachate treatment and management. Risks of stormwater infiltration, erosion and the resurfacing of waste material are present on closed landfill sites that use a clay capping method for its close-out phase.

1.2.4 The landscape architecture issue

Landscape architecture has the potential for applying multiple methods and design strategies to engage with urban renewal projects. However, the effectiveness of its contribution seems to be constrained by bureaucratic boundaries such as the perception that, landscape architecture should be limited to areas that have no infrastructure (Wellner, 2006).

1.3 Problem statement

Urban environments are rapidly expanding and the formation of wasted spaces are a natural cycle of urban growth that cannot be avoided, yet it seems to be ignored and has become a barrier within the urban network. These wasted spaces, or spatial holes, need to be incorporated into urban environments to enhance ecosystem services to the city and to form part of urban ecological regeneration and human health and well-being.

Generally viewed as an eyesore, landfill sites are placed on the outskirts of cities but urban expansion has begun to engulf these "waste landscapes" as seen in figure 1.1. Once closed, the landfill remains active in terms of management for 30 years but adds no beneficial value to its surrounding context at the end of its life span. The question arises as to the fate of "waste landscapes" such as landfill sites within the urban environment.

1.4 Research questions

This project will be conducted based on answering the following research questions:

i) How can the philosophy and application of landscape urbanism allow the Linbro Park Landfill Site to be integrated into the urban region and framework of Alexandra and Linbro Park?

ii) How can a closed landfill site be remediated for recreational use and public enjoyment?

iii) How can the Linbro Park landfill Site create a socially justified connection between Alexandra and the future development framework of Linbro Park?

iv) How can the remediation of the Linbro Park Landfill Site through landscape architecture improve current close-out methodologies of landfill sites such as stormwater management, soil erosion control and leachate treatment processes while allowing for the area to become a public green space?

1.5 Hypothesis

Landscape architecture has the capacity to redesign and incorporate "waste landscapes" and wasteful spaces into the urban fabric to enhance urban functions, social networks, cultural values and ecological functions through the landscape urbanism approach. This implies the following:

i) The integration of "waste landscapes" and wasteful spaces into the urban fabric as green public spaces through the theory of landscape urbanism.

ii) The intervention of the Linbro Park Landfill Site can allow Alexandra residence to be connected to Linbro Park and benefit from future economic opportunities.

iii) That a regional park can be created at the Linbro Park Landfill Site through the application of an improved ecological close-out capping methodology.

1.6 Objectives, aims and goals

The object of this paper is to understand the position of landscape urbanism within the urban environment in terms of a theoretical response, application methodology and guiding principles. The aim is to apply the theory of landscape urbanism to the Linbro Park Landfill Site with the following goals:

i) Develop connections and links between Alexandra to Linbro Park that are established through "waste landscapes" found within the study area.

ii) Create a framework that promotes possible interventions beyond the borders of the landfill site.

iii) Create a public green space that serves as a recreational park and also positively contributes to the operational close-out management of the landfill site.

1.7 Assumptions and delimitations

For this dissertation, it shall be assumed that:

i) The Linbro Park Landfill Site has been constructed per The National Environmental Management: Waste Act, (Act 59 of 2008) as a typical B Class landfill.

ii) The landfill site is currently undergoing its final capping process and that ecological rehabilitation is yet to commence Excavation work will need to be kept to a minimum, while it will be encouraged to add earthworks to the capping process.

iii) The landfill will continue to be owned, monitored and operated by the Pikitup as part of the close-out phase in accordance with the regulations of the Department of Water and Sanitation.

iv) The Linbro Park framework will be implemented as per the "Joburg Development and Growth Strategy" (City of Johannesburg: Department of Development Planning, 2016) and the "Linbro Park Urban Design Framework Plan" guidelines (BWLC development consortium, 2010).

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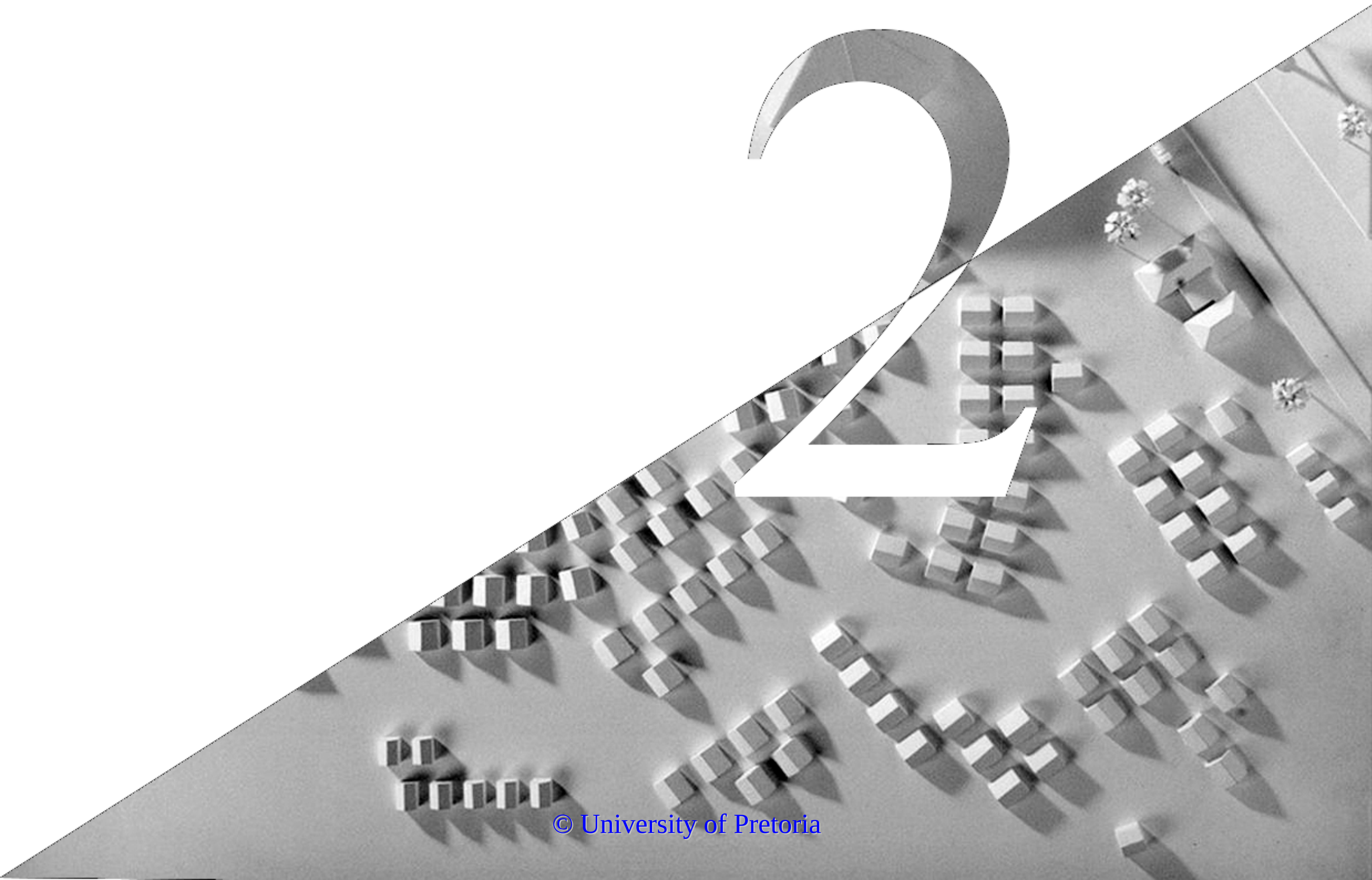


Chapter 2: Literature review

The literature review will investigate the origins of landscape urbanism, its stance within landscape architecture and its design principles.

2.1 Urbanisation effects on the landscape

The development pattern of urbanisation and its response to new conditions and influences, can be described by the three forms of a cooked egg as explained by Cedric Price in his "three eggs diagram" (Shane, 2006)

2.1.1 Ancient urban to pre-modern morphology as a boiled egg.

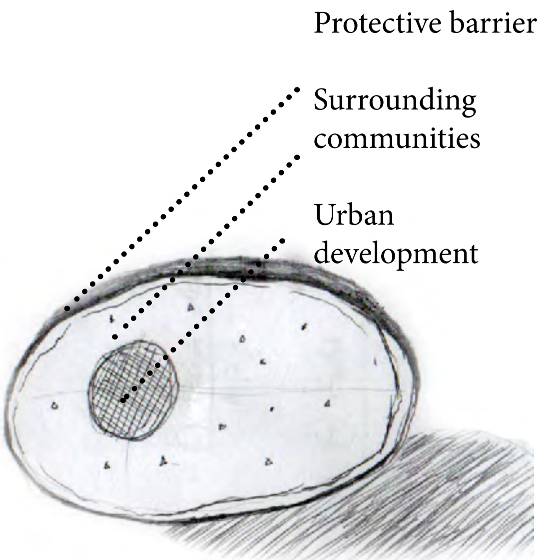


Fig 2.1 Urban environment represented as a boiled egg (Author, 2020)

The urban environment during the ancient period is metaphorically compared to a boiled egg. Cities would have an important nucleus or centre (the yolk) and defensive attributes (the shall). This form of protection could relate to both man-made elements such as walls, moats, etc. and geological elements such as rivers, mountains and other limiting passable terrain factors (Martinez, 2015).

2.1.1.1 *Case study: The urbanisation of Rome and Latium Vetus*

The region under discussion is located in Italy, bordering on the Tyrrhenian Sea.

During the 1960s to early 1980s, a series of survey and topographical analyses of early Iron Age settlements were completed by John W. Perkins. His interpretation of these isolated settlements on the plateaux displayed the movement of isolated groups coming together as an urban community near the end of the Iron Age. The synoecism that began this event was triggered by external factors such as the introduction of the new city-state model to southern Italy that was introduced by the Greeks (Fulminante, 2014).

However, an alternative explanation for the beginning stages of urbanisation was provided by researchers who adopted an "endogenous" perspective. This perspective states that the outer settlements surrounded a larger community, or proto-urban centre, that were occupied by closely related groups. This created the form of a centralised settlement. This was further emphasised by the fact that the travelling distance between the smaller, "rural" communities was relatively short. Shared spatial regions such as burial grounds, also known as necropolises or cemeteries, would act as buffer zones between the inhabited regions (Fulminante, 2014).

The study of materials used and the stratigraphy of the study area suggested that the monumentalisation of the city was completed during the 16th and 17th centuries. Structures such as temples, stone-based foundations and urban fortification circuits began to create a centralised power that represented the unification of people (Fulminante, 2014).

Additionally, the construction of aristocratic structures such as forums for public debate also proves that urbanisation began during this period (Fulminante, 2014).

Newly developed urban environments were located in areas that had certain geographical aspects. For example, open areas and lower sloped regions were only occupied seasonally and later abandoned during the Iron Age in favour of positions on top of higher slopes, because they offered greater protection from invasion. The urban layout showed the development of a "chiefdom" society into a state organisation through the use of orientation and hierarchy. These larger, centralised urban locations would connect the boundaries between smaller communities and establish a sense of order within the civilisation (Fulminante, 2014).

2.1.2 The Industrial Revolution and modernist urban morphology as a fried egg.

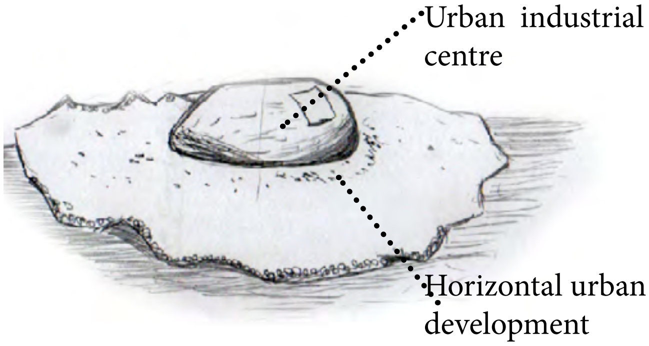


Fig 2.2 Urban environment represented as a fried egg (Author, 2020)

During the 20th century, urban planning and design followed a concept that focused on a mass production line inspired by the application of Frederick W. Taylor's scientific management principles of industrial production. This can be described as Fordism, where the city would be arranged in a strictly controlled manner to promote the efficiency of mass production logistics (Shane, 2006).

Long systems of organisational planning and assembly points would course through single-storey sheds across the suburban property. This led to the creation of large industrial complexes that caused a shift of urban central focus from social areas to economic and industrial plants. The industrial complexes became the new central point of urban planning (Shane, 2006)

2.1.2.1 *Case Study: Dearborn, Detroit Area*

Henry Ford began to create suburban regions that were inspired by Fredrick Taylor's mass production concept. The idea was that workers would stay within commuting distance from their workstations to maximise efficiency, as seen at the automobile manufacturing plants in Dearborn. The promise of jobs saw a massive increase in the number of residents in Detroit and was later known as the "great migration" of workers from the Southern areas, which led to urban expansion (Shane, 2006). The automobile industry became a contributing factor to the economic development and investment into Detroit. The concept of "mass production" was being applied to urban planning and architecture.

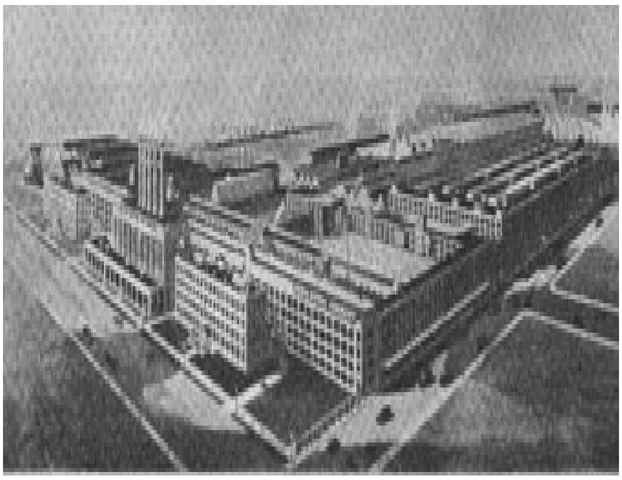


Fig 2.3 Ford Highland Park (Henry Ford Museum, 2020)

This form of the "mass production concept" became a source of inspiration for architecture's modernism period and urban development. An example can be seen in the Ville Radieuse city concept by Le Corbusier. He used the Ford Highland Park Plant, designed by Albert Kahn in 1909, as the main example of modernism in his book *Towards a New Architecture*. This new urban morphology became the next phase of the urbanisation's pattern as it began to shift from urban complexities into a "formalised urban machine" arrangement, according to Schumacher and Rogner (Shane, 2006).

Fig 2.4 Ville Radieuse, Le Corbusier Utopia (Kurt Kohstedt)

It should be noted that during this time, landscape architecture had limited large-scale landscape projects and mostly took on the design form of Romanticism, inspired by 18th century examples located in the English countryside. Projects such as the Central Park in New York had very limited intervention from human input other than a few flower beds. The majority of the area remained natural, which was accepted as the standard norm, as economic consideration and minimal maintenance requirements favoured this type of design style at the time (Treib, 1999). Marc Treib further explains that defining modernism architecture by its particular characteristics was mostly completed, however, "landscape modernism" seems to have never actually begun (Treib, 1999).

Modernism Architecture had little regard for the landscape as architectural elements would not be joined with the landscape to form a great whole or extension of the structure, but rather act as a vegetable buffer between buildings. This effect may have led to the perception that landscape architecture is rather irrelevant during the urban design phase (Treib, 1999).

2.1.3 Post-modernism as a scrambled egg

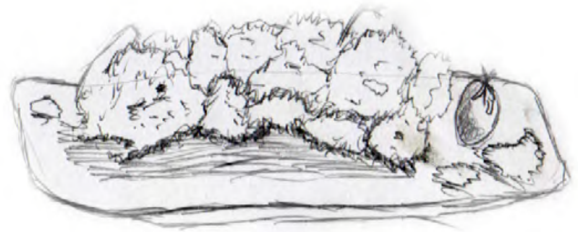


Fig 2.5 Urban environment represented as a scrambled egg (Author, 2020)

The development of highways, express routes and personal transport allowed for commuters to work in the dense urban environment and live in peaceful suburban regions as seen in Detroit. This was part of Henry Ford's vision of suburban planning which led to the beginning of urban sprawl patterns (Berger, 2006).

This new morphology of urban development can be described as a self-organising pattern of development, or more commonly known as urban sprawl.

Using Detroit as an example again, the increase of residents within the central urban environment began to lead to urban sprawl. The economic shift also began to move from the centre of the city towards the enclosed suburban regions. As urbanisation began a horizontal spread, the decentralisation of urban environments and the phase of Fordism began to dissolve regionally, nationally and later globally into the landscape (Wellner, 2006)

Regional and spatial areas began to develop wasted spatial holes, or "waste landscapes", within the urban environment. These included abandoned or leftover spaces, buildings and polluted land. These spaces can also relate to a landscape that is currently not being developed but held in reserve for future planning (Berger, 2006).

The effects of urban sprawl have allowed for the integration of aesthetics and culture to become part of the urban environment which was absent during the modernism phase of architecture. However, this has also led to fragmentation within the city through the forms of wasted space, toxic sites and reservation of space for future proposals (Shane, 2006).

2.2 Conclusions drawn from urban morphology

Urban growth requires an economic source for development and as a by-product of development, it generates wastelands and wasteful spaces. Three main factors that contribute to the formation of "waste landscapes" include:

i) Horizontal urban sprawl.

ii) The abandonment of the space caused by economic shifts.

iii) The pollution of leftover detritus or waste products generated by industrial processes and consumerism left in the landscape (Berger, 2006).

Cities such as Detroit have undergone a series of transformations and different growth patterns as the economy shifted, leading to the abandonment of factories and residential areas.

"Waste landscapes" and "in-between spaces" that are found in cities have potential value for adaptive re-use and reprogramming back into the urban environment. The potential of these spaces was recognised by Lars Lerup in his essay *Stim & Dross*. He views the urban environment as a large ecological envelope of systematically productive and wasteful landscapes. He concludes that the observed processes of growth and the formation of waste within nature is similar to that of the urban environment (Berger, 2006).

Therefore, urban planning needs to acknowledge that "waste landscapes" will inevitably form part of the urban environment and the new focus should shift towards incorporating these wasted spaces into the city (Berger, 2006).

The general goal of cities today is to become a sustainable, safe and inclusive environment according to the 11th goal of the United Nations 2030 agenda for sustainable development (Panagopoulos, 2019). Yet, little interest has been shown for the re-use and rehabilitation of "waste landscapes".

The theory of landscape urbanism has shown an interest in creating sustainable urban environments through adaptive re-use, ecological and social design within cities .

2.3 The origins of landscape urbanism

Landscape urbanism can be viewed as a branch of landscape architecture's knowledge base. It was developed in response to the issues caused by the architecture modernism movement. An example of such an issue relates to architecture modernism's inability to acknowledge human emotions in its principles of design as it was viewed as a "design for a machine" concept. Landscape urbanism also criticises certain principles of landscape architecture practice in the urban environment (Wellner, 2006).

The principles of landscape urbanism relate to creating a design that adheres to the needs of urban conditions, social well-being and ecological diversification within the city. The process involves engaging with the landscape's surrounding "networks" to connect it through the appropriate association of categories presented by its surroundings. This includes the area's history, organization patterns, well-being, ecological roles, urban infrastructure, and other elements that carry a value for the region (Burley, 2013).

2.4 The criticism of landscape architecture

2.4.1 The commodity of the landscape

During the 20th century, landscape architecture aimed to create green spaces in the urban environment that were "picturesque" and "rural" as seen in the design approach of Romanticism but failed to remediate any modern city issues through its scientific and technological design. Landscape designs in public parks, office compounds and housing developments in the United States and Europe kept to the practices of developing green spaces with past ideologies and sentimental aesthetic principles. There has been little regard for developing innovative landscapes that embrace technology which could enhance a design that improves urban conditions. In other words, landscape architecture can be seen to only value aesthetic properties that increase land value from an economic point of view while ignoring and even hiding some or all of the modern problems of the city. This practice hinders the development of a sustainable, green city (Corner, 1999).

2.4.2 The perception that limits landscape architecture's role in the city

Landscape architecture can create meaningful green spaces but there is currently a perspective that landscape architecture must only be involved in landscapes that are limited or have no infrastructure, and spaces where the aesthetics of the infrastructure needs to be hidden (Wellner, 2006).

Another limiting factor regarding landscape architecture's role in the urban environment is that the intervention must only occur within the scope of a project. Landscape architecture needs to participate more broadly and convince the bureaucratic authority to allow for green spaces and corridors to extend their influence as far as possible within the city (Wellner, 2006).

2.4.3 Loss of flexibility

Urban environments have three main factors that shape and change it, namely degeneration, permanence and transformation. Landscape designs that focus solely on permanence have the least beneficial value for the city, as urban environments continuously change over time (Girot, 2006).

It is also observed that multiple urban proposals that are created have little or no association with each other. Most proposals strategies consist of singular plans of development or ideologies that may deviate from their original principles and visions. This vision of redevelopment to uplift key communities can sometimes erase the natural systems, community expressions and the aesthetic identity (Girot, 2006).

2.4.4 The darker side of reclamation

The projects that adaptively re-use and reclaim “waste landscapes” are generally viewed as having a noble agenda. However, by over-imposing ideologies that take an excessive degree of control by disregarding the landscape’s existing programs or social uses can lead to the design only benefiting certain social groups. The process of adaptively re-using landscapes should aim to enrich the local community by incorporating their cultural and social values, while creating a welcoming and unique experience for visitors of the local community (Corner, 1999).

2.4.5 The constant cycle of remediation

There is a perception that the natural environment consists of only natural elements with the absence of culture. Landscape designs that follow this ideology create a landscape that is objectified and ignores the potential benefits and impact issues that the cultural influence has on the natural landscape. In cases where the negative impact of culture remains unchanged, the landscape design will either delay the damage or will become a continuous cycle of remediation (Corner, 1999).

3

Chapter 3: The process of landscape urbanism

There is a new vigour of interest in the functions of landscape architecture in urban environments. Landscape urbanism uses "waste landscapes" to "*serve as a possible medium in which it can synthesise its naturalistic and conscience experiences with that of the urban systems*" (Corner, 1999). Landscape urbanism's methods involve developing innovative solutions that address the concerns of multiple aspects of a modern city. The theory moves beyond the goal of environmental stewardship by acknowledging that culture, land use, and functions are part of the natural environment (Corner, 1999).

3.1 The city as a living organism

In nature, the development of certain pioneer plants to establish a new community may require the collapse of other environmental groups during ecological succession. The process of this collapse forms waste material that can be viewed as a starting foundation, allowing for the new pioneer plants to develop.

Similarly, urban growth can be viewed as a living organism. As growth occurs, cells transport nutrients to key areas and simultaneously remove any waste compounds that need to be expelled out of the body. Urban growth is driven by economic forces that provide "the energy and material" for development. Greater economic "energy" potential will cause faster urbanisation but also results in more potentially hazardous waste to be produced. Similar to a body maintaining homeostasis, urban environments are ever-changing due to the dynamic of the economic conditions. (Berger, 2006).

3.2 From "waste landscape" to drosscape

As previously discussed, the formation of waste is an inevitable by-product of growth. It is therefore impossible and naive to attempt to create a "wasteless urban environment". The management of the "waste landscapes" should focus on the integration of these inevitable spaces into a more flexible, aesthetically pleasing landscape that engages with urban strategies. This process of adaptively reprogramming a "waste landscape" into a drosscape begins by conducting fieldwork, examining urban trends and interpreting existing data (Berger, 2006).

Richard Wellner coined the term "datascapes" which refer to layers of information that relate to both tangible and intangible sources (Wellner, 2006). The process of this layering of information can be seen as an important guiding tool that relates to Alan Berger's concept of drossscape incorporation. It allows the designer and relative stakeholders to understand existing and potential connections and associations when engaged in urban planning.

James Corner's view on landscape urbanism's investigation into the recovery of "waste landscapes" begins with the unique attributes of the site and its setting. The success of the remediation of the "waste landscape" should be based on three processes:

i) The retrieval of memory, i.e. heritage value.
ii) Social programs.
iii) Ecological diversification.

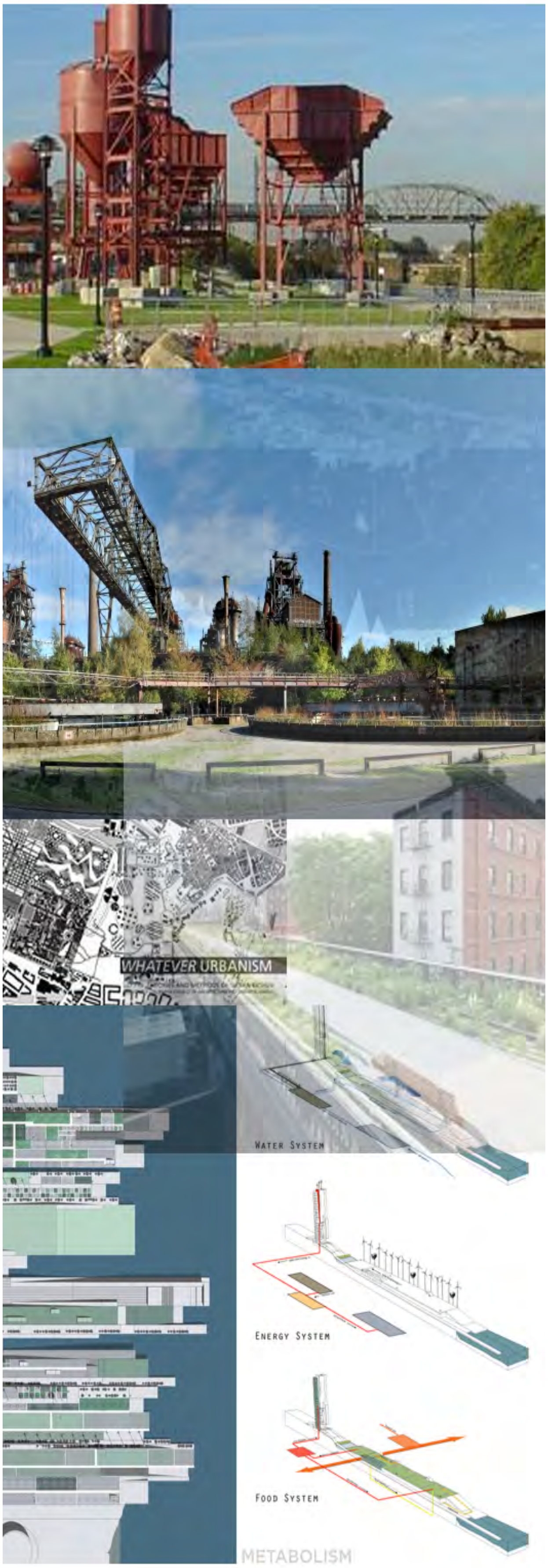


Fig 3.1 Landscape urbanism interpretation projects (Author, 2020)

James Corner's approach aims to create a landscape as a potential "performative" space. The goal is to allow for permanent and temporary programs to occur as well as informal activities. This is realised by creating open, flexible areas that can support such events. His view of ecology is shared by Carl Troll, who states that ecology is "the total spatial and visual entity of human living space." In other words, he incorporates ecological elements with that of urban systems and cultural activities (Shane, 2006).

Sébastien Marot developed four principles for landscape urbanism to follow in the process of studying the site which are (Marot, 1999):

i) Anamnesis
ii) Preparation
iii) Three-dimensional sequencing
iv) Relational structuring

3.2.1 Anamnesis/recollection

The analysis of the landscape should not only be limited to quantifiable and physical data but also include the expressions of the identity within the area. The form and type of ecology characteristics contribute as an element to communicating the identity (Marot, 1999). The term "palimpsest" is used to describe a document that has been written on and erased multiple times. In terms of landscape architecture, it is used to describe the past characteristic of a landscape that has been "erased" and reformed into a new characteristic with remnants of its past still embedded in it. Palimpsest offers the opportunity to express multiple temporal, artefactual and spatial events through its forms and materiality of the design (Herrington, 2017).

3.2.2 Preparation

Understanding the current physical conditions, quantitative data, the history of the site and its context allows for the design to accommodate the current processes that are occurring. These processes can relate to the elements such as hydrology, weathering, climate, etc. that occur over time. Taking these effects into account reinforces the notion that the landscapes in urban environments are not static places. The principle of preparation relates to the revitalization of the landscape to accommodate or resist natural effects by remaining as an open-ended design for future considerations (Marot, 1999).

Fig 3.2 Author's interpretation of the shift of landscape architecture towards landscape urbanism (Author, 2020)

3.2.3 Three-dimensional sequencing

Three-dimensional sequencing proposes an alternative to the traditional "plan view" designing process which often segregates and oversimplifies the intervention due to its limited surface vision. The design formation of elements and features should be done through a three-dimensional medium. This allows the designer to facilitate the integration and harmony of elements that relate to the site categories, such as earthworks, topography, soil, drainage, utilities, planting, etc. (Marot, 1999).

3.2.4 Relational structuring

Relational structuring refers to the importance of the site and how it connects to its context which can influence the quality of the space. The relationship of elements within the area can be associated through visual connection, transitions and sequences. This "relation approach principle" creates the idea that all landscape spaces should be designed in some form of relation to each other and that the design should acknowledge that its influences extend beyond the boundaries of the site (Marot, 1999).

3.3 Analysis of landscape urbanism projects

3.3.1 *Case study: Presidio Parklands, San Francisco, USA* *-James Corner*

The Presidio Parklands project was part of an international competition to redevelop the waterfront region of the Golden Gate Promenade in San Francisco, USA in 2014 and was won by Field Operations (King, 2018). To understand the application of relational structuring design method, the author used CAD software to create layers of lines that were drawn on top of existing movement pathways and connection points as proposed by Marot's approach (Marot, 1999):

1. The first task was to establish how the Presidio Parklands design connects with its surroundings. The process began by highlighting informative axes that ran through the park and into the surrounding city i.e. entrances, major roads.
2. Points where the initial axis lines intersected with each other, became an important, first-generation node.
3. The first generation of nodes defined the starting point for a secondary set of lines that began to show the formation of spaces and secondary walkways.
4. The spaces that were informed by the secondary lines generated the third set of lines and defined spaces.

It can be concluded that the utilisation of the axes to create connections becomes an important informant for the creation of space into the site.

The park also places a great emphasis on visual connection, panoramic views, multiple functional uses and ecological diversification (King, 2018).

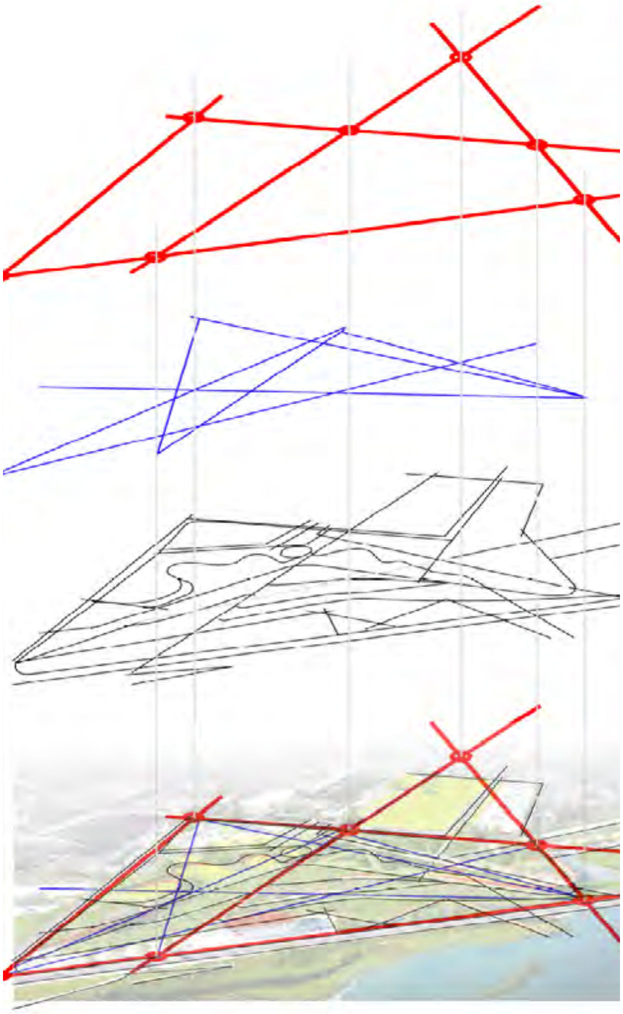


Fig 3.3 Layering the Presidio Parklands (James Corner, edited and CAD overlay by Author, 2020)

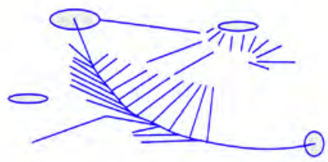
3.3.2 *Case study: National Arboretum Canberra, Australia -T.C.L Landscape Architects*

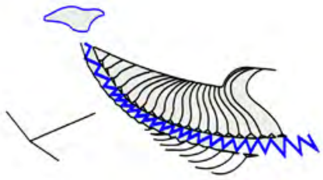
The National Arboretum project was a redevelopment proposal. Previously, the area was a pine forest plantation which was destroyed by a bushfire in 2003. The new forest plantations are a commemoration to the fire disaster. This was achieved by planting endangered trees from around the world in singular groups arranged according to a grid-like pattern. The form of the layout could be viewed as a recall or anamnesis of the patterns of the pine forest plantations and farm plots (Herrington, 2017). Another interesting observation is that the park responds to a futuristic relation of conservation by planting endangered trees.

Fig 3.4 Drainage channel (T.C.L, 2015)

Fig 3.5 Endangered trees (T.C.L, 2015)

Fig 3.7 Endangered trees (T.C.L, 2015)





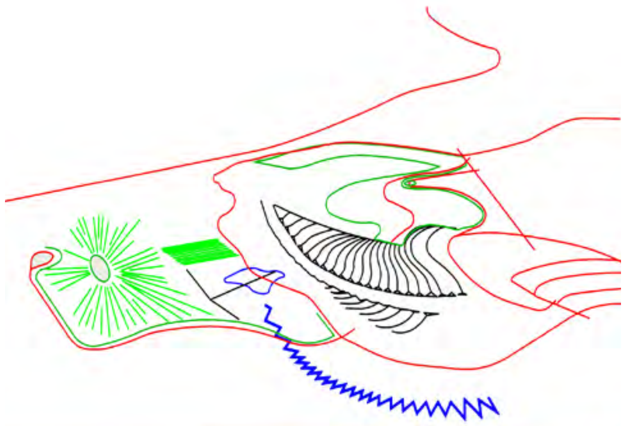


Fig 3.6 National Arboretum (T.C.L, 2015, edited by Author, 2020)

The typology and form of pine forest plantations are represented through the plantation of singular species in a similar manner.

3.3.3 *Case study: Freshkills Landfill, New York, USA - James Corner*

Freshkills Landfill Site was once the largest landfill in the world, receiving waste from the development of New York. It was opened in 1947 and closed in 2001. During this period, the landscape underwent functional changes from natural marshlands to waste disposal and into a cemetery during the 9/11 attacks. It was remediated into a public park through the incorporation of ecological services. It improved the ecological diversification of the area while also playing a role in the management of the landfill site in terms of leachate control and soil erosion (Vinnitskaya, 2013).

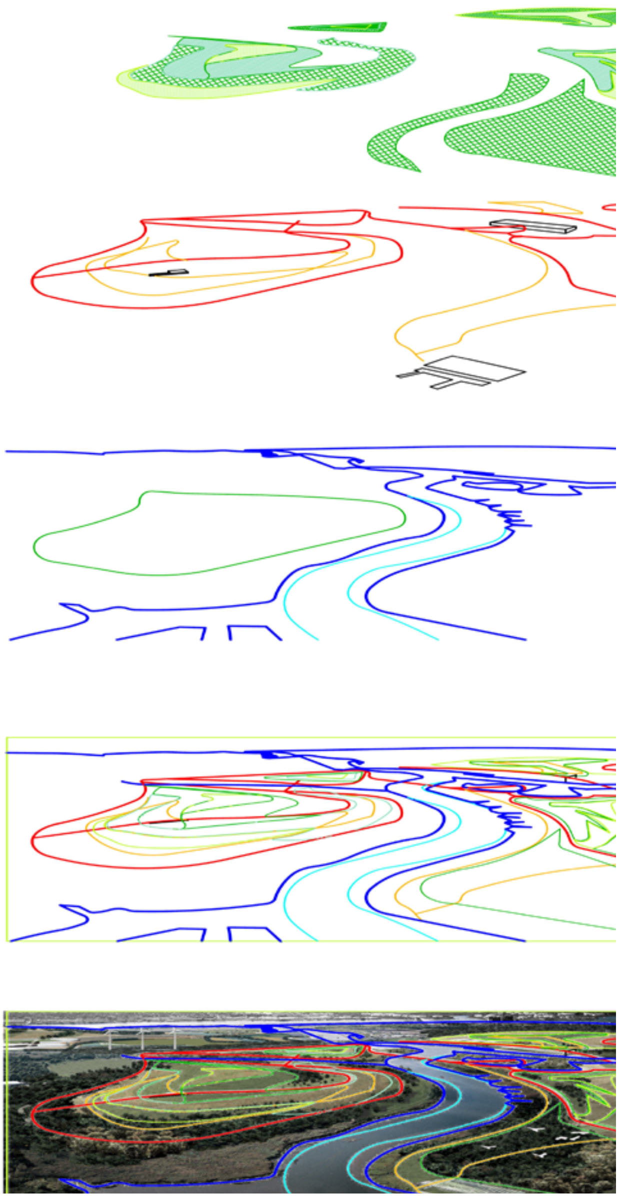


Fig 3.8 Ecological layering (Vinnitskaya, 2013, edited by Author, 2020)

Fig 3.9 Freshkills open landfill operation (Vinnitskaya, 2013)

Fig 3.10 World's largest landfill site (Vinnitskaya, 2013)

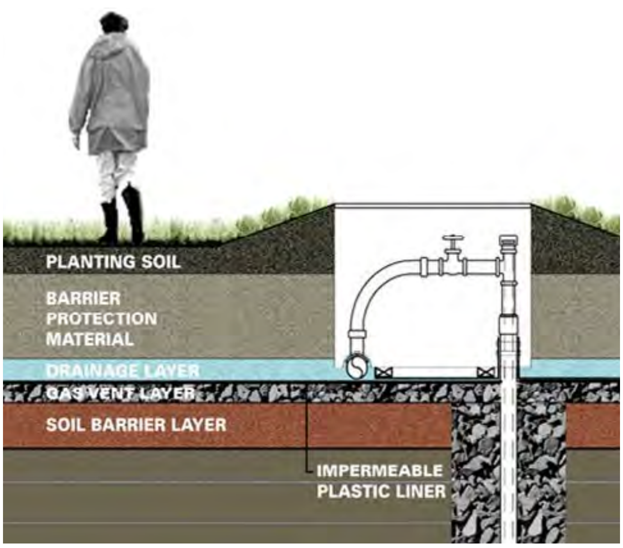


Fig 3.11 Freshkills Landfill capping process (Vinnitskaya, 2013)

3.3.4 *Case study: Parc de la Villette, Paris France -Bernard Tschunmi*

Parc de la Villette was the largest slaughterhouse in Northeast Paris. It was constructed in 1867 and closed in 1974 (Beaucardet, 2017).

The design process involved a superimposed composition of points, lines and surfaces on a grid. The lines were developed from movement patterns while the points were created as 10m by 10m cubes that would serve as cafés', galleries, public toilets etc. (Beaucardet, 2017).

According to Charles Waldheimhe, the park design proposal can be viewed as the forerunner to landscape urbanism. He emphasized that the landscape is seen as a complex medium that facilitated articulating relations between urban infrastructure, public events and revitalising post-industrial sites (Beaucardet, 2017).


Fig 3.12 Open spaces for events (Paris, 2018)


Fig 3.13 10m x 10m Cube points (Paris, 2018)

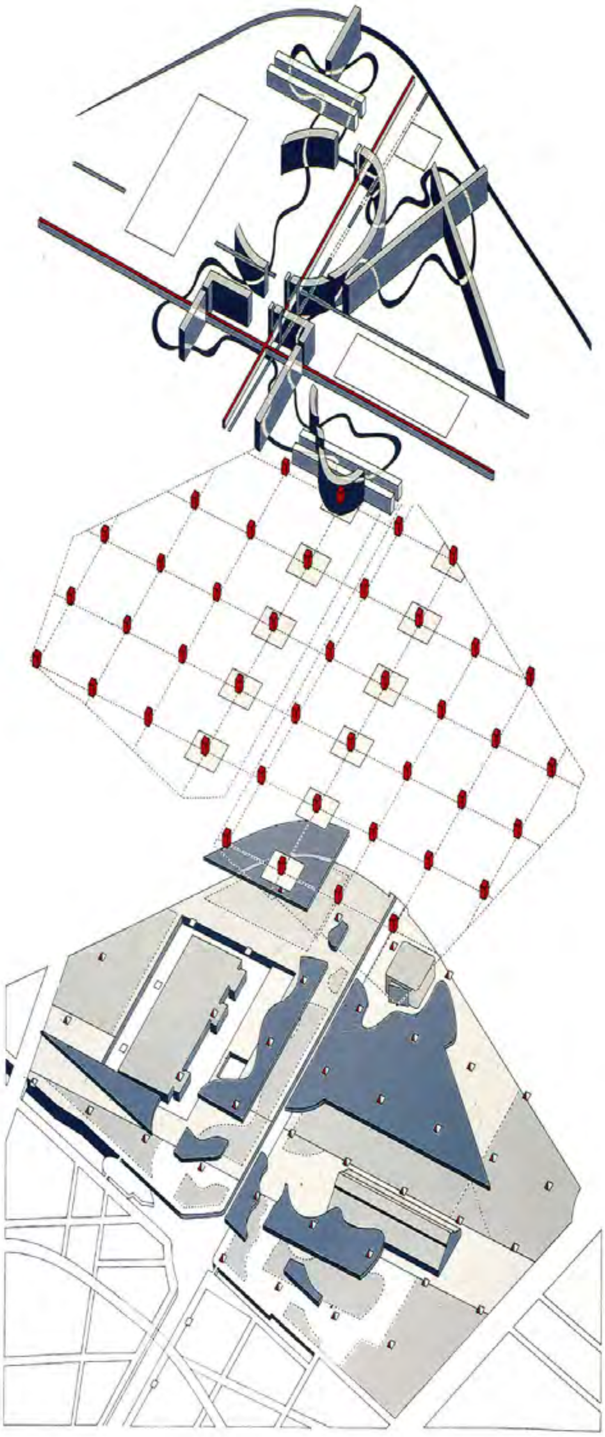


Fig 3.14 Superimposed systems of surfaces, points and lines (Tshumi, 2020)

Issues between Landscape Architecture and the Urban Environment

Separation of aesthetics and functional logic since 1950.

Perceived as being limited to areas of no infrastructure or where infrastructure must be hidden.

The dark side of landscape reclamation and possession.DD

Permanence

Landscape Urbanism Influencers

Simon Swaffield

Richard Weller

Ian McHarg

Alan Berger

James Corner

Christophe Girot

Rem Koolhaus

Fig 3.15 Author's interpretation of landscape urbanism concept and design approach (Author, 2020)

Landscape Urbanism Theories

Datascapes

Layers of social, ecological and urban patterns

Ecological Art of Instrumentality

Ecological systems

CAD-based Info

Ecology expressed as "total visual entity"

Empirical experience

Performative

Strong identity

Flexible

Open - ended

Landscape Urbanism Application

"Waste landscapes" as a point of urban departure

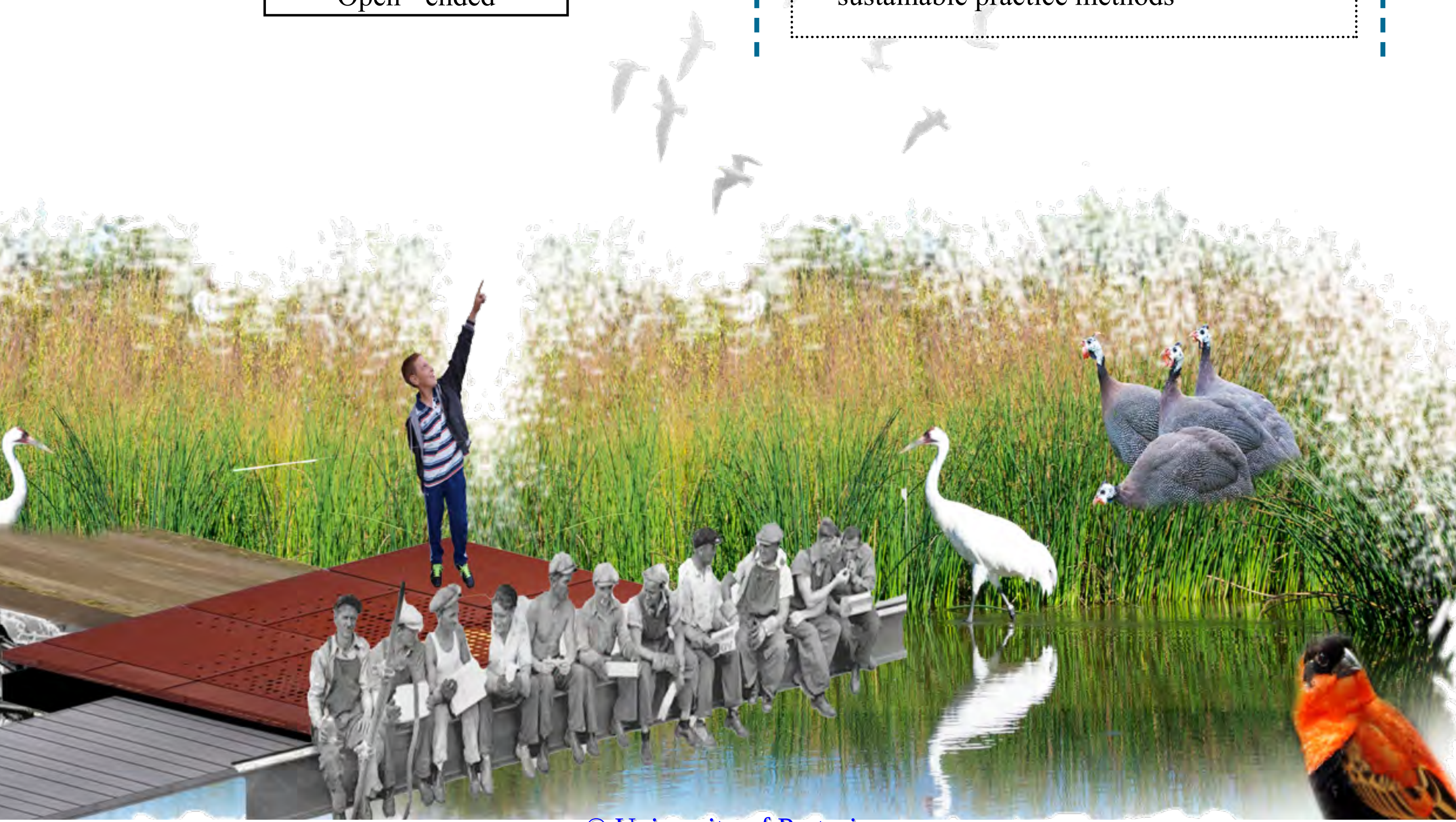
Anamnesis / recollection
- Cultural Expressions
- Ecological narrative

Preparation
- Allowing the site to develop over time
- Understanding site restrictions and adapting to accommodate a program

Three-dimensional sequencing
- Topography
- Ecology
- Social patterns

Relational structuring
- Importance of adjacent spaces and boundaries

Sustainability
- Utilising ecological services and sustainable practice methods




4

Chapter 4: Johannesburg segregation and remediation framework

This chapter of the dissertation attempts to bring in the theory of urban morphology and landscape urbanism analysis into the South African context.

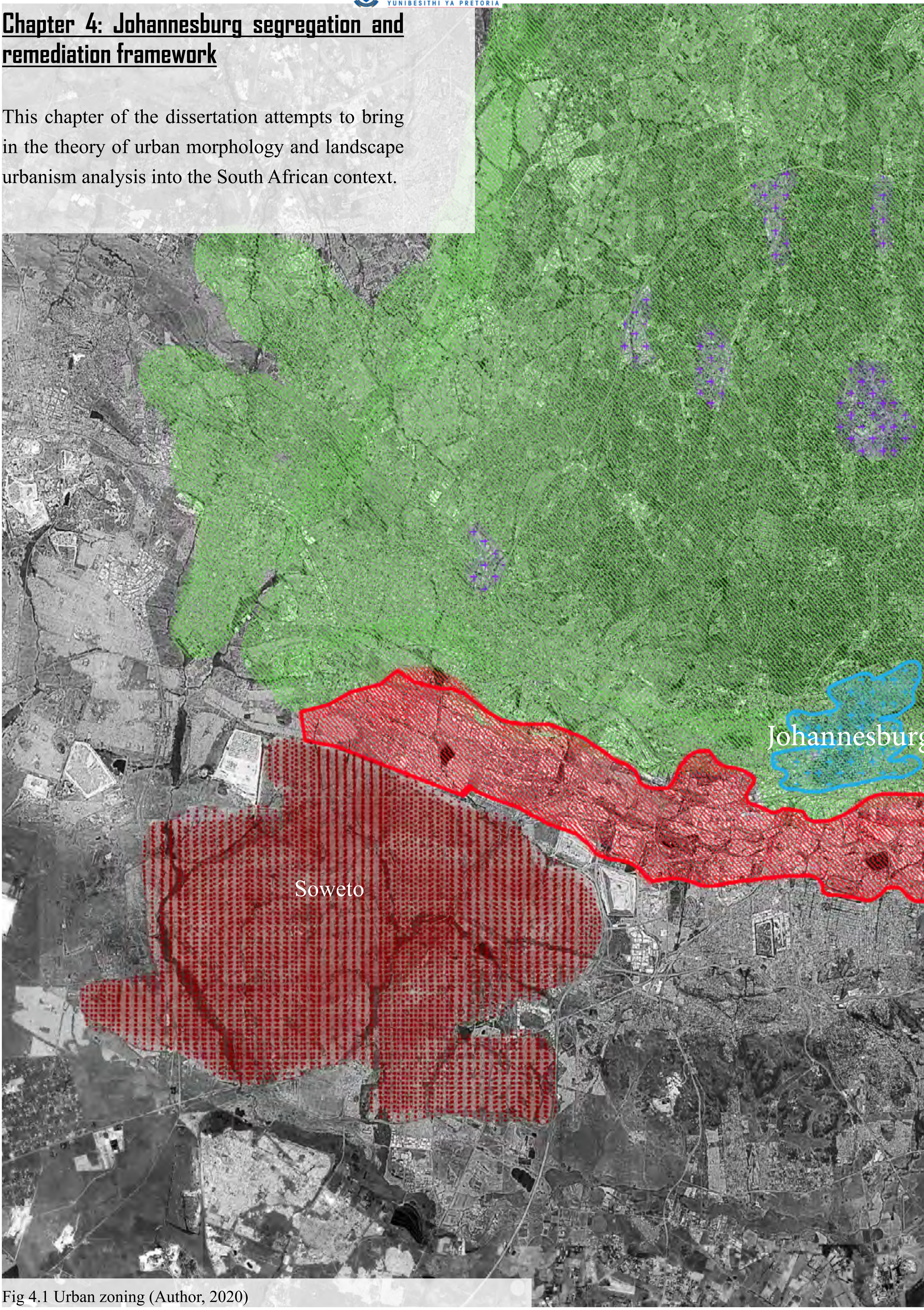
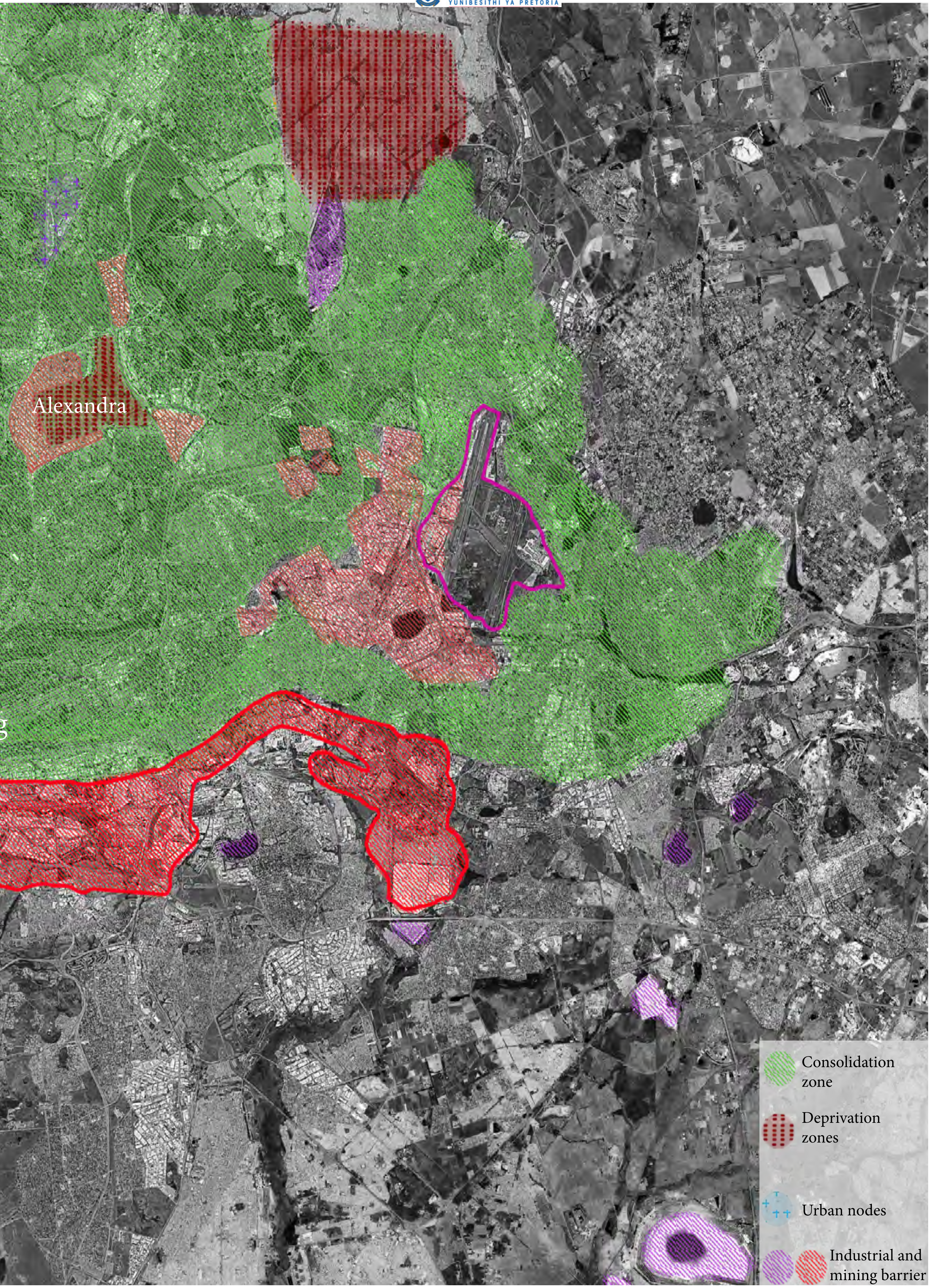


Fig 4.1 Urban zoning (Author, 2020)


Alexandra
g
Consolidation zone
Deprivation zones
Urban nodes
Industrial and mining barrier

4.1 Johannesburg urban sprawl and segregation

The urbanization of Johannesburg began when gold deposits were discovered in the Witwatersrand region in 1886 and became the economic catalyst for urban growth to start. The economic prospect attracted people who initially formed mining camps, villages, towns and eventually the metropolis of Johannesburg (Mubibwa, 2013).

The urban development followed a similar layout to that of North American cities during the 1900s through to the 1930s. The creation of suburban regions caused the horizontal urban sprawl effect. A unique characteristic of most of the South African urban plans was the inclusion of racial segregation planning, according to the Native Urban Areas Act (Act of 1923). Non-white suburbs lacked infrastructure and were placed relatively far from urban centres (Mubibwa, 2013).

In 1950s, the Group Areas Act was passed to relocate non-whites from the inner city to the outer regions. The allocated regions were linked by metro rail systems and limited points of access to "contain" the residents (Mubibwa, 2013).

In 1960, further segregation was created as development of "white neighbourhoods" started to move to the north of Johannesburg, away from the gold mines and mining dust while townships, like Soweto, were located on the southern region of the mining dumps (Mubibwa, 2013).

It is debated whether placing the "native" townships so close to the mine dumps was an act of the government's enforcement of racial segregation. In the placement of Soweto, the distance from the mine dumps was initially 2km to 3km away, but the combination of immigration into Soweto and the ever-expanding mining operation eventually clashed (Mubibwa, 2013). An alternative argument claims that the underlying Apartheid policies stated that industrial sections were planned adjacent to the African townships deliberately (Mubibwa, 2013).

At the end of the Apartheid era, new development and investment into the infrastructure of townships to become integrated into the urban fabric have been underway. However, the rate of integration and improvement has been lagging behind the current inward migration and natural population growth (Mubibwa, 2013).

Though a great effort has been made to reconnect the segregated urban area, "waste landscapes" in various forms still fragment the Johannesburg city. Even in contemporary times, good intentions can cause further urban separation. This is the cases of RDP dormitories and informal settlements being placed far away from economic hubs.

The construction of single-storey office parks is also contributing to the horizontal urban sprawl due to the limited usage of land (Mubibwa, 2013).

The natural grassland, agricultural and rural areas also becoming urbanised (Mubibwa, 2013).

4.2 Johannesburg urban renewal focus

The urban vision for Johannesburg is to create a socially just city. The proposal developed by relative stakeholders aims to identify and engage with challenges and opportunities for the spatial visions of the Future African City of 2040 (City of Johannesburg: Department of Development Planning, 2016).

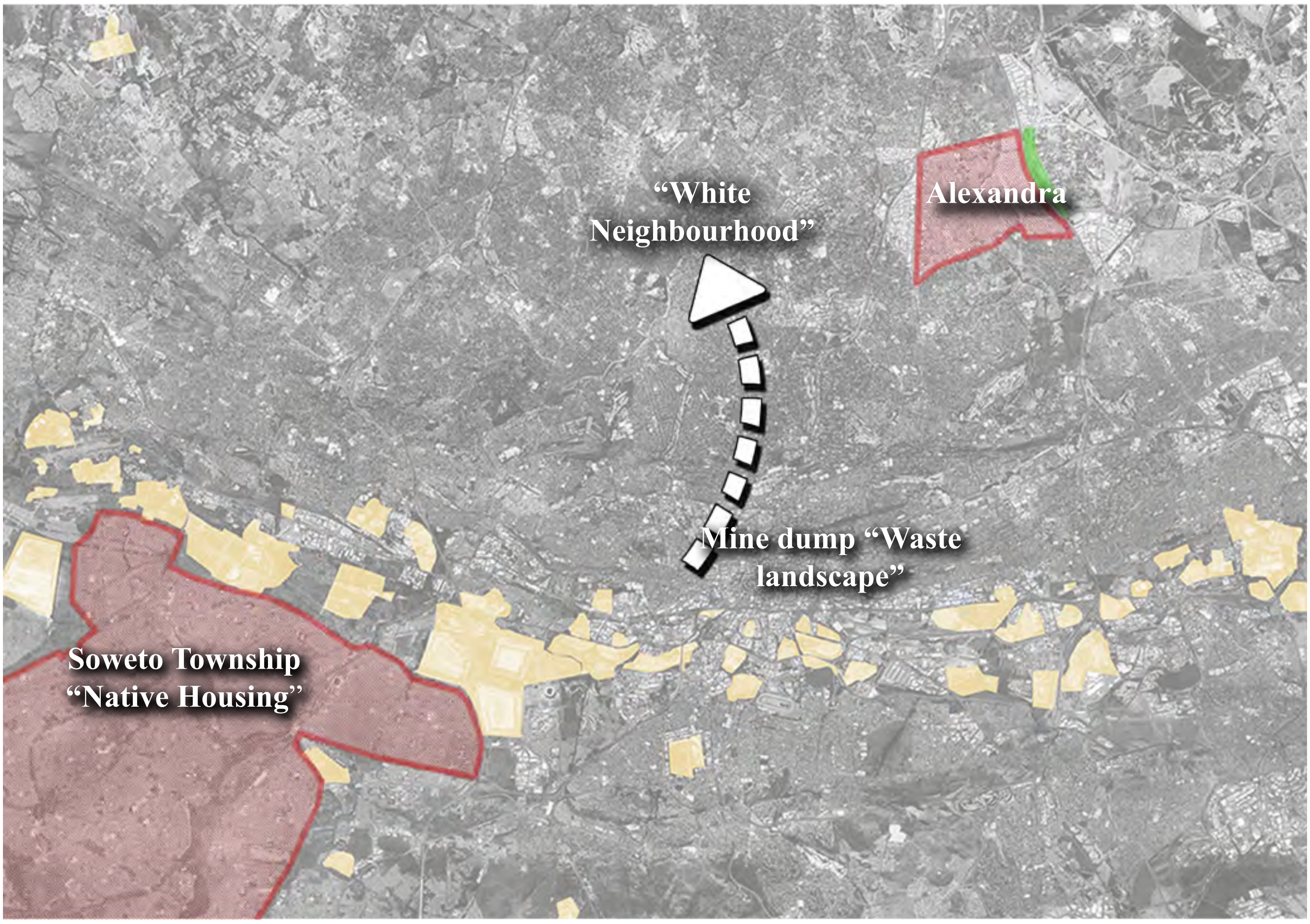


Fig 4.2 1960 Johannesburg urban development (Author, 2020)

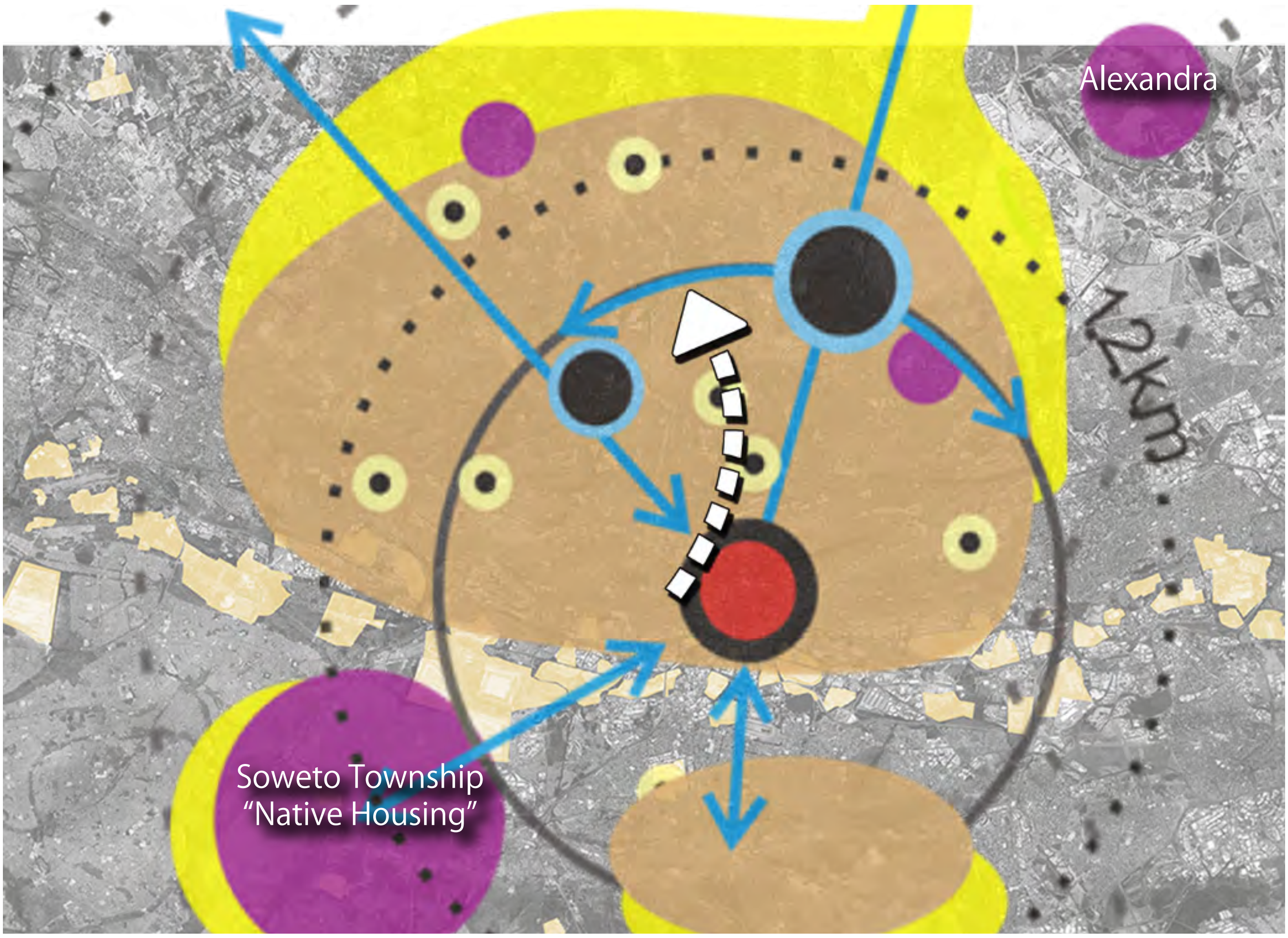


Fig 4.3 Inverse polycentric city of Johannesburg (City of Johannesburg Metropolitan Municipality, 2016, edited by Author, 2020)

Urban renewal projects for Johannesburg seek to address five major issues of its social and spatial landscapes (City of Johannesburg: Department of Development Planning, 2016). These five issues are discussed below:

4.2.1 The increased pressure on the green infrastructure, ecological services and natural environments.

Although Johannesburg is considered one of the largest, landlocked urban environments to have integrated an "urban forest", only 54,081ha of the 164,499.6ha, or 32.9%, of the Johannesburg municipality remains in a natural state of which only 0.6% is currently protected as nature reserves (City of Johannesburg: Department of Development Planning, 2016).

4.2.2 Urban sprawl and fragmentation.

Johannesburg urban planning currently has created a weak metropolitan core since high-density residences are separated from urban economic centres and transport nodes within the city. The result causes social segregation, with associated high economic and environmental costs (City of Johannesburg: Department of Development Planning, 2016).

Even though the isolation policy for the development of racial groups stopped at the end of Apartheid in 1994, the post-1994 development continued this urban sprawl effect due to the planning of gated and car-oriented communities. This has led to densification occurring on the outskirts of the economic hubs (City of Johannesburg: Department of Development Planning, 2016).

4.2.3 Spatial inequalities and jobs-housing mismatch.

The development pattern of economic and residential densities and their respective locations show that regions with high residential populations are located further away from regions of high economic density (City of Johannesburg: Department of Development Planning, 2016).

Currently, one region identified, which includes areas of Alexandra, Sandton, Bruma and Woodmead, share 27% of Johannesburg's economic output (City of Johannesburg: Department of Development Planning, 2016).

4.2.4 Exclusion and disconnection barriers.

Remnants of the Apartheid urban planning, in terms of segregation, are still visible within the urban pattern. Two major points of spatial discontinuation that are visible are at the mining belt of Johannesburg and the vacant, undeveloped lands within the region of Glen Austin and Modderfontein, which includes Linbro Park and Alexandra (City of Johannesburg: Department of Development Planning, 2016).

4.2.5 Inefficient diversity use of land and space.

The allocation of land functions within the city currently shows that 30% is for residential development while 10% is for economic and commercial zones. However, it can be observed that there is a very low diversity of land functions. The effect can cause higher energy consumption as well as an increase in travel distance and cost (City of Johannesburg: Department of Development Planning, 2016).

4.3 The Polycentric city model

The proposed form for Johannesburg city is a polycentric city model, which is described as an urban environment that has a strong centralised core, connecting to economic sub-centres through expansive public transit (corridor development) areas. The housing density decreases as one moves further away from the core (City of Johannesburg: Department of Development Planning, 2016).

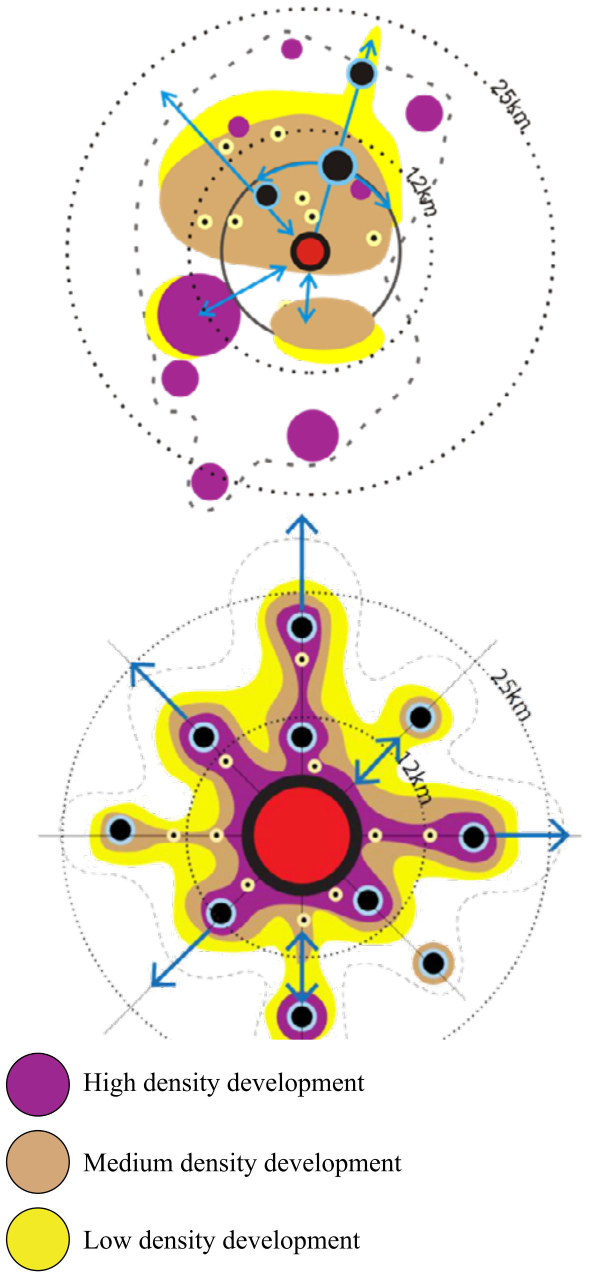


Fig 4.4 Comparison of an inverse polycentric city and a polycentric city (City of Johannesburg Metropolitan Municipality, 2016)

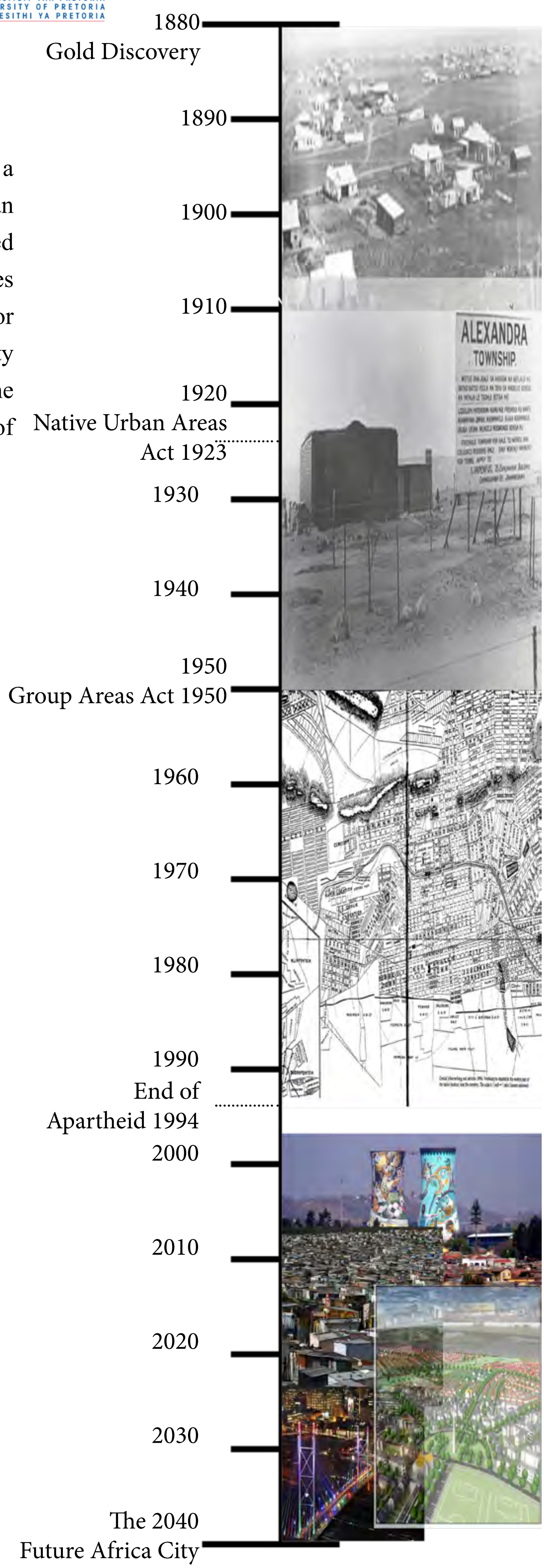


Fig 4.5 Johannesburg urban development shifts (Author, 2020)

4.4 The Johannesburg 2040 implementation strategy

The implementation strategy involves using a series of integration and transformation principles.

4.4.1 Integrating natural structure

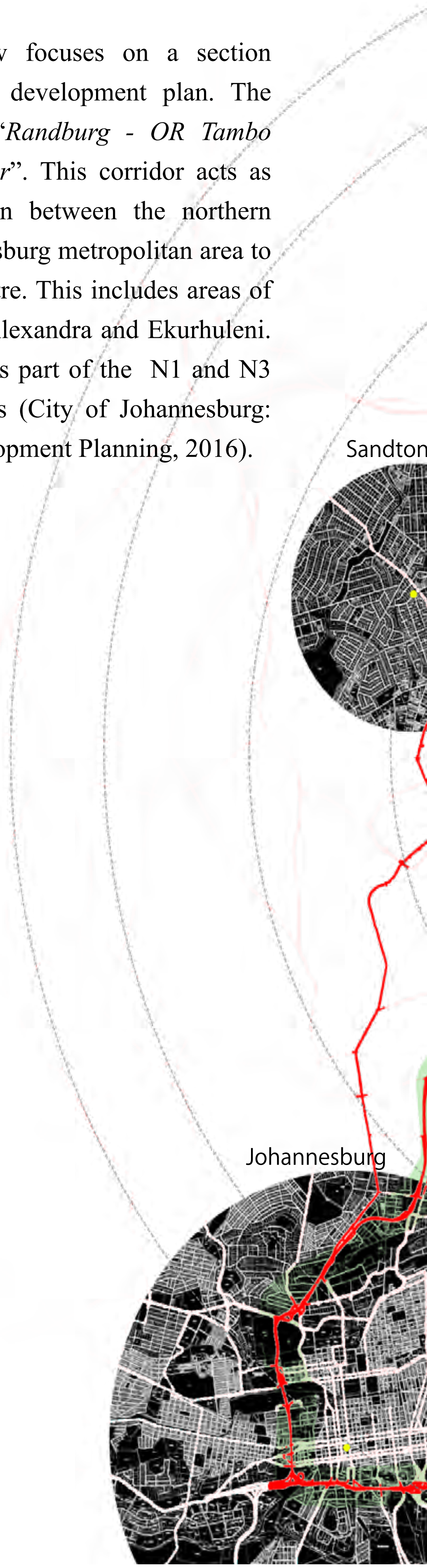
The natural environment of Johannesburg should be seen as an irreplaceable city asset. The value lies not only in its natural beauty but also for the ecosystem services that it provides. It is estimated that the ecosystem services has reduced the operational cost for the city authorities ranging from R38.6 million to R1.9 billion (City of Johannesburg: Department of Development Planning, 2016).

4.4.2 Transformation zones

Transformation zones are described as areas where investment should be concentrated to encourage the intensification and the growth of Johannesburg city.

An example of this development can be seen at "The Corridors of Freedom" which links Soweto through to the inner city via the Nelson Mandela Bridge (City of Johannesburg: Department of Development Planning, 2016).

The dissertation now focuses on a section of the Johannesburg development plan. The section area is the "*Randburg - OR Tambo Development Corridor*". This corridor acts as a strategic connection between the northern region of the Johannesburg metropolitan area to the Johannesburg centre. This includes areas of Randburg, Sandton, Alexandra and Ekurhuleni. This region also forms part of the N1 and N3 development corridors (City of Johannesburg: Department of Development Planning, 2016).



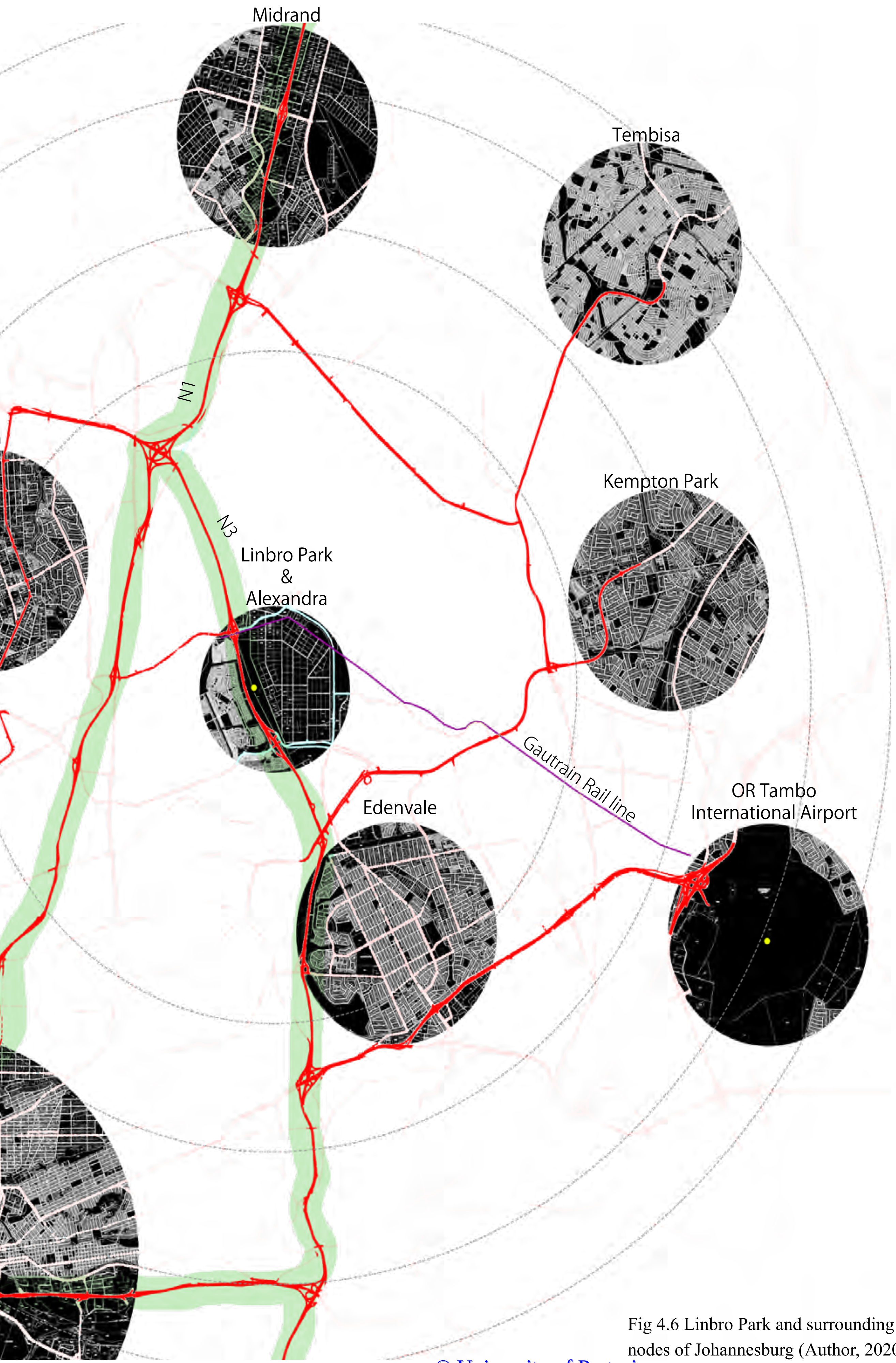
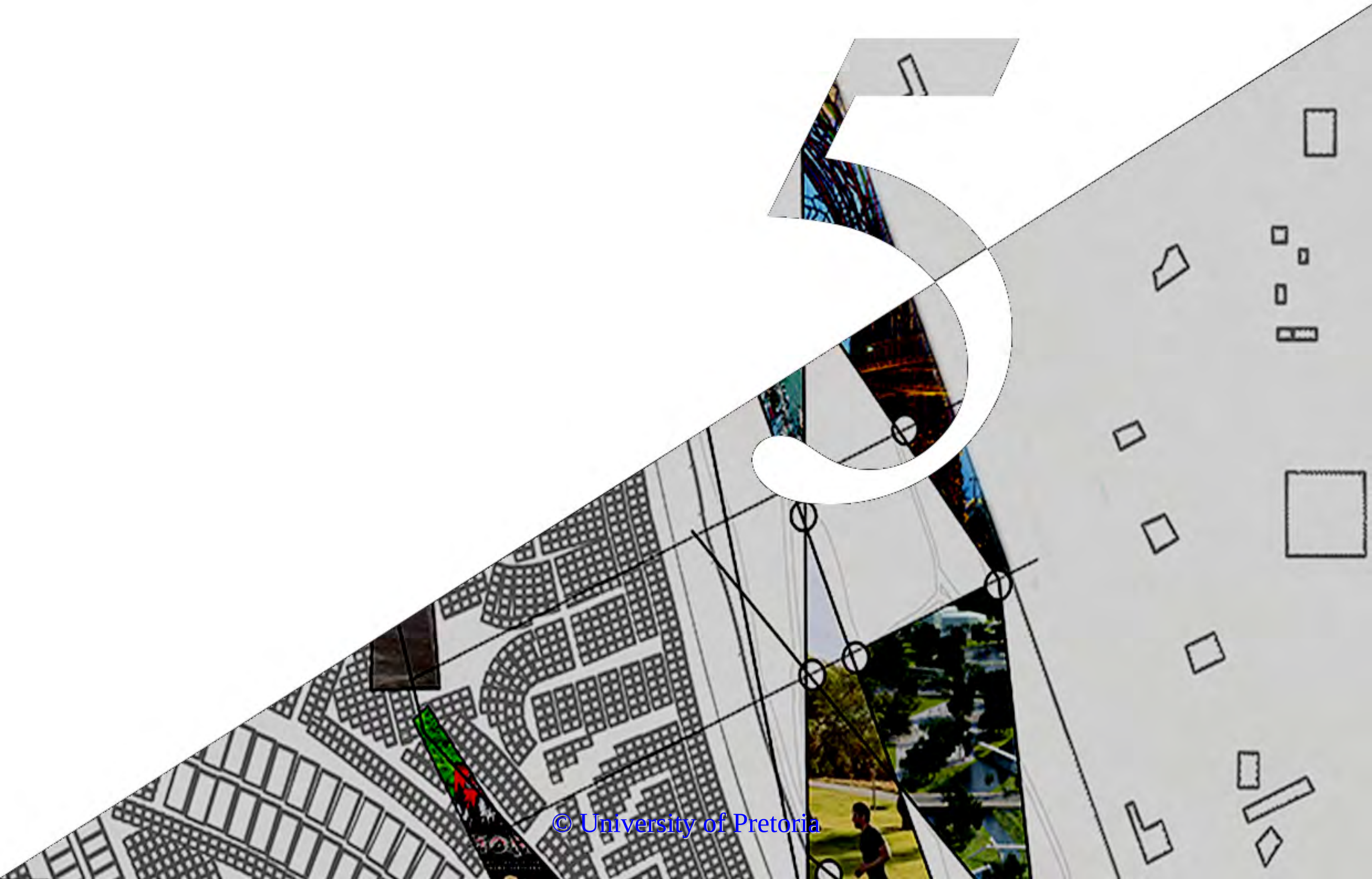


Fig 4.6 Linbro Park and surrounding important nodes of Johannesburg (Author, 2020)

5



Chapter 5: Linbro Park Landfill Site and surrounding context analysis

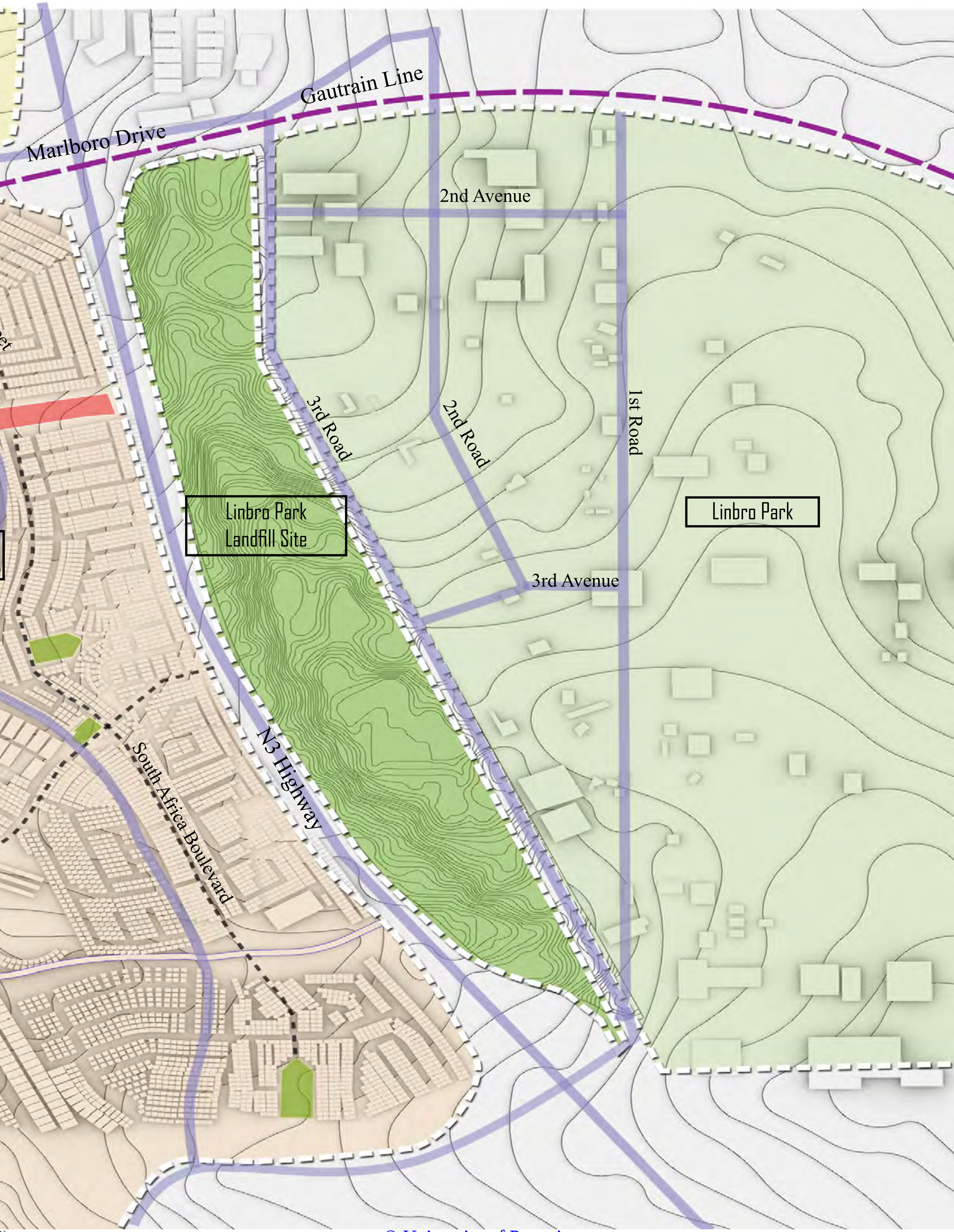
The focus of the investigation now moves towards understanding the site and its surrounding context. The issues and opportunities will be an important factor in considering the reprogramming of the Linbro Park Landfill Site while dealing with its on-site issues. The process will be based on Sébastien Marot's four principles as discussed in Chapter 3.

In Figure 5.1 shows the Linbro Park Landfill Site's context as well as the new proposals for the area.

Fig 5.1: Linbro Park Landfill Site and surrounding suburbs (Author, 2020)


Frankenwald
Modderfontein
Proposed town hall development
Linbro Park Landfill Site
Linbro Park
Thornhill Estate lakeside
Longmeadow business estate
Lombardy East

Fig 5.2 Linbro Park Landfill and intermediate context (Author, 2020


Marlboro Drive
Gautrain Line
2nd Avenue
3rd Road
2nd Road
1st Road
Linbro Park
Landfill Site
Linbro Park
3rd Avenue
N3 Highway
South Africa Boulevard

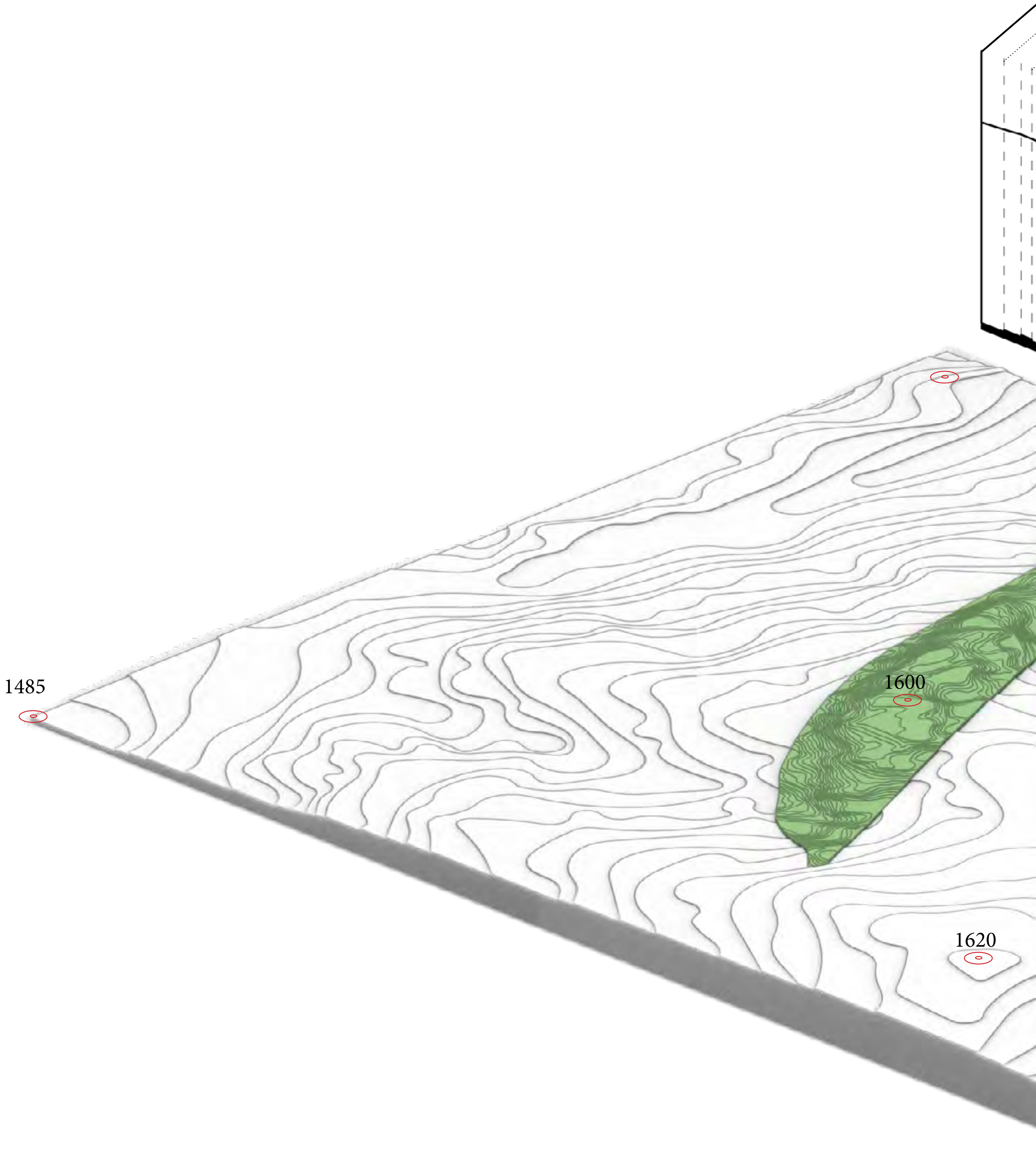
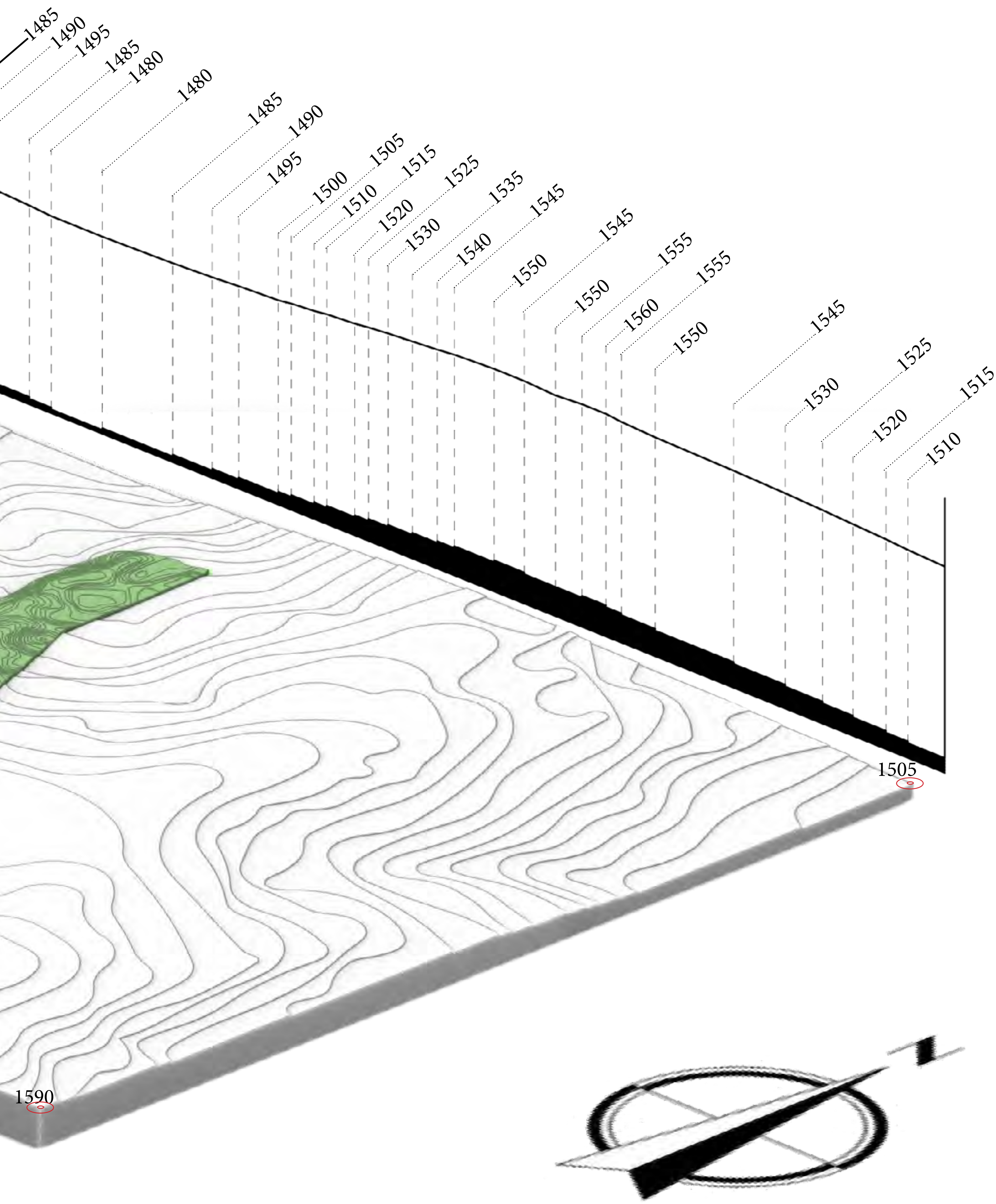


Fig 5.3 Regional contour model (Author, 2020)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5.1 Linbro Park

The Linbro Park framework was proposed in 2010 by *ADA Urban Design* to develop Linbro Park from its original purpose as stock farms into a high-density residential housing complex. The land uses entails office and commercial buildings as well as a new town centre. The region will also gain a new Gautrain station within a 2km radius from the Marlboro Station (BWLC Development Consortium, 2010).

The framework proposal makes little reference to remediating the landfill site into a public park and shows no intentions to unify the region of Alexandra and Linbro Park.

It can therefore be argued that the framework does not jointly remediate urban issues that have been set out in the Future African City plan. An example relates to the spatial transformation section to create an:

"*Inclusive city – ensuring balanced service provision (hard and soft) and opportunities for all by diversifying land uses, promoting social mixing and bridging social, spatial and economic barriers*". (City of Johannesburg: Department of Development Planning, 2016).

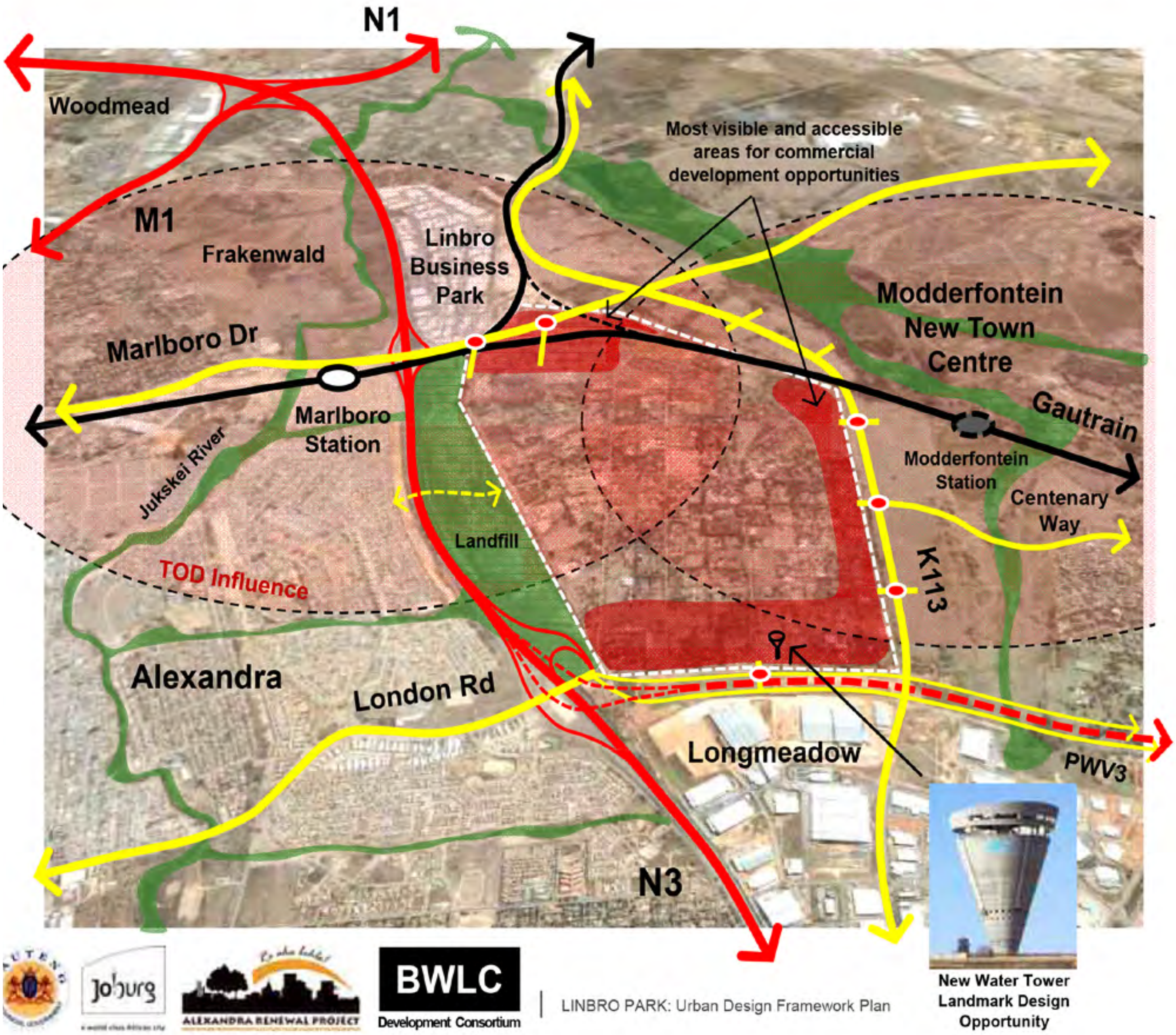


Fig 5.4 Linbro Park development proposal (BWLC development consortium, 2010).

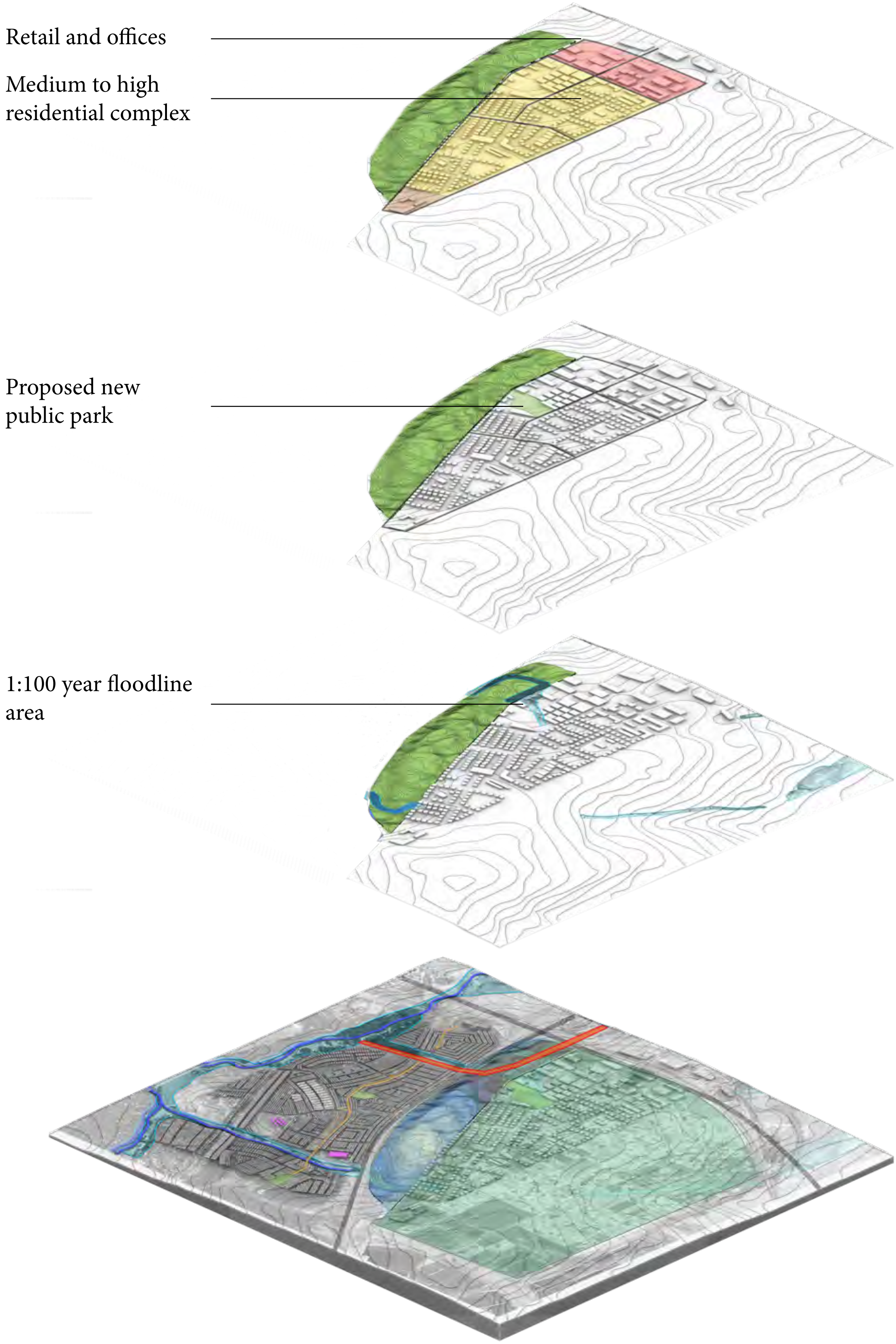


Fig 5.5 Linbro Park analysis (Author, 2020).

5.2 Alexandra township

The Alexandra township is located to the West of the landfill site. The township was an area allocated for housing development for African people as part of the Group Areas Act of 1950 and was meant to accommodate approximately 70 000 residents. Currently, the township has a population of approximately 179 000 people within a 6.92km² plot of land. Alexandra became a hub of accommodation for those seeking job opportunities within the surrounding areas such as Sandton (Sondzaba, 2019).

The Jukskei River, which runs through Alexandra, flows northward and joins with the Crocodile River before entering the Hartbeespoort Dam. It divides the settlement into western, eastern and southern sections (Kent, 1975). There are two major issues of concern with regards to the Jukskei River. Firstly, it is prone to flooding due to poor stormwater infrastructure and informal development occurring in floodline areas. Secondly, the health of the river is currently under threat as flood events can cause contamination by sewage and surface run-off. Alexandra has inefficient waste removal services, which encourages illegal dumping of domestic waste products on open land. The result is the formation of "waste landscapes" at the cost of public green spaces and ecological spaces (Sondzaba, 2019).

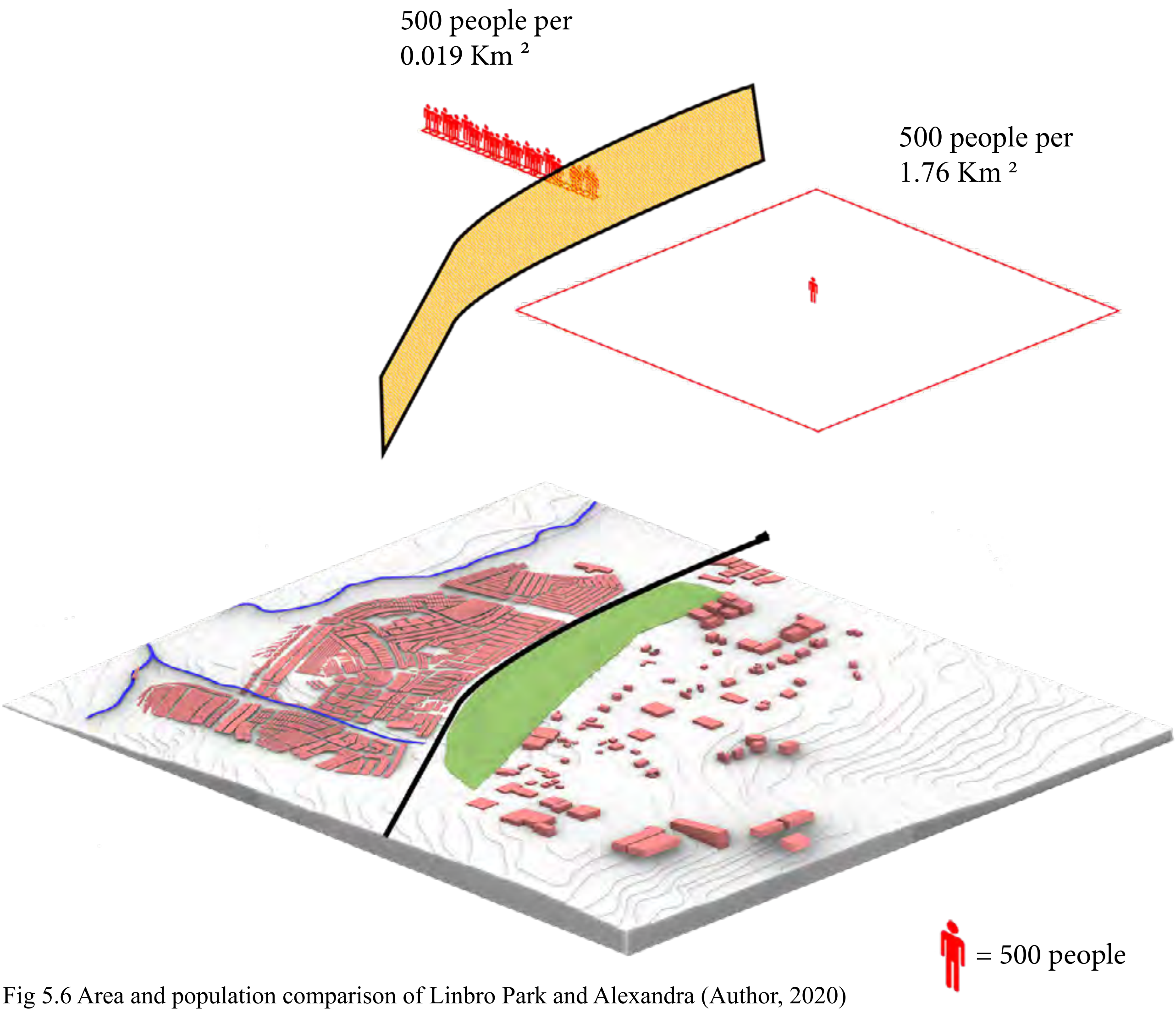


Fig 5.6 Area and population comparison of Linbro Park and Alexandra (Author, 2020)

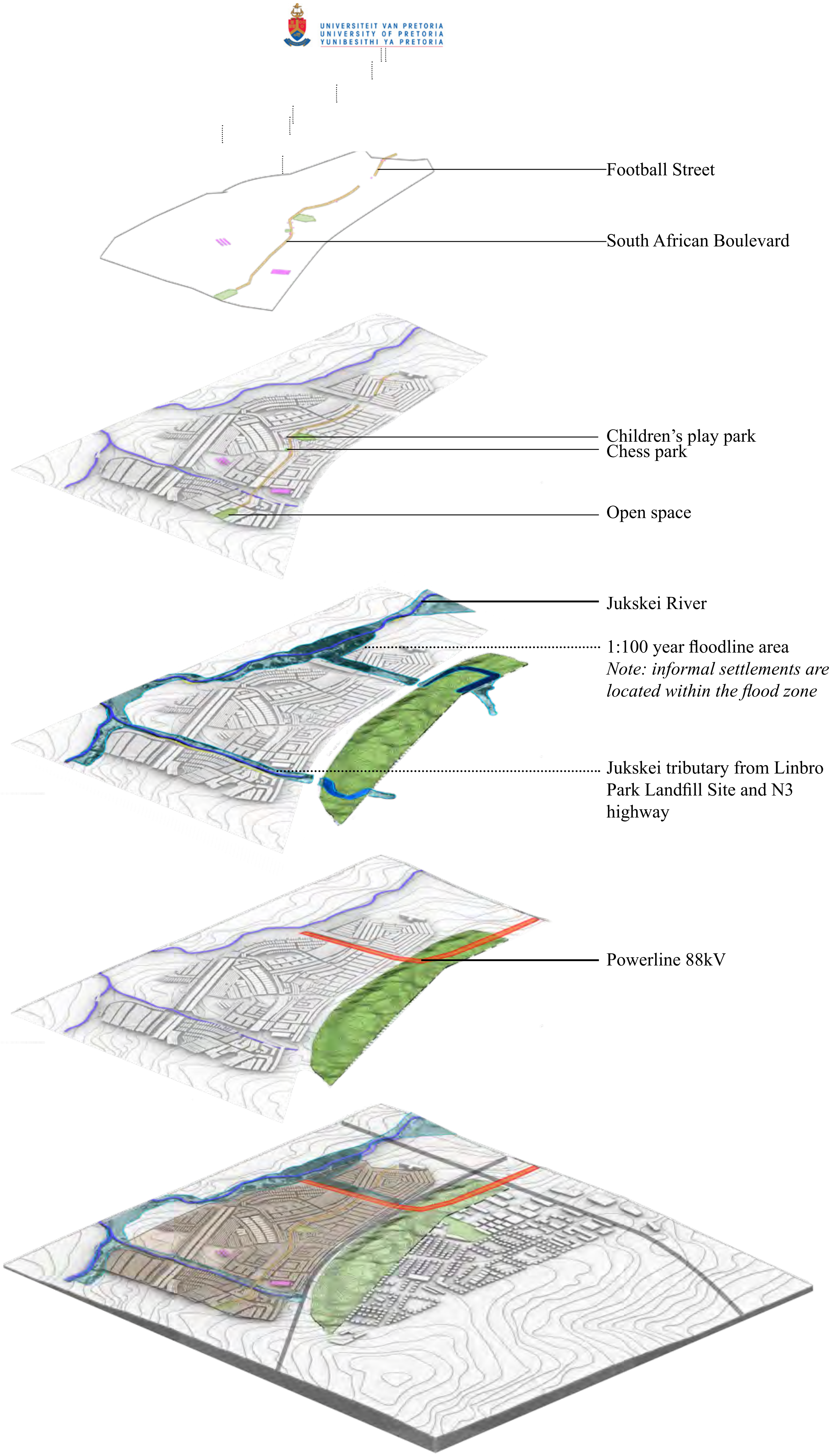


Fig 5.7 Alexandra analysis (Author, 2020)

5.2.1 The Alexandra Urban Renewal Project

The AUR project commenced in February 2001 and ran for approximately 10 years. The plan had objectives in four key aspects (Sondzaba, 2019):

i) Develop Alexandria heritage tourism

ii) Improve movement and accessibility

iii) Further diversify activities

iv) Development of green spaces

A study was carried out to determine the results of the initiative based on the views of the residents of Alexandra. The findings indicated that the programme had delivered some desirable outcomes but certain aspects had not been adequately addressed, such as the quality of public and natural green spaces. General issues that were found relating to green spaces include (Mbanjwa, 2018):

i) Limited recreational facilities.

ii) The dangers for children playing in public streets due to the lack of green spaces.

iii) General lack of trees.

As one participant explained, *"Alex is too crowded because of the shacks and the houses..., that is why it is difficult to create a separate area for the children's playground. We understand that... but it is still a problem for children to play in the streets…"* (Mbanjwa, 2018).

5.2.2 East Bank Alexandra green spaces analysis

Within the Eastern region of Alexandra, there are a few green spaces that have the potential to become part of a link. The "Project for Public Space" (Kent, 1975), was used as a tool to serve as a guideline for evaluating the quality of the public spaces which would influence and support the design decisions and functions in the repurposing of Linbro Park Landfill Site into a regional park.

The model was developed by William "Holly" Whyte, an urban theorist and journalist. The model provides a rating on our categories namely: sociability, functions, accessibility and comfort to measure the quality of green public spaces (Project for Public Spaces, 2020).

This model tool will help the designer to understand what interventions will have the greatest beneficial value towards the local community.

5.2.2.1 Children's park

Located adjacent to South African Boulevard, is a community park that has equipment for children to play on. The area is clean and maintained well. The location also acts as a central point within the community.

5.2.2.2 Open space

Located at the end of South African Boulevard, is a spatial region that currently has no function and does not support any visible local activities. The space has low biodiversity and has no other infrastructural interest that would encourage visitors to utilise the space.

5.2.2.3 Chess Park

Also adjacent to the South African Boulevard, this park has large tiled chessboard without pieces. The park offers a small communal zone but rather lacks any other unique, potential activities.

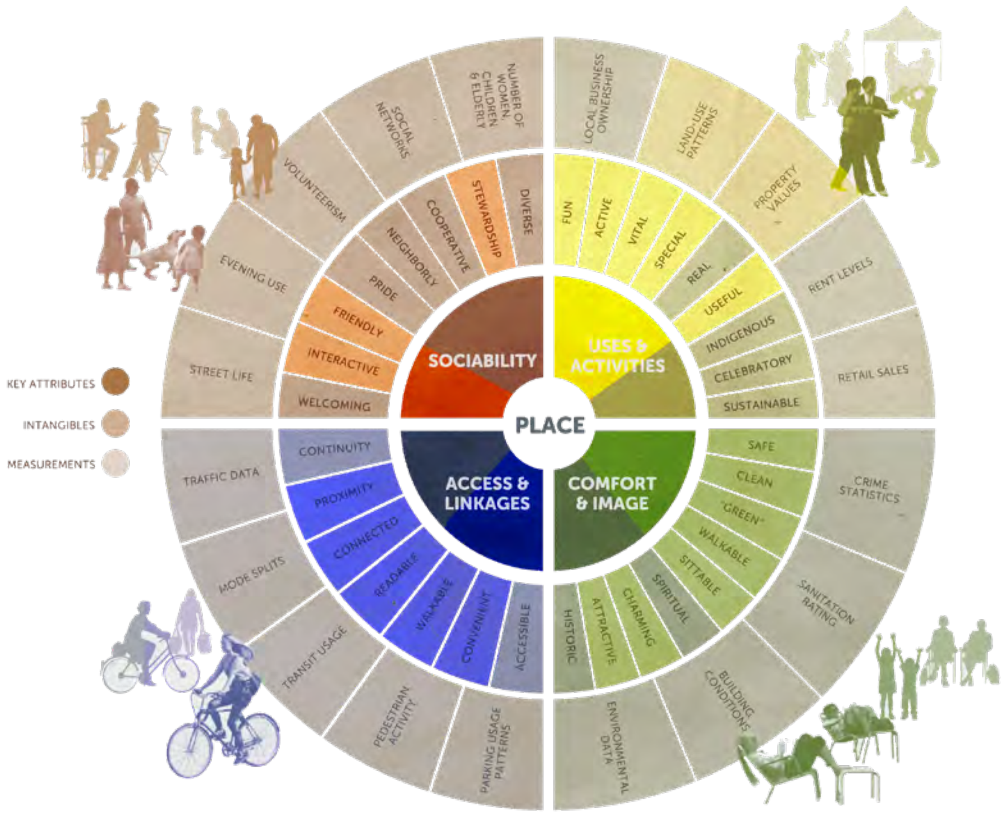


Fig 5.8 Alexandra Children's Park rating according to the PPS model (PPS 2016, edited by Author 2020)

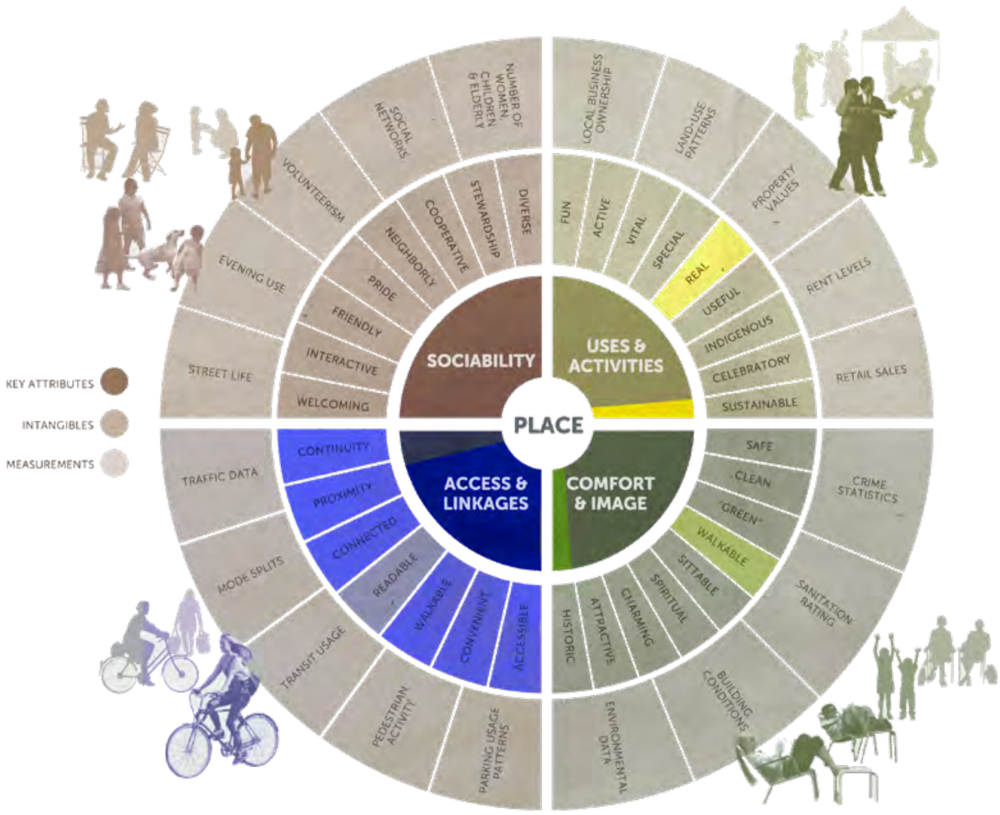


Fig 5.9 Alexandra Open Space rating according to the PPS model (PPS 2016, edited by Author, 2020)

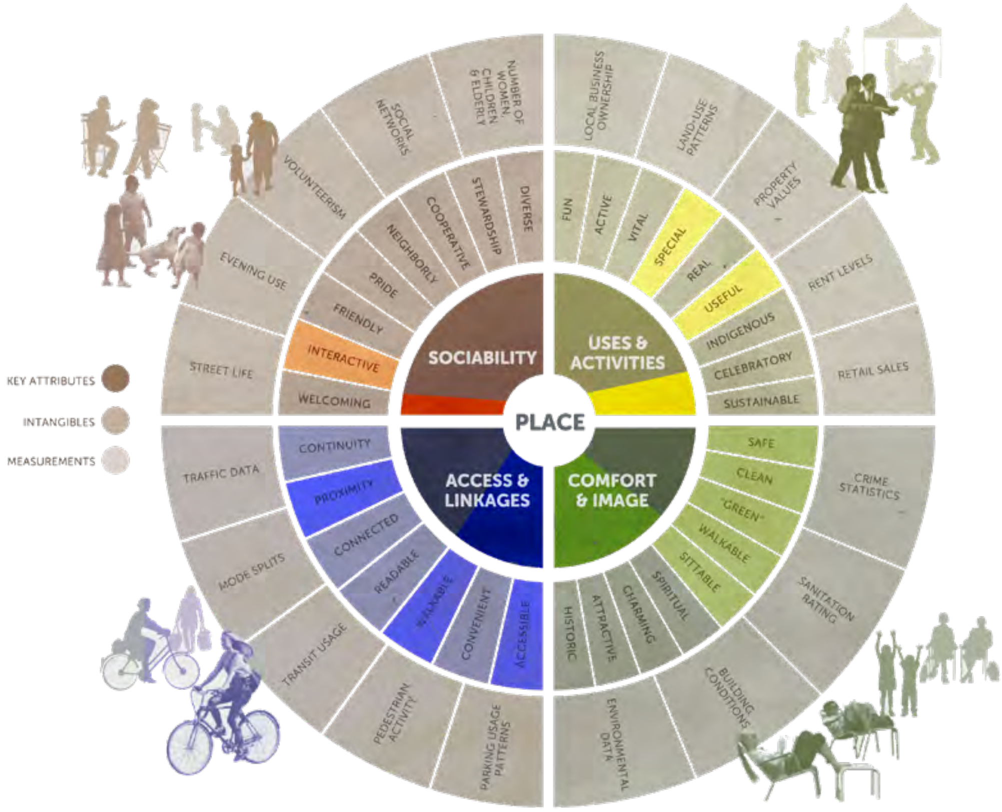


Fig 5.10 Alexandra chess park rating according to the PPS model (PPS 2016, edited by Author, 2020)

From the analysis, it was be observed that the green spaces are in a relatively good location within the community. However, the quality and social ownership is lacking, creating rather bland and uninteresting green spaces.

6

Chapter 6: Linbro Park Landfill Site

6.1 Biophysical environment

6.1.1 Climate analysis

Johannesburg is categorised as a subtropical highland climate according to the Köppen climatic classification (which is a globally used empirical classification system). Annual rainfall is 790mm, the wettest month occurs in January with 125mm and the driest during July with only 7mm of rain (climate-data, 2020).

The summer period has high possibilities of afternoon thunderstorms. The average day temperature is 19.9 °C but can reach temperatures as high as 25.8 °C and as low as 14 °C. The winter period has an average temperature of 12 °C. The expected maximum can reach 17.2°C in July and be as low as 3°C (climate-data, 2020).

6.1.2 Hydrology analysis

The landfill is divided into a Northern and Southern area by an imaginary line that continues from 3rd Ave of Linbro Park. Surface run-off moves in opposite directions, respectively.

There is a channel under the N3 highway that links the collection of surface run-off flowing down the western part of the southern section slope. The natural water table is located 4m below the baseline of the landfill site and rises closer to the surface as it approaches the Jukskei River in a north-western direction to a point of being 2m below the surface (Butler, 1998).

There are key areas of the landfill site that have been identified to be part of the 1:100 year floodline area, which raises concerns with regard to the percolation of water into the landfill waste layer (BWLC Development Consortium, 2010).

6.1.3 Current ecosystem activity

In South Africa, grasslands occur in the central, high plateau regions, inland along the Eastern seaboard, mountainous areas of KwaZulu-Natal and central areas of the Eastern Cape. Within the region of Gauteng, the grassland diffuses into the borders of the Savannah biome along the northern slope of the Magaliesberg (South African National Biodiversity Institute, 2009).

The term “grassland” considers vegetation that consists of a dominant layer of grass species mix. The diversity of grasslands characteristics are influenced by factors such as vegetation structure, precipitation amount during the summer period and the minimum winter temperatures and surface aspects (Powrie, 2015).

The landfill site is located on a border of the Egoli Granite Grassland group and the Carleton Dolomite Grassland group. Both grasslands groups are considered vulnerable (South African National Biodiversity Institute, 2009).

As per the terms of section 20b of The National Environmental Management Act 2008 (Act no. 59 of 2008) for the close-out phase of the landfill site, the landfill needs to be revegetated with indigenous plants. However, it can be observed that invasive plants are present on-site.

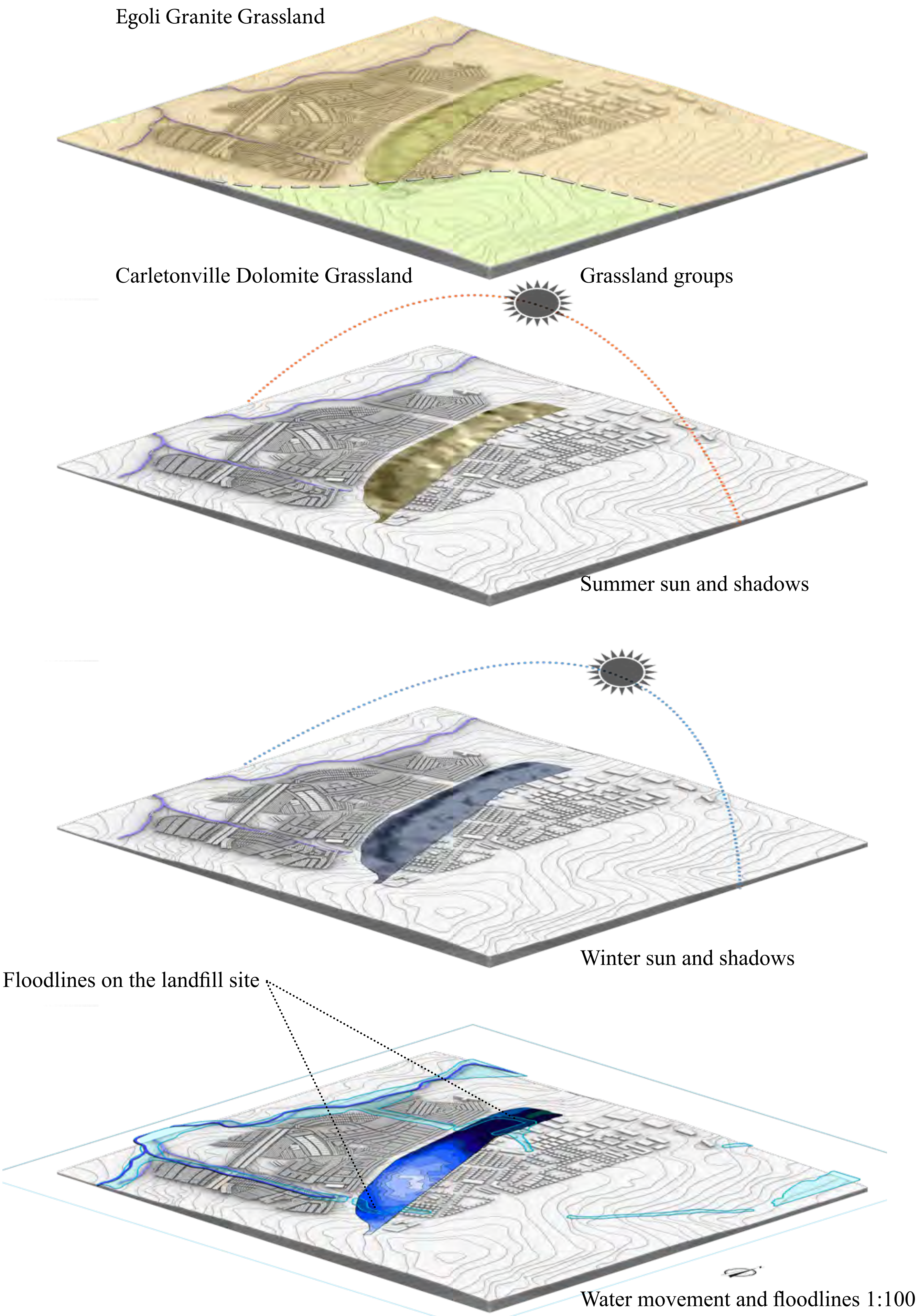


Fig 6.1 Linbro Park Landfill Site biophysical environment analysis (Author, 2020)

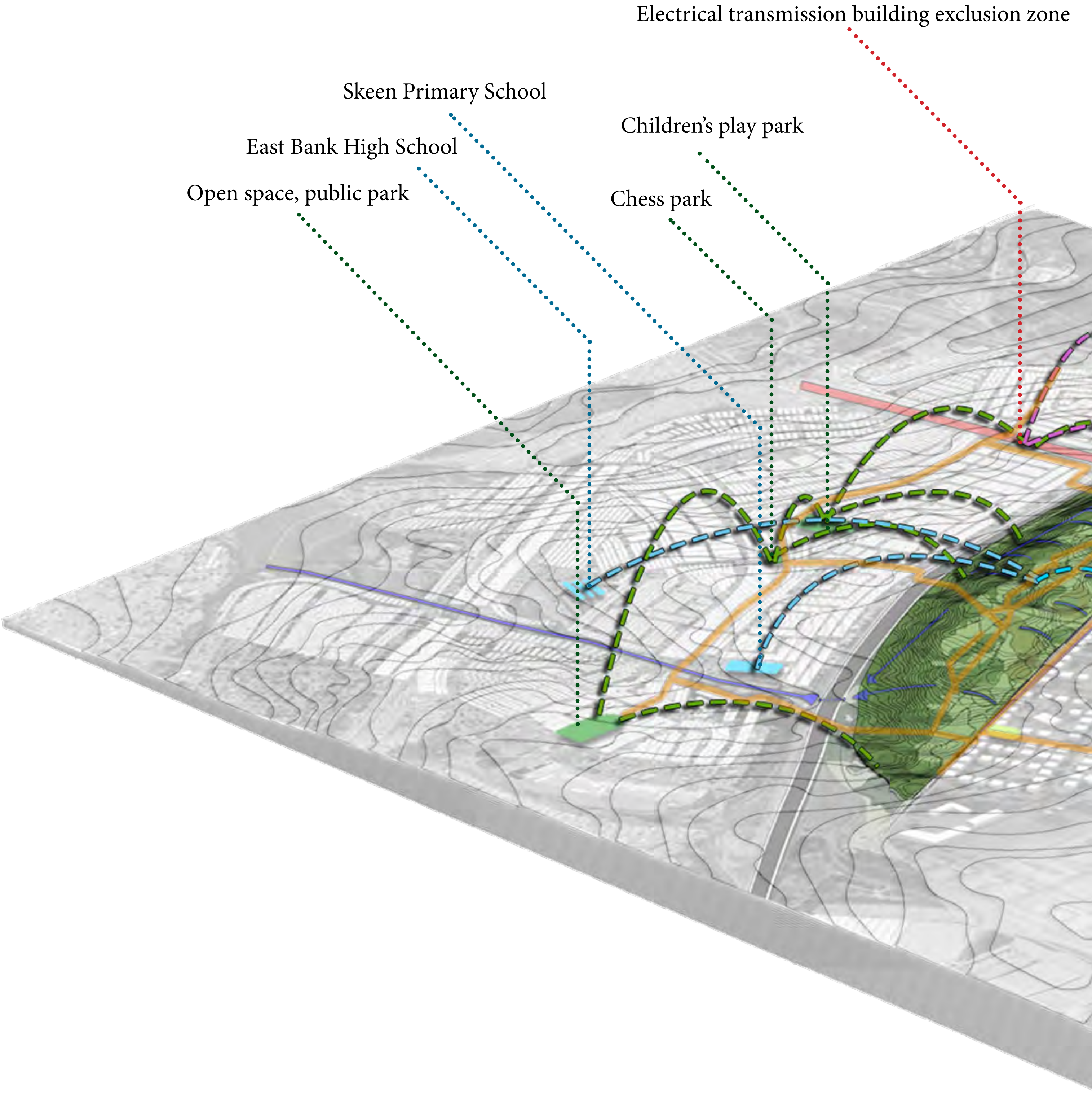
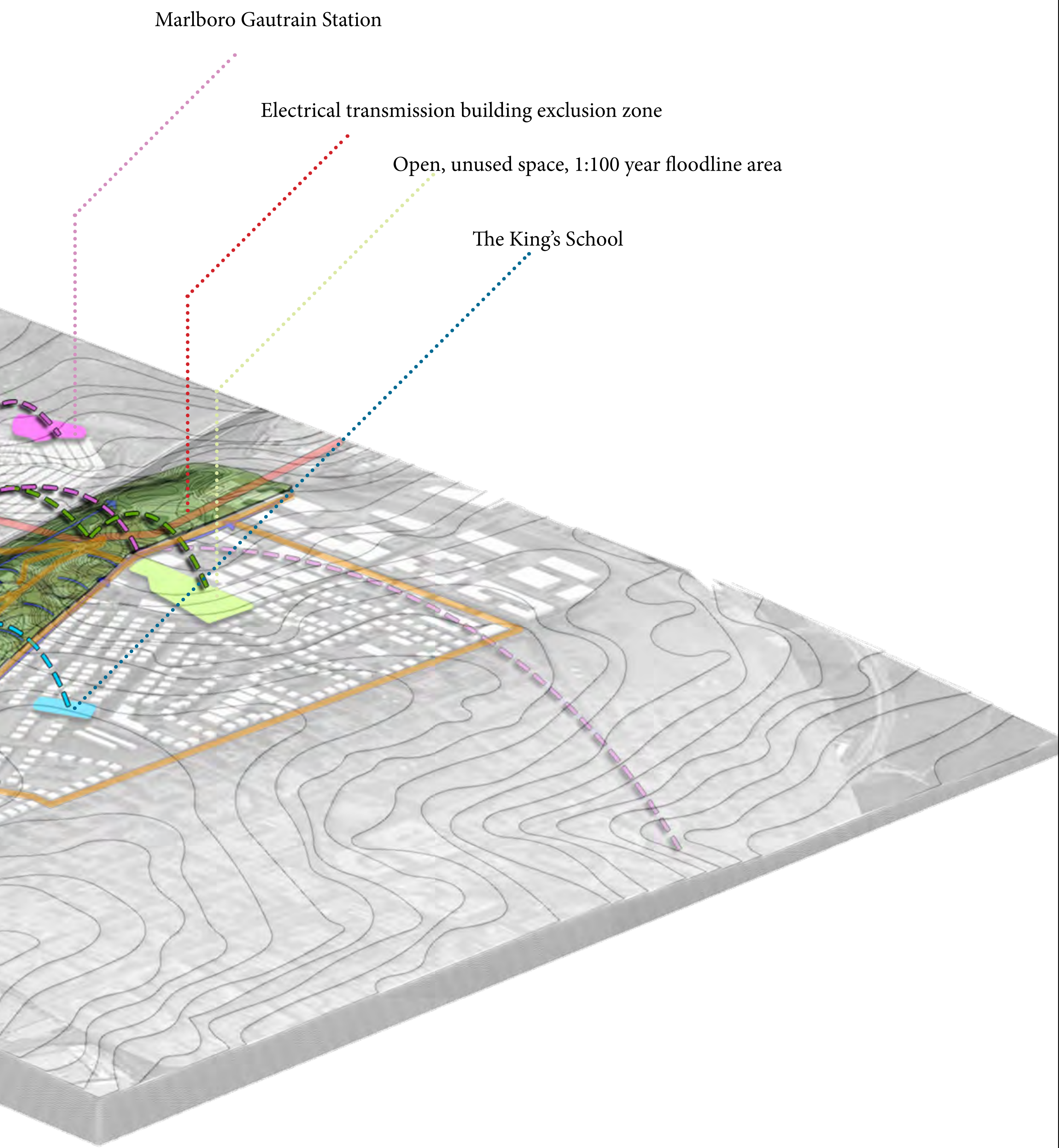


Fig 6.2 Possible links and connections into Linbro Park Landfill Site (Author, 2020)


Marlboro Gautrain Station
Electrical transmission building exclusion zone
Open, unused space, 1:100 year floodline area
The King's School

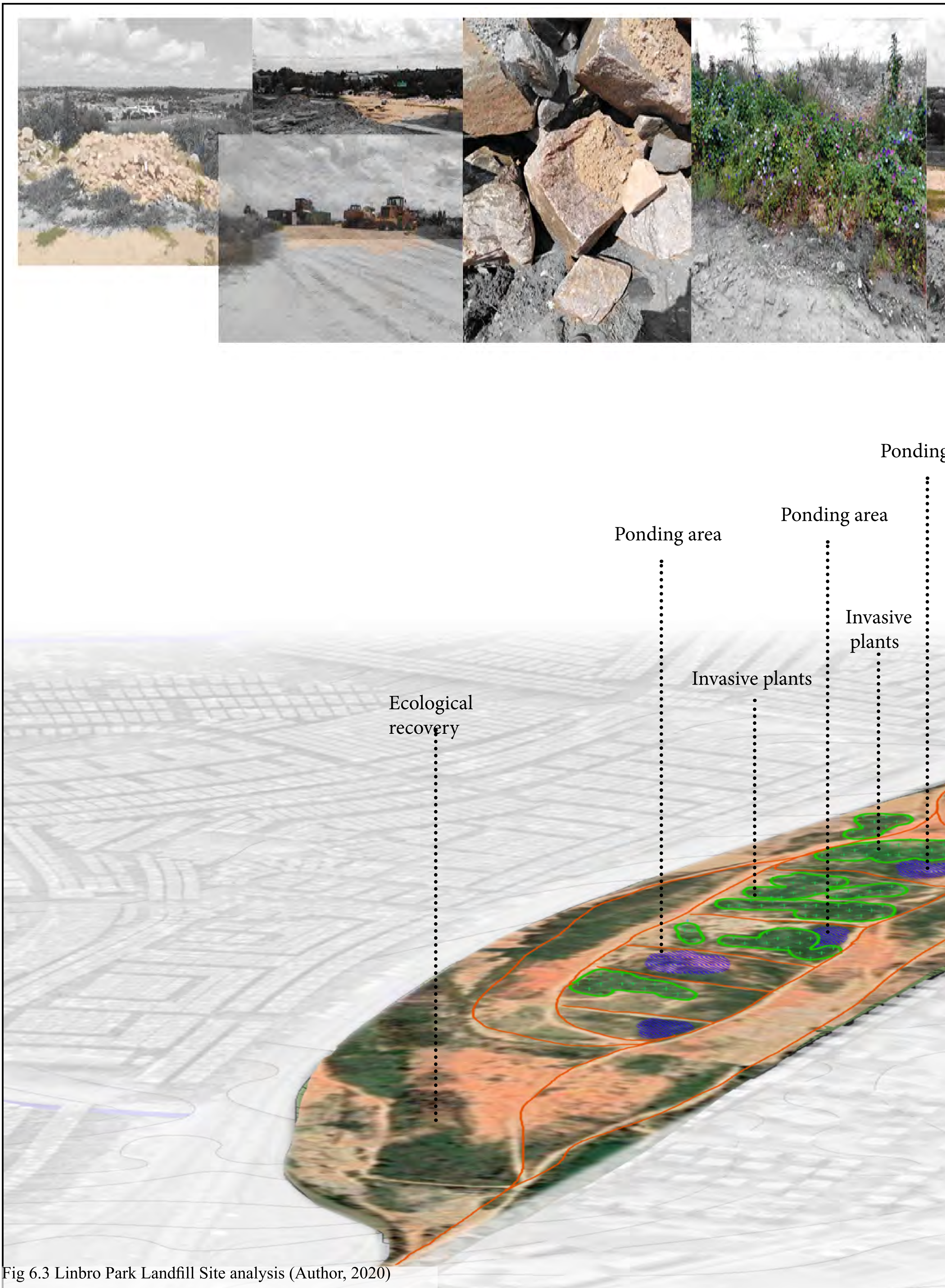
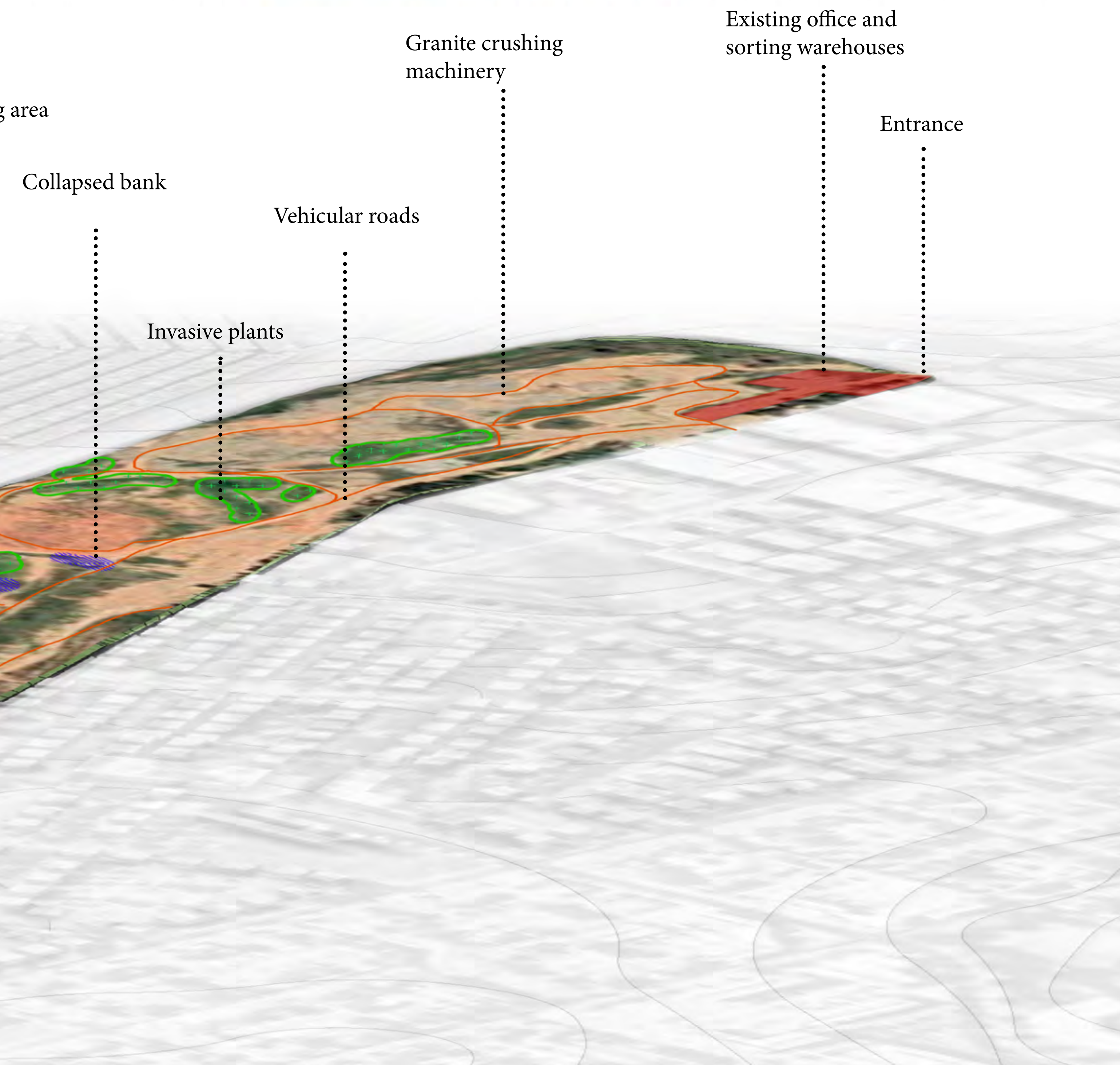


Fig 6.3 Linbro Park Landfill Site analysis (Author, 2020)


g area
Collapsed bank
Invasive plants
Vehicular roads
Granite crushing machinery
Existing office and sorting warehouses
Entrance

6.2 Linbro Park Landfill Site

The Linbro Park Landfill Site was opened in 1969 in the northern section and in 1989, the southern section was developed, accepting approximately 220 000 tonnes of waste per annum. The waste body consisted of domestic waste, building rubble, garden waste, and street refuse. Hazardous or toxic materials were not accepted, as the landfill was set to function as a B-Class landfill site. It closed in 2005 (Butler, 1998).

The construction of a B-Class landfill is managed by creating cells that will store the waste after being compacted by a landfill compactor. The base of these cells has high-density polyethene (HDPE) geomembranes at the base to prevent leachate from infiltrating natural water tables. At Linbro Park the cells are placed between two parallel berms situated about 30m apart. Cells are compacted to a maximum of 2m and covered with a 150mm to 300mm soil layer at the end of the working day to prevent waste being removed due to natural events, i.e. high winds etc. (Butler, 1998).

Fig 6.4 Photo on site (Author, 2020)

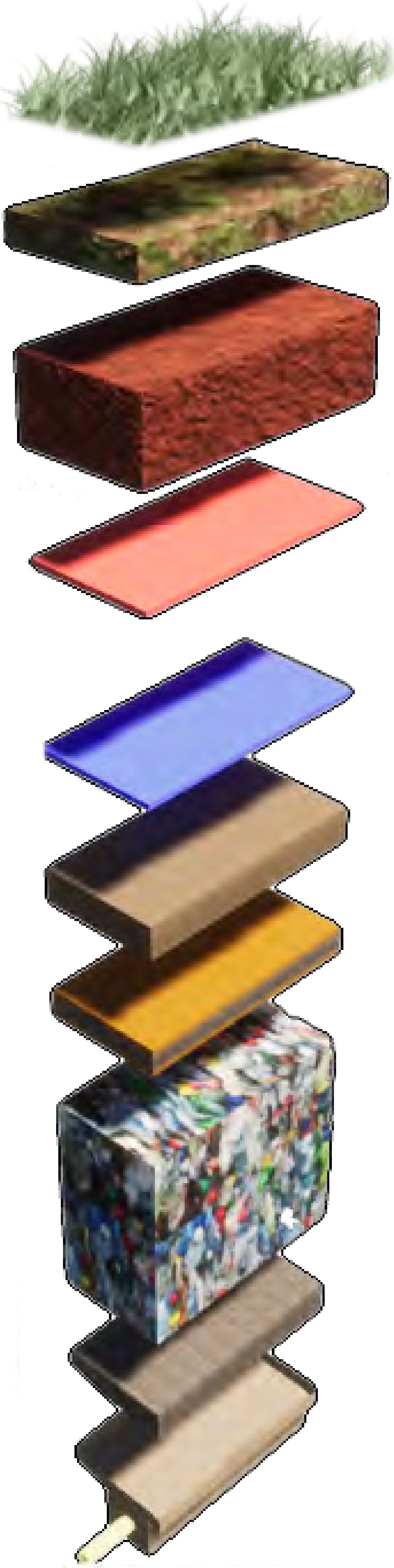


Fig 6.5 Typical layers of a B-Class landfill site (Author, 2020)

6.3 Landfill management

The final capping process involves the use of a clay-like material placed on top of a 600mm thick soil layer of decomposed granite. In accordance with the terms of section 20b of The National Environmental Management Act 2008 (Act no. 59 of 2008), there are several remediation requirements that need to be undertaken and maintained. These include:

i) Prevention of ponding occurring on site
ii) Management of stormwater surface run-off
iii) Prevention of stormwater contamination
iv) No erosion occurrence after rehabilitation
v) Achieving re-vegetation of the area with indigenous plants

The license holder needs to carry out regular gas and water monitoring of the site. Groundwater monitoring must be maintained and continued for 30 years after closure (Yawitch, 2010).

The closure notice described above gives instructions on the broad remediation of the landfill site but is silent on any intent to repurpose the closed landfill into a regional park. The legislation requirements will need to be incorporated into the design principles as part of the area's remediation.

6.3.1 Clay capping process

Stormwater infiltration control is important to prevent the infiltration of water into the waste layers where it can be contaminated by leachate. Clay-based material has very small pores which minimise water infiltration but this results in a relatively high surface run-off coefficient compared to other soil types, leading to soil weathering and erosion of the top organic layer. The exposure then causes the clay soils to crack, leading to high water percolation. Clay soils also limit the process of oxidation of the methane gases which is a necessary process for any landfill site to allow gases back into the environment (Ashwath, 2014).

Currently, the site is not complying with the regulations set out for the closure and rehabilitation phase as it was observed that ponding was occurring on top of the landfill ridge and large areas of soil erosion of banks and the resurfacing of waste materials was noticed.

Fig 6.6 Resurfacing of waste material (Author, 2020)

6.3.2 Leachate risk due to water infiltration

Leachate is a liquid that contains high levels of pollutants and waste solubles. It is formed when water percolating through the waste deposits comes into contact with the aerobic and anaerobic microbial decomposition of the waste. Leachate carries minerals from waste such as ammonium-nitrogen, chloride, sodium, chemical oxygen-demanding elements, biological oxygen-demanding elements, heavy metals and dissolved solids. Leachate needs to be treated before it infiltrates natural aquatic systems to prevent contamination (Wojciechowska, 2010).

The conventional method of treatment involves the transport of the leachate to a sewage treatment facility. This can be an issue for rural landfills. The method of treatment usually involves high-tech, expensive and energy-intensive processes such as reverse osmosis or ozonation. The leachate itself can vary in its composition which further complicates the treatment (Wojciechowska, 2010).

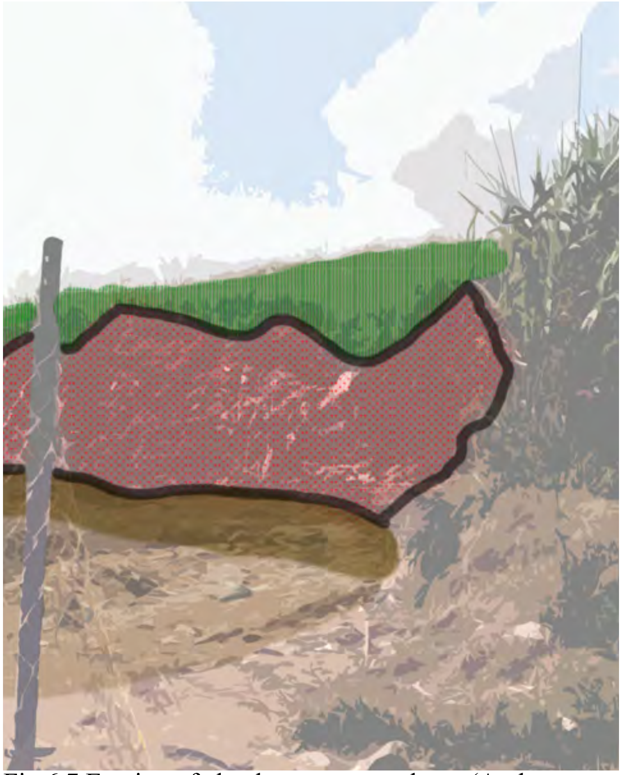


Fig 6.7 Erosion of clay layer to waste layer (Author, 2020)

6.3.3 Soil erosion and bank collapse

The decomposition of waste materials within a landfill can cause unstable movement of earth because materials have different decomposition rates. As mentioned before, the prevention of water infiltration discourages the idea to excavate areas for foundations of structures.

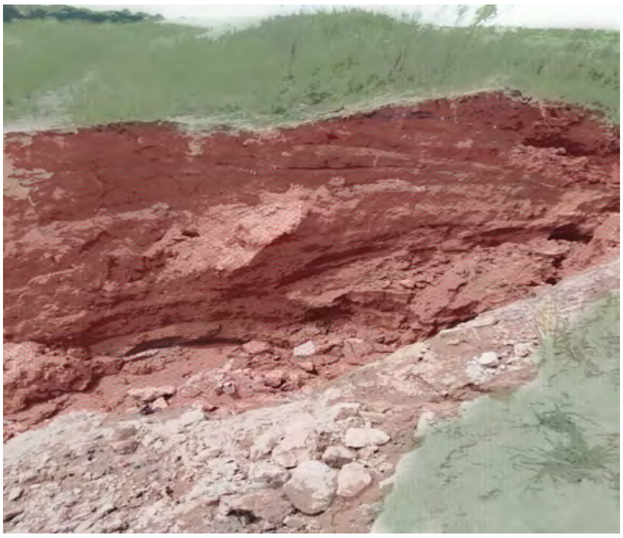


Fig 6.8 Collapse of banks from ponding (Author, 2020)

Fig 6.9 Collapse of banks from ponding (Author, 2020)

6.3.4 On-site water ponding

In key areas, water ponding is occurring on relatively flat areas on top of the landfill which poses the risk of water infiltration and excess leachate generation.

6.3.5 Invasive plant species

The Environmental Management Act 2008 (Act no. 59 of 2008) states that the close-out phase of the landfill site needs to be revegetated with indigenous plants. However, it can be observed that invasive plants such as *Ipomoea indica* (NEMBA category 1b), *Arundo donax* (NEMBA category 1b) and *Ricinus communis* (NEMBA category 1b) are present on-site (Hickman, 2017).

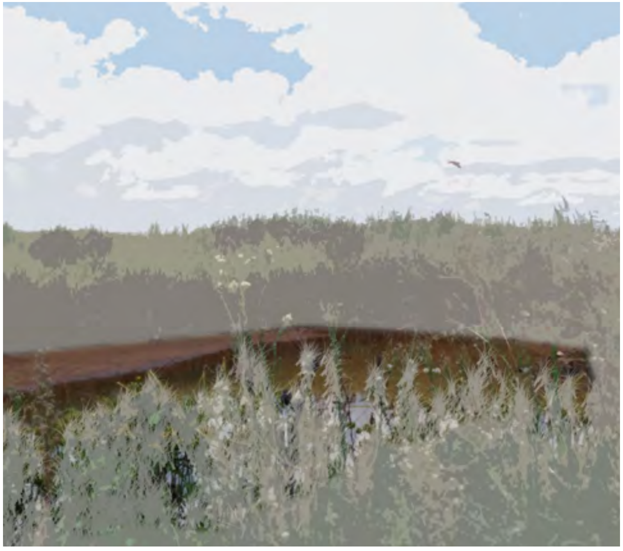


Fig 6.10 On-site ponding (Author, 2020)


Fig 6.12 *Ipomoea indica,* exotic plants (Author, 2020)


Fig 6.11 On-site ponding (Author, 2020)


Fig 6.13 *Arundo donax,* exotic plants (Author, 2020)

7

Chapter 7: Designing guidelines

The design guidelines shall attempt to address the dynamic issues that are occurring on multiple levels in the process of developing a final design. The goal aims at creating a regional park that responds to concerns to be addressed on-site and within the regional context.

7.1 Anamnesis/recollection response

7.1.1 Grassland diversification and ecology heritage

Grassland biomes and grassland communities support the second largest biodiversity of species in South Africa as well as endemic flora and fauna. It is also, unfortunately, the most threatened as 30% has already been transformed for other purposes: 23% for cultivation, 4% for forestry, 2% for urbanisation and 1% for mining. The process of phytocapping allows for a higher diversity of plant species than clay capping. The proposal to introduce the natural, regional ecology back into the urban environment is supported by James Corner's theory of ecological diversification. It is also an objective set out by the National Environmental Act, 2008 (Act no. 59 of 2008) concerning indigenous rehabilitation.

It can be observed that grassland communities can occur in small "pockets" among other grassland groups, particularly in regions where there is a dynamic microclimatic condition such as ridgelines. The chosen grassland groups are found either on or near the landfill site and have similar climatic conditions to the Egoli Granite Grassland (Mucina, 2006).

7.1.1.1 Egoli Granite Grassland - (GM 10)

Characteristics

The Egoli Granite Grassland has been identified as the main grassland community that covers the regions of Linbro Park. Due to urbanisation and urban process, 61% of this type of bioregion has been permanently transformed for other uses and only 0.02% of its coverage area is protected (Mucina, 2006).

Common characteristics include:

- Shallow drainage lines.
- Crests, slopes and valley bases.
- Rocky terrain.

The *Hyparrhenia sp.* is the dominant species that can occur in disturbed grasslands or construction ruins. This particular grassland has a high richness in diversity with key patches being dominated by various grass species dependant on a particular micro-climate or unique conditions. The vegetation is considered to be highly sensitive to frequent impacts such as grazing, trampling and general domestic activities. (Mucina, 2006).

Fig 7.1 Egoli Granite Grassland (Mucina, 2006)

Wetland subgroups of the Egoli Granite Grasslands such as the *Schoenoplectus corymbosus- Berkheya radula group* are located in drainage areas and can be identified as a permanent or a seasonal wetland. Common dominant species are (Mucina, 2006):

- *Berkheya radual*
- *Conza podocephala*
- *Senecio erubescens*
- *Cyperus congestus*

The woodland subgroups of Egoli Granite Grassland occurs on rocky outcrops and microhabitats created by geological formations. Dominant woody plants include (Mucina, 2006):

- *Searsia lancea*
- *Senegalia caffra*
- *Asparagus suaveolens*

The dominate grass species is the *Erogrotis lehmanniana* (Mucina, 2006).

7.1.1.2 Carletonville Dolomite Grassland - (Gh 15)

The Carletonville Dolomite Grassland can be found in Potchefstroom, Ventersdorp and Carletonville. It spreads westwards to Ottoshoop and northwards as far as Centurion. The topology consist of slightly undulating plains, which are dissected by rocky ridges. The mosaic pattern is highly diverse in species (Mucina, 2006).

Dominant species include:

- *Aristida congesta*
- *Brachiaria serrat*
- *Cynodon dactylon*
- *Digitaria tricholaenoides*

This grassland community is considered to be in a vulnerable state due to the effects of cultivation, urban sprawl and mining pollution (Mucina, 2006).

Fig 7.2 Egoli Granite Wetland (Mucina, 2006)

Fig 7.3 Carletonville Dolomite Grassland (Mucina, 2006)

7.1.1.3 Eastern Highveld Grassland - (GM 21)

The Eastern Highveld Grassland is mostly found at the summit of ridges and mountain ranges. The soil is shallow with stones and large boulders that cover the plateau. The vegetation can be recognised by the clumping of trees and shrubs that are sheltered by rocky habitats (Mucina, 2006).

Dominant species include:

- *Cussonia transvaalensis*
- *Vernonia myriantha*
- *Buddleja auriculate*

The grassland community is considered to be in a vulnerable state due to granite mining. Consideration for conservation should be put forward as this community holds valuable water resources within its arid surrounding (Mucina, 2006).

Fig 7.4 Eastern Highveld Grassland (Mucina, 2006)

7.1.1.4 Soweto Highveld Grassland - (GM8)

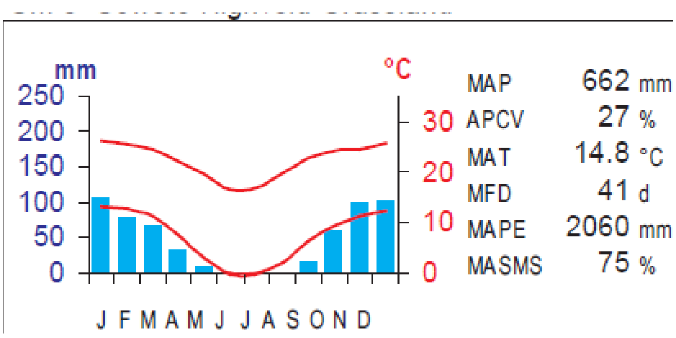
Found in the undulating terrain of the Highveld plateau, this bioregion supports medium to high grasses, mostly dominated by *Themeda triandra* and other plants such as *Elionurus muticus, Eragrostic racemose* and *Tristachya leucithrix*. The overall visual connection continues throughout the landscape unless broken by rock outcrops and disturbed areas (Mucina, 2006).

The Soweto Highveld Grassland has the ability to thrive in a wide array of temperatures, including withstanding the effects of frost. However, the majority of the threat to this grassland unit is the encrouchment of urbanisation and agricultural development. Currently, more than two-thirds of the grassland group has been permanently altered while only 3% of its region is protected (Mucina, 2006).

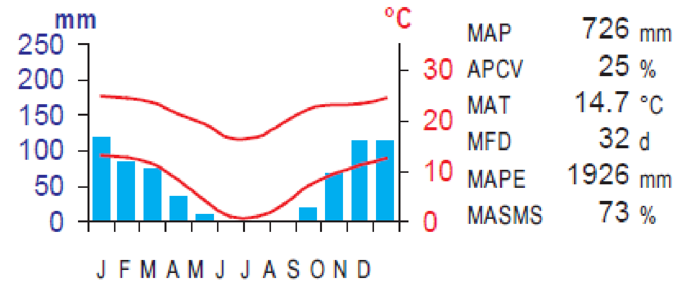
Dominant species include:

- *Adropogon appendiculatus*
- *Brachiaria serrata*
- *Berkheya annectens*

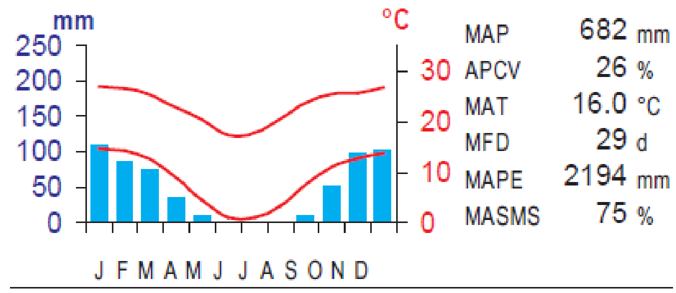
Fig 7.5 Soweto Highveld Grassland (Mucina, 2006)



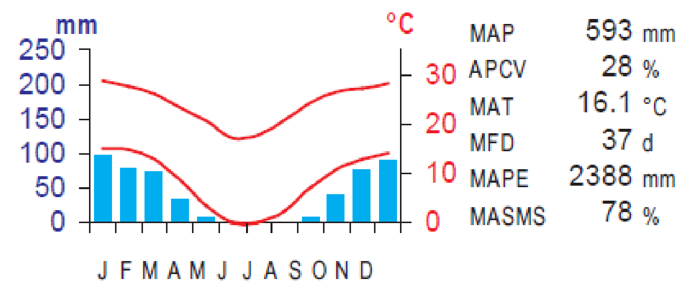
Soweto Highveld Grassland



Eastern Highveld Grassland



Egoli Granite Grassland



Carletonville Dolomite Grassland

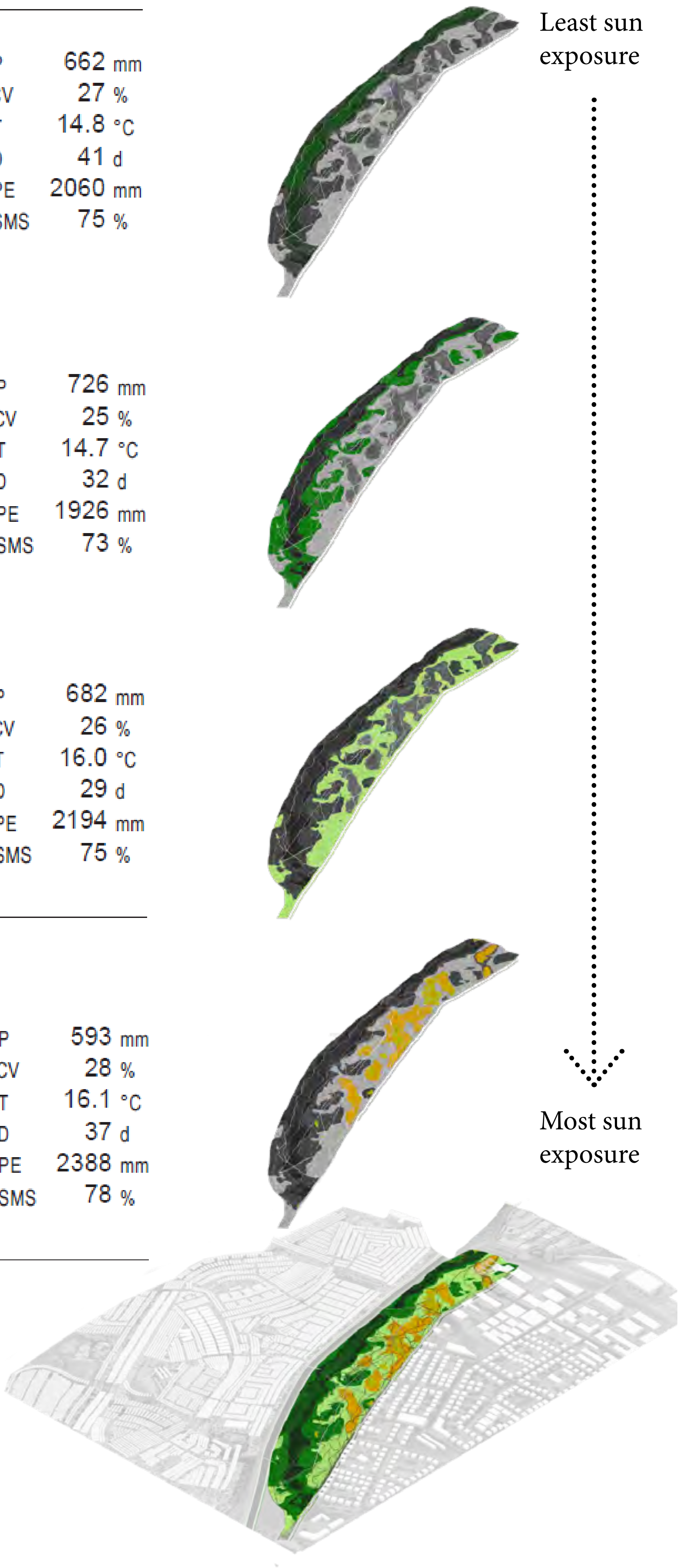


Fig 7.6 Selected Grasslands based on sun study and native grasslands (Mucina, 2006)

7.2 Preparation response

7.2.1 Preparing the landfill site for future use

7.2.1.1 Disadvantage of clay capping

The disadvantage of clay capping for the closure phase of landfill sites is that clay-lined layers tend to crack over time and deteriorate, allowing for water to mix with leachate. Other layers such as the high-density polyethene and geosynthetic clay liners are also prone to cracking. The recommended 200mm layer of organic material is too shallow to allow for a diverse range of indigenous vegetation to rehabilitate the site. There are also the concerns of roots penetrating the clay cap and the poor organic quality of clay soil (Venkatraman, 2009).

7.2.1.2 Phytocapping theory application

An alternative solution to the conventional capping process of landfill sites relates to "phytocapping". The process involves the application of a vegetation layer, such as perennials and grasses, to minimise cracking of the clay layer, effectively managing water through evapotranspiration and improving the integrity of the capping layer. The phytocapping also allows for the use of trees that would have been prohibited on a landfill site (Venkatraman, 2009).

An example of the success of phytocapping with regard to stormwater management and infiltration can be seen at the Rockhampton Landfill Site, see Figure 7.7. A test was conducted that showed that a 1400mm layer of organic capping had a percolation rate of 16.7mm per year. A 700mm thick layer had a percolation rate of 23.8mm per year.

The control, which had no additional biosolids, had a percolation rate of approximately 78mm per year which proves that phytocapping can reduce leachate formation from water percolation (Venkatraman, 2009).

The use of trees, perennials and the addition of an organic soil layer contributes to the reduction of water percolation rates into the waste layer. This is achieved by the vegetation acting as "bio-pumps" and "rain interceptors", in other words, canopy evaporation. (Venkatraman, 2009).

The proposal to add an organic layer such as mulch is useful in the promotion of the methanotrophic bacterial activity. A test of the growth medium of a phytocapped landfill site in South Australia was studied to determine the efficiency of phytocapping over a range of high organic content soil. This was compared against a control zone of having no additional organic content. It was observed that the addition of organic soil layers to the capping process improved plant growth. Most clay mediums that are used as per the conventional capping method, have very little organic material to support growth and the compaction of the clay also hinders root growth (Venkatraman, 2009).

The Linbro Park Landfill Site is currently undergoing its capping process. Method 2 surface ceiling, approach as seen in Figure 7.8. will be the proposed phytocapping solution.

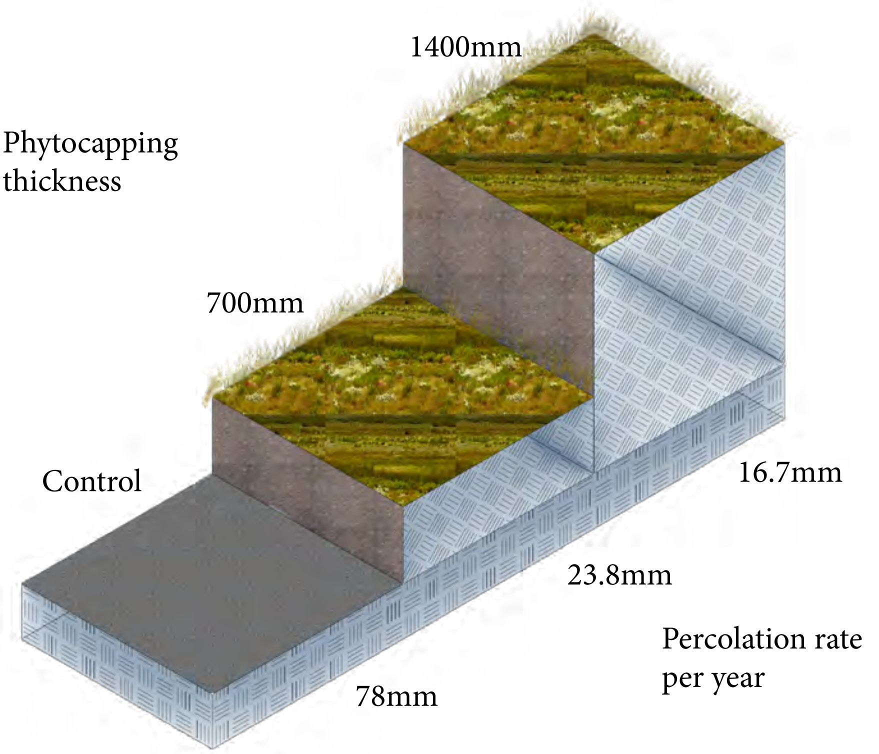


Fig 7.7 Comparison of percolation rates for different phytocapping thicknesses (Author, 2020)

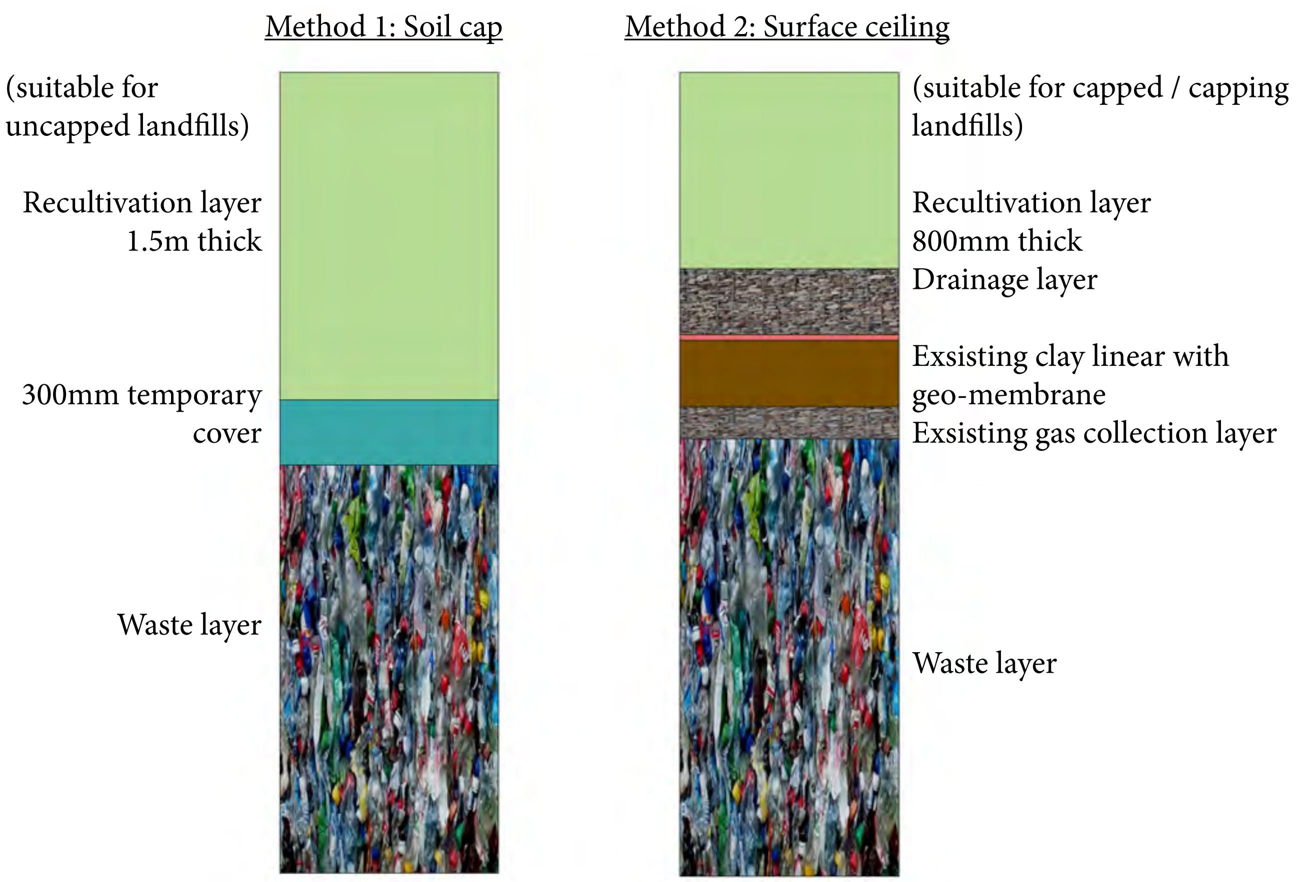


Fig 7.8 Comparison of layer composition of two different phytocapping methods (Author, 2020)

7.2.2 Landfill leachate wetland treatment

The conventional method of treatment for leachate can be an energy-intensive and inefficient process due to the unpredictable variation of organic content. The traditional methods that are used to treat leachate at municipal sewage plants involve:

1. Aerated lagoons and evaporation ponds. By adding oxygen, organic compounds are reduced, but inorganic compounds are left untouched. A silt layer on the evaporation ponds inhibits natural evaporation. This technology requires long retention times and a lot of space.

2. On-site physical-chemical treatment. Chemicals are added to neutralise the organic compounds and convert them into a sludge, which is then disposed of. Inorganic pollution remains untouched.

3. Thermal treatment by evaporation. Raw leachate evaporates while the pollutants remain behind. High operating costs, heavy odours and a corrosive mechanical environment are some of the drawbacks of this type of treatment.

The alternative solution is to utilise a constructed wetland for on-site treatment of leachate. Its effectiveness was tested and compared at three different landfill sites namely, Szadółki and Gatka in Poland, which use a subsurface flow wetland, and Örebro in Sweden which, uses a freeflow wetland system (Wojciechowska, 2010).

The natural process breaks down volatile organics such as ammonia nitrogen through volatilisation or biodegradation. Gases are released after the nitrification and denitrification processes. Dissolved metals are accumulated by hydrophytes and undergo an ion exchange that forms insoluble solids in the bottom sediments (Wojciechowska, 2010).

The Örebro Landfill Site's wetland used pre-treatment tanks which allowed for the control of leachate volume and, to a certain degree, the levels of pollutant concentrations. The results of the pre-treatment showed a decrease in the concentration of ammonium ions ($N\text{-}NH_4^+$), biological oxygen-demanding and chemical oxygen-demanding concentrations.

The observations of the constructed wetlands at Örebro (freeflow wetland system), Szadółki and Gatka (subsurface flow systems) showed that wetlands can effectively treat leachate. However, the freeflow wetland at Örebro performed the best in terms of operation and results. This is due to the absence of clogging which was experienced in the subsurface flow wetlands. The pre-treatment allowed for better control of the treatment system as variable amounts of leachate are given off at any time, and its monthly pollutant concentration fluctuates. Although the total suspended solids of the freeflow wetland were higher than the other two subsurface flow wetlands, the issue of clogging never occurred (Wojciechowska, 2010).

It is therefore recommended that the proposal for a freeflow wetland at Linbro Park Landfill Site will need a three-stage system that should consist of:

1. A leachate aeration tank where oxygen is passed through the liquid to allow for nitrogen stripping.

2. A sedimentation tank to reduce the total suspended solids (TSS) and thus prevent clogging of the constructed wetland. The tank also acts as a buffer to allow for a continuous flow of leachate throughout the year.

3. Settling ponds (reed beds) that remove pollutants before the leachate is discharged into a municipal sewage system.

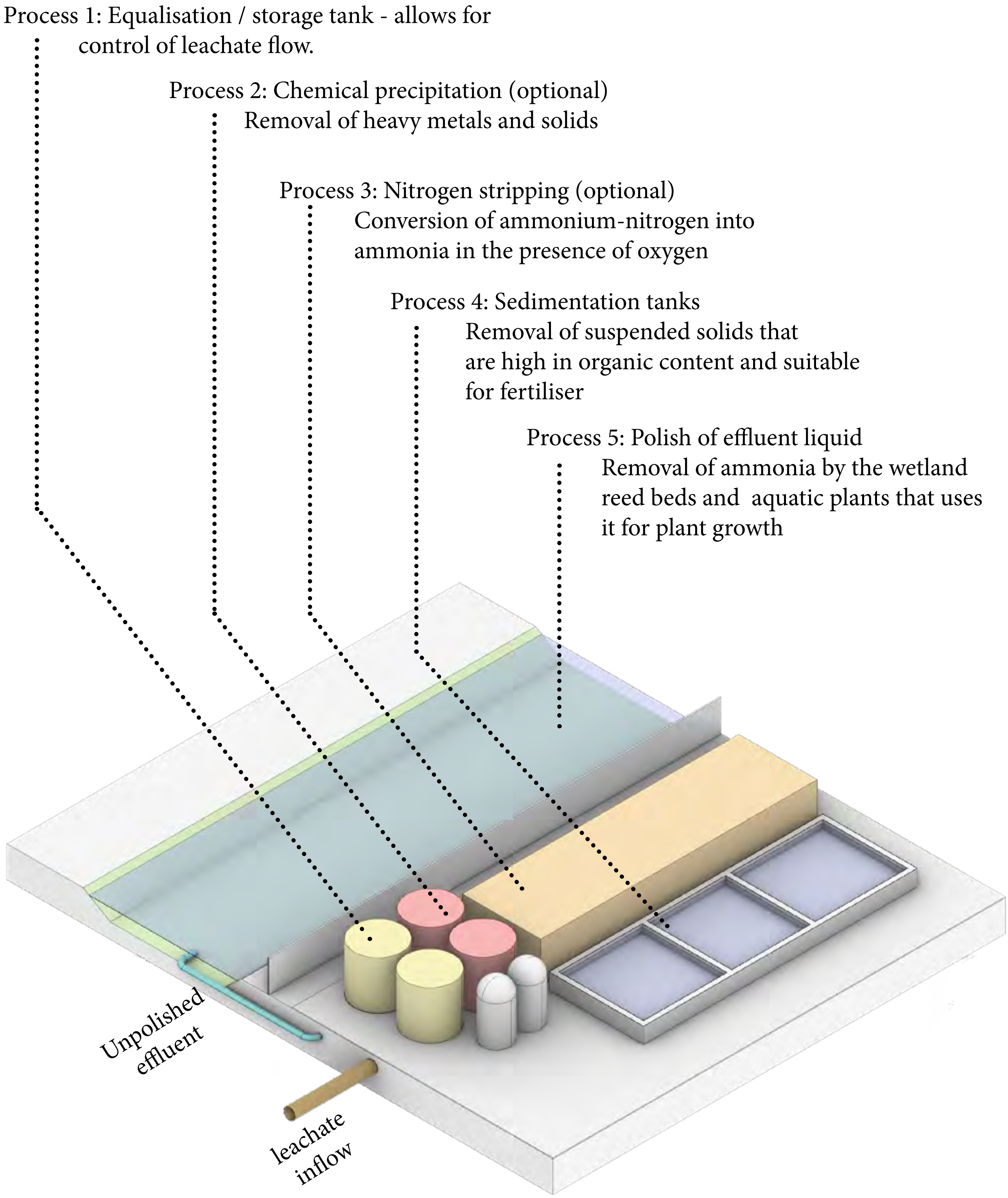


Fig 7.9 On-site leachate treatment process (Author, 2020)

7.3 Three-dimensional sequencing response

The design response was developed through three-dimensional mediums that include drawings, Papier-mâché models and CAD information.

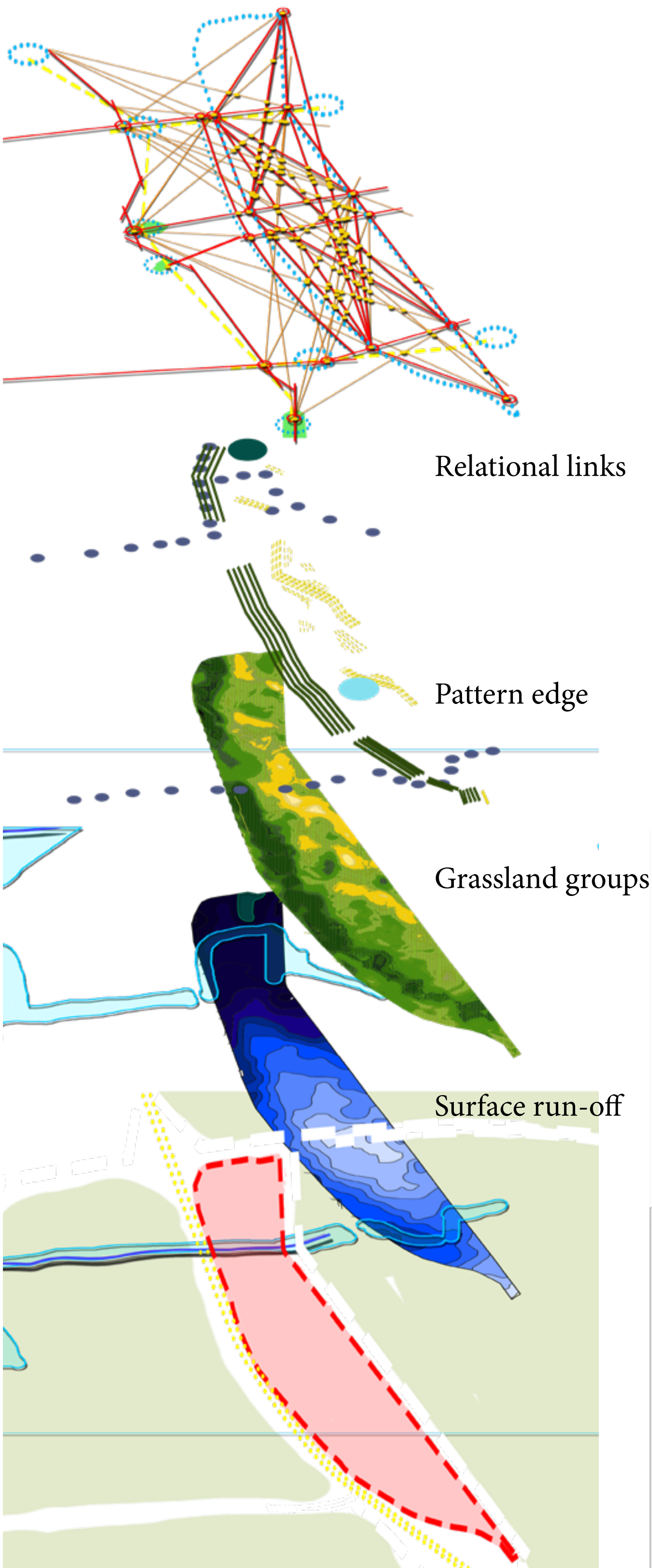


Fig 7.10 Layers of design informants (Author, 2020)

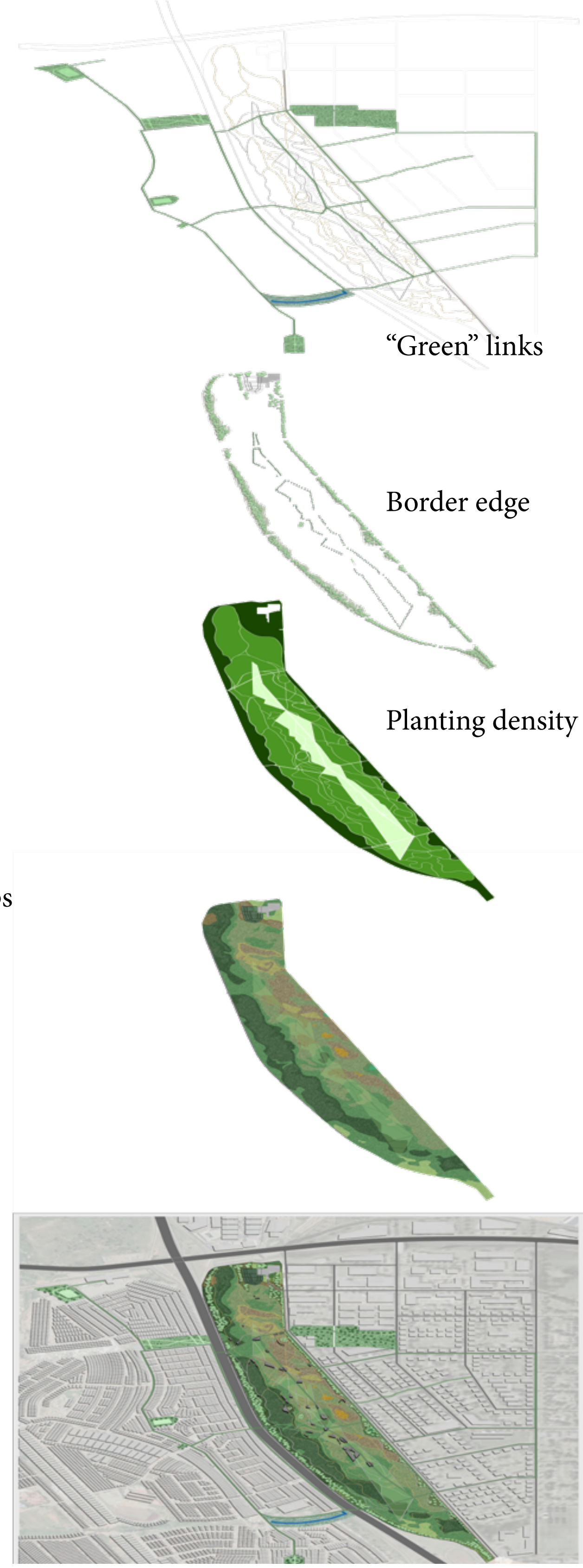


Fig 7.11 Layers of design informants (Author, 2020)

Fig 7.12 3D site analysis on papier-mâché model (Author, 2020)

Fig 7.13 Superimposing design grid guidelines (Author, 2020)


Fig 7.14 Papier-mâché exploration (Author, 2020)


Fig 7.16 Design exploration (Author, 2020)

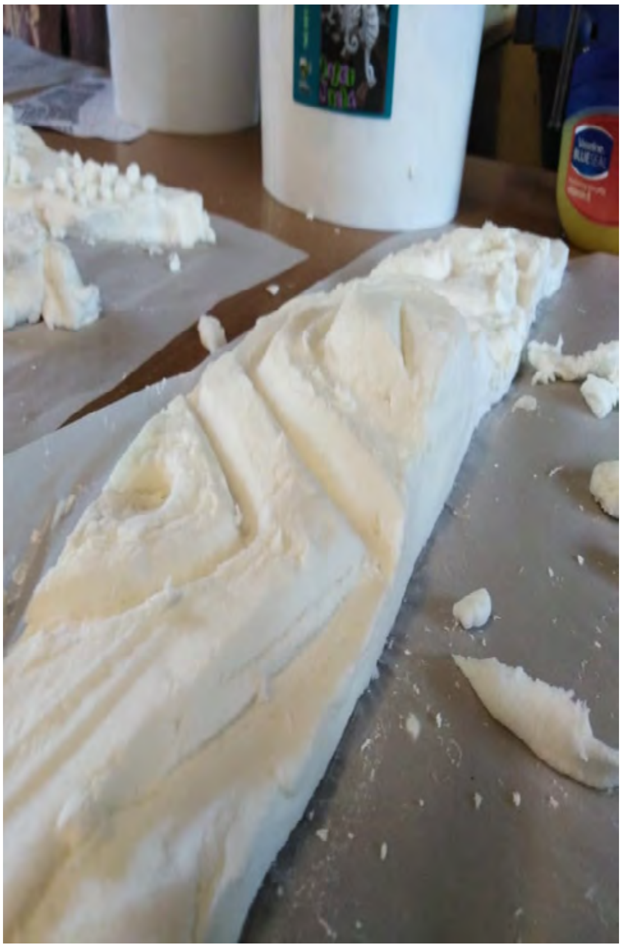


Fig 7.15 Papier-mâché exploration (Author, 2020)


Fig 7.17 Papier-mâché exploration (Author, 2020)

Fig 7.18 Papier-mâché with landscape urbanism principles (Author, 2020)

7.4 Relational structuring

7.4.1 Connecting Linbro Park Landfill to the surrounding areas

The starting point of the axis generation shall begin in "waste landscapes" as per Alan Berger's response to incorporating "waste landscapes" into the urban environment (Marot, 1999).

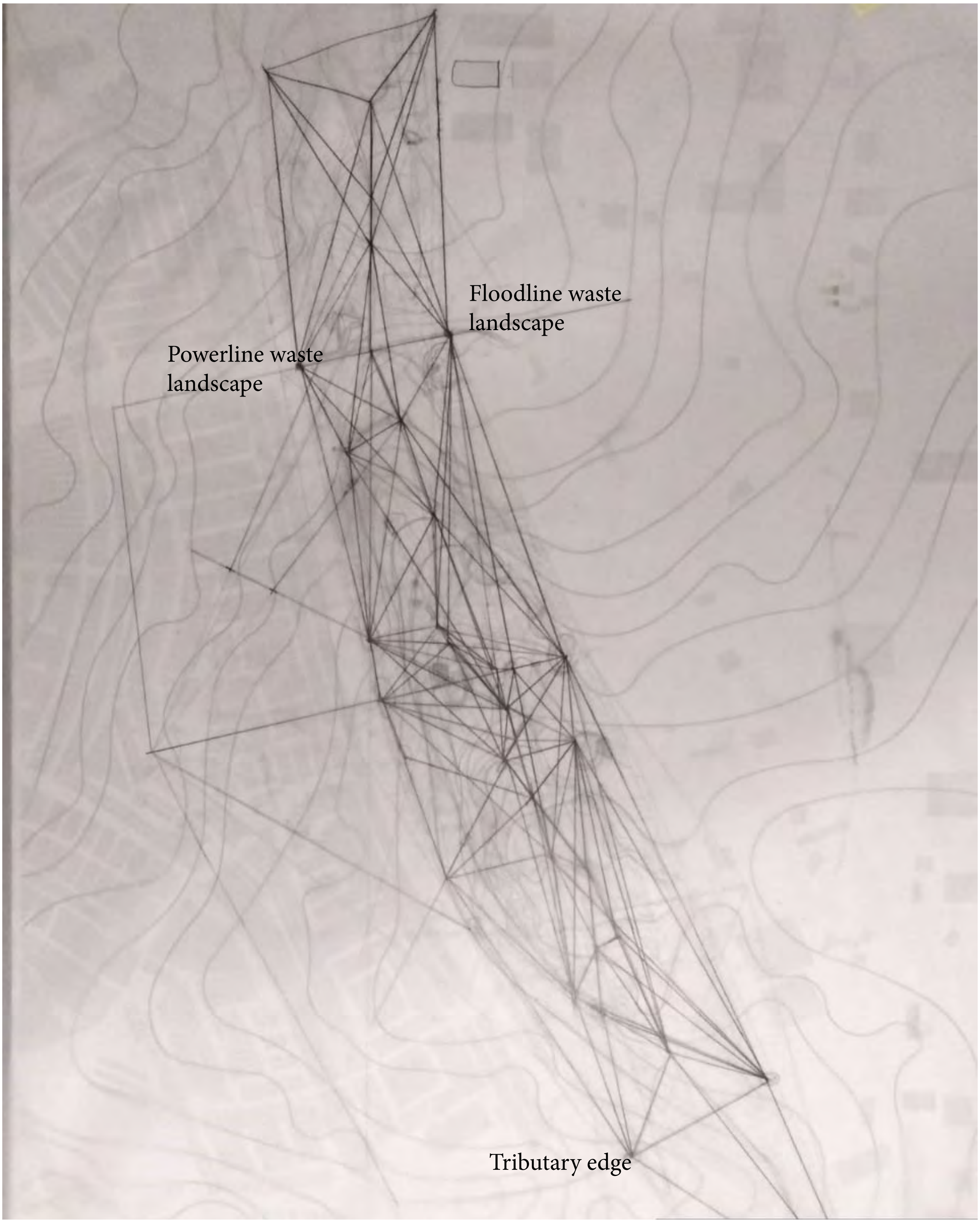


Fig 7.19 Framework link (Author, 2020)

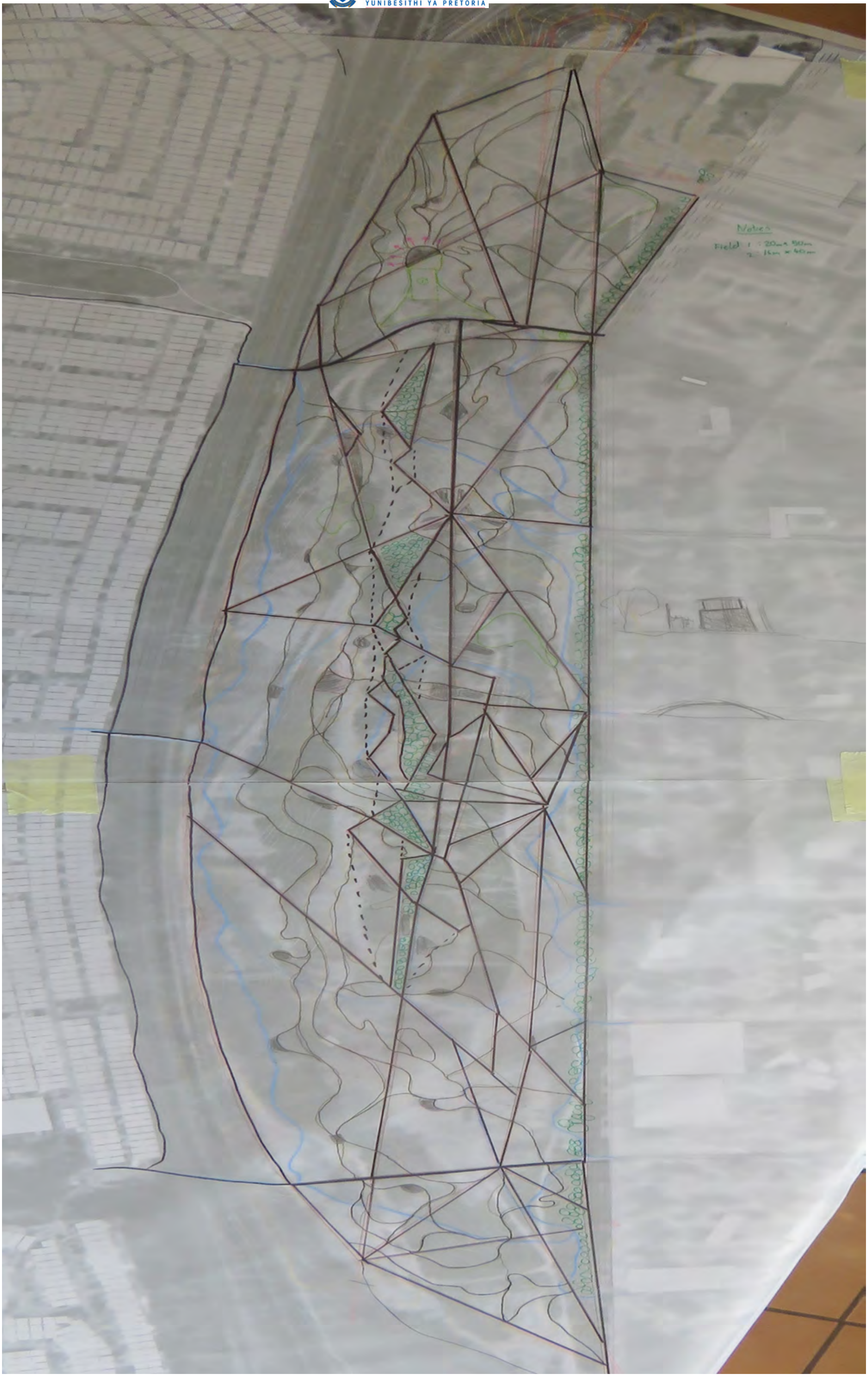


Fig 7.20 Design draft (Author, 2020)

7.4.2 Transmission powerline waste landscape

The dissertation has already explained that a landfill site is a "waste landscape". Another type of "waste landscape" relates to the building restriction spaces around electrical transmission lines, which have a network that runs through the urban environment. The zone has the potential to become part of urban ecological services and urban green spaces. The zone that runs through Alexandra will become an import conversion of a "waste landscape" into a drosscape.

An example of reprogramming this type of "waste landscape" into a drosscape can be seen at the powerline transmission servitude that passes through the landscape and community at Horsham in Canada. The transmission line spaces have been converted into an 8.43km multi-use trail which links to several parks and other facilities such as schools (Wetmore, 2014).

Fig 7.21 Powerline building prohibition zone (Author, 2020)

Fig 7.22 Powerline in Alexandra (Author, 2020)

7.4.3 Reconnection with bridges

Cities such as Johannesburg have a high volume of commuters from townships such as Soweto and Alexandra who face the dangers of crossing dual carriageways or spend up to 40% of their income on transport. The cost of transport can be traced back to the effects of the Apartheid Group Areas Act of 1950 in which access to the township regions was linked mostly by train and other limited entry points (City of Johannesburg: Department of Development Planning, 2016).

A possible solution is to develop pedestrian-orientated bridges to aid in the reconnection and reformation towards a polycentric city. These bridges can become places of economic potential and cultural relevance.

Fig 7.23 Nelson Mandela Bridge (South Africa Tourism, 2017)

An example of the success of using bridges to remediate urban disconnections can be seen at the Nelson Mandela Bridge. The bridge spans 284 meters to connect Jan Smuts Avenue and Carr Street which links the business districts of Braamfontein and Newtown. The areas surrounding the bridge became important historical and cultural nodes, while allowing for better movement through the city. Not only does the bridge serve as part of urban infrastructure but it has also created economic connections and opportunities for the people in the adjacent area. The symbolism of the bridge is emphasised by its stunning vistas of the surrounding urban environment and also lights up in a range of colours to create a spectacular beacon at night. The bridge has also hosted a series of public events (South African History Online, 2019)

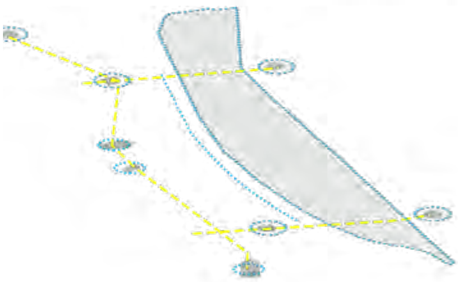
Fig 7.24 Nelson Mandela Bridge (South Africa Tourism, 2017)

Fig 7.25 Nelson Mandela Bridge (South Africa tourism, 2017)

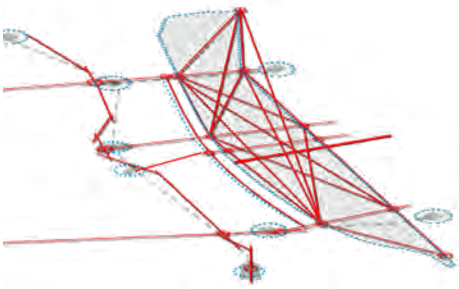
Fig 7.26 Grayston Pedestrian Bridge (South Africa Tourism, 2017)

The Grayston pedestrian bridge is another example of connecting the isolated community of Alexandra with the economically rich hub of Sandton. More than 10 000 people utilise the bridge during their working day (Eamonn, 2019).

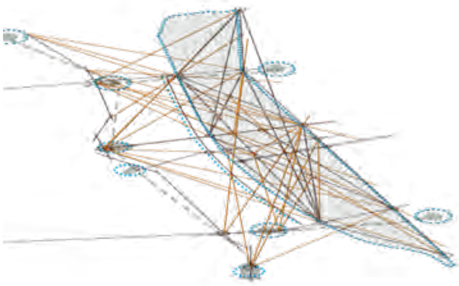
Layer 1: Landfill site and waste landscapes



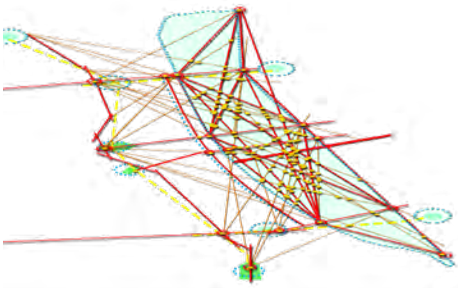
Layer 2: Creating connection points



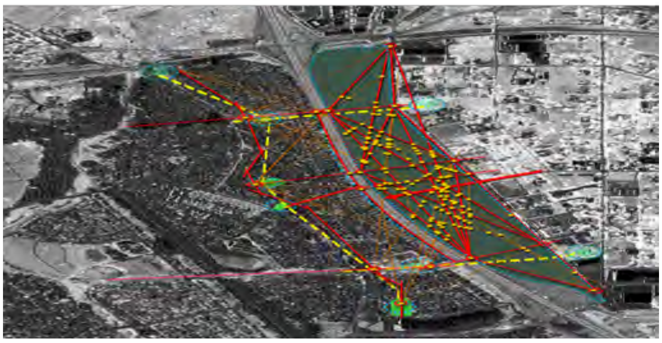
Layer 3: Creating main axis lines through the connection of points



Layer 4: Connecting main axis intersection points



Layer 5: Generating 2nd set of axis from the 2nd intersection points



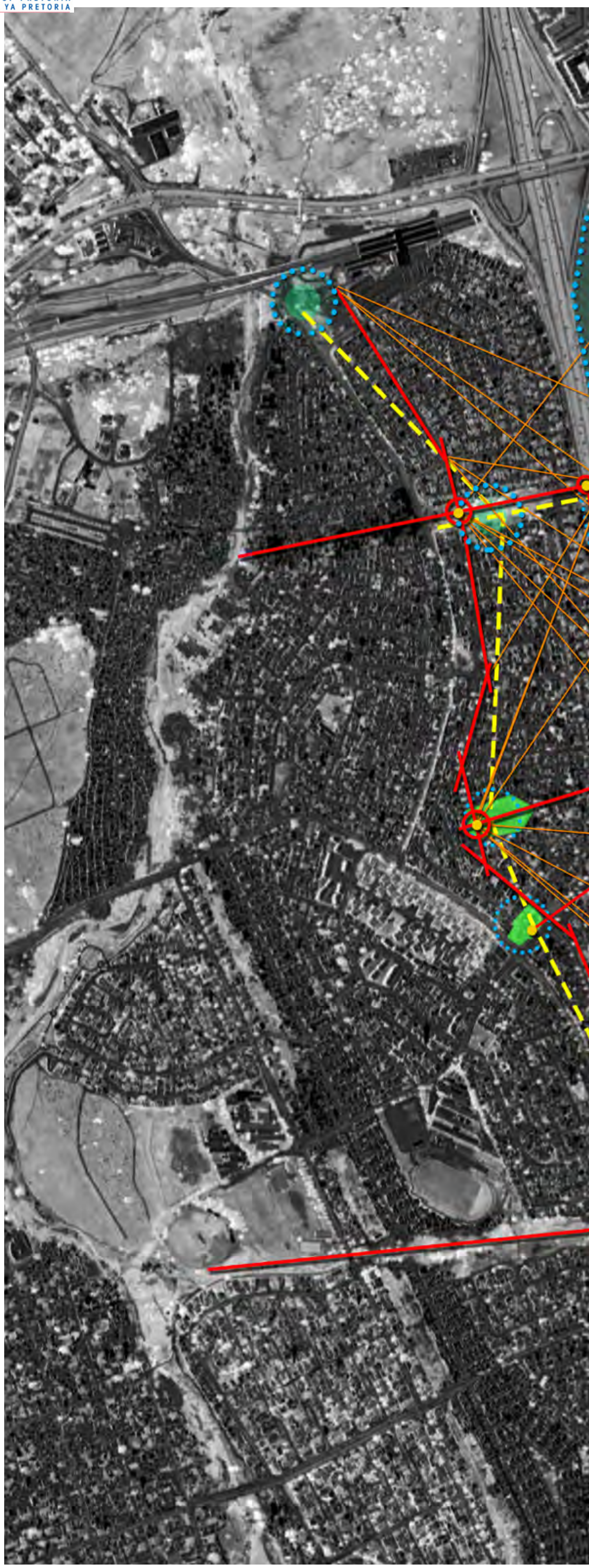
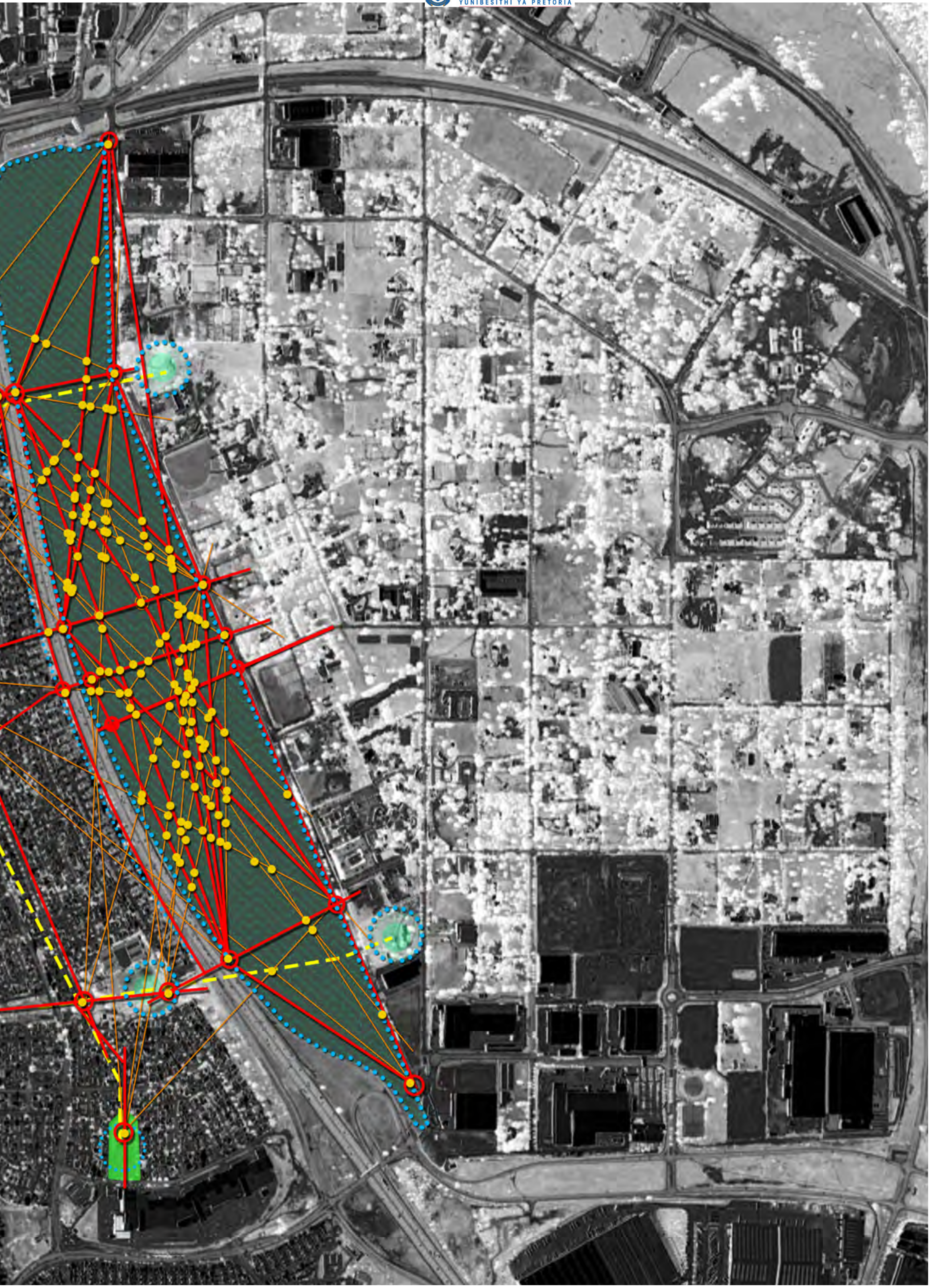
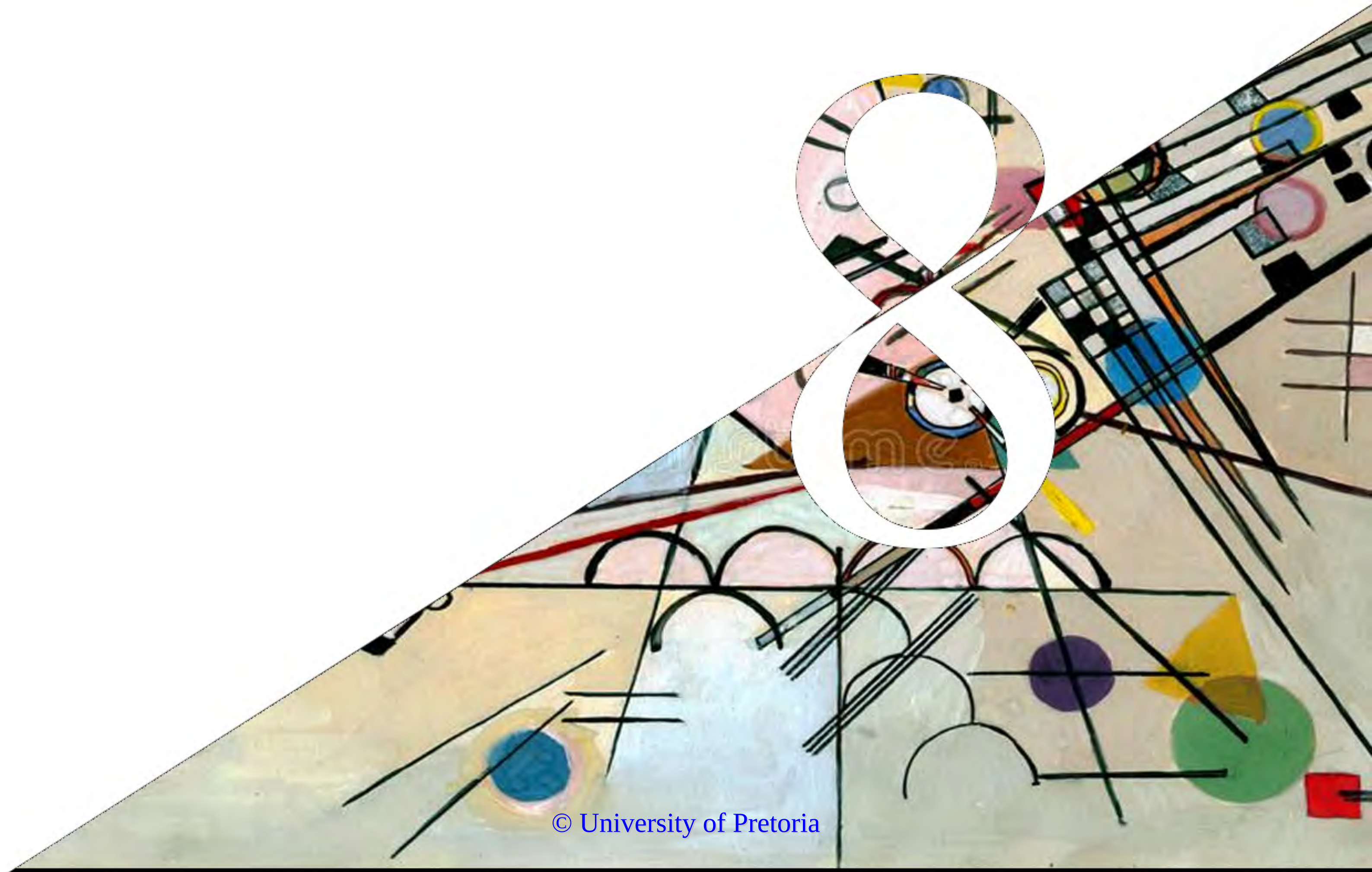


Fig 7.27 Layering process of axes for form generation (Author, 2020)



8



Chapter 8: Concept development

8.1 Interpreting the grassland experience

Based on the author's experience while traveling from Durban to Pretoria, areas of the Highveld grasslands present unique characteristics. The interpretation of these characteristics will be explained through the theory of Wassily Kandinsky and Sylvia Crowe.

Wassily Kandinsky was an artist born in Moscow in 1866. He created a particular style that relates to the law of correlation. His works expressed the rhythm displayed between harmonies and contrast of colours and form. He undertook vigorous studies into the theoretical and technical elements of art, in a similar manner to the principles of landscape urbanism, with the freedom and eagerness to express creativity in correlation to the laws of counterpoints and technification (Kandinsky, 1979).

Fig 8.1 Transverse Line (Kandinsky, 1923)

Points are described as intangible things. When taking into consideration "a point" as an incorporeal element and its substance as equivalent to zero as seen on a geometric plane that stands in relation to multiple elements, it can be said that "a point" is the most singular union of silence and speech. In writing, it symbolises the end and interruption but also signifies a bridge to another existence. As a point is "released" out of its restricted sphere of silence, its inner attributes become heard and known (Kandinsky, 1979).

The geometric lines that connect spaces and elements are intangible and are created by the movement of points that have broken through their self-contained repose. Lines can be very diverse in their variation based on the forces acting upon them (Kandinsky, 1979).

8.1.1 Straight lines

Straight lines form when forces break out of a point and move in any direction and tend to lead a straight course to infinity. They represent the most concise form of the potentiality for endless movement (Kandinsky, 1979).

Horizontal lines or planes are described as being subtle while vertical lines are described as being bold. Both are present in a form of balance when relating to diagonal lines. The grouping of straight lines can inform a centric plane in which a common centre is found, or create a common ground that lies outside of the centre (Kandinsky, 1979).

8.1.2 Angular lines

Angular lines are formed by the pressure of two forces acting from different angles. Angular lines present a closer association with their plane as it carries the representation of the characters within it (Kandinsky, 1979).

8.1.3 Zigzag lines

The formation of zig-zag lines allows for the animation of a series of straight lines. The horizontal lines create a sense of movement on the plane while the vertical lines emphasise height change (Kandinsky, 1979).

8.2 Transmission lines as a representation of the grassland's typology

Sylvia Crowe recognised the potential of power transmission towers as a representation of the landscape's typology, forming patterns that may be simple and linear or rugged. She also recognised the seamless flow of cultivated land underneath the powerline towers (Crowe, 1958).

Although modern transmission line towers are perceived to be an engineer's domain, there are great opportunities for public green spaces within the powerline prohibition zones. In some cases, the design of the powerlines has become part of the landscape design (Crowe, 1958).

Fig 8.2 Adaptive reuse and re-envision the function of power transmission lines (Author, 2020)

Fig 8.3 Conceptual ideas for the Linbro Park Landfill (Author, 2020)

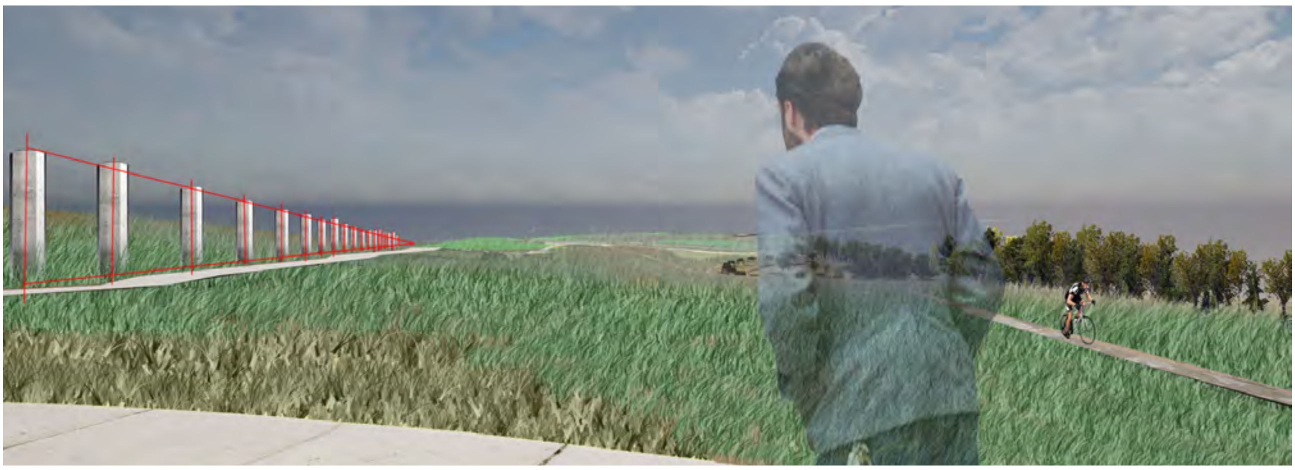
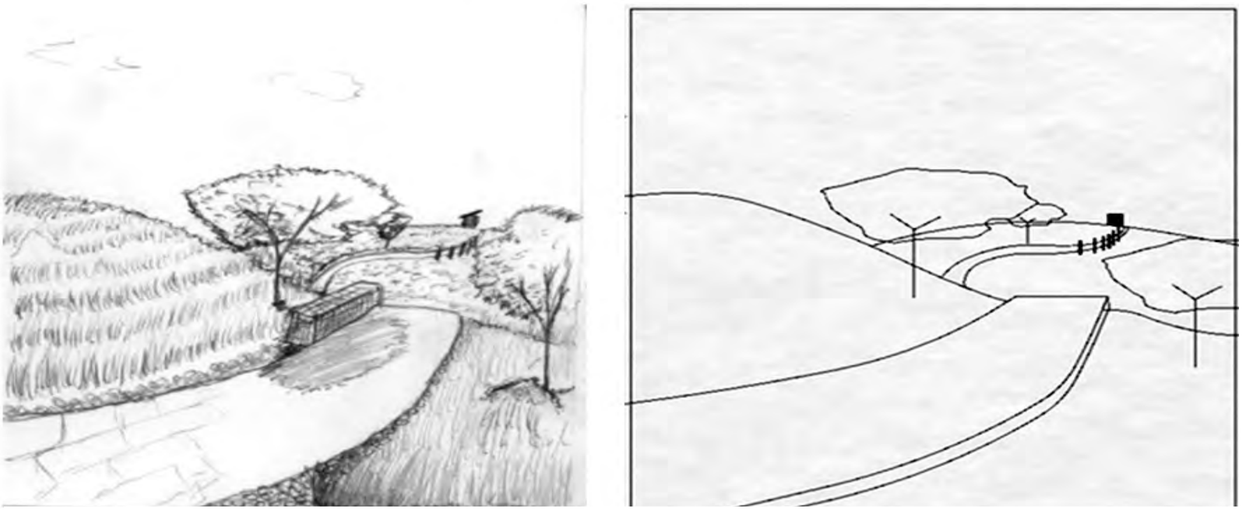
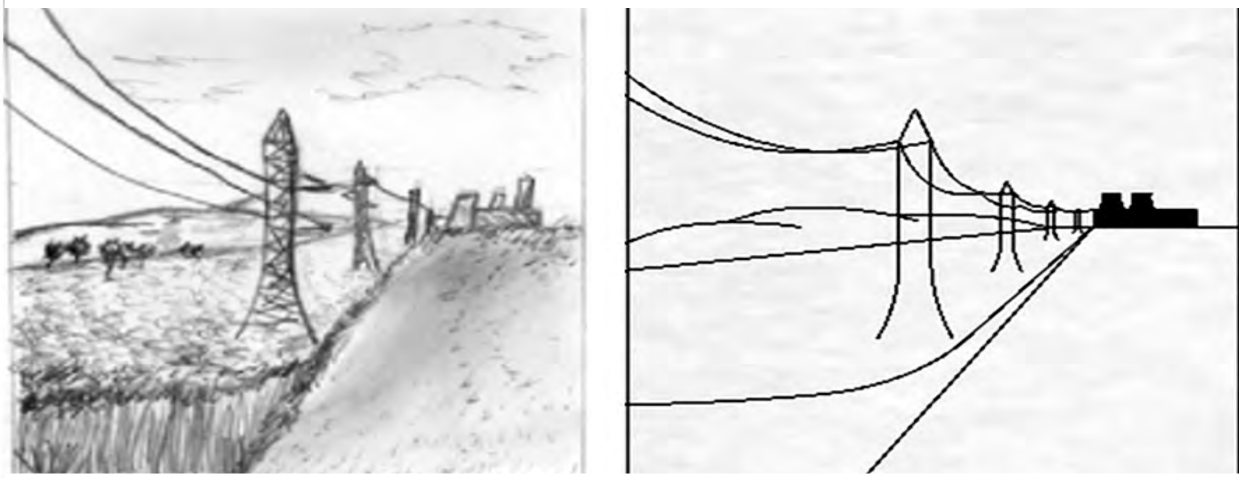


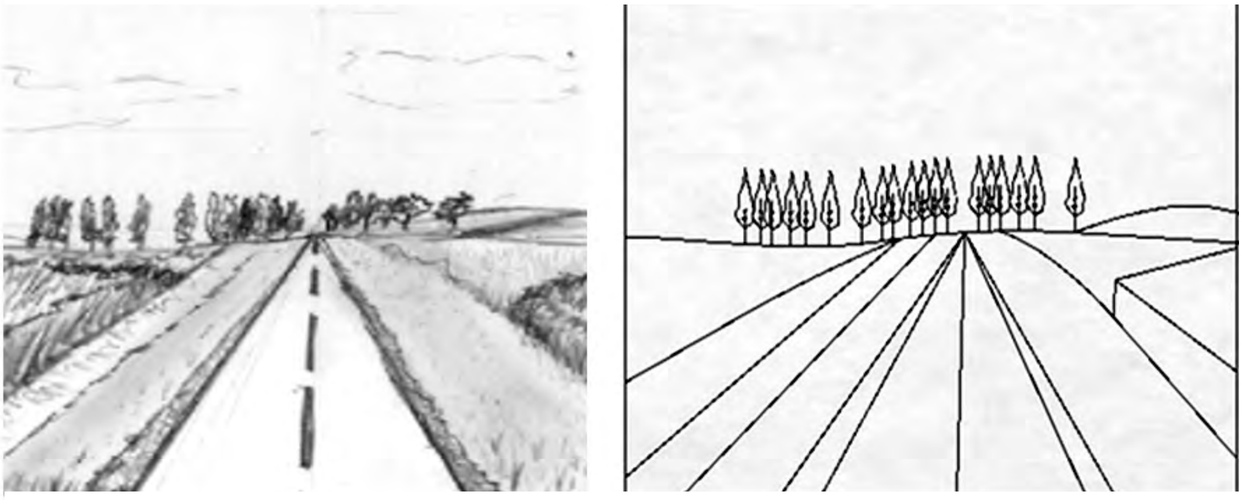
Fig 8.4 Conceptual ideas for the Linbro Park Landfill (Author, 2020)



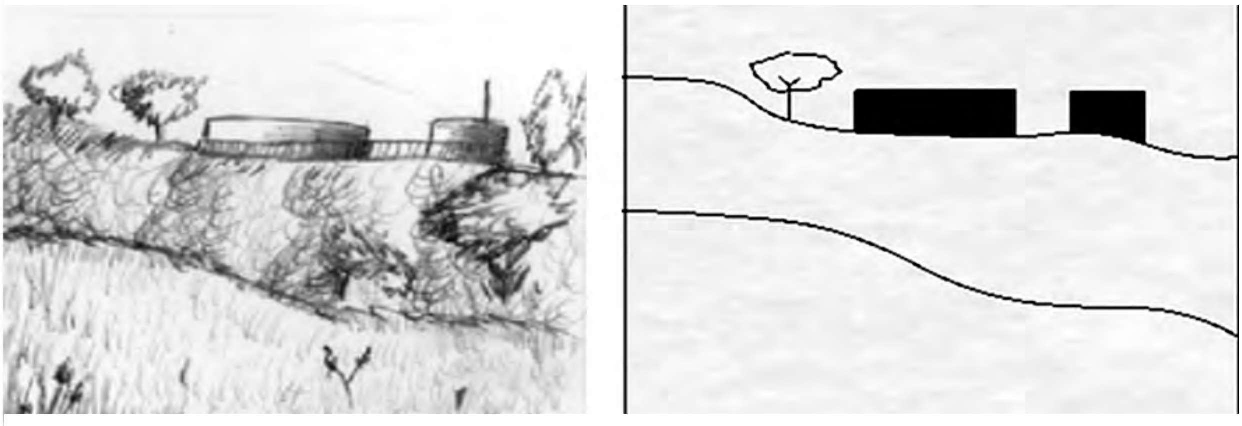
Meandering of the grassland



Transmission lines through the grassland plains



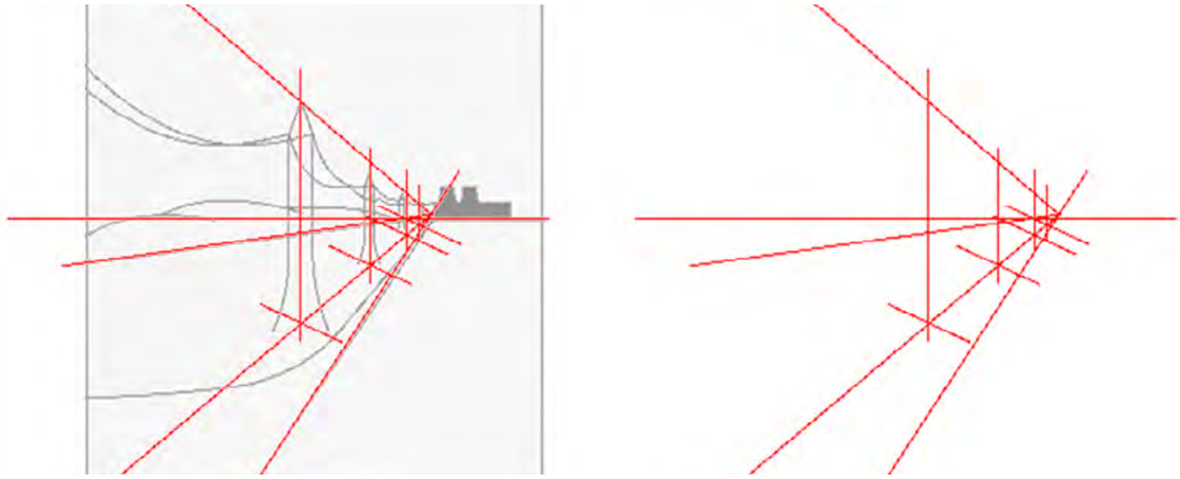
N3 road towards Johannesburg through the grassland



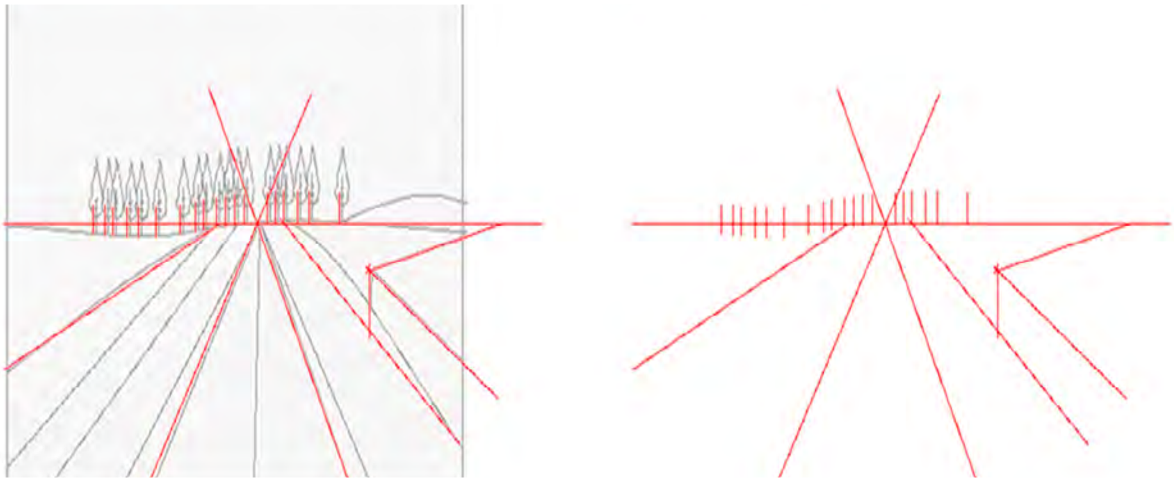
Focal points of elements in the grassland

Fig 8.5 Author’s refinement of grassland experiences for analysis (Author, 2020)

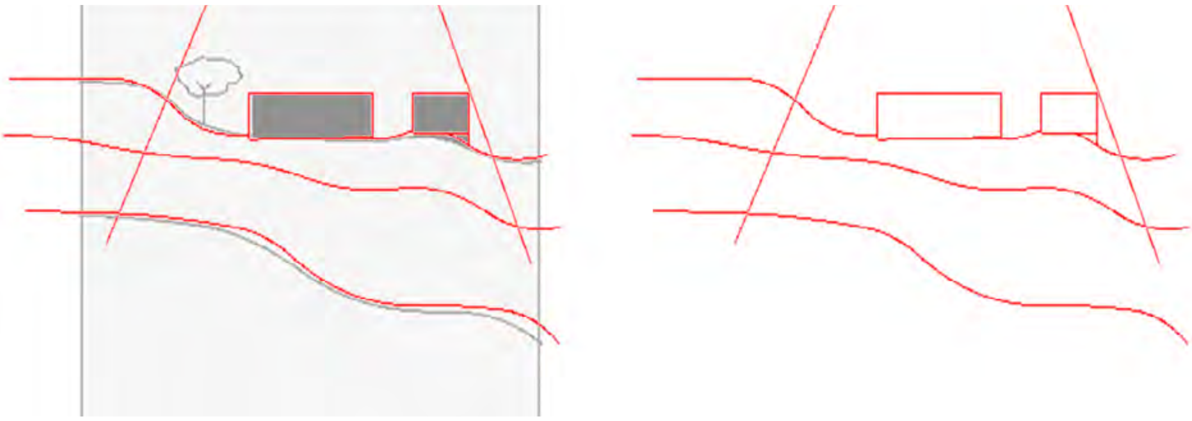
“Pathways and movement are visible and clear, leading to a focal point or position.”



“The transmission lines create vertical patterns and draw the user’s visual focus to a point on interception at the horizon.”



“The horizon typology is represented by vertical elements on the horizon line.”



“Element’s and structure’s volume creates a focal point within the light plants of the grassland”

Fig 8.6 Author’s interpretation of the points, lines and planes of the grassland (Author, 2020)

8.3 Design precedence

8.3.1 Hiriya Landfill, Tel Aviv, Israel

The Hiriya Landfill was a project developed by Latz and Partners. The landfill was rehabilitated to protect its capping from wind and soil erosion while also providing public spaces such as view vistas, educational facilities and a restaurant. Special retention ponds are located at the summit which are used to irrigate an indigenous forest.

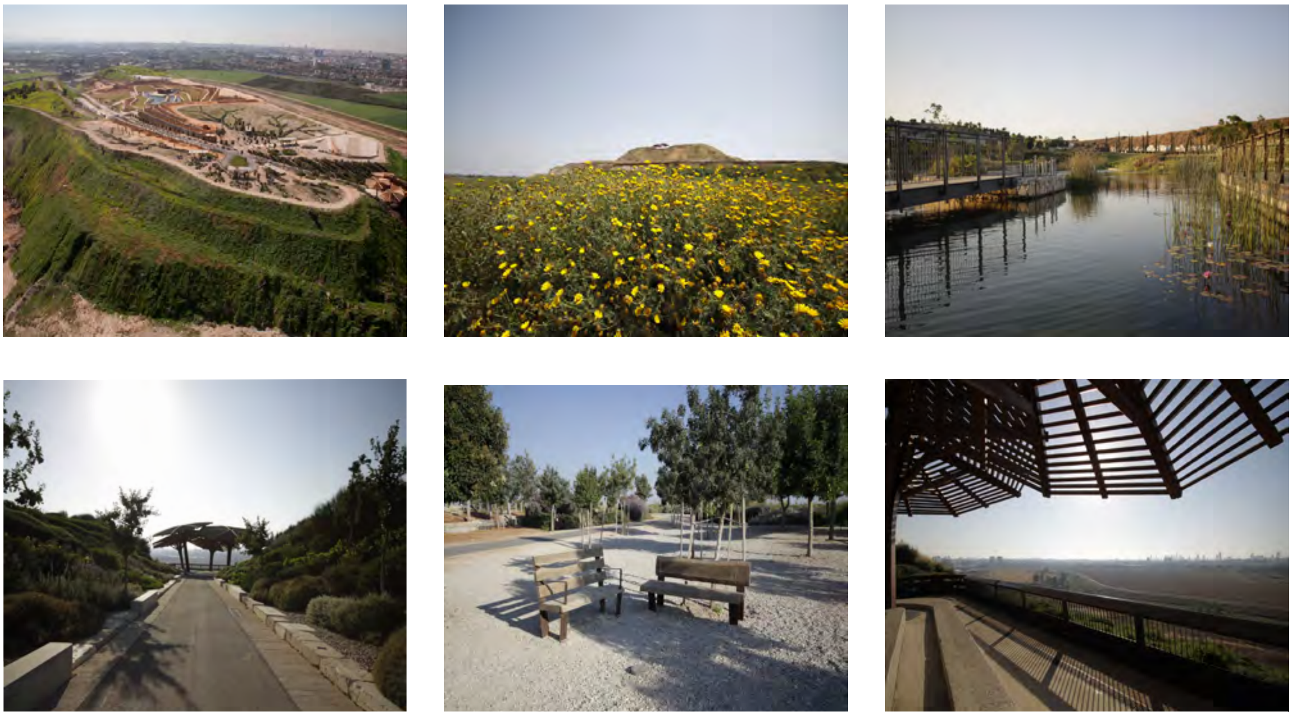


Fig 8.7 Hiriya Landfill, Tel Aviv (LATZ+PARTNERS, 2004)

Fig 8.8 Hiriya Landfill, Tel Aviv (LATZ+PARTNERS, 2004)

8.3.2 Green Point Park, Cape Town, South Africa

Green Point Park was considered to be a dysfunctional public open space that has been developed into a public park for the people of Cape Town The area has a series of spaces for fitness, recreation and education.

Fig 8.9 Green Point Park (photos by Author, 2020)

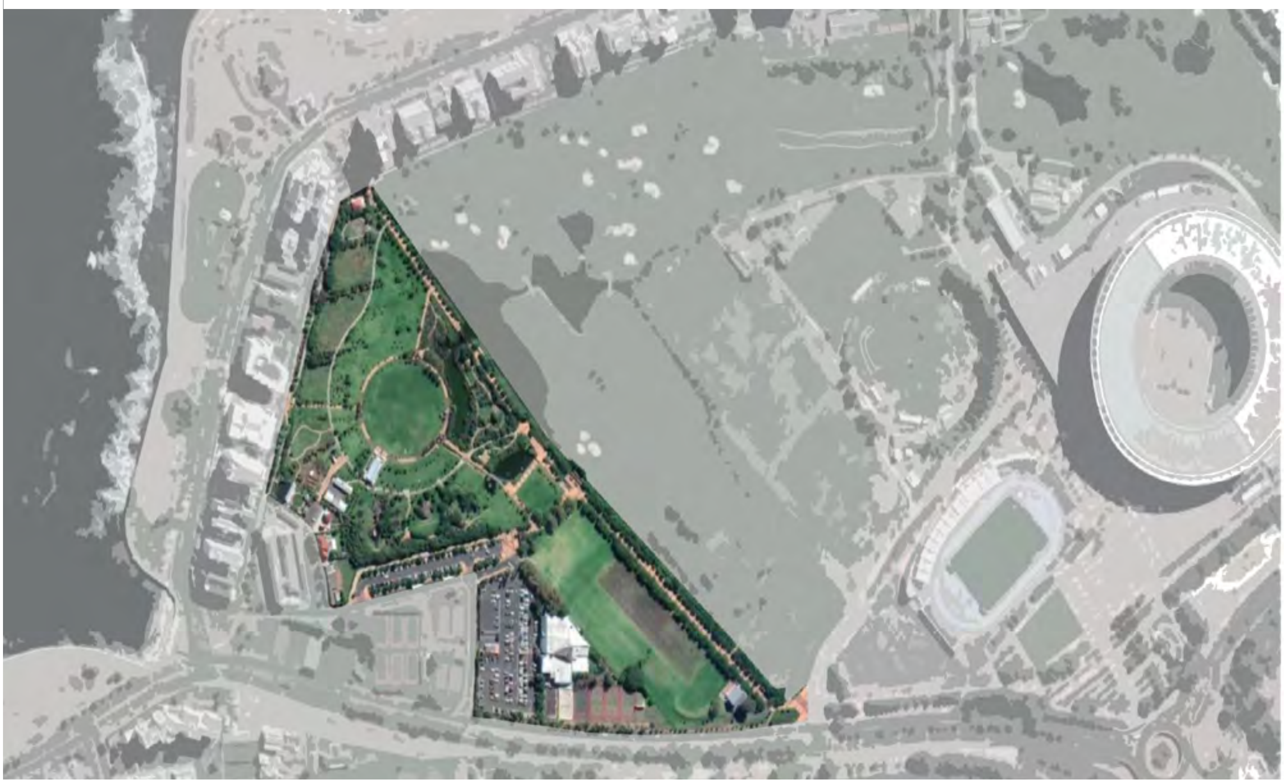


Fig 8.10 Green Point Park, Cape Town (Google Earth, 2020, edited by author, 2020)

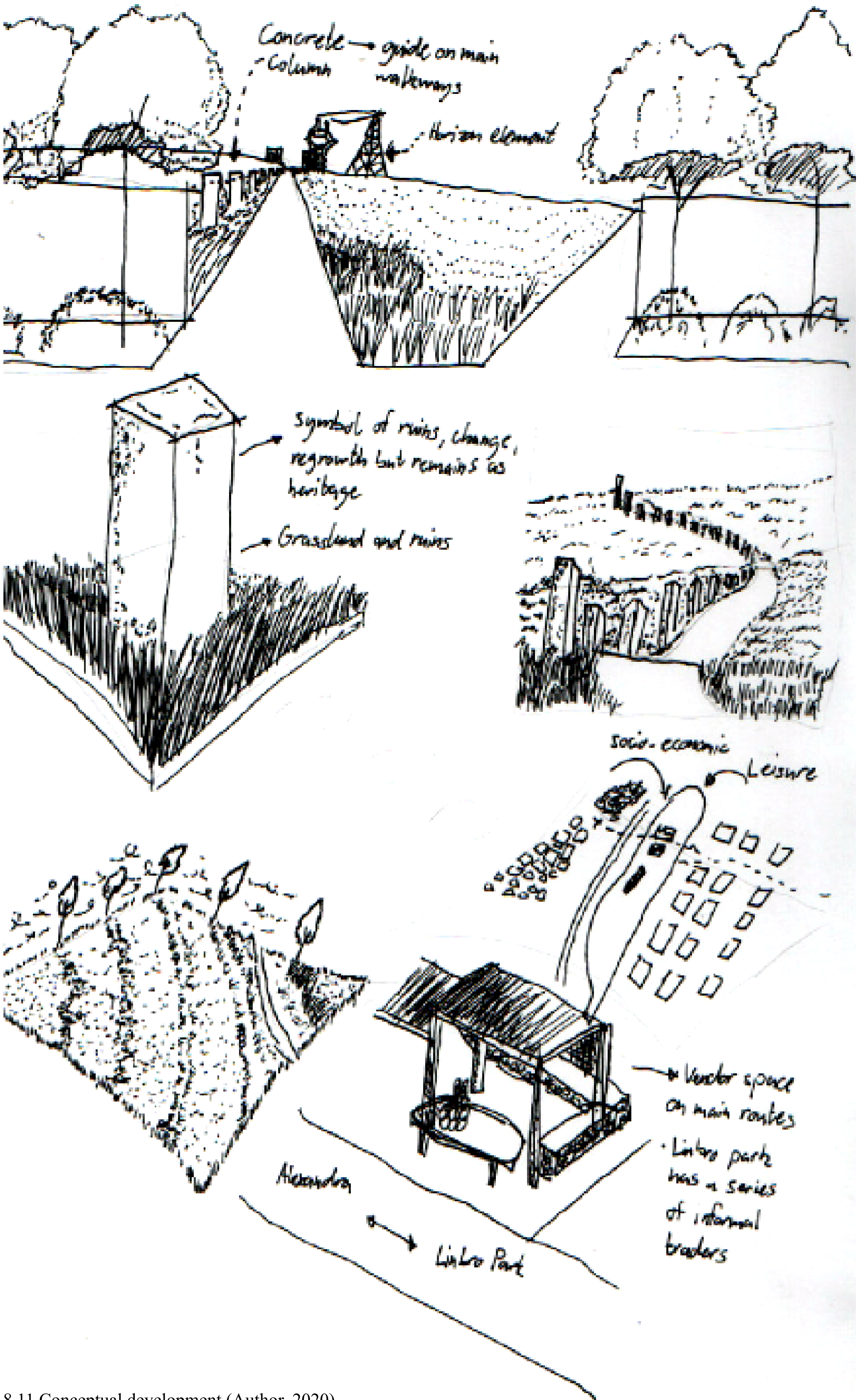
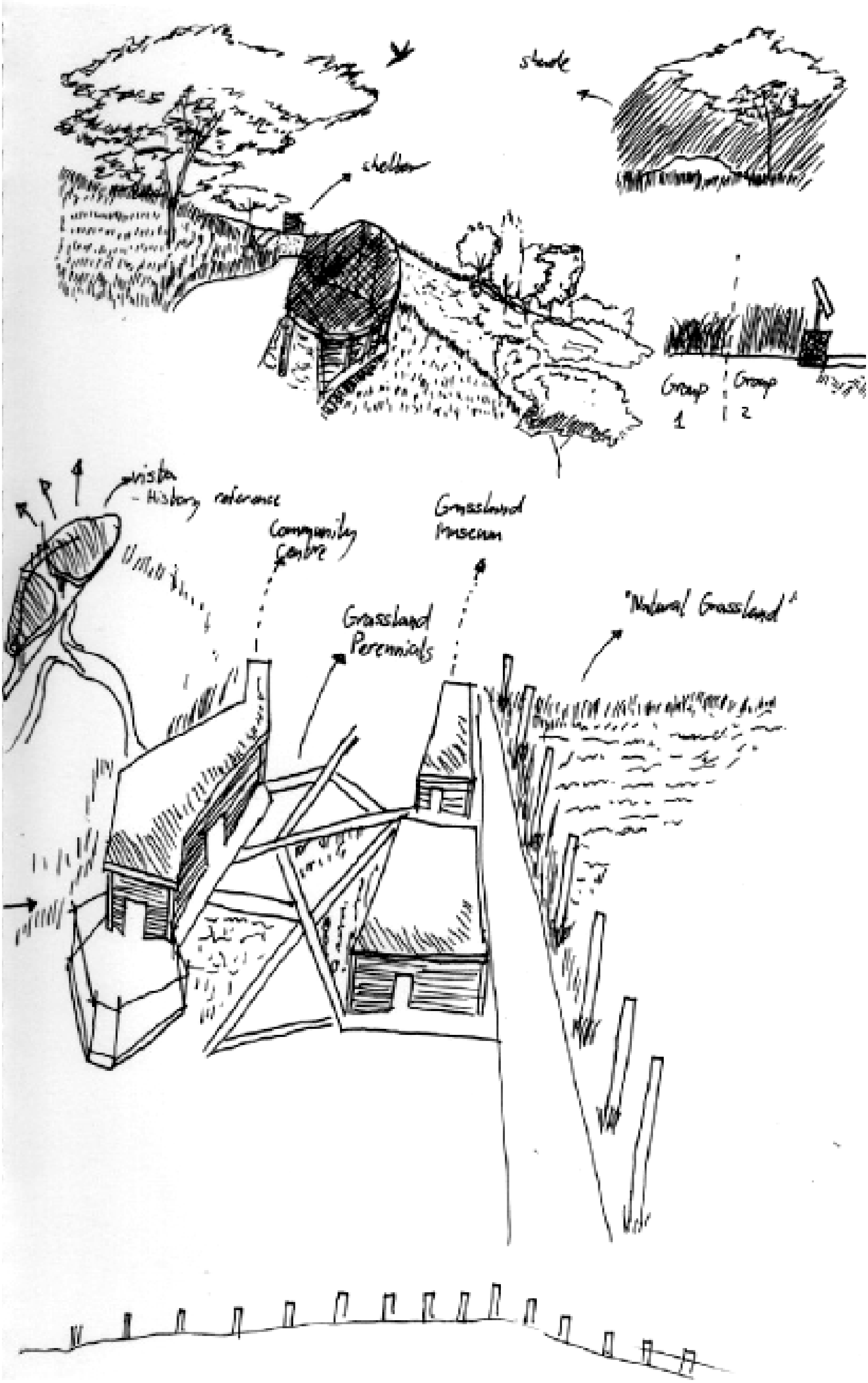


Fig 8.11 Conceptual development (Author, 2020)


shade
shelter
Group 1
Group 2
vista
- History reference
Community centre
Grassland Museum
Grassland Perennials
'Natural Grassland'

9

Fig 9.1 Masterplan render (Author, 2020)

Fig 9.2 Masterplan zoning (Author, 2020)

9.1 Sketchplan

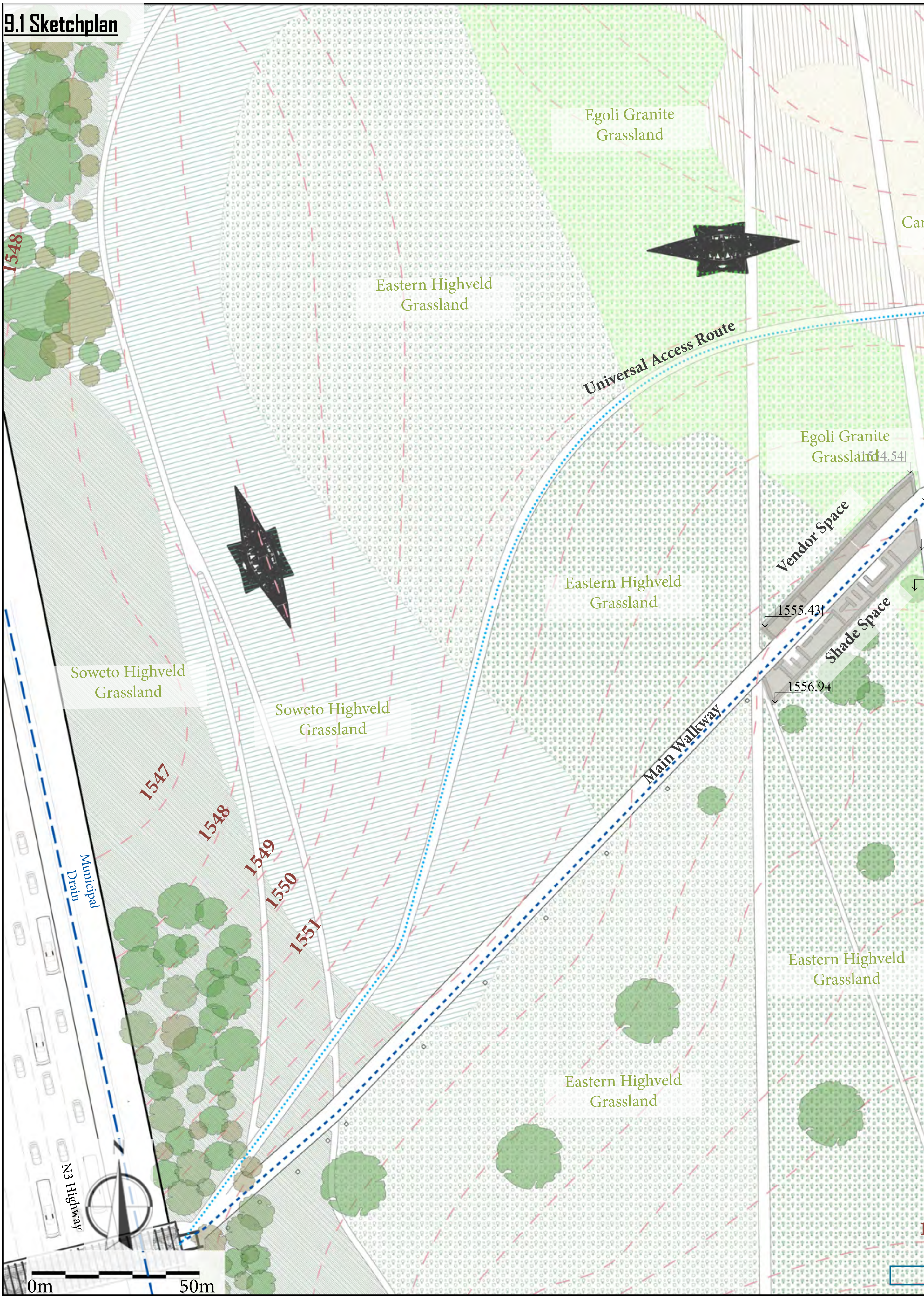
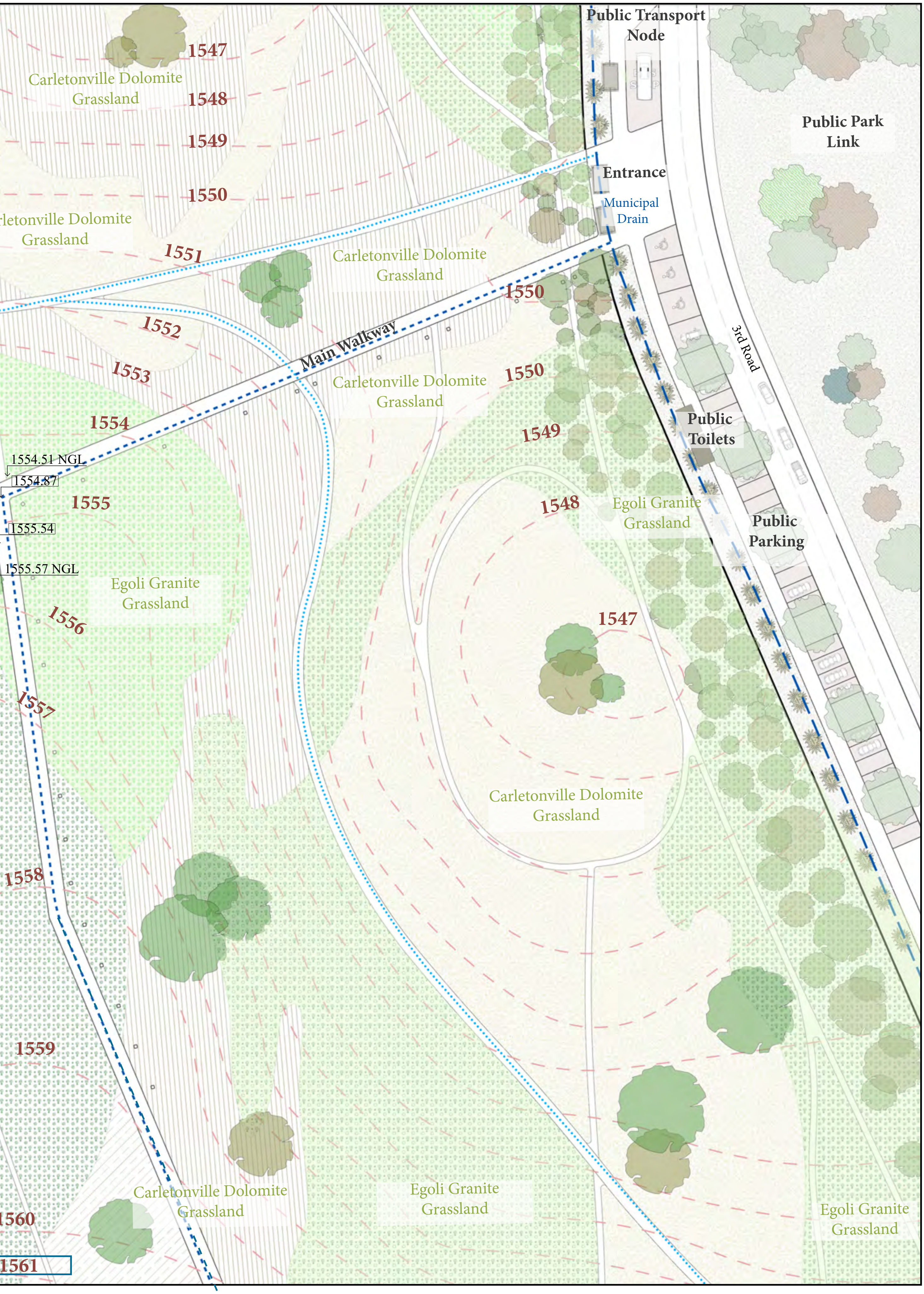


Fig: 9.3 Technical sketchplan (Author, 2020)


Public Transport Node
Public Park Link
Entrance
Municipal Drain
3rd Road
Main Walkway
Public Toilets
Public Parking
Carletonville Dolomite Grassland
Egoli Granite Grassland
1547
1548
1549
1550
1551
1552
1553
1554
1554.51 NGL
1554.87
1555
1555.54
1555.57 NGL
1556
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1558
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1560
1561

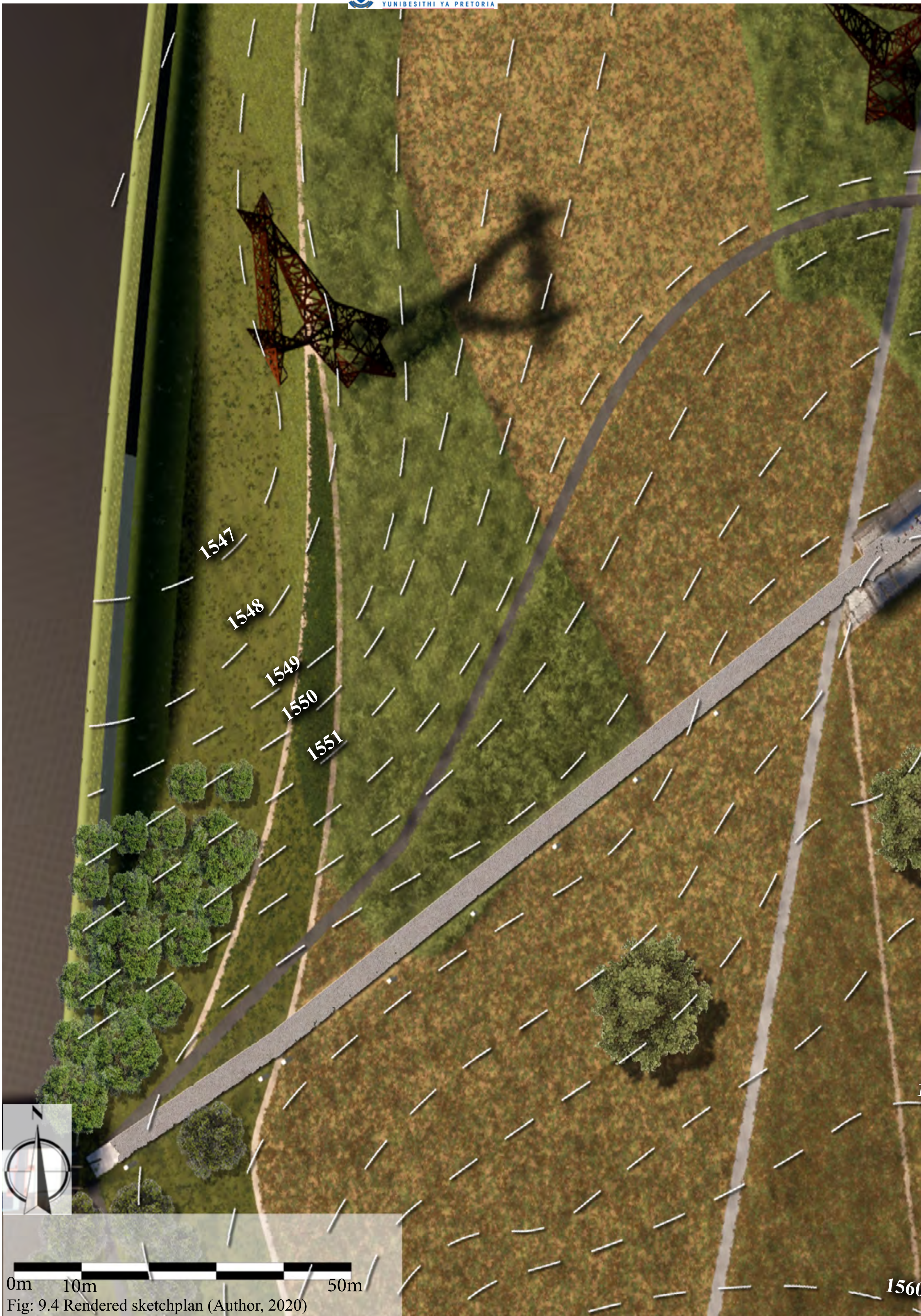

Fig: 9.4 Rendered sketchplan (Author, 2020)


1549
1550
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9.2 Wetland area

Fig 9.5 Conceptual vision of treatment wetland (Author, 2020)

The wetland will be closed off from the public as it is part of an important service to the municipality.

The wetland, reed plants and trees allow for suitable bird habitats.

Fig 9.7 Birds on-site (Author, 2020)

Fig 9.6 Bird hide view (Author, 2020)

9.3 Bridge access over the N3

The design of the bridge draws inspiration from Alexandra's Heritage Centre which utilises a steel frame truss system. The combination of the grass effect and steel adds to the experience of a post-industrial drosscape.

Fig 9.8 Alexandra Heritage Centre Bridge (Peter Rich, 2020).

Fig 9.9 Bridge over the N3 (Author, 2020)

Fig 9.10 Entrance to park from Alexandra (Author, 2020)

9.4 Park entrance

Fig 9.11 Entrance to park from 3rd Road (Author, 2020)

Fig 9.12 3rd road park edge(Author, 2020)

9.5 Main walkway experience

Fig 9.13 Main walkway with shelters and unprogrammed trading (Author, 2020)

Fig 9.14 Pathway to community centre (Author, 2020)

9.6 Alexandra visual vista

Fig 9.15 Alexandra view vista point (Author, 2020)

Fig 9.16 Alexandra heritage structure (Author, 2020)

Fig 9.17 Johannesburg urban development timeline boards (Author, 2020)

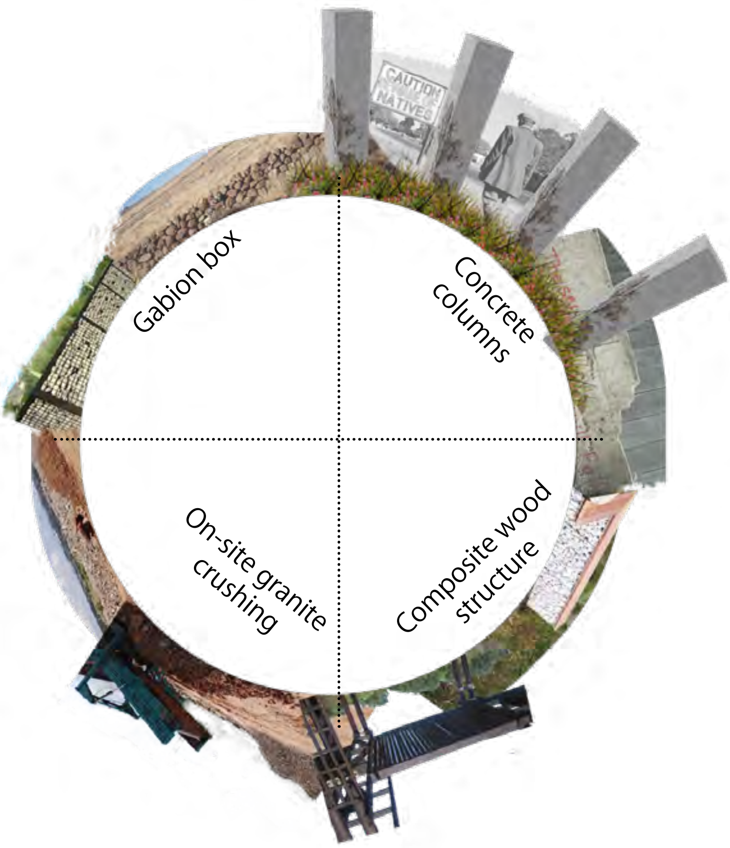


Fig 9.18 Material selection (Author, 2020)

9.7 Community centre

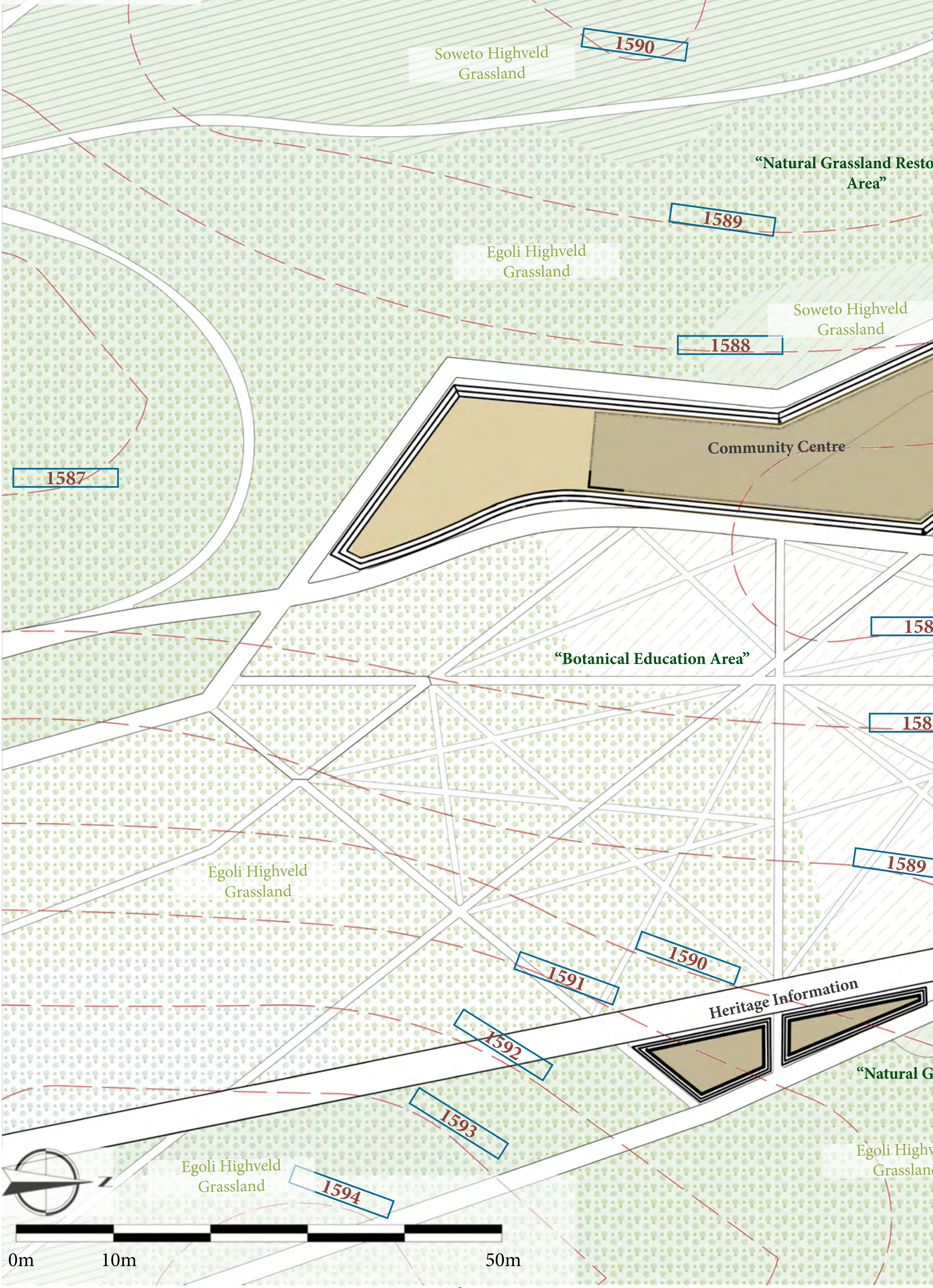
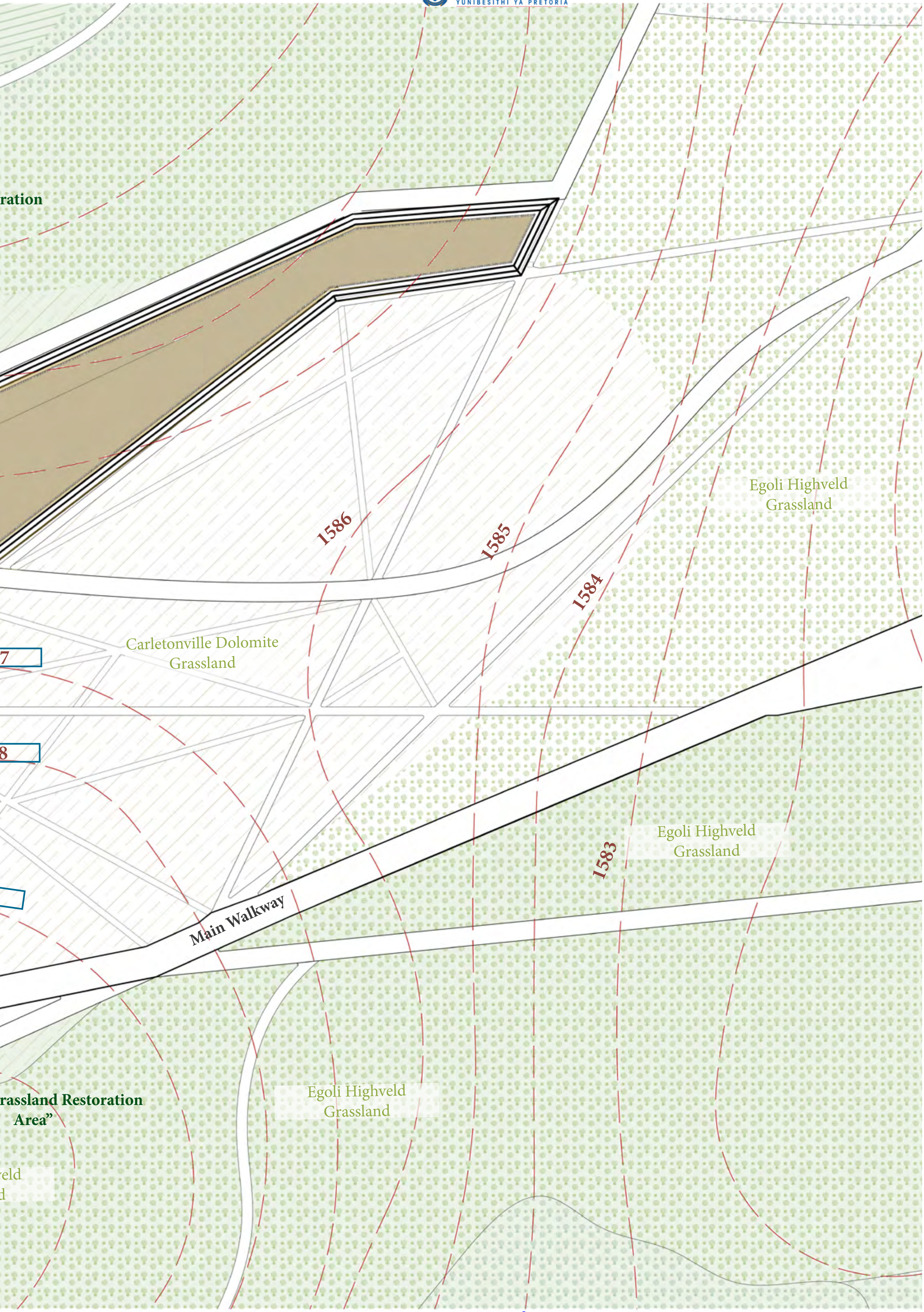


Fig: 9.19 Community centre sketchplan (Author, 2010)


ration
1586
1585
1584
1583
Egoli Highveld Grassland
Carletonville Dolomite Grassland
Egoli Highveld Grassland
Main Walkway
rassland Restoration Area”
Egoli Highveld Grassland
eld
d
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8

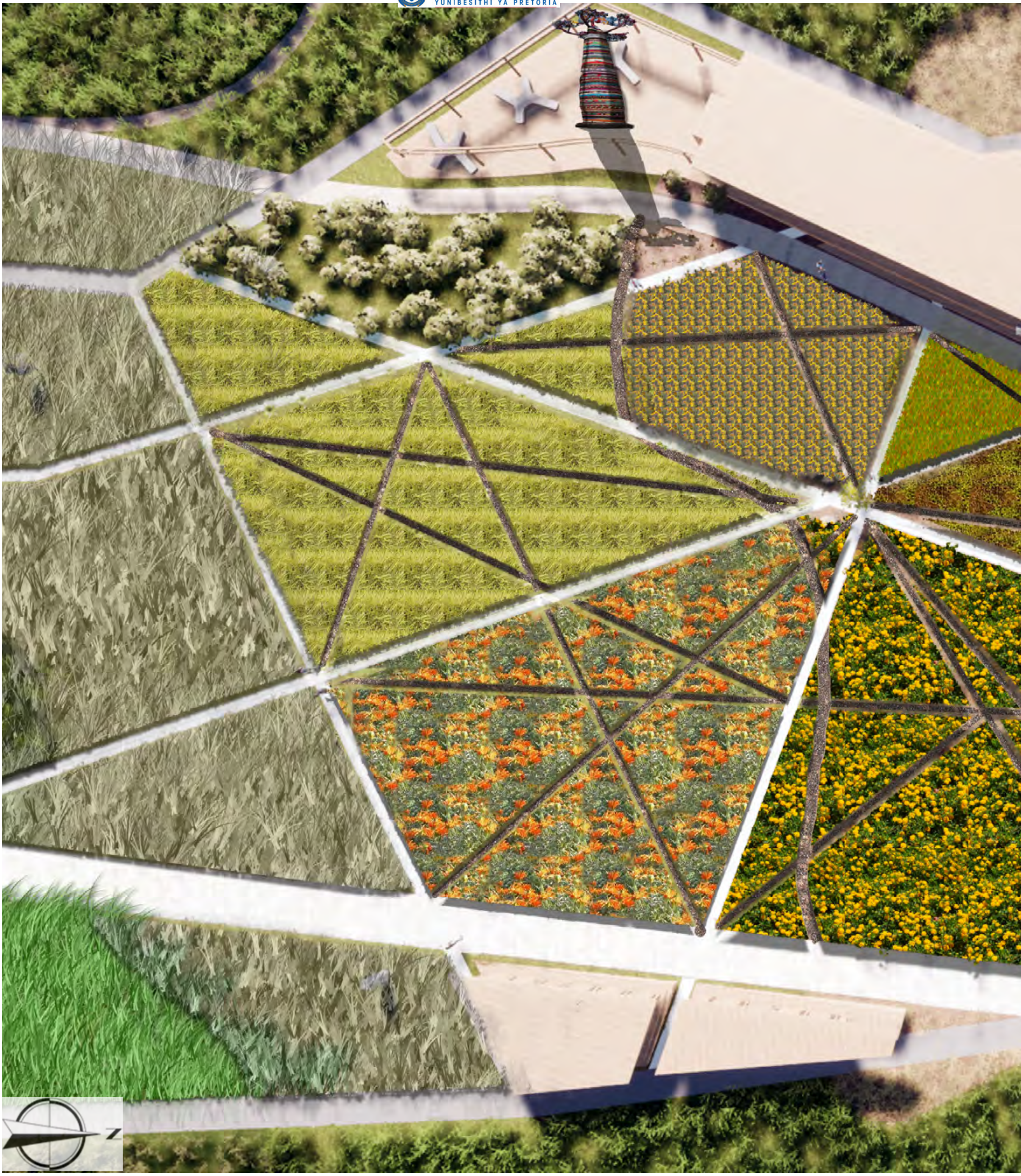


Fig 9.20 Community Centre and Garden (Author, 2020)

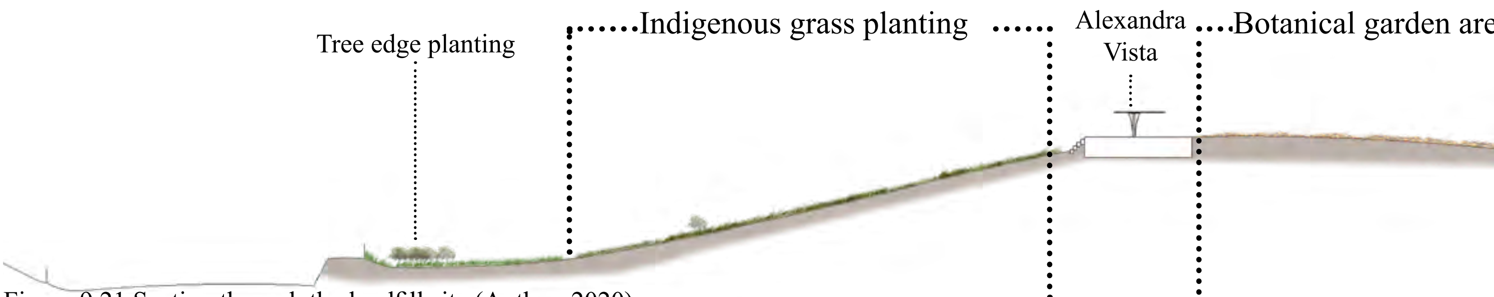
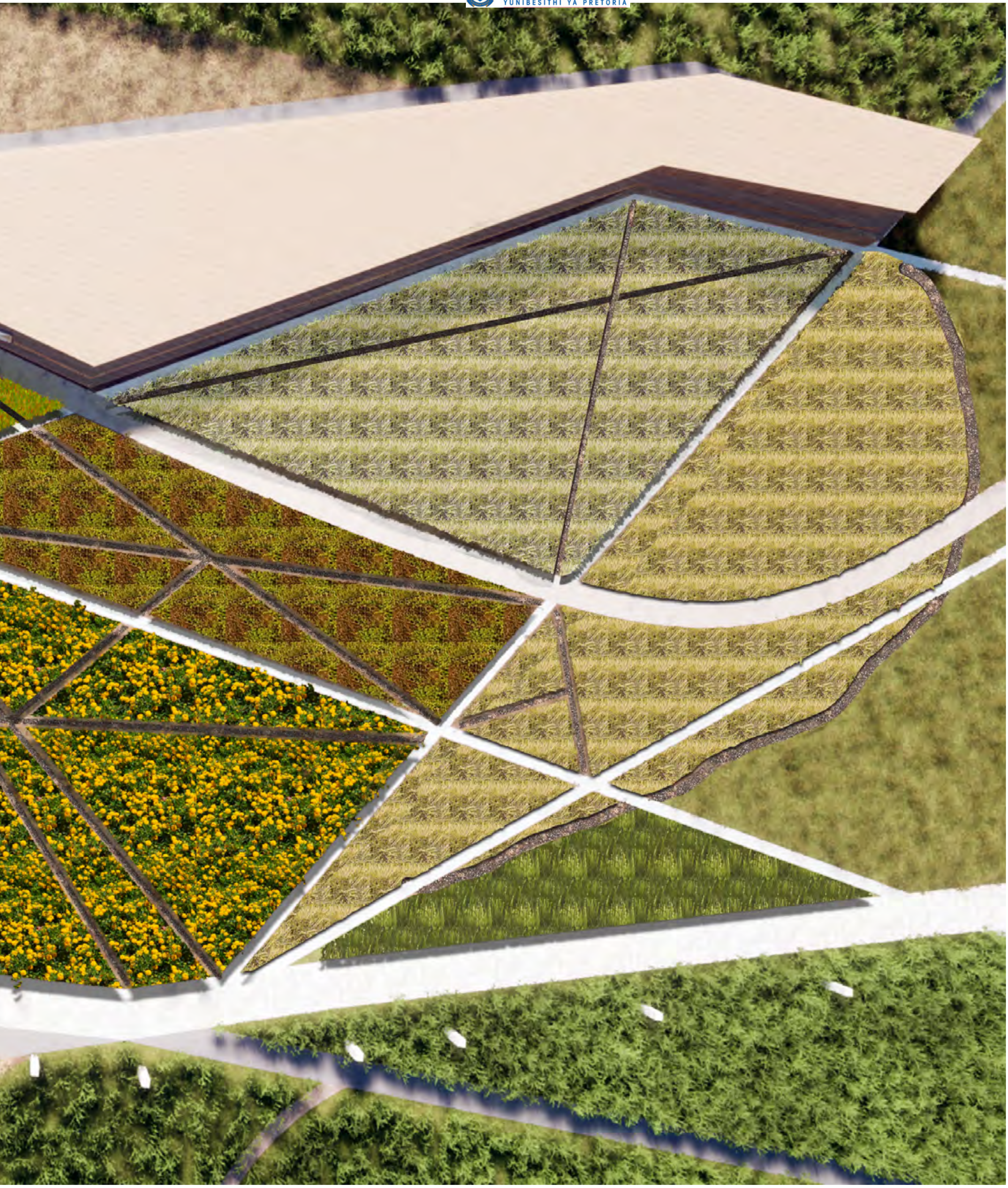
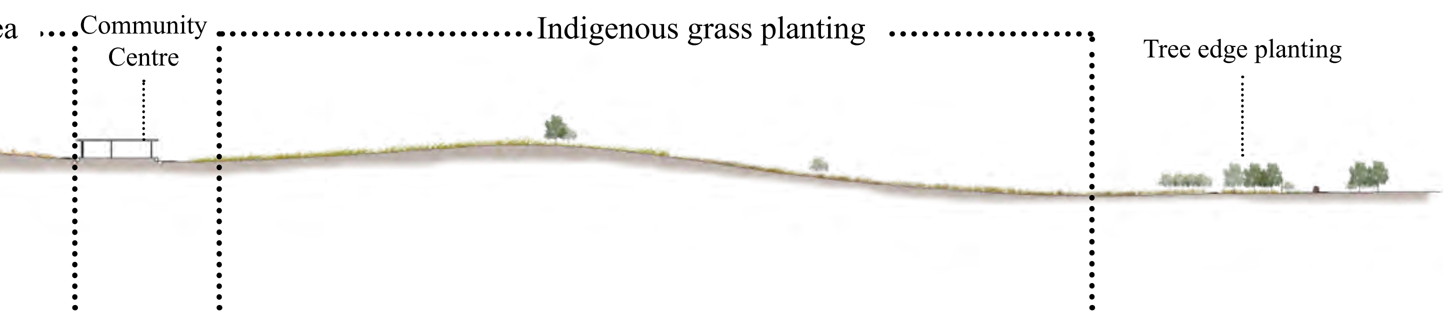


Figure 9.21 Section through the landfill site (Author, 2020)




Community Centre
Indigenous grass planting
Tree edge planting

9.8 Community centre area

Fig 9.22 Explanation of concrete dividing columns (Author, 2020)

Fig 9.23 Biodiversity information boards (Author, 2020)

Fig 9.24 Community centre's garden (Author, 2020)

Fig 9.25 Community centre and art display (Author, 2020)

10

Chapter 10 Technification

10.1 Phytocapping layering

10.1.1 Phytocapping process

The first stage will involve the establishment of natural grasses as soon as the final phytocapping top layer has been installed. Controlling erosion during the establishment of the grassland groups will be an important factor in the monitoring of the site. Due to the size of the site, the photocapping may have to be applied in stages in certain areas (Liu, 2012).

The second stage begins after one or two years and involves the planting of selected trees and shrubs. If the grasses die off in a location, it is unlikely that deeper-rooted vegetation will thrive. Further soil remediation may need to be carried out if this is the case. During this second stage, paths and infrastructure will have been laid out, which will also prescribe where medium-sized plants will be placed.

The third stage will involve the planting of perimeter trees in areas that are not necessarily directly over the capped waste landfill.

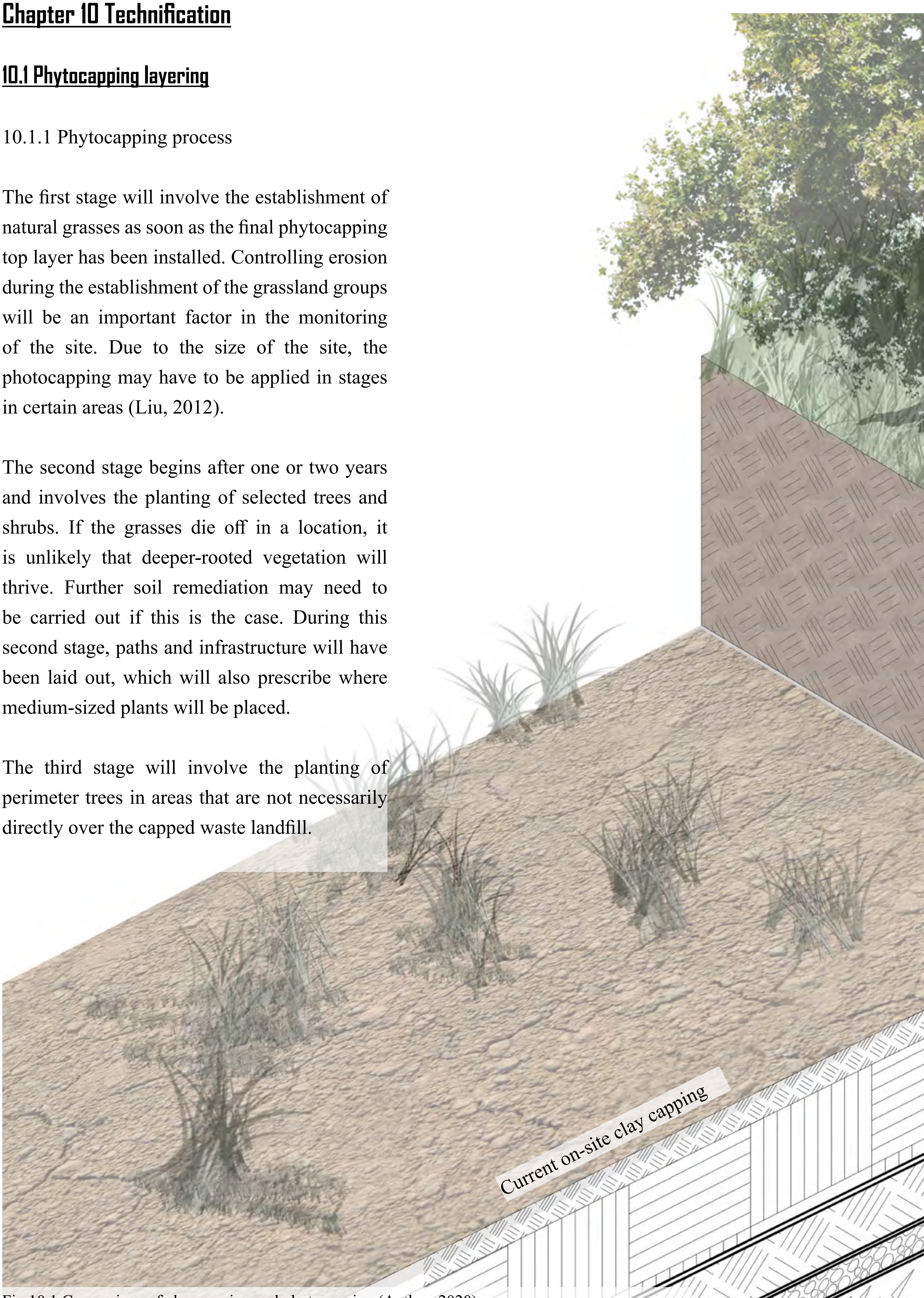
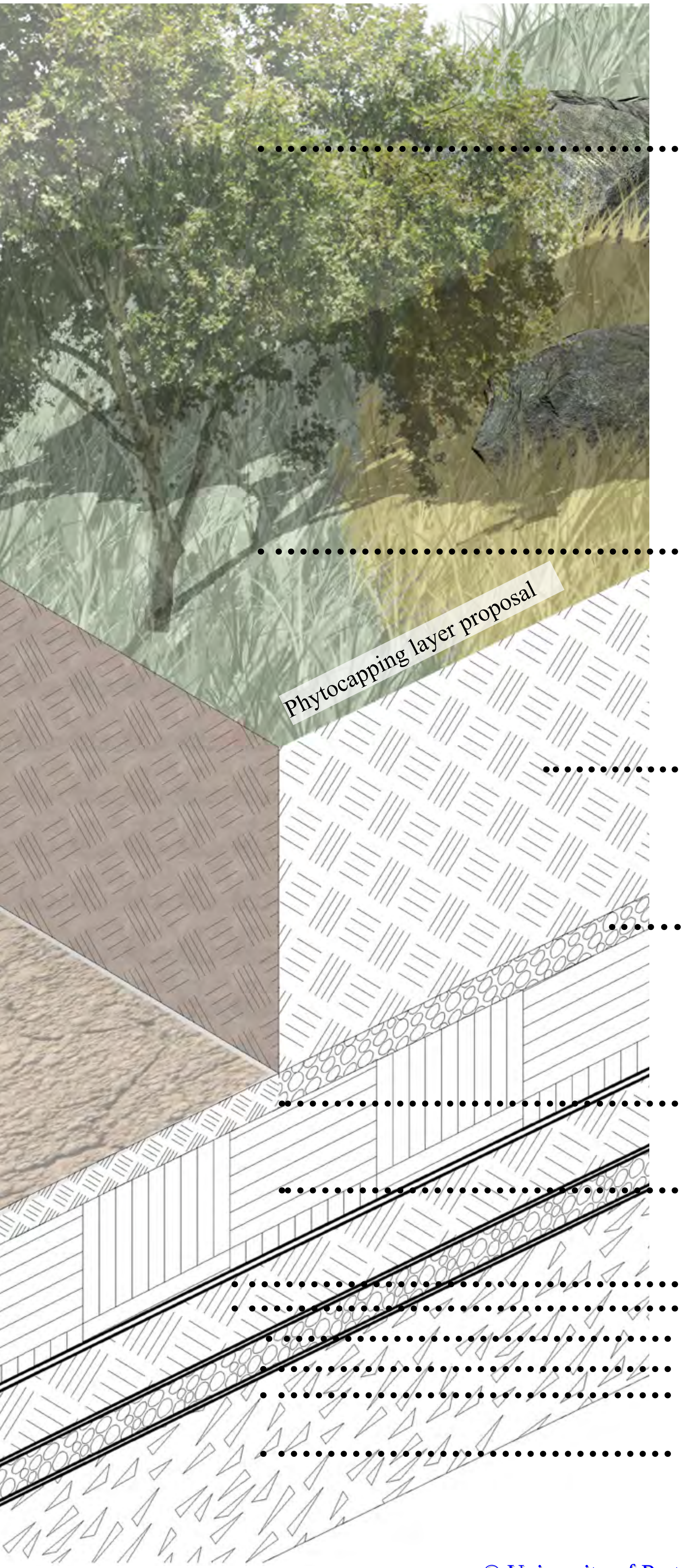


Fig 10.1 Comparison of clay capping and phytocapping (Author, 2020)


Phytocapping layers
Rhizome rooted trees
Rehabilitated grassland group
Phytocapping layer proposal
Recultivation layer ranging from 0.8m to 2m. Thicker layers have low percolation rates
Drainage layer
On-site layers
200mm Organic layer
600mm Clay capping material
Geosynthetic clay liner layer (4kg/m ²)
300mm Cohesive soil
Separation geotextile
150mm Granular gas drainage layer
Separation layer
Compacted waste

10.1.2 Recultivation layer addition

The function of this layer is to protect the barrier layer, support vegetation and prevent erosion. The thickness typically varies between 0.8-1.5m. The composition is usually made up of natural loamy and/or fine sandy soils. It is also beneficial for the topmost layer to contain a higher component of organic matter to support the vegetation (Liu, 2012).

10.1.3 Drainage layer addition

The drainage layer consists of a material with high hydraulic conductivity (sand, gravel). The thickness can vary from 150-300 mm. This layer is to discharge water that has infiltrated past the cultivation layer into channels (Liu, 2012).

10.1.4 Plant selection for phytocapping

Slow versus rapid growing species

Slow-growing trees are more tolerant of landfill conditions than rapid growing species. Fast growers generally draw more water and would therefore require more irrigation. On the other hand, fast-growing species will produce more cover in a shorter time.

10.1.5 Small versus large plants

Trees planted while small (<1m) exhibit better growth than when planted when taller (>2m), regardless of species. Trees planted while younger can adapt their root system to the soil conditions by spreading their roots close to the surface and away from any gas emissions. Larger plants can only be used in areas not affected by the emission of landfill gases (Liu, 2012)

10.1.6 Natural rooting depth

Trees and shrubs that have shallow root systems have a significant advantage over species requiring deeper root systems. The deeper root systems are more likely to come into contact with landfill gas and lower oxygen levels. Table 10.1 indicates the recommended root depth of various plants.

Grass	
Common	Forage Grass
<30 cm	>100 cm
Shrub	
Small	Big
30 - 45 cm	45 - 60 cm
Trees	
Shallow root	Deep root
60 - 90 cm	90 – 150 cm

Table 10.1 Root depth comparison of vegetation (Almuktar, et al., 2018)

10.1.7 Phytocapping Stages

Stage 1 - bank stabilisation and ecological establishment

In order to prevent erosion of the new recultivated soils, pioneer plants will be used, namely:

Cynodon dactlyon

Chloris gayana

Digitaria eriantha

Athephora pubescns

A period of one to two years will allow for the pioneer plants to stabilise the banks and also indicate possible poor soil conditions, should the plants not establish themselves.

Stage 2 - Introduction of indigenous grassland groups

As the soil becomes stabilised, the introduction of plants from the grassland community can begin

Stage3 - Potential introduction of trees

Introduction of trees in areas will be based on the success of the pioneer plant species

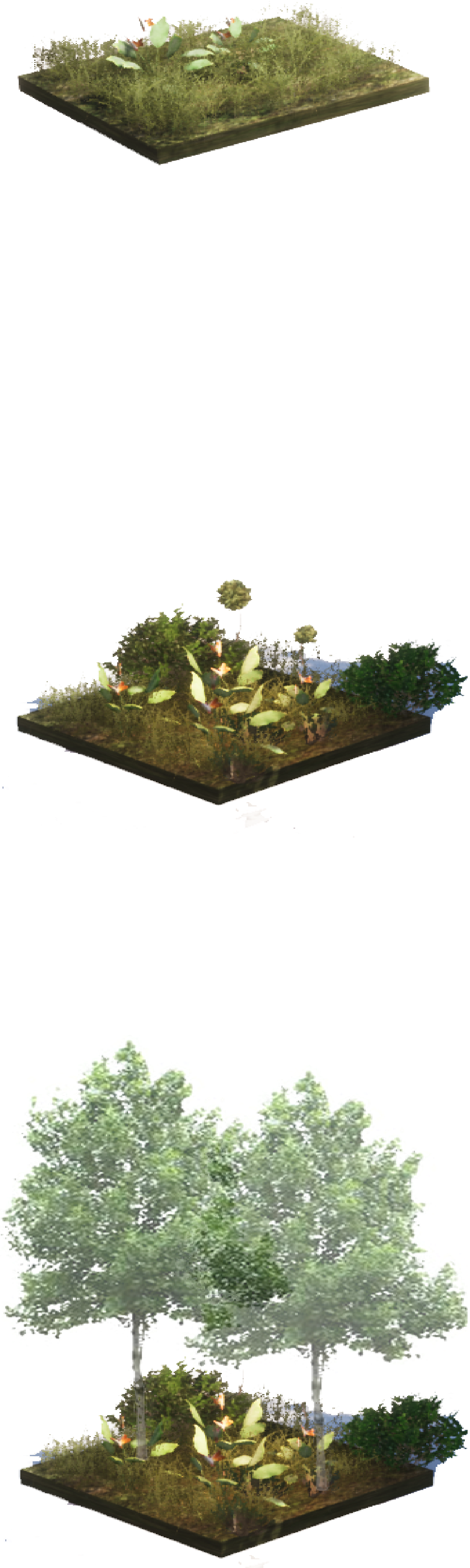


Fig 10.2 Stages of phytocapping implementation (Author, 2020)

10.2 Leachate treatment wetland volume

- Linbro Park covers an area of approximately 726 500 m^2.
- The average amount of annual precipitation for the area is 718.0 mm

Using the formula from the Emission Estimation Technique Manual of the Australian government, the leachate volume can be calculated.

$$V=0.15 \times R \times A$$

(Department of the Environment, Water, Heritage and Arts, Australian Government, 2010)

Where:

V = volume of leachate discharge in a year (m^3/year)

R = annual rainfall (m)

A = surface area of the landfill (m^2)

Applying the figures to the formula, the results indicate an average volume of the leachate of 78 224 m^3/year, or 6 520 m^3/month. It must also be noted that for the wetter months of November to January, the monthly volume increases to 10 897 m^3/month (Department of the Environment, Water, Heritage and Arts, Australian Government, 2010).

10.3 Leachate treatment wetland construction

There are few standards available in the literature to define the exact dimensions of wetland ponds in the South African environment. Some guidelines are presented but these are dependent on the actual flow variation, hydraulic loading and composition of the leachate. For a free water surface flow (FWSF) wetland, the following parameters can be applied:

Parameter	Design criteria
Bed size	As large as possible
Length to width ratio	3:1-5:1
Water depth	0.3-0.5m
Hydraulic slope(%)	<0.5%
Hydraulic Retention Time(days)	5-30 days
Media	Natural Media and Industrial byproducts preferred, porosity 30-50%, particle size <20mm, 50-200mm for inflow and outflow areas
Vegetation	Local species preferred, plant density 80% coverage

Table 10.2: Design and operation recommendations for treating wastewater using constructed wetlands (Almuktar, et al., 2018)

Bricken suggests the design Hydraulic Retention Time (HRT) for a landfill site application should be 10.6 days (Bricken, 2003).

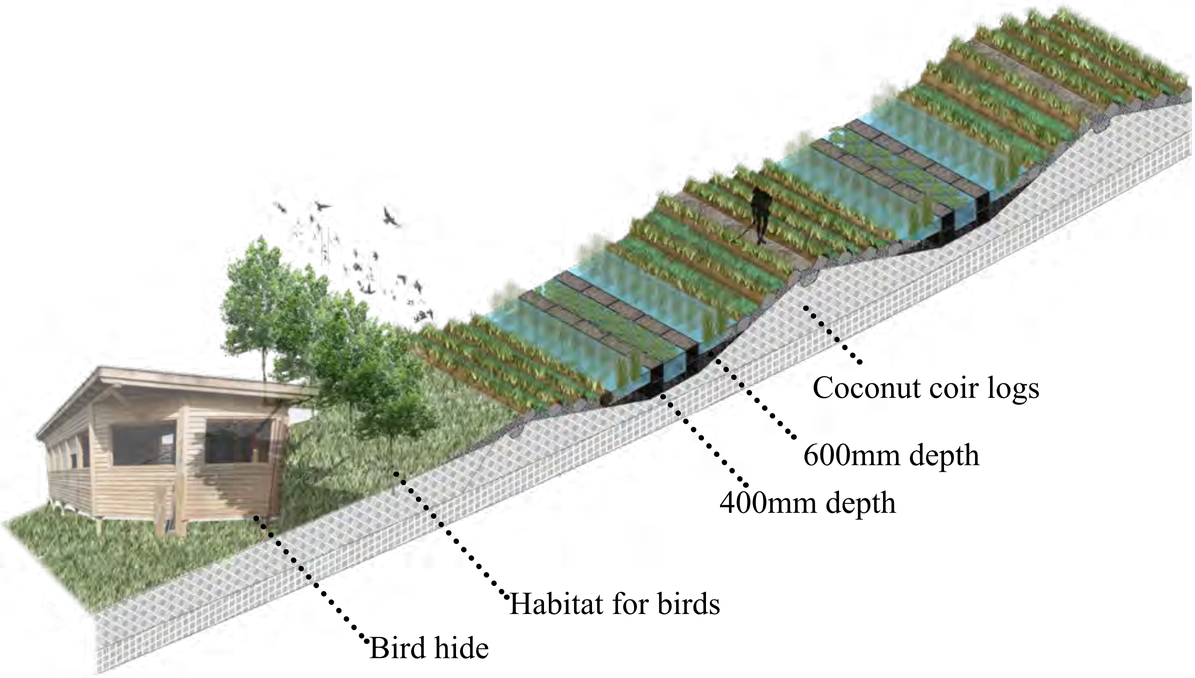


Fig 10.3 Wetland whole section (Author, 2020)

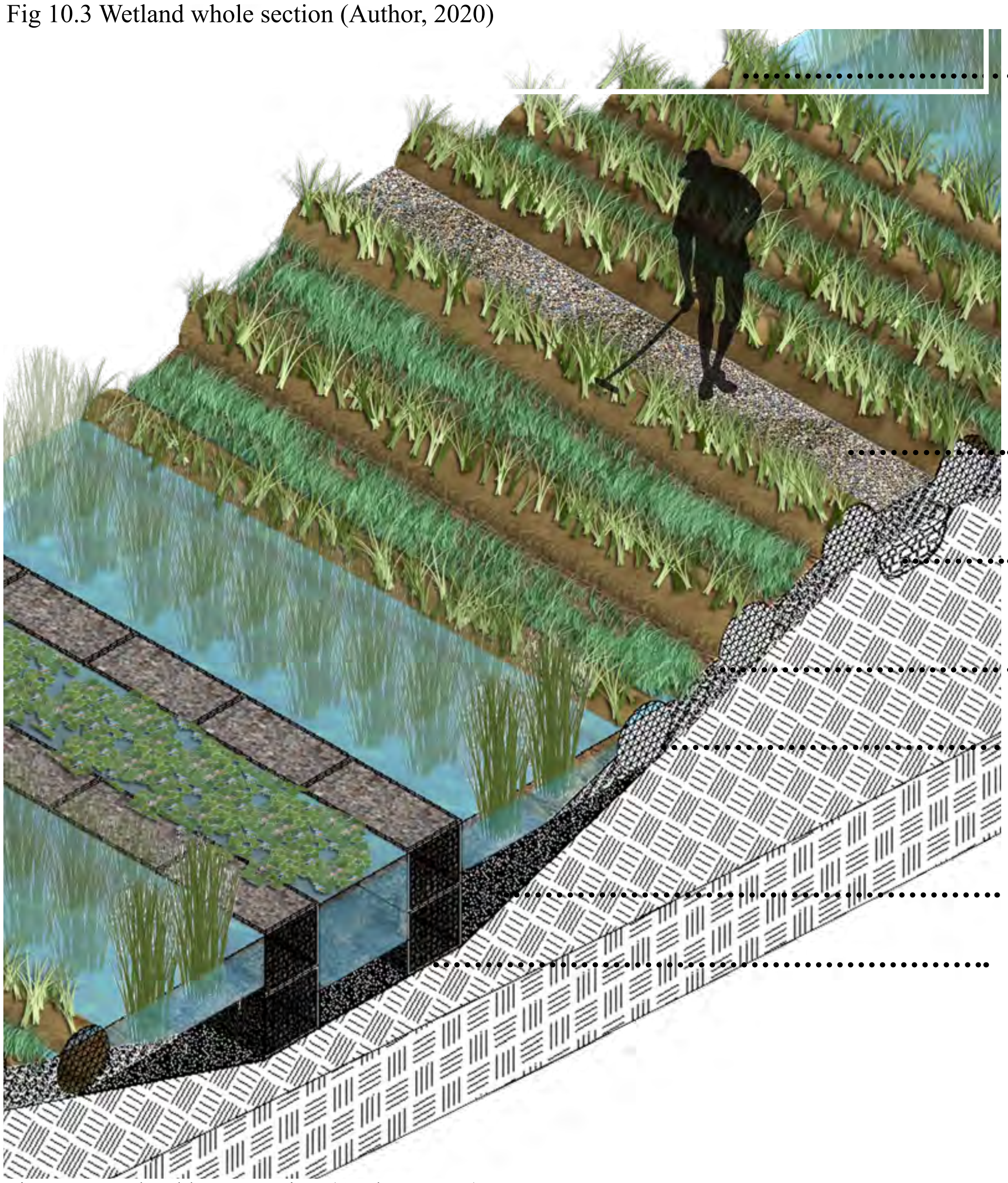


Fig 10.4 Wetland berm section (Author, 2020)

Based on an average inflow of 6250m^3 / month (or 205.5 m^3 / day), and an HRT of 10.6 days, the total volume of the wetland is calculated as: V=HRT x average daily inflow (Bricken, 2003).

V = HRT x average daily inflow

V = 10.6 x 205.5

V = 2178.8m^3 as the recommended volume for the wetland

Taking into consideration an average depth of 0.4m, the surface area will be 5 445 m^2 (Bricken, 2003).

Bricken also stated that actual HRT has been reported as 40-80% lower than the theoretically calculated value (as above). Hence, the design for Linbro Park will increase this surface area to 8000m^2 to further improve the leachate treatment and reduce the amount discharged to the municipal water waste treatment (Bricken, 2003).

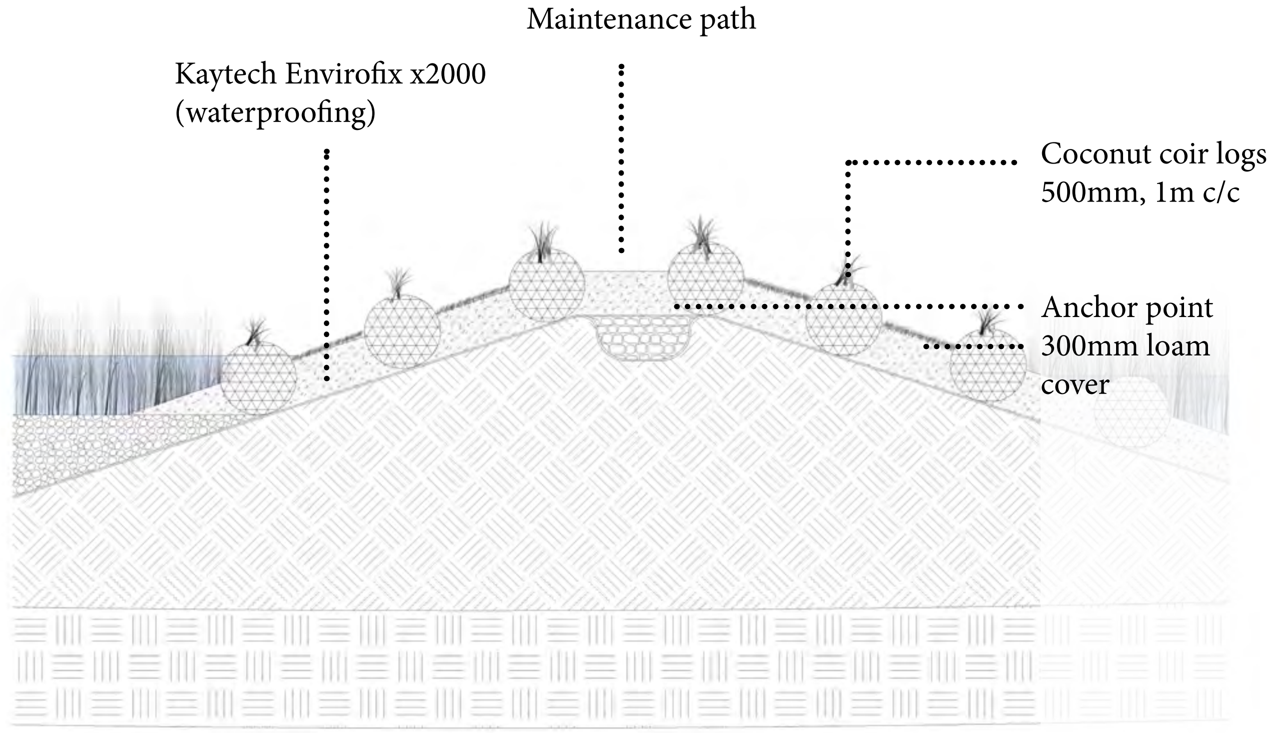


Fig 10.5 Wetland section - mound (Author, 2020)

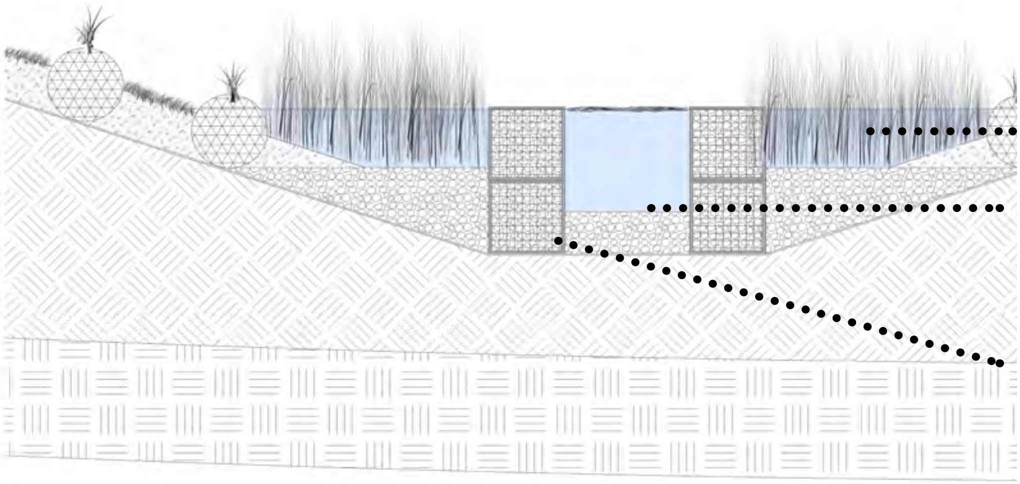


Fig 10.6 Wetland section - channel section (Author, 2020)

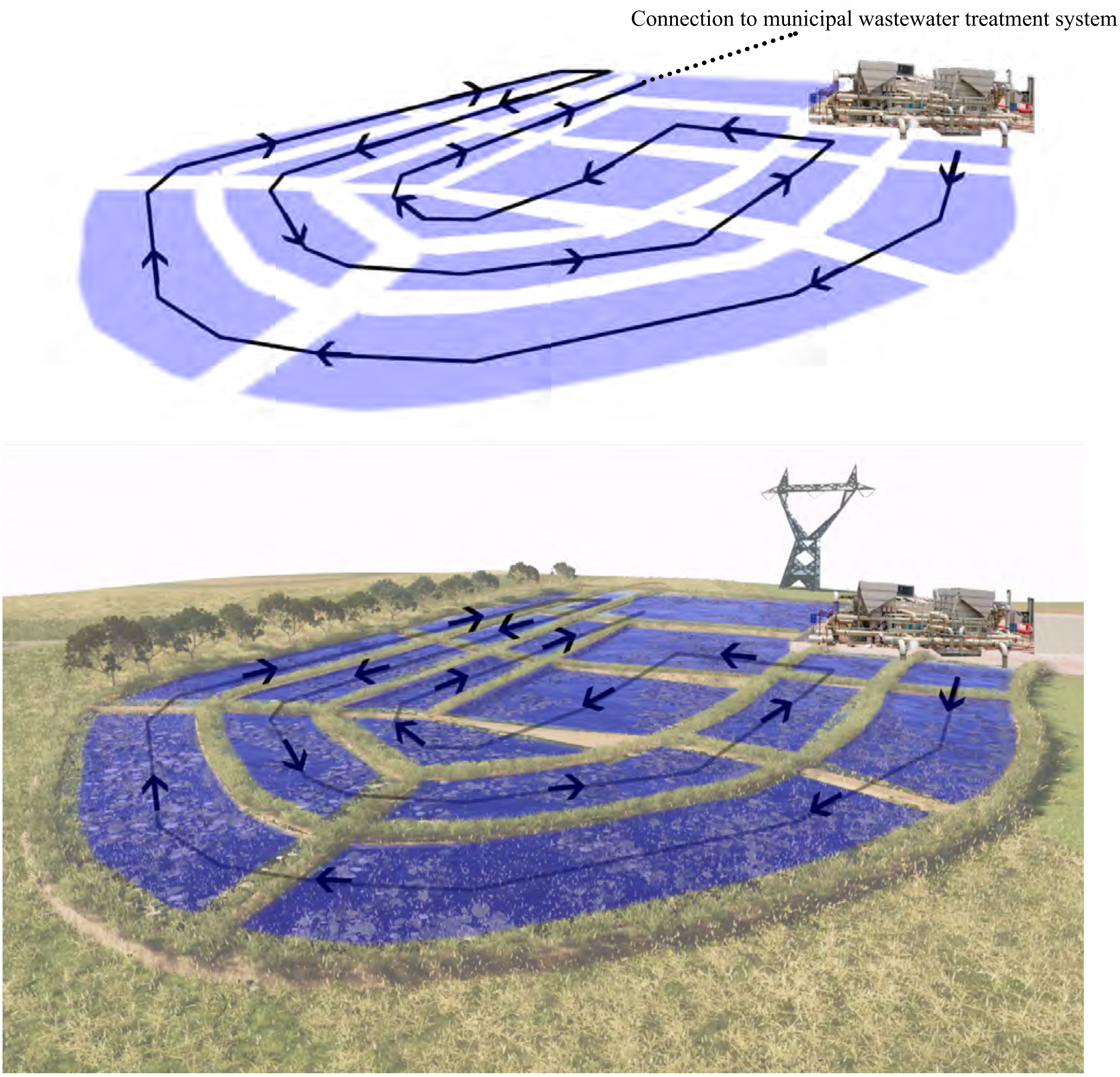
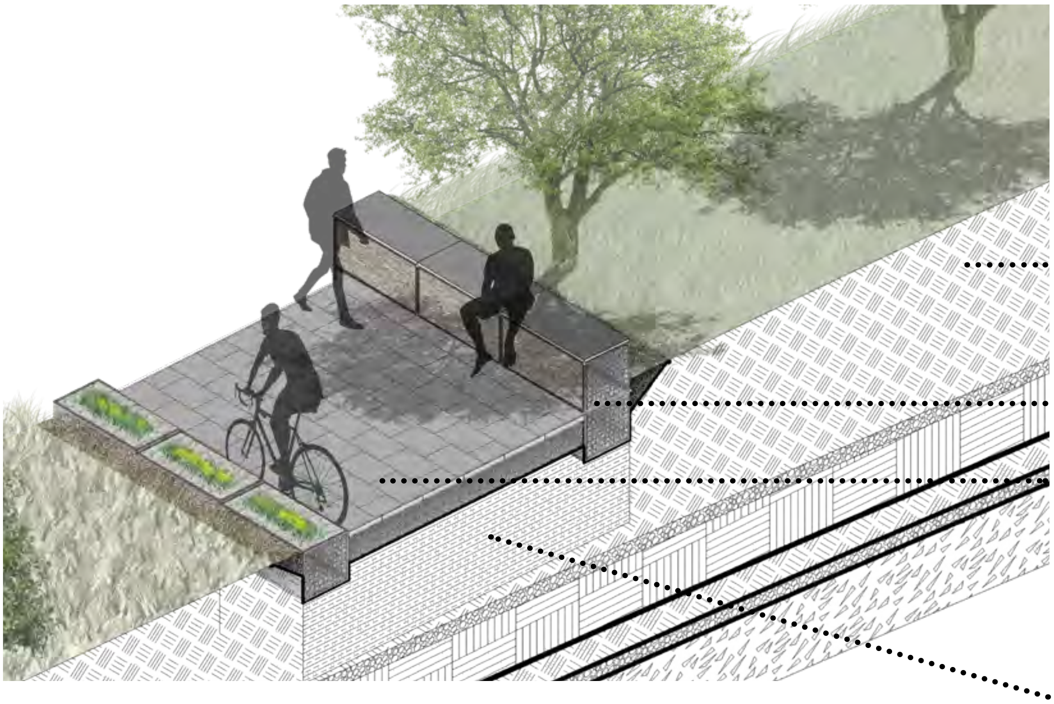
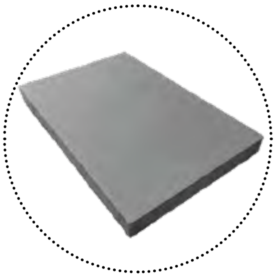


Fig 10.7 Wetland circulation (Author, 2020)

10.4 Main walkway

Due to the unstable soil conditions, walkways will need pavers that can allow for movement and gabion boxes for stabilisation. Drainage channels below the walkways paver allow for water to flow underneath the walkway.





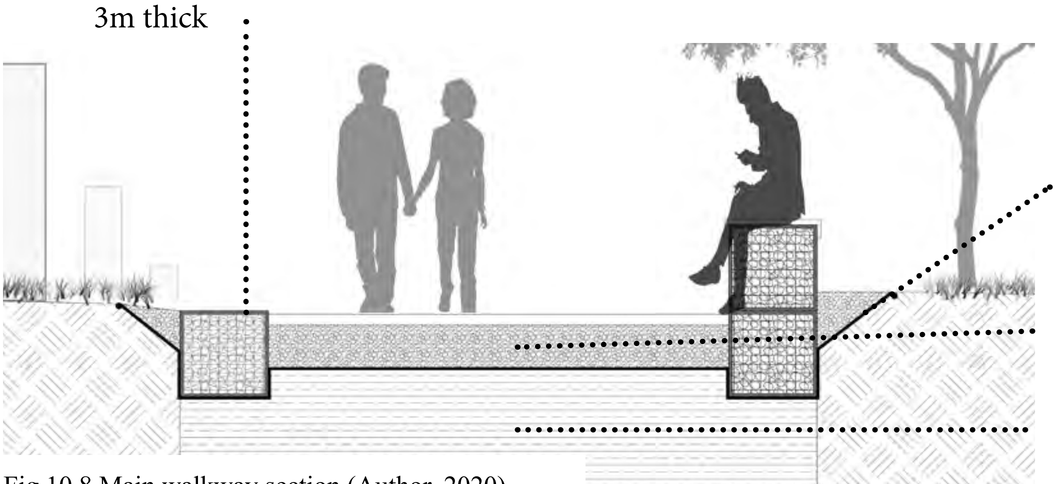


Fig 10.8 Main walkway section (Author, 2020)

10.5 Construction on a landfill site

Structures will require a geogrid soil base and in some cases, concrete pilings may be drilled into the landfill layers based on the engineer's specification.

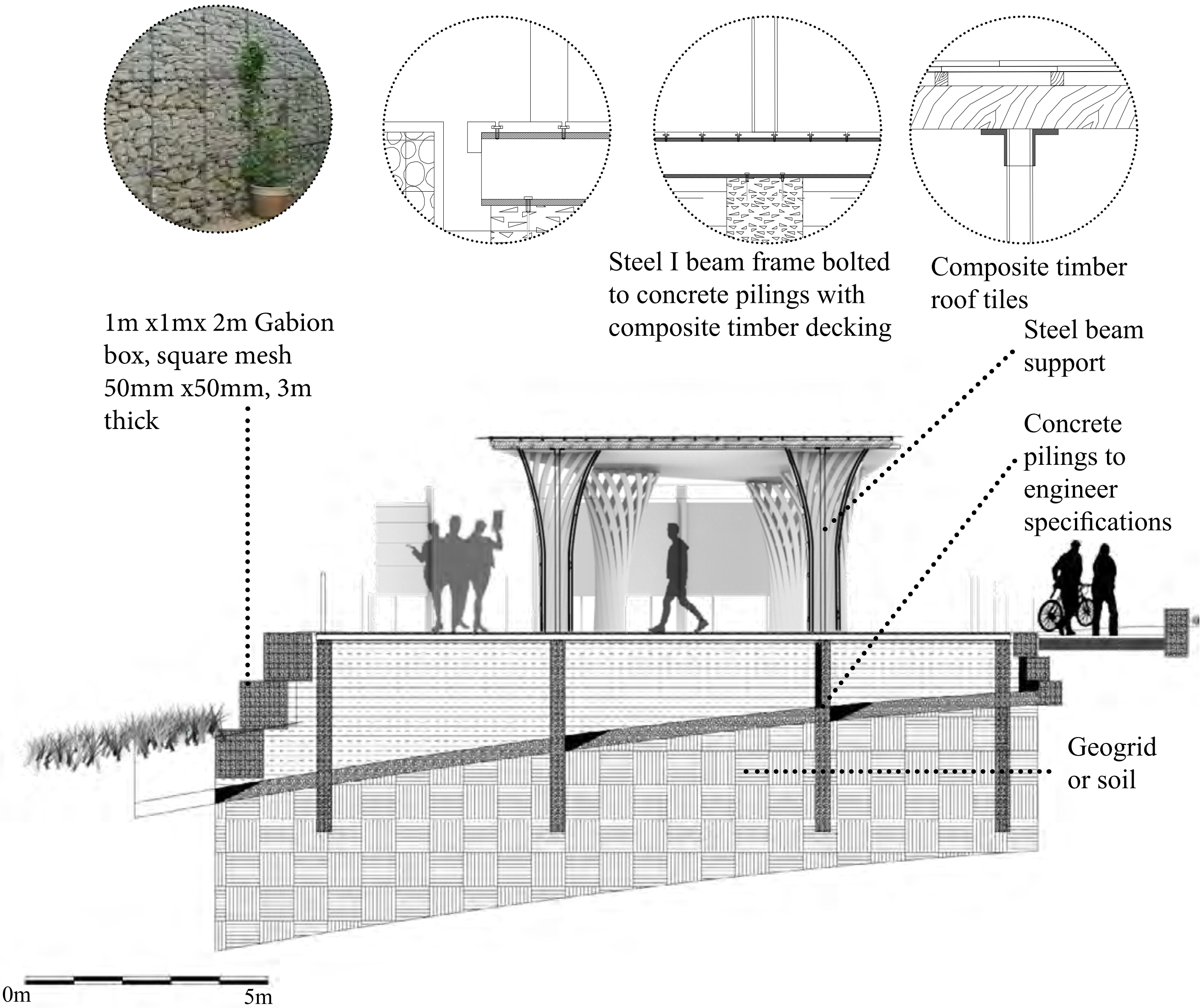


Fig 10.9 Foundations for construction on a landfill site (Author, 2020)

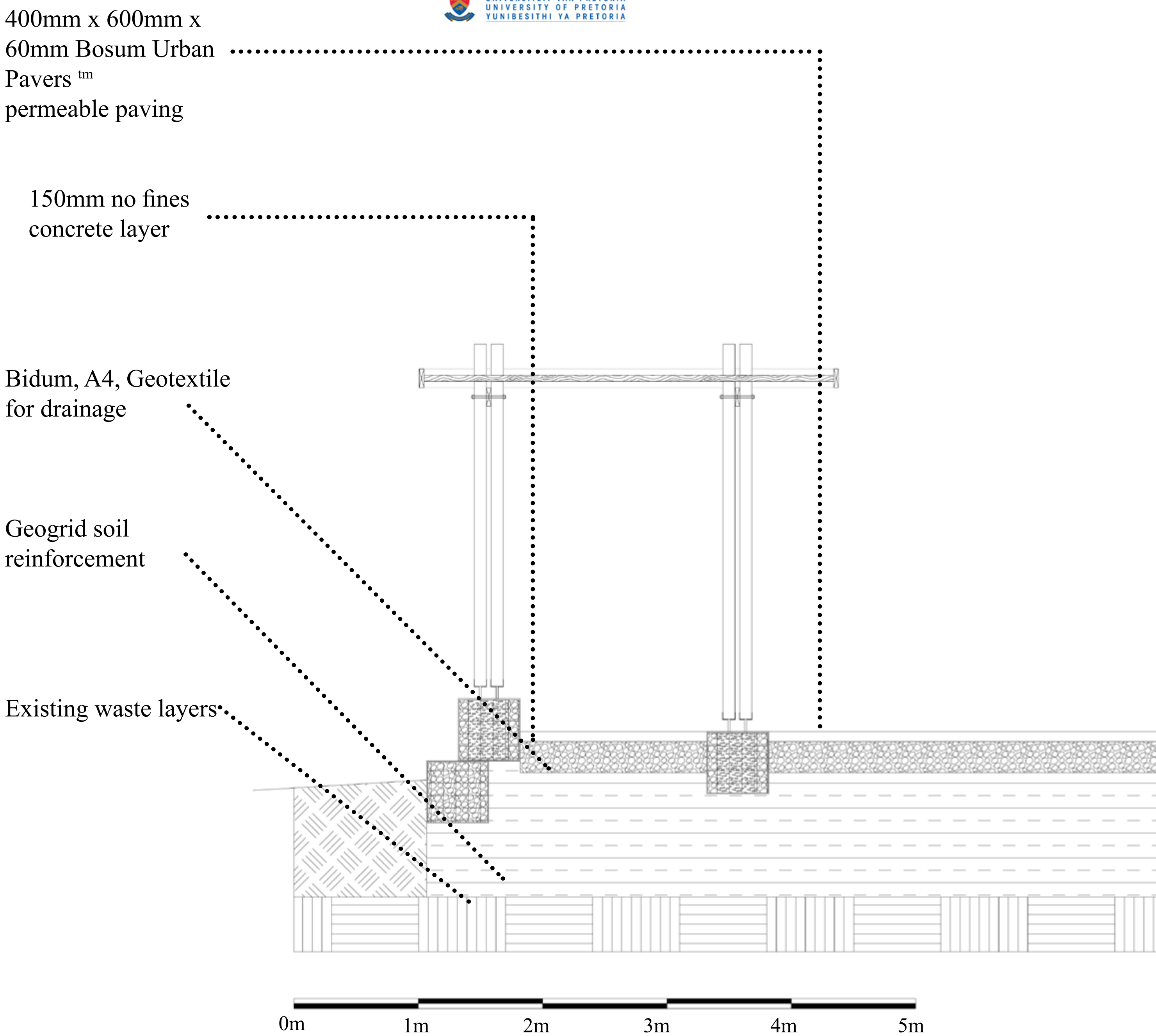
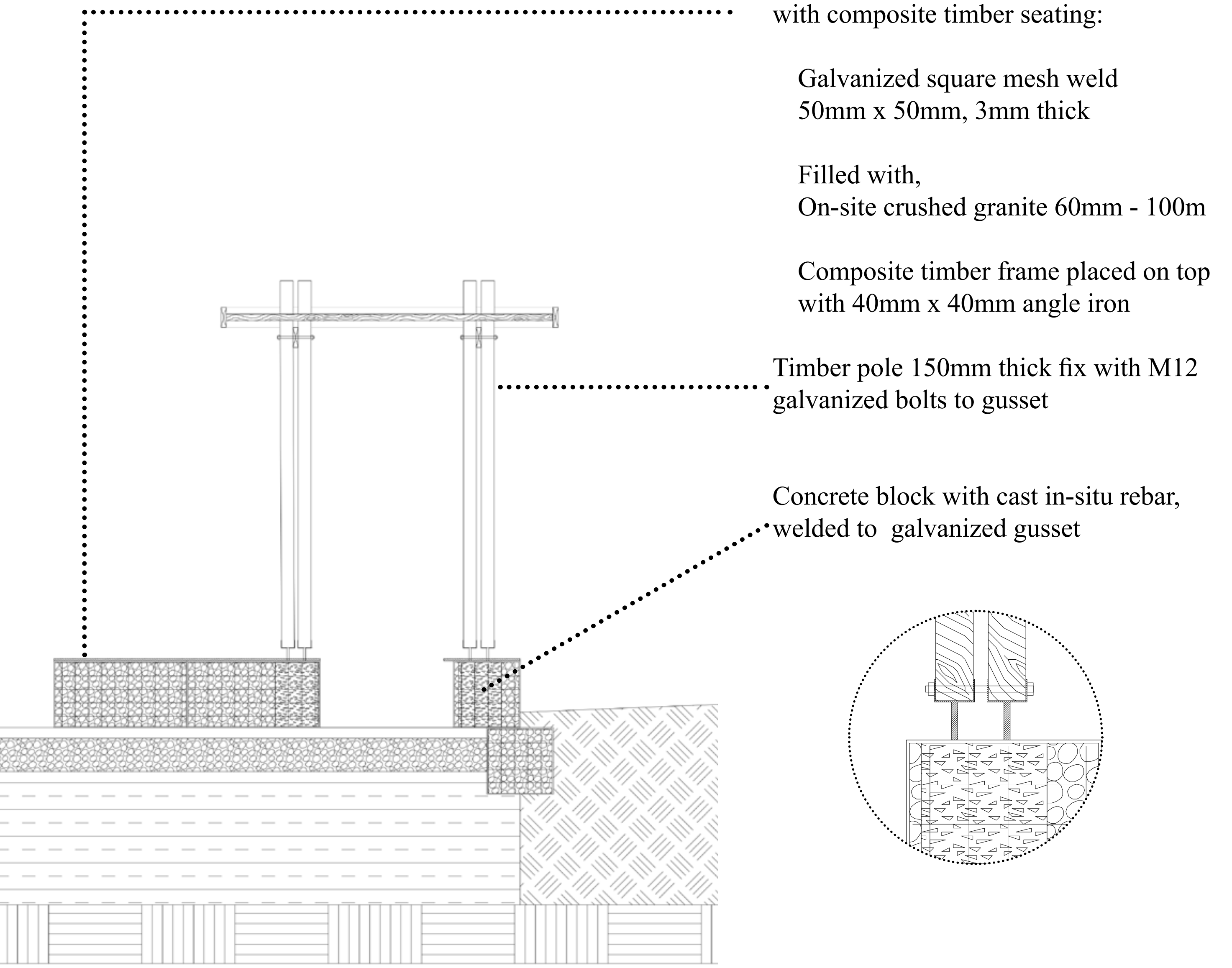
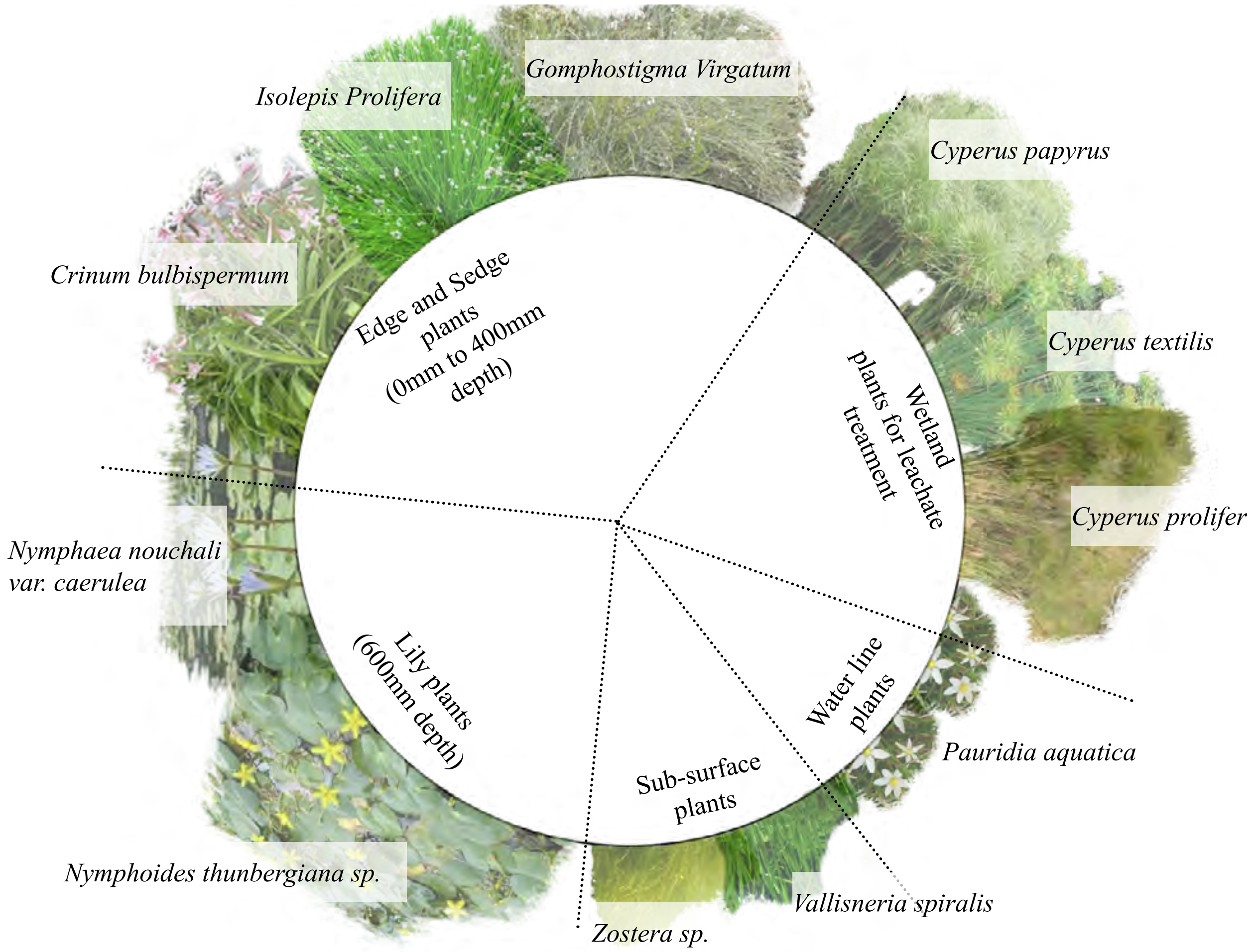


Fig 10.10 Vendor and shade structure (Author, 2020)


500mm x 500mm x1000mm, Gabion Box, with composite timber seating:
Galvanized square mesh weld 50mm x 50mm, 3mm thick
Filled with, On-site crushed granite 60mm - 100m
Composite timber frame placed on top with 40mm x 40mm angle iron
Timber pole 150mm thick fix with M12 galvanized bolts to gusset
Concrete block with cast in-situ rebar, welded to galvanized gusset

10.6 Planting list example



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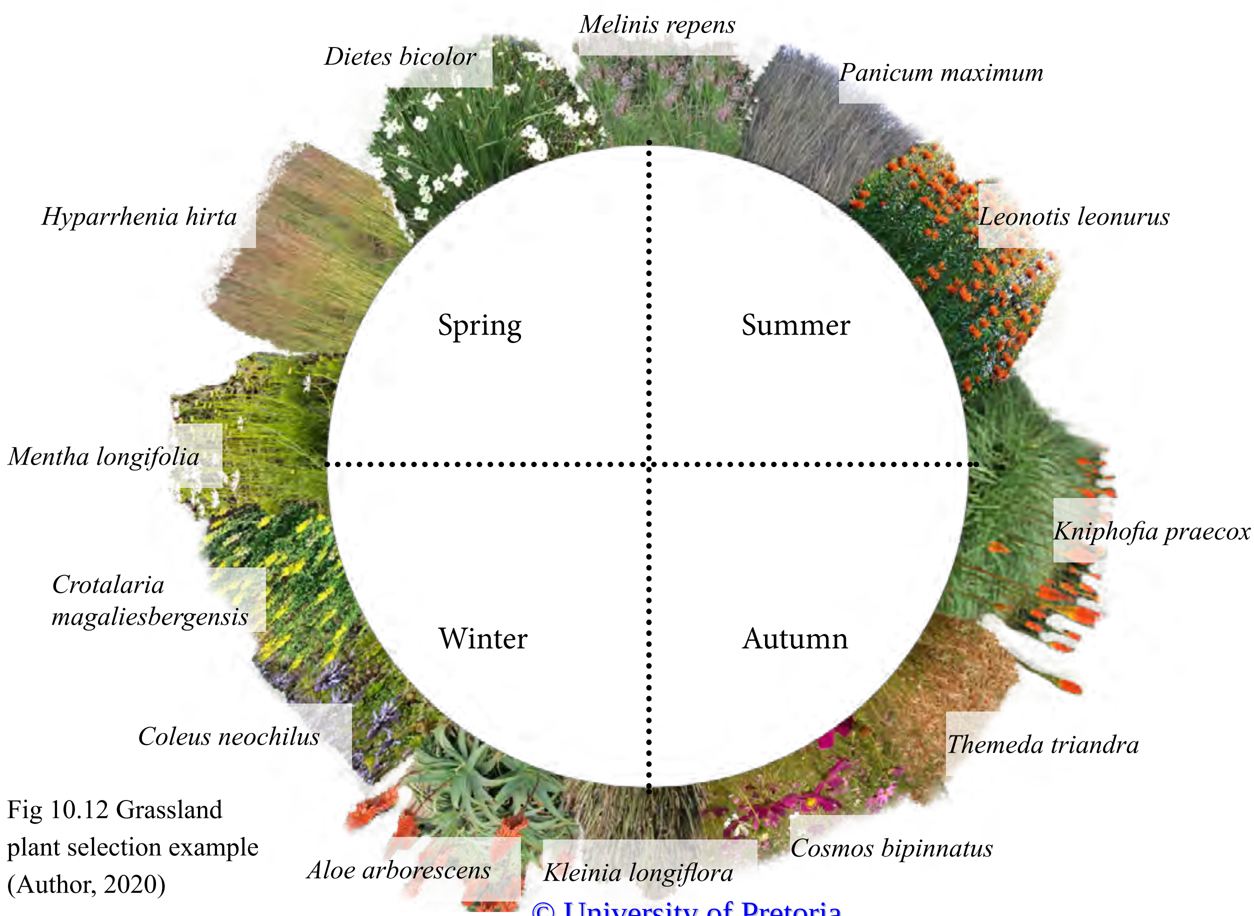

Fig 10.12 Grassland plant selection example (Author, 2020)

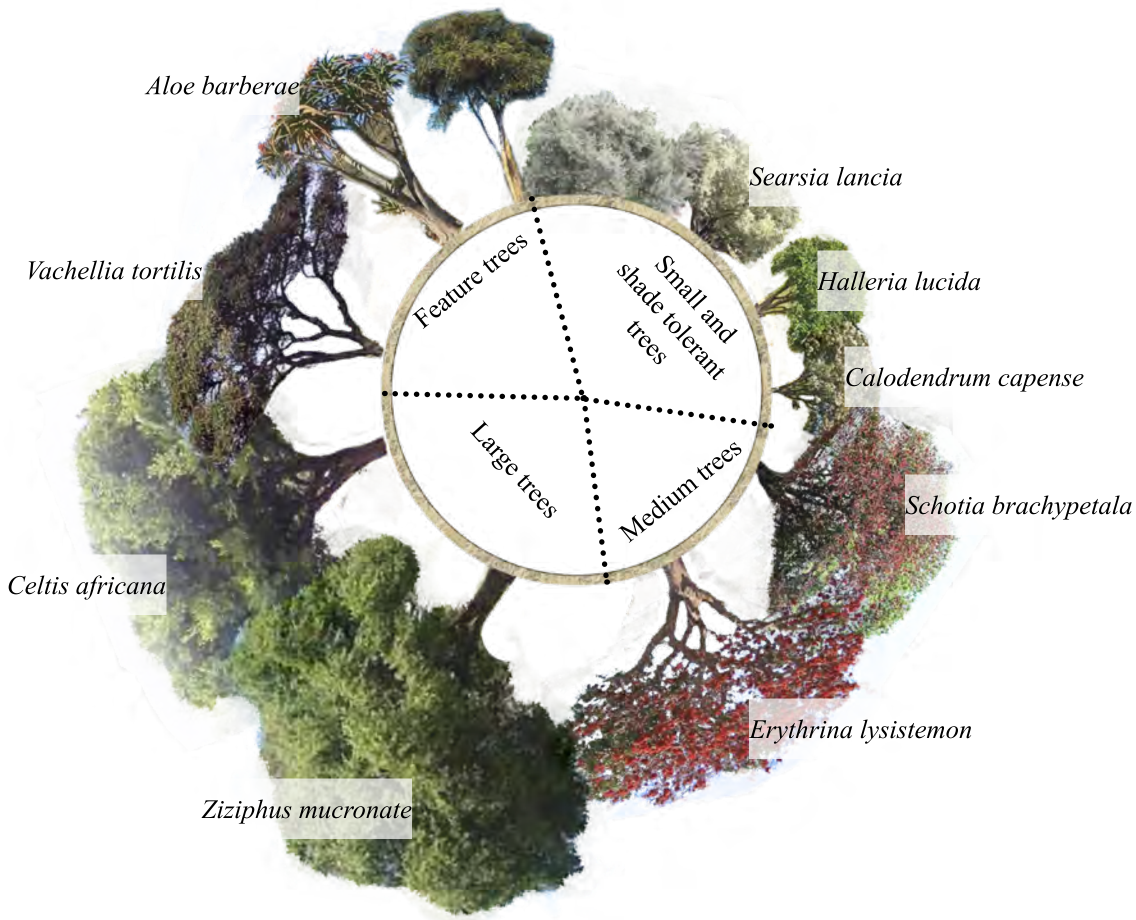

Fig 10.13 Tree selection (Author, 2020)

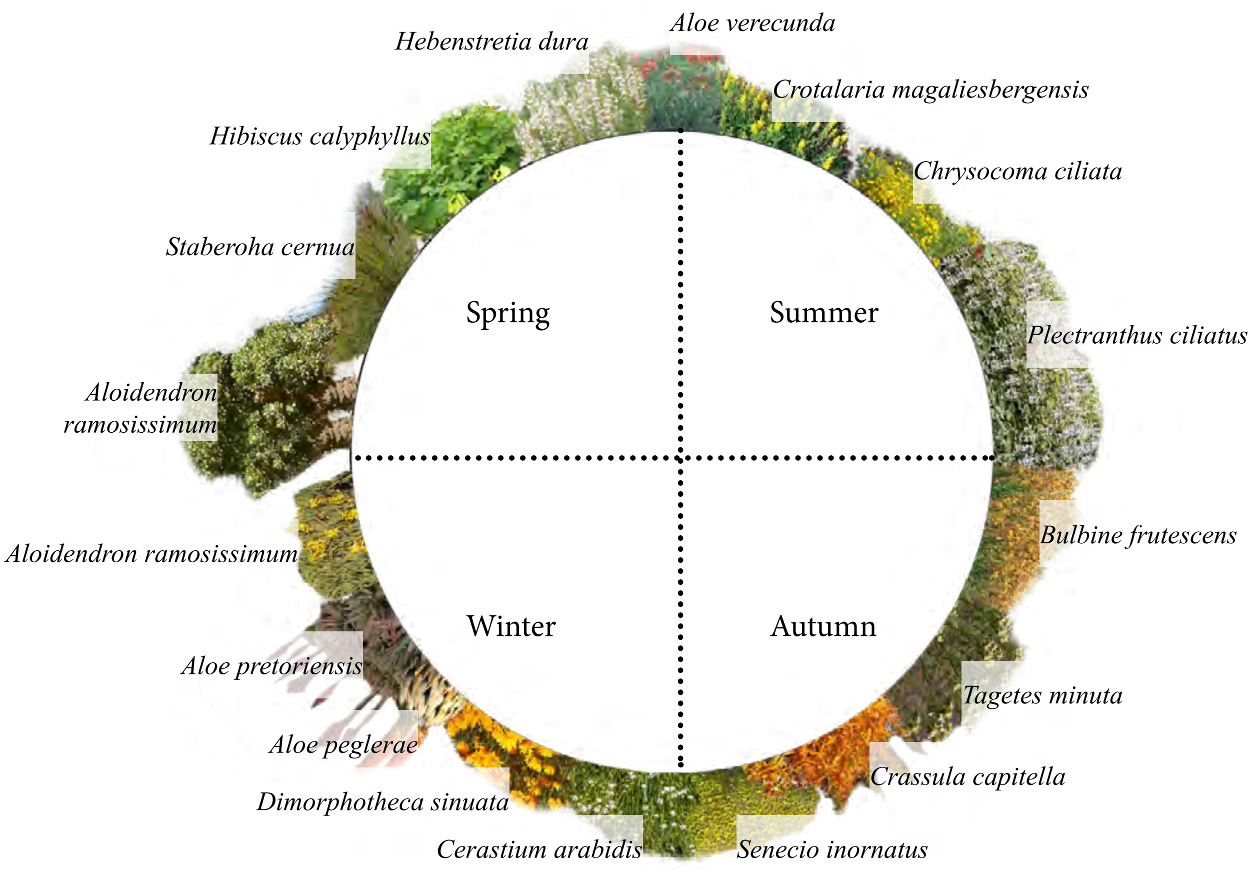

Fig 10.14 Biodiversity garden (Author, 2020)

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Chapter 11: Conclusion

The project proposes to create a regional public green space through the adaptive re-use of "waste landscapes." Through the application of landscape urbanism theory, The Linbro Park Landfill Site allows for socially justified connections for the people of Alexandra and Linbro Park to green spaces. This enables Alexandra to become part of Linbro Park's development framework and enables the potential for investment.

As James Corner stated, "t*he success of a landscape project should be based on its performance*." The application of phytocapping allows the landfill site to be repurposed for use as a recreational park that will provide an experience of the regional grasslands through education and sensory means. The education aspect of the grasslands will portrays their importance and its vulnerability to the conditions of urbanisation.

Furthermore, the phytocapping layers play an ecological service role in terms of reducing water infiltration and reducing the risk of soil erosion and leachate formation. The application of the constructed wetland improves the operational effectiveness of leachate treatment.

South African cities still bear the scars of social segregation and continue to remain apparent even despite good intentions to remediate them. To truly create the "Future African City of 2040", the reconnection of communities through sustainable and social links can be guided through landscape urbanism. Landscape urbanism should be involved in the early stages of development and planning processes of urban remediation.

"Today we are faced with a challenge that calls for the shift in our thinking so that humanity stops threatening its life-support systems. We are called to assist the Earth, to heal her wounds and in the process heal our own - indeed to embrace the whole of creation in all its diversity, beauty and wonder. Recognising that sustainable development, democracy and peace are indivisible is an idea whose time has come".

- Wangari Maathai, Nobel Peace Prize, 2004

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Appendix

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Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en Inligtingtegnologie / Lefapha la Boetšenere, Tikologo ya Kago le Theknolotši ya Tshedimošo

Reference number: EBIT/53/2020

Ms C Karusseit
Department: Architecture
University of Pretoria
Pretoria
0083

Dear Ms C Karusseit

FACULTY COMMITTEE FOR RESEARCH ETHICS AND INTEGRITY

Your recent application to the EBIT Research Ethics Committee refers.

Conditional approval is granted.

This means that the research project entitled "Masters Professional Dissertation in Architecture, Landscape and Interior Architecture" is approved under the strict conditions indicated below. If these conditions are not met, approval is withdrawn automatically.

Conditions for approval
Approved based on the summaries provided.
Applications from each student (including application forms and all necessary supporting documents such as questionnaire/interview questions, permission letters, informed consent form, etc) will need to be checked internally by the course coordinator/ supervisor. A checklist will need to be signed off after the checking.
All of the above will need to be archived in the department and at the end of the course a flash disc / CD clearly marked with the course code and the the protocol number of this application will be required to be provided to EBIT REC administrator.
No data to be collected without first obtaining permission letters. The permission letter from the organisation(s) must be signed by an authorized person and the name of the organisation(s) cannot be disclosed without consent.

This approval does not imply that the researcher, student or lecturer is relieved of any accountability in terms of the Code of Ethics for Scholarly Activities of the University of Pretoria, or the Policy and Procedures for Responsible Research of the University of Pretoria. These documents are available on the website of the EBIT Ethics Committee.

If action is taken beyond the approved application, approval is withdrawn automatically.

According to the regulations, any relevant problem arising from the study or research methodology as well as any amendments or changes, must be brought to the attention of the EBIT Research Ethics Office.

The Committee must be notified on completion of the project.

The Committee wishes you every success with the research project.

Prof K.-Y. Chan
Chair: Faculty Committee for Research Ethics and Integrity
FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY