
WASTE NOT, PLANT, ROT

A wastewater treatment centre that produces sustainable resources in
Norwood, Johannesburg.

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

Date: 13th February 2024

Supervisor: Brigitta Stone-Johnson

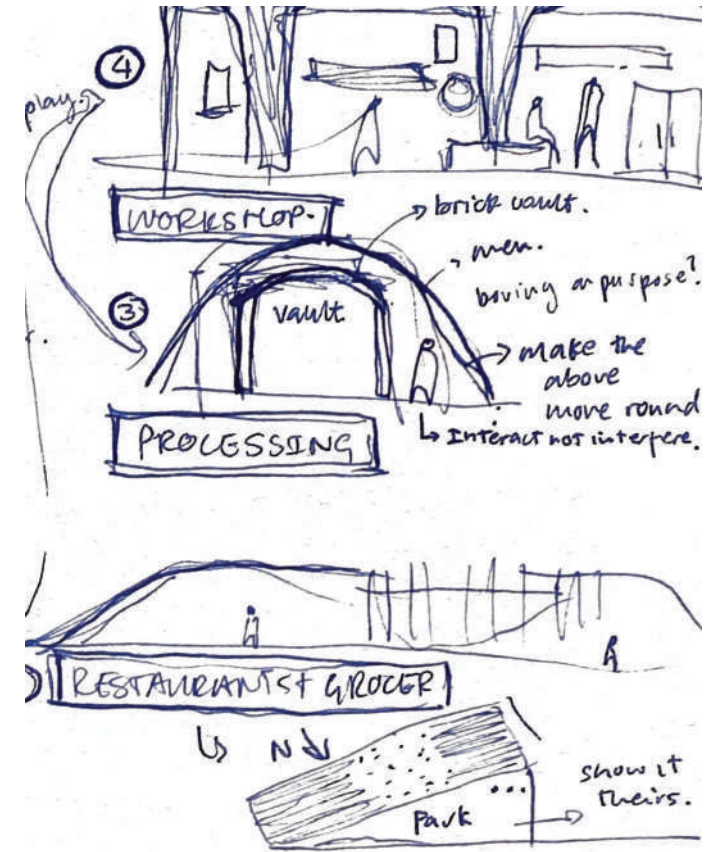
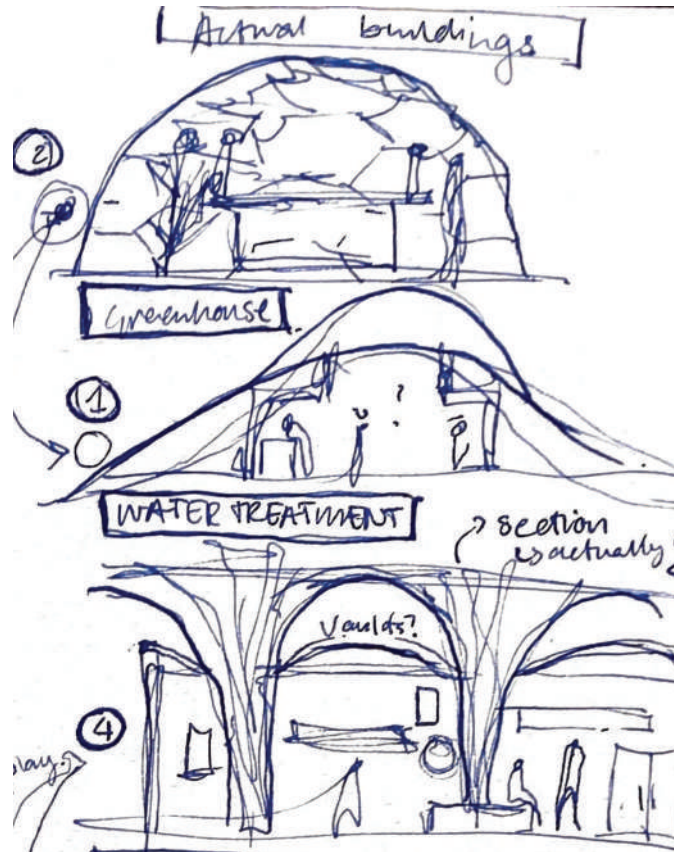
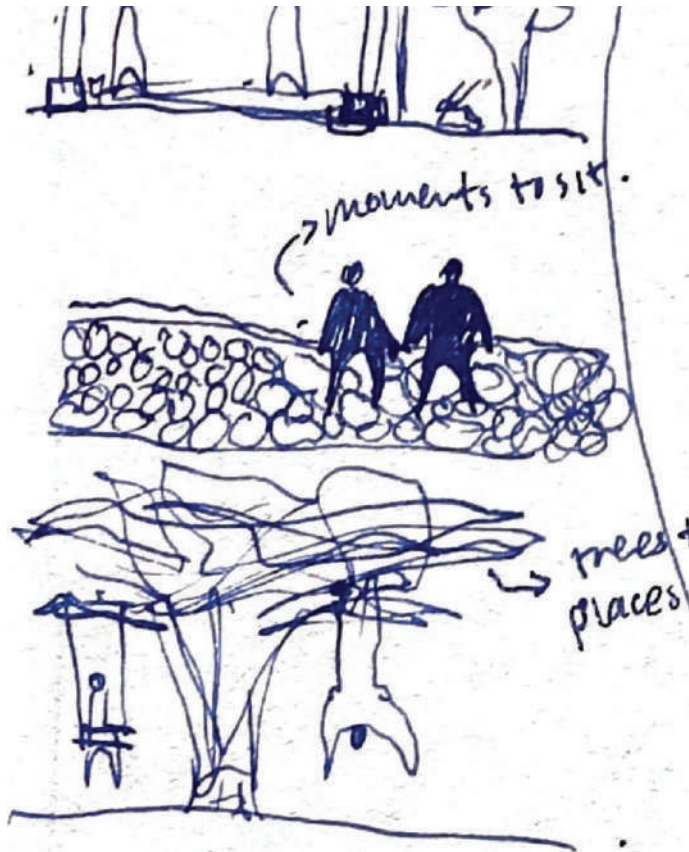
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School of Architecture & Planning

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Johannesburg, South Africa



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Robyn Alice Glanville // 1600937

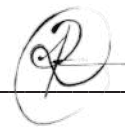
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13th February 2024

Abstract

This research investigates the delivery of essential resources - water, energy, and food around Orange Grove and Norwood, Johannesburg, where all three aspects are threatened by pollution and inaccessibility. Drawing upon permaculture and biomimicry principles, the study explores localized resource management in neighbourhood nodes to address the pressing issue of sustained inequality in South Africa. Focusing on a wastewater treatment plant and an aquaponic farm in Orange Grove, Johannesburg, the project aims to generate sustainable materials, produce, clean water, and energy while fostering spatial and social justice opportunities through community engagement and learning.

Dedication

To the village who raised me, the friends who question me and lend me books, Jo and Summer for helping me, Brigitta who guides me, Ri and Mum who make me tea with love, Merlin who provided much needed singing breaks, Eric who calms and supports me, and myself; who has so far persevered.

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Brigitta Stone-Johnson, for her incredible supervision and for being the most rational, kind, and well-read lecturer I have had the pleasure to work with. Her guidance has helped shape me as an architect, artist, and environmentalist.

Tony, the head gardener at Victoria Yards for incredible knowledge and keenness to explain.

Mark, the aquaponic specialist who I have worked with for years for the gift of opportunity and excitement for sustainability.

All drawings and photos are from the author during dates unless otherwise stated.

Table of Contents

PART 1

01	xii	1 Introduction
	4	1.1 Methodology
02	5	2 History of Orange Grove and Norwood
	11	2.1 History of Orange Grove and Norwood
03	13	3 Service Delivery
	16	3.1 Water treatment of the Sandspruit River
	18	3.1.1 Water treatment precedent: St Stithians Water Treatment Centre
	21	3.1.2 Water treatment precedent: Rand Water Zuikerbosch treatment centre
	23	3.2 Aquaponic farming
	27	3.2.1 Aquaponic Precedent Study: Ichthys Aquaponics Urban Farm
	32	3.3 Urban farming in Johannesburg
	34	3.3.1 Urban farming precedent study: Victoria Yards
	44	3.3.2 Impact and feasibility of urban farming and park
	45	3.4 Material production and phytoremediation
	51	3.5 Local labour

04	53	4 Theoretical approach
	54	4.1 Principles of park design
	58	4.2 Issues of migration
	60	4.3 Urban design principles and dialogue orientated urban transformation
	70	4.4 Framework for self-sustaining neighbourhoods and diversity
05	76	5 Architectural design drivers
	77	5.1 Biomimicry
	83	5.2 Parametric design
06	86	6 Design
	88	6.1 Site Analysis
	102	6.2 Land Use Rights
	103	6.3 Design accommodation
	105	6.4 Organogram
07	106	7 Design Development
	107	7.1 Sketch Charette and materiality
	112	7.2 Site logic and response
	115	7.3 Water Treatment Centre
	116	7.3.1 Initial design response and logic
	117	7.3.2 Sketches and exploration

118	7.3.3 Geometry
119	7.3.4 Precedent for Water Treatment Centre: Bosjes Chapel // Steyn Studio
120	7.4 Aquaponic Farm
121	7.4.1 Initial design response and logic
123	7.4.2 Geometry and Biomimicry
124	7.4.3 Precedent for Aquaponic Farm: Wooden Geodesic Dome Planetarium
126	7.4.4 Section detail of unit
127	7.5 Processing and Storage
128	7.5.1 Initial design response and logic
129	7.5.2 Sketches and exploration
131	7.5.3 Precedent for Processing and Storage: TECLA Technology and Clay 3D Printed House / Mario Cucinella Architects
132	7.6 Workshops and stores
133	7.6.1 Initial design response and logic
134	7.6.2 Sketches and exploration
135	7.6.3 Precedent for Workshops and stores: The Nine Heasley Country Club / Shigeru Ban Architects
136	7.6.4 Material and construction considerations

08

PART 2

138	7.7 Restaurants, Grocers, and Soup Kitchen
139	7.7.1 Initial design response and logic
141	7.7.2 Geometry
142	7.8 Open plan grid and entrance
143	7.8.1 Initial design response and logic
146	7.9 Park design features
148	8 Conclusion
150	PART 2
165	References

List of figures

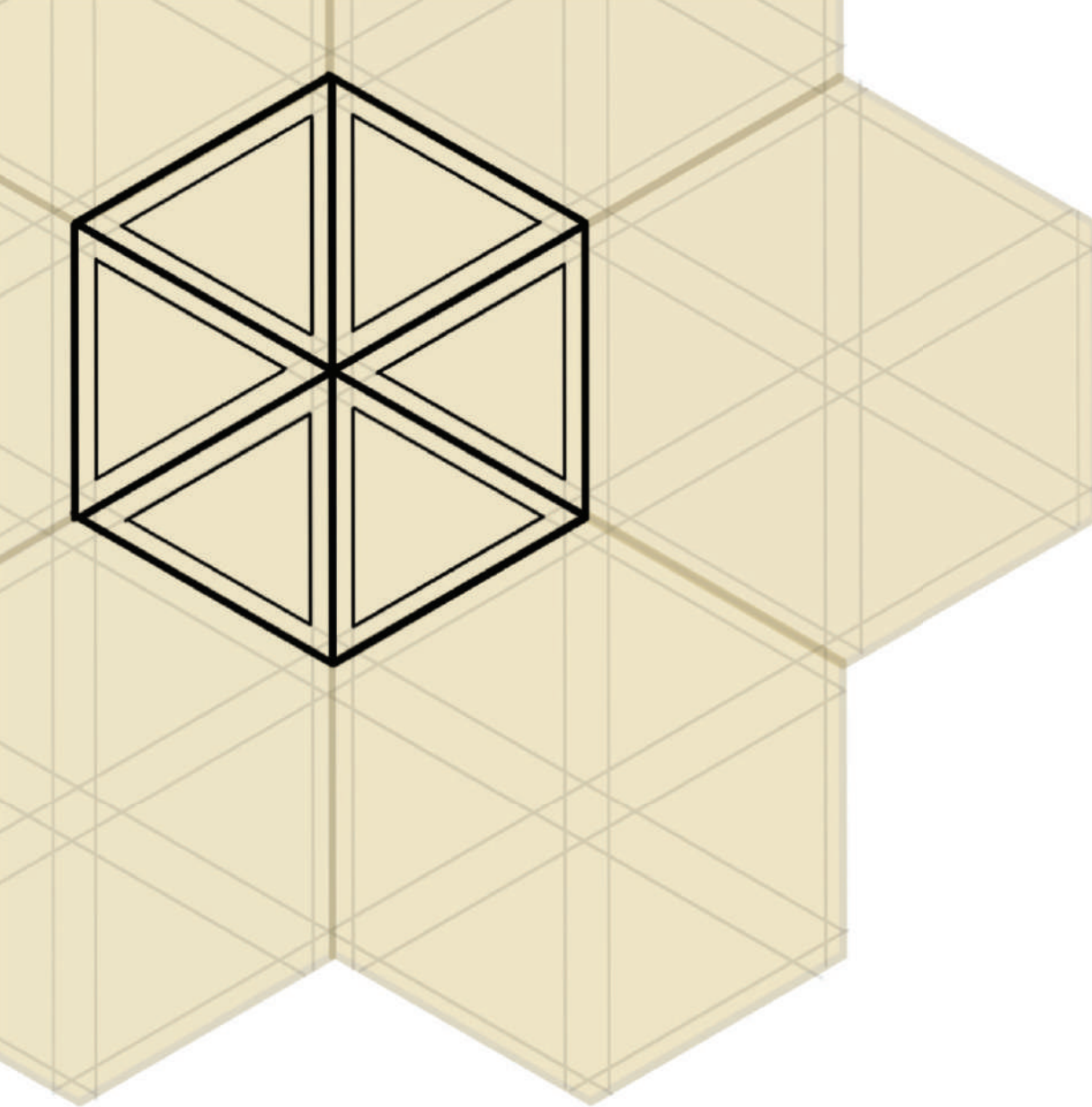
List of Figures

7	Figure 1 - Timeline of Johannesburg
9	Figure 2 - Timeline of Norwood and Orange Grove
12	Figure 3 - Map showing Income brackets according to density and plot size and access routes to site
17	Figure 3a - Water system layout in Johannesburg
18	Figure 4 - St Stithians Water Treatment Centre – 07/05/2023
20	Figure 5 - St Stithians Water storage – 07/05/2023
22	Figure 6 - Zuikerbosrand water treatment centre
24	Figure 7 - Grant Avenue at night
25	Figure 8 - Mapping of businesses and cuisines that would benefit from the proposed programme
26	Figure 9 - Yields and ROI of produce within the Aquaponic farm
27	Figure 10: Photo from inside Aquaponic Greenhouse at Ichthys Midrand
28	Figure 11: Aquaponic Vertical Towers
30	Figure 12: Media bed and bell siphon system
30	Figure 13: Bell Siphon and Media bed system
31	Figure 14 - Aquaponics diagram
32	Figure 15 - Winter Vegetable box from Victoria Yards
33	Figure 16 - Internal shot of Urban farming at Victoria Yards
34	Figure 17 - Internal shot of main farming area at Victoria Yards
35	Figure 18 - Internal shot of pathway at Victoria Yards
36	Figure 19 - Victoria Yards Programme analysis
37	Figure 20 - Victoria Yards Weekend usage of space
38	Figure 21 - Victoria Yards Visual Accessibility from the Road
39	Figure 22 - Design elements from Victoria Yards
40	Figure 23 - Aesthetics, materiality, and clerestories in Victoria Yards
40	Figure 24 - Clerestories in Victoria Yards Art Gallery

47	Figure 25 - Viability of growing construction materials on site
48	Figure 26 - Internal view of the sports hall
49	Figure 27 - Bamboo as a construction material
50	Figure 28 - Structure and material elements
56	Figure 29 - Intricacy and Centering
56	Figure 30 - Enclosure and sun
69	Figure 31 - Project thesis link to SDGs
77	Figure 32 - Gooseberry study
79	Figure 33 - Gooseberry study - form follows function
81	Figure 34 - Gooseberry study - life cycle
83	Figure 35 - Render of Ting Xi Bamboo Restaurant
83	Figure 36 - Construction of Ting Xi Bamboo Restaurant
84	Figure 37 - Load diagram of Ting Xi Bamboo Restaurant
84	Figure 38 - Elevation of Ting Xi Bamboo Restaurant
84	Figure 39 - Section through Ting Xi Bamboo Restaurant
85	Figure 40 - Ground floorplan of Ting Xi Bamboo Restaurant
88	Figure 41 - Project Location in Country
89	Figure 42 - Location of the Project at multiple scales
90	Figure 43 - Green structures, green links of the area, and accessibility of green spaces
91	Figure 44 - Arterial Roads, and Transport Nodes of the area
92	Figure 45 - Transport Nodes of the area
93	Figure 46 - Zoning map
94	Figure 47 - Trees and Wind direction
95	Figure 48 - View from Ninth Street and colour palette of Norwood Police Department
96	Figure 49 - View from Ninth Street and colour palette of Paterson Park Multi-Purpose Centre
97	Figure 50 - Public Amenities and Community Centre at Paterson Park

100	Figure 51 - View from Ninth Street and colour palette of example residential area
101	Figure 52 - Mapping of issues around the site
102	Figure 53 - Land Use Rights
107	Figure 54 - Catenary and light explorations
108	Figure 55 - Quartz Exploration
109	Figure 56 - Dry moss exploration in acetate box
110	Figure 57 - Process work of attempting eco-friendly biodegradable plastic with coconut husk
111	Figure 58 - Building material palette from explorations
112	Figure 59 - Site logic and reasoning
113	Figure 60 - Current Site Plan for Design
114	Figure 61 - Logic of the programme
116	Figure 62 - Initial design of Water Treatment Centre
117	Figure 63 - Sketches for Water Treatment Centre
118	Figure 64 - Geometry of Water Treatment Centre
119	Figure 65 - Photograph of Bosjes Chapel
119	Figure 66 - Sections of Bosjes Chapel
121	Figure 67 - Current design of Aquaponic greenhouse
122	Figure 68 - Sketches of Aquaponic greenhouse
123	Figure 69 - Geometry of Aquaponic Farm
124	Figure 70 - Detail of Geodesic dome
124	Figure 71 - Photograph of Geodesic dome
124	Figure 72 - Elevation of Geodesic dome
125	Figure 73 - Detail elevation of Geodesic Unit
125	Figure 74 - Sketches of Geodesic Unit
126	Figure 75 - Detail section of Geodesic Unit
128	Figure 76 - Initial design of Processing and Storage Centre

128	Figure 77 - Application design of online store
129	Figure 78 - Sketches for Processing and Storage
130	Figure 79 - Exploration of materials and ideas for Processing and Storage
131	Figure 80 - External Photograph of TECLA 3D Printed Prototype
131	Figure 81 - Chosen exploration for Processing and Storage Centre
131	Figure 82 - Internal Photograph of TECLA 3D Printed Prototype
133	Figure 83 - Initial design of Workshops
134	Figure 84 - Sketches and models of Workshops
135	Figure 85 - Logic of Kagome pattern
136	Figure 86 - Construction options for Workshop design
137	Figure 87 - Programmed Kagome Pattern on Rhino
139	Figure 88 - Initial sketches of Entrance and Restaurants
140	Figure 89 - Initial design of Restaurants and Grocers
141	Figure 90 - Geometry of the Entrance building
143	Figure 91 - Initial design of Bamboo grid
144	Figure 92 - Bamboo Grid on site
145	Figure 93 - Bamboo Grid on site
146	Figure 94 - Unpaved pathway
146	Figure 95 - Paved pathway
147	Figure 96 - Seats designed into planter
147	Figure 97 - Natural seating



Part 1

1. Introduction

2. History of Orange Grove
and Norwood

3. Service Delivery

4. Theoretical Approach

5. Architectural Design
Drivers

6. Design - Site Analysis

7. Design Development and
precedents

8. Conclusion

Part 2

Final Design

References

01

Introduction

Main Question:

How can closed wastewater systems be used in architecture to promote a more holistic, regenerative approach to design and construction?

Aim:

The aim of this research is to pioneer a holistic approach to addressing the critical challenges of service delivery, encompassing water, energy, and food. These services face severe threats due to pollution and limited access to essential resources. By leveraging the principles of permaculture and biomimicry, this study aims to revolutionize resource management at the neighbourhood level,

presenting a potential solution to the persistent inequality issues plaguing South Africa. Specifically, through the development of a wastewater treatment plant and an aquaponic farm in Orange Grove, Johannesburg, the project seeks to establish a sustainable ecosystem capable of generating vital materials, clean water, and energy. Simultaneously, it strives to foster spatial and social justice by actively involving the community and promoting learning opportunities. Ultimately, the research aspires to transform the local landscape into a model of sustainability, resilience, and equity, paving the way for a brighter and more inclusive future.

Sammy, the car guard at the Hokkaido restaurant on Grant Avenue, sits on a blue plastic bottle crate next to the bustling street, looking over the ludicrous SUVs and other oases of warmth. The glacial wind beats his face; warm breath is forced out of his chest on his hands with a vigorous rub to counteract the burning sting of a Johannesburg winter. The pits of his stomach aching with hunger, he awaits a contribution from the unlikely consumers of the street. He has not eaten in two days; his last meal consisted entirely of pap – he still smiles and greets everyone with kindness and gentleness.

We have failed Sammy as a society, we have failed every person on the street who dies due to starvation and cold, we have failed to support local businesses, we have failed to produce clean, renewable energy, we have failed to look at people as individuals instead of a number. Service delivery of water, food, and electricity is a pressing issue throughout the world that affects all people. The unsustainable resources and service delivery channels are becoming increasingly strained under the pressure of overpopulation. As with most issues, those affected live in the already strenuous conditions of poverty – the exact people that governments should be helping to protect.

This research focuses on the service delivery of water, energy, and food in and around the Sandspruit River in Norwood, Johannesburg. All three aspects are in danger of becoming polluted, inaccessible, or under threat due to global warming (Palmer et al., 2017, p. 4). The research considers a permaculture-based set of rules on how to localise resources in neighbourhood nodes. This research is relevant in South Africa as there is a significant population who do not have access to basic resources such as clean water and affordable food; this sustained inequality in South Africa can be noted by the Gini coefficient of 63 (“Gini Index,” 2021; Palmer et al., 2017, p. 7). The project intends to create spatial and social justice opportunities through service delivery.

The project centres around a wastewater treatment plant that cleans the polluted water of the Sandspruit River in Orange Grove, Johannesburg, to use within an aquaponic farm that yields sustainable materials, produce, and energy. Architecture, especially in South Africa, is inherently political. While architecture cannot solve social justice issues, this project proposes to assist spatial and social justice through programme development and community participation (Awan et al., 2011, p. 44). Architecture can address the above issues by creating the environment to host the processes that can help people while creating spaces geared towards community participation and support.

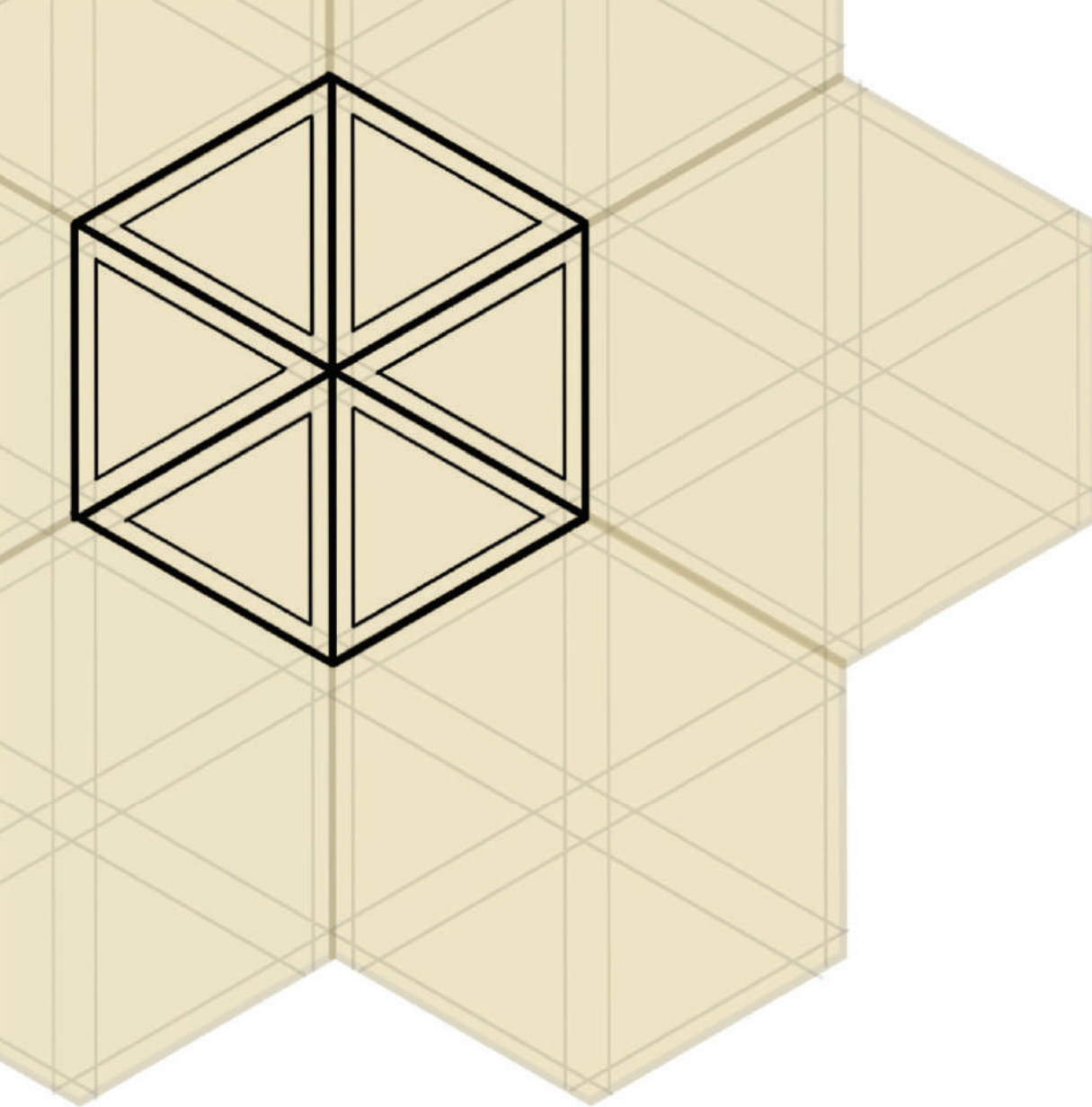
“Philosophers have only interpreted the world in various ways; the point is, to change it” Marx Epitaph (Awan et al., 2011, p. 63).

The following chapters will look at an overall understanding of the project area, including the history of the site of Paterson Park on the border of Orange Grove and Norwood in Johannesburg and the social justice issues around the area/project. Secondly, the specifics of the technologies used in the programme, such as water treatment centres and aquaponic farming. Thirdly, the theory behind service delivery in the area and how it can be a tool for spatial justice, theory regarding park design and urban ecology, and sustainable goal development. From there, the thesis will look at precedent studies to support the programme, strategies for the site and programme according to theory, a feasibility study of the programme, site and urban analysis of the area, the theoretical framework used for research and design development, the design of the project, and finally conclusions of the thesis. The feasibility of the project will be interlinked with relevant chapters.

1.1 Methodology

“Creative research through design is a combination of inductive reasoning, interpretation and imagination linked to various themes, constraints (such as technological considerations, building site, client, and user groups) and precedents (urban and architectural). The creative research process in terms of discourse and design alike, takes on an iterative (inductive-deductive), nonlinear, cumulative, cyclical, and open-ended exploration to achieve its creative outcomes. The research combines qualitative and quantitative approaches to knowledge and argumentation, whilst the creative component translates the same into a defensible architectural proposition.” (“Course Outline: ARPL7003A - Architectural Design and Discourse-2023-FYR,” 2023).

The information used throughout this thesis will be collected through desktop study, site visits for contextual observations with photography in public use areas, drawings and note-taking. Expert information and opinion will be collected through semi-structured interviews. The interviewees include an aquaponic specialist, an urban planning specialist, a representative of the water treatment centre at St Stithians, representatives of Paterson Park, and finally representatives of the Norwood Oaklands Residents Association. The questions for the experts will be used in a semi-structured interview that hopefully will result in information about the site, functional programme, users, and urban landscape.



Part 1

1. Introduction

**2. History of Orange Grove
and Norwood**

3. Service Delivery

4. Theoretical Approach

5. Architectural Design
Drivers

6. Design - Site Analysis

7. Design Development and
precedents

8. Conclusion

Part 2

Final Design

References

02

History of Orange Grove and Norwood

The timelines below (see Figures 1 and 2) show a simplified history of Johannesburg, Norwood, Orange Grove, and Louis Botha Avenue. The timeline is limited to the relevant information for the project and should not be seen as a complete history. The information used for the timeline comes from sources that were collected around the area during the 1950s, 1960s, and 1970s when people of colour were required a special pass to enter the area under Apartheid laws – to show how the area became more integrated and diverse over time, the laws and events that limited people into this space have been noted in the timeline. The yellow dotted lines show the increase in the area's population, while the green lines show the freedom for people of colour to live and participate economically.

Figure 2 focuses on the specific site and explores how the Sandspruit River in Orange Grove was originally used as a water source for surrounding farms, and later as a public swimming pool. The positioning, link to farming and public use of the Sandspruit River in Orange Grove reveals the ideal site at Paterson Park which has direct access to the Sandspruit eye (Burgess, 2016, pp. 5–9). Paterson Park had previously been home to its own public swimming pool and a range of public amenities (Burgess, 2016, pp. 5–9). The previous history of this site is directly linked to what is proposed in the following chapters.

Figure 1 - Timeline of Johannesburg

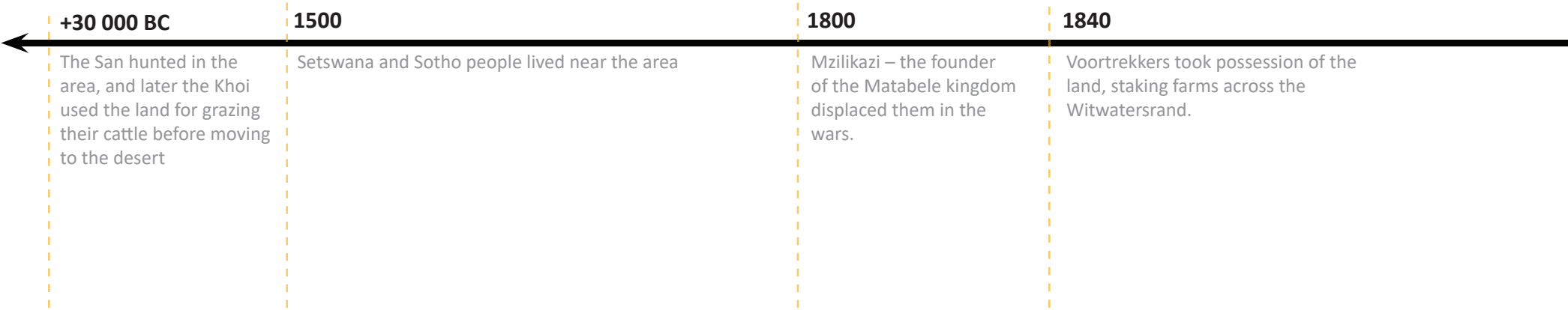


Khoi-San people

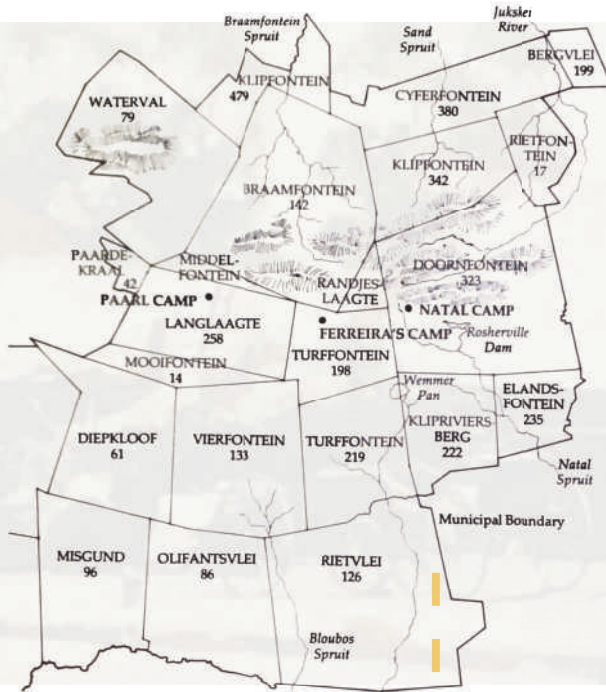
The Khoi-San – among the first to walk the road



The Voortrekkers arrived in the 1840s



Sources:
Information (Burgess, 2016, pp. 5–9)
Image of Randtjslaagte triangle, Khoi-San, Voortrekkers, mining equipment, and old Johannesburg (Burgess, 2016, pp. 6,7)
Image of original farm boundaries (Johannesburg 100 years, 1986, p. 2)
Background Images: Ferreiras' Camp 1887, Original corrugated iron buildings. (Burgess, 2016, p. 7)



1881

Jan Gerritse Bantjes and Stephanus Minaar discover a significant amount of gold on the Kromdraai farm.

1884

A second good yield was found on farm Vogelstruisfontein by Bantjes

1886

George Harrison declared the gold-rich vein at Pretoria offices – securing the digger's rights for a month. The undesirable triangle of Randjeslaagte was unclaimed government property. The northern tip lies just off Louis Botha. The government auctioned off 980 tiny stands in the triangle and named it Johannesburg.



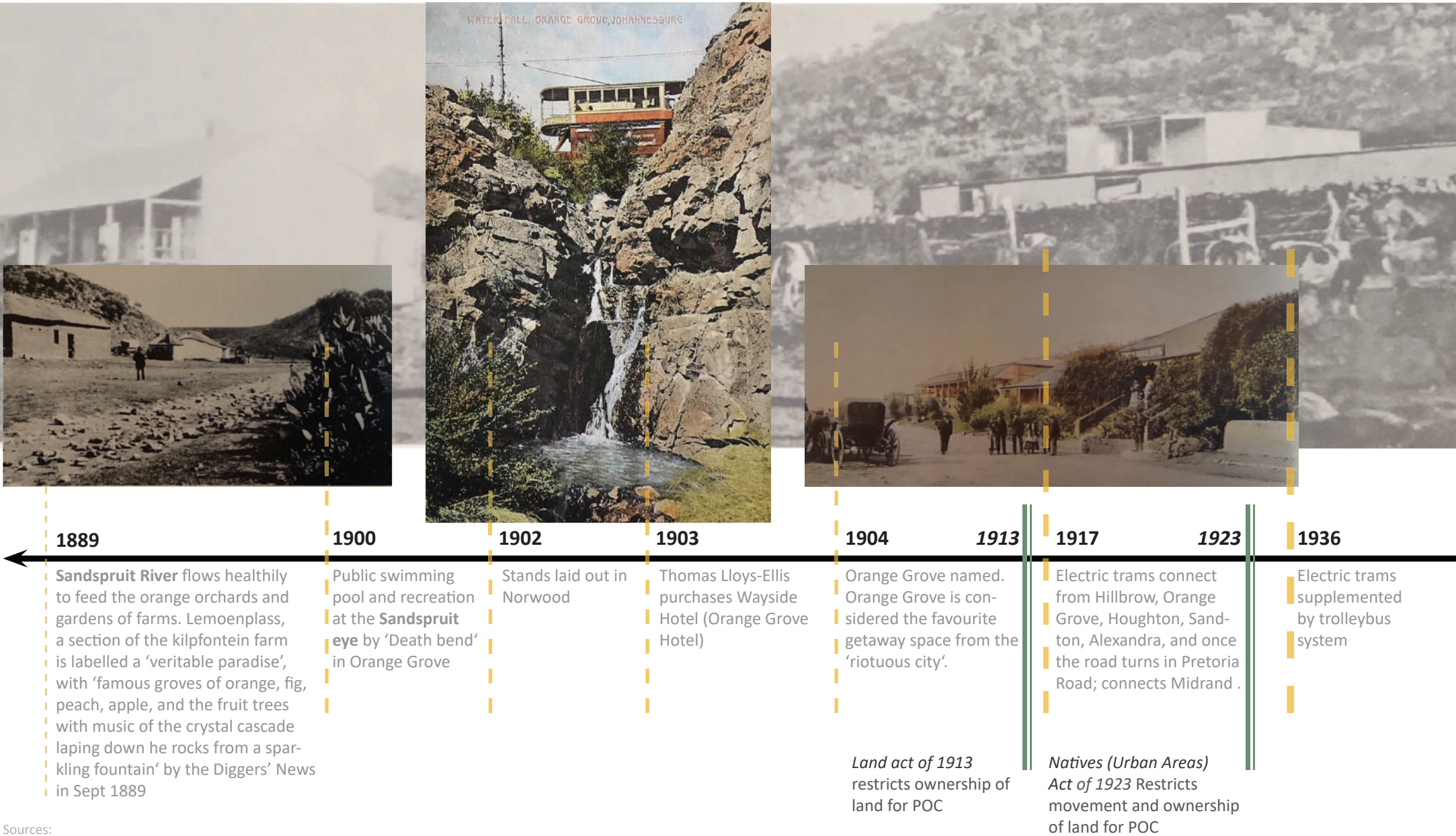
1896

Johannesburg is the largest town in South Africa, overcoming Cape Town which was 200 years old.

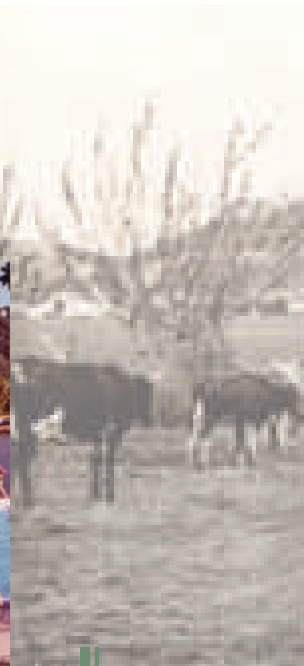


By the early 1900s, Johannesburg was the largest city in South Africa

Figure 2 - Timeline of Norwood and Orange Grove



Sources:
Information (Burgess, 2016, pp. 26 - 38)
Image of Viljoens farmstead, The Orange Grove Hotel 1906, The orange grove hotel (Burgess, 2016, pp 26, 38, 26)
Image of Orange Grove Waterfall Postcard (Sandspruit eye) (The Heritage Portal, n.d.)
Image of Public Swimming pool at Paterson Park (Love Norwood, 1970)



1939

Highlands North suburb develops around school established in 1939.

1947

King George, Queen Elizabeth, Princess Elizabeth, and Princess Margaret visit and travel down Louis Botha

1950

Group Areas Act of 1950 enforces racial segregation and determines where races can live

1955

1961

Tramway is closed

Freedom Charter

ANC and allies create the freedom charter demanding equal rights for all people. Act to redesign society entirely. The government does not abide, and the segregation intensifies.

1960s

Paterson Park with tennis courts, lawn-bowls club, sports fields, and a public swimming pool is a thriving space

1970s

Paterson Park is revamped.

1976

1976: Soweto Uprising
Protest against Afrikaans as the medium of instruction in POC schools, leads to widespread demonstrations and violence

1990s

Paterson Park is privatized and fails.

End of Apartheid
Nelson Mandela is elected president with the ANC. Dismantling laws of apartheid opens neighbourhoods to all people

1994

2018

Community Centre at Paterson Park is redesigned and includes fields, swimming pool, courts, indoor gym and courts, public library and arts centre.

2.1 History of Orange Grove and Norwood

Income areas, politics, current existing amenities for communities, the Sandspruit River and pollution.

As seen in the above timeline, the Sandspruit River in 1889 was thriving, “The spruit was crystal clear and the water so pure it was almost sweet” (Burgess, 2016, p. 1). The river was used as a water source for the orange orchards and gardens on the farms in Orange Grove. The land was abundant with ‘famous groves of orange, fig, peach, apple, and the fruit trees with music of the crystal cascade lapping down the rocks from a sparkling fountain’ (Diggers’ News in September 1889) (Burgess, 2016, p. 26). The waterfall was used as a public swimming pool for people in the area or traveling on Pretoria Main Road to spend time in Orange Grove or town (Burgess, 2016, p. 29). After this point, the area further develops, and the river becomes subterranean and channelised so plots can be sold off and developed (Burgess, 2016, p. 28).

The Sandspruit River has become increasingly polluted, with ‘gargantuan amounts of sewerage’ found in the water source (Bega, 2023). This pollution, coupled with the poor stormwater design of Ninth Street next to Paterson Park (where the water meets the surface again), has created a potentially dangerous scenario that may result in

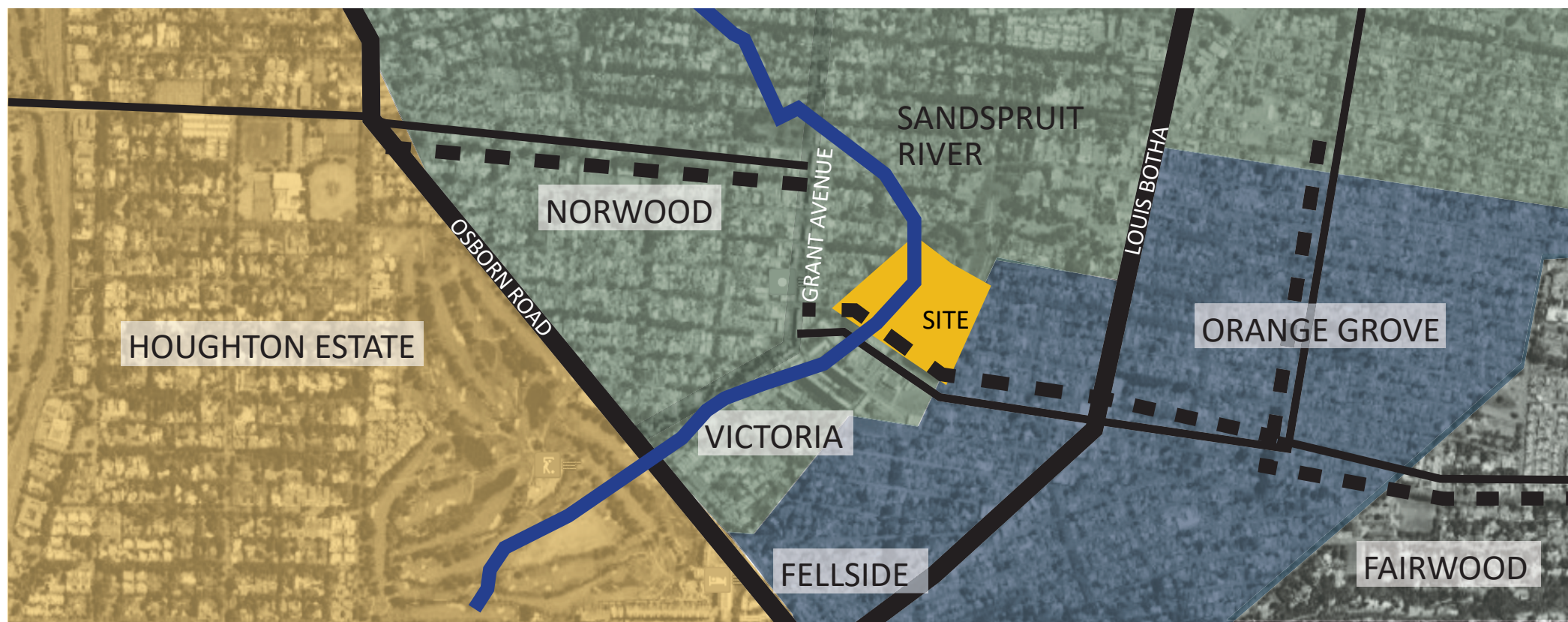
the local users becoming ill, plants becoming rife with bacteria, and removes the ability of users to grow their food. From discussions with locals, some plots have collapsed due to the river and damaged sewer pipes running underneath. Given the area’s significant agricultural history, there is a poetic resonance in reclaiming inaccessible public land and using it for urban farming. The intention is to breathe new life into the Sandspruit River and reintroduce agriculture in a technologically advanced way that is accessible to all. This initiative aims to support individuals adversely affected by an unjust and discriminatory society, fostering a more equitable future.

The general area of the site includes Paterson Park, Orange Grove, and Norwood in South Africa, which is home to a growing diverse community. It was not designed to cater to this size population and has been in a transitory state since its inception. Apartheid gave rise to a system that debilitated specific communities and ensured a series of poverty cycles that are usually inescapable. The proposed project site on the precipice of Norwood and Orange Grove, Johannesburg, is positioned next to disadvantaged

communities and financially thriving communities such as Houghton, Orchards, and Oaklands (South African Research Chair in Spatial Analysis and City Planning, 2017, p. 5).

Figure 3 shows how the income brackets are situated around the site. The usefulness of this map is to show how the site sits on the precipice of income brackets and can use the financial resources of the wealthier to support the development that will assist both the wealthy and the impoverished.

From the thriving Sandspruit River that had public use and agricultural value to an area that no longer has its basic services maintained, the proposed area of Orange grove is in dire need of intervention with regards to public use spaces, access to clean water, and food production. The following chapter looks at the current state of service delivery in the area, what could be an improvement in this space, and interrogates precedents and existing designs of the proposed program.



Income brackets according to density and plot size

	High income bracket
	Medium to high income bracket
	Low to medium income bracket

Routes to access site

	Main Arterial route
	Access via vehicle
	Pedestrian access
	Sandspuit River

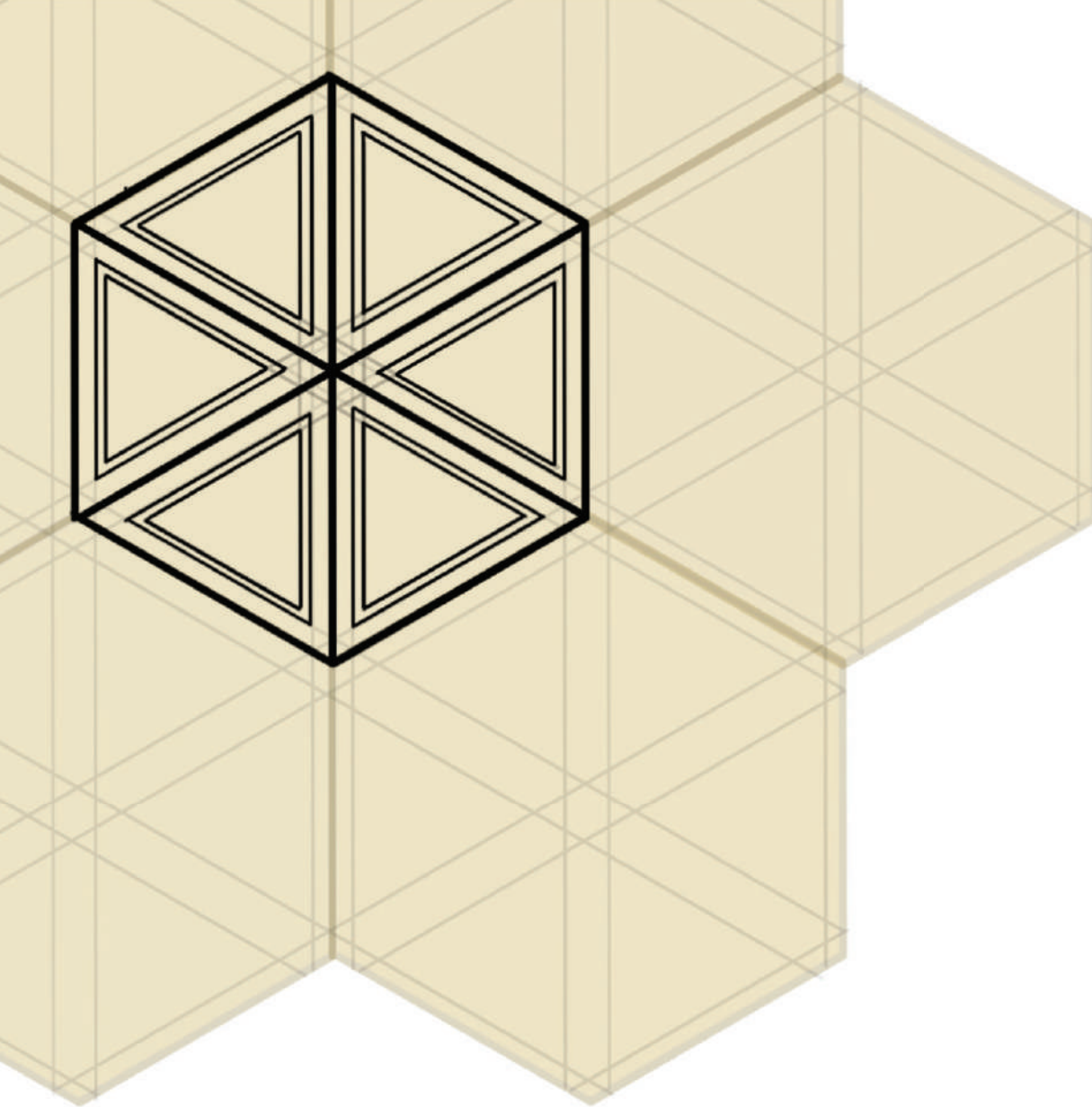
Threats:

Limited access to pedestrians and cars, awkward place to turn right, possibly could be promoting further gentrification in the area and be useful for the wealthy.

Opportunities:

The site needs to be as pedestrian friendly as possible and must expose the programme so those who feel they do not belong, can see that they do.

Figure 3 - Map showing Income brackets according to density and plot size and access routes to site (AfriGis, 2017)



Part 1

1. Introduction

2. History of Orange Grove
and Norwood

3. Service Delivery

4. Theoretical Approach

5. Architectural Design
Drivers

6. Design - Site Analysis

7. Design Development and
precedents

8. Conclusion

Part 2

Final Design

References

03

Service Delivery

Service delivery, including access to sustainable resources such as food and clean water, is a fundamental issue in South Africa and is currently running on systems that are failing in a manner that is unequal and exclusionary to the impoverished (Palmer et al., 2017, p. 4). While Orange Grove had access to well-connected and maintained service delivery for a good portion of Apartheid, the area experienced a decline during the 1970s and 1980s due to economic and demographic shifts (South African Research Chair in Spatial Analysis and City Planning, 2017, p. 5). Louis Botha and Orange Grove can be linked to the decline of Johannesburg CBD, while Norwood is linked to the Northern Suburbs that are home to higher income brackets (South African Research Chair in Spatial Analysis and City Planning, 2017, p. 5). During site visits, the decline of the area has become apparent through the lack of servicing of public spaces.

This includes:

- Sewerage spilling onto Ninth Street, this was noted through sight and smell.
- Litter gathering on the streets, specifically by stormwater drains on Ninth Street.
- Stormwater drains are not serviced and have caused flooding on Ninth street, repairs that are done (such as laying down water pipes) are not completed wholly so large portions of the street are kept as sand.
- Some of the public institutions such as the library on Ninth street are in disrepair, have been abandoned, and/or have been vandalised.

The systemic injustice of low-income areas has become more apparent over the years. In this area, it can be noted through the lack of maintenance resulting in polluted water sources, failing sewer systems, and poor stormwater design. During Apartheid, service delivery was focused on a small privileged percentage of the country as a discriminatory tactic; this dysfunctional system remained after the institutionalised segregation policies were changed as inequality and exclusion were and still are entrenched in the service delivery system (Palmer et al., 2017, p. 7). It is imperative to address these issues as a nation as it affects the most vulnerable, making it harder for people to escape poverty cycles.

The South African population is currently recorded as 59.39 million people; 20 million people in the population do not have access to safe water, 8 million do not have access to electricity, and 14 million do not have access to basic sanitation (Dorasamy, 2021; Sarkodie and Adams, 2020). This thesis considers Norwood and Orange Grove, both of which are connected to municipal water, electricity, and sewerage connections. This area is privileged based on this fact; the consideration behind working in this area is that it is easier to set a precedent in an area that requires 20% to be fixed compared to an area that requires 80% of the service delivery issues to be fixed (Palmer et al., 2017, p. 7).

While it would be useful to set this project in a highly disadvantaged area, I am taking the stance that “designers [have to] contribut[e] in making these promising cases more accessible, effective and reproducible” (Awan et al., 2011, p. 61), which would be achievable on the chosen site. Once a precedent can be set, it is easier to reproduce it in areas that might not be as viable through economics but would impact social viability.

The following section looks at arguably the most important resource of the project; water. The section will introduce how the Sandspruit River is connected to the Johannesburg water system and will look at existing precedents in South Africa to inform technical design choices for the final design.

3.1 Water treatment of the Sandspruit River

As seen in the historical timeline, the Sandspruit River (the central river in Orange Grove) had been an integral part of farming in Orange Grove before being forgotten to the depths of the earth as a subterranean channel. The Sandspruit River, Jukskei River, and Braamfontein Spruit River are connected before separating into their separate streams (see Figure 3a on page 17). All three of these streams are polluted and are health hazards (Fiddes, n.d., p. 39). The Jukskei is being researched and restored by Water for Future at Victoria Yards. The following treatment centre is a highly effective precedent linked to the Braamfontein Spruit, located at St. Stithians in Johannesburg, South Africa. The following precedents show the potential water cleaning possibilities and space/ water storage requirements for a similar-scale project.

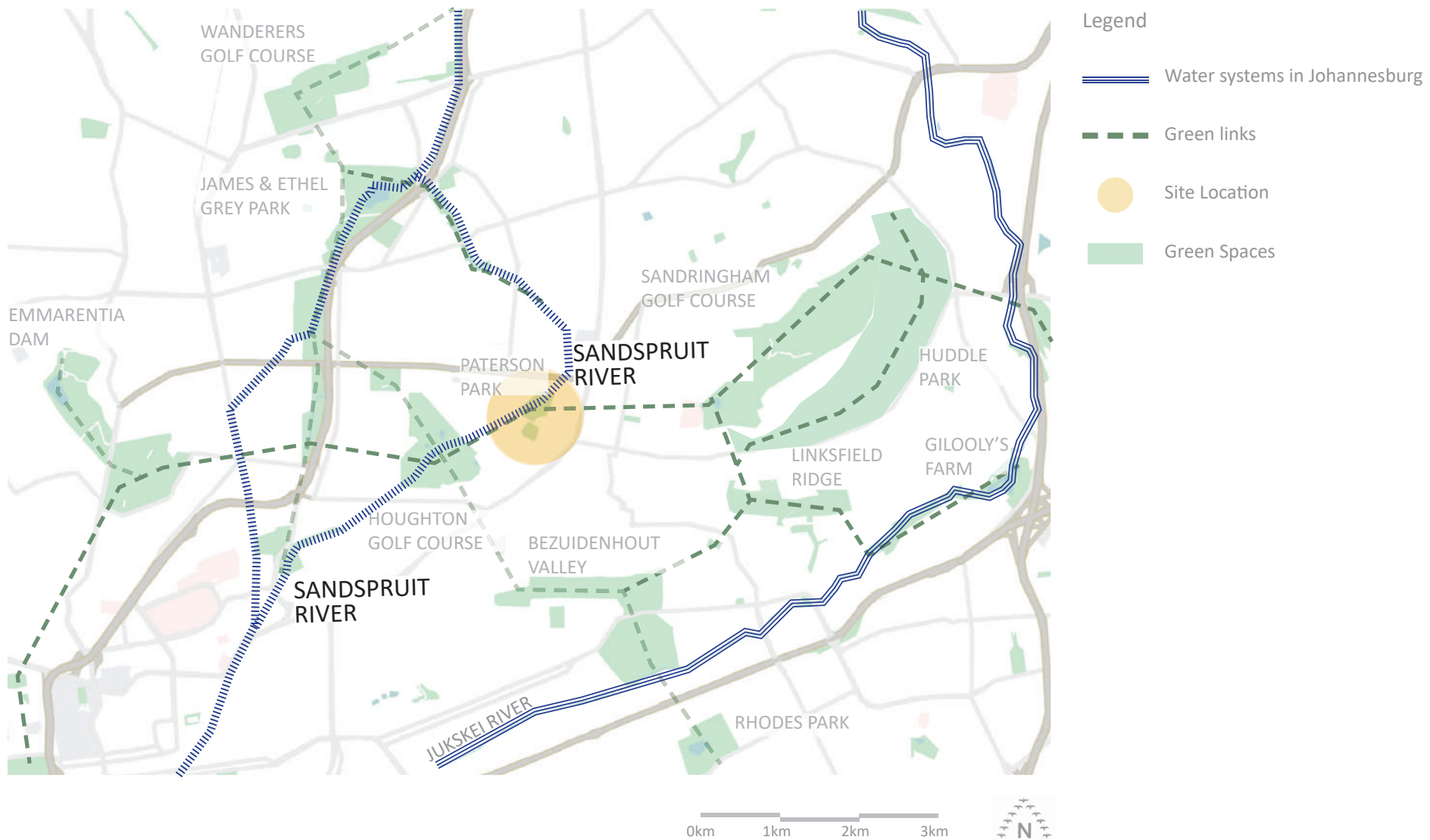


Figure 3a - Water system layout in Johannesburg

(AfriGIS (Pty) Ltd, 2017)

3.1.1 Water treatment precedent: St Stithians Water Treatment Centre

Designer/Contractors: Pure Care (Pty) Ltd.

Date of completion: December 2021.

Zoning: Educational.

Cost of project: R6 million.

Capacity of the project: 250 000 litres per day.

Breakeven point: Financial Model that will yield a Return on Investment in 18 months (St Stithian College, 2021a).

The overall objective is to Source, Process and Supply 250 000 litres per day of potable water that complies with the full legal SANS 241 requirements (St Stithian College, 2021a).

Total size of project: $471\text{m}^2 + 436\text{m}^2 = 907\text{m}^2$.

Water treatment building size: 110sqm.

Supplies more than 70% of all water requirements of the college (St Stithian College, 2021b, 2015) (St Stithian College, 2021a).

Water storage tanks: 3.

Size of water storage tanks: 545 000L, 68 000L, 270 000L.



Figure 4 - St Stithians Water Treatment Centre – 07/05/2023

The St. Stithians Water treatment centre offered useful information regarding the logistics behind a similarly scaled water treatment centre similar to the one in the design.

Useful information from a small-scale water treatment centre:

- The size of the water treatment centre is appropriate for what I am trying to achieve.
- 250 000 L/day would be sufficient to cover the aquaponics and return clean water to the system.
- The financial model for this is reasonable and would make a viable project.
- A minimum of 20 weeks will need to be planned for when doing the phasing of the project.

Potential issues that have to be considered:

- The water they are cleaning comes from a borehole. The water the proposed project is cleaning will likely have additional issues that will need to be considered, such as plastic filtering and heavy metal filtration.
- Water quality must be at a certain standard to enter the aquaponics component and be dealt with before entering the system.
- The water treatment plant will be at the lowest part of the site, so the water will require a pump as it cannot be gravity-fed.

For this programme to be included in the proposed design, it is imperative to understand how the process of cleaning water works so it can be appropriately integrated and showcased to inform people. The following precedent is a large-scale project for a province but clearly explains how the water purification process happens and what is necessary.



Figure 5 - St Stithians Water storage – 07/05/2023

3.1.2 Water treatment precedent: Rand Water Zuikerbosch treatment centre – Vereeniging

Designer: Contract split by Rand Water.

Date of completion: December 2024.

Cost of project: R3.9 Billion.

Size of Project: 2.56km².

Future capacity of project: 600 Mℓ/day.

Designed for 1000 Mℓ/day.

Potential issues that have to be considered:

- If the cleaning process has sludge, how will it be dealt with on the site without causing environmental issues?
- The time to construct the project would be around 21 weeks (Ncube, 2022).
- Requires access to a constant supply of electricity – backup power systems are necessary (Ncube, 2022).

Useful information from the large-scale water treatment plant:

- This project size is appropriate to clean enough water to supply entire provinces. This program is not an appropriate size for the proposed site.
- The steps for purification are simple and use minimal energy and chemicals to clean the water.
- Some filtering could be swapped out for eco-friendly substitutes on-site, such as bamboo for phytoremediation.

How this information has impacted my design:

- The process has been included at a smaller scale in my design, and the water treatment centre has direct access to the polluted water on site.
- Phytoremediation has been included on-site before the water enters the system to help clean the water through natural processes.
- Bamboo has been used for phytoremediation and will later be used in construction.
- The site generates its own electricity so there is a constant electricity supply to the centre.
- Sludge can be fed to the biogas digester to generate gas from organic compounds.

The water treatment centre on site has been designed to consider the water treatment process, the requirements, and how to use the byproducts to generate positive outcomes.

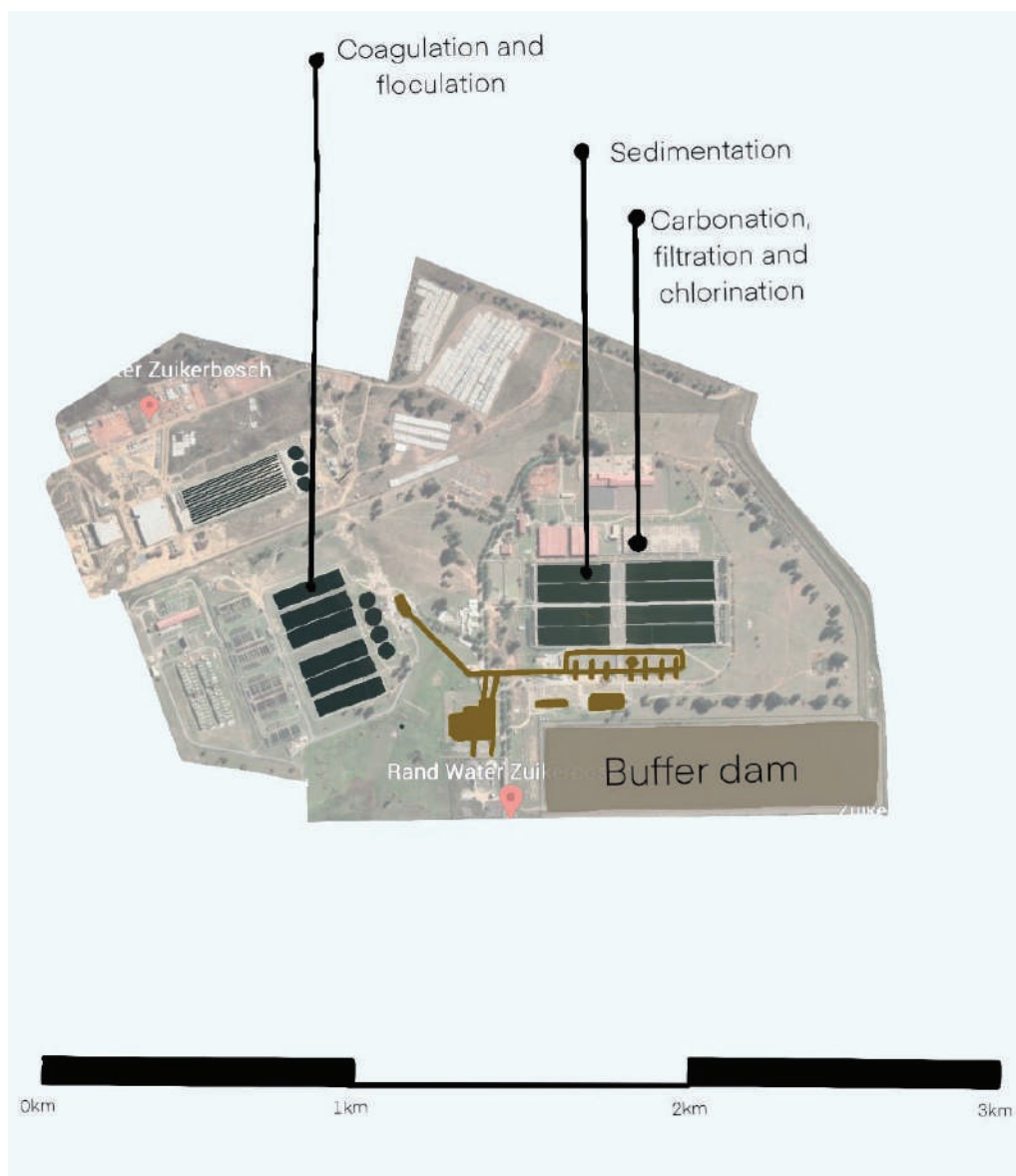


Figure 6 - Zuikerbosrand water treatment centre

(AfriGIS (Pty) Ltd, 2022; Mashilo, 2018; Rand Water, 2023)

Steps for purification:

A) Water collected from Vaal Dam.

B) Water is screened – the first filter of large items such as fish, sticks, leaves.

C) Water flows in the buffer dam before the 7-step filtration.

1) Coagulation - Water and raw limestone are mixed to destroy bacteria or algae to stabilise the water. This is done in the poly-dosing plant.

2) Flocculation – The particles coagulate in the above site (floc) and float to the top.

3) Sedimentation – The water flows into the sedimentation bay where the floc from above sinks to the bottom and is considered sludge. The water above the sludge layer is clean and is pumped to the carbonation bay. The sludge is removed using desludging bridges.

4) Carbonation – Carbon dioxide is added to the water to stabilise the pH levels that were changed when raw limestone was added.

5) Filtration – Process within a dark filter house to prevent the growth of algae. Water may still contain germs and algae; water is taken through sand and small pebble filters to trap small living organisms.

6) Chlorination – water is disinfected using chlorine to kill any germs.

7) Pumping – Pumped to boosting stations and tested biweekly.

(AfriGIS (Pty) Ltd, 2022; Mashilo, 2018; Rand Water, 2023)

3.2 Aquaponic farming

Using Aquaponic farming to decentralise produce, remove unnecessary CO2 emissions, and increase job opportunities for local labour.

As previously mentioned, the proposed area had previously been used for agricultural purposes, the location of the site and the potential to create natural resources could have a positive impact on the community. The following section will look at Aquaponics, the cuisines of the restaurants on Grant Avenue and a precedent study located in Midrand, South Africa.

Aquaponic farming combines aquaculture (fish) and hydroponics (growing plants in nutrient-rich water, without soil) to create a closed-water system that uses significantly less space and minimal resource wastage compared to traditional farming practices. The logic of an aquaponic system is to use the nutrient-rich water produced by fish excrements in the fish tank, filter the water through biological filtration (bacteria) and mechanical filtration (physical filters), the nutrient-rich water is then pumped to the plant area where the plant's roots are submerged and provide the necessary nutrients for optimal plant growth, the plants clean the

water through this process and the clean water is then pumped back into the fish tanks (Goddek et al., 2015, p. 2). Aquaponics is an elegant solution to reducing land usage and unnecessary water wastage, increasing plant yield, and removing the area constrictions of well-known farming practices.

Currently, there are no existing policies nationally, provincially or in council addressing urban farming and the use of aquaponics in a site such as Paterson Park (City of Johannesburg Metropolitan Municipality, 2021, p. 58). The existing paradigm of cultivating produce in farms on the outskirts of towns or other provinces with favourable climatic conditions enforces a cycle of redundant transportation, excessive energy usage to maintain the cold chain required for stores such as Woolworths, excessive energy used for storage, and the resultant food waste due to unsold products. The decentralisation of resources, including produce and fish, creates the potential for improvement. For local restaurants, the ability to streamline their

operation by being able to source precise quantities required daily or weekly. For produce stores, the opportunity to improve efficiency and sustainability through produce cost reductions, reduced energy usage, and minimal food waste.

Lastly, an aquaponic farm provides residents access to affordable, organically grown food that contributes to improved overall well-being and a more sustainable food system. Additionally, the design incorporates a biogas digester plant that takes food waste, including any offcuts or fish bones and produces gas that can be used to cook with and heat the fish tanks.

The project viability of the aquaponics looks at Grant Avenue, the street perpendicular to 9th Street, where the project is situated (See Figure 7). Grant Avenue has a diverse, large population of restaurants, produce-selling stores, and residents. The following diagram (Figure 8) shows a mapping of the street regarding the location of the stores and restaurants, the types of cuisines, what plants are used frequently in the cuisines, and how long the plants would take to grow in an aquaponic system.



Figure 7 - Grant Avenue at night (AfriGis, 2017)



Lebanese / Afghani / Mediterranean

Fast grow time: 30 - 60 Days

Arugula (rocket), Swiss Chard, Mint, Parsley, Coriander, Dill, Fennel, Cucumber, Tomatoes

Medium grow time: 50 - 90 days

Eggplant, Bell Peppers, Tomatoes, Corn, Onions

Slow grow time: 90 - 120 days

Bell peppers, Fennel, Eggplant.
Tilapia, Trout (12 - 18 Months)

North Indian Cuisine

Fast grow time: 30 - 60 Days

Lettuce, Spinach, Swiss Chard, Fenugrek, Coriander, Mustard greens, Chilli pepper, Tomatoes

Medium grow time: 90 - 120 days

Potatoes, Curry leaves, Cumin

Slow grow time: 8 - 10 months

Garlic, Ginger

Chinese / Japanese Cuisine

Fast grow time: 5 - 60 Days

Mustard Greens, Watercress, Scallions, Bean Sprouts, Bok Choy.

Medium grow time: 60 - 90 days

Shiitake mushrooms, Chinese Cabbage

Slow grow time: 8 - 10 months

Garlic, Ginger Tilapia, Trout (12 - 18months)

Minimal plants / Takeaways

Fast grow time: 30 - 60 Days

Lettuce, Tomatoes, Cucumbers, Onions.

Slow grow time: 8 - 10 months

Garlic, Ginger

Figure 8 - Mapping of businesses and cuisines that would benefit from the proposed programme (AfriGis, 2017)

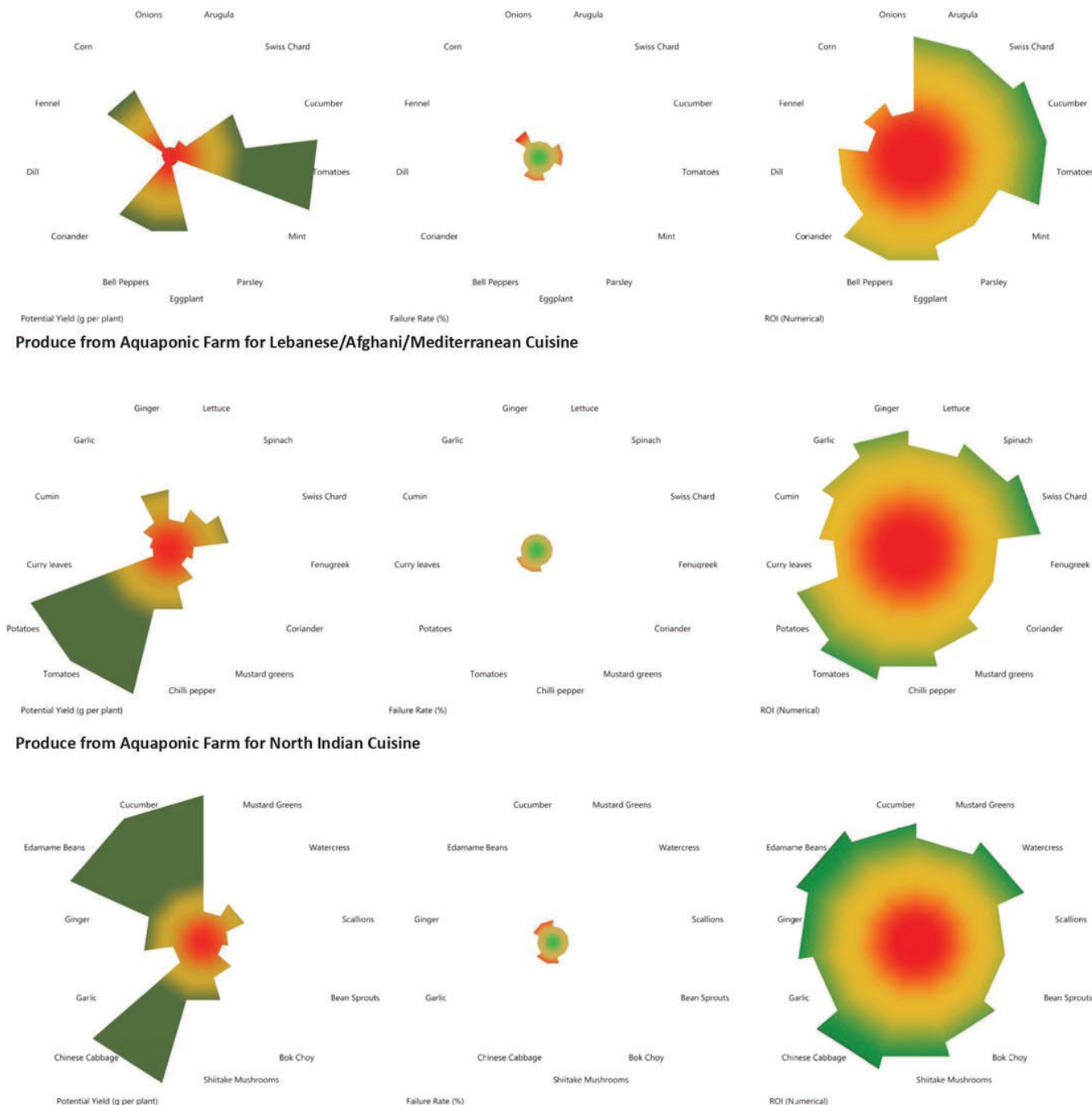


Figure 9 - Yields and ROI of produce within the Aquaponic farm

Data to understand which cuisine and products are viable for an aquaponic farm in Norwood

The data to the left looks at the potential yield of each plant, the failure rate of the product, and a numerical rating of the return on investment (ROI). This information brings to light what produce is ideal to grow across the cuisines found on Grant Avenue in the proposed Aquaponic farm.

Lebanese/ Afghani/ Mediterranean Cuisines:

Tomatoes are the most viable plant due to the high yield, reasonable failure rate, and the high ROI. Fennel and onions are the least viable due to the limited potential yield and the minimal ROI per plant.

North Indian Cuisine:

Tomatoes and potatoes are the most viable plants due to the high yield, minimal failure rate, and the high ROI. Curry leaves are the least viable due to the limited potential yield and the minimal ROI per plant. While this indicates the high yield plants are good, it must be seen with if the ROI is high to see if it is viable.

Chinese/ Japanese Cuisines:

Cucumber, edamame beans, and chinese cabbage are the most viable plants due to the high yield, reasonable failure rate, and the high ROI. Garlic, bean sprouts and scallions are the least viable due to the limited potential yield and the minimal ROI per plant.

General Conclusions and information to consider:

The yield percentage is dependant on what product produces the most in that group of information. The size of the plants and necessary requirements could mean that growing one plant of the product (such as arugula) is not viable but growing 20 of them in the same required size of one plant (such as potatoes) would make them viable.

3.2.1 Aquaponic Precedent Study: Ichthys Aquaponics Urban Farm

The following precedent looks at an existing aquaponic farm situated in Midrand, South Africa. The precedent sets an example for how commercial aquaponic farms run, the space and water requirements, and possible issues that a project may face.

This aquaponic greenhouse precedent revealed positive aspects, such as helpful information regarding logistics and potential issues that may become relevant to my design.

Developer: Justin Hess.

Location: 48 Kruger Rd, President Park, Midrand, 1685.

Size of development: 10 000sqm.

Zoning: Farm.

Programme:

- Aquaponic farm with fish: 5000 sqm.
- Admin building / Training area: 387 sqm.
- Processing and Cold storage: 390 sqm (GCRO, n.d.).

The breakeven point is not reliable on produce as this farm sells farm setups to others farmers.

Useful information from Ichthys:

- The average size of a greenhouse for aquaponics: 645 sqm.
- Cold storage and processing facilities are required on-site for ease of production and CO2 emission reduction.
- The precedent showed the aquaponics process and how it works logistically (See Figure 14).
- The amount of water required is equivalent to 15,000 litres per tank. This information needs to be considered for water treatment purposes and the weight of 15 tonnes per tank.



Figure 10: Photo from inside Aquaponic Greenhouse at Ichthys Midrand

(Glanville, 2023a; Hess, 2023a)

Potential issues that will have to be considered:

- The Ichthys Farm is not built to have the public interact with the space. I would need to design so that the public can't impact the system's health but can interact with the process.
- The greenhouse will be a safety concern as the material is easily cut through. This issue needs to be mitigated without changing the usability of the structure.



Figure 11: Aquaponic Vertical Towers

(Glanville, 2020a; Hess, 2023b)

How this information has impacted my design:

- The size of each greenhouse is 700 sqm.
- Cold storage and processing facilities are available on-site, and the site has been selected to be close to a range of potential clients to reduce emissions further.
- The farm has been designed as a circle to emphasise the idea of a closed system further so that tours can be educational.
- The water tanks within the farm hold 15,000 litres of water, and reduced carbon concrete has been used in these areas to compensate for the load.
- The farm has been designed so that viewers can interact with the plant portion and see the fish without being able to put their hands in the water. If the users interact with the water in the plant section, the water will be filtered through mechanical and biological filters before returning to the fish.
- I have designed the greenhouse as a geodesic dome with glass panels, reducing the ability to break in. If people are able to break in, the most valuable assets are the fish and pumps, which can be easily replaced and are quite challenging to take surreptitiously.
- The aquaponic farm within this project has been designed to highlight the beauty of the system while considering logistics and potential issues that could harm the program's functionality.



Figure 12: Media bed and bell siphon system

(Glanville, 2020a; Hess, 2023b)



Figure 13: Bell Siphon and Media bed system

(Glanville, 2020a; Hess, 2023b)

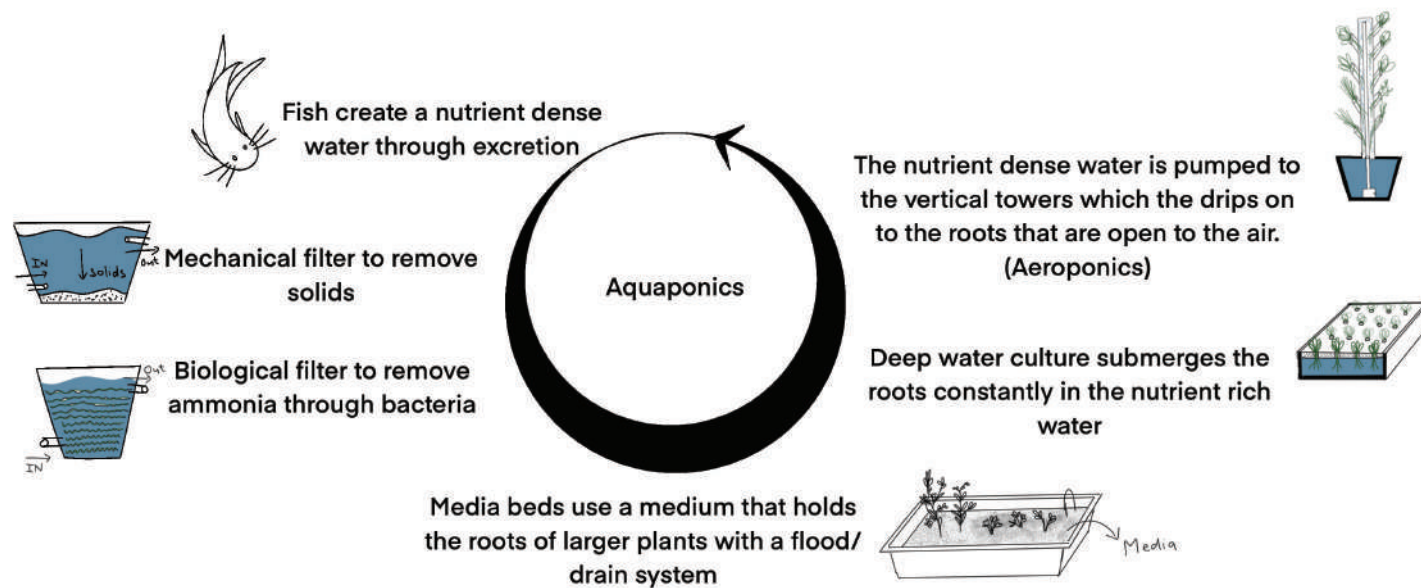
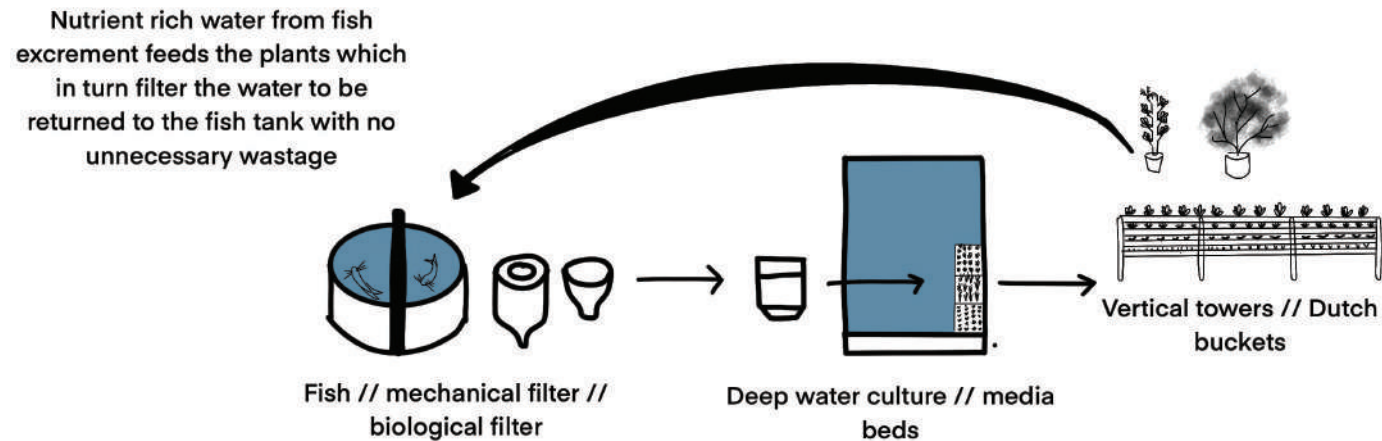


Figure 14 - Aquaponics diagram

(Glanville, 2022)

3.3 Urban farming in Johannesburg

While the yield and variety of aquaponics makes a strong case as to why it is the preferred method of farming, the next section will look at how urban farming can be a useful tool in natural resource management, can reduce the carbon emissions that are linked to transportation of produce and will look at an existing precedent located in Lorentzville, Johannesburg.

Urban farming has incredible potential to reduce unnecessary carbon emissions and costs to the consumer if managed correctly and using permaculture logic. Victoria Yards, Lorentzville, South Africa, is an elegant precedent of adaptive reuse, skill development, and urban farming. It sets a precedent for the transformation and destabilisation of broken paradigms.

“Even in the most seemingly most intractable situations, there are opportunities for destabilisation and transformation” (Awan et al., 2011, p. 39).

Through interviews with Mike (the events coordinator and owner of the Victoria Yards Bar), Tony (the principal gardener and manager of the grounds), and secondary research, I was able to receive significant material regarding how the project worked, why it works, and what could be done to improve the concept.

Unfortunately, the urban farming portion of the project has not been financially viable since its inception in 2018, and the farm relies on a limited group of dedicated customers and impulse purchases. The products sold are of high quality and organic. Figure 15 shows 15 different vegetables worth R260, the same amount of vegetables sold for R360 – R440 from local farms nearby, such as Farm Fresh Online (FarmFreshOnline, 2020).



Figure 15 - Winter Vegetable box from Victoria Yards

The project employs three people: the head gardener, a picker, and a packer. The issues that the farm deals with are potential clients requesting vegetables that are out of season, limited marketing strategies, not having the capacity to host an online business for the farm, and not having the space or capacity to extend the shelf life of products such as pickling or jams (Bensusan, 2023). To mitigate the above issues, the head gardener is exploring alternative paths to generate income through product creation. The positive aspects of the farm include supplying the schools in the area with vegetables at a low cost (one of the boxes feeds 150 children per day) and supplying vegetables to an onsite soup kitchen that provides hot meals every week to large groups of recyclers, the farm also is used as an education programme for children and is

used by the Green College to teach people how to preserve food (Bensusan, 2023). The social viability of the farm is exceptional as it creates a support structure in a highly impoverished area.

In response to the information collected, my design makes use of an aquaponic farm that has a substantially higher yield of products per plant and square meter, can produce any plant regardless of the season through environmental control, and has included a programme for service-added products to extend the shelf life of products with increased variety. Due to the capacity of the design, an online store and wholesale clients would be economically viable. The project also includes a soup kitchen that would improve the project's social viability in an area with many impoverished people.



Figure 16 - Internal shot of Urban farming at Victoria Yards

3.3.1 Urban farming precedent study: Victoria Yards

Developers: Group 44.

Architects: Daffonchio & Associates Architects.

Location:

16 Viljoen St, Lorentzville, Johannesburg, 2094.

Zoning: Industrial 1.

Sponsors: Nando's, Divercity, Itoosart Insure, Business and Arts South Africa, Hollard Insurance.

Size of Development: 30,000 sqm.

Type of Development: Urban renewal, adaptive reuse.

Previous use of site: "Grand laundry in the 1920s"- Green (von Geusau, 2020).

Objective:

"This needed to be a property where artisans could showcase their work among a supportive community of like-minded people" (von Geusau, 2020).

Type of programmes available:

Restaurants, artisans, gin distillery, urban farming and medicinal farming, Water for the Future, galleries, rentable event spaces and workshops.



Figure 17 - Internal shot of main farming area at Victoria Yards

(Glanville, 2020b)

Social sustainability:

Community gardens, upskilling members of the public through farming, job creation in the area, money generation for the area, areas for children to go to do homework/ work areas (Group 44, 2018).

Environmental sustainability:

The project incorporates minimal changes to the site for reuse, urban farming, and new buildings that use sustainable materials (Group 44, 2018).



Figure 18 - Internal shot of pathway at Victoria Yards
(Daffonchio & Associates Architects, 2018; Glanville, 2020)

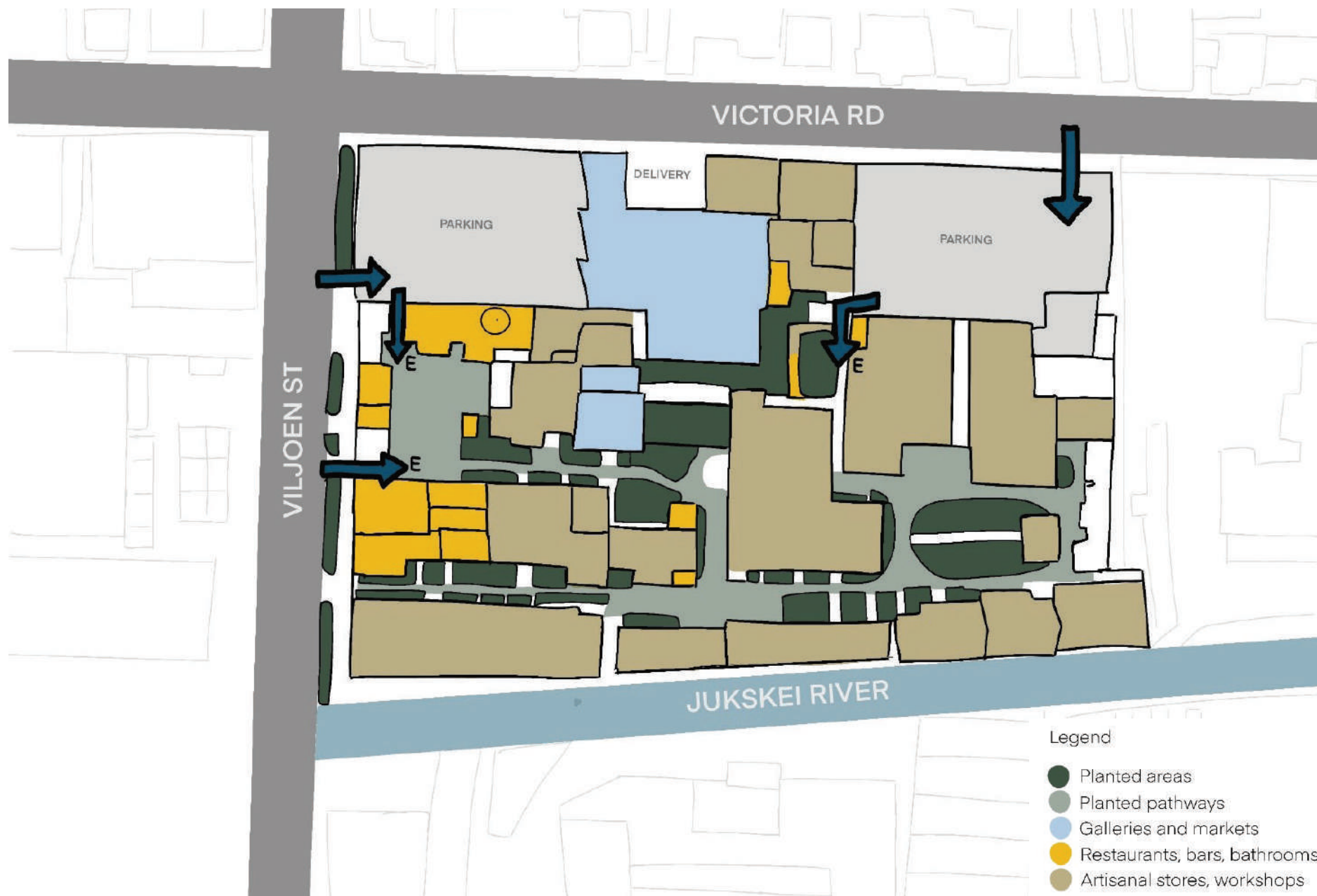


Figure 19 - Victoria Yards Programme analysis

(Group 44, 2018; AfriGIS (Pty) Ltd, 2023; Daffonchio & Associates Architects, 2018)

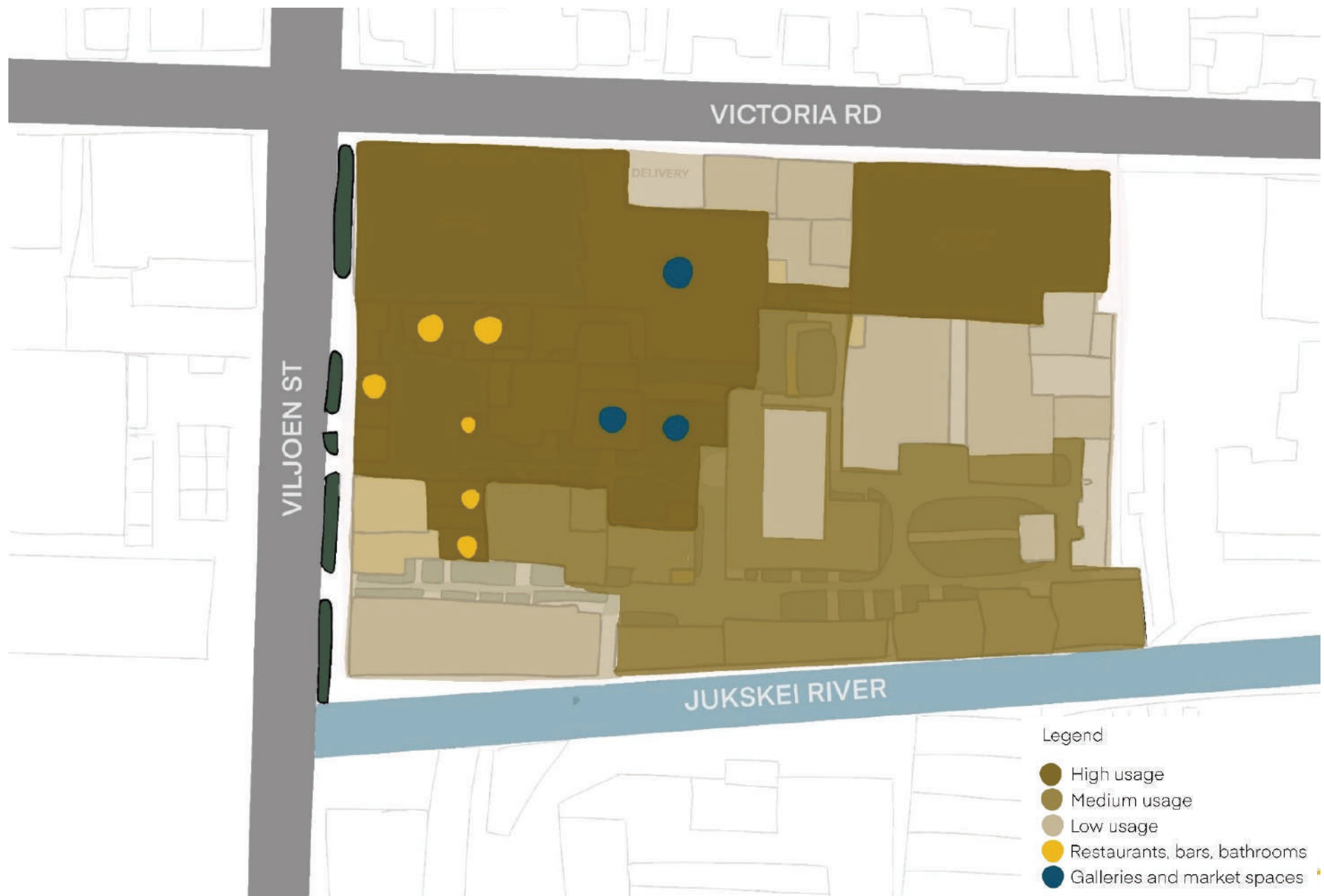


Figure 20 - Victoria Yards Weekend usage of space

(Group 44, 2018; AfriGIS (Pty) Ltd, 2023; Daffonchio & Associates Architects, 2018)

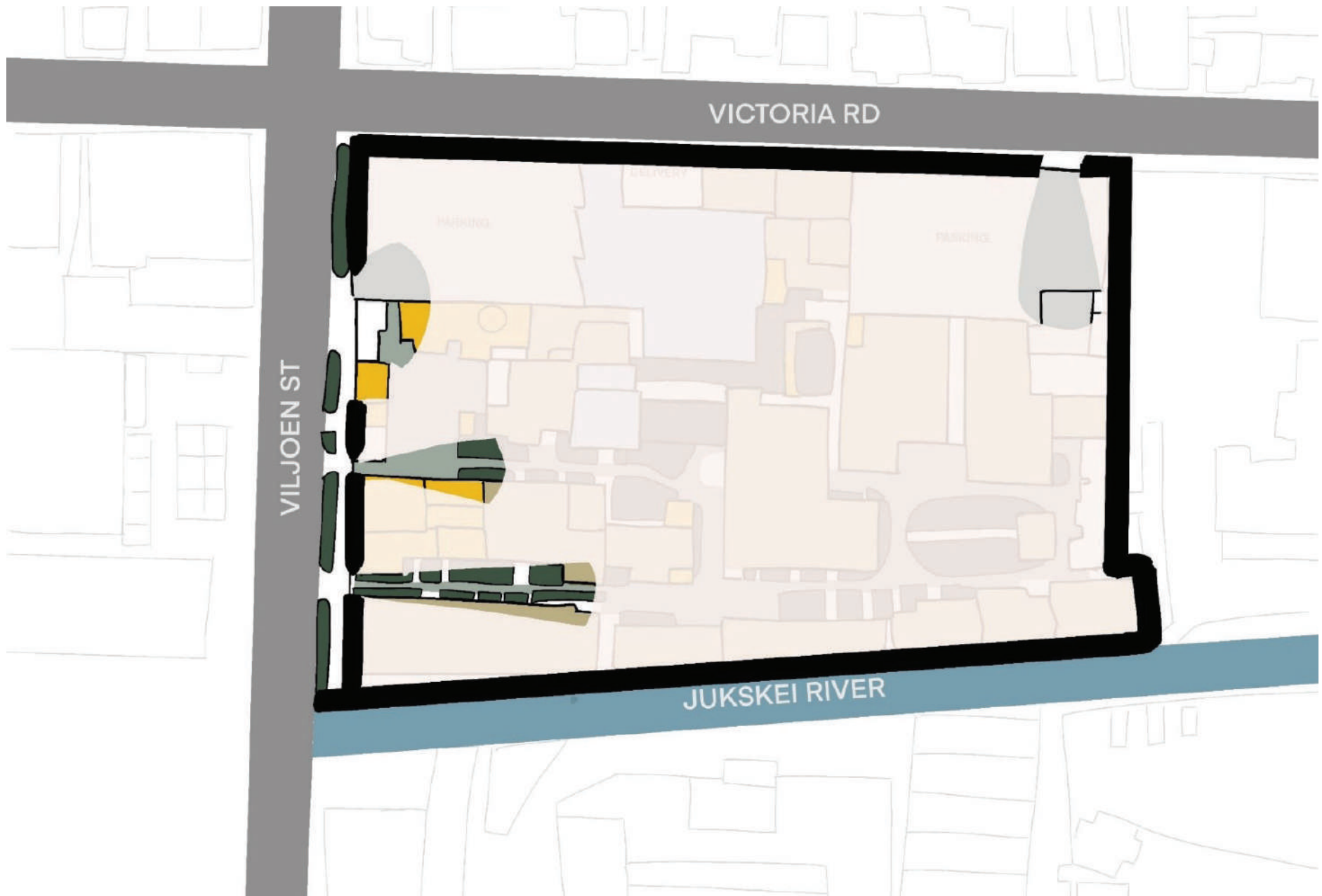


Figure 21 - Victoria Yards Visual Accessibility from the Road

(Group 44, 2018; AfriGIS (Pty) Ltd, 2023; Daffonchio & Associates Architects, 2018)

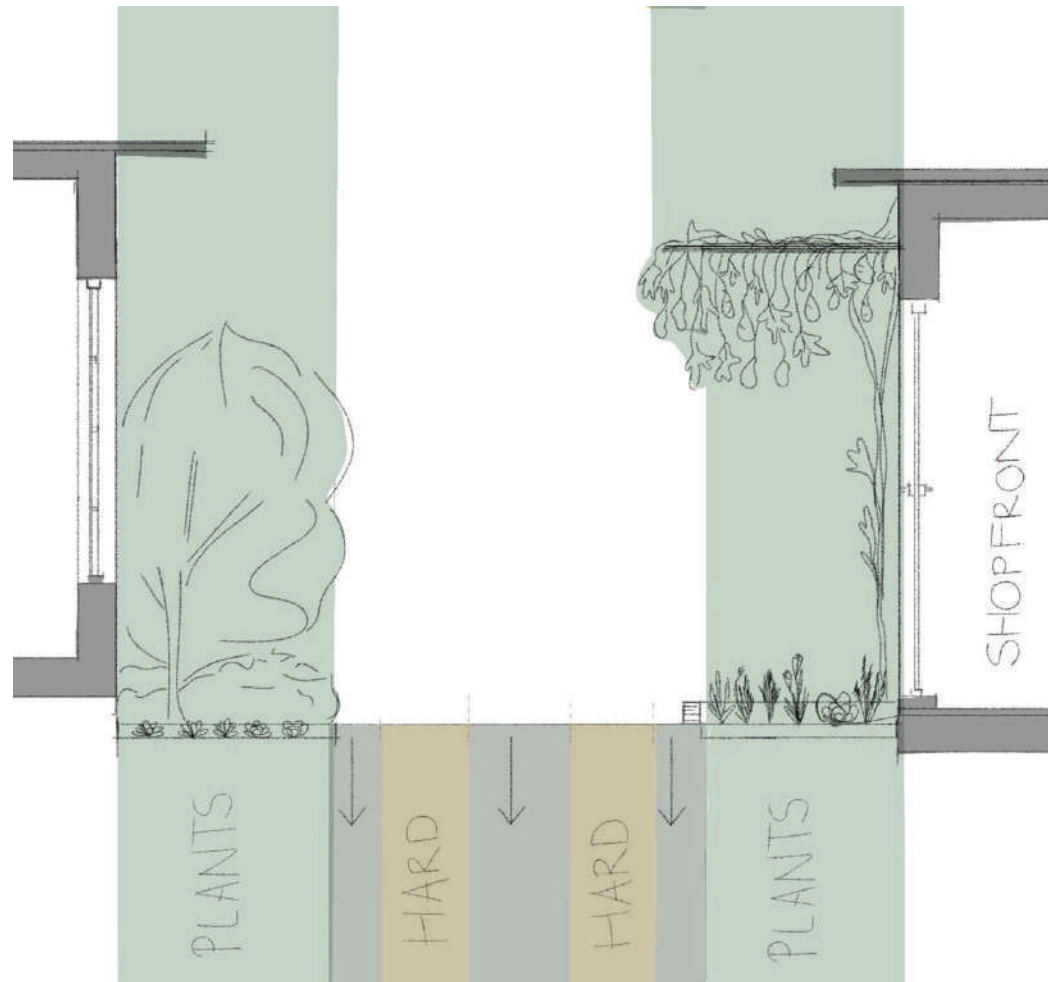


Figure 22 - Design elements from Victoria Yards

(Group 44, 2018; Daffonchio & Associates Architects, 2018)



Figure 23 - Aesthetics, materiality, and clerestories in Victoria Yards
(Group 44, 2018; Daffonchio & Associates Architects, 2018)

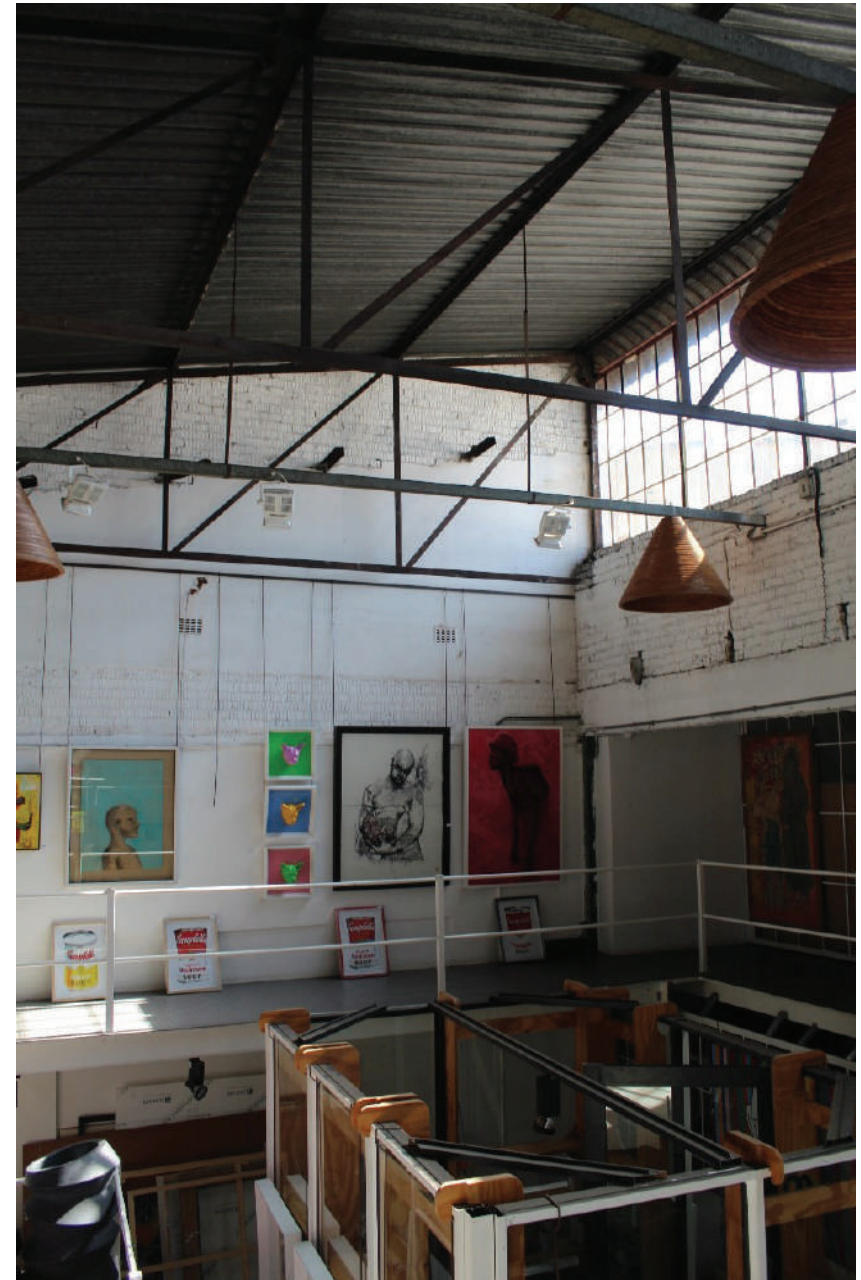


Figure 24 - Clerestories in Victoria Yards Art Gallery
(Group 44, 2018; Daffonchio & Associates Architects, 2018)

Useful information from Victoria Yards:

- It is recommended to include additional programs that make the space more usable, such as artisanal spaces for making items out of grown materials.
- Urban farming and landscape design create an urban oasis for the community to interact with.
- Programmes like this should create opportunities to upskill the community through farming and social programs.
- The pedestrian public should be able to interact with a site that is also accessible through vehicles.
- Materiality should be chosen to draw people in and minimise environmental damage.
- Businesses and restaurants should be clustered for optimal design and logic.
- It is necessary to co-exist with the neighbourhood.
- The design should use small local teams during construction to ensure that money earned on-site goes back to the community and creates an opportunity to upskill during construction.
- If you give an opportunity to incubators of design and community, it will make all the difference.

Potential issues that have to be considered:

- Accessibility is limited at Victoria Yards – areas are difficult to access for those who are differently abled.
- There is gentrification of the site; the users travel from areas outside the direct precinct, and those in the precinct don't feel welcome.
- There are dead ends in the design that rarely have people going to the areas; these areas consist mainly of small businesses.

How this information has impacted my design:

- The project includes a range of programmes to create multiple sources of income.
- The site is designed to draw pedestrians from the main road and allows users in a vehicle to park off the main road.
- The materiality chosen reduces the impact of the project on the environment.
- Local labour and local material production are crucial to this project to promote upskilling in the community.
- The site has been designed for accessibility.
- The project filters the programme from most public to the water treatment centre, so people are constantly within the potential dead zones.
- All buildings have been designed as an experience to help spark interest in the programmes.
- The urban farming and public use spaces of my design have considered how this successful precedent runs and have drawn lessons that could aid the usability of the site and programme.

3.3.2 Impact and feasibility of urban farming and park

For the project's aquaponics and urban farming aspect to be viable, they will have to create additional products through value-adding services. The processed products will increase the shelf life of the products and reduce wastage (Austin, 2023). To incorporate this into the project, the aquaponics portion of the farm has a processing centre that allows for the processing, storage, and distribution of products, with a store at the front of the site to sell the products on-site (Glanville, 2023b, p. 5). An example of the value-added service is using tomatoes grown in the project, creating sundried tomatoes, and storing them in olive oil. The process involves taking fresh, non-shelf-stable tomatoes, subjecting them to minimal processing, and converting them into a shelf-stable condition. This method enhances the value and usability of the original product, allowing it to be stored for an extended period until it is opened (Austin, 2023; Glanville, 2023b, p. 5). It is advisable that the project adopts this approach to increase the farm's profitability. While the aquaponic farm might break even, incorporating processing methods will contribute to generating profits (Austin, 2023; Glanville, 2023b, p. 5).

Park Maintenance and design

The water treatment on site cleans 250 000 litres of polluted water daily; the aquaponic has a once-off requirement of 155 000 litres across the three greenhouses and then is topped up throughout the project (Glanville, 2023b, p. 6). The project can be supported by Johannesburg City Parks and the Department of Water and Sanitation with possible financial reductions for cleaning polluted water that can go back into the system (Glanville, 2023b, p. 6). The project could be presented to the departments to determine if it can be reimbursed for "the maintenance and watering of the park by the allocated budgets in each department" (Glanville, 2023b, p. 6). With or without this funding, the control of the aesthetics and maintenance of the park is necessary for the project to be successful (Glanville, 2023b, p. 6).

The following section will reveal how designing the park can create the ideal environment to grow materials for the construction of the proposed buildings, what materials can be grown on the site, if it is a viable solution, and finally will consider precedents that use the proposed materials.

3.4 Material production and phytoremediation

The project intends to promote a logic of building and construction to contradict the current status quo of using materials that have a high embodied energy, require excessive transportation, and take advantage of the labour force. Through the aquaponic farm design and water treatment centre, the design will grow a significant quantity of materials that can be used as alternatives for construction materials. The design must be phased to allow the project time to grow the materials. The use of site-grown local materials is more sustainable for the environment and the economics of the project with a direct impact on the “skill base and economy, and [reduces] the reliance on multinational conglomerates” (Awan et al., 2011, p. 60).

Bamboo will be used in the phytoremediation of the water, which will assist in cleaning the water by removing heavy metals; the water with nutrients will, in turn, promote a high yield of bamboo (Bian et al., 2020). Hemp, soy, flax seeds, and mushrooms will be grown in the aquaponic system and can be used for insulation and non-loadbearing structures.

The first material of bamboo has been used in other projects in South Africa for phytoremediation and has shown that the clusters of bamboo become naturalised and maintain a self-sustaining population (Canavan et al., 2021) and are therefore not considered an invasive alien (Glanville, 2023b, p. 6). The second main material of hemp will be grown in the aquaponics system and manufactured onsite to create hempcrete bricks and panel boards (Glanville, 2023b, p. 6). The final main construction material uses compressed coffee ground panels, with the coffee grounds collected from the restaurants on Grant Avenue (Glanville, 2023b, p. 6).

Figure 25 below tabulates a cost and feasibility analysis of the above-mentioned materials regarding the time of the plant to grow to maturity, the cost of the plant in the system, what the cost of the same material from a reputable supplier would be, the equivalent cost of a standard construction method such as bricks, and the social/environmental benefits to growing the plant on site (Glanville, 2023b, p. 6).

The analysis displays that utilising bamboo as a construction material would bring financial benefits due to its availability on-site as a byproduct of phytoremediation. Construction phasing will depend on the growth time of the bamboo, which takes approximately three years to mature for production (Glanville, 2023b, p. 7). Hemp plants reach maturity in just four months, allowing for earlier utilisation and influencing the project's phasing. Although the cost of hemp plants may not be financially viable, the material's social, environmental, and precedent-setting possibilities outweigh the cost implications (Glanville, 2023b, p. 7). The coffee ground tiles are both financially and environmentally feasible while also providing social benefits such as establishing relationships with local restaurants and creating opportunities for community education.

Therefore, growing plants on-site for this project is viable and has a wealth of benefits that add to the community. The construction phasing will be based on the growth time of the plants; the coffee grounds will be utilised for the preliminary structures, the hemp will be used after four months, and the bamboo will be used for structures after three years. A secondary use of the growing of materials on site is that they can be sold or used by onsite designers to create ongoing income sources for the project while creating local jobs (Glanville, 2023b, p. 7).

Name of product	Time to grow in the system	Cost to grow in the system	The cost to purchase this item	Cost of Corobrik equivalent for reference	The social benefit of growing on site	Environmental benefit
Bamboo (Moso Bamboo)	5 years to reach full maturity for construction. Reaches 20m in a few months (maturity height) 2 year old plants with well developed root systems will be used in the phytoremediation and reduce the time to 3 years.	The bamboo is being used for phytoremediation in the water treatment system so the cost is absorbed by that programme and funding.	R200 per pole (SaBambu, 2023)	57 bricks to one 20 m bamboo pole = 57 x R5.20/brick = R296	Improves the water quality of the river. Job Creation for cultivation, material production, and construction.	Absorbs pollutants and heavy metals from polluted water. Minimal water usage. No fertilizers or pesticides are required.
Hemp for hempcrete and compressed panel boards	3 – 4 months to reach maturity to be used in the construction methods. The hemp hurds is used for the hempcrete and hemp fibres for the compressed panel boards.	R180 per plant – this cost includes the cost of a small plant or seed, the labour costs per plant in a commercial aquaponic farm, and additional products to the water.	Due to regulations, difficult to find reputable sources	1 plant = 1 hemp panel board brick size = 1 standard brick R5.20 for a single brick compared to R180	Hemp can offer more products such as textiles, CBD oil, and medicinal uses (dependent on regulations). Eco-friendly material production.	Fast-growing product, minimal pesticides required.
Coffee grounds insulation panels	Coffee grounds will be collected from restaurants on Grant Avenue to reduce unnecessary waste on the street	No cost to grow in the system, only cost for production with labour costs and resin which can be estimated at R10 a tile the size of a brick	Not available in the market yet.	R10 compared to R5.20/standard brick	Establishes partnerships with the restaurants. Community engagement regarding recycling and waste management. Job creation.	Waste diversion from landfill. End of life considerations and permaculture thinking. Material sustainability.

Figure 25 - Viability of growing construction materials on site

The following precedent looks at the design qualities of bamboo and the possibilities to work with construction that uses minimal change to the plant. The project is based in Chiang Mai, Thailand and is a zero-carbon sports hall for 300 students (Chiangmai Life Architects and Construction, 2017).



Figure 26 - Internal view of the sports hall
(Chiangmai Life Architects and Construction, 2017)



Figure 27 - Bamboo as a construction material
(Chiangmai Life Architects and Construction, 2017)

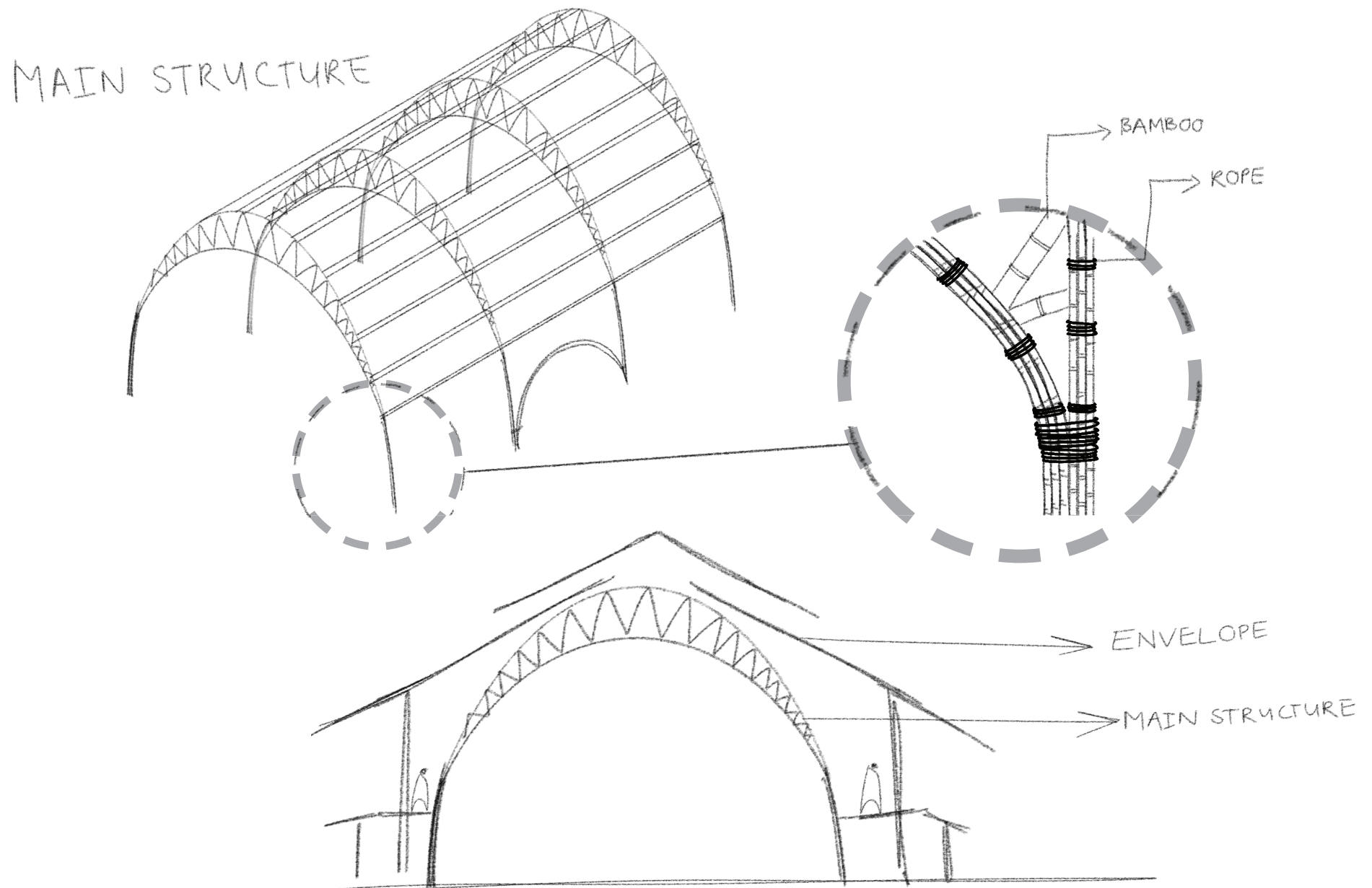


Figure 28 - Structure and material elements

(Chiangmai Life Architects and Construction, 2017)

3.5 Local labour

South African labour is known to be cheap and is one of the main reasons many buildings use labour-intensive materials that would not be viable in other countries. While this may seem like a positive aspect for the economics of construction, it is, in fact, a sign of a systemic issue that continues an inescapable poverty cycle that has been perpetuated since Apartheid. “Political manipulation of space to entrench power relations and deliver cheap labour is the hallmark of South African history. In order to force the black majority to work for low wages, first in the mines and the farms, and later the booming construction and manufacturing sectors, the cost of reproduction needed to be kept low” (Palmer et al., 2017, p. 25).

As a designer, I do not want to perpetuate the cycle of taking advantage of the disadvantaged. The design uses construction logic that those employed by the project through the farm will have skills developed in sustainable construction practices and will be paid to build and maintain the building. This practice allows skill development to increase potential earnings and job security.

Training the local labour or the unemployed in new construction techniques will make the construction systems and structures easy to understand and construct on-site (Awan et al., 2011, p. 60). The advantages of growing construction materials on site and training local labour in new construction techniques are potentially life-changing for those who interact with the project. The project creates opportunities for locals to learn how to grow sustainable resources and how to use them in the construction industry; this idea is liberating as it reveals possibilities for local construction materials to be used in other projects and to promote the local economic growth with minimal emissions. Essentially, we can start to work towards an industry that helps support small business owners instead of solely supporting conglomerates that source the material at the cheapest price with little regard for human rights and the environment.

Impact and feasibility of using local labour

Ensuring the quality of the aforementioned growing materials is crucial to addressing potential threats

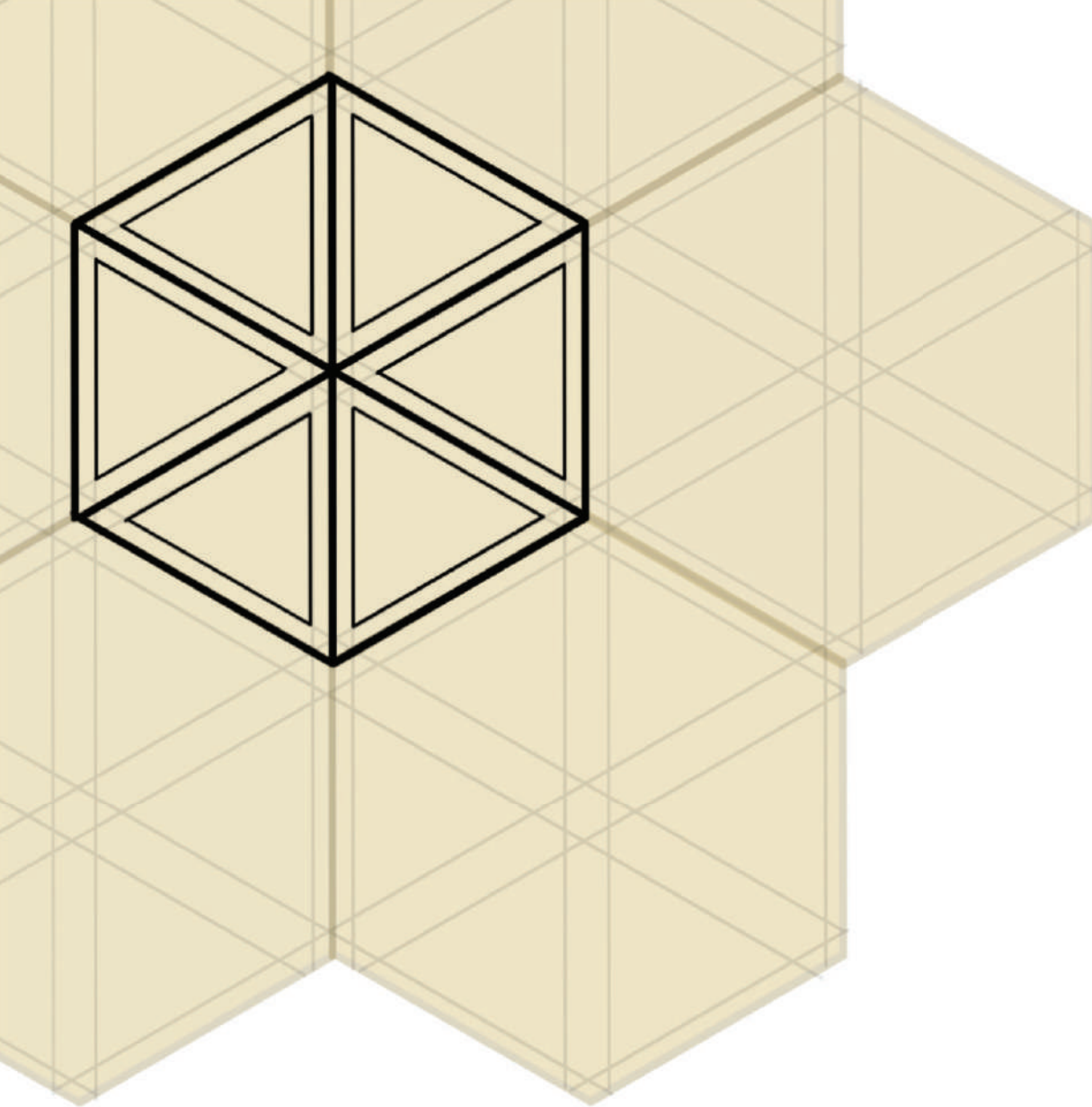
and guaranteeing the work’s integrity. Before using these non-standardised materials in construction, thorough testing will be required, accompanied by obtaining a certificate of Agrément, enabling the project’s use of such materials (Agrément South Africa, 2023)(Glanville, 2023b, p. 8). Training the labour force in utilising alternative materials and construction methods is essential to mitigate risks effectively (Glanville, 2023b, p. 8). To further mitigate threats, sections of the design incorporate a structural frame system using bamboo or aluminium and employ non-loadbearing walls, so the wall materials bear only their weight and environmental loads (Glanville, 2023b, p. 8). The training of local labour not only serves to mitigate risks but also presents an opportunity for skill development within the community (Glanville, 2023b, p. 8).

Labour skill development in this project is a core component of the construction; I believe it is necessary to significantly impact all who interact with the project (Glanville, 2023b, p. 8). The government offers funding for skills development, specifically, “The Department of Small Business Development” and the “Enterprise Incubation Program”, which could provide funding to train and pay the salaries of the workers during the training period (Glanville, 2023b, p. 8). The funding available from the Enterprise Incubation Programme is R5 – R10 million (Glanville, 2023b, p. 8) (Department of Trade, Industry and Competition, 2023).

For this project, local labour is defined as living within the community or a 5km radius of the site, and this can be increased if need be. The boundary is set to promote and assist in long-term employment in the

area with minimal transport. While it may be more financially viable to hire trained non-local labour or to take advantage of illegally residing residents, this would conflict with the conceptual approach of the project to support and develop the community in a sustainable manner (Glanville, 2023b, p. 8).

Cheap labour in South Africa is often referred to as a positive aspect of our construction industry. It is a sign that the industry takes advantage of a large group of people and does not pay them a livable wage for work that will have a lasting effect on their health. This section looked at the approach to construction and material choices while the following section explores the theoretical approach to design that makes the public feel welcome, safe, and keen to interact with the space.



Part 1

1. Introduction
2. History of Orange Grove and Norwood
3. Service Delivery
- 4. Theoretical Approach**
5. Architectural Design Drivers
6. Design - Site Analysis
7. Design Development and precedents
8. Conclusion

Part 2

Final Design

References

04

Theoretical approach

4.1 Principles of park design

The theoretical approach of this project will be linked to the following authors and books: Jane Jacobs' "The Death and Life of Great American Cities" (1961). Although the book was published in 1961, the information is still highly relevant and links directly to the advocacy of small, self-sustaining neighbourhoods with mixed-use development that this project intends to achieve. "The city as resource: texts and projects 2005-2014" by Rieniets et al. (2014) regarding poverty-stricken areas and design opportunities. "Textbook: collected texts on the built environment, 1990-2018" by Christiaanse (2018) and "Massive Small: The Operating Programme for Smart Urbanism." by Campbell (2011) for additional information on urban design and architecture. "Urban Design Lab (UDL) Handbook: Dialogue-oriented urban transformation processes and practical approaches from Latin America and the Caribbean" for urban design guidelines and principles (Urban design lab handbook, 2019) regarding urban design practices and Circle Lab (Circle Economy, n.d.) for regenerative, circular design for cities.

Park design and how to create a thriving community hub

Paterson Park is located along Ninth Street Norwood; the street is regularly populated with vehicles and pedestrians as it is a main route to access Louis Botha Avenue, one of the city's main arterial roads. The surrounding buildings include low to medium-rise residential properties, a police station with a jail and police barracks behind it, and a recently renovated community centre that consists of a swimming pool, sports fields, an indoor gym and basketball court, various courts, an arts centre, and a public library.

The existing park is currently locked off using ClearVu fencing, which allows the users of the area to witness the complete failure of a public space that is not maintained and is poorly managed. Paterson Park does not aid in real estate stabilisation and does not act as a community anchor. The mere existence of the park does not indicate that it has a positive effect on the community. Instead, it demonstrates that a poorly managed and designed park can negatively impact a neighbourhood.

Jacobs suggests that poorly managed parks are:

1. Not used for the majority of the day (Jacobs, 1961, p. 94).
2. The area's lack of "eyes" on it creates unsafe spaces in its surroundings, leading people to avoid the location (Jacobs, 1961, p. 95).
3. If a park is not situated downtown, it should be located where there are programmes that incorporate work, cultural activity, residential, and commercial activity (Jacobs, 1961, p. 101).

The initial issues of the park can be linked directly to the points above made by Jacobs regarding badly performing parks such as:

1. Paterson Park is not used for a large portion of the day (Jacobs, 1961, p. 94); in this case, the park is never used as it is locked up.
2. Paterson Park lacks "eyes" on it and creates dangerous spaces in the surrounding areas that cause people to avoid the area (Jacobs, 1961, p. 95). This issue may change due to the proposal of an apartment building in the UDF.
3. Paterson Park is not downtown and, therefore, should be in an area where there are programmes that allow for work, cultural, residential, and commercial activity (Jacobs, 1961, p. 101). While Grant Avenue, perpendicular to Ninth Street, thrives in all four programs. Ninth Street currently lacks work and commercial activity while being disjointed from Grant Avenue and, therefore, needs intervention to help assist the park's success.

Additional issues that have been witnessed on-site include that the community centre parallel to the site does not show the programme or proposed users from the outside and uses the same ClearVu fencing, which may discourage the public from trying to find out what is happening as they are not welcome at Paterson Park that uses the same material.

The design addresses the aforementioned issues by incorporating the following elements and theories based on Jacobs' criteria for functional parks (Jacobs, 1961, pp. 103–106).

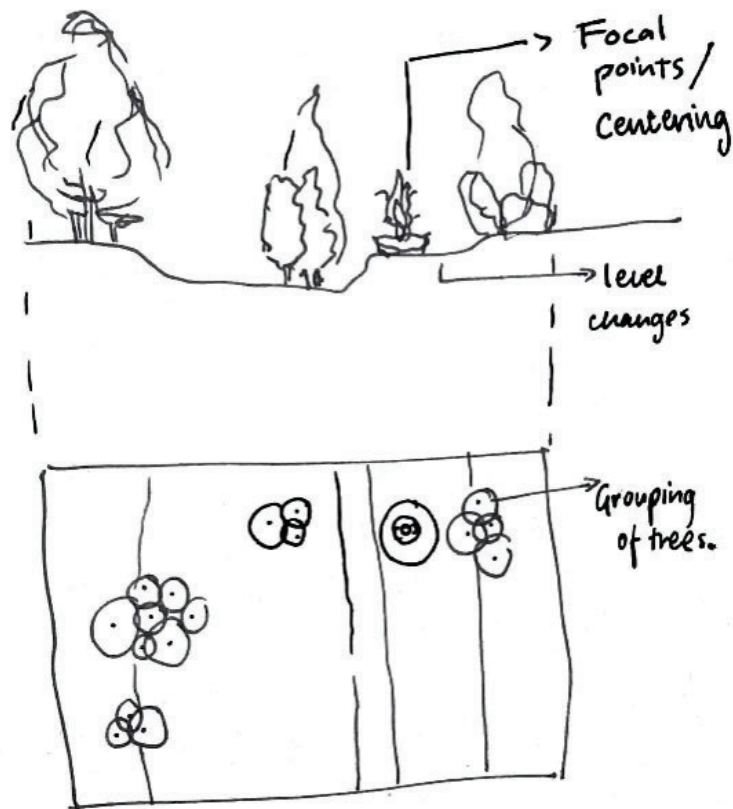


Figure 29 - Intricacy and Centring

The first two design elements include 'Intricacy' and 'Centring'. The park requires various reasons to be visited, level changes, and a climax based on Jacobs' criteria for functional parks (Jacobs, 1961, pp. 103–106).

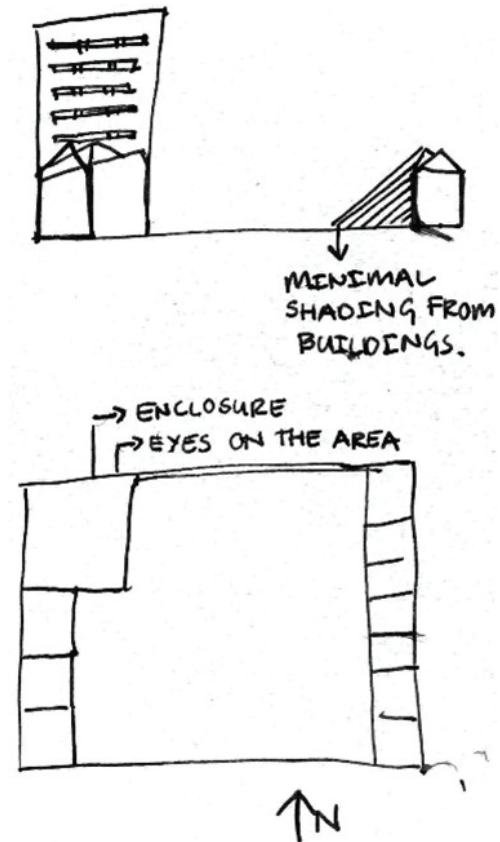


Figure 30 - Enclosure and sun

The second two design elements include enclosure and sun. The park should be enclosed and the buildings should shade minimally.

While design elements are necessary to consider, the programmes on Ninth Street are a limiting factor of the site perpetuating the above-mentioned concerns. The benefit of the positioning of Grant Avenue is that the street has an abundance of shops and services and a continuous lively sidewalk. A perpendicular street to the park's street with the above characteristics has been noted to assist other successful park precedents (Jacobs, 1961, p. 95). The diversity of the programmes and functions assists with creating a user group that is diverse in schedules, which has the power to create a thriving park (Jacobs, 1961, p. 97, 1961, p. 101).

To tap into the market and user group of Grant Avenue, Ninth Street will have to become an extension of the already thriving area and have to support “demand goods” instead of “impulse sales” (Jacobs, 1961, p. 107). The requirement for additional programmes to the site is that the park will not function as a ‘generalised park’ and will have better chances if it functions as a ‘specialised park’ due to its positioning and surrounding programmes (Jacobs, 1961, p. 108). The design incorporates a multi-faceted programme with demand for goods such as food that could be more affordable than the surrounding stores, creating a selling point for users

to visit the site. With the proposed design, there is a confident expectation that the community centre across the road will experience increased visibility and attract a larger pool of potential users. The intention is that the project will become “a creature of its surroundings and of the way of its surroundings generate mutual support from diverse uses” (Jacobs, 1961, p. 98) and this will result in a more viable, usable programme for both the proposed design and the community centre.

Poverty, pollution, and access

South Africa's deeply unequal society and general rural-to-urban movement patterns have resulted in a large population of impoverished people and vagrants living in Johannesburg. The following theory examines why this has happened, the possible effects, how the government could assist, and whether the proposed project would be useful to this context.

4.2 Issues of migration

Why is there migration to the city, is it beneficial to the individual or the society?

The migration from rural regions to Johannesburg can be understood by considering what the city can offer compared to rural life; the city has more job opportunities at higher salaries, improved access to socialised healthcare, access to social benefits, and possible educational opportunities to aid their children's future (Rieniets et al., 2014, p. 11) . Of course, people will try to move to the city because it can offer a better quality of life. With that being said, there is much a miss with living in a city; "the increase in social risks correlates directly with the growth of a city, as does the increase in wealth and productivity. With every doubling of the number of inhabitants, cases of disease and criminality also rise by 15% per capita"(Rieniets et al., 2014, p. 14)¹.

The increase in health issues due to air and water pollution, a lack of community, a lack of generational support in the home, and an increased cost of living

contribute to this. The reasons to move to the city do outweigh the reasons not to; this is useful for society due to the significant progress in social, cultural, and intellectual spheres that cities promote and achieve – the educational opportunities increase the opportunities to specialise, which in turn offers more opportunities for the urban labour market, letting individuals use their skills most efficiently and productively (Rieniets et al., 2014, p. 9).

This information is relevant as Orange Grove has seen a significant increase in people who have migrated from more rural areas (South African Research Chair in Spatial Analysis and City Planning, 2017, p. 5). People moving to the city put additional stress on infrastructure and city services that are struggling with the increasing population; Orange Grove currently has failing service delivery as the infrastructure has not been updated to contain the

exponential growth. This failure is not the shortfall of the individual but rather the shortfall of a government that is elected to maintain and update these kinds of infrastructures. Impoverished people (seeking employment) moving to a South African city has a list of positive outcomes such as "reduc[ing] relation growth, as cities all over the world have lower birth rates than rural areas. They alleviate the lack of education, as their level of education of the migrants' children and grandchildren rises. And they create wealth, because they offer better income opportunities in the surrounding countryside, albeit at a lower level" (Rieniets et al., 2014, p. 12).

¹City as Resource by Rieniets et al is a collection of work from Professor Kees Christiaanse at ETH Zurich, edited by teaching collaborators. The book is based on Professor Kees Christiaanse's work, he is an internationally renowned urban design practitioner and teacher.

The migration from more rural areas to Orange Grove may positively impact the project as the locals may have useful experience in small farming techniques and could help share their knowledge to improve practices. The project could help inform the locals about waste disposal, such as the process of biogas digestors that are more prevalent in urban spaces.

Service delivery, such as waste disposal, is split between multiple layers of governance and needs to be reviewed as it regularly fails due to bureaucracy. The relationship between local, city, provincial, and national governance is complex. The national departments are responsible for the service delivery of water, sanitation, and electricity (Palmer et al., 2017, p. 63). The Department of Water and Sanitation is responsible for water resource infrastructure and supporting municipalities with service delivery (Palmer et al., 2017, p. 63). The Department of Energy is responsible for electricity generation and transmission as a national function; they regulate municipal undertakings (Rieniets et al.,

2014, p. 63). The Municipal Systems Act (RSA, 2000) integrates “performance management, monitoring, and evaluation practices with respect to the local government” (Palmer et al., 2017, p. 86). Section 46 of the Act requires that all municipalities submit an annual performance report to their provincial member of the executive council (MEC), Section 47 requires the MEC to report on all municipalities in the province to the national minister for local government (Section 47), and section 48 requires the Minister of Cooperative Governance to consolidate this information nationally (Palmer et al., 2017, p. 86). This reporting system has not succeeded due to insufficient definition of performance indicators, comparing performance across multiple municipalities with different priorities, and poor reporting and consolidation of information of provinces and the National Department of Cooperative Governance (Palmer et al., 2017, p. 87). This has resulted in failure and lack of maintenance in municipalities as the departments are unaware of the failing systems requiring assistance (Palmer et al., 2017, p. 87).

4.3 Urban design principles and dialogue orientated urban transformation

Existing urban design and possible design choices

The trends of modernist urban design implemented by designers such as Ebenezer Howard tried to reduce the previously mentioned risks to provide greater security and comfort for users (Campbell, 2011, p. 17; Rieniets et al., 2014, p. 15). As a result of this, urban design principles such as spatial separation and distancing have been adopted into urban design layouts (Rieniets et al., 2014, p. 15). Multizone areas have been simplified into single functional zones, cars are seen as a priority, and pedestrians have been removed from the roads (Campbell, 2011, p. 17) (Rieniets et al., 2014, p. 15). This planning has backfired in many areas and works against the idea of Jane Jacob's "eyes on the street" for the safety of areas (Jacobs, 1961), resulting in areas that are only functional during the day and dangerous at night/weekends. "Eyes on the street" refers to the concept that people from different programmes and spaces should view public spaces at different times of the day – an example would be an apartment block and restaurant overlooking a park (Jacobs, 1961). To counteract these issues, the following needs to be considered for the project:

"The biggest challenge for contemporary urban design is, therefore, to plan the city itself as a regenerative cycle, not only in terms of shaping its spatial and aesthetic qualities, but also in relation to its development over time" (Rieniets et al., 2014, p. 1).

Johannesburg and the neighbourhoods of the project are rapidly changing – the overarching reason that people are still moving to these spaces is that the amenities of the countryside do not match those in the city as they do in countries that are further developed (Rieniets et al., 2014, p. 12). As the country further progresses and the wealthy emigrate – there is no certainty for what the future of this area holds. The project and programme have been designed to house aspects (such as water treatment and food production) that are necessary regardless of population and have multiple income streams to protect the use of the site for the public (IOL Staff, 2023). To be able to design future urban design possibilities, it is necessary to consider potential future uses and issues. While the future is uncertain, it is possible to extrapolate current limitations and design for a range that may become relevant. If the future takes another path, the design

is linked to current knowledge and promotes core beliefs of renew-ability, diversity, and equality. All of which respond to Jane Jacobs' "Self-destruction of diversity" that is seen in the urban design process that regularly results in a homogenization of use and built form (Jacobs, 1961, pp. 241–256; Rieniets et al., 2014, p. 74). We can't design for every eventuality, but we can design for better possibilities. Designs such as mine need to integrate safe, walkable spaces on site and buildings that can accommodate change to be future-resistant. My design includes walkable spaces that are accessible, well-lit, and overlooked by apartments and pedestrians. The design features structures that can be easily changed internally and promote experience regardless of the program – creating future possibilities.

The following guidelines are based on the "Urban Design Lab (UDL) Handbook: Dialogue-oriented urban transformation processes and practical approaches from Latin America and the Caribbean" as the pillars and design principles are recent, based on reputable authors, and have many successful precedents in countries similar to South Africa to learn from (Urban design lab handbook, 2019, pp. 116–119).

The foundation rule that the following principles and pillars rely on is that urban design must be human-centered when identifying and addressing urban problems (Urban design lab handbook, 2019, p. 116).

Co-design

Use a bottom-up approach that uses input from multiple relevant stakeholders such as “local communities, experts, academic partners, and representatives from the public and private sectors”(Urban design lab handbook, 2019, p. 116). The ideal process would include a local support group and inviting the key actors in communities to participate in co-design together as a means to promote the generation of ideas and have realistic and individualised solutions while giving the community a sense of ownership over the project (Urban design lab handbook, 2019, p. 116).

Community ownership and empowerment

Community ownership is propelled by including the groups throughout the design process through the above-mentioned local support group while also including the municipality in the decision-making process to continue the core values after the designers leave (Urban design lab handbook, 2019, p. 117). Participation is often confined to informing the public about designs without two-way communication (Urban design lab handbook, 2019, p. 117). The power dynamic mimics teacher/student relationships or parent/child relationships. It is necessary to strengthen democracy and empower the community in this process by giving them the platform to voice their opinions and ideas.

Creativity and flexibility

Due to the scale of urban design, many variables may drastically change, such as time, space, people, and resources (Urban design lab handbook, 2019, p. 118).

A “Glocal” approach with in-situ activities

“Global knowledge meets local circumstances” (Urban design lab handbook, 2019, p. 118). Local users share their experiences of the site, and designers share their experiences from practice and other precedents to create a more holistic approach.

Resiliency and sustainability

Designing projects that are resilient, self-sustaining, and maintained by the community (Urban design lab handbook, 2019, pp. 118–119). Projects should be designed with co-designed dynamic solutions that empower citizens while strengthening the community. Users must identify, take care of, and contribute their skills to improve the project (Urban design lab handbook, 2019, p. 119). While it is difficult to achieve all the above in this thesis due to ethical clearance limitations and time constraints, I have incorporated as many of the above criteria that would be possible in this scenario by interacting with the space personally, living locally, attaining information from experts in the field across each category, and interacting with academics to assist with imperative knowledge.

Pollution, energy, and the future

Unfortunately, the rise in population increases the amount of pollution and energy consumption in the city at a faster rate than in rural areas. Not just in Johannesburg but worldwide, “cities account for about 70% of the total energy requirement and about 80% of the greenhouse gases that are emitted in cities. This is despite the fact that only around 50% of the world’s population is city dwellers” (Rieniets et al., 2014, p. 19). The high energy consumption of Johannesburg can be seen as a result of dependency on the long-term availability of cheap energy (Rieniets et al., 2014, p. 19). We can now see this as a cruel joke in South Africa as we continue to have coal as our primary energy source and load-shedding for months on end.

The structures in the city were designed to use a high level of this cheap, dirty energy to operate and maintain – a choice that has had a negative impact on economics, the environment, and the livelihoods of so many (Rieniets et al., 2014, p. 19). Any structure that is built or retrofitted needs to be considerate of this information and attempt to alleviate some of the strain on the system and the environment. Today, making cities environmentally friendly and resource efficient is therefore one of the most important tasks of policy and planning” (Pawlyn, 2016, p. 1; Rieniets et al., 2014, p. 19). The following sustainability guidelines are all connected to reducing excessive consumption that is ubiquitous in the industry.

Construction and use of buildings should:

- **Use a minimal amount of energy, making use of passive green technologies** (Rieniets et al., 2014, p. 20). Regardless of the project generating clean energy, the overarching issue is overconsumption.
- **Use a minimal amount of space** (Rieniets et al., 2014, p. 20). It would be ideal to retrofit a building for projects to use existing structures that do not have working programmes to reduce unnecessary carbon emissions. Instead, this project intends to create a precedent for growing construction materials and to act as a carbon sink.
- **Reduce how many vulnerable resources are used** (Rieniets et al., 2014, p. 20). The project cleans water, one of the vulnerable resources that are frequently wasted in construction. The project improves the microclimate by planting indigenous plants, improving the river's water quality, and maintaining a green space in a built-up area that experiences the urban heat island effect.
- **Minimise harmful emissions during operation and construction** (Rieniets et al., 2014, p. 20). The emissions from this project are minimised with the programme and design; furthermore, it removes harmful emissions from the environment through phytoremediation (the removal of heavy metals in water) and water treatment. The project has a positive environmental and societal impact on the area as it cleans polluted water while producing organic produce.
- **If the building is demolished, to minimise the amount of pollutants left behind** (Rieniets et al., 2014, p. 20). The project uses products that can either be recycled, such as glass and aluminium, or naturally decomposed, such as bamboo, hemp, coffee grounds, and timber.
- **Be adaptable to future possibilities to increase life span and sustainability** (Pawlyn, 2016, p. 144). The project creates spaces that can be adapted internally for many possibilities by using non-loadbearing internal walls and access to natural light from clerestories.

To enhance the above guidelines, the Sustainable Development Goals have been used as criteria for this project as holistic sustainability goals; the project will be using additional sustainability criteria at a later point that are specific to design and construction (The Global Goals, 2023).

1 – No Poverty

The project starts to address **Target 1.1** (*Eradicate extreme poverty*) and **Target 1.2** (*Reduce poverty by at least 50%*) in the area by offering food provided by the soup kitchen, and by making healthy food more affordable by removing unnecessary costs in transportation (The Global Goals, 2023). The project addresses **Target 1.4** (*Equal rights to ownership, basic services, technology, and economic resources*) and **Target 1.5** (*Build resilience to environmental, economic, and social disasters*) by providing access to localized, affordable clean water and food (The Global Goals, 2023). The pandemic revealed how easy the supply chain is to break during a crisis, and the load-shedding revealed how close the system is to failure. It is necessary to build resilient projects that must not only be self-sufficient but also be localized.

2 – Zero Hunger

The programme of the soup kitchen, the shopfront to sell the produce from the on-site aquaponic farm, and Gcwalisa (a store that sells pantry items at bulk prices) are linked to **Target 2.1** (*Universal access to safe and nutritious food*), and **Target 2.2** (*End all forms of malnutrition*) (The Global Goals, 2023). The Aquaponic farm addresses **Target 2.3** (*Double the productivity and incomes of small-scale food producers*) and **Target 2.4** (*Sustainable food production and resilient agricultural practices*) as the farm has a much higher yield of produce per m² than current farming practices and will upskill the labour who work in it as it is specialised (Austin, 2023; Fish 2.0, 2015; The Global Goals, 2023). These efforts ensure that the project enhances both economic opportunities and environmental sustainability.

3 – Good health and well-being

Target 3.3 (*Fight communicable diseases*) - The water treatment of the Sandspruit helps to reduce water-borne diseases by treating water that has high amounts of sewerage (Bega, 2023; The Global Goals, 2023).

Target 3.9 (*Reduce illnesses and death from hazardous chemicals and pollution*) The project helps to alleviate water pollution in the area, and produces fruit and vegetables that are grown in non-contaminated soil or water (The Global Goals, 2023).

4 – Quality Education

Target 4.4 (*Increase the number of people with relevant skills for financial success*) The local labour is upskilled through construction skills training programmes, and in aquaponic management and maintenance (The Global Goals, 2023).

5 – Gender equality

Target 5.8 (*Promote empowerment of women through technology*) The restaurants provide free-to-use Wi-Fi in a safe enclosed area, and on Ninth street (The Global Goals, 2023).

6 – Clean Water and sanitation

Target 6.1 (*Safe and affordable drinking water*) The water treatment centre cleans the stormwater and water from the Sandspruit to help provide clean water to the community (The Global Goals, 2023).

Target 6.2 (*End open defecation and provide access to sanitation and hygiene*) A public bathroom is provided that is open for all and at the front of the site for ease of use and safety for all (The Global Goals, 2023).

Target 6.3 (*Improve water quality, wastewater treatment and safe reuse*) The project improves the water quality of the Sandspruit River and treats stormwater and its own wastewater (The Global Goals, 2023).

Target 6.4 (*Increase water-use efficiency and ensure freshwater supplies*) The project is designed with construction techniques that are majority zero-waste as minimal concrete is used on site (The Global Goals, 2023). The project uses efficient water usage, and the farm includes a closed-loop system, reducing potential water waste in agriculture by 95% (Fish 2.0, 2015, p. 5). The water treatment centre provides a freshwater supply to help reduce the number of people suffering from water scarcity.

Target 6.7 (*Protect and restore water-related ecosystems*) The water treatment facility helps to restore the Sandspruit River (The Global Goals, 2023).

Target 6.8 (*Support local engagement in water and sanitation management*) By designing the entire project as an experience for people to understand and learn from, the locals are promoted to engage in the process and management (The Global Goals, 2023).

7 – Affordable and clean energy

Target 7.2 (*Increase global percentage of renewable energy*) The aquaponic farms and restaurants use bio-gas digesters to create gas for heating, cooking, and electricity (The Global Goals, 2023). The parking lots are covered with solar panels to generate additional electricity.

8 – Decent work and economic growth

Target 8.2 (*Diversify, innovate and upgrade for economic productivity*) The varied programmes innovate the existing typologies and create additional economic potential in the area by providing job opportunities and fresh produce to the restaurants and grocers (The Global Goals, 2023).

Target 8.4 (*Improve resource efficiency in consumption and production*) The buildings are designed to efficiently clean and use water in construction and management. The produce grown on-site provides the area with easy-to-access food with minimal transportation and wastage (The Global Goals, 2023).

Target 8.6 (*Promote youth employment, education and training*) The project employs local labour and upskills them during construction (The Global Goals, 2023).

9 – Industry, innovation, and infrastructure

Target 9.1 (*Develop sustainable, resilient and inclusive infrastructures*) The infrastructure is designed to be resilient against failing municipal services by decentralising water treatment, food production, and energy generation (The Global Goals, 2023).

Target 9.4 (*Upgrade all industries and infrastructures for sustainability*) The project upgrades aquaponic farming for sustainability by cleaning the water available on the land (The Global Goals, 2023). The use of aquaponic farming instead of commercial dry-land farming is highly sustainable as it uses 90% less land and 95% less water (Fish 2.0, 2015).

10 – Reduced inequalities

Target 10.1 (*Reduce income inequalities*) The grocers and aquaponic farm store provides the community with affordable, healthy food. The soup kitchen provides food to those who are classified as extremely impoverished (The Global Goals, 2023). The workshops provide rent-controlled studios for local artists to make and sell products.

11 – Sustainable cities and communities

Target 11.3 (*Inclusive and sustainable urbanization*) The decentralisation of services allows each community to be self-sufficient; this project aims to be a precedent for other communities (The Global Goals, 2023).

Target 11.7 (*Provide access to safe and inclusive green and public spaces*) The local park on which the project is situated remains for public access and is maintained by the project for safety (The Global Goals, 2023).

12 – Responsible production and consumption

Target 12.2 (*Sustainable management and use of natural resources*) The water treatment centre and aquaponic farm promote the sustainable management and use of water and plants (The Global Goals, 2023). All materials used on-site for construction promote the sustainable use of natural resources.

Target 12.3 (*Halve global per capita food waste*) The bio-gas digesters process any natural off-cuts or bones from on-site restaurants, aquaponic farms, and workshops into piped gas (The Global Goals, 2023). The community can contribute their household waste to the bio-gas digesters.

Target 12.8 (*Promote universal understanding of sustainable lifestyles*) The entire site is designed to be an experience and to teach the users about sustainable practices in farming, water treatment, construction, and lifestyle (The Global Goals, 2023).

13 – Climate Action

Target 13.5 (*Promote mechanisms to raise capacity for planning and management*) By decentralising food production and water treatment, there is an increased capacity for future planning (The Global Goals, 2023).

14 – Life below water

Target 14.4 (*Sustainable fishing*) Aquaponics is a sustainable fishing method; the fish are bred in captivity, and careful consideration is taken regarding feeding and nutrients for the fish as the water has to be a high standard to grow the plants (Austin, 2023; The Global Goals, 2023).

Target 14.9 (*Support small-scale fishers*) The aquaponic farm is a small-scale fishing centre. The fish is fresh, well cared for, and fed high-quality food (Austin, 2023; The Global Goals, 2023).

15 – Life on land

Target 15.1 (*Conserve and restore terrestrial and freshwater ecosystems*) The water treatment centre restores the water of the Sandspruit River through phytoremediation and the aforementioned 7-step process (Mashilo, 2018; The Global Goals, 2023).

Target 15.8 (*Prevent invasive alien species on land and in water ecosystems*) The bamboo used for phytoremediation is a non-invasive alien plant to assist in the removal of heavy metals. The rest of the site uses indigenous plants and existing non-invasive aliens (Bian et al., 2020; The Global Goals, 2023).

16 – Peace, Justice, and strong institutions

Target 16.6 (*Develop effective, accountable and transparent institutions*) The project is designed to be a supportive, reliable infrastructure for the communities of Norwood and Orange Grove (The Global Goals, 2023).

17 – Partnerships for the goals

Target 17.7 (*Promote sustainable technologies to developing countries*) Aquaponics is a highly sustainable technology that thrives in urban settings such as Johannesburg due to the limitations on space and optimal temperatures (Austin, 2023; Fish 2.0, 2015, p. 2; The Global Goals, 2023).

The above information shows that my project has incorporated all relevant goals from the UN's Sustainable Development Goals by integrating programmes such as water treatment, aquaponics, and community spaces that focus on creating a more socially and environmentally conscious future.

The following infographic (Figure 31) shows the process of the project, the outputs, and what sustainable development goals are achieved by each accommodation.

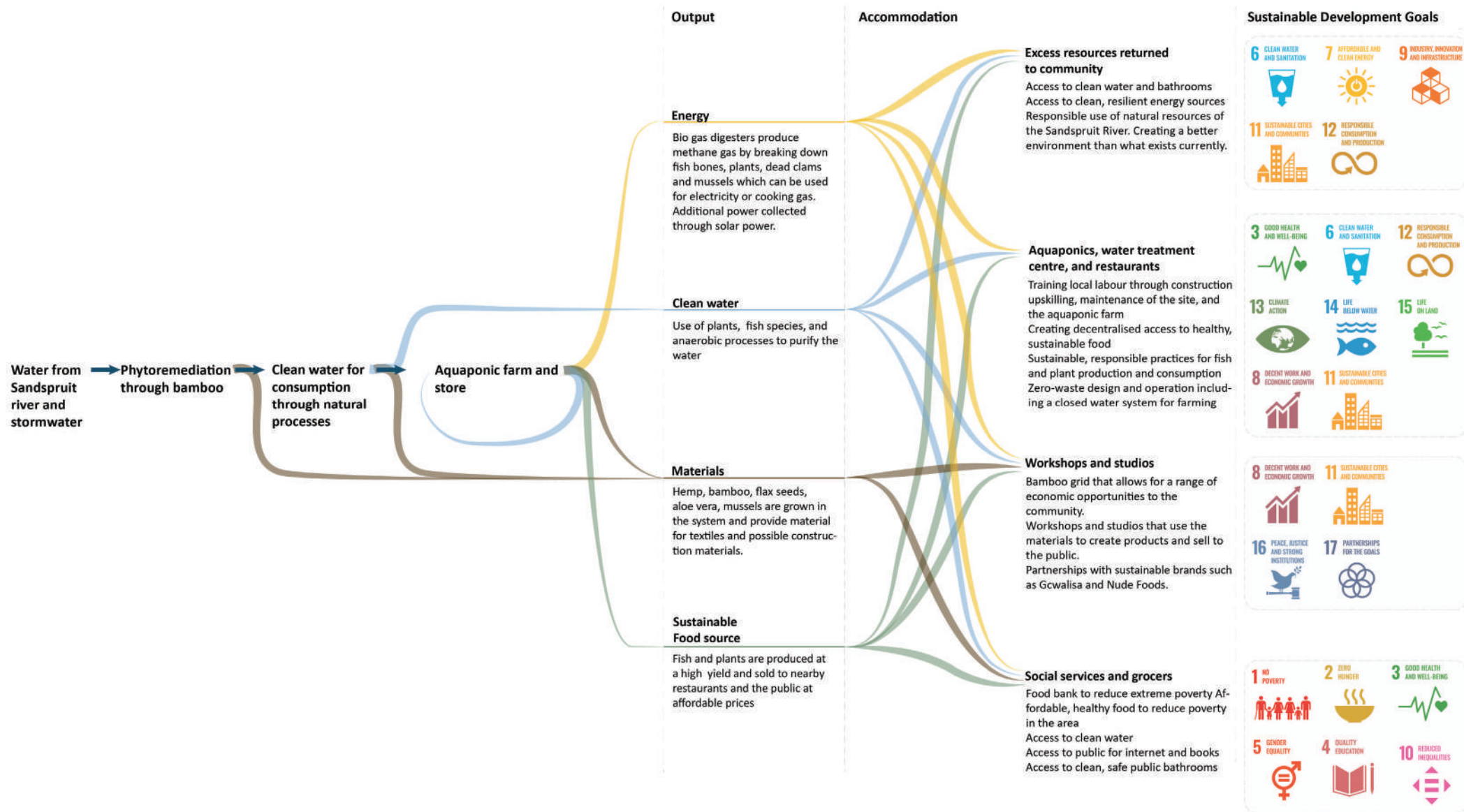


Figure 31 - Project thesis link to SDGs
(The Global Goals, 2023)

4.4 Framework for self-sustaining neighbourhoods and diversity

This project intends to assist in creating a self-sufficient neighbourhood that is resilient to an uncertain future; the theory in the following paragraphs looks at "The Death and Life of Great American Cities" by Jane Jacobs (1961), "The city as resource: texts and projects 2005-2014" by Rieniets et al. (2014), and the more recent "Circle lab for Cities" by Circle Economy (Circle Economy, n.d.) that looks at closed loop systems in neighbourhoods.

Creating programmes that are useful over a wide range of times

The project requires an infusion of programmes that would result in people in the area when the district needs them the most for "time balance; mid-afternoons (between two and five o'clock), evenings, Saturdays, and Sundays." (Jacobs, 1961, p. 158). The infusion of programmes ensures that there are eyes on the street for safety, use of the area when the residents leave for work during the day, and economic injection on weekends and evenings to keep the area lively and attractive to

people who work in the district (Jacobs, 1961, p. 158). The primary uses of the project can be seen as the restaurants, grocers, and the park at the site's entrance; the secondary uses of the site are the markets, the aquaponic farm, and workshops. This combination puts people on the streets at different times and can be economically stimulating due to this (Jacobs, 1961, p. 162) – the secondary use would be "secondary diversity" as they are enterprises that grow in response to the presence of the primary uses, "serving the people that the primary uses draw" (Jacobs, 1961, p. 162). Due to the aquaponic farm being unusual/unique in the area, if it flourishes sufficiently, then it itself will become a primary use of the site. According to Jacobs, mixing primary uses requires a mix of night and live cultural uses (not museum pieces or once upon a time) (Jacobs, 1961, p. 169). The project has considered this by including restaurants that are used during the day and evening with the bamboo grid at the entrance that has market spaces during the weekend.

Types of programs and building resilience in the neighbourhood and closed-loop systems

This project is designed with the understanding that architecture cannot solve societal issues; the programme and site design are designed to assist in creating opportunity and access to basic resources for the community. The intention is to help create a resilient community by producing useful, experiential, innovative uses for the area. The logic this project follows is that by creating diverse spaces of opportunity, the area can be “fully tapped as a resource” if the building and programme coincide with the urban design and with the district’s character (Rieniets et al., 2014, p. 28) (Jacobs, 1961, p. 158). Jane Jacobs “The Life and Death of Great American Cities” fought against the ‘loss of attractive lively and humane urban space’, with many designers attempting to redesign entire existing cities using ‘better’ types such as Ebenezer Howard’s Garden City movement (Campbell, 2011, p. 18; Rieniets et al., 2014, p. 10) that destroyed elements of the city such as “street, block, discrete public space and differentiated private space” (Campbell, 2011, p. 21).

The “Circle Labs for Cities” by Circle Economy offers a framework to support closed-loop systems in cities to help build resilience and promote sustainable lives for the users while creating cross-collaboration across city departments, industries, and businesses (Circle Economy, n.d.).

The framework consists of four sections:

1 – “Strengthen Urban-Rural links within the food system”

The central issue with the current food system is that the farms that produce the food are situated in peri-urban areas far from where the produce is required (Circle Economy, n.d.). The city should support the link of food producers in urban and peri-urban areas closer to the city to create localised, resilient food systems. The city will have more influence on how food is produced and how natural resources such as water and land are managed. This support will create local economies, encourage local seasonal diets, densified local transport networks, and a distributed system that relies upon a diverse range of suppliers (Circle Economy, n.d.). The thesis project

uses aquaponics; this version of farming is estimated to produce up to 25 times more produce than soil agriculture (90 7128kg/acre), using 95% less water than dry-land farms, and has a 90% reduction in space usage compared to dry-land farming (Fish 2.0, 2015). Essentially, the project creates a highly productive decentralised food system on a small piece of land with more than one use and can service the area, which would be in the city’s and its users’ best interest. A case study of a city that implemented a policy that supports projects such as the one designed in this thesis is “Connect the Dots - Long running project for sustainable food chain in São Paolo” by the Municipality of São Paolo (City of São Paolo, 2023). The programme supports “local farmers who transition to regenerative practices by purchasing their products at 30% more than the market value” within a 50km radius of São Paolo. While this may seem like a financial burden on the municipality, the project has led to the participation of 160 farmers, with approximately 40% successfully transitioning from conventional methods to organic or regenerative practices. This initiative has resulted in high-quality foods that are localised and better soil quality.

2 – “Self-sufficient neighbourhoods”

Self-sufficient neighbourhoods build resilience against urban sprawl and rural-urban migration patterns. A self-sufficient and socially inclusive neighbourhood ensures that it is centralised, can support its community, minimises dependency on inputs from outside the system, and maximises opportunity and interactions for its inhabitants (Circle Economy, n.d.). These kinds of communities often produce their own renewable energy, treat their own wastewater, improve the security of the area, ensure efficient resource usage, and offer new livelihood opportunities for the users while promoting local value (Circle Economy, n.d.). A valuable example of this is the town of Hammarby Sjöstad, Stockholm, Sweden, which had initially

been considered an unsafe, polluted industrial and residential area in the 1990s – but has since then been redesigned with the above characteristics and now is one of the most pleasant neighbourhoods in Sweden due to the urban renewal (“Hammarby Sjöstad, Stockholm, Sweden | Urban green-blue grids,” 2004). It is important to note that I do not mean exclusionary neighbourhoods such as Steyn City, Johannesburg, that are limited to the wealthy and create an island for them to not integrate into the rest of the town. Rather than this classist segregation, a neighbourhood that is accessible by all, not limited to the wealthy, inclusionary, and a framework for how all neighbourhoods should function.

3 – “Support local renewable energy cooperatives”

The citizens of South Africa have an intimate understanding of the shortfalls of the current energy generation system that relies heavily on fossil fuels. Unfortunately for the rest of the world, the failure of our system is a warning flag, as up to 90% of the world’s energy use is derived from fossil fuels (Circle Economy, n.d.). There are many elegant, clean, efficient ways of generating energy – using this outdated version is irresponsible at best. There are many factors as to why cities have not transitioned to clean energy; the main two factors are the land requirements for such projects and the high upfront costs (Circle Economy, n.d.). In South Africa, an additional reason is likely that the failure of a system is highly lucrative for those with a contract to fix it continuously. This failure has formed the perfect breeding environment for corruption and incompetence.

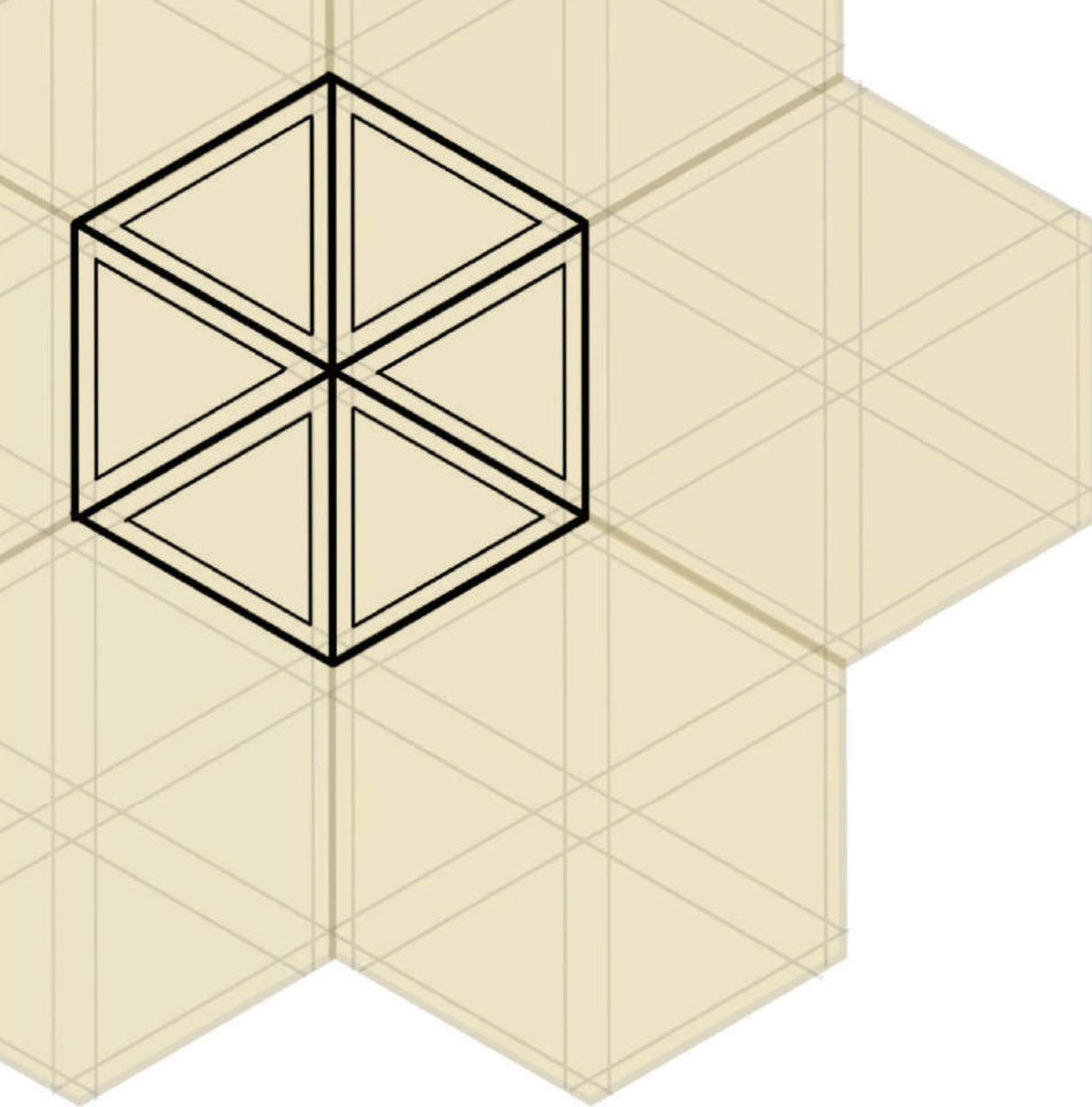
Decentralisation of the generation of renewable energy could help solve all three of these factors (Campbell, 2011, p. 59). By involving residents and potentially incorporating individual generation of power back into the grid through compensation,

there is a high generation of electricity with minimal input from the municipality. The argument against this is that the wealthy will be able to generate electricity as it is expensive to set up individually, and the subsidised citizens will not have access to as much electricity as the government will have to compensate individuals for electricity generation. The City of Joburg currently will not allow individuals to connect to the grid to aid the generation of electricity. My thought on this is to let people try – offer a reduced compensation for electricity over three months, offer that people can connect without compensation, and use the money that could be saved in the areas with many wealthy people to create low-cost solar panels in impoverished areas, get assistance from philanthropists, stop stealing from the poor. The answer cannot just be that it won’t work; it should be what can work. The project in the thesis sets up a biogas digester that the community could assist in generating gas by bringing their offcuts from home and a solar panel collection area while creating spaces accessible by the community to use when the current system has load-shedding.

4 – “Supporting solutions that maximise food, water, and energy synergies”

Sustainable development and management of water needs to be considered in multiple layers, from water resource management, ecosystem protection, water supply and sanitation. A holistic approach to dealing with the issues surrounding water is circular water systems that maximise the synergies between food, water, and energy systems (Campbell, 2011, p. 59). This synergy helps to protect water availability to “maintain agricultural production in water-scarce regions, or by recovering energy from wastewater treatment, replacing fossil fuels used for cooking or heating”(Circle Economy, n.d.). Solid organic matter, or biosolids, recovered from a sewage treatment

can also be used as a fertiliser, preventing harmful chemicals from polluting water streams so that water sources are clean and safe to drink. Biosolids can be retrieved from sewage treatment and used for energy generation or as natural fertiliser, reducing harmful chemicals in clean water sources (Circle Economy, n.d.). The thesis project is designed to clean the stormwater and wastewater on-site, use the clean water within a closed food production system, generate electricity through offcuts from the farm and then return clean water to the neighbourhood and the Sandspruit River.



Part 1

1. Introduction
2. History of Orange Grove and Norwood
3. Service Delivery
4. Theoretical Approach
- 5. Architectural Design Drivers**
6. Design - Site Analysis
7. Design Development and precedents
8. Conclusion

Part 2

Final Design

References

05

Architectural design drivers

5.1 Biomimicry

The theoretical approach set a criteria on how the public, the environment, and resource generation will be incorporated into the final design. The following section looks at the forms of the buildings, specifically through biomimicry and parametric design.

Lessons from a Gooseberry

Nature is incredibly mathematical – from fractals to growing most fruit in the most efficient shape of a sphere. It is planned and a result of elegant design in the universe, not a random collection of spirals or curves. The mathematics of nature is complex and something to be in awe of. We often treat ourselves as if we are aliens to the universe and attempt to redesign everything when we have a wealth of answers around us. Humans have designed systems that directly conflict with ecological systems; instead of diverse and distributed systems, we focus on centralisation and mono-culture; instead of closed-loop systems, our processes are linear (Pawlyn, 2016, p. 68). The Gooseberry is an apt study for an architectural design driver as it showcases lessons from nature that would improve design and construction. The following points and drawings are the lessons from studying gooseberries and text.

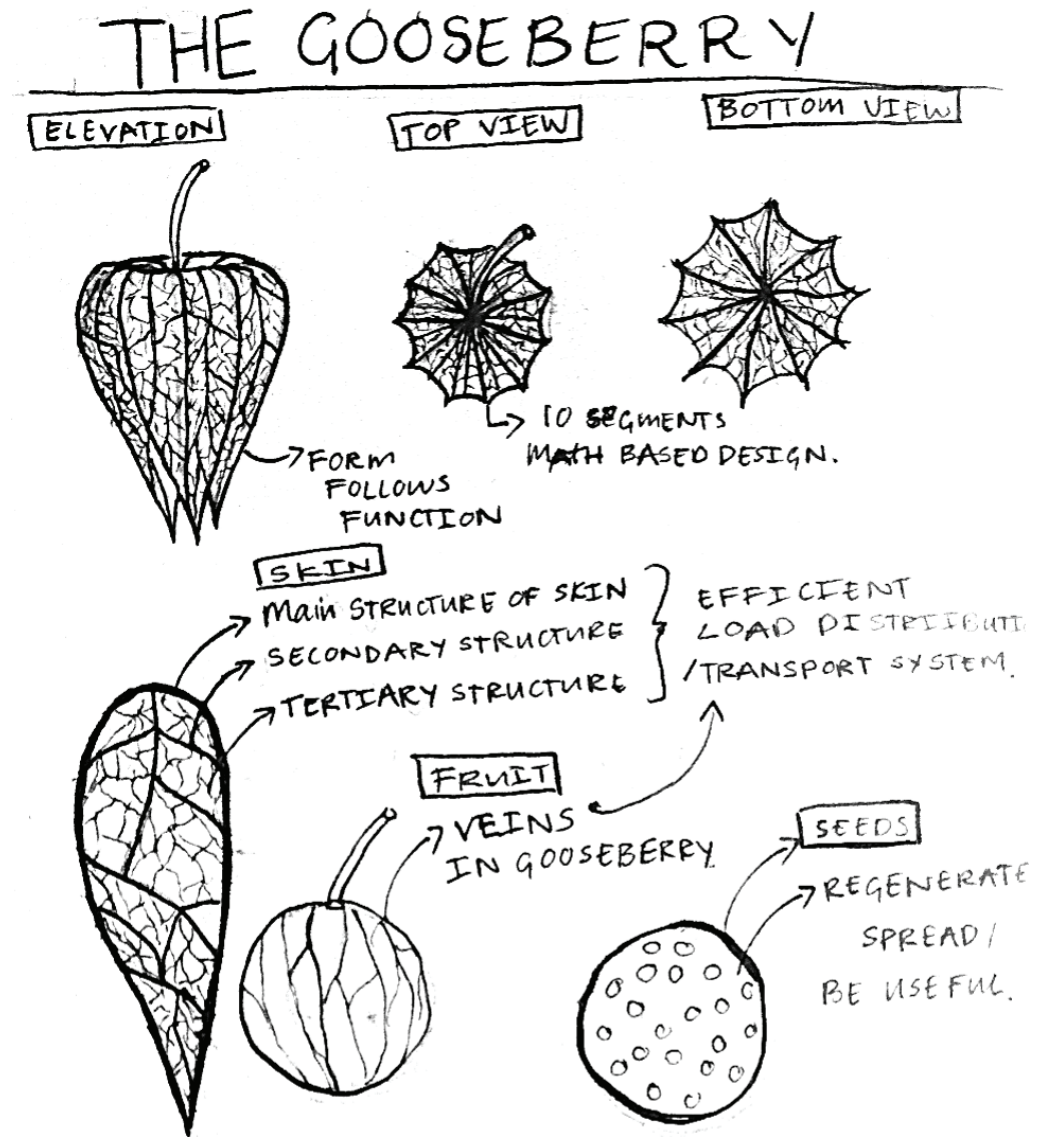


Figure 32 - Gooseberry study

Load paths, transport, and nature

In architecture, we are taught in a linear manner how load is taken through a structure. In a simplified explanation, the load from the slab splits equally into the beams; from there, the load splits into the columns and then is taken into the foundations. The load, in reality, is not that uniform; there are large pockets of unnecessary structure – as can be seen with the efficient design of waffle slabs (Pawlyn, 2016, p. 144). The logic of nature can be mimicked by using mathematics and programming. While I am not a structural engineer – I have designed the buildings for this project using Rhinoceros 3D and Grasshopper, which can assist with the efficient design of the building according to mathematics.

Every system is connected for transport – neurons transport subcellar cargo, veins transport blood, bronchi transport air, highways transport people, the air transports sound, the structure transports load, and the pen transports ink and thoughts. We can design with efficient use of materials and resources while creating wonderful structures (Pawlyn, 2016, p. 144). A brilliant case study of this logic is where researchers used slime mould in a Tokyo-like setup with food sources such as oats representing major cities in the region. The slime mould grew and interconnected the food sources. Within 26 hours, the slime mould formed a more efficient network than Tokyo's existing rail system – a system engineers had worked on for generations (Sanders, 2018).

Form follows function(s)

Form follows function is a well-known theory in architecture by Louis Sullivan (Modi, 2021), where the form of the building is derived from the functionality it serves, emphasising the importance of its purpose in shaping its design. I agree with this to a point; the theory behind this is sustainable as it ensures that the building is efficient based on the programme. The argument against this is that the pandemic revealed an abundance of unused office buildings designed to this logic – the form did follow function, but it does not serve a range of functions. I propose that when we design, we design for a future use that is not linked to a single typology but to many. By showing possible alternative plans and programmes, the future possibilities become more usable without significant reconstruction.

The gooseberry is protected by the environment by a delicate cover, one that many other berries lack. The gooseberry could survive without it, but the intricate design creates interest, beauty, and additional protection. For the thesis design, I have designed with this logic in mind that functionality is not the only use of the building; an experience of beauty and joy is necessary for success. Sustainable

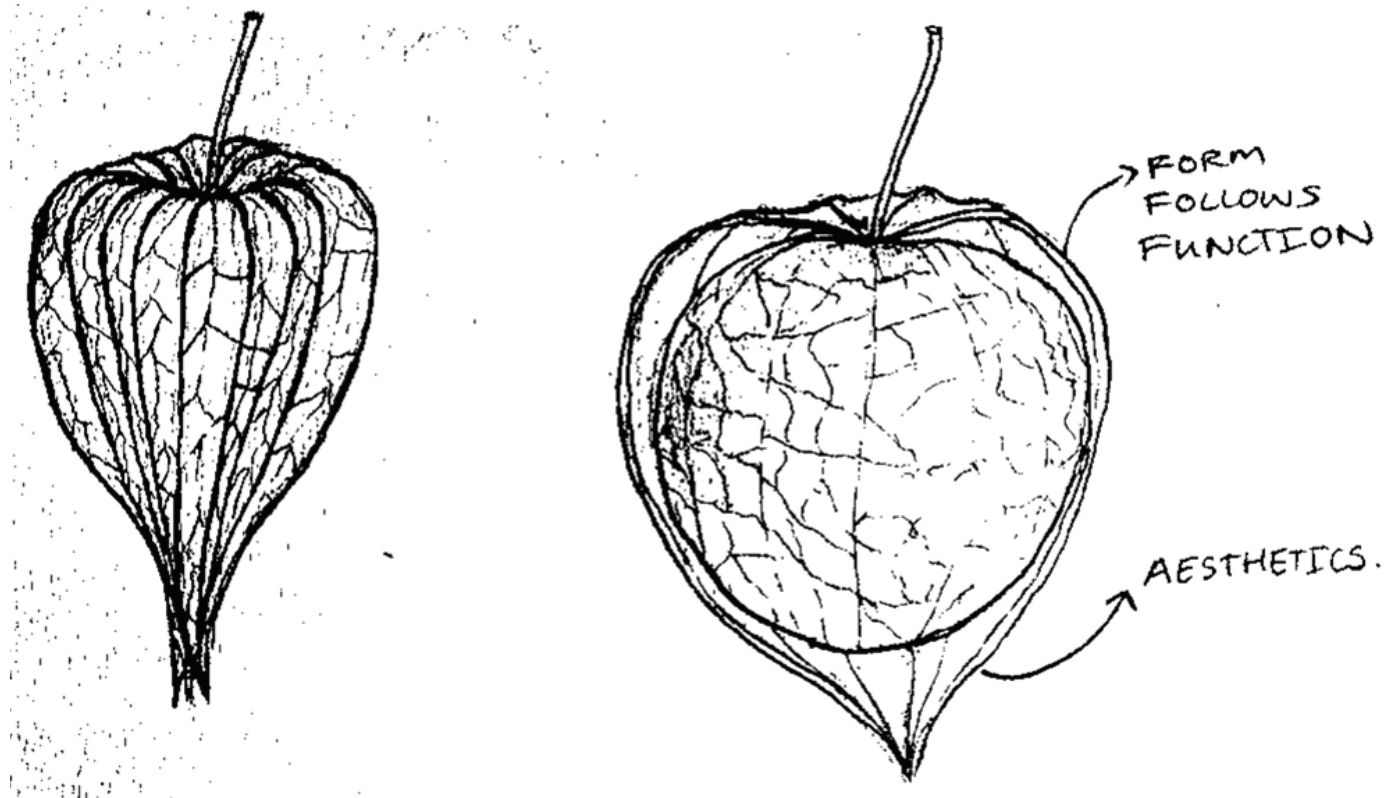


Figure 33 - Gooseberry study - form follows function

design often assumes minimalism is the only acceptable route. However, by growing all materials and using clean energy for the project, there is more freedom to incorporate aesthetics and 'frivolous' use of material for aesthetics that could return to the closed loop system once the project is demolished (Pawlyn, 2016, p. 78).

Be delicious – be an experience, change according to the season, show people when and how to consume you.

The abovementioned experience is required for the programme as it is a majorly technical programme and not one that regularly draws users in. The project is designed to make each interaction an experience through light, colour, temperature, and planting for the architecture to be a place to visit, learn, and enjoy. The gooseberry is able to share a range of experiences: sometimes sweet, bitter, dry, or juicy, and sometimes a combination of all four. Just as with architecture, these experiences change according to the season, the weather, and the time of day. As a designer, it is crucial to ensure these experiences are designed so people can enjoy the space with change. The project has been designed for multiple seasons and times of day by using changes in light and temperature.

The second lesson in being delicious is showing when and how to be consumed; the gooseberry skin changes colour and the leaves start to open up, indicating that they should be pulled apart to reveal an amber-coloured berry. The project needs to be easy to read and understand, and the public spaces clearly demarcated to show that the buildings are ready to be consumed. For humans, we can use signage, lights at night time, open areas without gating, greenery that is linked to the existing public space of the road, no change in level from the public use of the road to the project, colour, and exposing public use buildings such as restaurants quickly.



Figure 34 - Gooseberry study - life cycle

Regenerate, spread, and use outputs.

The gooseberry has a survival strategy to regenerate itself within each fruit; the seeds of a single fruit hold the capacity to regenerate the entire plants many times over and in many different areas. When walking in Johannesburg, gooseberry plants are found along highways, pathways, dumpsters, and gardens. The plant's success is multiplied as it regenerates itself over many areas as a food source for animals. Just as a gooseberry is a decentralised food source, a project such as this must be regenerated in many areas and over a wide range of areas to make a significant impact. Just as biological systems work in closed loops, it is imperative that we start to design our projects with closed-loop systems so that there is no wastage but instead that every process has an output that is used for another process (Pawlyn, 2016, p. 67).

When you are no longer useful, adapt or die.

This sentiment may sound morbid, but it is freeing. Once a project is no longer achieving what it set out to do and is failing, the best thing it can do is adapt to include different functions, or it should die and return the materials to another process (Pawlyn, 2016, p. 144). This is not the case with buildings that use high embodied energy materials such as concrete; the buildings should remain and shift their functionality, but the programme should die. The project instils the idea that nature perpetuates; waste is an opportunity (Pawlyn, 2016, p. 68). The systems in nature are the ones that this project focuses on closed-loop systems, dense connections and symbiosis, every output is used as a nutrient for another process, there are no persistent toxins in the environment, distributed and diverse programs, self-regulation, runs on clean energy, optimization of an entire system, regenerative, and uses local resources (Pawlyn, 2016, p. 68).

5.2 Parametric design

Parametric design and biomimicry are drivers that highlight the beauty of each other when used simultaneously. Parametric design is an algorithm-based method that seamlessly merges the design intent with the design outcome; essentially, it is a mathematics-based form generator through specified parameters such as dimensions, scale, effect of gravity, and structure type (Koumari, 2022). Parametric design allows for highly intricate and complex forms that can assist in creating a form that is seen as an icon to visit. The link between biomimicry and parametric design is that both are linked to parameters and algorithms for efficiency and reality. The project uses Rhinoceros 3D (and Grasshopper) with parameters that are based in nature with regard to gravity, efficiency, and load distribution. The material choice of the materials grown in the system (and coffee grounds) is natural but can be shaped into complex forms through heat, water, or compression. The importance of this choice is to show that the current trend in construction does not have to be achieved using high embodied energy materials but can still be achieved through natural materials.

Parametric design is not a new phenomenon; Antonio Gaudi designed his churches using the basic parametric principles when designing catenary arches with suspended weighted strings that could be adjusted to change the shape (Koumari, 2022). In more recent times, designers have used programs such as Rhinoceros 3D and Grasshopper to assist in this process while having more control over a broader range of parameters.

An example of this kind of design with intricate detailing and bamboo use is the Vo Trong Nghia-designed “Ting Xi Bamboo Restaurant” in a suburban area by forestry near the centre of Xiamen (designboom, 2017). The following pages show how the building works and the floor plans.



Figure 35 - Render of Ting Xi Bamboo Restaurant

(Vo Trong Nghia Architects, 2017)



Figure 36 - Construction of Ting Xi Bamboo Restaurant

(Vo Trong Nghia Architects, 2017)

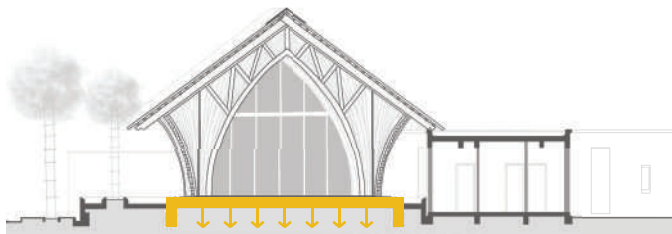
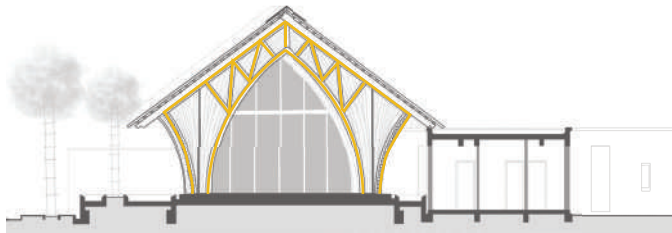
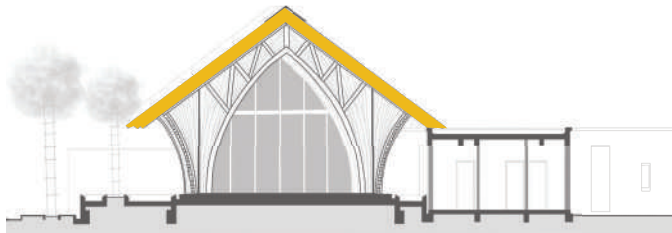
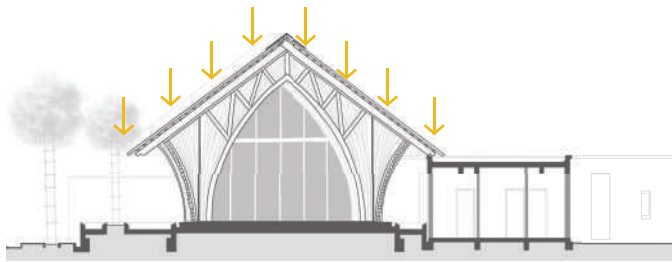


Figure 37 - Load diagram of Ting Xi Bamboo Restaurant
(Vo Trong Nghia Architects, 2017)

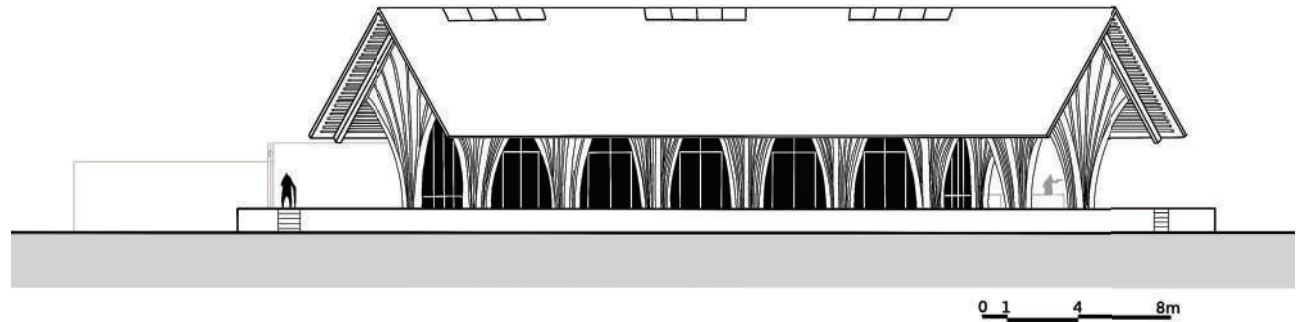


Figure 38 - Elevation of Ting Xi Bamboo Restaurant
(Vo Trong Nghia Architects, 2017)

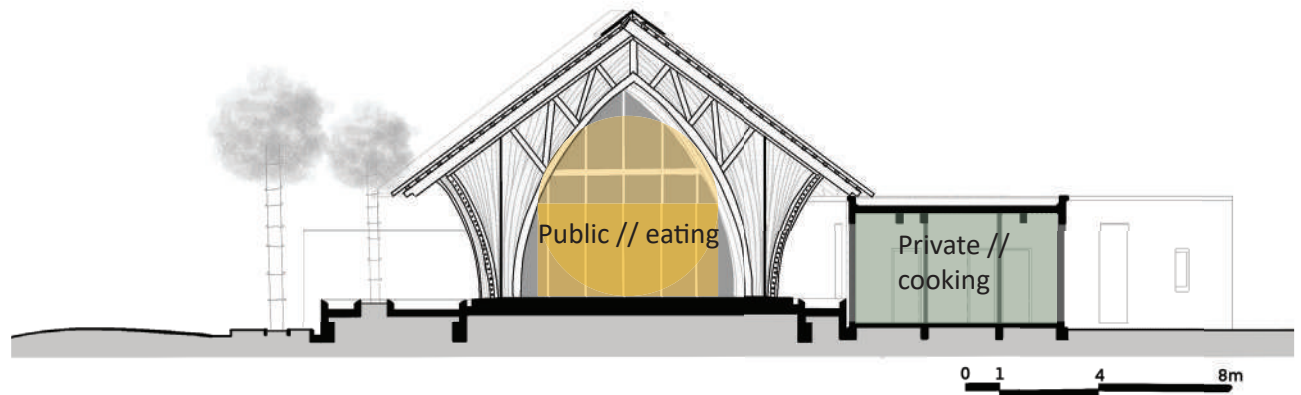


Figure 39 - Section through Ting Xi Bamboo Restaurant
(Vo Trong Nghia Architects, 2017)

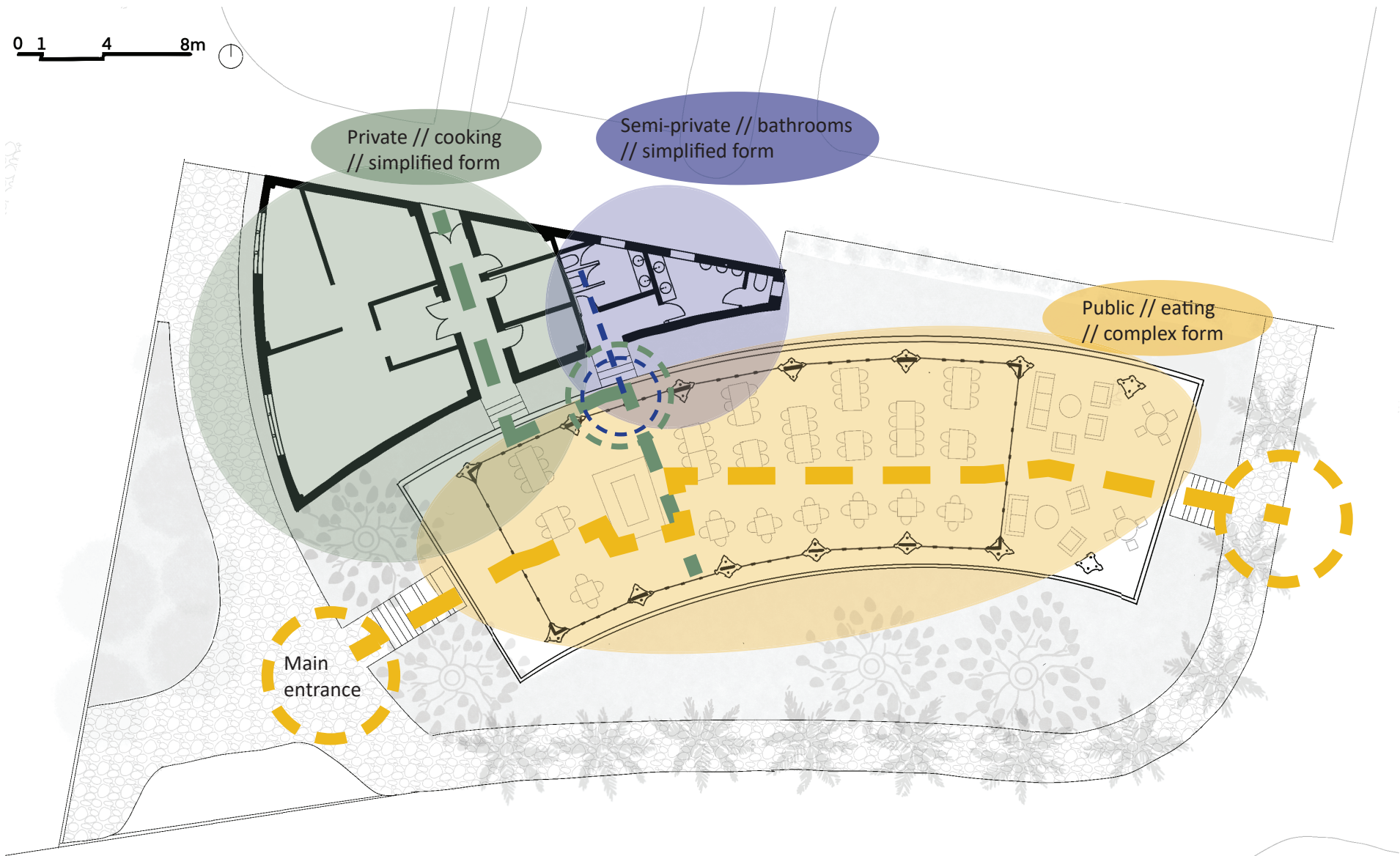
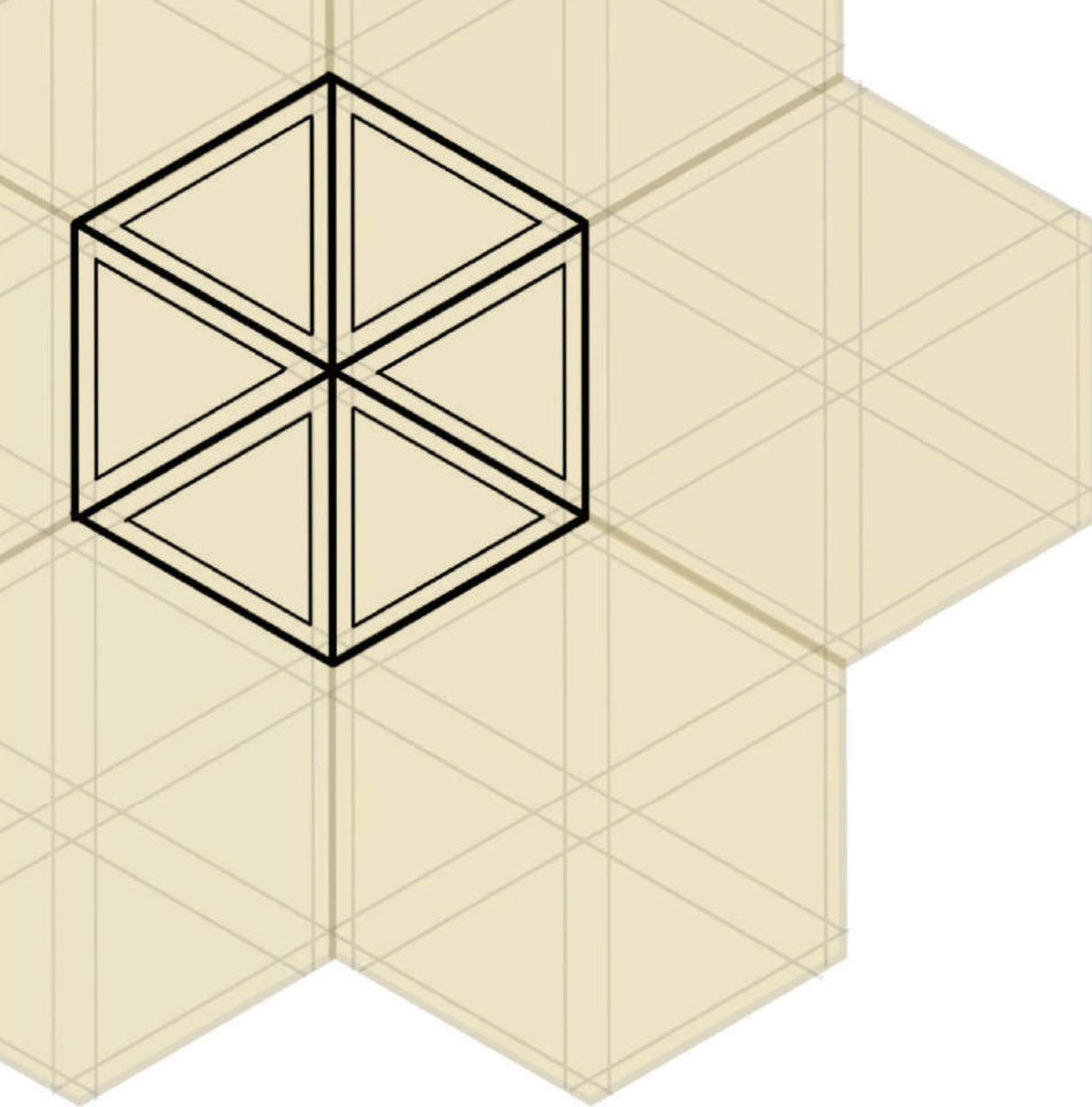


Figure 40 - Ground floor plan of Ting Xi Bamboo Restaurant
(Vo Trong Nghia Architects, 2017)



Part 1

1. Introduction
2. History of Orange Grove and Norwood
3. Service Delivery
4. Theoretical Approach
5. Architectural Design Drivers
- 6. Design - Site Analysis**
7. Design Development and precedents
8. Conclusion

Part 2

Final Design

References

06

Design

Site selection, site analysis, proposed UDF.

The project has been designed to benefit “diverse cultures and income groups, enhance the local environment, and improve community infrastructure” (Glanville, 2023b, p. 5). A crucial consideration is addressing the challenge of sustainable maintenance plans during the construction phases to prevent deterioration of public areas— this has been mitigated through careful design of the phasing to ensure the project’s usability at each stage (Glanville, 2023b, p. 5).

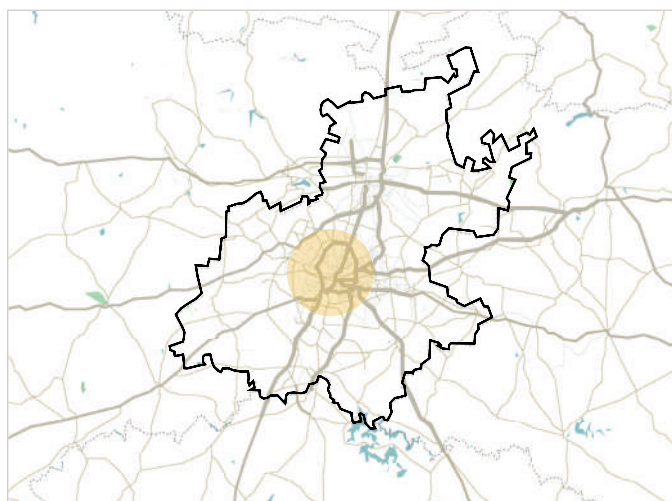
The Grant Avenue Precinct Plan expresses numerous changes to the precinct to make it more usable and rejuvenated; 9th Street, where the site is located, will have medium-rise residential developments to the west of the site linking to Grant Avenue (MetaCity

Architects, 2016, p. 103). The road will be changed to incorporate suitable footpaths to increase foot traffic and pedestrian safety with additional street lighting (MetaCity Architects, 2016, p. 103). The Precinct plan for the chosen site is to maintain it as a park for the area (Glanville, 2023b, p. 5; MetaCity Architects, 2016, p. 51). My design maintains the park while improving productivity and usability by making it a “specialized park”(Glanville, 2023b, p. 5). The project encompasses the current proposal of the precinct plan and aims to improve it (Glanville, 2023b, p. 5). The changes to the area with increased residential will increase potential foot traffic and use of the park on weekends, potentially increasing the project’s viability (Glanville, 2023b, p. 5).

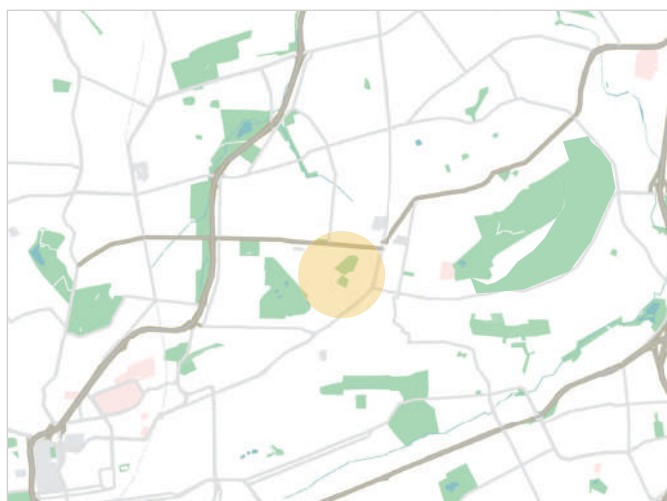
6.1 Site Analysis



Figure 41 - Project Location in Country (AfriGIS (Pty) Ltd, 2017)



Gauteng Province, Johannesburg



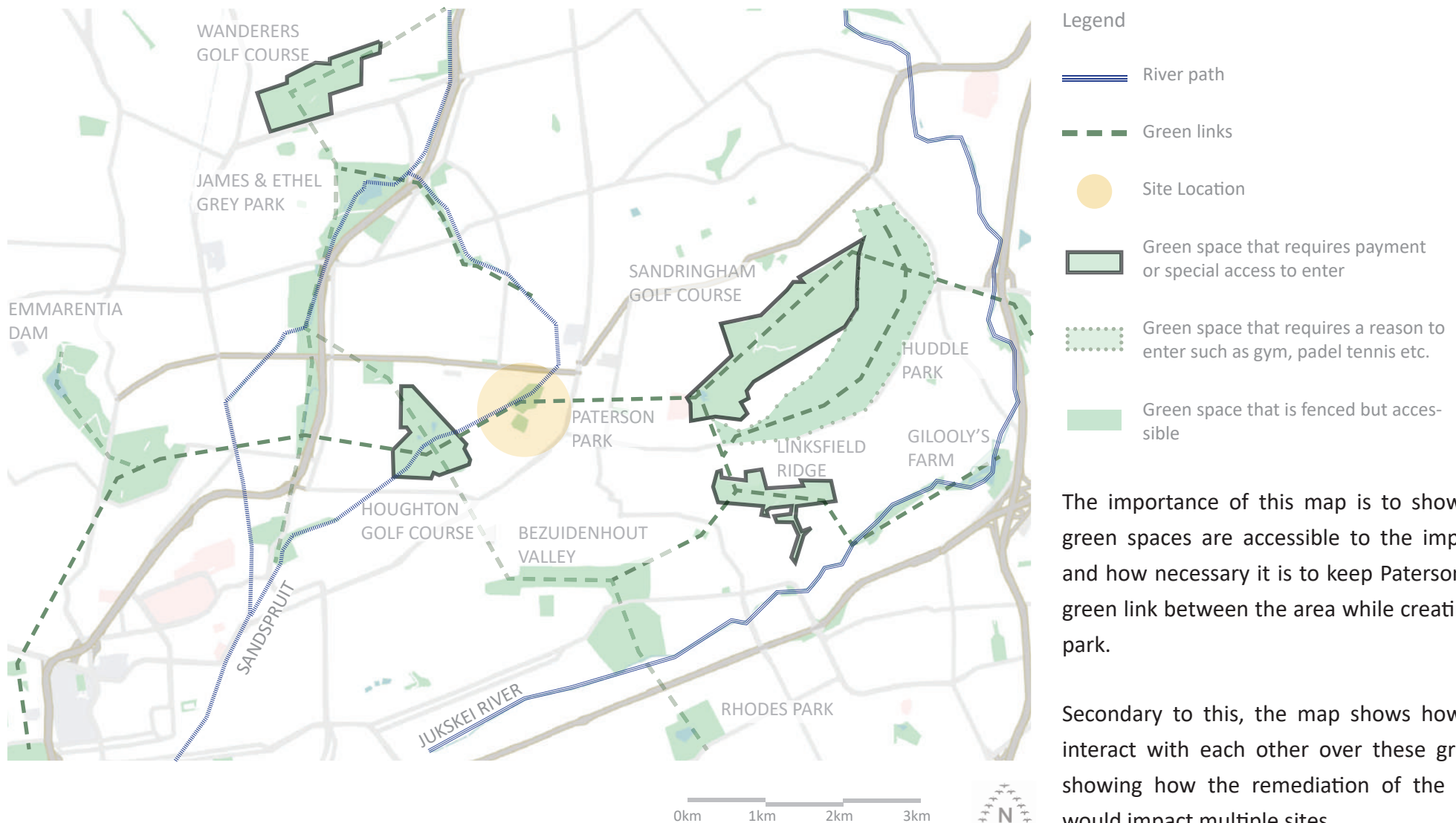
Norwood and Orange Grove Neighbourhoods



Paterson Park on Ninth Street



Figure 42 - Location of the Project at multiple scales (AfrigiS (Pty) Ltd, 2017)



The importance of this map is to show how few green spaces are accessible to the impoverished, and how necessary it is to keep Paterson Park as a green link between the area while creating a public park.

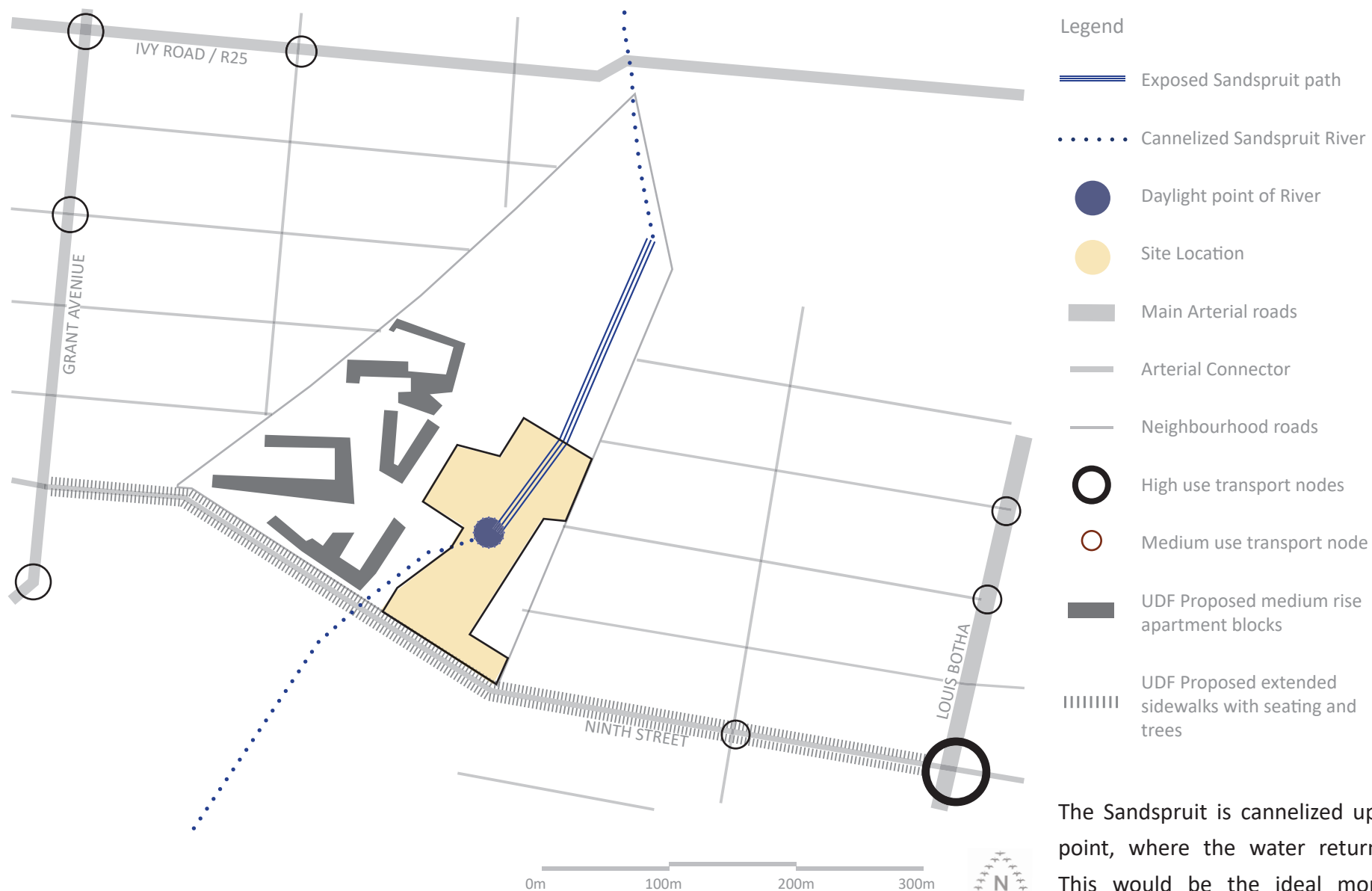
Secondary to this, the map shows how the river interact with each other over these green spaces, showing how the remediation of the Sandpruit would impact multiple sites.

Figure 43 - Green structures, green links of the area, and accessibility of green spaces (AfriGIS (Pty) Ltd, 2017)



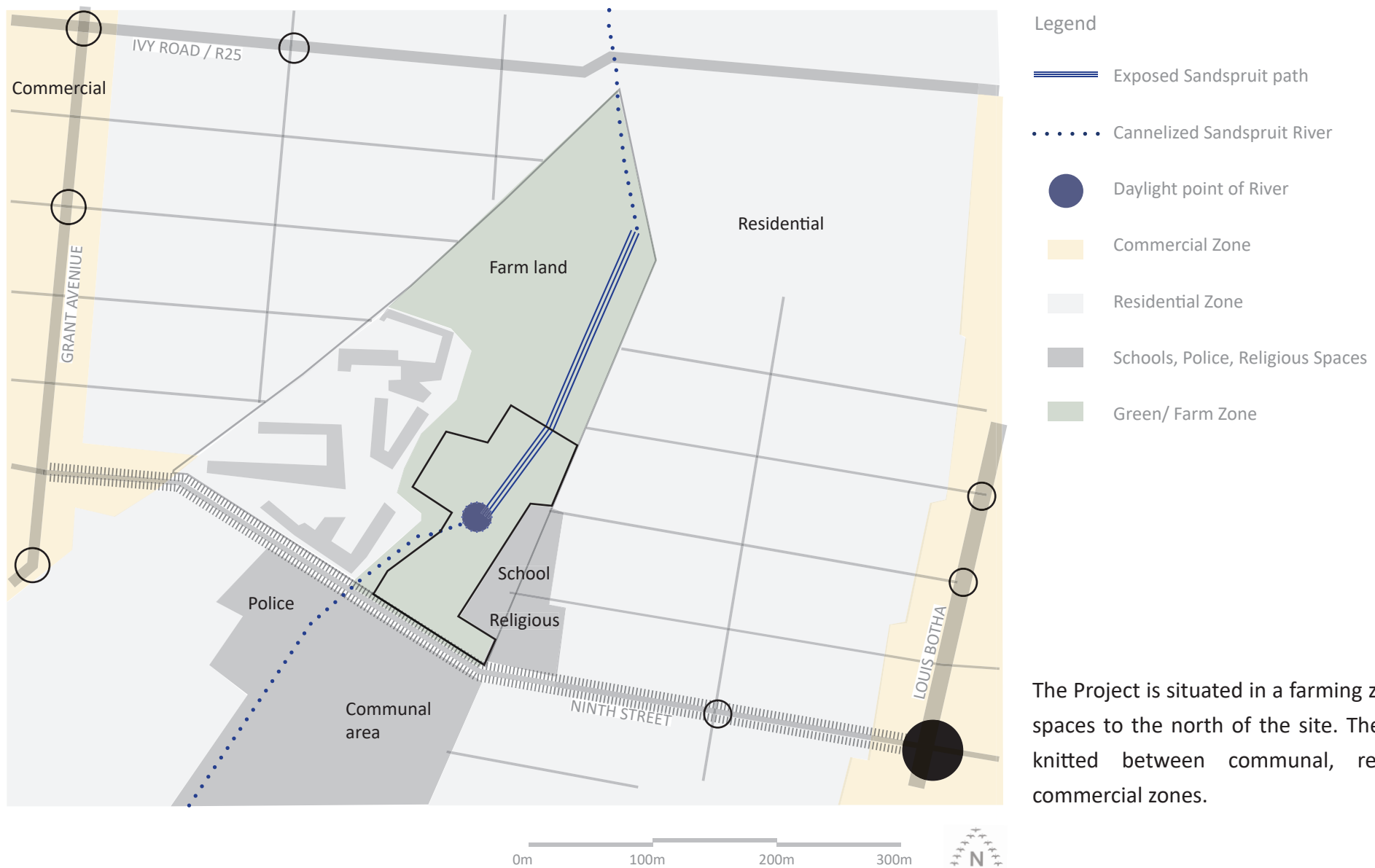
Paterson Park is an ideal position due to value as a green structure, the access to the polluted water of the Sandspruit, the nearby transport nodes, and a range of incomes.

Figure 44 - Arterial Roads, and Transport Nodes of the area (AfriGIS (Pty) Ltd, 2017)



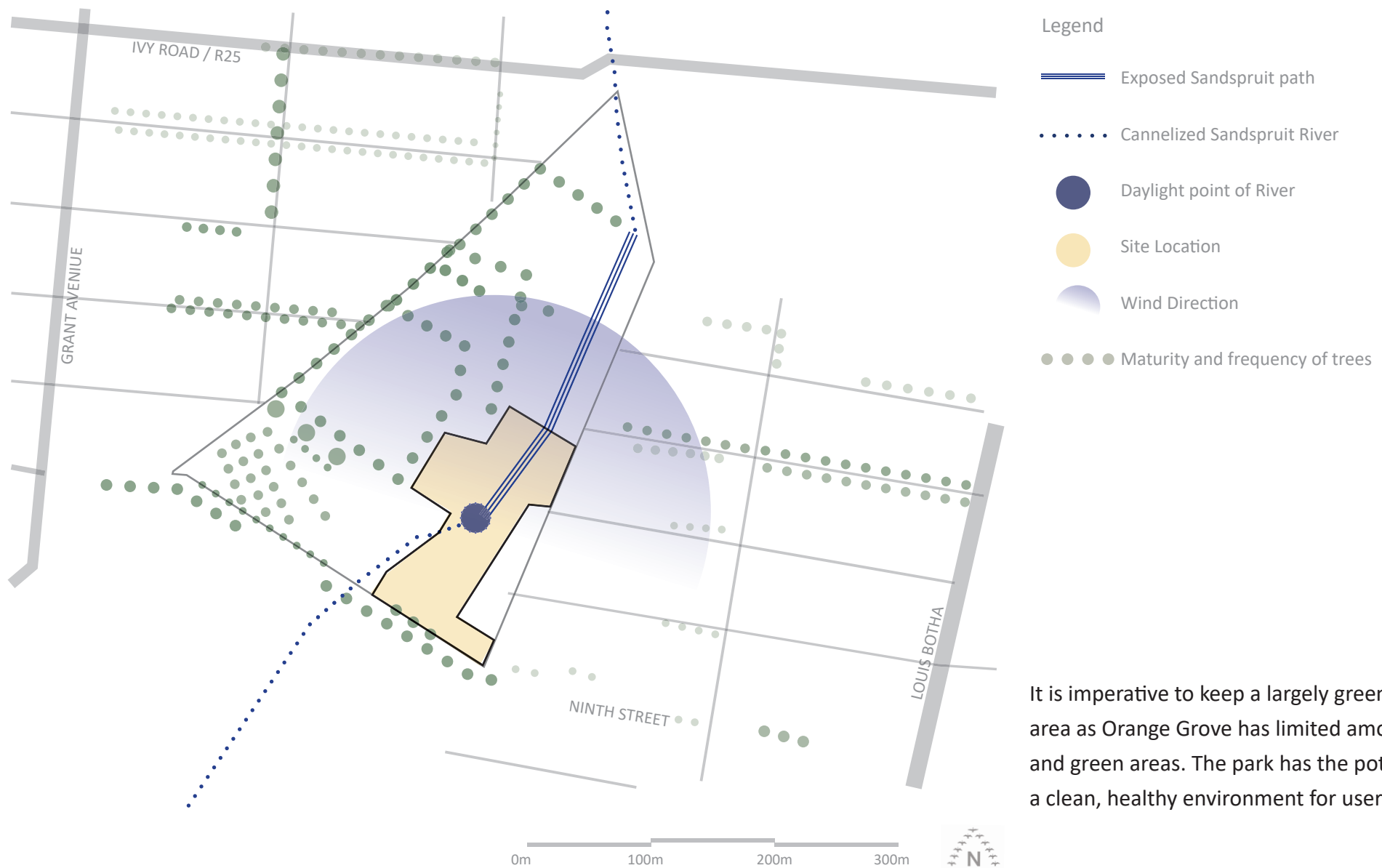
The Sandspruit is cannelized up until the daylight point, where the water returns to the surface. This would be the ideal moment to create a phytoremediation pond before the water enter the water treatment centre.

Figure 45 - Transport Nodes of the area (AfriGIS (Pty) Ltd, 2017)



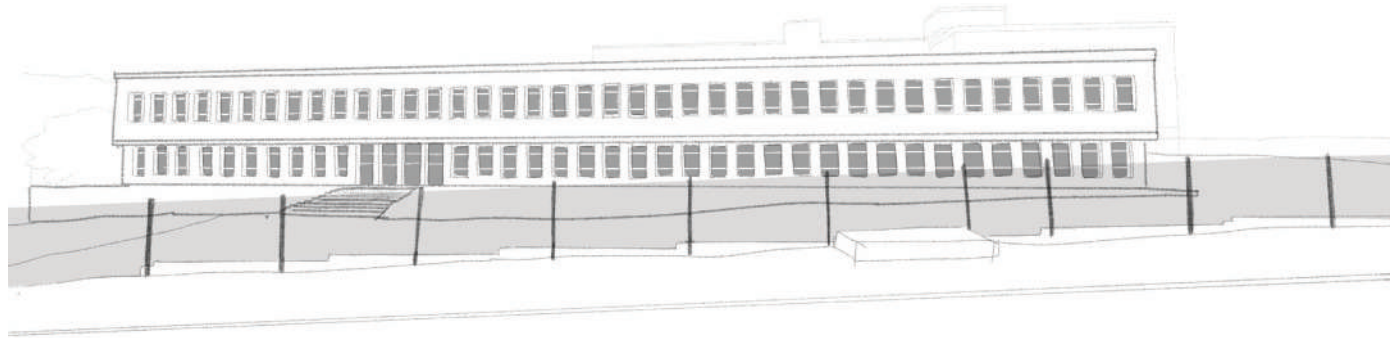
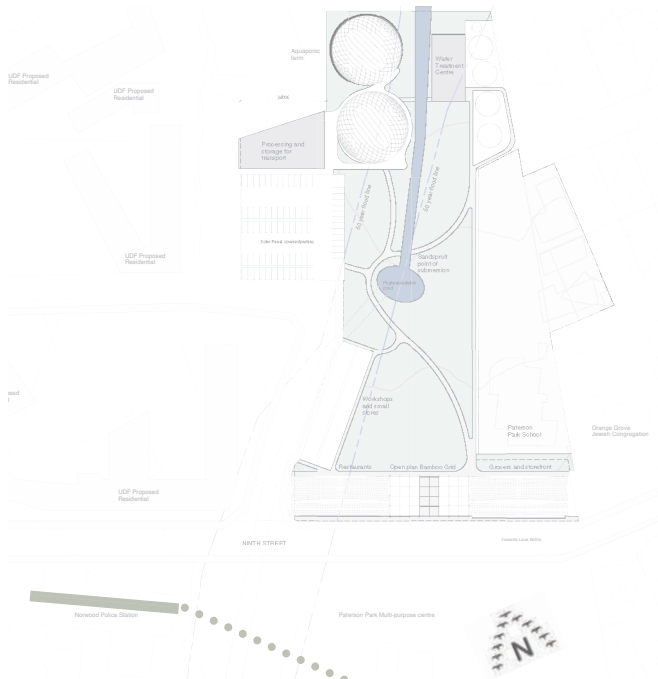
The Project is situated in a farming zone with green spaces to the north of the site. The site is closely knitted between communal, residential, and commercial zones.

Figure 46 - Zoning map (AfriGIS (Pty) Ltd, 2017)



It is imperative to keep a largely green space in this area as Orange Grove has limited amounts of trees and green areas. The park has the potential to crate a clean, healthy environment for users of the area.

Figure 47 - Trees and Wind direction (AfriGIS (Pty) Ltd, 2017), (Meteoblue, n.d.)

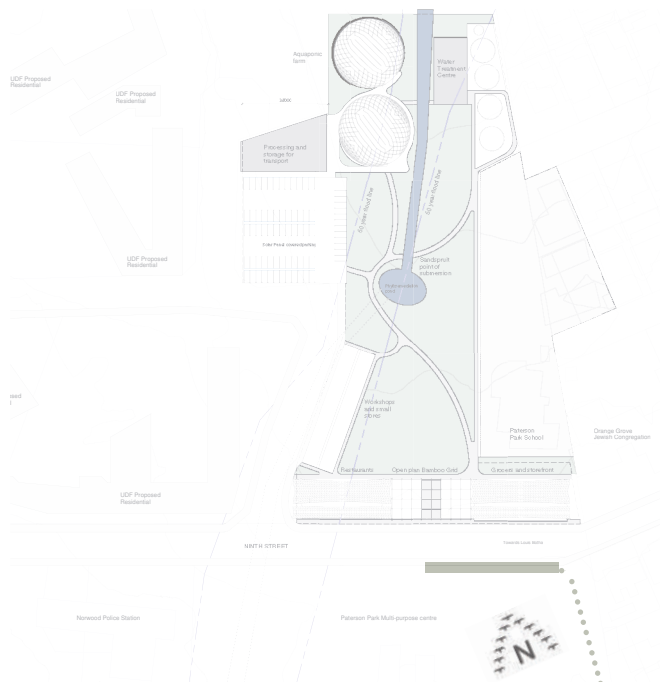


Colour Palette

-  Brown Facebrick
-  Painted Slab
-  Painted Steel Window frames
-  Sidewalk and Road
-  Plants in background

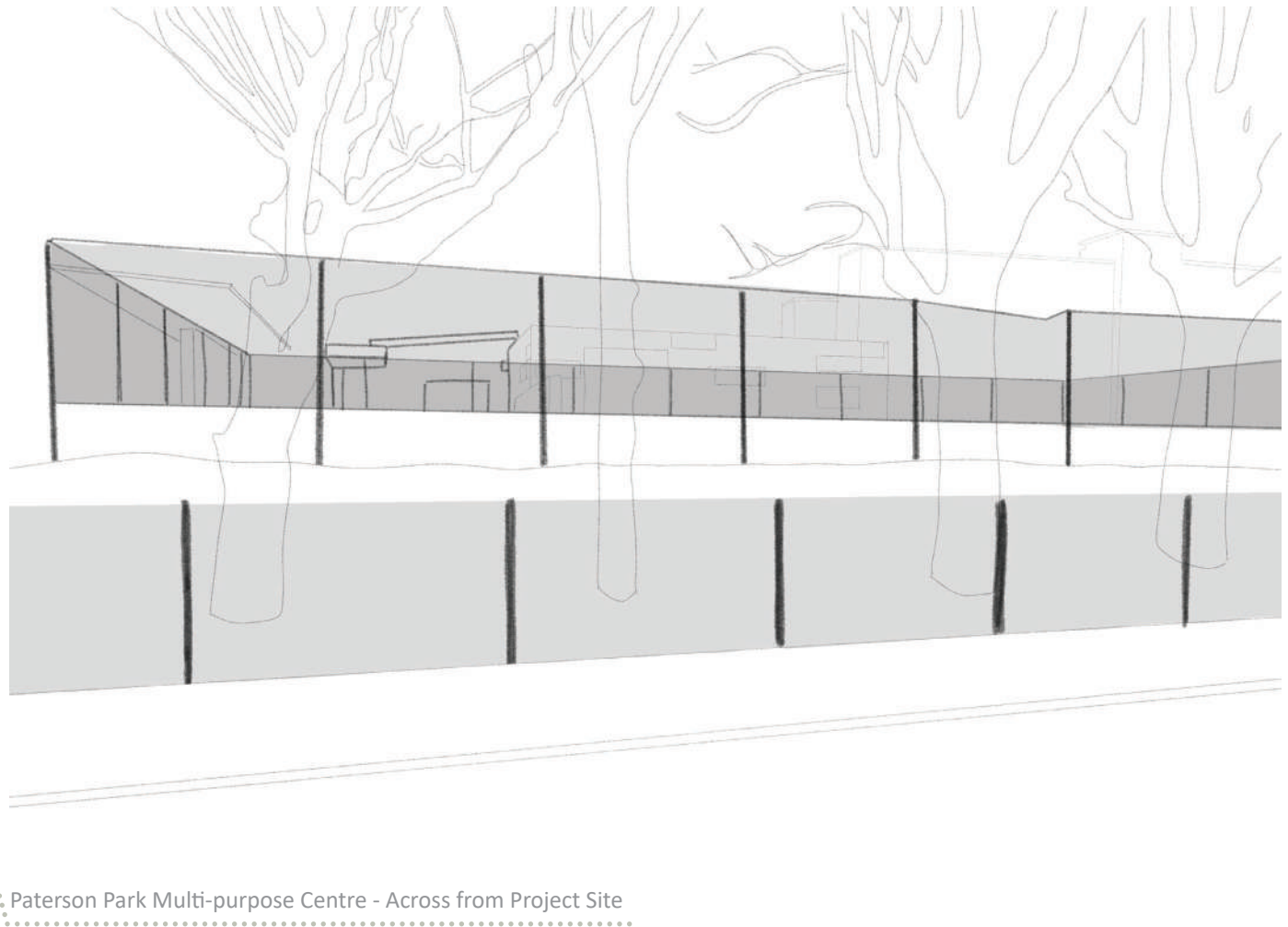
Norwood Police Department - Across from Project Site

Figure 48 - View from Ninth Street and colour palette of Norwood Police Department (AfriGIS (Pty) Ltd, 2017)



Colour Palette

-  Red Facebrick
-  Powder Coated Aluminium: Dark Charcoal
-  Painted Zinc Plate Cladding
-  Painted Zinc Plate Cladding
-  Fencing and plants



Paterson Park Multi-purpose Centre - Across from Project Site

Figure 49 - View from Ninth Street and colour palette of Paterson Park Multi-Purpose Centre (AfrigiS (Pty) Ltd, 2017)



Public Amenities and Community Centre at Paterson Park

1. Gym and Indoor court
2. 5 a side court and Soccer field
3. Public Library and Art centre
4. Hall with Kitchen and Deck
5. Public Swimming Pool
6. Tennis, Volleyball, Netball and Basketball courts
7. Police Station

Threats:

During a site visit on the 19th March 2023 over 3 hours - it was clear that about 10% of the building was being used by schools and the community. As a member of this community, the building was not obviously for public use and seemed to only invite cars and buses in. The sporting areas outside including the pool are well used but the arts and crafts was closed (indefinitely), and the library was poorly stocked.

Opportunities:

The threat above gives an opportunity to aid the success of this building by having a strong interface with it and potentially proposing a new entrance formation on 9th street as the current one is hindering the success of the project.

Figure 50 - Public Amenities and Community Centre at Paterson Park

Materials and structure at the Community Centre at Paterson Park



4. Hall with Kitchen and Deck



4.CLT Construction



6. Tennis, Volleyball, Netball and Basketball courts



6. Steel construction connection



6. Murals by courts

Materials and structure at the Community Centre at Paterson Park



Offices



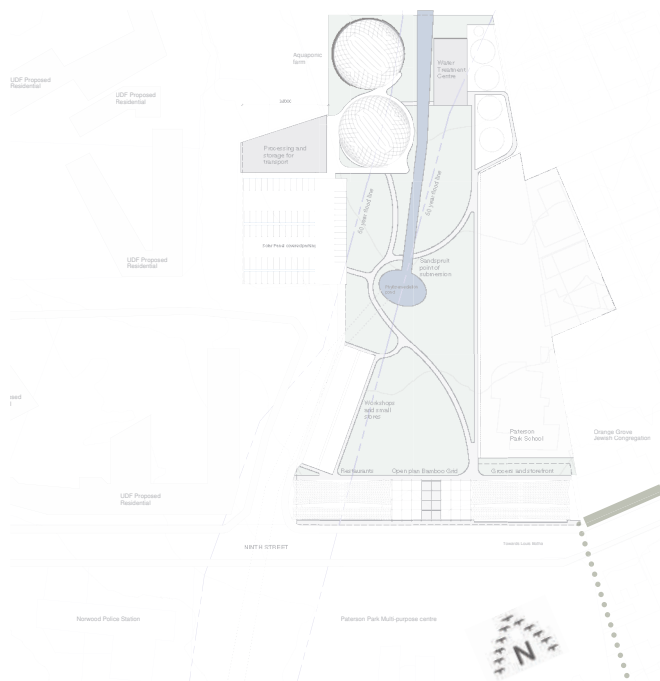
Murals in green areas



3. Public Library



4. Hall with Kitchen and Deck



Colour Palette

-  Sidewalk and Road
-  Painted walls
-  Painted walls
-  Painted Zinc Plate Roof
-  Painted Zinc Plate Roof



Figure 51 - View from Ninth Street and colour palette of example residential area (AfriGIS (Pty) Ltd, 2017)



Issues around the area

- Insufficient parking, traffic
- Poor Stormwater design floods
- Many people feel unsafe or uncomfortable near police
- Unused public space that is blocked off to public
- Medium to high turnover rate for businesses
- Gentrification is worsening the car to people ratio. This has altered the noise pollution, air pollution, and pushes those who could previously afford this area out.

Threats:

The gentrification of the area is pushing the less fortunate out, those with higher incomes park with large SUVs on Grant Avenue which hides the facades of businesses and makes Grant Avenue stressful. The unused public space may be dangerous due to the lack of eyes on it.

Opportunities:

Design facilities that do not outcast people on purpose, link building to future development of social housing for eyes on the park so green space can be kept.

Figure 52 - Mapping of issues around the site



6.2 Land Use Rights

Land Use Rights	
Current zoning:	Public Open Space
Land type:	Farm
Owner:	Municipality of Johannesburg
Stand no:	RE/48/58-IR
Primary Land Use rights:	Public Open Space
Secondary Land Use Rights:	None
Proposed land use:	Private open space
Secondary land use:	Sport and recreation clubs, agricultural purposes, urban agriculture, recreation resort
Height zone:	No height zone assigned to this site yet. This will change through town planning. The proposed height zone is A (three storeys) to match the community centre across the road
Proposed Coverage:	50%
Floor area:	1,2
Building line restrictions:	3 and 1.5m

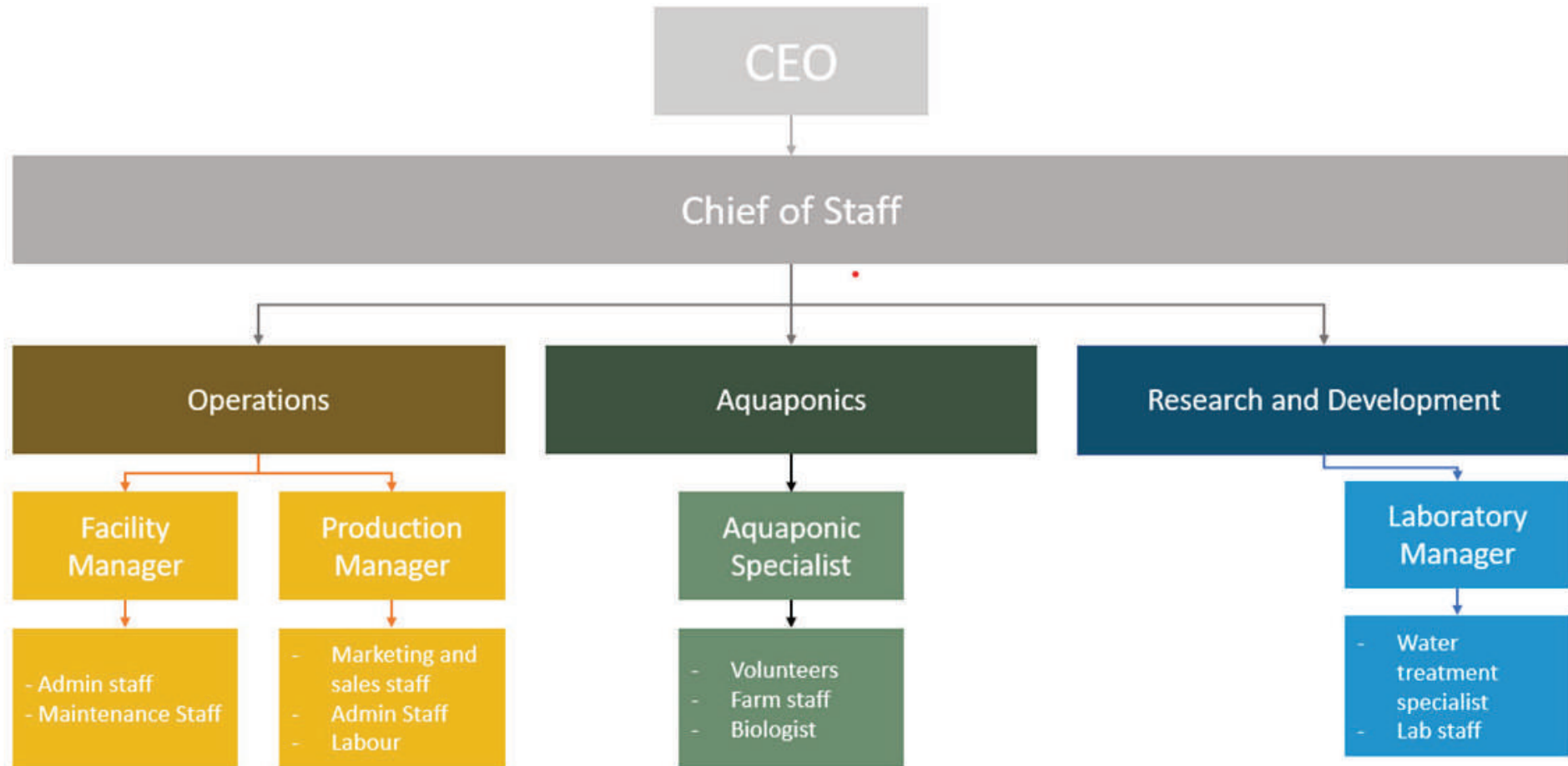
Figure 53 - Land Use Rights

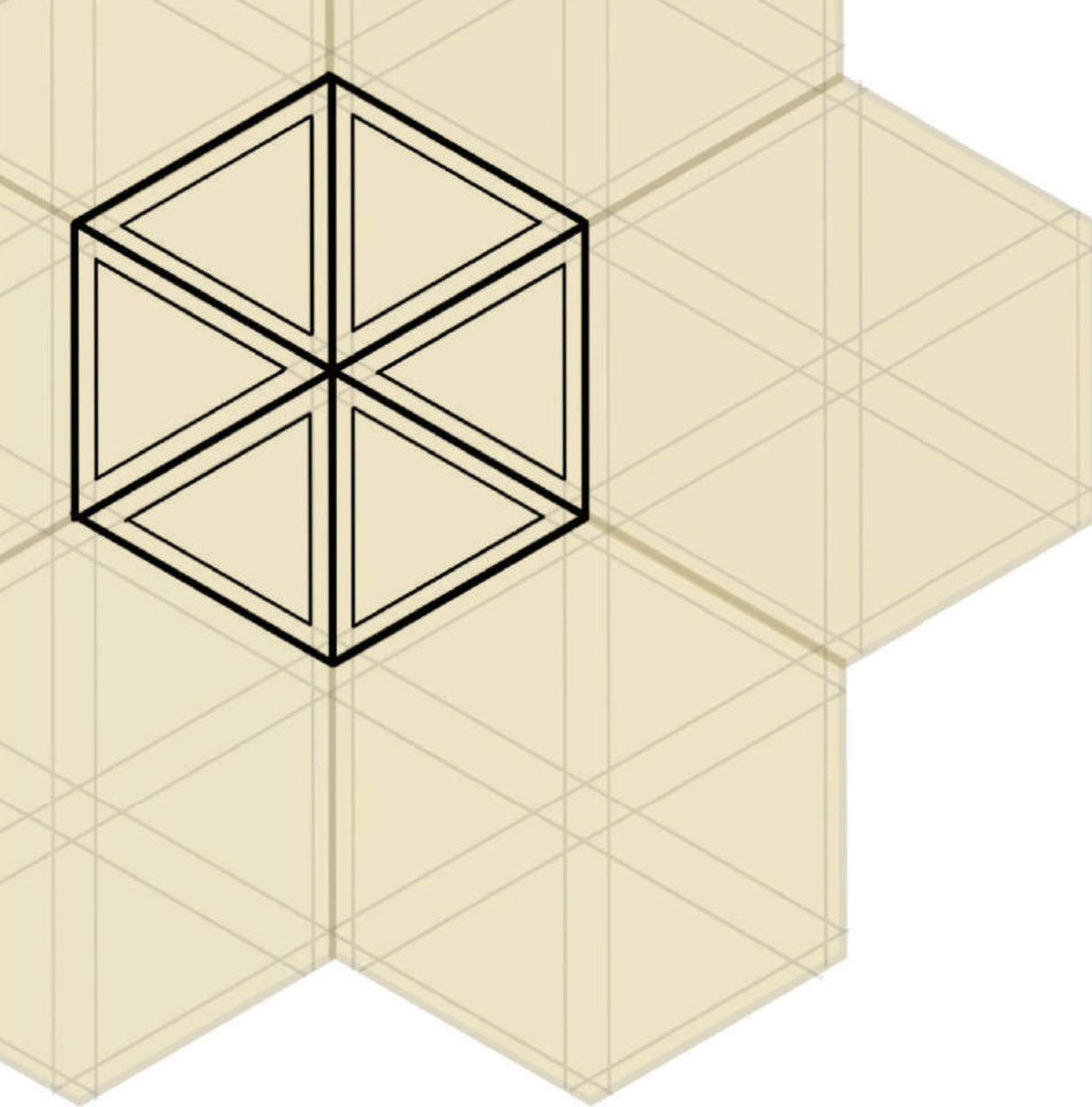
6.3 Design accommodation

ACCOMMODATION SCHEDULE FOR PATERSON PARK					
Accommodation	Details	m ²	Amount	Max Population	Time
Water treatment facility					
Monitoring and control room	Access to the water source	50	1	4	
Water storage	3 Water tanks	800	1		
Laboratory	Connected to monitoring for quality testing	80	1	6	
Pump room	Water is to be distributed to aquaponics and back to the system	30	2	2	
Chemical storage	Safety precautions required	10	2	2	
Restrooms	According to SANS, include cultural bathrooms and unisex bathrooms	15	3	3	
Kitchen and rest area		30	1	10	
Total:		1085m²	10	10	
Aquaponic farm					
Farm greenhouse	Fish tanks, grow beds, aeroponic towers.	645	5	5	
Laboratories	Water testing and aquaponics	60	1	4	
Offices	Admin staff and scientists	15	4	4	
Conference room	For presentations	50	1	10	
Restrooms	According to SANS, include cultural bathrooms and unisex bathrooms	15	3	3	
Kitchen and rest area		30	1	15	
Total:		3470m²	10	20	
Biogas digester (Energy Generation)					
Biogas digester	Access to farms easily, water required	24	1		
Biogas redistribution network	Connected to a facility for cooking and heating of water tanks	5	1		
Total:		29m²	2	0	

Packing, storage and transport of produce					
Packaging for picked produce		200	1	10	
Cold Storage room for picked produce	Constant temperature required	300	1	6	
The loading area for transport	Access to the road for trucks	150	1	4	
Restrooms	According to SANS, include cultural bathrooms and unisex bathrooms	15	3	3	
Kitchen and rest area		30	1	12	
Total:		725m²	7	16	
Shopfront for produce					
Display area using Aeroponic towers	Access to water and electricity	30	1	6	
Frozen/ Fridge section for fish	Connection to Electricity	5	1	1	
Checkout		20	1	2	
Restrooms	According to SANS, include cultural bathrooms and unisex bathrooms	15	3	3	
Total:		100m²		10	
Foodbank and Restaurant					
Kitchen	Donations and restaurant	150	1	10	
Dining area	Connection to Electricity	200	1	50	
Checkout counter		5	1	2	
Restrooms	According to SANS, include cultural bathrooms and unisex bathrooms	15	3	3	
Break room		20	1	6	
Total:		420m²		10	
OVERALL TOTAL:		6724m²			

6.4 Organogram





Part 1

1. Introduction
2. History of Orange Grove and Norwood
3. Service Delivery
4. Theoretical Approach
5. Architectural Design Drivers
6. Design - Site Analysis
- 7. Design Development and precedents**
8. Conclusion

Part 2

Final Design

References

07

Design Development

7.1 Sketch Charette and materiality

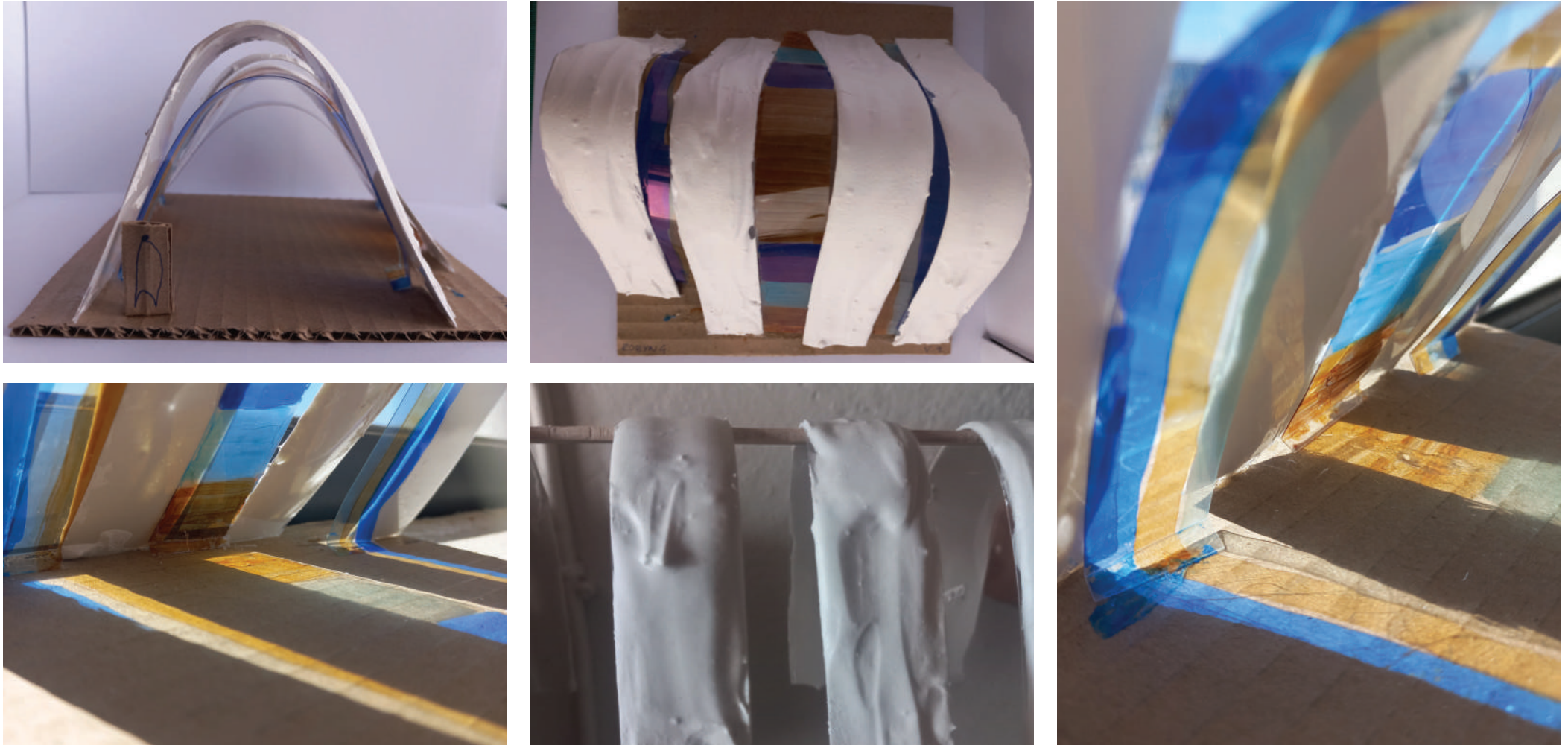


Figure 54 - Catenary and light explorations

During the explorations, I looked at how sunlight and colour could be used within buildings. The idea was to allow for **moments of interest and experience that changes during the day with the sun, as nature does with circadian rhythms.**



Figure 55 - Quartz Exploration

The stone explorations look at material that is available on site with regards to Quartz. The internal of the quartz could be used in a wall to show the **progression of time as the newness fades**. This type of material would have been used in the original buildings around this site and would be an interesting link to history.



Figure 56 - Dry moss exploration in acetate box

The final exploration looked at how moss, an easily grown plant could be dried and used as a **material** within walls as a sound insulator, in glass as a divider that brings nature into the building, or simply stuck onto walls for texture.





Figure 57 - Process work of attempting eco-friendly biodegradable plastic with coconut husk

The above exploration looked at how to create an eco-friendly biodegradable plastic using the coconut husk and boiling it for an hour with bicarbonate of soda. While this did not yield the results I was hoping for, it sparked interest in biodegradable materials such as hemp bricks made on site.

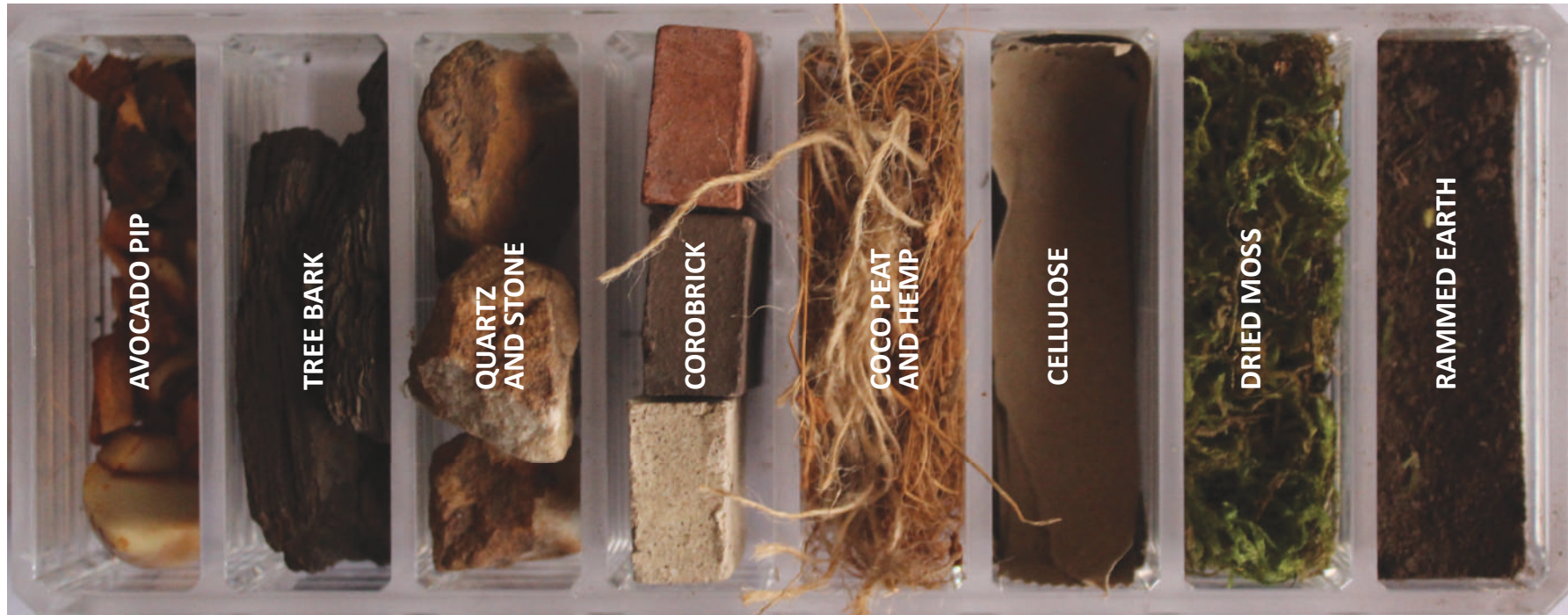


Figure 58 - Building material palette from explorations

The building palette from the exploration has shifted slightly to include additional structural materials such as aluminium. This exploration was very useful as it created a colour and texture palette for future design choices.

7.2 Site logic and response

Aquaponic farm

- Access to the cleaned water for the aquaponic system.
- Access to the Processing and transportation area.
- Access to large area with minimal shading for the greenhouse.

Processing and storage of products

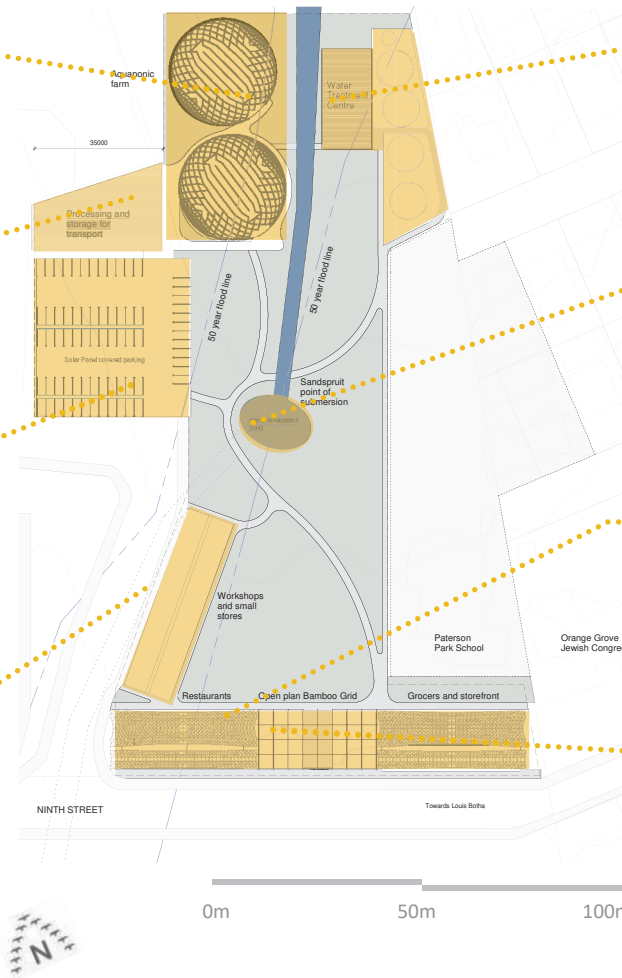
- Access to the main road for transportation of goods.
- Access to the Aquaponic farms for efficient internal transport and system design.

Parking and delivery

- Access to the main road without interrupting traffic on Ninth street.
- Eyes on the site from multiple spaces to help create safer moments.
- Allows for small transportation trucks to access the space and collect orders or delivery goods.

Workshops and stores

- Access to pedestrians and residents across the road.
- Commercial use straight after entrance to promote users knowing about the shops.



Water treatment centre

- Access to existing water source at the lowest contour.
- Technical space that is not geared towards public use.
- Requires large space for water storage.

Phytoremediation pond

- Cleans water of heavy metals through natural processes.
- Theory on creating interesting moments in parks.
- Interacts with the public walking route as an educational moment.

Restaurants and grocers

- Access to pedestrians from Louis Botha and Grant Avenue.
- Shows that the space is for the public and not private.
- Iconic building to draw public into the rest of the space.

Open plan grid and Entrance

- Access to pedestrians from Louis Botha and Grant Avenue.
- Shows that the space is for the public and not private.
- Public use design such as community markets, community gardens, jungle gyms.

Figure 59 - Site logic and reasoning

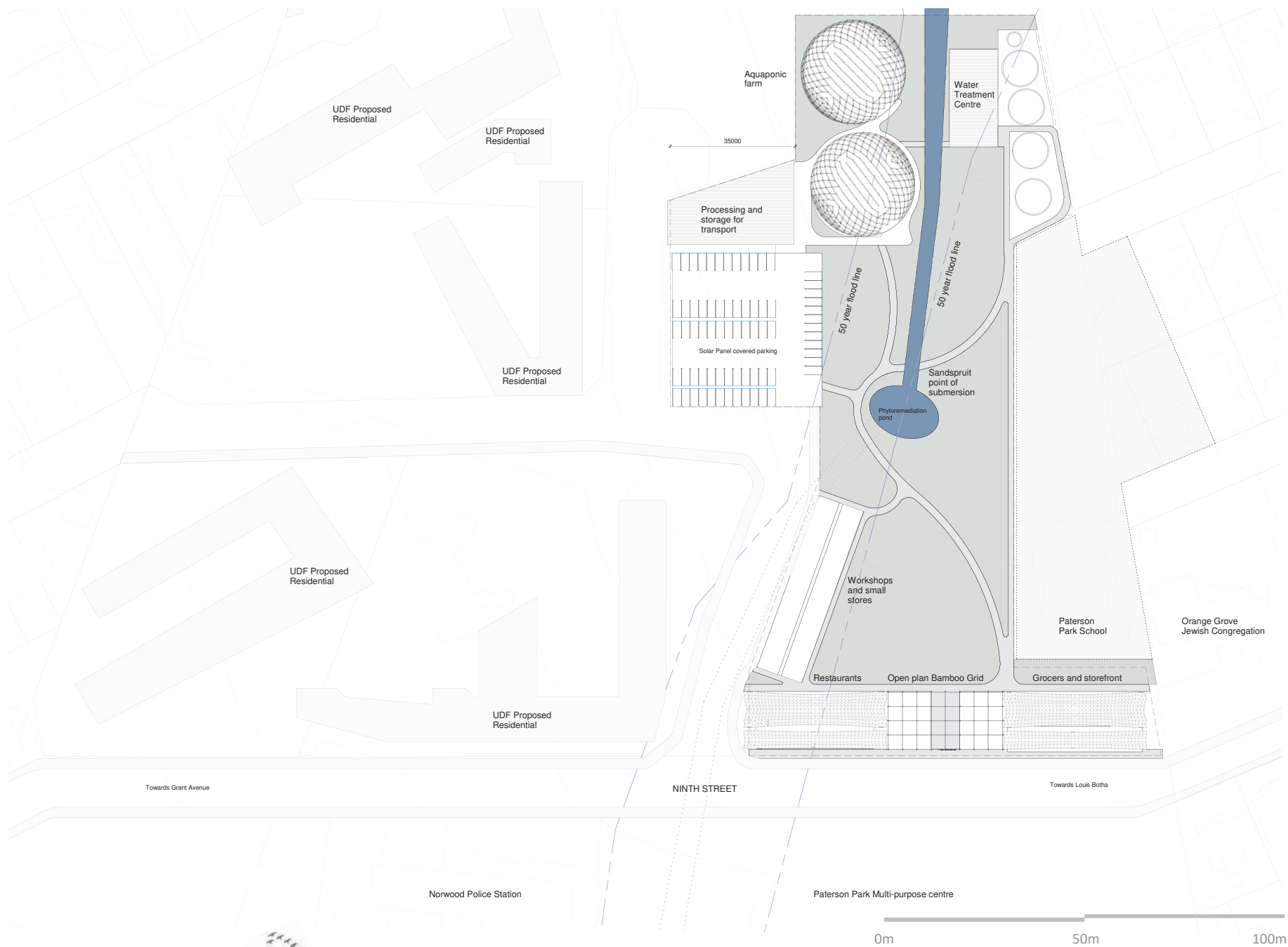


Figure 60 - Current Site Plan for Design

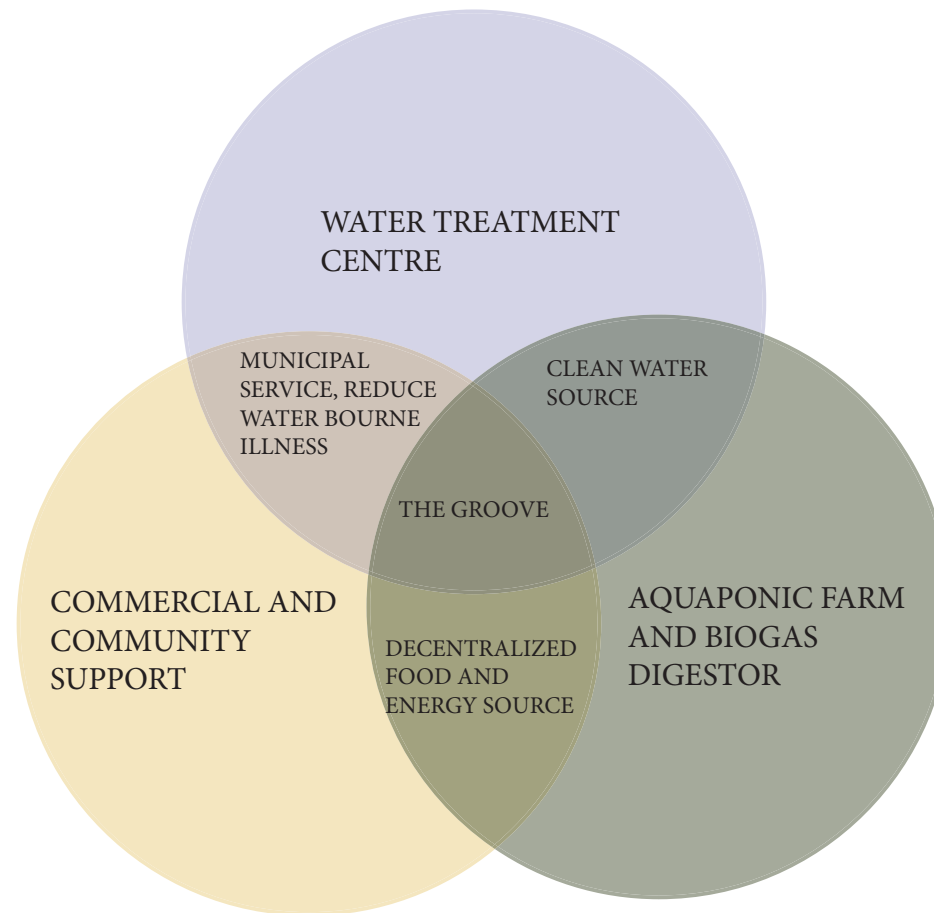
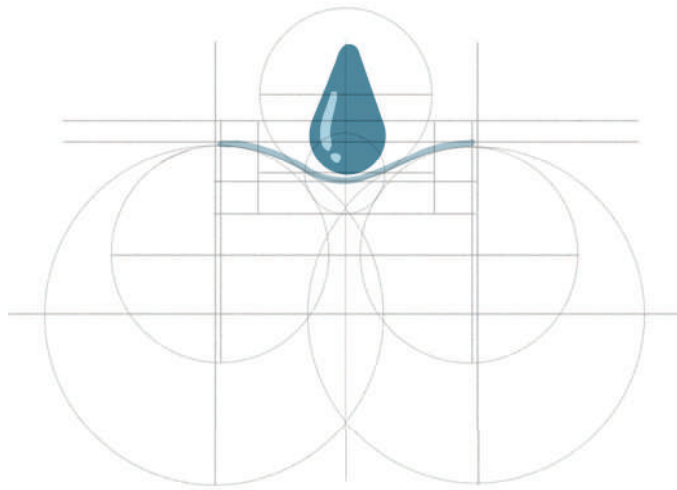


Figure 61 - Logic of the programme



7.3 Water Treatment Centre

7.3.1 Initial design response and logic

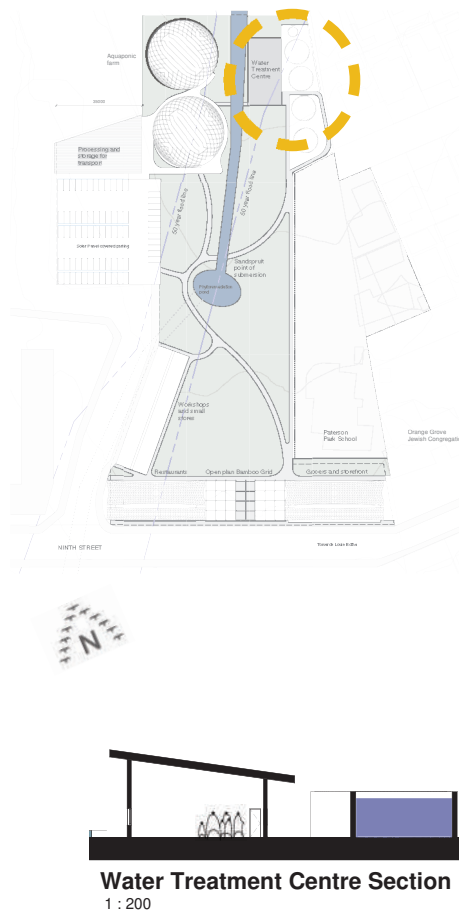


Figure 62 - Initial design of Water Treatment Centre



Programme and use:

Cleaning, processing and storage of water from the Sandspruit River.

Initial design response:

Technical response with minimal architectural features.

Strength:

Accurate sizing and programme

Weakness:

The building and programme are not interesting to the public; the design creates a dead space.

Opportunities:

Create an experience in the building to promote STEM and interest in nature.

Response:

To create a building that speaks to the beauty of water and how time of day changes how water is interacted with. Mimic the feeling of water through stained glass windows and the change of day.

Link to thesis and architectural design drivers:

Biomimicry and Parametric design.



7.3.2 Sketches and exploration

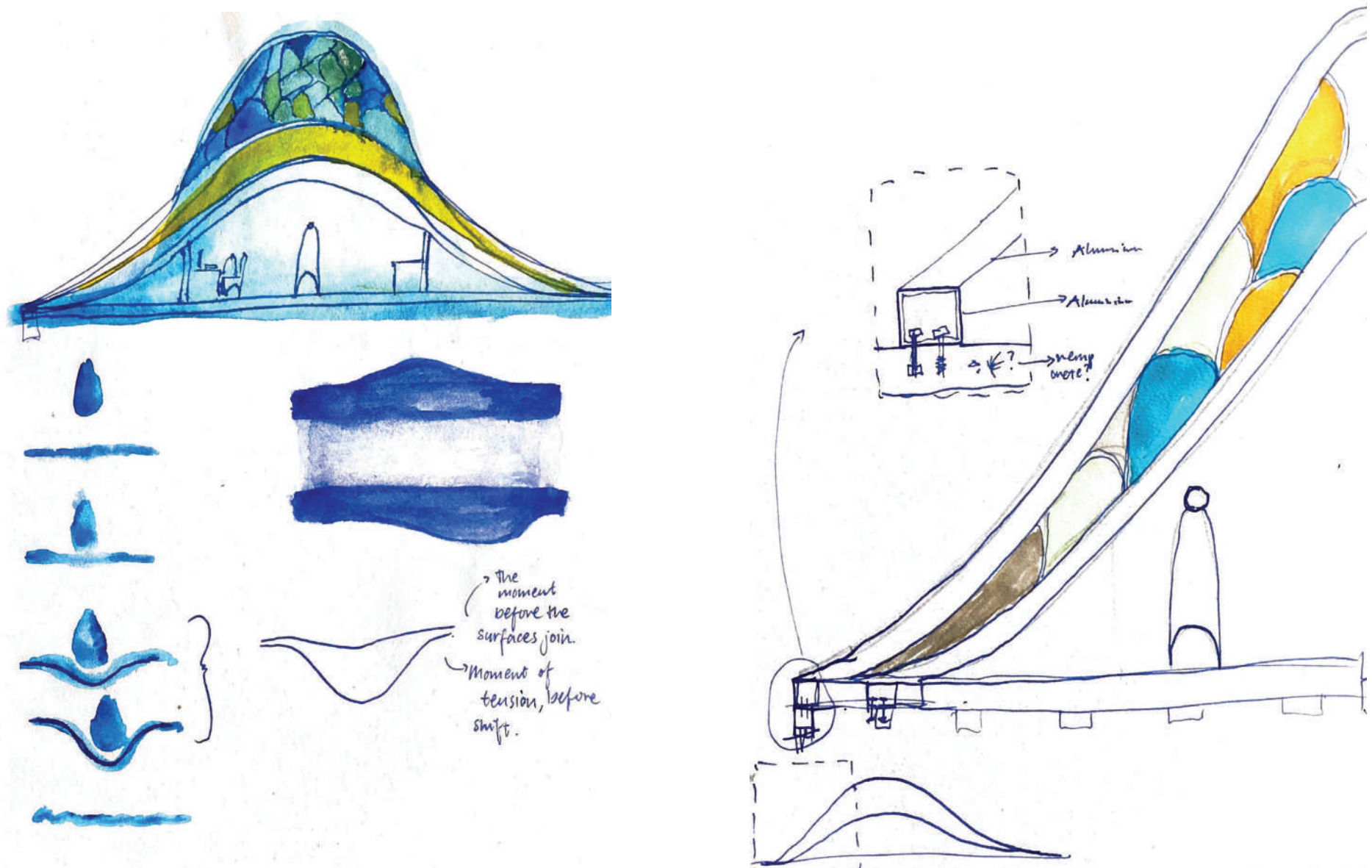


Figure 63 - Sketches for Water Treatment Centre

7.3.3 Geometry

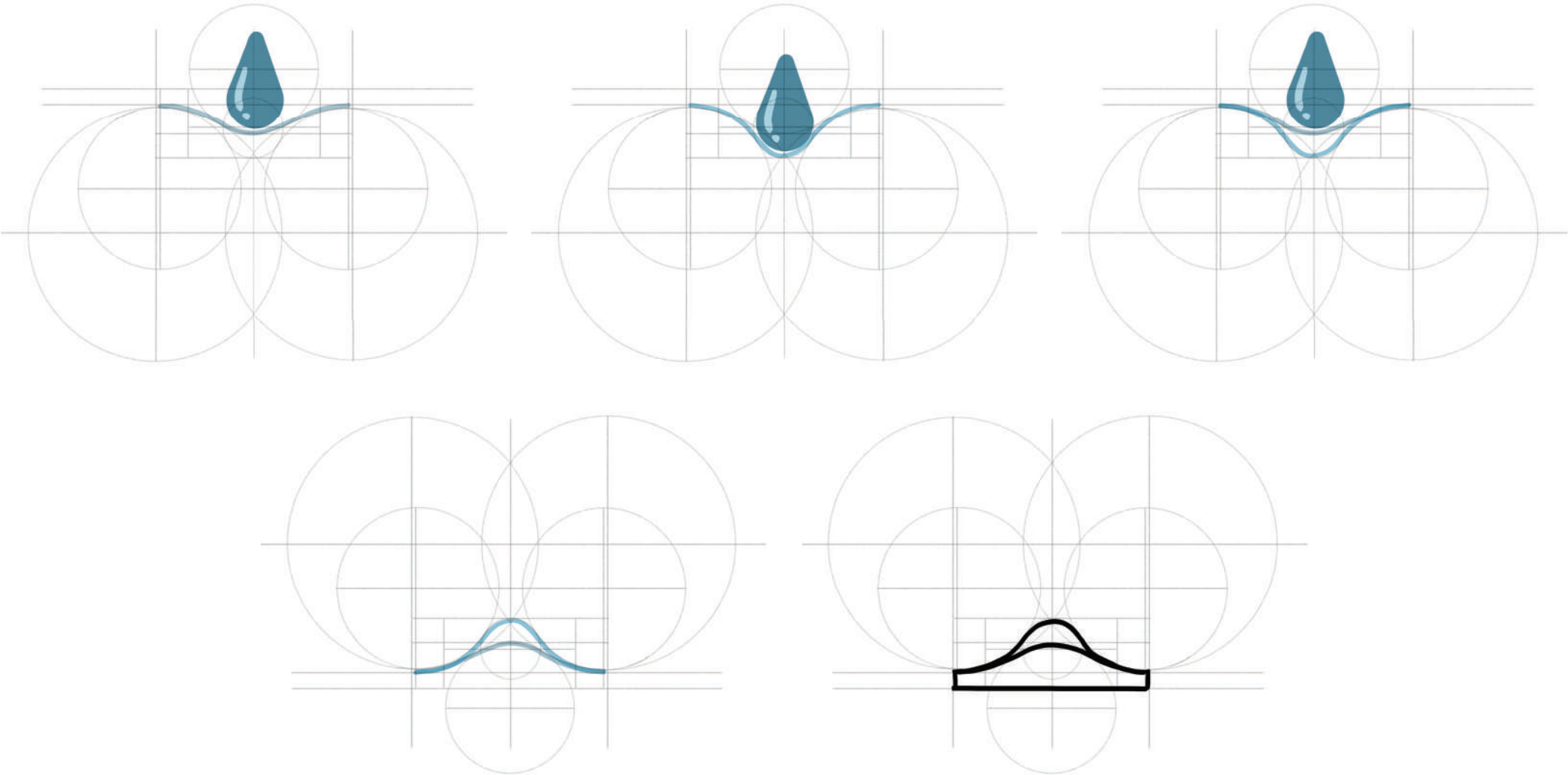


Figure 64 - Geometry of Water Treatment Centre

7.3.4 Precedent for Water Treatment Centre: Bosjes Chapel // Steyn Studio



Figure 65 - Photograph of Bosjes Chapel

(Steyn Studio, 2020)

The Bosjes Chapel is an incredible space designed for religious ceremonies such as weddings (Steyn Studio, 2020). While the water treatment centre is not a religious building, I wanted to create an experience that showed the beauty of nature and water. I found the geometry of this precedent invigorating as it combines computational design, nature, and experiential architecture.

Water treatment centres are usually highly technical and hidden in a grey rectangular building. I designed this space so that the sun would interact with the stained glass windows during the day, mimicking what the water experiences during the changes of the day and season. The site and all buildings are designed to create experiences for the users.

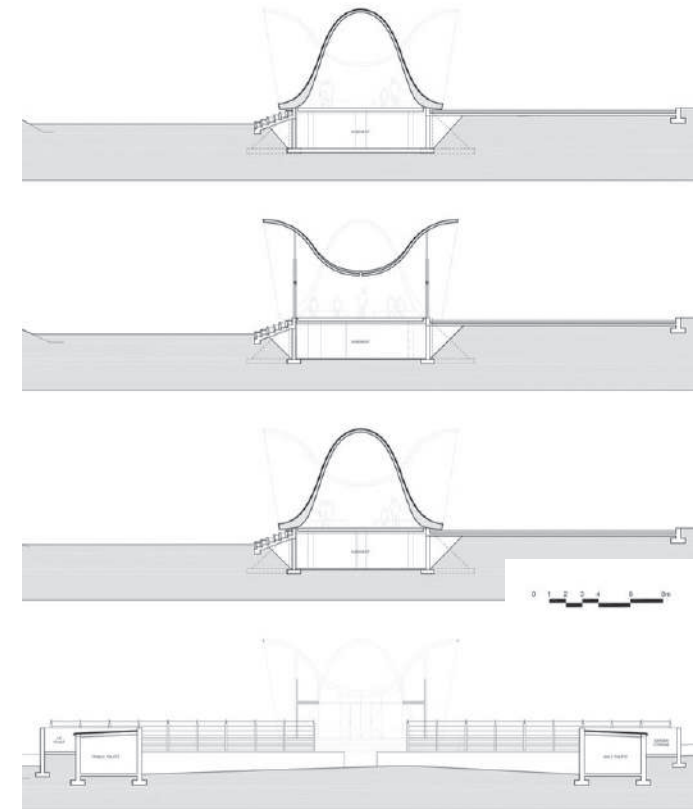
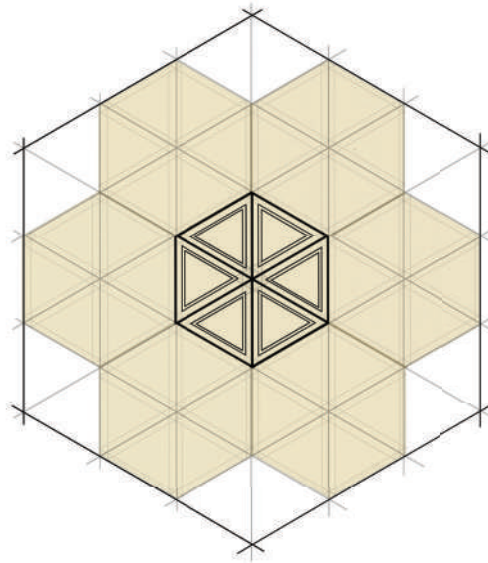


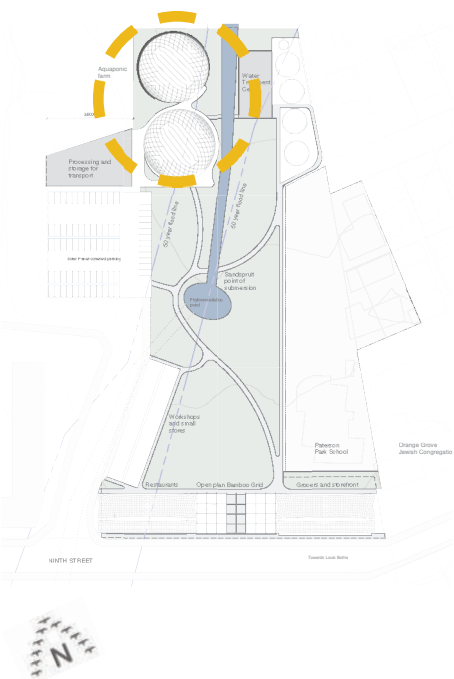
Figure 66 - Sections of Bosjes Chapel

(Steyn Studio, 2020)



7.4 Aquaponic Farm

7.4.1 Initial design response and logic



Programme and use:

Aquaponic farm, Biogas digestors, and mushroom wall.

Initial design response:

The initial response was the rectangular greenhouses regularly used in commercial farms. The second design was a geodesic dome that allowed the greenhouse to become an icon instead of a solely technical response.



Strength:

The geodesic dome allows for a publically accessible space that explains the closed system concept well and allows for interaction instead of viewing.

Weakness:

The amount of glass will create the greenhouse effect and cause an uncomfortable internal environment for plants or humans.

Opportunity:

It is possible to include moving units that can self-regulate the building's temperature and humidity according to external and internal readings.

Response:

Each hexagonal unit is programmed to open and close according to the internal and external environment. The building creates interaction inside and outside, allowing some panels to be glass and others to be insulated.

Link to thesis and architectural design drivers:

Biomimicry.

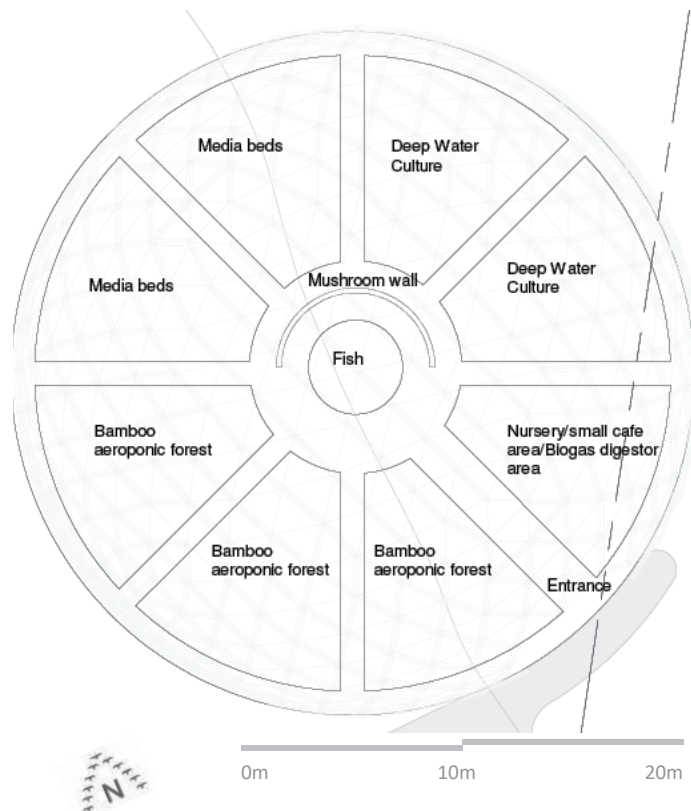
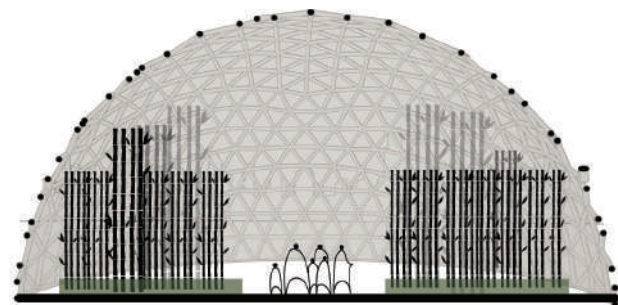


Figure 67 - Current design of Aquaponic greenhouse

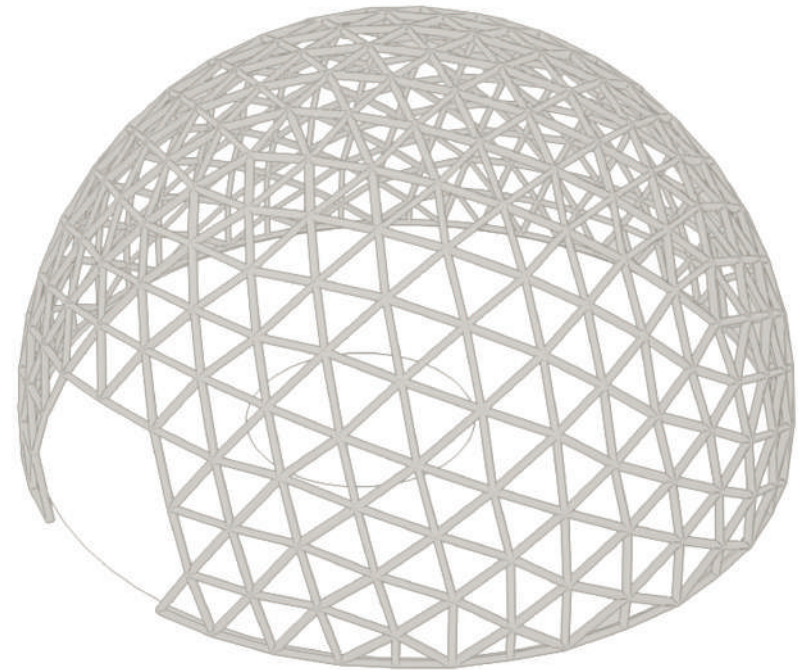
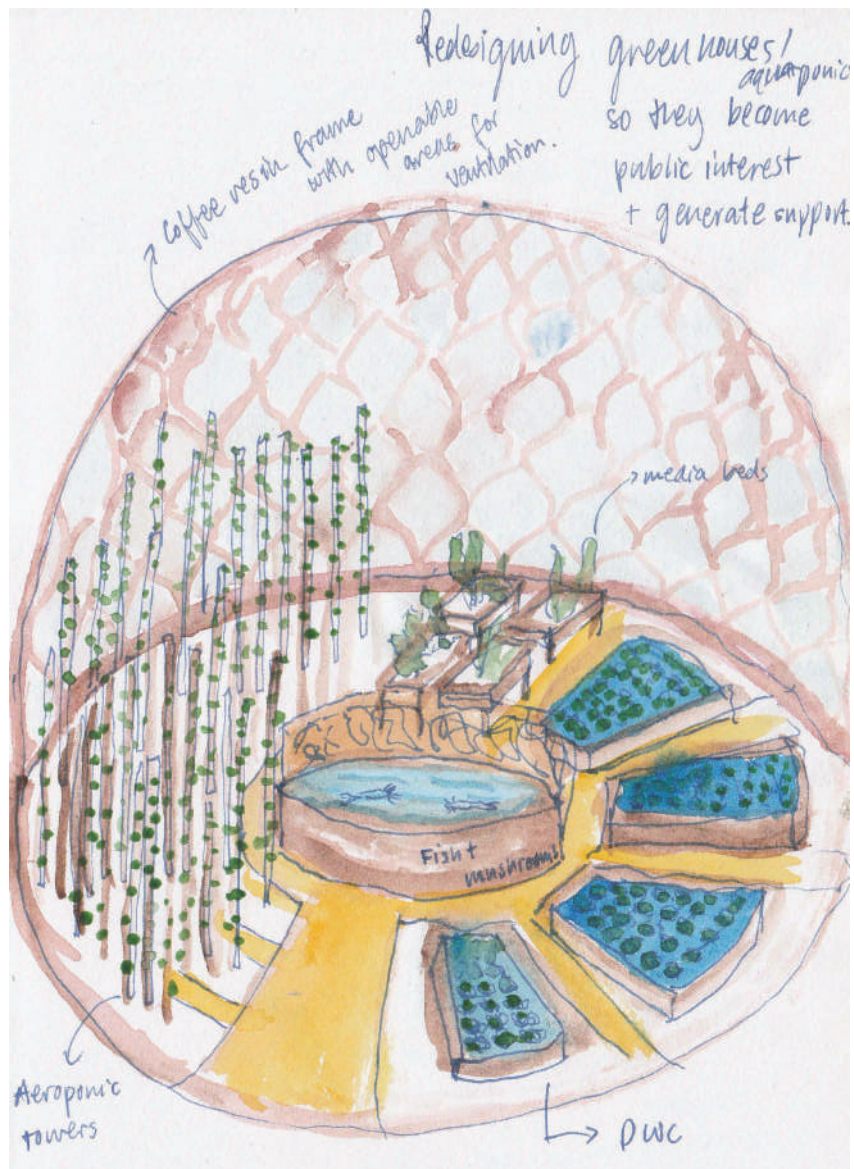


Figure 68 - Sketches of Aquaponic greenhouse

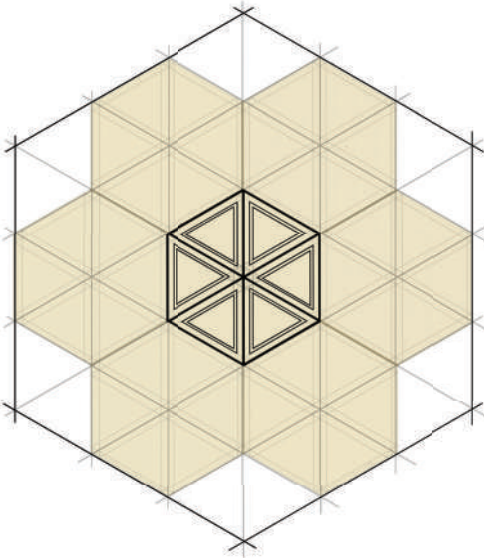
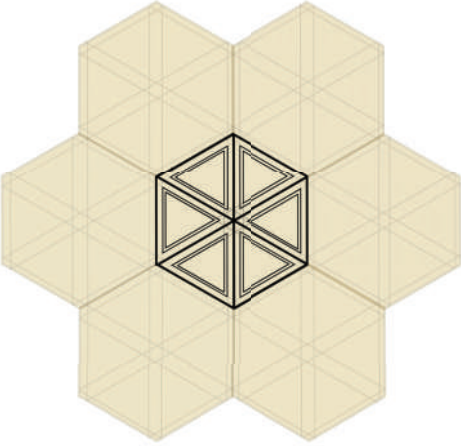
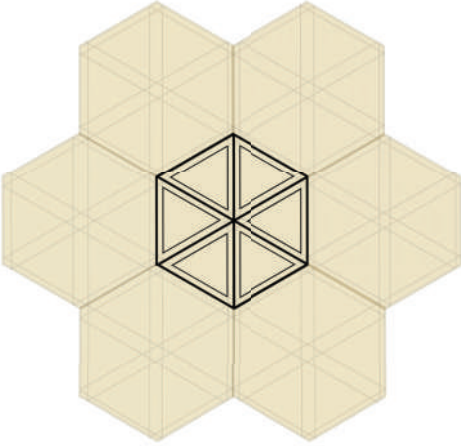
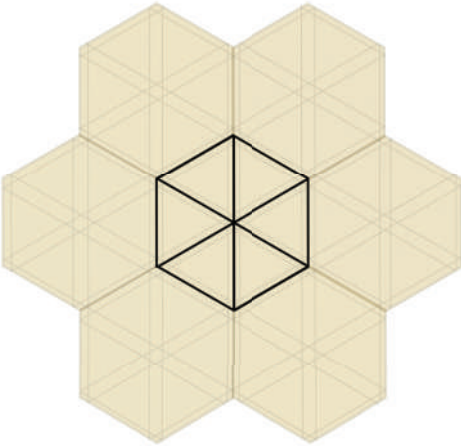
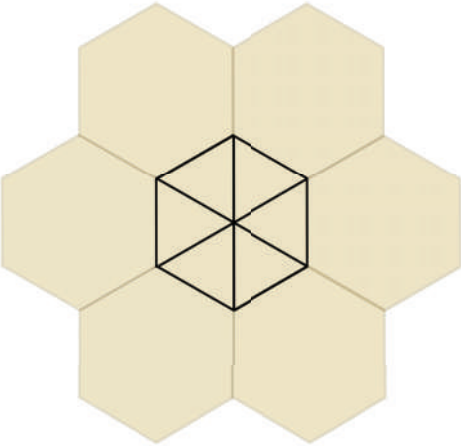
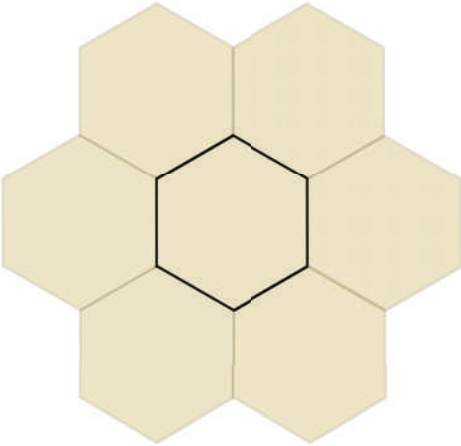


Figure 69 - Geometry of Aquaponic Farm

7.4.3 Precedent for Aquaponic Farm: Wooden Geodesic Dome Planetarium

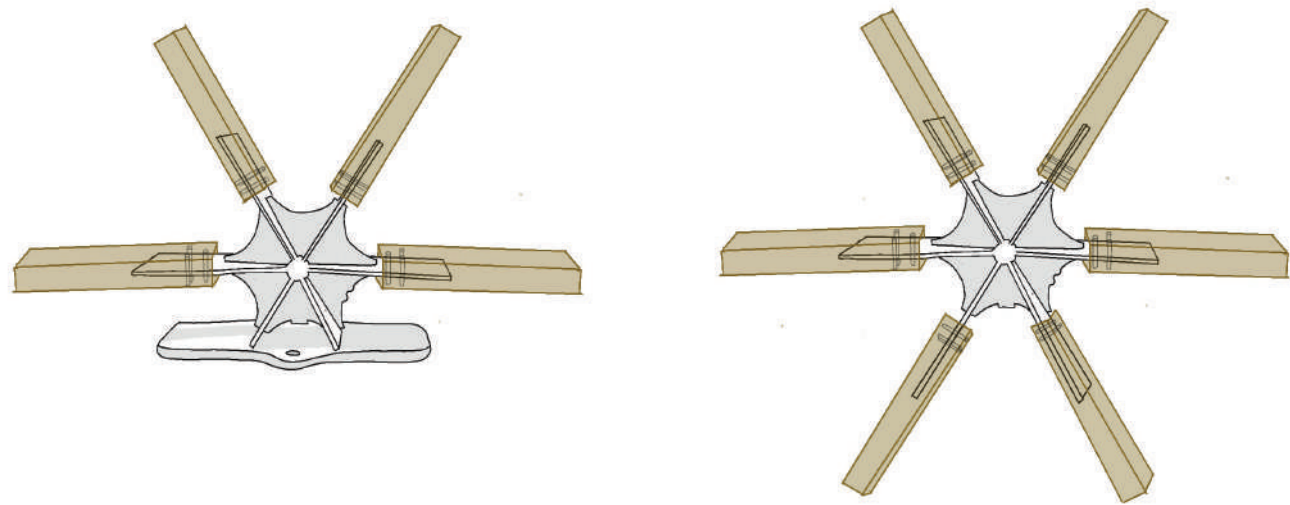


Figure 70 - Detail of Geodesic dome
(Geosoto Company, 2018)

The wooden geodesic dome planetarium set a precedent, proving that the scale of a geodesic dome similar to the proposed aquaponic farm was achievable and could be technically resolved in timber. While the original intention was to use a material such as timber, I have opted to use aluminium due to the climate of Johannesburg and to create a lighter frame, as each hexagon is installed with a moving unit.



Figure 71 - Photograph of Geodesic dome
(Geosoto Company, 2018)

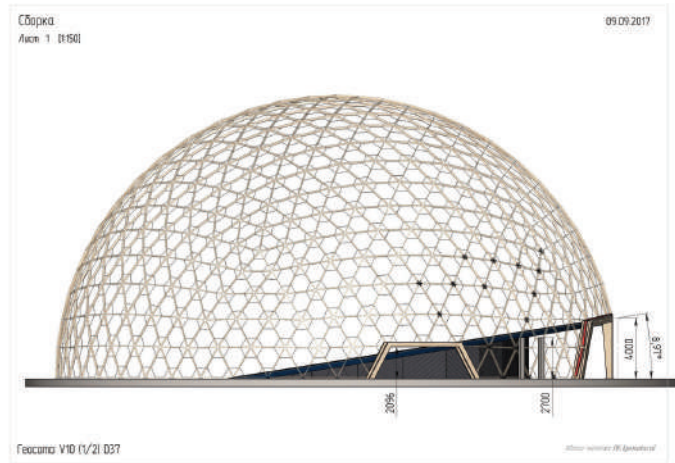


Figure 72 - Elevation of Geodesic dome
(Geosoto Company, 2018)

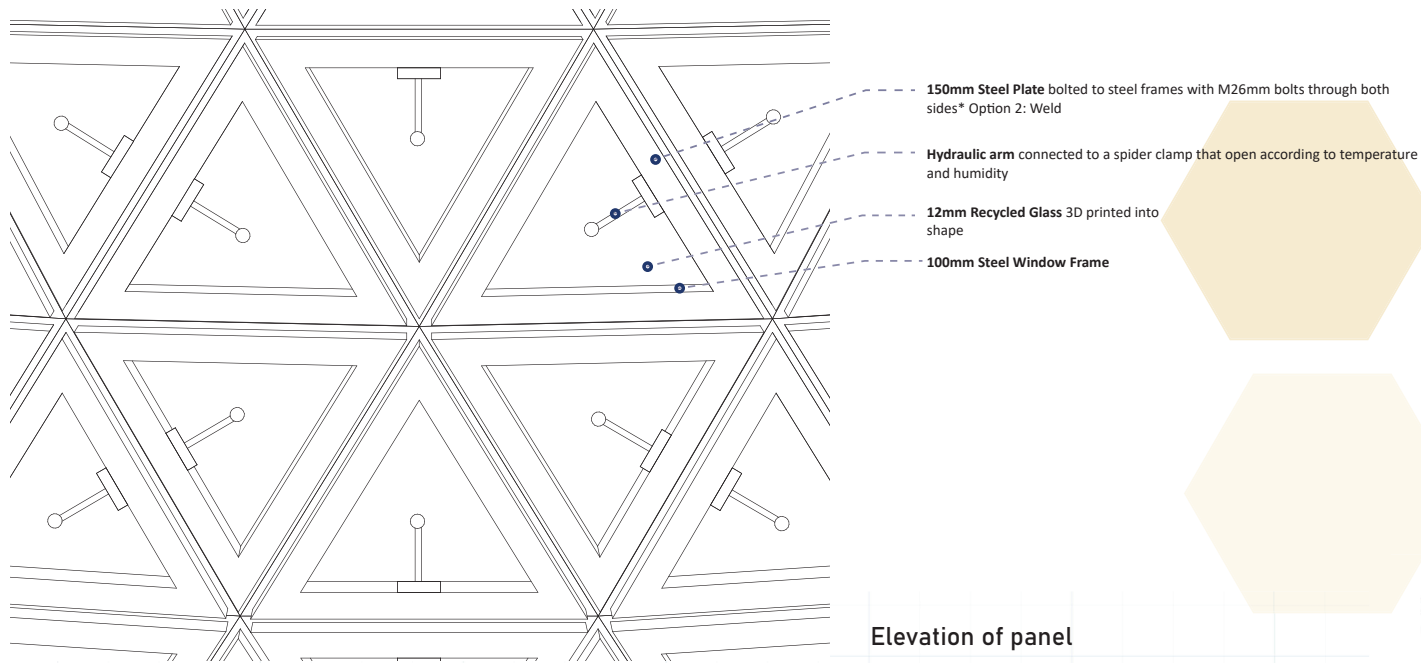


Figure 73 - Detail elevation of Geodesic Unit

Link to design drivers and project

- 1) Biomimicry of beehives and lungs
- 2) Parametric design for efficiency
- 3) The Hexagon is transformed into the Kagome Pattern for the workshops

Link to thesis

- 1) Self-regulation
- 2) Sustainable Materials
- 3) Exposing structure and technology to users

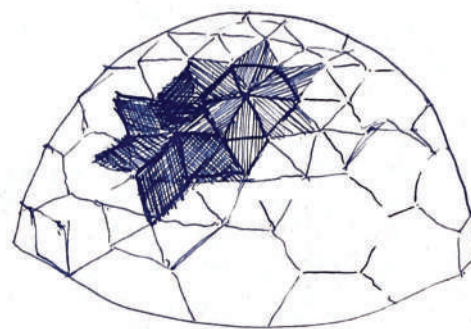
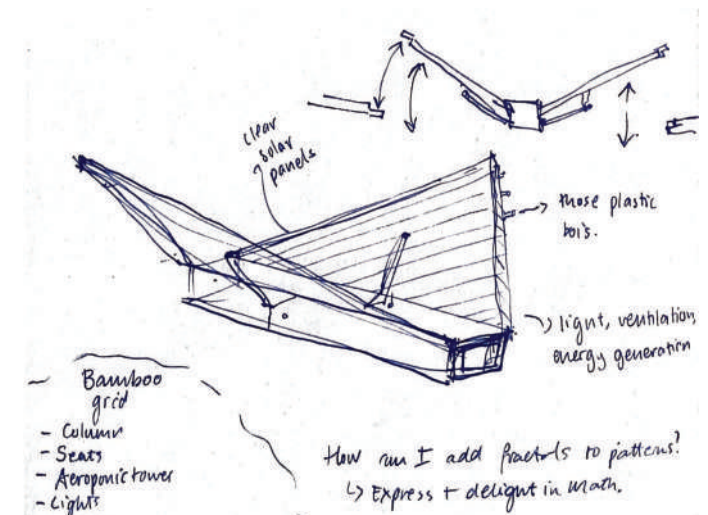


Figure 74 - Sketches of Geodesic Unit



7.4.4 Section detail of unit

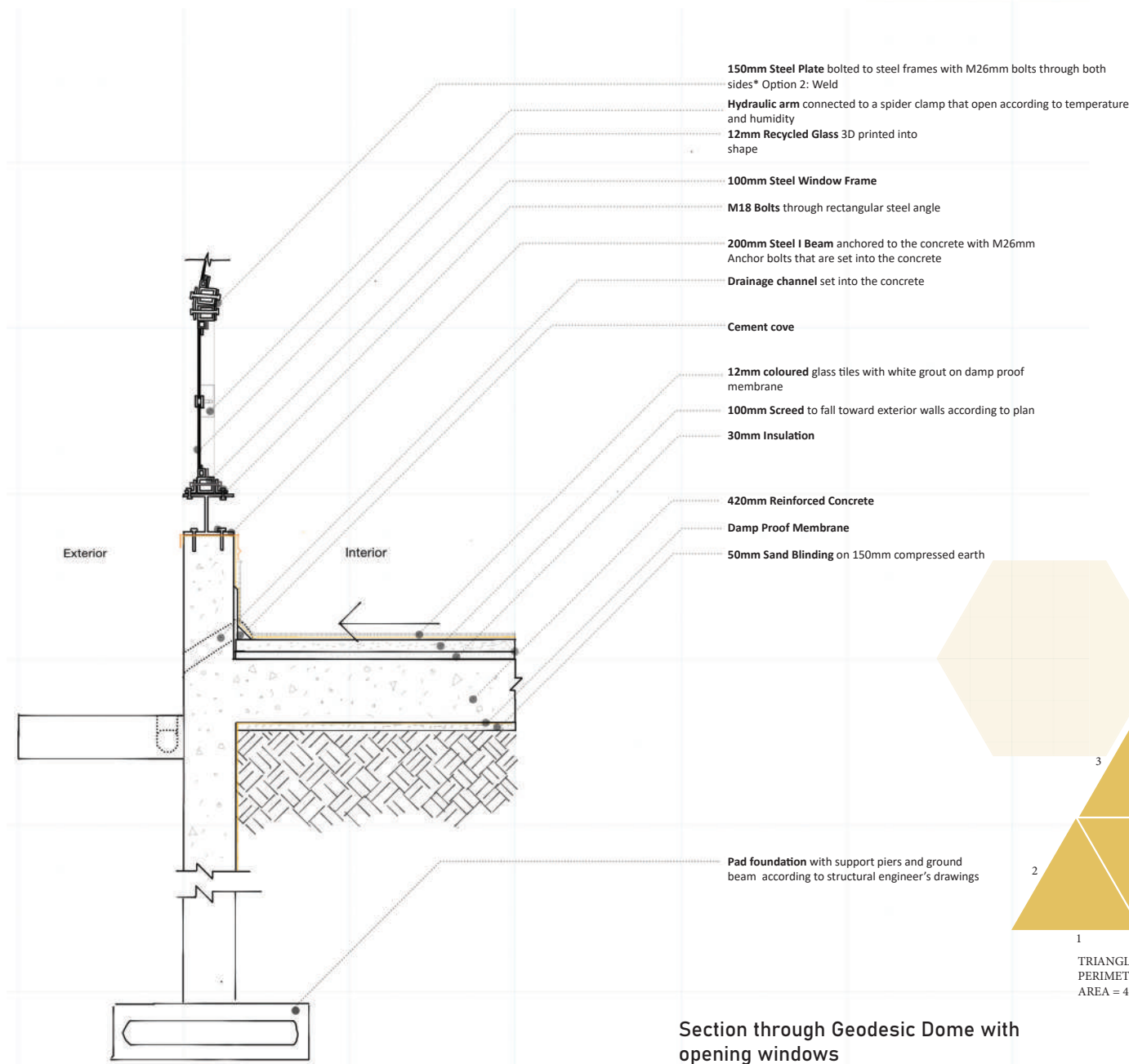
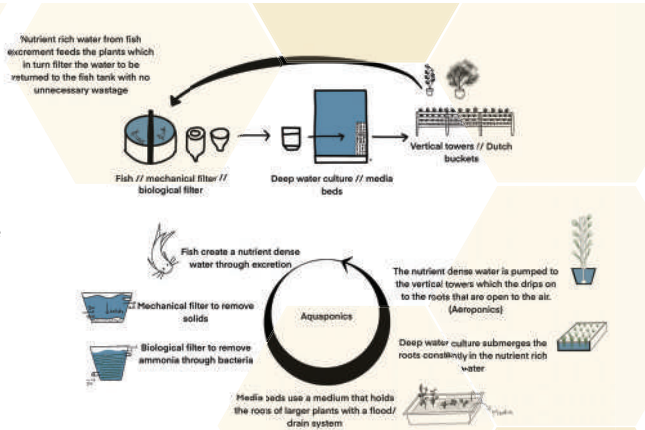


Figure 75 - Detail section of Geodesic Unit

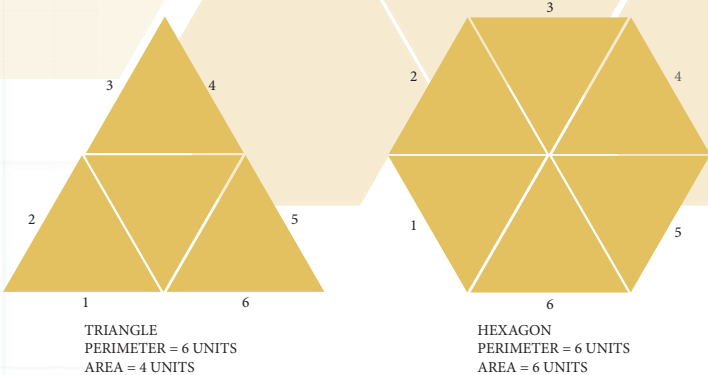
Section through Geodesic Dome with opening windows



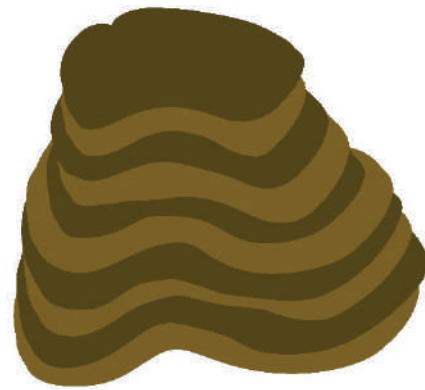
PROS OF GEODESIC DOME AND HEXAGONS

- 1) Decreased surface area = less materials
- 2) Concave Interior creates natural airflow
- 3) Extreme wind is decreased due to shape

HEXAGONS ENCLOSE A LARGER AREA WITH THE SAME AMOUNT OF WALL MATERIAL



AQUAPONIC GREENHOUSE



7.5 Processing and Storage

7.5.1 Initial design response and logic

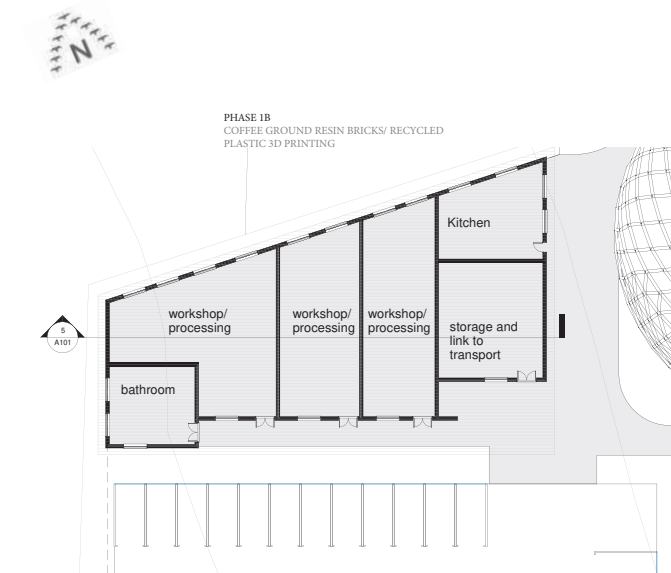
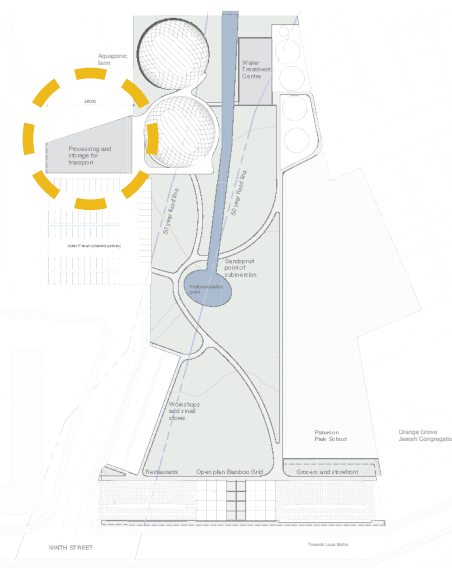


Figure 76 - Initial design of Processing and Storage Centre

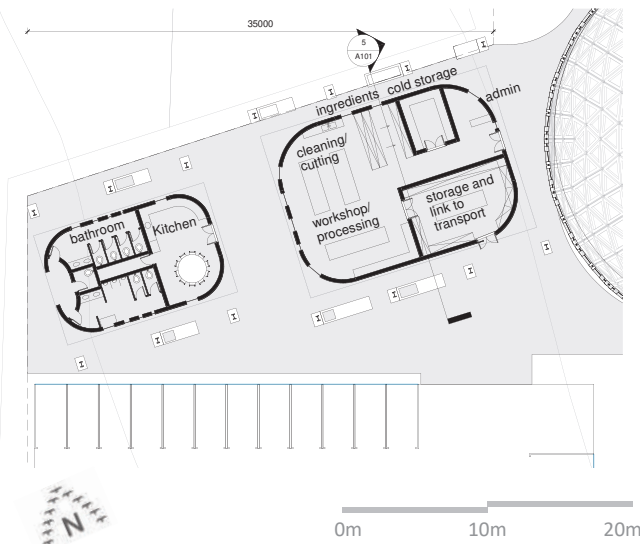


Programme and use:
Ingredient storage, processing of fish and fresh produce, storage, administration, and transport link.

Initial design reponse:
Technical spaces with minimal design features.

Strength:
Placement on site and ability to interact with deliveries and the farm.

Weakness:
The building lacks architectural qualities and prevents users from seeing how the process works.



Opportunity:
Create spaces that can be seen from the outside and interacted with without limiting efficiency or cleanliness.

Response:
Material usage is linked to historical materials used in South Africa for the storage and transportation of food. The new design uses a 3D-printed building using clay while allowing windows and a walking area on the outside for users to view the process within.

Link to thesis and architectural design drivers:
Biomimicry.

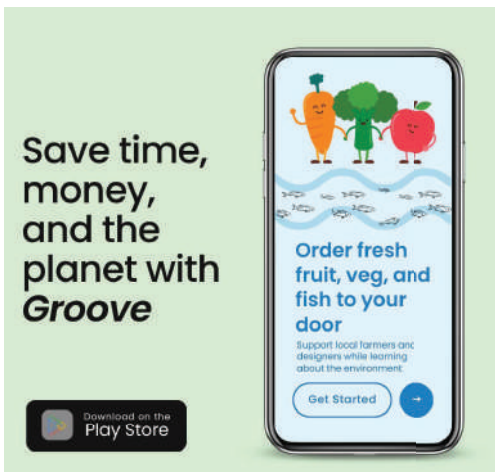


Figure 77 - Application design of online store

7.5.2 Sketches and exploration

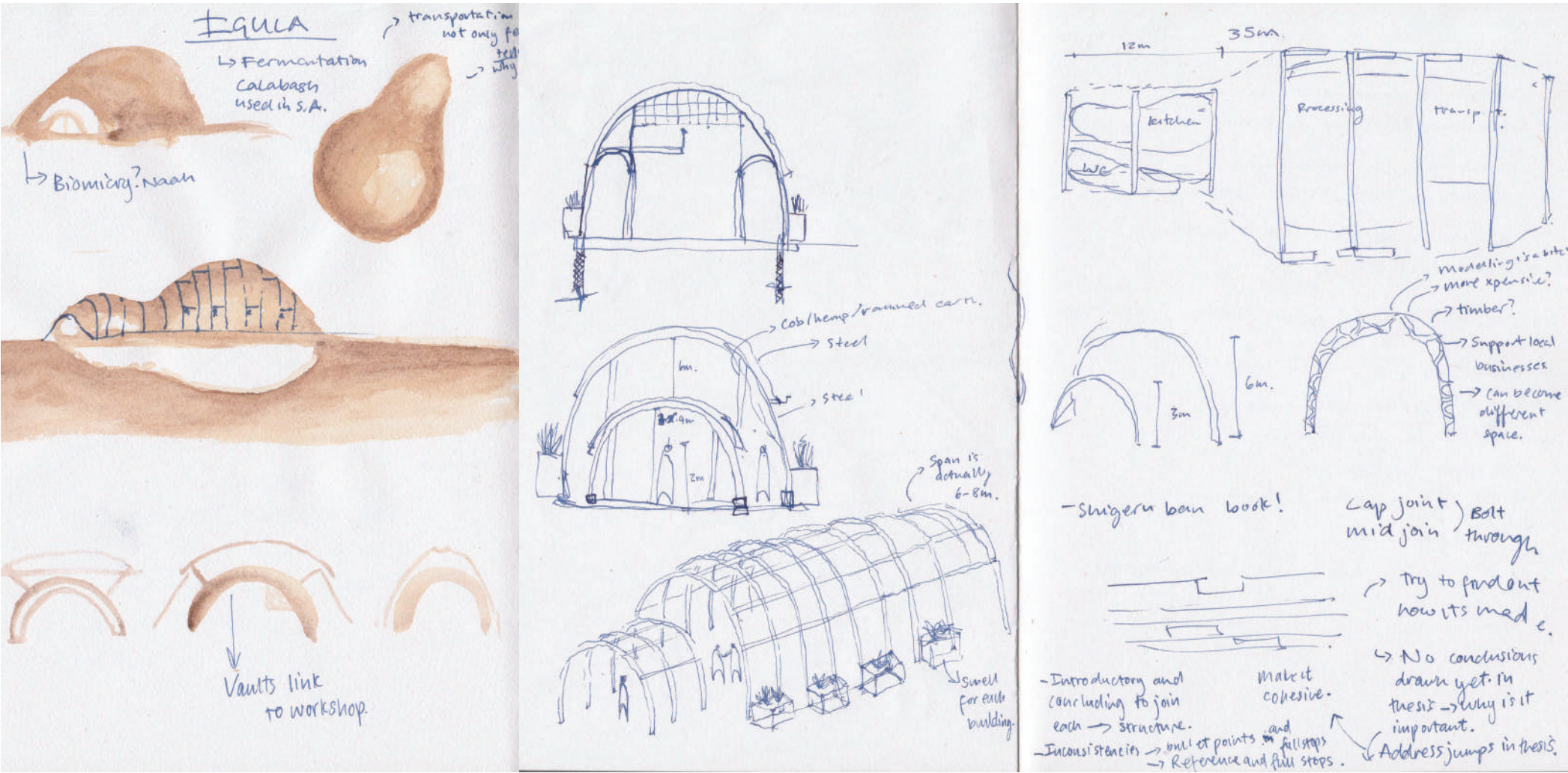


Figure 78 - Sketches for Processing and Storage



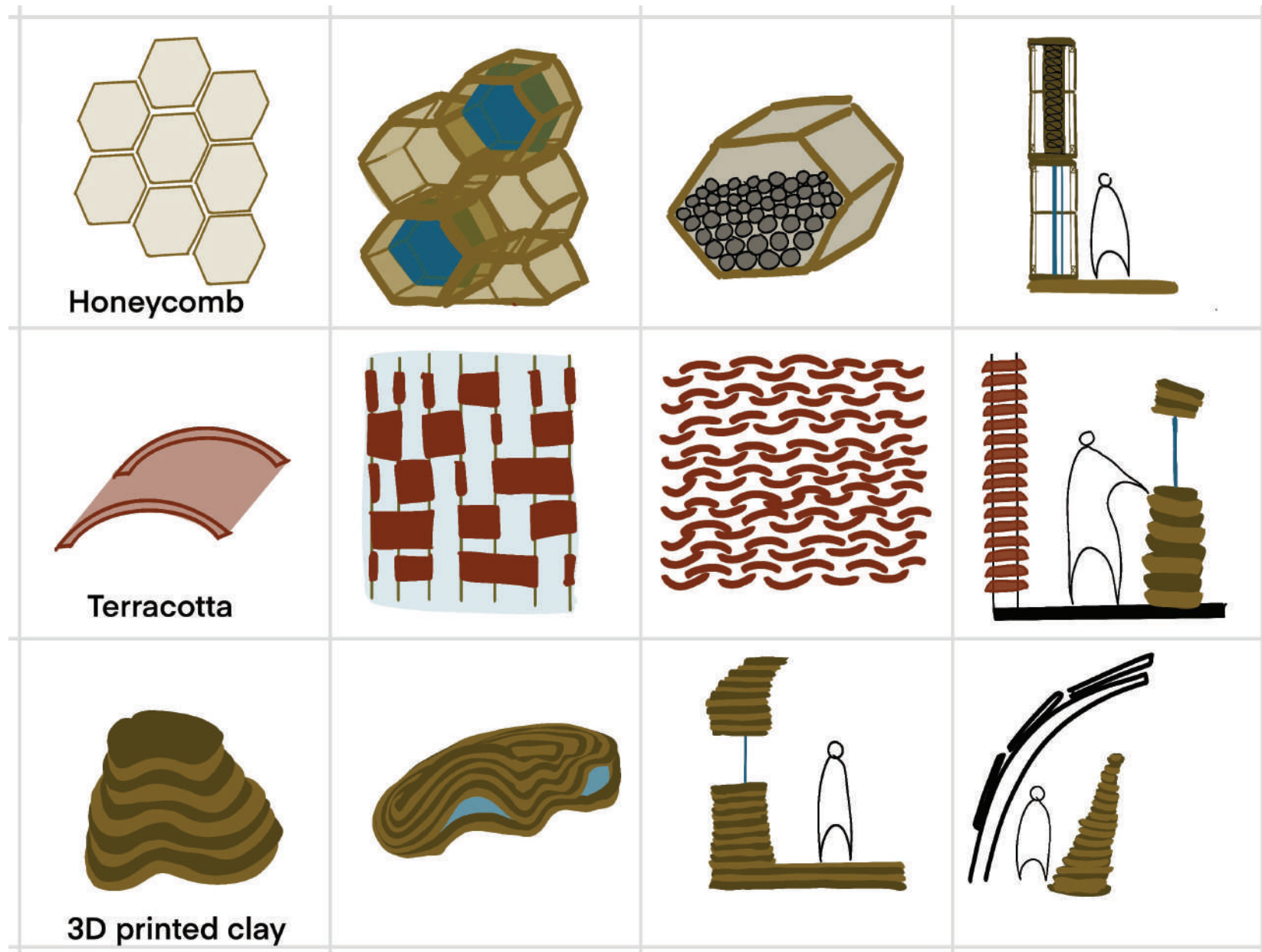


Figure 79 - Exploration of materials and ideas for Processing and Storage

7.5.3 Precedent for Processing and Storage: TECLA Technology and Clay 3D Printed House / Mario Cucinella Architects

The Tecla 3D printed house/prototype is a valuable precedent as the processing/storage centre uses materials historically used for food storage in South Africa. This precedent shows the potential to connect a historical material such as clay and a recent invention of 3D printing. This construction material and method links directly to the thesis regarding local materials and upskilling local labour in new construction methods. Additionally, the walls can become the cooling element and create an experience through texture and light.

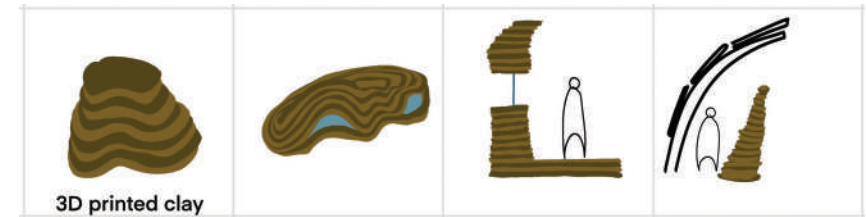


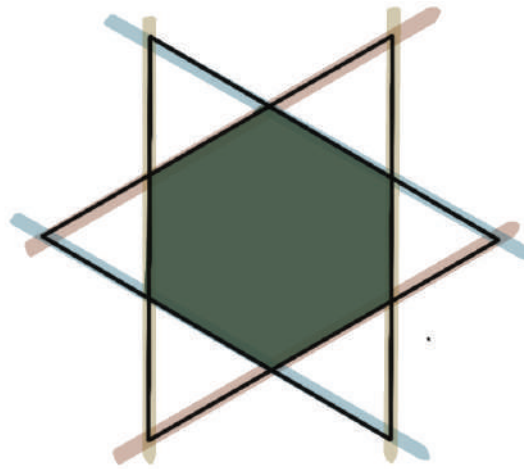
Figure 81 - Chosen exploration for Processing and Storage Centre



Figure 80 - External Photograph of TECLA 3D Printed Prototype
(Mario Cucinella Architects, 2021)



Figure 82 - Internal Photograph of TECLA 3D Printed Prototype
(Mario Cucinella Architects, 2021)



7.6 Workshops and stores

7.6.1 Initial design response and logic

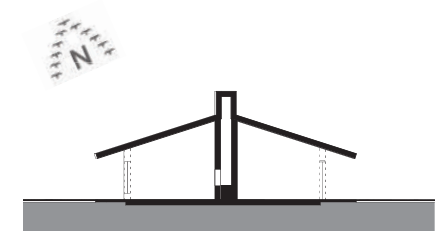
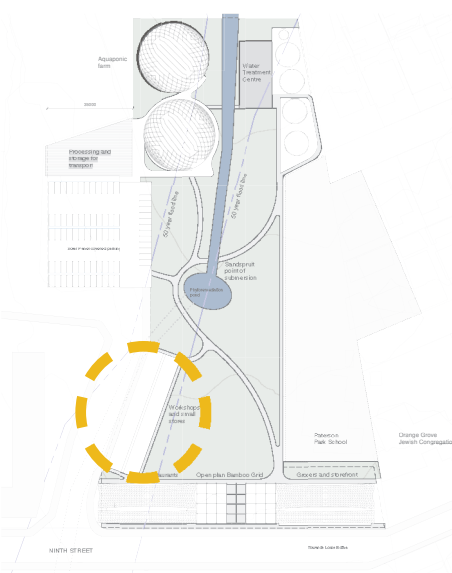
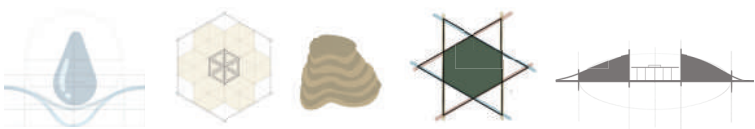
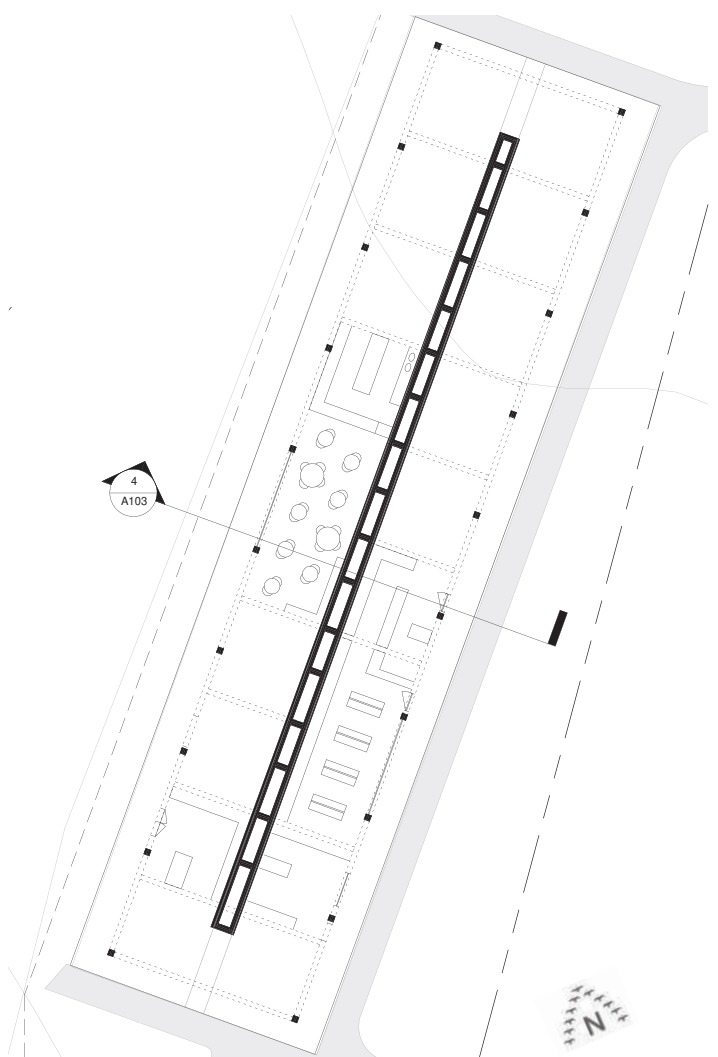


Figure 83 - Initial design of Workshops



Programme and use:
Workshops, cafes, and small stores.



Workshops and small stores

0m 10m 20m 30m

Initial design reponse:
Moveable walls to allow for a range of future uses, a set hearth and a set roof structure.

Strength:
The movable walls are linked to the theory that spaces need to be future-resistant.

Weakness:
The building does not show what is happening inside or that people should be spending time in and around the area.

Opportunity:
Liminal space design and outdoor design to promote interaction.

Response:
A weaving pattern has been created as an external shading structure over the building. This design combines parametric design and handmade crafts to show internal use and create beautiful structures that tie computational design and program.

Link to thesis and architectural design drivers:
Parametric design.

7.6.2 Sketches and exploration

Weaving to show handmade craft, exposing the beauty of human made items mixed with parametric design and engineering.

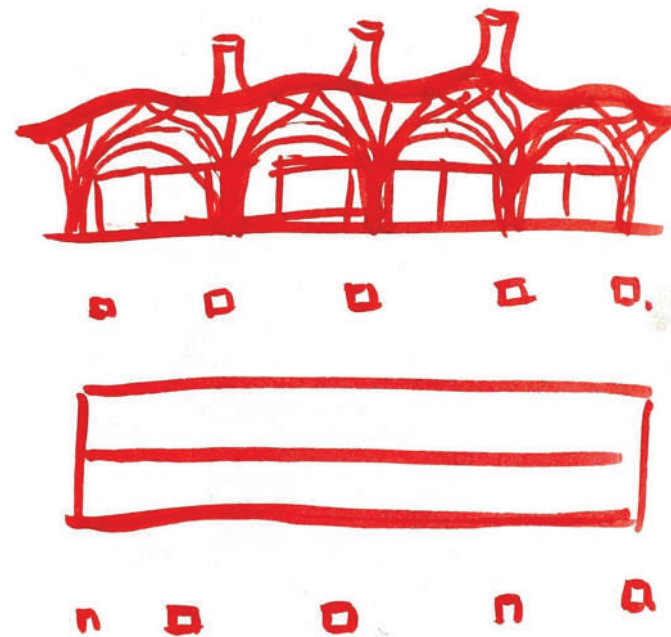
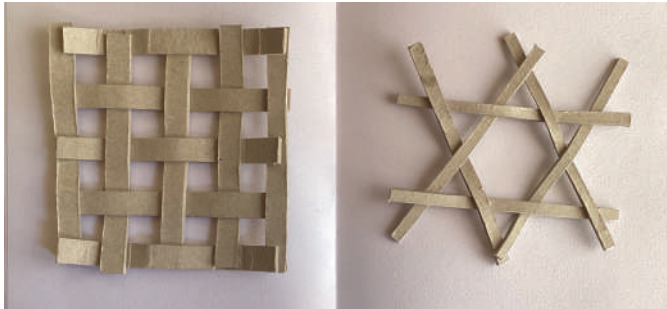
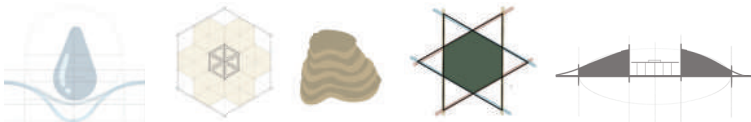
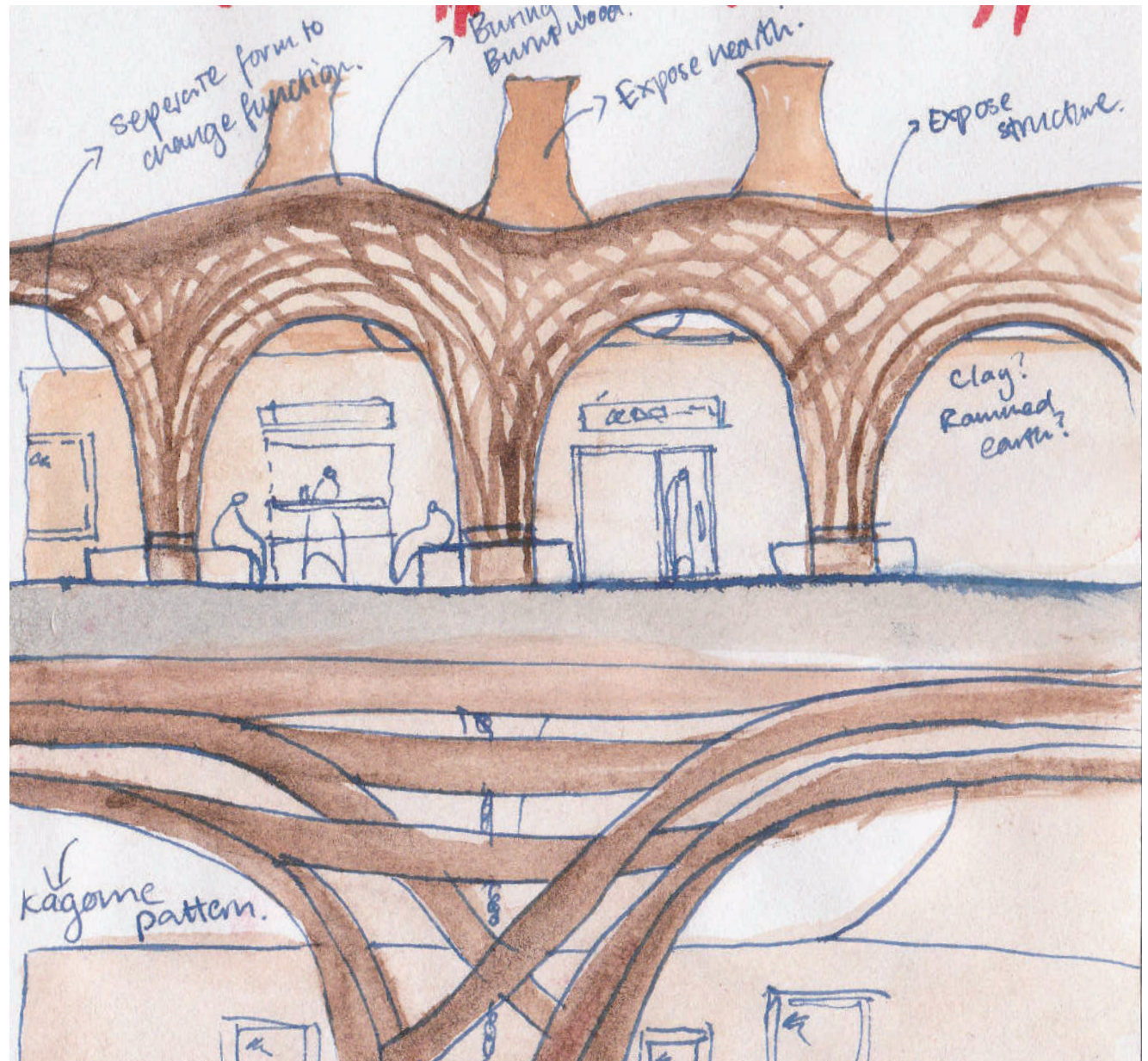
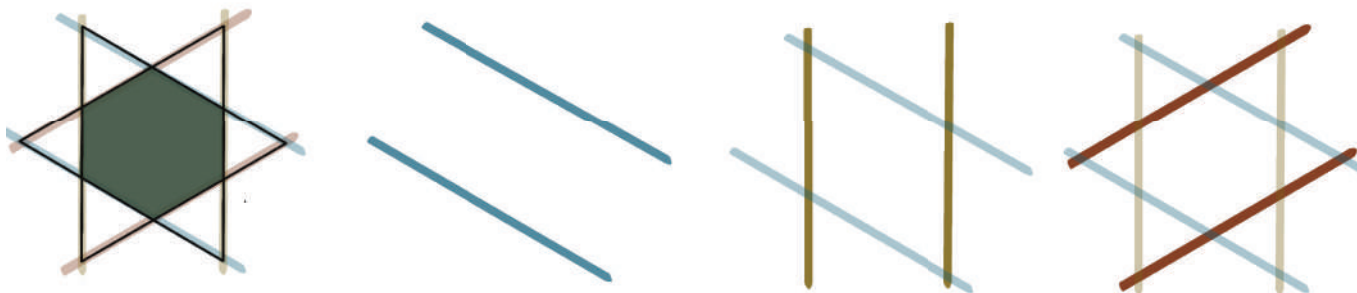
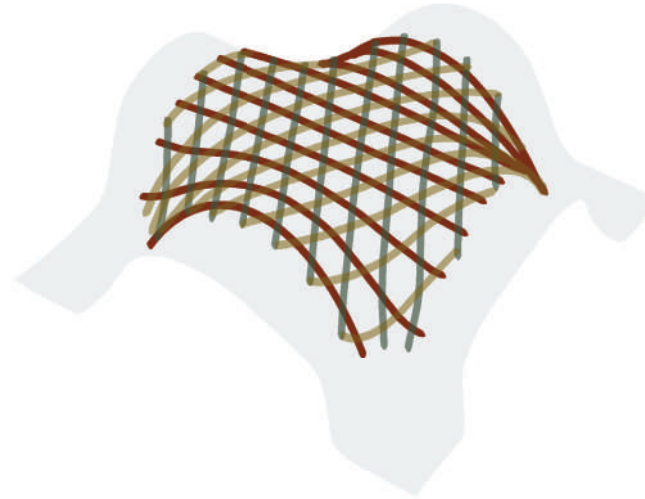
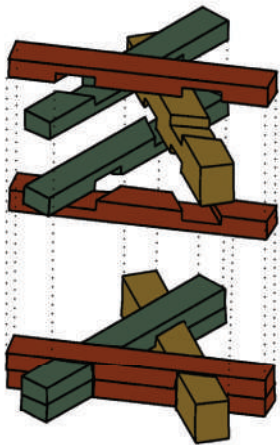


Figure 84 - Sketches and models of Workshops

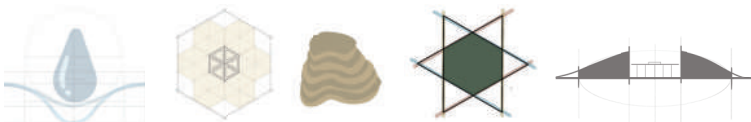


7.6.3 Precedent for Workshops and stores: The Nine Heasley Country Club by Shigeru Ban Architects



The Nine Heasley Country Club by Shigeru Ban Architects uses the Kagome pattern (a traditional Japanese weaving pattern) to create a parametric-based structure for the building structure (Shigeru Ban Architects, 2010). The workshops and small stores in my design have small business owners and artists who create handmade art from on-site materials. I designed the building to show the link between the program and the site while being easily read by users. The Kagome pattern structure exposes the handmade crafts within the structure while linking parametric design and timber. The precedent was useful as it presented an option for a construction method and what it could look like.

Figure 85 - Logic of Kagome pattern
(Shigeru Ban Architects, 2010)



7.6.4 Material and construction considerations

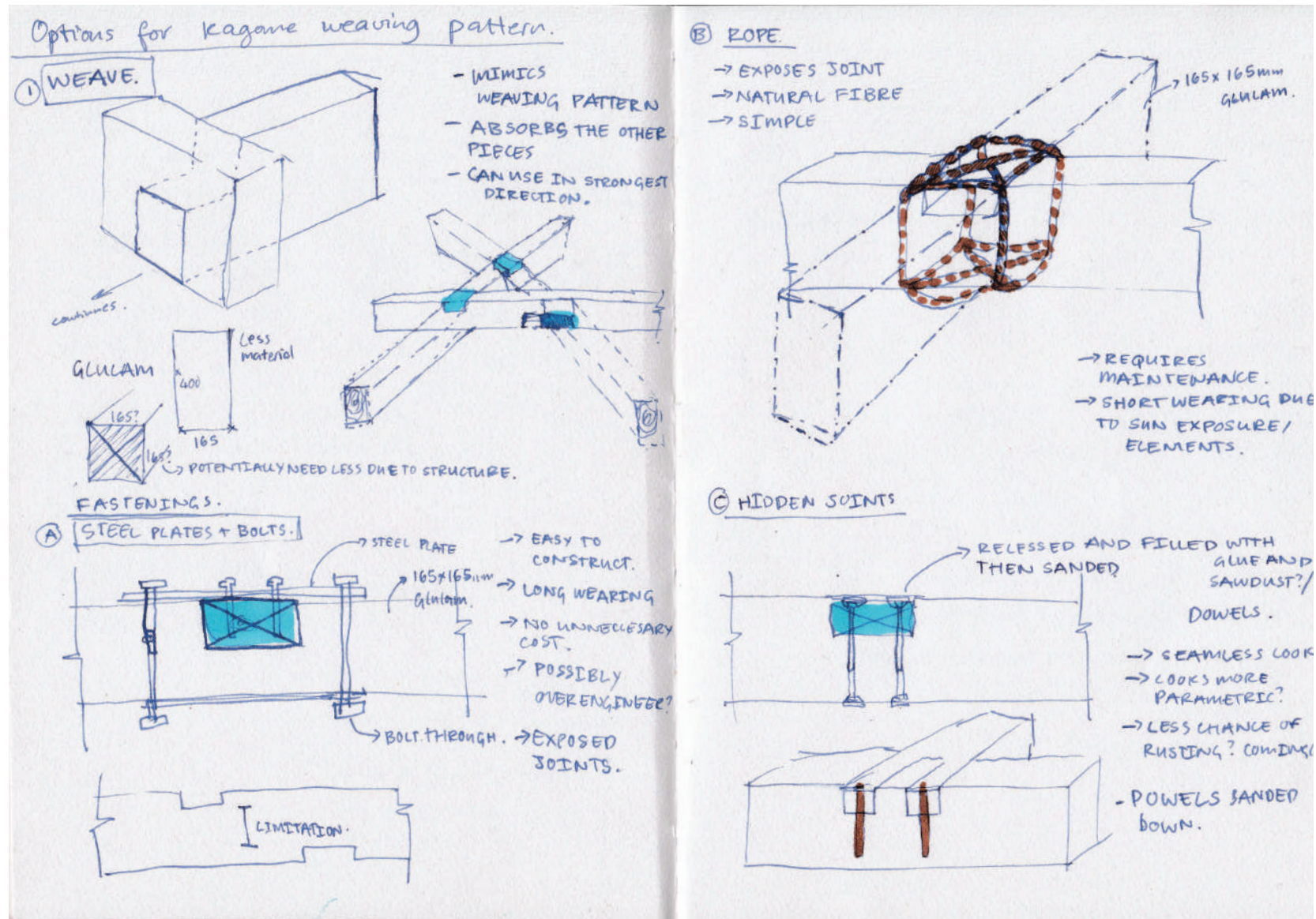
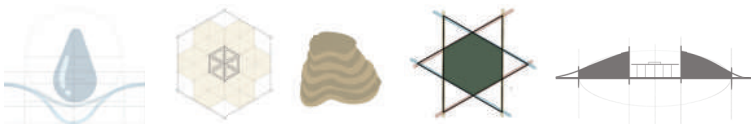


Figure 86 - Construction options for Workshop design



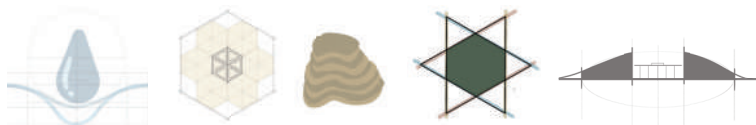
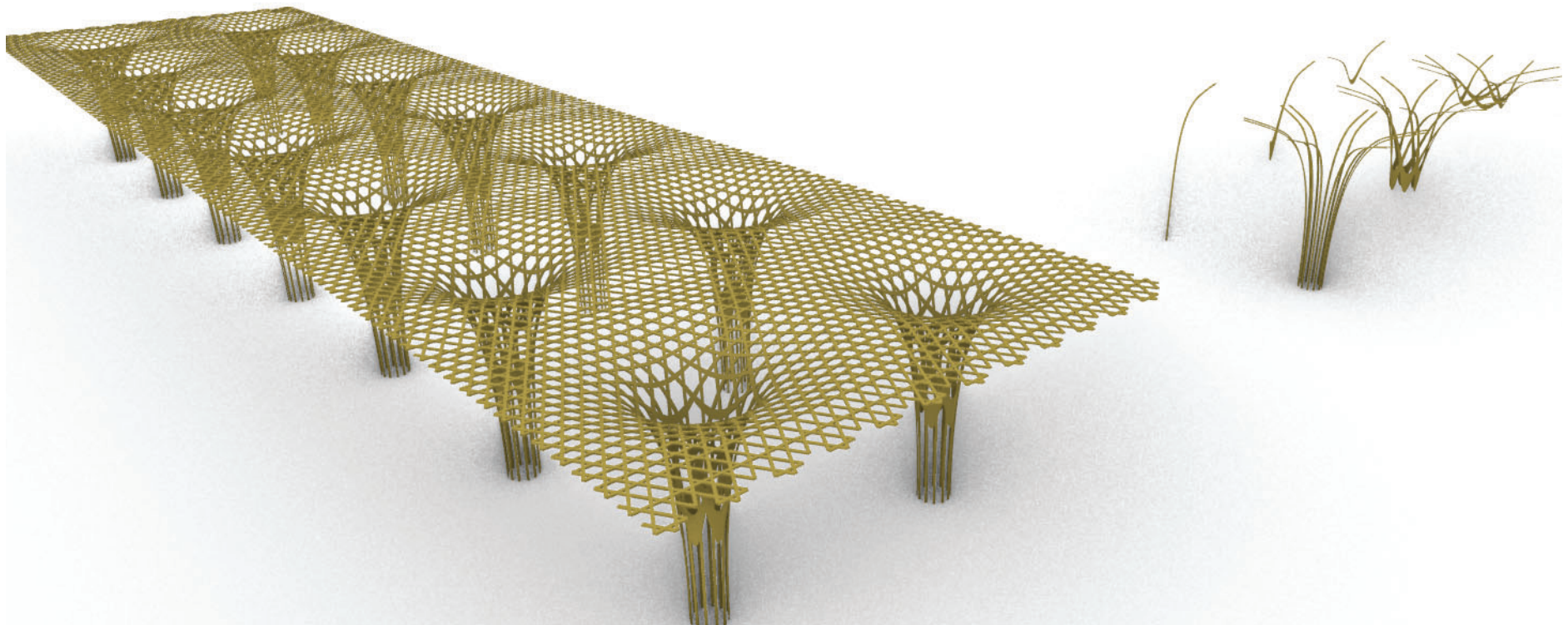
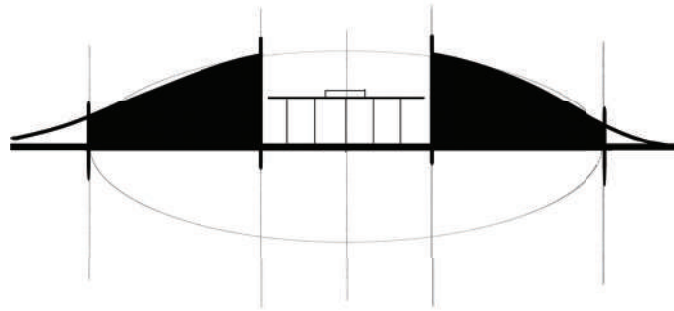
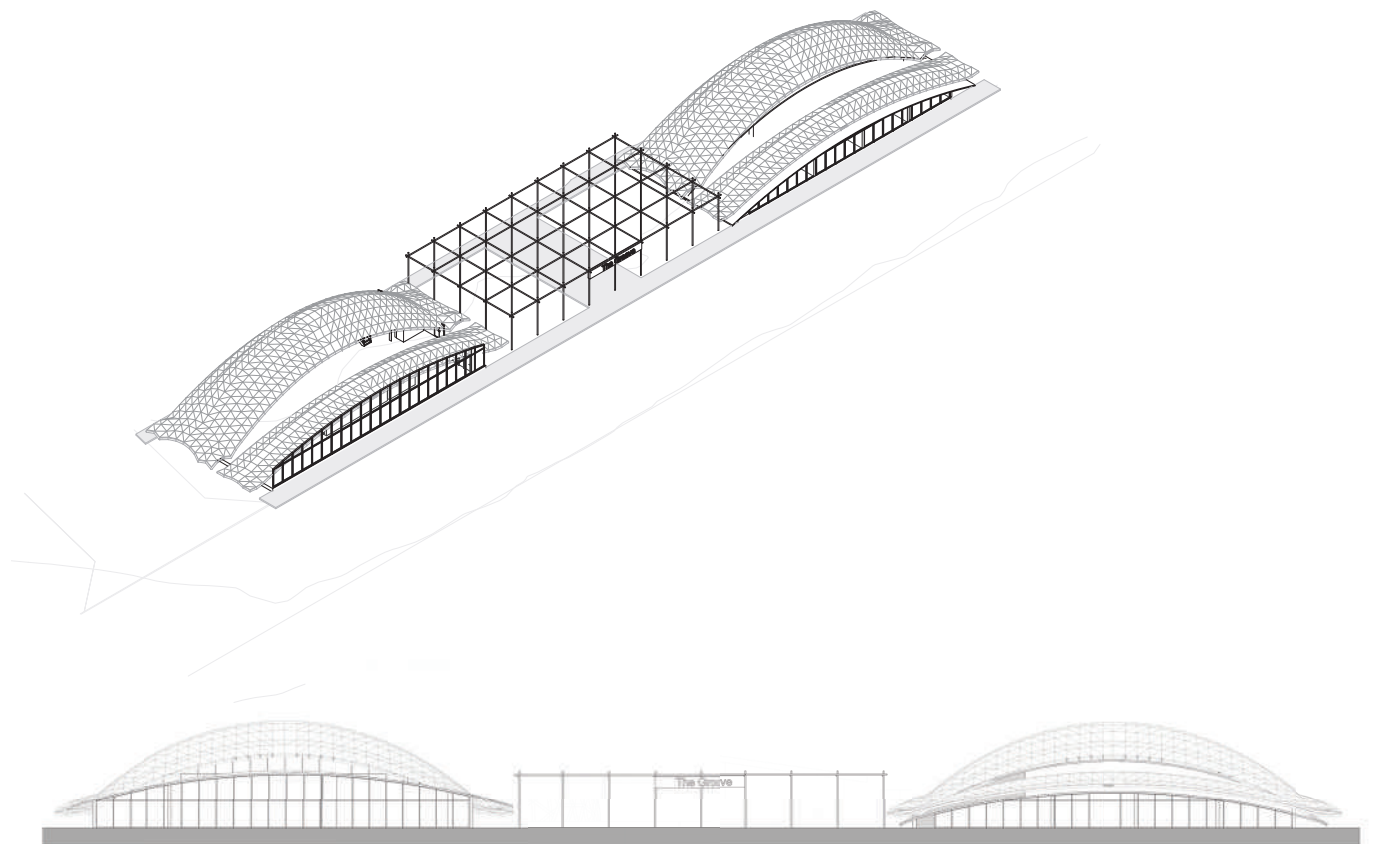


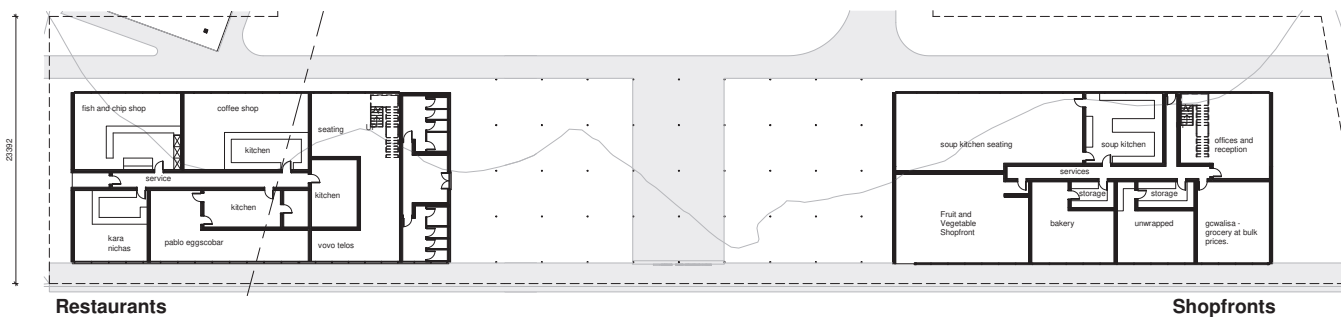
Figure 87 - Programmed Kagome Pattern on Rhino



7.7 Restaurants, Grocers, and Soup Kitchen



Road Elevation
1 : 200



0m 10m 20m 30m

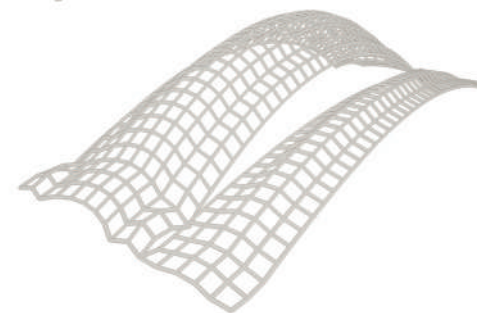
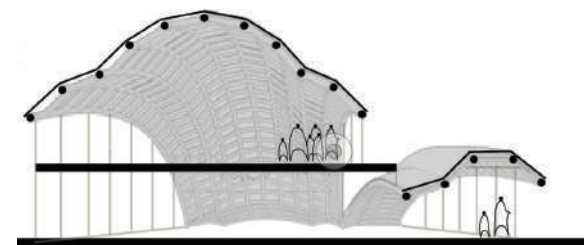


Figure 89 - Initial design of Restaurants and Grocers

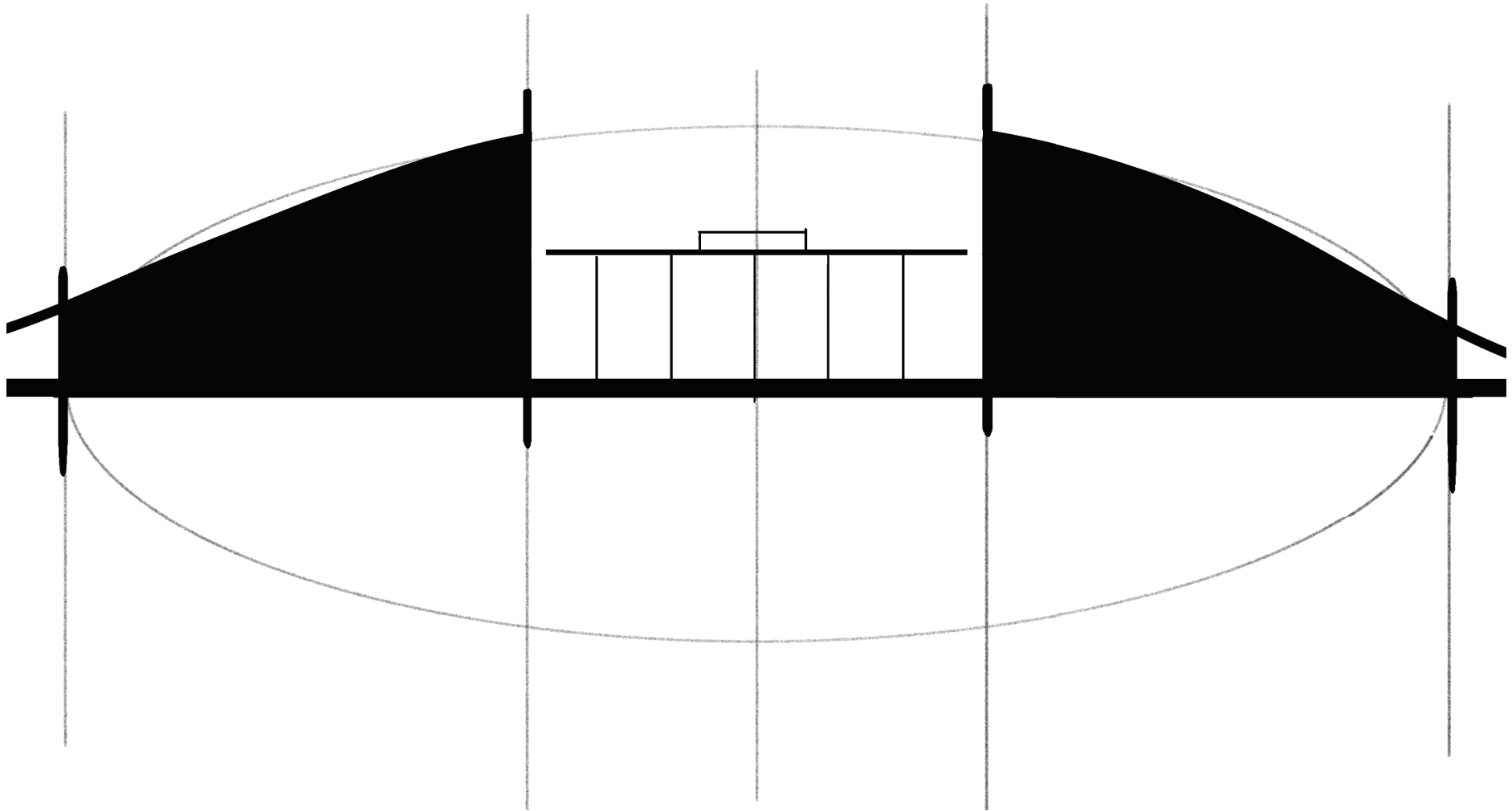
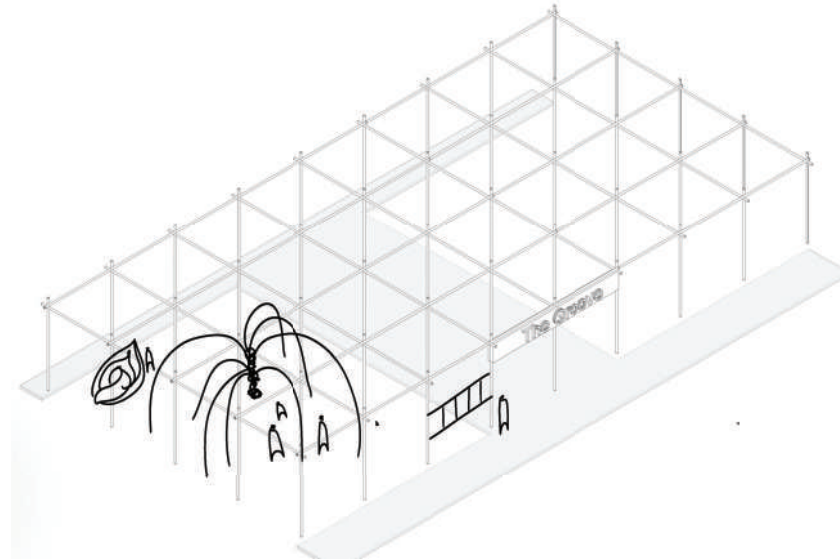


Figure 90 - Geometry of the Entrance building





7.8 Open plan grid and entrance

7.8.1 Initial design response and logic

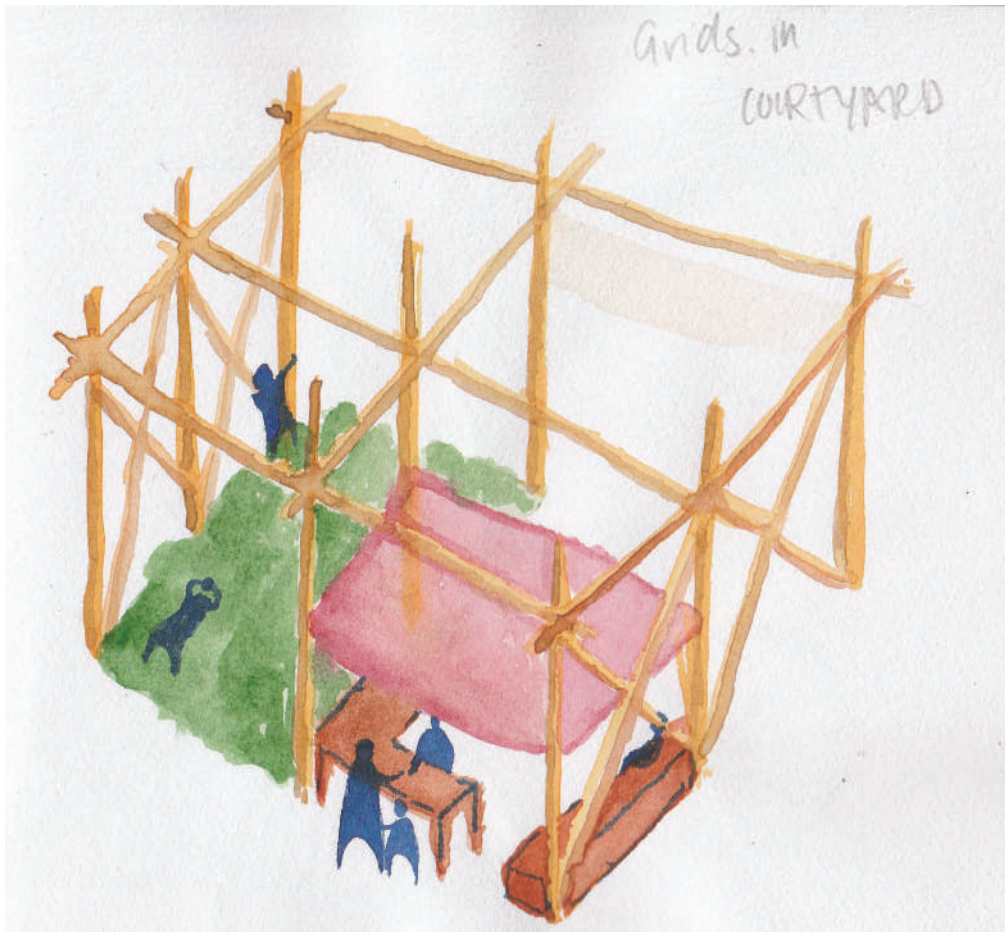


Figure 91 - Initial design of Bamboo grid

The open-plan grid has been designed to create usable blocks of space that can be transformed according to the public's requirements. The design incorporates a simple bamboo structure with soft and hard surfaces. This design is closely linked to the theory regarding creating usable future spaces. The figure on the following page shows examples of how this could be used, such as a community garden, an outdoor cinema, and a market. This idea derives from the Sunday markets throughout Johannesburg at places like Huddle Park and Bedfordview Night Market, which show excellent community engagement and interest. The placement on the site would draw in pedestrians and show that the site is for public use.



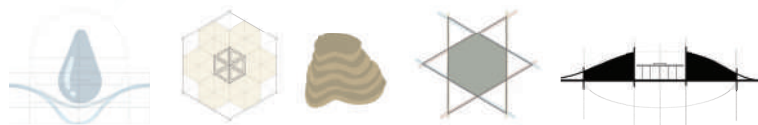
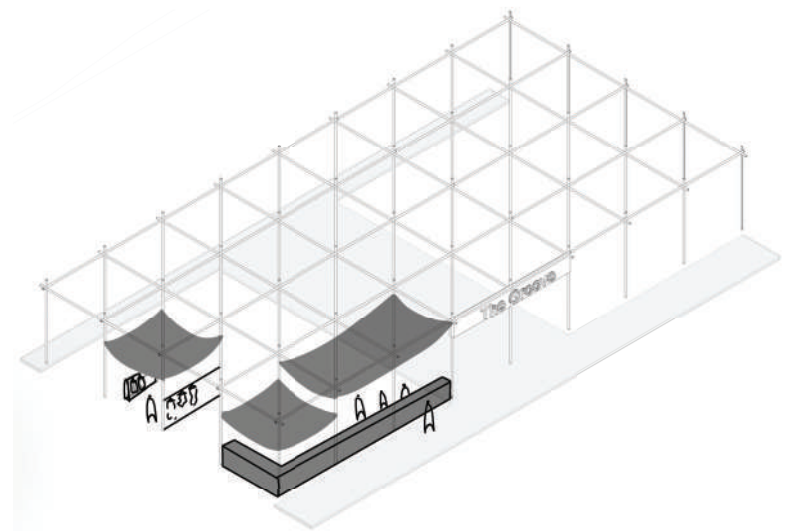
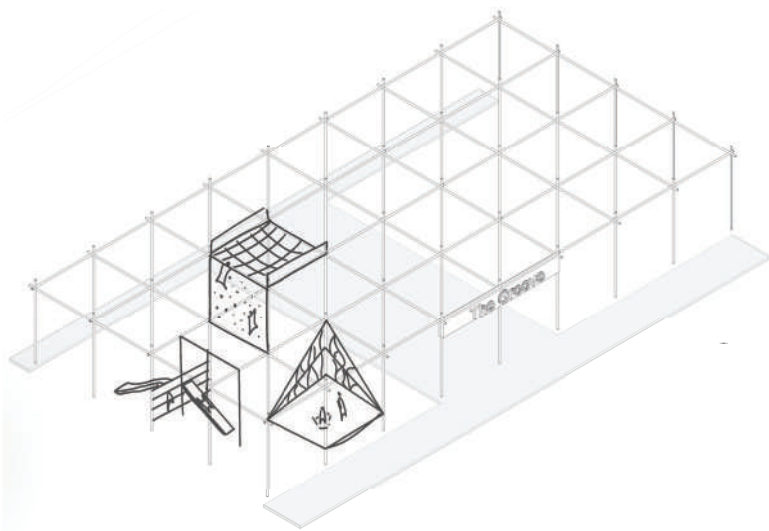
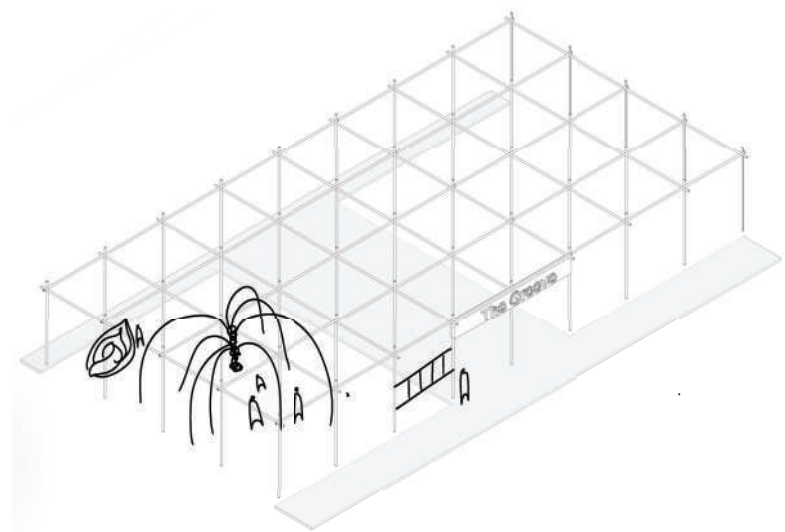
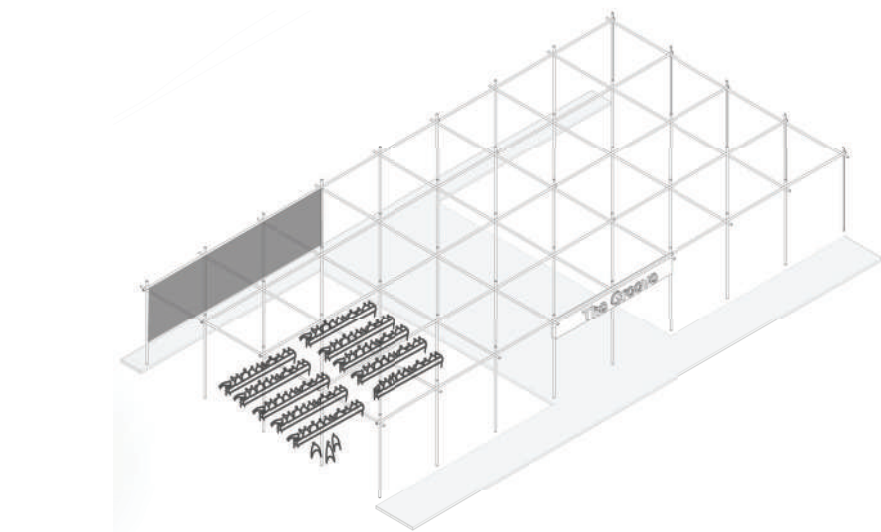


Figure 92 - Bamboo Grid on site

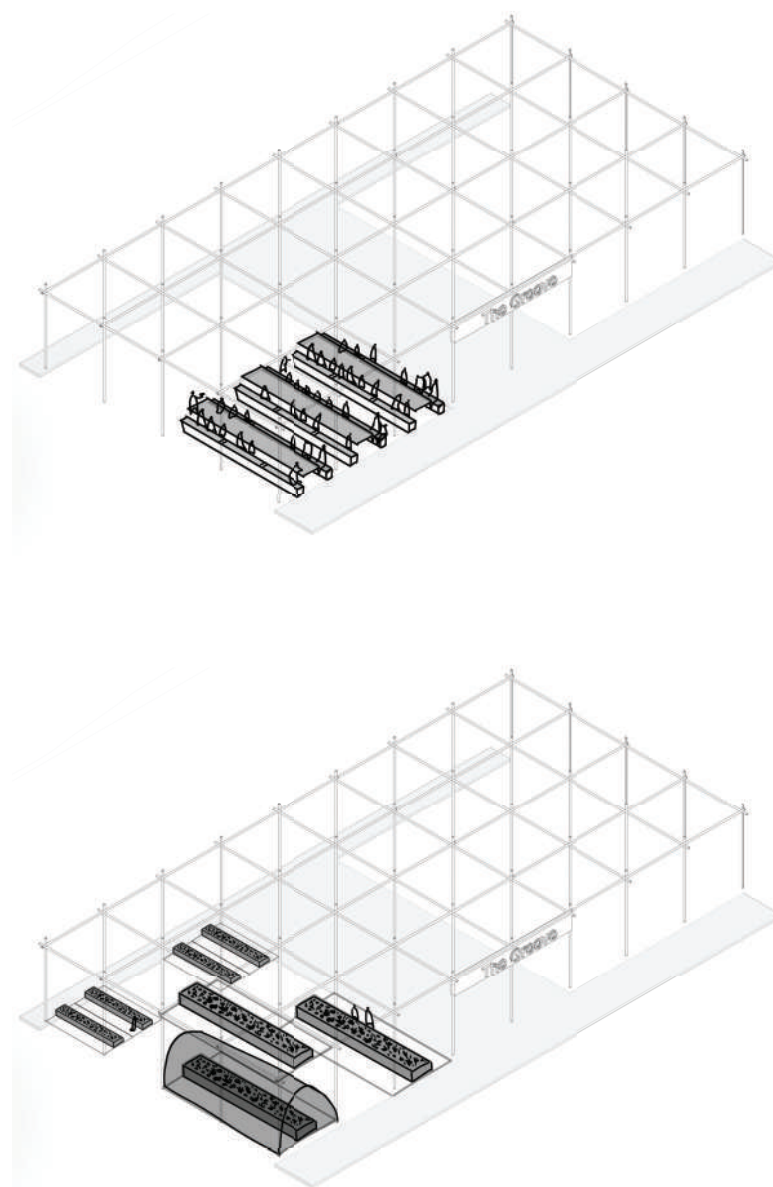
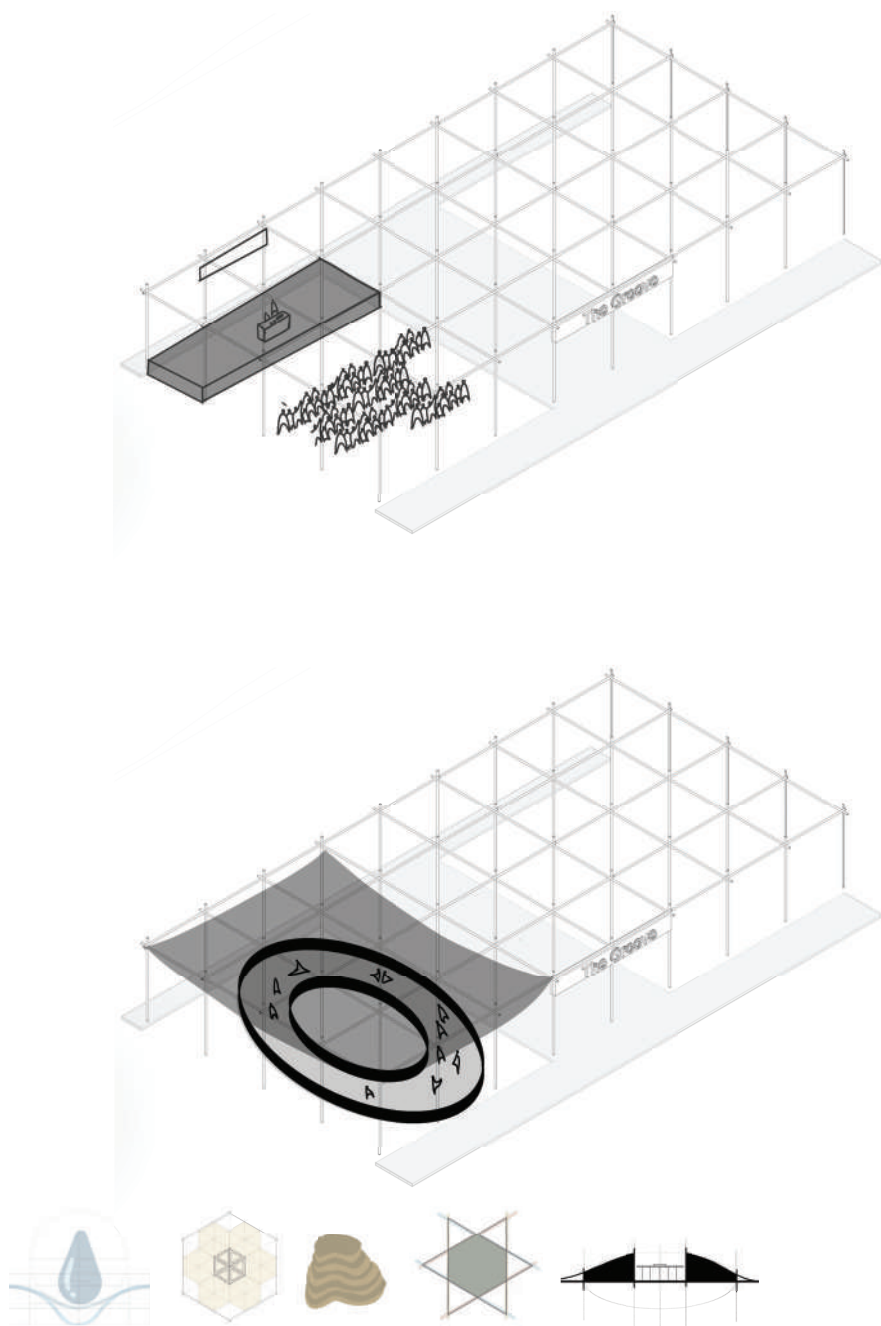


Figure 93 - Bamboo Grid on site

7.9 Park design features



Figure 94 - Unpaved pathway

The paved and unpaved paths are lined with trees so that the users can quickly identify how to walk around the site without getting lost. This design allows users to experience nature without feeling anxious.

The park design is based on Emmarentia Dam, Johannesburg. Emmarentia Dam is frequently visited and well known in Johannesburg, with a range of facilities such as a dog park, dams, a Shakespeare garden, and a medicinal garden. Through a site visit and documentation, I discovered additional small-scale elements that make the park more appealing and user-friendly while keeping the large-scale design previously mentioned in theory in mind. The following drawings/ photographs show how these small moments work and how people interact with them.



Figure 95 - Paved pathway

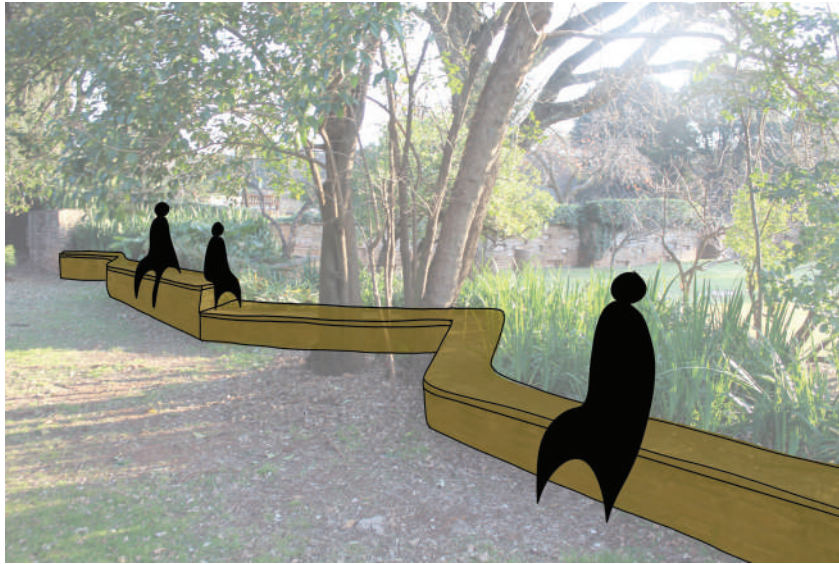


Figure 96 - Seats designed into planter

The park offers multiple types of seating for planned moments like picnics or impromptu moments like watching birds by the fountains. The seats are incorporated into the design of the planters and retaining walls.

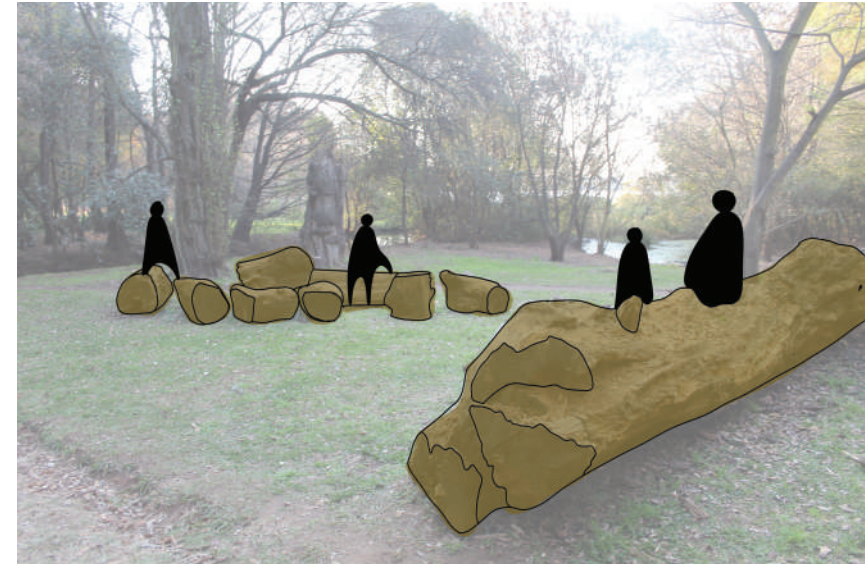
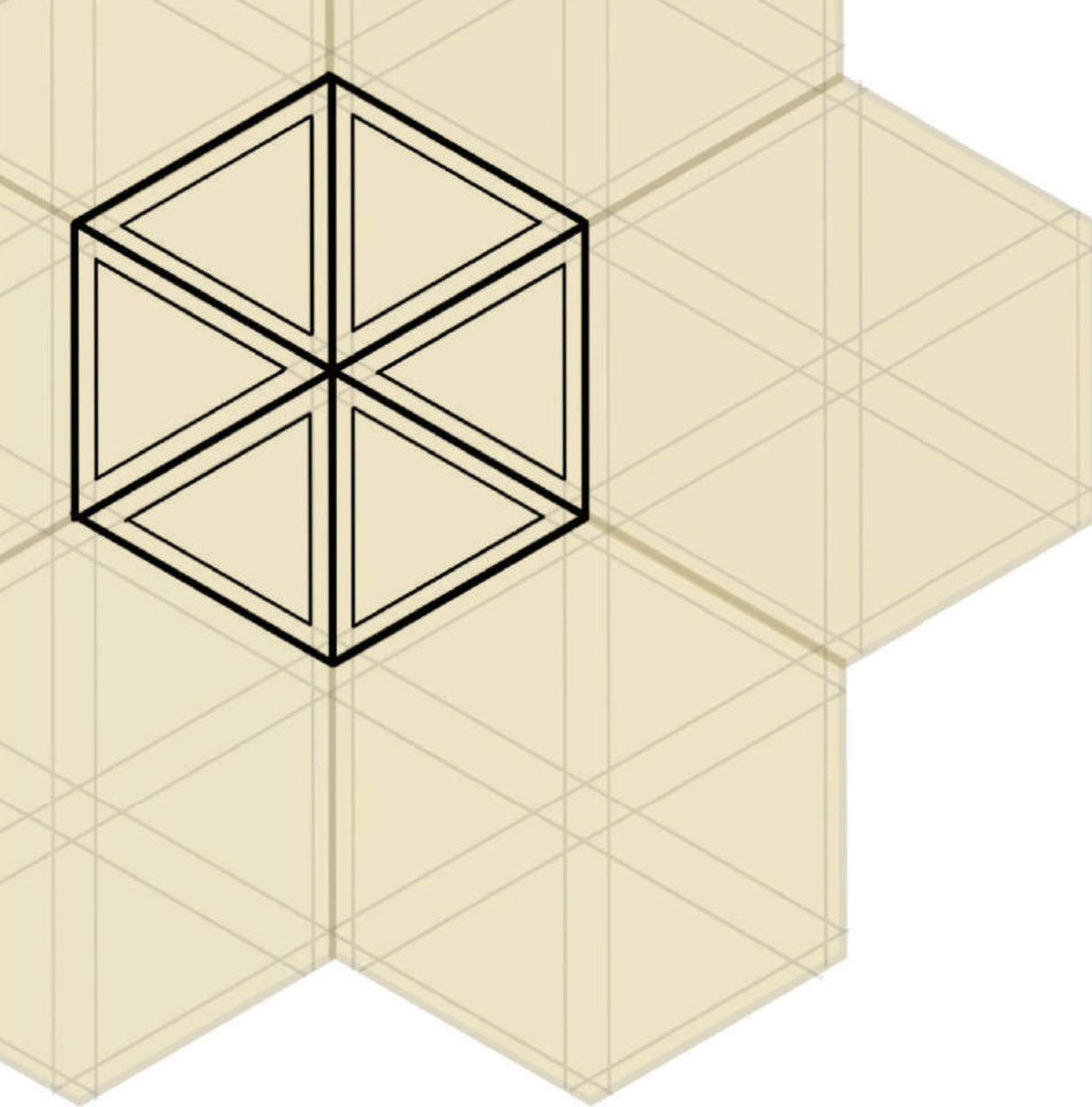


Figure 97 - Natural seating

Additionally, the park places naturally occurring seats, such as large trees that have fallen for more spontaneous moments.



Part 1

1. Introduction
2. History of Orange Grove and Norwood
3. Service Delivery
4. Theoretical Approach
5. Architectural Design Drivers
6. Design - Site Analysis
7. Design Development and precedents

8. Conclusion

Part 2

Final Design

References

08

Conclusion

In conclusion, the design I have proposed, consisting of a water treatment centre, aquaponic farm, workshops and small stores, restaurants, a soup kitchen, and zero-waste grocers, considers and responds to the failure of the service delivery system in Orange Grove, South Africa. The project cleans the polluted water of the Sandspruit River while producing organic produce and construction materials within the aquaponic greenhouse, which are used at the workshops, restaurants, soup kitchen, and grocers. The design creates a community support structure that improves users' overall well-being while promoting the local economy through job creation and material production.

The project has been designed to be spatially, socially, and environmentally conscious to create a precedent of spaces that are experiential while creating a better-running neighbourhood through decentralised resources and service delivery. The logic of the buildings and site design is based on relevant theory, interviews with experts, precedents, and the sustainable development goals. The intention of this thesis was to create a design that could positively impact the neighbourhood, water source, environment, and labour force while creating an economically viable programme that could educate and inspire younger generations, which I believe has been achieved.

This document is PART 1, and includes the sketch design and development without final drawings. The final design will be presented in PART 2.

Part 1

1. Introduction

2. History of Orange Grove
and Norwood

3. Service Delivery

4. Theoretical Approach

5. Architectural Design
Drivers

6. Design - Site Analysis

7. Design Development and
precedents

8. Conclusion

Part 2

Final Design

References

PART 2

Final Design Drawings

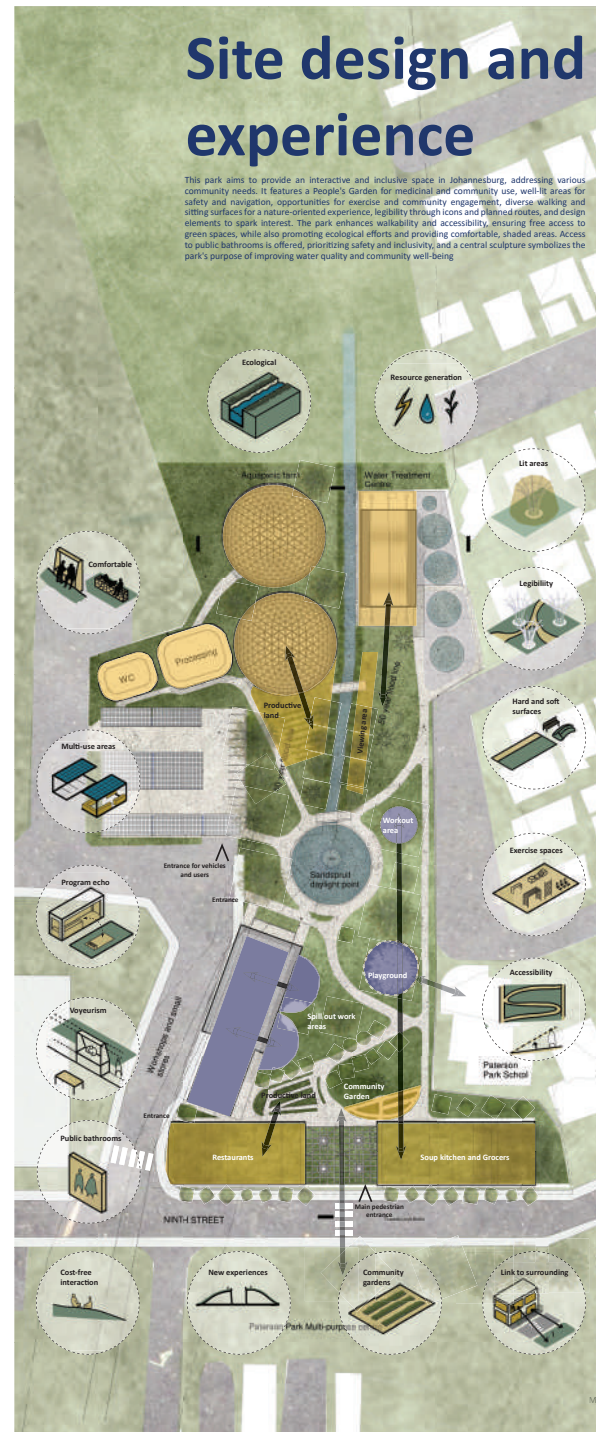
Table of Contents

PART 2

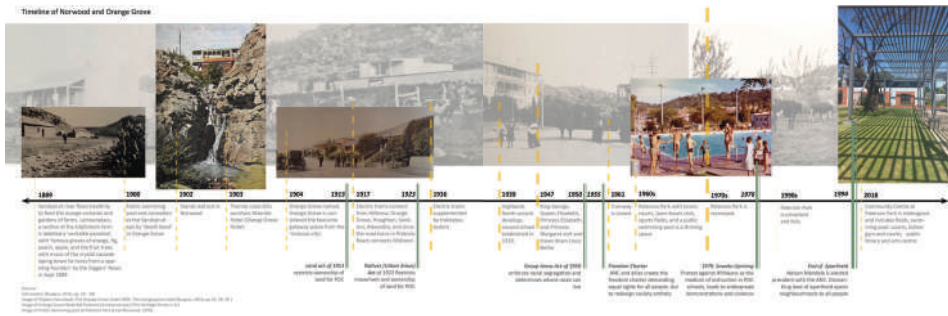
01

152	Site Plan
153	Site Design and Experience
154	Information page
155	The Groove - Restaurant and Grocers
156	Designer's Nexus - Workshops and Small stores
157	Designer's Nexus - Section detail 1:20
158	The Bubble Club - Processing Centre
159	The Biodome - Aquaponic Farm
160	Ripple Tank - Water Treatment Centre
161	Phytoremediation pond
162	Section through site 1:200
163	User experiences
164	User experiences





Information



Latinas / Spanish / Mediterranean

Fast grower (less): 30–60 Days
Ancho (Jalisco), Salsa Chica, Mint, Parsley, Coriander, Cilantro, Fenel, Coriander, Parsley
Medium grower (less): 50–90 days
Eggplant, Bell Peppers, Tomatoes, Corn, Onion
Slow grower (less): 120 days
Red Beans, Fenel, Eggplant
Tilapia, Trout (3–18 Months)

North Indian Cuisine

Fast grower (less): 30–60 Days
Lentils, Spinach, Swiss Chard, Fenugreek, Coriander, Mustard greens, Chik peapod.
Medium grower (less): 70–120 days
Potatoes, Curry Beans,
Slow grower (less): 8–12 months
Garlic, Ginger

Chinese / Japanese Cuisine

Fast grower (less): 1–30 Days
Cabbage, Carrots, Watermelon, Spinach, Beans, Spinach, Bok Choy
Medium grower (less): 30–60 days
Chinese mushrooms, Chinese Cabbage
Slow grower (less): 4–10 months
Garlic, Ginger, Tilapia, Trout (3–18 months)

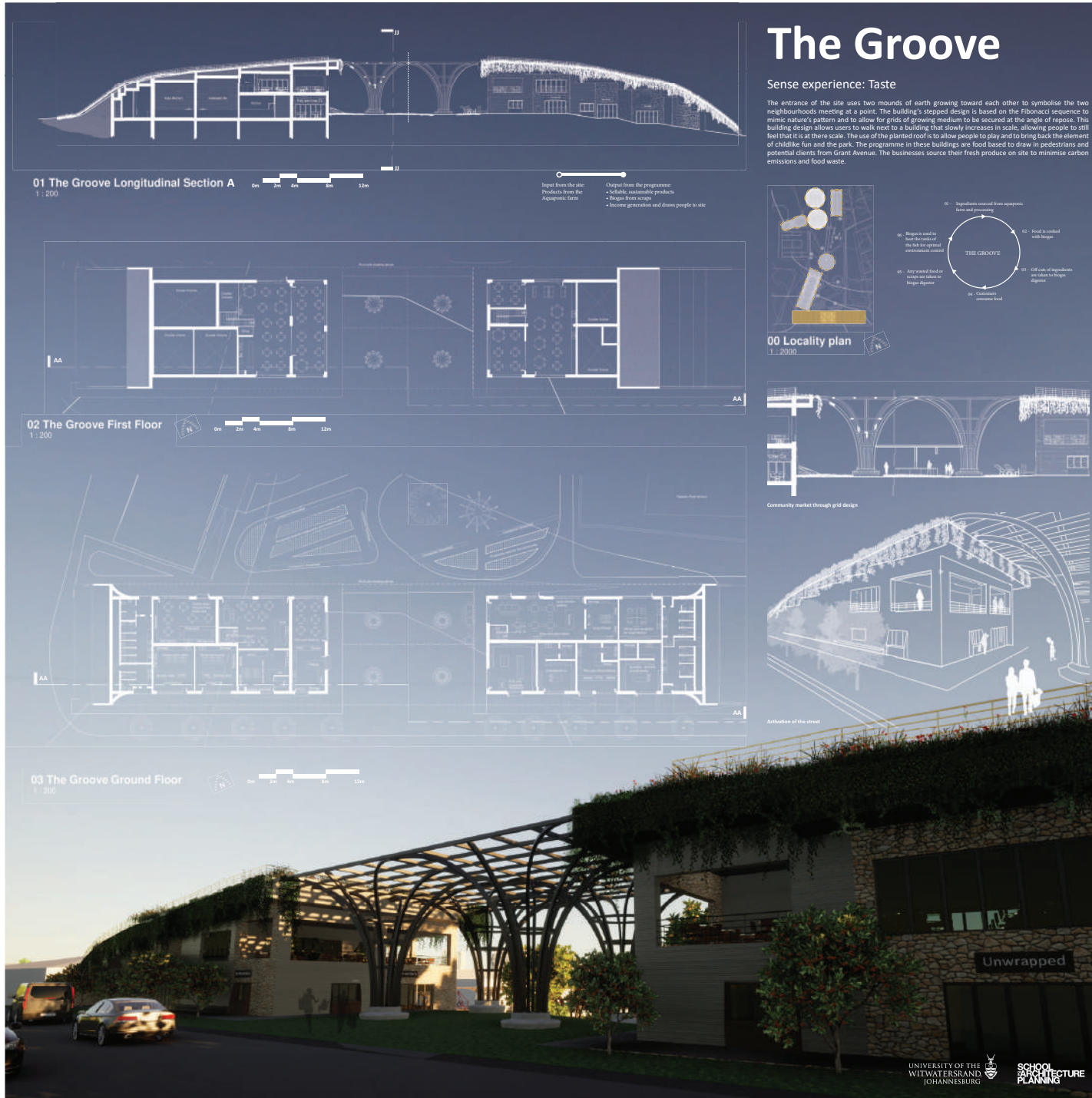
Mineral (plants) / Tuberous

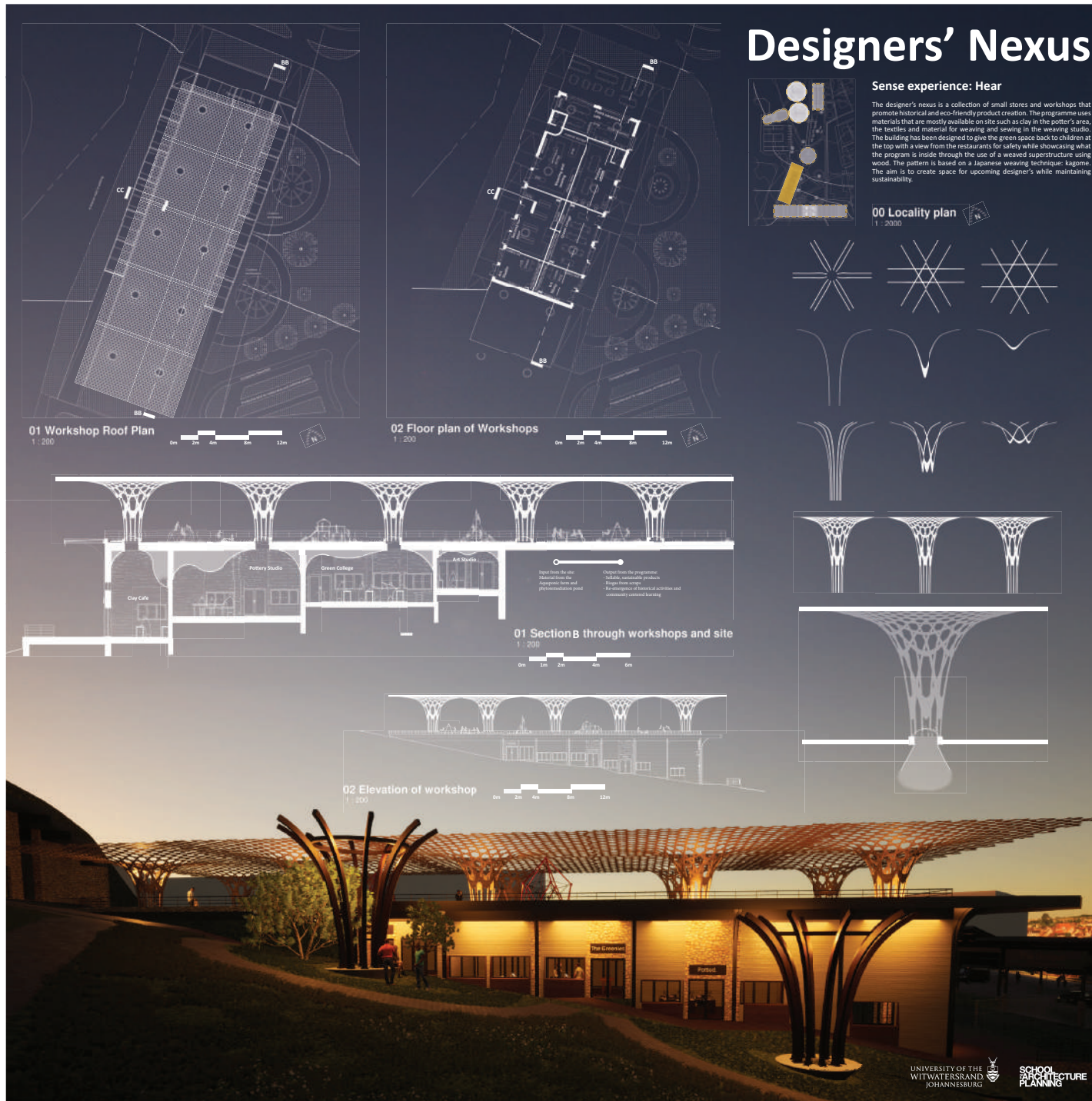
Fast grower (less): 30–60 Days
Lentils, Tomatoes, Cauliflower, Beans.
Slow grower (less): 8–10 months
Garlic, Ginger

ACCOMMODATION SCHEDULE FOR WEDNESDAY 19th			
Event/Activity	Room	Start	End
Registration	Room 1	08:00	10:00
Breakfast	Room 1	10:00	11:00
Session 1: Introduction to the course	Room 1	11:00	12:00
Session 2: Advanced topics in the course	Room 1	12:00	13:00
Session 3: Practical applications of the course	Room 1	13:00	14:00
Session 4: Case studies and group work	Room 1	14:00	15:00
Session 5: Final presentation and discussion	Room 1	15:00	16:00
Session 6: Networking and social activities	Room 1	16:00	17:00
Session 7: Reflection and evaluation	Room 1	17:00	18:00
Session 8: Closing remarks and certificates	Room 1	18:00	19:00
Session 9: Free time and social activities	Room 1	19:00	20:00
Session 10: Final wrap-up and feedback	Room 1	20:00	21:00
Session 11: Departure and travel arrangements	Room 1	21:00	22:00
Session 12: Final check-in and departure	Room 1	22:00	23:00
Session 13: Final departure and travel arrangements	Room 1	23:00	24:00
Session 14: Final departure and travel arrangements	Room 1	24:00	25:00
Session 15: Final departure and travel arrangements	Room 1	25:00	26:00
Session 16: Final departure and travel arrangements	Room 1	26:00	27:00
Session 17: Final departure and travel arrangements	Room 1	27:00	28:00
Session 18: Final departure and travel arrangements	Room 1	28:00	29:00
Session 19: Final departure and travel arrangements	Room 1	29:00	30:00
Session 20: Final departure and travel arrangements	Room 1	30:00	31:00
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Session 31: Final departure and travel arrangements	Room 1	41:00	42:00
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Session 33: Final departure and travel arrangements	Room 1	43:00	44:00
Session 34: Final departure and travel arrangements	Room 1	44:00	45:00
Session 35: Final departure and travel arrangements	Room 1	45:00	46:00
Session 36: Final departure and travel arrangements	Room 1	46:00	47:00
Session 37: Final departure and travel arrangements	Room 1	47:00	48:00
Session 38: Final departure and travel arrangements	Room 1	48:00	49:00
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Session 40: Final departure and travel arrangements	Room 1	50:00	51:00
Session 41: Final departure and travel arrangements	Room 1	51:00	52:00
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Session 72: Final departure and travel arrangements	Room 1	82:00	83:00
Session 73: Final departure and travel arrangements	Room 1	83:00	84:00

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The Groove

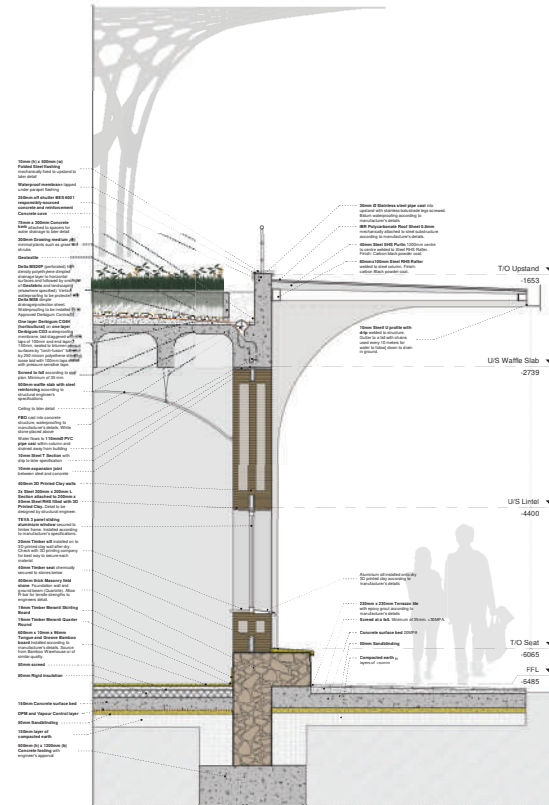




Designers' Nexus

Sense experience: Hear

The material palette of this building uses quartz that are sourced from site during construction or surrounding construction sites, clay that may be sourced from the site depending on the water table allowances or from nearby construction sites. The building has been designed at a residential scale with regards to the windows and doors to allow for small, precious moments looking into the building and moments to enjoy the space through wall design and window sill design. The design uses 3D printed clay, stone, and wood as the main elements. All which have been used in historical art creation. The 3D printed clay and wood use a natural material in a manner that is technologically advanced and shows pushing boundaries naturally.



Section C detail of workshop
1:20



Site logic and response

The Bubble Club

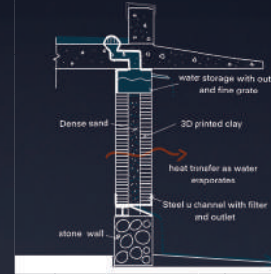
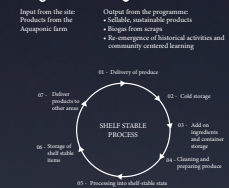
The Bubble Club

Sense experience: Feel

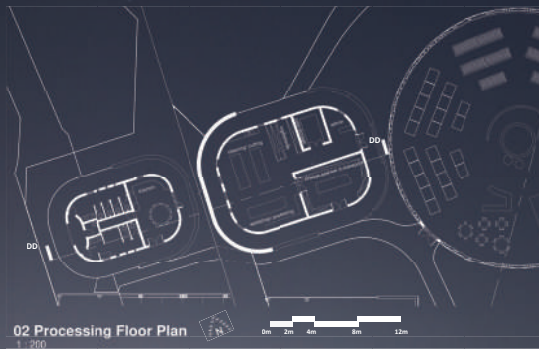
The bubble club hosts the processing to make the fresh produce from the aquaponic system shelf stable through minimal processing. The building has been design so that viewers may see from the outside when there is no tour how the process works and can enter during tour times. Due to the use of fresh produce, this building has been designed with the thought of how food can be stored naturally - through a double pot clay system that uses water and sand within the walls to aid in heat transfer from inside to outside. The beauty of this building is that it uses rain water collection and allows the wall to be wet which goes against architectural principles.



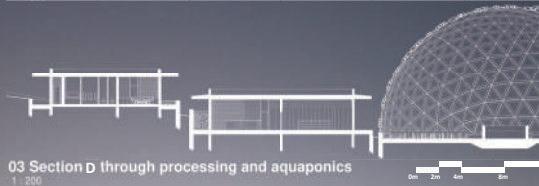
00 Locality plan
1 : 2000



Clay fridge wall concept



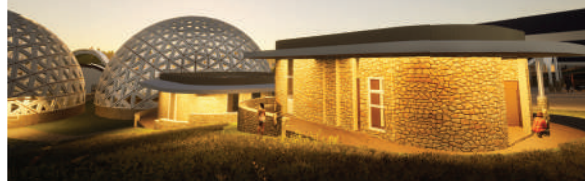
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1 : 200



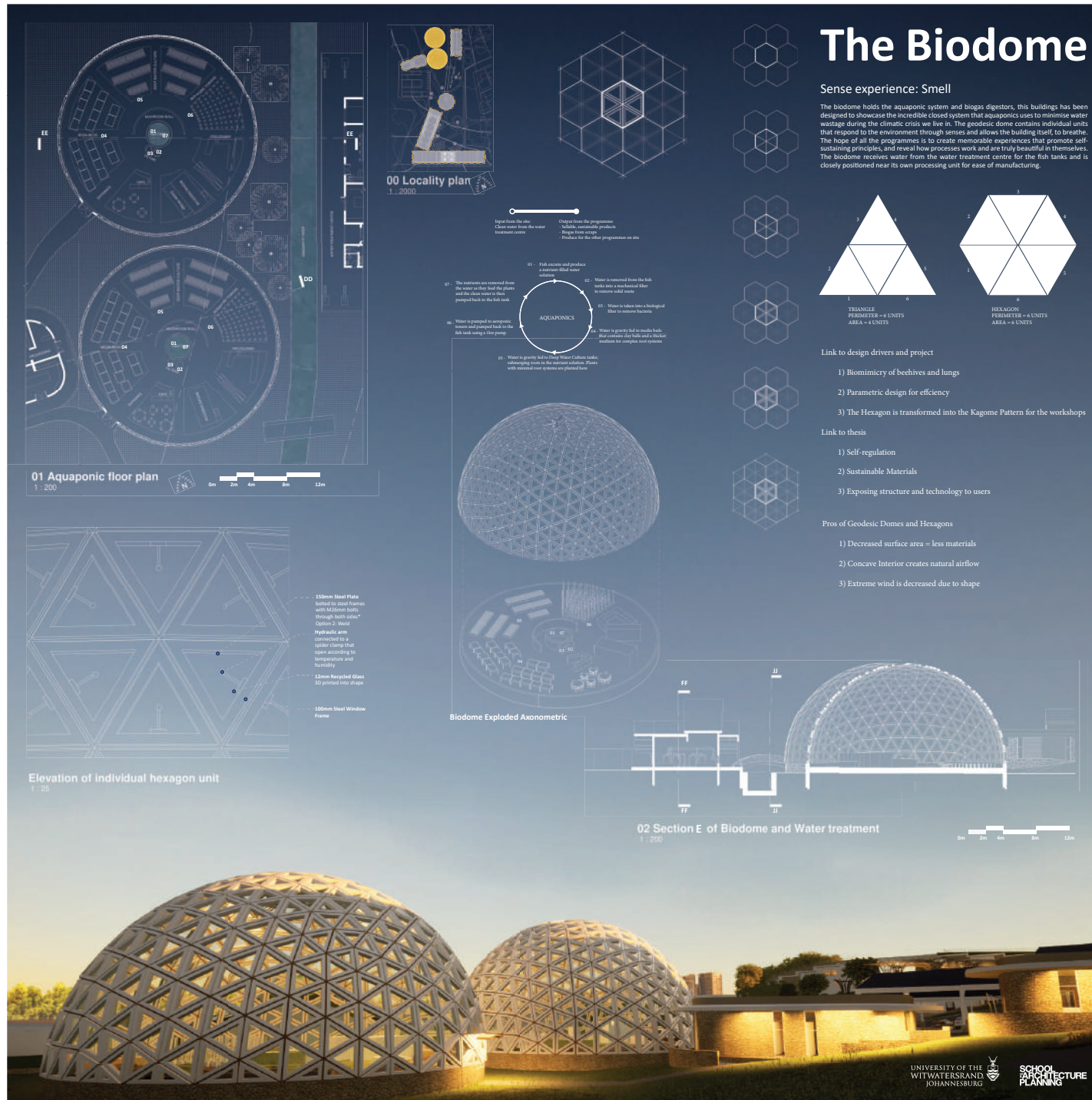
03 Section D through processing and aquaponics
1 : 200



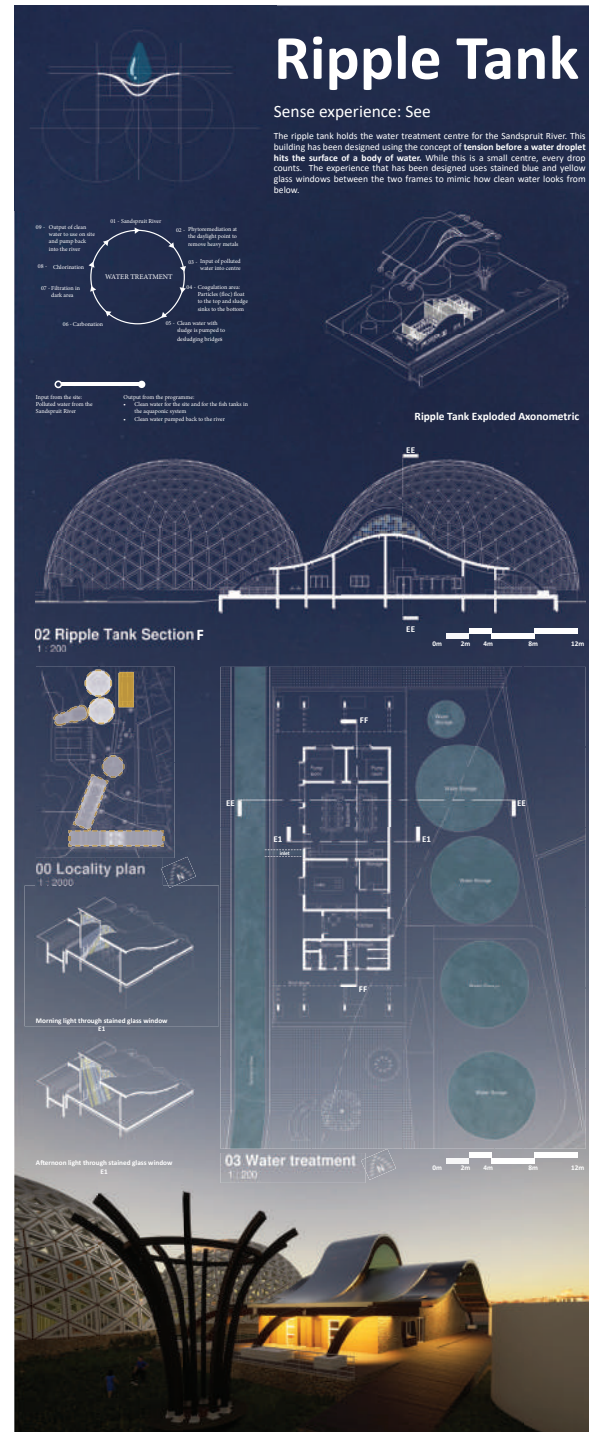
04 Processing Elevation
1 : 200



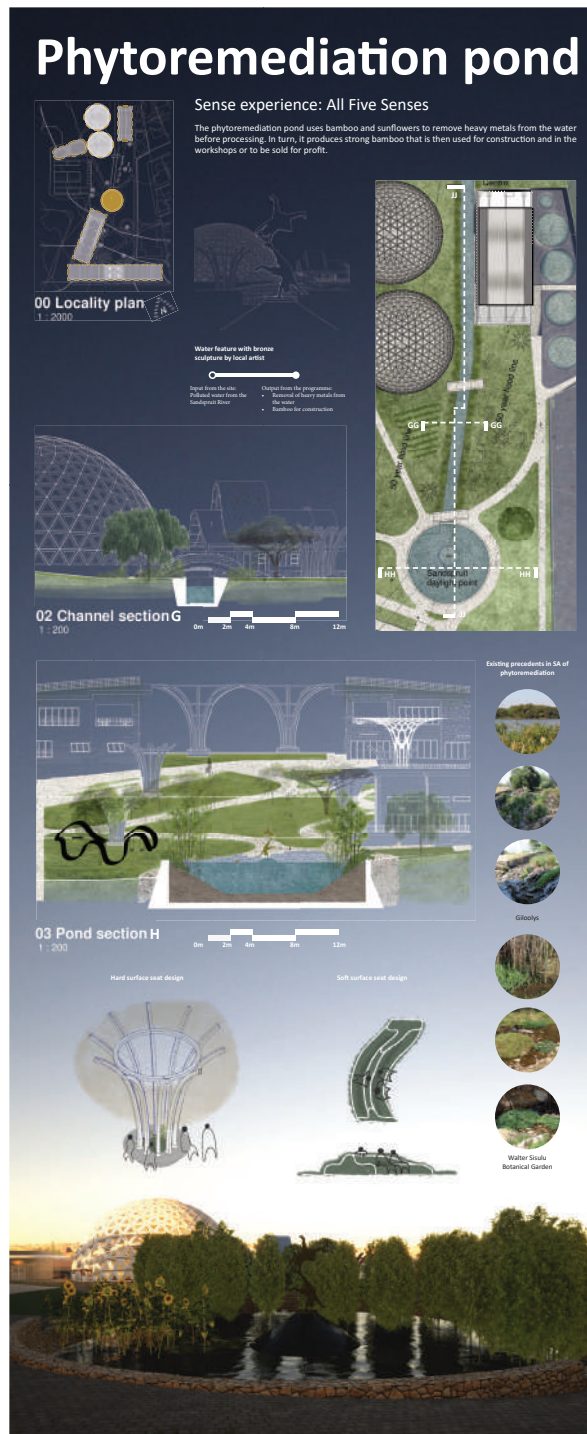
The Biodome



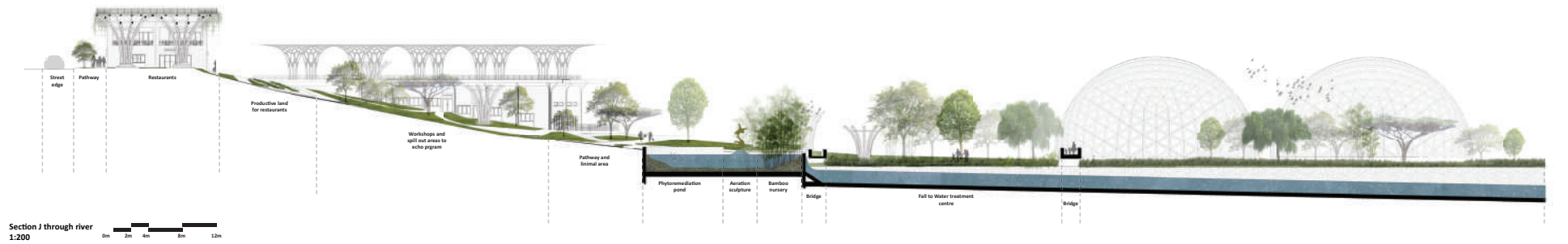
Ripple Tank



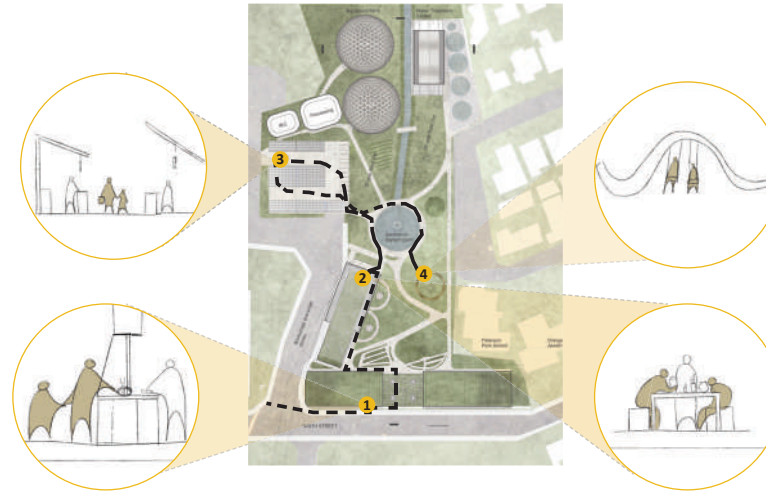
Phytoremediation pond



Section through River

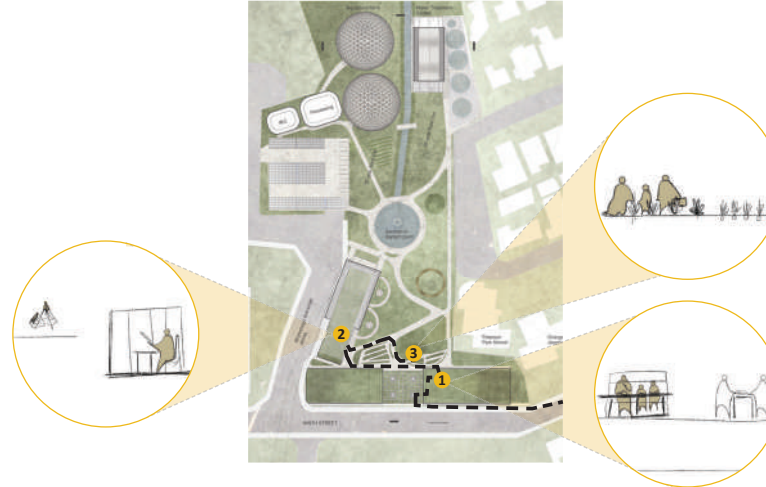


User Experiences



User 1: Mother and child

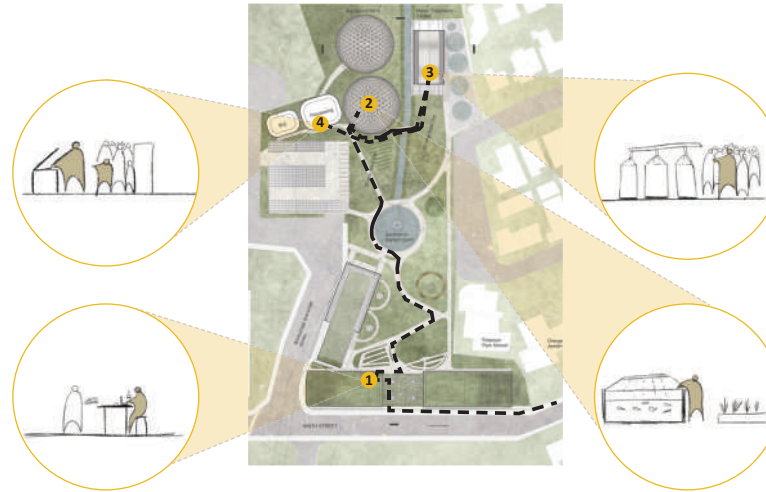
The mother and child walk from their residence on Grant Avenue on a warm, summer day. They start their afternoon purchasing fresh fish and chips, interacting safely on the street edge¹. They enter the site and eat their food at the open seats under the shading. Once their newspaper wrapped food is finished, they head to the colour cafe where they get to design a special matching set of cups². Once their designs are finalized, they head to the community market for a delicious home made brownie³. To finish off the afternoon, the mother and child play on the playground together and both get to experience glee and togetherness⁴.



User 2: Impoverished family

A father and his two children walk from Louis Botha toward Ninth street, thunder threatens a storm in the distance. They have not had a warm meal since last Sunday. The children's hands are dry and uncomfortable and the father grasps tighter to ensure they do not wonder into the street. They arrive at the site and wait in line for the food served at the soup kitchen¹. They drink tea and have access to electricity, a shower, and water. The week has become slightly easier to deal with. The children play on the playground on the workshop, in eye sight of the father as he looks through the bulletin board for a possible job². They collect spinach before going away³.

User Experiences



User 3: Tour guide and farm worker

The young person starts their day walking from their bus stop on Louis Botha with a quick stop for their favourite mocha from De La Creme, the sun is rising above the horizon¹. They tend to the fish and remove and bolted celery from the deep water culture beds in the farm². The first tour starts at 8am. They start at the water treatment centre and walk the 12 guests through the process of the system³. A child shows a keen interest in the trout, the tour guide hands the child a smoked, fresh piece of trout; as fresh as it can be⁴.



User 4: Wealthy family from Norwood

A family of four and their dog leave their home in an SUV and drive to the site with the intent to do Christmas shopping. They park their car at the parking lot that has been barricaded in half to allow for the Christmas market¹. They wonder through the site looking at nature and the blue crane that has made a home by the pond with the dog on a lead². They purchase local products for their family; a delicious tomato chili jam, a small hydroponic tower, a handmade bag made from shwe shwe³. They finish their day by watching the women by the workshops weaving baskets outside⁴.

References

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24 May 2023

Faculty of Engineering and the Built Environment:

Ethics clearance letter:

Dear Robyn Glanville

Student number (1600937), this letter confirms that your ethics application has been cleared. Your clearance/protocol number: SOAP002/04/2023

Yours sincerely

A handwritten signature in black ink, appearing to read 'Lerato Nkosi'.

Lerato Nkosi