CHILD-CENTRED COMMUNITIES

ARCHITECTURAL INTERVENTION AS CATALYST FOR EARLY CHILDHOOD DEVELOPMENT

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SOLI DEO GLORIA

Child-Centred Communities
Submitted by:
Jason Oberholster
Student number: 12034968

Study Leaders:
Dr. Carin Combrinck
Course Coordinator:
Prof Arthur Barker
Research field:
Human Settlements and Urbanism

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The site:
50 Mtshwene Street,
Mamelodi,
Pretoria,
0112
25°42'51.0"S 28°23'35.0"E

The client:
Mamelodi Early Childhood Development Forum in association with the Department of Education

The Programme:
Resource centre for early childhood development

Edited by Karlien van Niekerk

ABSTRACT

Early childhood development (ECD) is a critical stage of development that forms the foundation for the future welfare and edification of children (UNICEF 2017:1). A key principle in this development is the notion that everything which surrounds the child, both visible and invisible, has an impact on the child (Cook & Cook 2009; Steiner Waldorf Education 2014).

In this dissertation the impact of the architectural environment on early childhood development is addressed, bringing together the fields of pedagogy and architecture. The research determined the development of a set of design principles and guidelines that acts as a catalyst to generate architectural design solutions that can improve early childhood development, allowing children to engage in their spatial environments through active play and everyday use. Therefore, their early childhood development is enhanced as a result of reconfigured experiential built environments and spatial arrangements, where the environment acts as a third teacher and gives a heightened role to architecture as a medium for child development.

Keywords: early childhood development, education, didactic, sensory design, haptic

EKSERP

Vroeë kinderontwikkeling is 'n kritieke stadium van ontwikkeling wat die fondament vir die toekomstige welsyn en opbou van 'n kind vorm. 'n Sleutelbeginsel in hierdie ontwikkeling is die begrip dat alles wat 'n kind omring, beide sigbaar en onsigbaar, 'n inslag op die kind het (Cook & Cook 2009; Steiner Waldorf Education 2014).

In hierdie dissertasie word die inslag van die argitektoniese omgewing op vroeë kinderontwikkeling aangespreek, en sodoende word die velde van pedagogie en argitektuur saamgevoeg. Die navorsing het die ontwerp van 'n stel ontwerpbesginsels en riglyne bepaal wast as katalisators optree om argitektoniese ontwerpoplossings te genereer. Hierdie oplossings kan vroeë kinderontwikkeling verbeter, en kinders toelaat om deur middel van aktiewe spel en alledaagse gebruik by hul ruimtelike omgewings betrokke te raak. So word hulle vroeë kinderontwikkeling versterk deur middel van 'n hersaamgestelde proefondervindelike bou-omgewing en ruimtelike ordening, waarin die omgewing as 'n derde onderwyser funksioneer, en 'n verhoogde rol aan argitektuur as medium vir kinderontwikkeling toegeken word.

Sleutelwoorde: vroeë kinderontwikkeling, didakties, sensoriese ontwerp, hapties

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1.1 THE RESEARCH PROBLEM

It is argued that failure in sufficient early childhood development can constrain the optimal development of children throughout their lives, and is a stage in life when the environment actually has an important impact on determining how a child grows and develops (Cook & Cook 2009).

While ample access to new tools, resources, learning theories and pedagogical paradigms are available, the built environment still seems to be detached and lacking from this development (Bautista & Borges 2013:18; Tigran, Kotnik & Ustinova 2014:41). It is argued in this dissertation that the effect of our spatial environment on educational development cannot be ignored, and that a missing link exists between the built environment and the pedagogical functions and approaches.

1.2 THE PROJECT STATEMENT

In this dissertation it is proposed that architecture can, through the facilitation of didactic spaces, contribute to early childhood development, and aid in the empowerment of children to become protagonists in their own development and capable agents of change and resilience.

1.3 THE RESEARCH QUESTION

How can the built environment, through didactic space, have a catalytic effect on early childhood development?

1.4 THE RESEARCH INTENTIONS

The intention of this dissertation is to push the boundaries and limitations of early childhood development and

infrastructure in order to create a new relationship between architecture and education.

The aim is to bridge the gap and provide for the shortcomings of current architectural schemes for early childhood development (ECD) centres, as well as solve problems in the transitioning from early childhood into primary school, in an attempt to contextualise the educational environment.

1.5 SITE

The first part of the site is located at 50 Mtshwene Street, in Ward 4 of Mamelodi East, in an existing community recreational park. The proposal is to extend the existing park to the open site (Site Two) on the bend of Marishane Street and to connect these two sites through a corridor that is situated on the northern unutilised land of the existing primary school grounds (Site Three.)

SOUTH AFRICA   GAUTENG   PRETORIA   MAMELODI

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1.6 PROGRAMME

The proposed programme aims to provide in and support the shortcomings of the existing early childhood development centres within the area. These crèches have varying needs; therefore flexible and multi-use spaces will be developed from a needs analysis. The programme is divided into three zones: contained space, filter space and high-stimulus zones.

The contained spaces provide an extended educational environment that the crèche network can utilize for activities that cannot be accommodated within its own facilities.

The filter spaces act as critical thresholds between the high-stimulus and low-stimulus programmes, encouraging the recalibration of the children's senses as they move from one level of stimulus to the next.

The high-stimulus zones provide areas of play and physical activity. A cultivation space provides a platform on which the community can produce fruit and vegetables to feed the children, helping to solve the issues of malnutrition in the area surrounding the existing crèche facilities.

1.7 CLIENT & STAKEHOLDERS

The proposed primary stakeholders are the Mamelodi Early Childhood Development (ECD) Forum in association with the Gauteng Department of Education, the local municipality and ASIDI (Accelerated Schools Infrastructure Delivery Initiative). The focus will be on the network of crèches within Ward 4, which becomes the main client.

Through the creation of a child-centred community and the use of the public park, the community of Ward 4 becomes a secondary stakeholder. Further to this, the existing private partnerships between the crèche network and the different departments at the University of Pretoria will also form part of the group of secondary stakeholders.

Map of the crèche network (Author 2017) 1.11

1.8 RESEARCH METHODOLOGY

In order to address the proposed research objectives, the following methods will be utilised so as to develop an appropriate architectural solution.

Theoretical exploration

In support of the research question, the following theoretical premises will be investigated: early childhood development and psychology; pedagogy and the physical environment; sensory design; learning through play; and phenomenology.

Precedents

A selection of local and international case studies will be discussed throughout the document and will relate to precedents of educational pedagogy as well as educational architecture. These will support both a tangible and intangible understanding of the requirements throughout the development of the project.

Context Analysis

A thorough exploration of the proposed urban site will be conducted through physical mapping, unstructured discussions and observations. Visits to the network of crèches within the area will be conducted and a resultant needs analysis developed. This active research will allow the author to understand the potential users of the architectural intervention that is proposed.

1.9 DELIMITATIONS

The aim with this dissertation is not to propose a new educational system, but to explore the role that architecture can play in the facilitation of education and early childhood development.

In this dissertation the understanding of the educational infrastructure and community environments of young children, and the effect that these environs have on the children, will be dealt with. The intervention that will result from the research and design will respond to the educational needs of the local communities.

1.10 LIMITATIONS

Although the entire site development will be included and considered as one holistic entity, a phased approach is suggested, with the design focus on the first two phases in order to illustrate the best response to the research problem.

1.11 ASSUMPSIONS

It is assumed that the proposed site, as well as the proposed extensions thereof, would be approved by the local municipality, the primary school board and the Department of Public Works.

Action research in Mamelodi (UP BArch(Hons). 2016) 1.12

CHAPTER TWO
THEORETICAL PREMISE
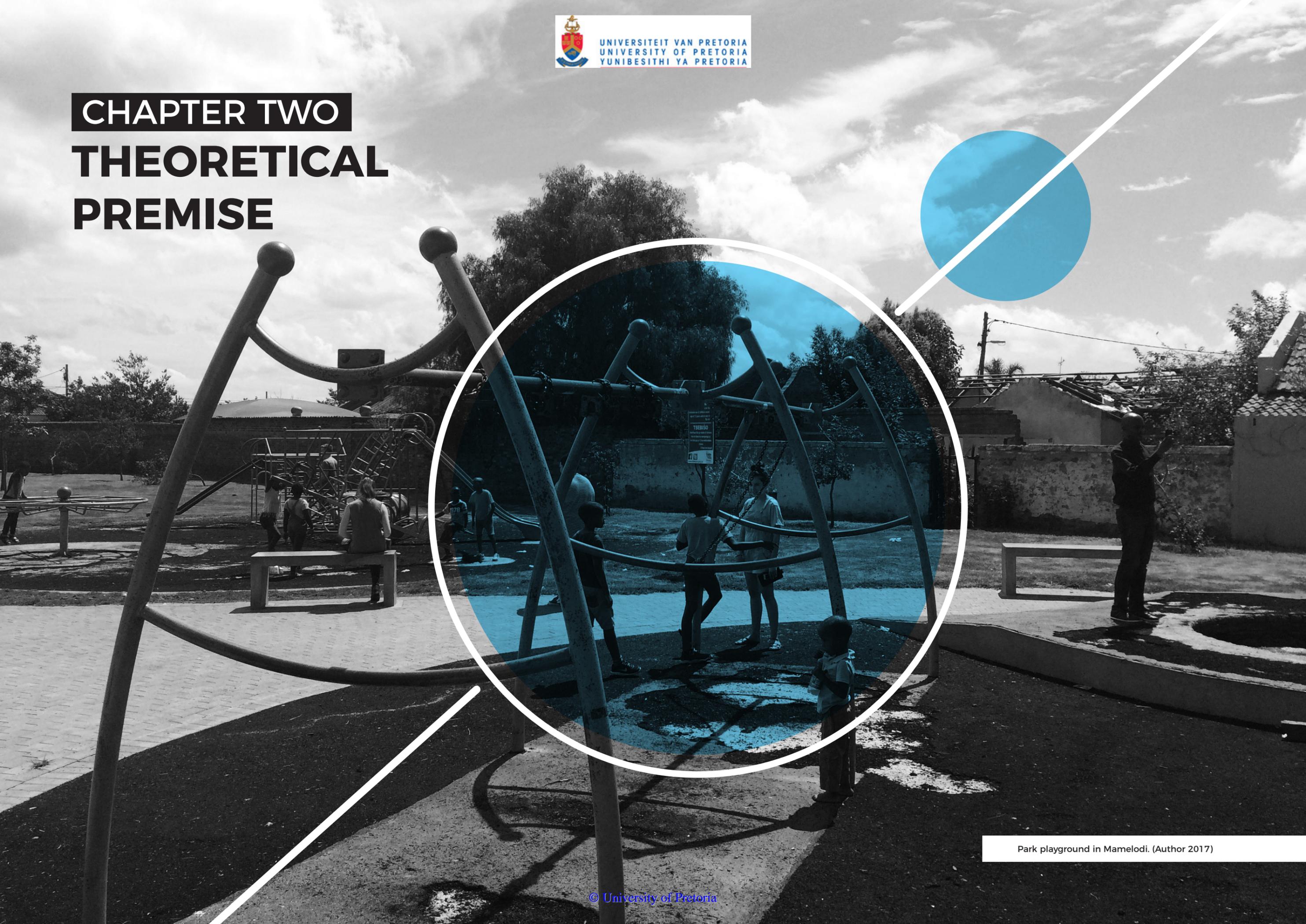
Park playground in Mamelodi. (Author 2017)

2.1 INTRODUCTION

The world is witnessing rapid and on-going transformations in various aspects of society, including technological development, architecture and pedagogy. It is evident that learning spaces and environments have not experienced sufficient change to keep up with this ever evolving society (Bautista & Borges 2013; Tigran, Kotnik & Ustinova 2014). While ample access to new tools, resources, learning theories and pedagogical paradigms is available, the built environment still seems to be lacking in the architectural development to enhance and encourage educational development. A missing link exists between the architectural

and functional design and the pedagogical functions and approaches to be applied (Mostafa 2016). The influence that the built environment has on educational development cannot be ignored, and this calls for the revision of the concept of learning environments (Tigran *et al.* 2014).

Early childhood development is a critical phase of development that forms the foundation for the future well-being and education of children. Research by the United Nations Children's Fund of the Democratic Republic of Korea (2017:1) indicates that early childhood interventions can result in lifelong ef-

fects on intellectual capability, character and social behaviour, crucial for the mental and physical development of a child. Failure to enable sufficient early childhood development, at a stage in life when the environment actually has an important impact on determining how a child grows and develops, can constrain the optimal development of children throughout their lives (Cook & Cook 2009). For this reason it is important to understand the various aspects of early childhood development and how these relate to the environment of the child, before an architectural intervention can be proposed.

2.1 An ECD centre playground on the sidewalk with minimal safety barriers to the adjacent street in Mamelodi East, South Africa. (Author 2017)

2.2 EARLY CHILDHOOD DEVELOPMENT & PSYCHOLOGY

The National Department of Education defines early childhood development (ECD) as ... *the processes by which children from birth to nine years of age grow and thrive physically, mentally, emotionally, morally and socially* (NDA 2012:1). Infants and young children absorb the world primarily through their senses and respond in the most active mode of knowing, namely imitation. The influences over a young child affect the body for a lifetime (Steiner Waldorf Education 2014), and we have a responsibility to create an environment, both physical and emotional, that is worthy of a child's unquestioning imitation.

Steiner Waldorf Education (2014:4) states that pre-school children are not emotionally, physically or intellectually ready for formal learning, and that young children benefit greatly from a stress-free environment where they can discover the world around them. Such an environment allows children to master the critical and fundamental development of their physical co-ordination, speech, and social and other life skills prior to being introduced to formal education in primary school; therefore, it is extremely important that children achieve adequate development to prepare them for formal schooling.

Five facets of early childhood development. (Author 2017) **2.2**
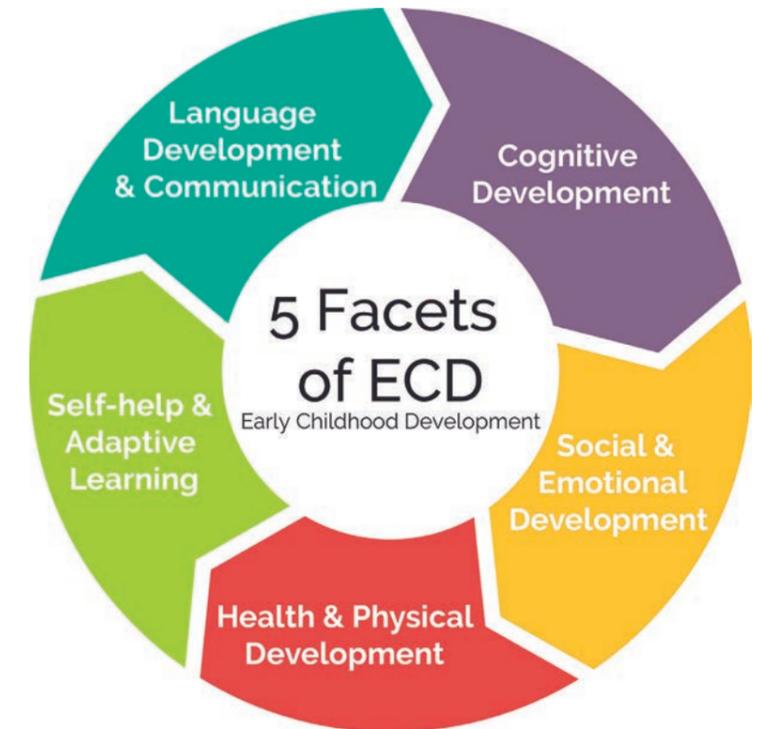
Priority should be given to, but not limited to, the development of the following ECD facets: language and literacy, cognitive development, physical development, health, emotional and social skills, respect for the natural environment, and working with parents and caregivers (ECLC 2017:5; Steiner Waldorf Education, 2014:4-5). It is important to understand that these different facets of ECD are highly interrelated and cannot be seen as separate.

2.3 EARLY CHILDHOOD DEVELOPMENT IN SOUTH AFRICA

In order to understand the short-comings of early childhood development in South Africa, it is important to understand the foundation of our educational system. The South African Constitution (1996:1257) states in sub-section 29 that everyone has the right to a basic education and, according to UNICEF South Africa (2016), the country has adopted the United Nations Sustainable Development Goal to achieve universal and rightful early childhood development (ECD) by 2030. These goals include plans to provide every child, up to the age of five years, with a minimum of two years' pre-primary school exposure before entering the compulsory formal basic education system.

According to Mabugu and Rakabe (2015), most of the greater educational challenges in South Africa can be attributed to the restricted quality of foundation-phase education. Children under the age of five years represent 10.8% of South Africa's population (UNICEF South Africa 2016), of which only 49% attend day-care or educational facilities outside their homes (SAHRC & UNICEF 2016:52).

Mabugu and Rakabe (2015) state that a recent audit indicates that 70% of these ECD centres do not provide adequate levels of care and services, which may be due to ECD being almost solely self-funded through enrolment fees and donations, resulting in inadequate resources to build and manage suitable facilities. The small subsidy provided by the government is only allocated to facilities that comply with the specified norms and standards, excluding the ECD centres that are most in need. This situation is indicative of a subsidy that disregards the children in the most vulnerable and poor areas that are lacking the very infrastructure that serves as a basis for accessing the subsidy (Department of Social Development 2006)

It is evident that the very basis of our educational development and economy is being neglected, prohibiting the full realisation of individual development and success; thus it becomes extremely important to investigate how the fundamental development of young children can be supported through the improvement of their educational environments.

An ECD centre classroom operating out of the garage of a home in Mamelodi East, South Africa. (Author 2017) **2.3**

2.4 PEDAGOGY & THE PHYSICAL ENVIRONMENT

Although the relationship between childhood development and the physical environment has been highlighted by many ECD researchers such as Rudolf Steiner, Christopher Day and Bettina Rühm (Tigran *et al.* 2014), a need still exists for theoretical design guidelines that are geared towards addressing the problem. It is important, however, to first understand how this development can be influenced by physical spaces – an understanding which can be gained through relating findings in the field of pedagogy, child psychology and architecture.

Christopher Day (Tigran *et al.* 2014) points towards the ability of our environments to influence our thoughts, emotions and actions, subconsciously shaping our behaviours and beliefs, and encouraging physical, mental and social development. Architects, therefore, have the power to use appropriate design in order to achieve desirable outcomes, bring-

ing together pedagogy and architecture in the search for environments that influence learning.

In the National Training Laboratories learning pyramid (Tigran *et al.* 2014:42) we see that the most effective learning methods are discussion groups, practice by doing, teaching others, and immediate use. These methods advocate the important role of children in their own development, being most effective where children can actively participate, interact, learn from each other and even learn on their own. As children are different and learn differently, their spatial environments should allow for diverse types of learning that creates a dynamic group of spaces.

2.5 KEY PEDAGOGICAL PRINCIPLES

The above discussion links to a key principle of ECD where everything that surrounds a child, both visible and invisible, has an influence on that child. The development takes account of the entire child. Steiner Waldorf Education (2014) suggests

that children's learning flourishes when they are exposed to tranquil, predictable, familiar and unrushed environments that recognise the young child's sensory sensitivities.

We should not neglect the interconnectedness of the emotional, spiritual, social, physical and intellectual development of children. Whitebread (2009) demonstrates that children reason with their entire physical being, and that they learn through actions, experiences and imitation in order to develop good motor, social and practical skills; therefore, practical application is important. Young children need to be exposed to normal everyday living in order to experience the relevance and meaning of their world.

The Reggio Emillia approach to education focuses on self-directed experiential learning within relationship-driven environments (Edwards 2002). The philosophy is based on a set of principles where children have control over the direction of their education, enabling them to learn through experiences of touching, listening and observing, thereby creating a relationship-driven environment and providing for infinite means and opportunities for children to express themselves.

This approach links strongly to the natural development of children as well as the close relationship that children have with the natural environment. Edwards (2002) explains that the Reggio Emillia approach aims to create spaces where the classroom is integrated with the sur-

rounding environment, including the community that it is situated in. The importance of this approach is highlighted in the belief that children best create meaning out of their world through environments that provide for interaction, exploration, respect and community.

Similarly, Montessori education emphasises the independence of children through free choice of activities that confers a sense of freedom, yet they are subtly guided by the teacher towards the achievement of specific goals. As Lillard (2013:161) explains … *it embeds freedom within structure and structure within freedom.* Areas of the curriculum are tightly interconnected and the overarching principle of play within the Montessori curriculum allows for the children's behaviour to be beneficial for their development, as well as for the community. According to Lillard (2013), evidence indicates that Montessori programs have superior developmental outcomes in the social and cognitive realms.

The importance of play in the learning environment is also highlighted by both Dudek (2012) and Steiner Waldorf Education (2014). Play in ECD has a vast impact on cognitive, physical, emotional and social development. It is extremely important to the all-round development of children, therefore the notion of learning through play will be discussed in further detail later in the document.

Rhythm and repetition in activities play a crucial role in the fostering of a sense of safety and self-confidence in children. It helps them cope with change and assists them in relating to both the natural and man-made

worlds. Children's memories are also strengthened through repetitive experiences, according to Steiner Waldorf Education (2014). Reference is made to different moods in a day, helping children to understand and adjust their behaviour in different settings and situations, and to become aware of invisible boundaries.

Uys and Selesho (2017) stress the importance of hearing in ECD, as hearing forms the foundation of speech and language development. Without the full development of a child's hearing abilities, speech and language cannot fully develop, also affecting how they acquire reading and writing skills. A delay in development of any of the ECD areas will have a ripple effect, in turn resulting in the delay of the consecutive developmental stages, and ultimately in educational challenges. For instance, the way that spaces are designed has an effect on reverberation and echoes of sound, affecting the hearing development of children. This could in turn result in delayed speech and language development, consequently impacting numeracy skills that are dependent on language development.

It is also important to consider both the intrinsic and extrinsic barriers that inhibit children. Uys and Selesho (2017) explain that intrinsic barriers are factors that are part of us; for instance, physical disabilities, sensory deficits, listening and language delays, psycho-social disturbances, chronic illness, as well as differing intellectual capacity. Extrinsic barriers are often neglected, but play a major role in learning and development throughout our lives. These are external factors such as lack of parental involvement and inadequate resources.

It can therefore be concluded that early childhood is a period in human development in which the environment has an important effect on defining how a child's brain and central nervous system grow. This development is, to a great extent, guided by the child's sensory experiences, consequently making it essential to understand the notion of sensory design (UNICEF DPR Korea 2017:1).

2.5 Hallway with flexible play environment at the English for Fun Facility. (ArchDaily 2017b)
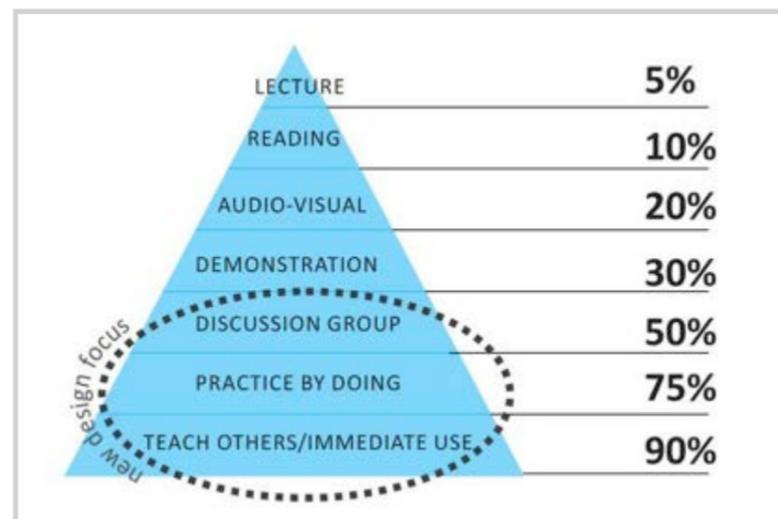
2.4 The NTL learning pyramid as a basis for new educational design. (Tigran *et al.* 2014:42)

LECTURE 5%
READING 10%
AUDIO-VISUAL 20%
DEMONSTRATION 30%
DISCUSSION GROUP 50%
PRACTICE BY DOING 75%
TEACH OTHERS/IMMEDIATE USE 90%

new design focus

2.6 SENSORY DESIGN

As Mostafa (2014:13) states, architecture deals with the manipulation of our physical surroundings in order to enable certain programmes or stimulate anticipated behaviour. These environments mainly consist of sensory elements – textures, colours, patterns, acoustics, etc. – and play an important role for young children concerning their development, intellect and integration.

The Sensory Design Theory is founded on the notion that the sensory environment is a key part of our process of perception and development (Malnar & Vodvarka 2003). The theory argues that our sensory experiences, responses, sentiments and memories should be seen as critical design factors equally important to structure and program. Celebrating our sensuous occupation of the built environment contributes to achieving a more humane environment.

It is proposed that, through modifying this sensory input in a manner that is designed to accommodate specific needs, a more beneficial environment would be created for more effective early childhood development. This theory offers a flexible tool that acts as a catalyst for the development of architectural design guidelines, responding to the sensory needs of children.

Sensory integration is more complex than a messy play exercise where kids get their hands dirty. Our sensory system forms part of our nervous system and sends information about our surroundings to our nervous system, which in return processes the information to generate a response or reaction. According to Abraham, Heffron, Braley and Drobnjak (2015:3) and Isbell & Isbell (2007:12-13) our sensory system includes:

- **The Auditory System –** *the sense of hearing*
- **The Olfactory System –** *the sense of smell*
- **The Oral Sensory Processing –** *the sense of taste*
- **The Tactile System –** *the sense of touch*
- **The Visual System –** *the sense of sight*
- **The Vestibular System –** *how we sense where our bodies are in space*
- **Hapticity –** *sense as experiences through the skin*
- **Proprioception –** *our sense of the way our bodies move*
- **Kinaesthesia –** *the sense that allows us to experience the environment through the movement of our bodies*
- **The Interoceptive System –** *responsible for the general sense of our body's physical condition, such as hunger, thirst and internal discomfort.*
- **Synaesthesia –** *a phenomenon rather than a sense that can be understood as the transferral of sensory information from one sense to another*

Through unpacking the sensory systems it can be seen that children can understand their environments more clearly through sensory experiences and so enhance their early childhood development. It is important to understand that not all children respond to sensory experiences in the same way, and that each child processes his/her environments and experiences differently. Children can be over-stimulated by the world around them, or they can be unresponsive to their surroundings, causing a wide range of confusing and sometimes negative behaviours (Abraham *et al.* 2015:3).

Consequentially, children should have thoughtful and guided exposure to the sensory experiences of their environments, with special attention paid to play and learning environments. It is imperative that both the built environment and landscape play a crucial role in ECD, influencing how children process, assimilate and generate appropriate responses to the sensory information in their environments.

2.7 LEARNING THROUGH PLAY

Object and socio-dramatic play are shown to provide important opportunities for the development of children's metacognitive and self-regulatory processes (Whitebread 2009), a development that is most effective when it is child-initiated, requires creativity and problem solving, and is open-ended. The Steiner Waldorf Education (2014:16) curriculum emphasises that young children discover their own learning conditions within play, being protagonists in their own learning.

A young child should be given the opportunity for self-led free play, both indoors and outdoors, through the child's own observation of life, giving them the opportunity to integrate socially and re-imagine their experiences. It is important that minimal adult interference occurs in free play. Adults must merely act as observers in the situation and stand by for assistance when required. This idea links to the emphasis on independence of children in Montessori education where, as mentioned before, children have free choice of activities while being subtly guided by the educator towards the achievement of specific goals (Lillard 2013:157-180).

Areas of the curriculum are tightly interconnected and the overarching principle of play within the Montessori curriculum allows for the child's behaviour to be beneficial to both their own development and the community. Components within children's environments should therefore be understood in reference to the particular developmental activities that they encourage, understanding the ECD environment as multiple elements that are spatially and texturally perceived. Harry Heft (Dudek 2012) calls these concepts affordances, where architects must understand the effects and implications of their designs, and explains it through the implications that *"…a smooth flat surface affords or encourages walking or running, whilst a soft spongy surface affords lying down and relaxing. Add a slight tilt to the surface and the experience engages the child's brain / body coordination more fully"* (Jackson 1998:5).

Described here is an environment in which the architecture enables children to explore sensory learning through play, opening them up to a world that is open to interpretation and curiosity. In this way a blended approach between formal and informal learning is suggested to achieve enhanced early childhood development. Research by both Dudek (2012) and Steiner Waldorf Education (2014:16) indicate that learning through play develops multiple cognitive areas and imagination (essential for scientific exploration), strengthens concentration, and supports physical, social and emotional development.

Playground at the Eduplex Pre-school. (Author 2017) **2.6**

2.8 PHENOMENOLOGY

Further to this, the theory of phenomenology acknowledges the vital role of architecture through the implementation of sensory design in order to establish experiential architectural space. The manipulation of space, materials, light and shadow impacts the human senses in order to create a memorable encounter with the built environment. The integration of sensory perception as a function of built form is therefore promoted (Kraus 2017).

The intention is to develop a unique experience and way of exploring spaces, taking into account the dynamics of human perception, so as to influence the built form and function to ultimately produce sensory architecture. Alberto Pérez-Gómez (1994) emphasizes the power of phenomenology, and challenges architects to create environments of experience that become ingrained in memory, as he believes there is no such thing as meaningless architecture.

This idea also links to John Dewey's *Philosophy of Experimentalism*, referred to by Meyers (2013:33), i.e. that education cannot be separated from real life and everyday existence. It should be about interaction with the world, experiencing it and developing an understanding of the connections within life, thus allowing for individual exploration, participation, flexibility and user adaptation.

Although the relationship between child development and the physical environment has been highlighted by many ECD researchers, a necessity still exists for design principles that are geared towards improving this relationship. It is evident that these principles need to consider the varying challenges in ECD, allowing for a method of user customization and contextual approaches. These principles will also enable the generation of general design guidelines that could lead towards the development of future policies.

Although it might seem prescriptive, the Autism ASPECTSS design index, developed by Mostafa (2014:144), indicates that the proposed development of a strategy can allow for various levels of application. It supports the establishment of diverse stimulus zones that respond to both the diverse activities and skill levels of its users. The issue of generalisation through the use of graduated sensory spaces that allow for on-going early childhood development is therefore avoided. Mostafa (2014) further indicates that the application of sensory design has resulted in increased attention spans, faster response times, and improvements in the behavioural temperament of its educational users.

The Steiner early childhood curriculum also links strongly to the notion of sensory design, and is centred on an understanding that young children's senses are very susceptible to influences from their immediate environments (Steiner Waldorf Education 2014). The curriculum proposes that a young child's surroundings have a direct, sometimes subtle, effect on the child, and that intentional consideration should be given to the spatial qualities of ECD centres; however, much improvement is still needed in order to fully translate and apply this notion to architecture.

View of the sensory garden in the Advance School for Developing Skills of Special Needs Children in Qattameya. (Mostafa 2014)

2.9 FIELD RESEARCH & PRECEDENTS

In order to connect early childhood development to architecture the critical research question should be asked: How can the built environment, through didactic space, have a catalytic effect on early childhood development? Through this lens one is able to critically analyse and evaluate the field research and precedent studies.

From the field research conducted by the UP BArch(Hons) (2016) research group at the Woodlane Village informal settlement in Pretoria, South Africa, it is evident that the young children struggle to transition between their homes and educational environments. The Woodlane Village informal settlement consists of 846 housing plots with shack houses built from various found and recycled materials. These stand in sharp contrast to the facilities of the adjacent Pure Hope School that the children from this settlement attend.

The interaction with the children and teachers during the visits to the school has shown that the children struggle to relate to the spatial environment of the school facilities, and consequently struggle to concentrate on the activity at hand. The unsafe living conditions within Woodlane Village and the high crime rate has resulted in the need for multiple professionals to assist at the school. These include councillors, various health practitioners and social workers, according to the UP BArch(Hons) (2016) research group. Even though these children attend a school that provides high level educational facilities and environments, the children's contextual environment outside of the school directly impacts their experience of the school facilities. The field research clearly links the physical environment of the children to their development.

This classroom in an ECD centre within Mamelodi, South Africa, has light levels that are too high in some areas, high light contrast, minimal ventilation, and high reverberation levels. (Author 2017)

In Mamelodi, the field research by the UP MArch(Prof) (2017) Mamelodi research groups found that the living conditions of the children are better than those of Woodlane Village; however, the educational facilities do not match the quality of the Pure Hope School. The ECD centres in Mamelodi East have minimal indoor and outdoor play spaces, and are supplemented by public facilities that are far from the ECD's. Travelling with the children is difficult and becomes costly; therefore these excursions are kept to a minimum, resulting in limited exposure of the children to various landscapes and spatial scales. The facilities also have minimal to no connection to the natural environment, limiting the sensory experiences of the children. Due to limited space, the classrooms are utilised for most educational activities, making it difficult for both teachers and children to transition from high-stimulus to low-stimulus activities.

Some of these classrooms are very dark, with sharp contrast from natural light streaming in from windows and openings, making it difficult for the children to see detail, and resulting in them seeing silhouettes. Other classrooms provide sufficient light; however, the lighting configuration is not even throughout the rooms, causing deep shadows. Both of these conditions limit the children's sensitive sight and also impact their hearing development, as children often connect visuals to sound (Uys & Selesho 2017). The acoustics of the facilities result in a lot of reverberation and background noise, making it difficult for the children to develop their hearing, and consequently limiting their language skills as well. These difficulties in hearing and lack of language development can lead to social exclusion, as the children cannot communicate properly (Uys & Selesho 2017). The limited amounts of space impair individual interaction and mostly only allow for group activities. Due to the above factors, the children often become overwhelmed

and they do not have any personal individual space where they can retreat to and be comforted. These facilities seemingly result in the delayed development of these young children.

As a precedent study, the East China Normal University Affiliated Bilingual Kindergarten, by Scenic Architecture Office, shows the courtyard environment of the school where children can perceive nature, recognise society and experience a core part of their cognitive and emotional development (ArchDaily 2017a). The hexagonal shape of the building creates a dynamic indoor and outdoor space and accommodates a flexible combination of spaces for the varying functional needs of ECD education. The classrooms are connected by zigzag corridors, where children pass through layers of courtyards with various gardens, allowing them to experience a transition between their spatial environments. The layering of courtyards and paths creates connections between different inte-

2.9 Axonometric of the East China Normal University Affiliated Bilingual Kindergarten. (ArchDaily 2017a)
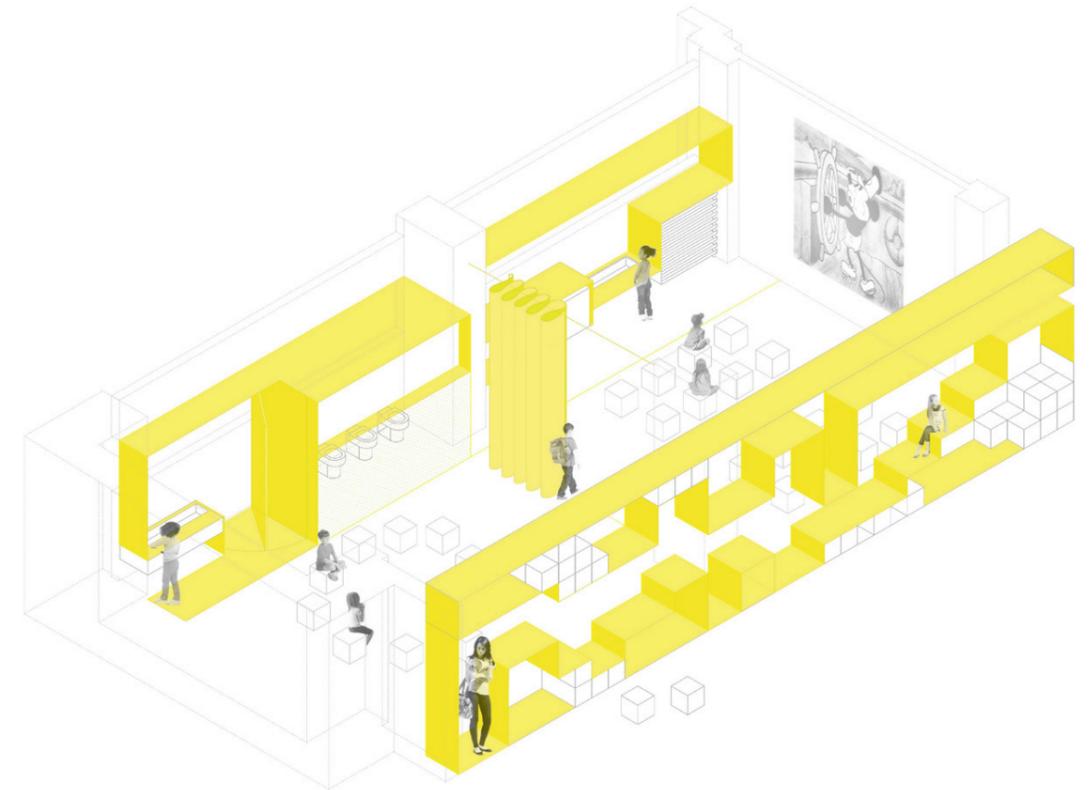
2.10 Axonometric of flexible space at the English for Fun facility. (ArchDaily 201ba)

rior and exterior spaces on various scales, where children experience a sense of nature and society. According to the architects, these experiences of exploration, perception and communication become part of the development of these children in an unconscious and healthy way (ArchDaily 2017a).

At the English for Fun facility by Lorena Del Río and Iñaqui Carnicero in Madrid, Spain, the philosophy of learning English through the five senses is applied in their facility, where the built environment of the school is considered as a third teacher and the child becomes an active part of the learning process (ArchDaily 2017b). The building consists of an equal number of adult-scaled and child-scaled spaces, where children can inhabit and own spaces just for

them. This is achieved through extended space within the wall configuration, where the wall is thickened and creates a series of habitable spaces for children. The configuration consists of a generic module that can be utilised in various ways, allowing for flexibility and adaptability. The permeability of these walls also allows for a visual connection between spaces that enable the expansion of the children's perception of space, and avoids the predictive and orthodox compartmentalisation of classrooms. The configuration of the wall allows for children to play an active part in their learning processes, where they can construe their own interpretation of their spatial environments (ArchDaily 2017b).The

2.12 Sensory herb garden at the Eduplex Pre-school. (Author 2017)

Active playground landscape with an amphi theater that doubles as a tumbling and rolling landscape for children at the Eduplex Pre-school. (Author 2017) 2.13

same notion of extending the spatial environment can also be seen at the KM Kindergarten and Nursery by Hibinosekkei and Youji no Shiro in Osaka, Japan, where an undulating transition occurs between the various floor levels and the roofscape (ArchDaily 2017c), allowing children to explore their built environment in a physical way and improving their overall fitness and motor skills. The various building materials and textures further enhance the sensory experience of the children through touch and sound, improving their overall early childhood development through the physical use of the building.

A local ECD, the Eduplex Pre-school by Snapp Architects in Pretoria, South Africa, has a vast, open landscape providing learners with the freedom to explore among the visual security and comfort of their teachers. The landscape acts as a didactic space where children can learn through their interaction with play equipment and various sensory gardens. Specific attention is given to supplement all of the ECD facets. For instance, the play landscape allows for the development of both fine and gross motor skills on various levels, improvement of stamina through extended running and riding paths, and

A smooth transition between levels at the KM Kindergarten and Nursery, where children can physically explore their built environment. (ArchDaily 2017c) 2.11

experiences that enrich cognitive development. The strongest educational aspect of the school is the prominent use of different floor surfaces that allow for sensory experiences. Nienaber (2017) explains that the children mostly walk barefoot, with the floor surfaces having a prominent impact on the nerve endings in the children's feet, resulting in a sensory experience that enhances the development of the learners' proprioception (Isbell & Isbell 2007:12-13).
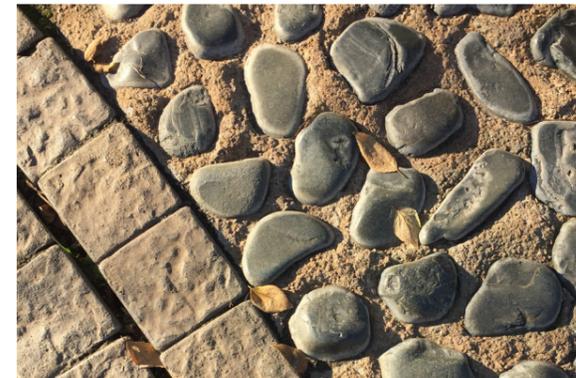
2.14 Various textures are used within the outdoor floor surfaces at the Eduplex Pre-school. (Author 2017)

Multiple indoor floor textures at the Eduplex Pre-school. (Author 2017) 2.15

Further to this, a clear benefit of shared resources is evident as, according to Nienaber (2017), the school only provides each classroom with the basic everyday educational resources and equipment. These are then supplemented through various educational resource storage spaces within the school, where the teachers have access to shared resources as and when needed. Through this shared platform, the school has achieved extensive cost savings that has aided them in providing a greater variety of resources to ultimately enhance their educational service.

The successful community-based ECD programme, implemented by Ilifa Labantwana (2017), also supports this notion where the availability and access to ECD in KwaZulu-Natal and the North West has successfully been improved through a community based model in the first phase of the project. In the North West, the outcomes of Phase One of the Ilifa Labantwana (2017) project has shown that the community-based model has achieved an expansion on the previous ECD centres existing in isolation, to a community network of 5 different ECD interventions. These con-

sist of home visits to caregivers and children, community playgroups with parent education components, community playgroups without education components, and centre and school-based interventions. The effect of this shared community platform far exceeds the isolated upgrade and development of individual ECD centres and facilities (Ilifa Labantwana 2017).

In holistically combining the findings of the literature review, field research and precedent studies, common themes that point toward the impact that spatial environments have on ECD become evident. These common themes are developed into a set of design principles placed in four categories: sensory experience, characteristics and features; connectivity and identity; and clarity and legibility. These design principles form the driving force behind the programming and development of the design criteria at all levels: detailed program development; contextual considerations and connections; spatial organization; and materials and specifications. Together they have the capability to act as catalysts to generate design solutions.

The sensory experience category focuses on the critical considerations regarding the effect of spaces on a child's sensory development. The concept links strongly to the sensory design theory discussed earlier, with both the field research and precedent studies strongly supporting this notion and clearly indicating the benefits of the sensory environment on the development of young children. The category is therefore divided up into the following sensory principles:

1. **Haptic Space** - The notion of haptic space considers all the senses and how they influence our experience of our environments. Therefore, a thorough understanding of the spatial programming needs to be developed and supplemented with relevant haptic qualities to enhance the child's experience of the space and activity. The notion of haptic space can therefore be utilised to enhance and facilitate some of the other principles mentioned below.

2. **Visual connectivity** - It is important that young children have visual access to their teachers or caretakers to give them a sense of comfort and security. As a result, visual connectivity between various spaces and programs, without them losing their sense of privacy and independence, is extremely important.

3. **Olfactory system** - The sense of smell is the only one of our five senses that connects with the brain. It plays an important role in a child's orientation, sense of identity and memory (Abraham *et al*. 2015). Consequently, the inclusion or exclusion of scent and smell should be strongly considered throughout the child's spatial experience. Consequently, the inclusion or exclusion of scent and smell should be strongly considered throughout the child's spatial experience.

4. **Audibility** - It is important that childhood spaces be adapted to limit echoes and reverberations, as acoustics impact learning and listening skills, which in turn affect children's language and speech development (Uys & Selesho 2017).

    Three factors to keep in mind when designing are noise, reverberation and distance.

    The level of the acoustical control that is to be implemented should vary according to the focus level required for the activity taking place within the space. For instance, high-focus activities (low stimulus) should have a greater level of acoustical control in order to minimize reverberation. A critical consideration to bear in mind is the gradual layering of the acoustical control between different spatial environments.

    Outdoor environments should also receive high acoustical consideration due to the existence of background noise. Children with a delay in the development of their communication skills can easily be misunderstood in the presence of background noise, and this may result in social exclusion of the child (Uys & Selesho 2017).

The next category focuses on the characteristics and features that need to be considered for ECD environments. As can be concluded from the analysis and understanding of the precedents from Steiner Waldorf Education (2014), Mostafa (2014), Dudek (2012), Montessori Education (Lillard 2013) and The Reggio Emilla approach (Edward 2012), these precedents, on both spatial and curriculum levels, point toward common characteristics and features that have a clear influence on and benefits for ECD. The field research conducted also supports these principles:

5. **Break out zones** - The principle of break-out zones aims to provide respite for the children from being overwhelmed or over-stimulated in their environment. Such zones can strengthen a between-ness and connection of activities and may contain a small detached area or crawl space within rooms, or throughout the building and outdoor environment in the form of quiet corners. It is important that these spaces offer a neutral sensory environment with minimal sensory stimulation, possibly allowing the child the opportunity to customize it with the necessary sensory input that comforts them.

6. **Flexibility** - Design for early childhood development should allow for different types of flexibility such as adaptability, movability, responsiveness, convertibility and transformability, finding a middle ground between the degree of permanence and the degree of change to the built environment. The principle allows for a spatial configuration that enables maximum use of the built environment, through multiple usages and possible changes in needs and to the curriculum in an ever advancing world.

7. **Scaled spaces** - Scaled spaces that both children and adults can relate to should be created, encouraging the children's growth toward independence.

8. **Active play** - The concept of active play rests on the notion of not merely providing basic playing facilities, but to rather explore opportunities that enable children to participate in the creation of their own playground. This is achieved by creating environments where children can dynamically partake in – and become protagonists in – their own learning. The building should be integrated with the play space, giving children the opportunity to experience their environment and develop essential motor skills through everyday use of the building and play space; therefore, each play environment is created specific to its context, time and community. All of this contributes to the positive stimulation of childhood development.

9. **Interdisciplinary team** - ECD programmes and spaces should allow for the participation of teams from multiple disciplines to ensure the correct and full development of the young children. It is important that these teams access the children in the comfort and safety of a familiar everyday environment.

    The parents and caregivers should be seen as the most important members of the team, with educators forming the anchor for all other team members.

These include, but are not limited to, audiologists, community health workers, general practitioners, dieticians and occupational therapists (Uys & Selesho 2017).

10. **Didactic space** - Similar to haptic space, didactic space acts as a third teacher where the physical environment can disseminate knowledge through structure, space, scale, size, light, repetition, texture and design. This principle suggests that the five facets of early childhood development are strongly considered and applied in relevant ways in the architecture to enhance, supplement and facilitate teaching.

11. **Inclusive education** - Design for ECD should provide conditions that are conducive to the inclusion of all students, no matter what their intrinsic barriers are. Studies have shown that children that are included in these types of environments continuously outperform those that are placed in special needs environments (Uys & Selesho 2017).

    Intrinsic barriers are those factors that are part of the child. These may include physical disabilities, sensory deficits, listening and language delays, psycho-social disturbances, chronic illness and varying intellectual capacity (Uys & Selesho 2017:252).

The third category includes principles on connectivity and identity. These were formed through the field research process, and are supported by the theoretical understanding and precedent studies. The field research was conducted through various site visits in which observation, analysis of conditions and informal discussion have led to the following principles:

12. **Social integration** - Children should be exposed to environments where they can interact socially on different levels, such as in individual engagements, in small groups, and as part of public interaction. The initial listening and learning experience for children is more powerful and effective when integrated as a social experience, a situation that also sustains the future social inclusion of these young children.

13. **Natural environment -** The natural environment principle rests on the notion of creating opportunities for a child to view the environment from another level and is geared toward immersing children in nature.

14. **Cultural environment -** Besides the connection to the natural environment, it is also important to create a connection with the cultural environment with which children can identify, and in which they can learn to place themselves within the greater community.

15. **Local ownership -** Continued support and participation by local communities are crucial to the operations and growth of early childhood development. Through enabling local ownership, the community will become more involved in the development of these young children, ultimately enhancing multiple of the principles mentioned here. By connecting children, educators, parents and the local community, ECD centres become community orientated public buildings, allowing for increased use of the buildings through shared space for everyone to benefit from. This idea links strongly to the notion of social integration and connecting children with their cultural environment.

16. **Exploration -** The principle of exploration represents the idea of being surprised by spaces of wonder and discovery. The designer should seek to create spaces that are uncommon, yet still consider the notion of safety, comfort and familiarity. Children should be intrigued and provoked to explore and learn through finding new things, sparking their curiosity and desire to learn – which can be achieved through subtle relationships, unclear circulation or organization, and the creation of openings for glimpses into spaces or activities. This kind of exploration should also consider the physical development of children – through building stamina and motor skills – as well as their sensory development.

17. **Familiarity -** It is important that children find themselves in an environment where they can familiarize and orientate themselves, leaving them with a sense of comfort and safety. This principle also takes into account contextual familiarity, strongly suggesting a contextual design that allows children to assimilate and recognise their environment.

18. **Safety -** The safety of children takes on various forms and is an extremely important principle in vulnerable young children's lives. The principles of safety are to be applied to every situation and environment of the child, from physical safety to emotional safety.

This notion should also be applied to the spatial zoning and programming of the building and the physical conditions of spaces, as well as the access to and interaction between different users of the spaces. Safety also links to the principle of familiarity, creating a sense of direction and orientation for the children.

The last category covers principles on clarity and legibility. These principles are rooted in the theoretical premise, and were developed through a critical understanding of the common themes in the literature review and relating these to a spatial environment:

19. **Critical thinking -** The spatial environment should reveal indications as to its organisation, hinting towards the putting together of the structure and systems, offering an opportunity for the children to recognize and consider the multiple relationships between the parts, and of the parts to the whole.

20. **Filter spaces -** The creation of filter spaces between different zones, high stimulus and low stimulus, assists these young children to recalibrate their senses as they transition from one zone to another. These spaces can take a variety of forms, from subtle circulation spaces to full rooms that allow for this recalibration to take place.

21. **Overstimulation -** It is important that children are encouraged to pursue all the activities accessible to them without being overstimulated. This principle, therefore, takes into account a careful consideration of the implementation of all the other principles, so as to implement them in a way that does not create a situation of possible overstimulation.

22. **Spatial zoning -** The spatial zoning principle requires that spaces be organised in a logical order, based on the activities they house. It includes the sequencing from high-stimulus to low stimulus zones, from active to calm environments, and from active group spaces to more individual spaces. There needs to be a clear hierarchy and diversity between different spaces – small places, big places, various secluded and semi-secluded places. This principle also includes the notion of creating as many conditions as possible, within an early childhood development setting, so that the children can experience the world through their built environment.

Although these principles may seem prescriptive, they allow for various levels of implementation and adaptation, advocating the establishment of diverse applications that react to different user activities and skills levels. These principles give an indication of the impact that a spatial environment can have on ECD, and forms the basis from which a set of design guidelines are developed. In this set of guidelines these principles are translated into potential spatial and built environments, where the designer can visualise how architecture can directly influence ECD through didactic space. The guidelines in the image lead the designer towards possible solutions that can be implemented in their design in a contextual manner; therefore, the architect is assisted to generate architecture that is didactic and positively influences the early childhood development of the user.

Sensory Experience

HAPTIC SPACE
experience · interaction · recognitic motor skills · communication

VISUAL CONNECTIVITY
sense of autonomy · privacy access · security · comfort

OLFACTORY DEVELOPMENT
identification · memory emotion ·recognition

AUDIBILITY
accoustics · reverberation background noise · identification emotion · communication

Characteristics & Features

BREAKOUT ZONES
respite · stimultation neutral sensory environment

FLEXIBILITY
adaptibility · transformability convertability

SCALED SPACES
encourages growth towrads independance

ACTIVE PLAY
protagonist of own learning motor skills · stimulation interaction · exploration

INTERDISCIPLINARY TEAM
participation · inclusion engagement

DIDACTIC SPACE
space as third teacher

INCLUSIVE EDUCATION
inclusion of all intrinsic barriers

Connectivity & Identity

SOCIAL INTEGRATION
connectivity · group interaction individual engagement · emotions

NATURAL ENVIRONMENT
immersing children in nature connection · recognition

EXPLORATION
curiosity · wonder · free flow stimulation · stamina · growth

LOCAL OWNERSHIP
development · responsibility support · growth · networks community consolidation

SAFETY
general · comfort · health orientation · altered sence

FAMILIARITY
comfort · safety · growth

CULTURAL ENVIRONMENT
community orientated

Clarity & Legibility

CRITICAL THINKING
rational conncetion · organisation relationships · recognition

FILTER SPACES
transitioning · re-calibrate identification

OVERSTIMULATION
safety · emotions · comfort concentration

SPATIAL ZONING
high stimulus · low stimulus routine · logic · hierarchy diversity

2.16 Design principles developed for early childhood development. (Author 2017)

2.17

Design guidelines developed in response to the design principles. (Author 2017)

PROGRAMME	SCALE	GROUND PLANE	WALL	ROOF / ENCLOSURE
CONTAINED SPACE Be(Qualities): Didactic, audibility, flexibility, secure, inclusive, familiar scale Accommodate: visual connectivity, inclusivity, critical thinking, social integration, break out zones, local ownership Not: Overstimulate,	child scaled openings, fittings and spaces adult scaled openings, fittings and spaces intimate individual scale + larger group scale	soft ground plane (acoustic mitigator) visual connectivity social dramatic play performance space flexible gathering space	visual connectivity / reading / break out zones / sound habitable acoustic wall texture / flexibility crawling	exposed trusses / visual connectivity habitable roof extended cover
THRESHOLD (FILTER SPACE) Be(Qualities): Haptic experience, visual quality, olfactory, audible, inclusive Accommodate: Mediate stimulus Not occupied	intimate child & adult scale individual scale + small group scale	textured transitions contrasted ground plane / permeable ground plane (acoustic mitigator) shrubs with strong smell dynamic transitions	Visual quality / texture / sound smell texture / Visual quality	visual connection / nature (texture) smell shaddows visual quality / visual connection
HIGH-STIMULUS Be(Qualities): Haptic experience, visual connectivity, olfactory, audibility, flexibility, natural environment, didactic, safety, inclusive, familiarity Accommodate: Active play, exploration, break out zones, critical thinking, social & cultural integration, local ownership Not: Overstimulate	child scaled zones adults scaled zones intimate individual scale + larger group scale community & public scale	Dynamic active play landform hills individual / performance group sunken gatherings soft ground plane (acoustic mitigator) educational gardening / texture permeable ground plane (acoustic mitigator)	Visual connectivity / Natural environment / noise / Social active play / Smell habitable / climbing / crawling noise / Social Hear / Touch	Visual connectivity / Active play natural canopy green roof playground bridges tree canopy
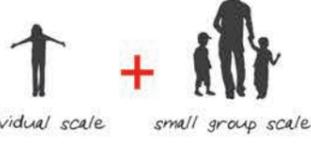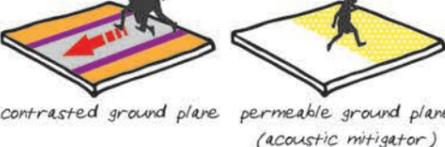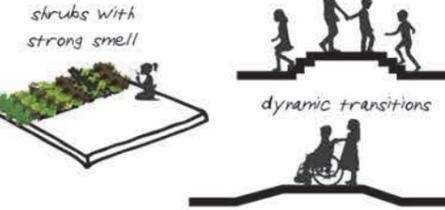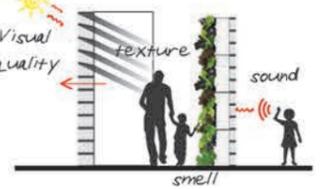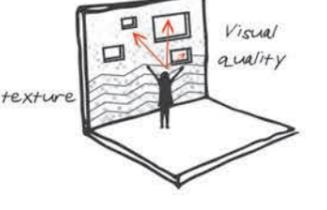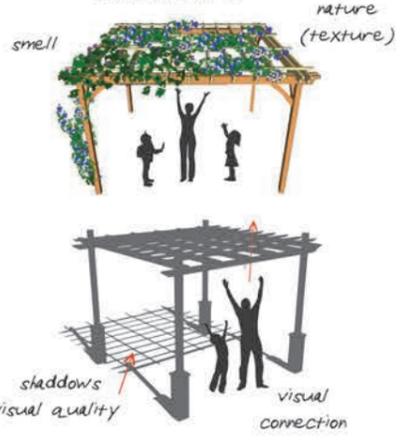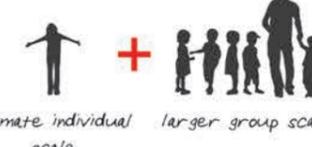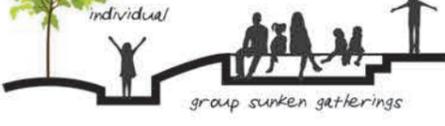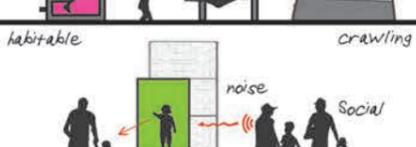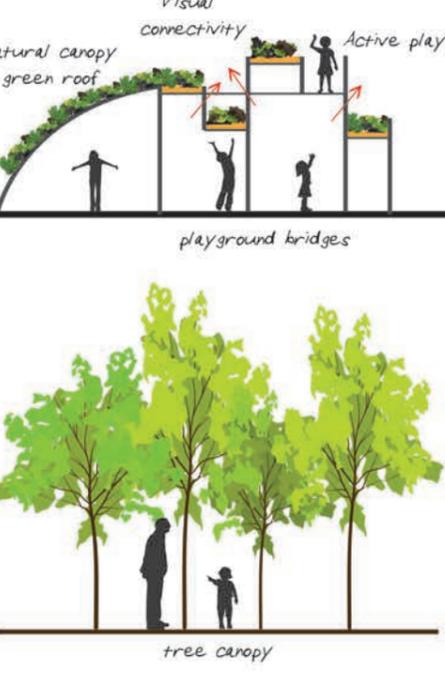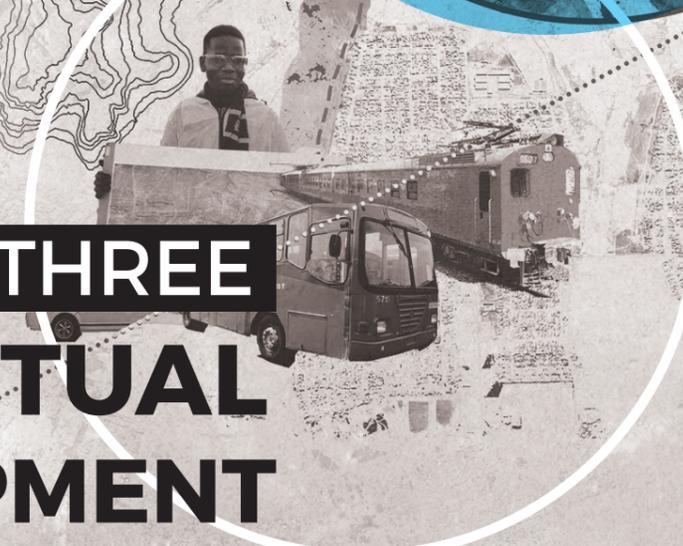
CHAPTER THREE
CONCEPTUAL
DEVELOPMENT

Conceptual vision for Mamelodi East(Author 2017)

3.1 URBAN DEVELOPMENT

In accordance with the principles developed in the previous chapter, it is important that a design resolution is developed within a contextual approach. With the architectural problem in mind, it is evident that South Africa has been experiencing an exceptional rate of urbanization and, as a result, government bodies are struggling to meet the qualitative and infrastructural demands of the developing sector in under-developed areas (Cox, Hemson & Todes 2007:14). Mamelodi East, situated on the periphery of Pretoria, was chosen to be investigated on an urban level as it stands on the threshold of reaching critical capacity (Steyn 2005). The city of Pretoria does not have the adaptive capacity to provide a solution to this critical capacity (Du Plessis & Peres 2013:5), resulting in the intense densification of Mamelodi.

Over the last thirty years the population of Mamelodi has tripled, bordering on one million residents (Gildenhuys, Badenhorst & Du Toit 2017), and through this rapid ur-banisation poverty and inequality is exacerbated. From the mapping it is clear that Mamelodi has filled nearly all available space imposed upon it by physical barriers, with the rapid densification putting a lot of stain on the already restricted foundation phase education that was discussed in the previous chapter. The data from Wazi-ECD (2017) indicates that Mamelodi East has an early childhood age group density that is more than double the figure of both the provincial and national figures. A mere 50% of these young children attend ECD centres, of which over 67% receive early learning subsidies (Wazi-EDC 2017). With these figures on the rise, it is clear that Mamelodi East is at a critical stage in which the qualitative and infrastructural demands exceed the capacity that the area can provide.

2008
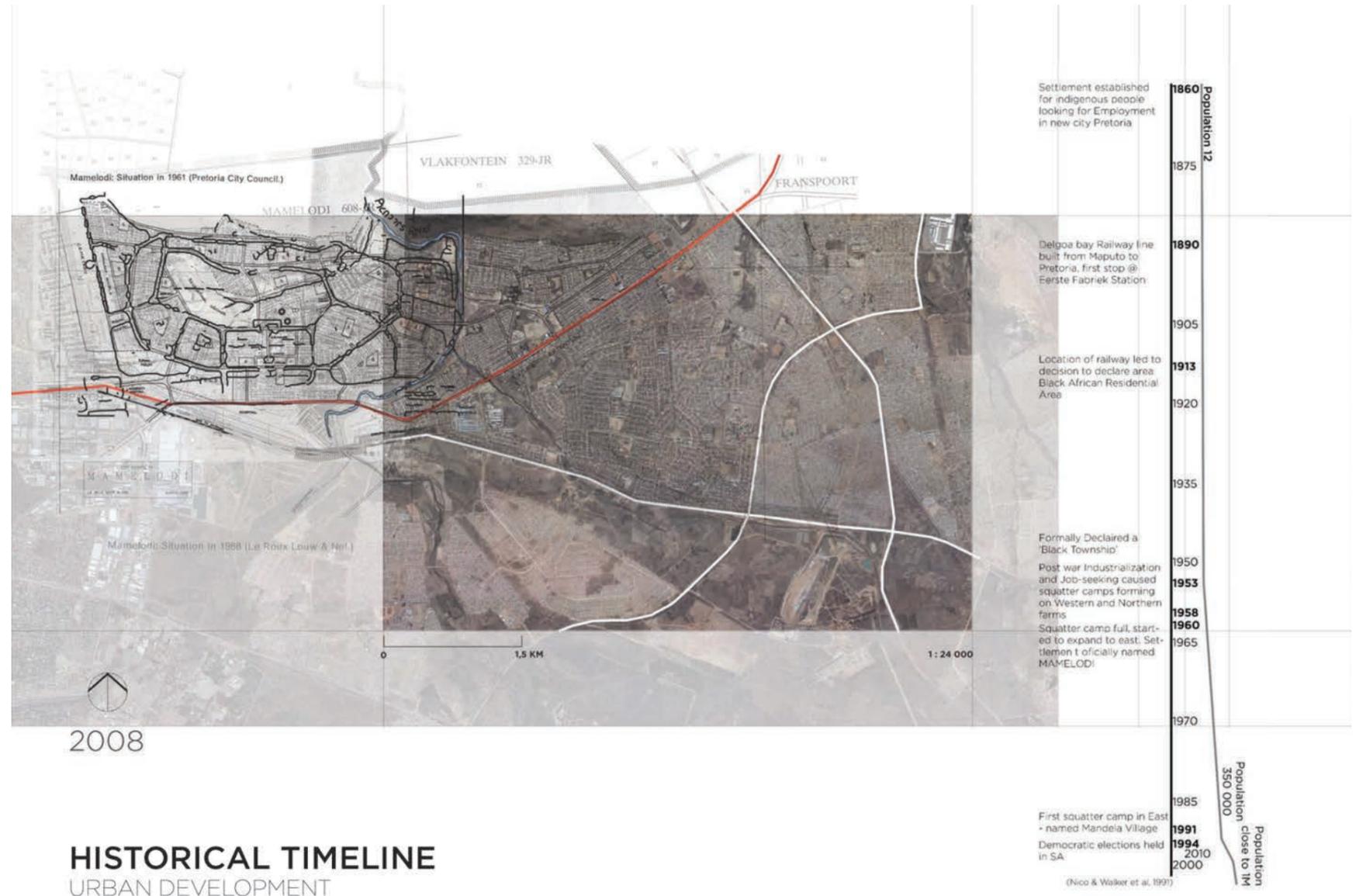
HISTORICAL TIMELINE
URBAN DEVELOPMENT

Historical timeline of the urban development of Mamelodi. (UP MArch(Prof) 2017) 3.1
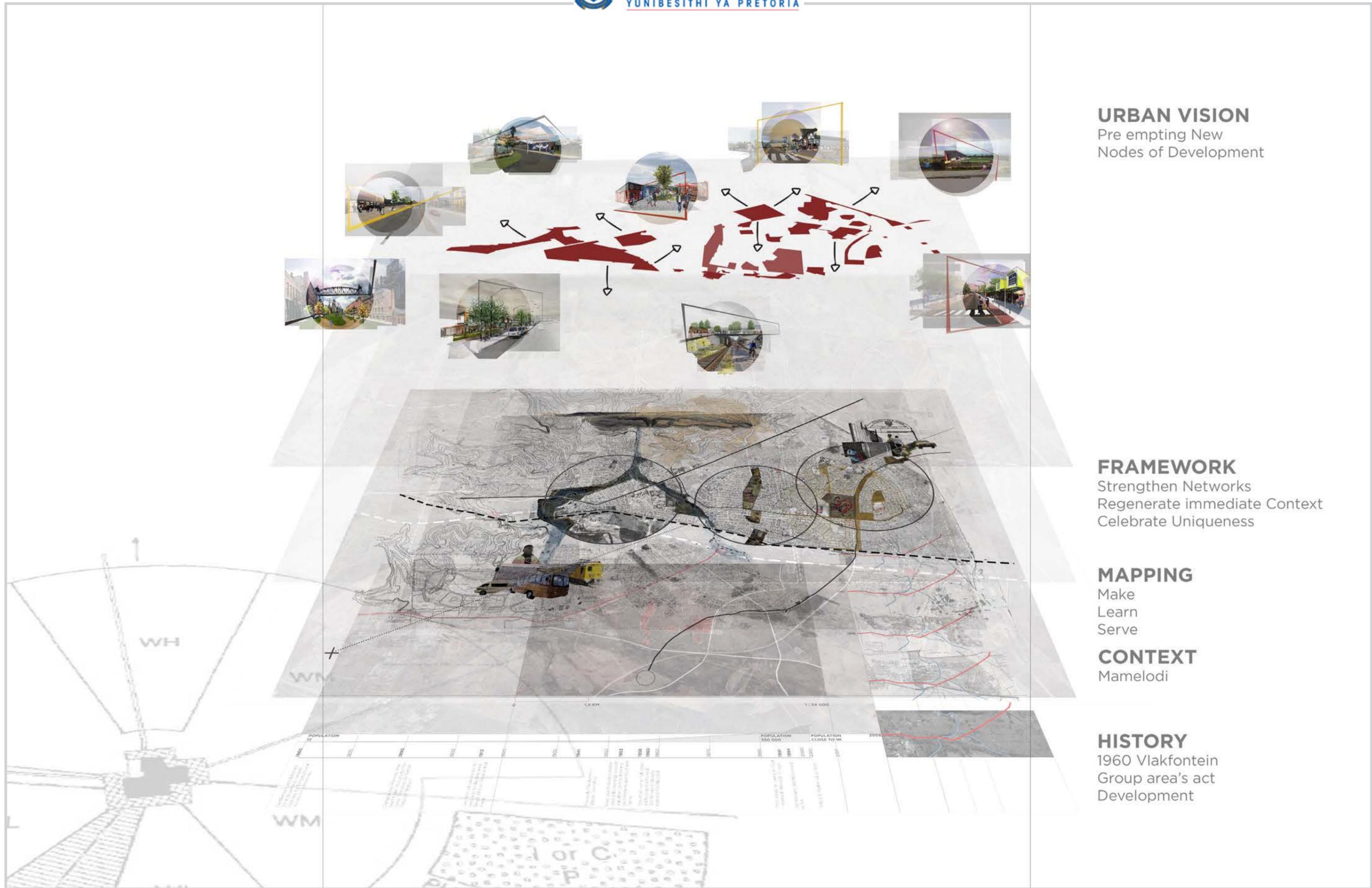
URBAN VISION
Pre empting New
Nodes of Development

FRAMEWORK
Strengthen Networks
Regenerate immediate Context
Celebrate Uniqueness

MAPPING
Make
Learn
Serve

CONTEXT
Mamelodi

HISTORY
1960 Vlakfontein
Group area's act
Development

Representation of the urban vision for
Mamelodi. (UP MArch(Prof) 2017) 3.2

An urban vision for Mamelodi is proposed with the aim of resolving the space constraints and densification within the area. The proposal argues for a method to negotiate the impending tipping point of critical capacity, presenting a unique opportunity in the adaptive cycle of Mamelodi. It is crucial to carefully negotiate a transition from the current conditions into a new, possibly improved, condition.

Mamelodi has been evolving within its inherited spatial legacy which still has an effect on how the city functions. Consequently, an opportunity presents itself to consciously manage and adapt this continuously evolving urban condition to improve the urban quality, yet protect the inherited spatial legacy (Du Plessis & Peres 2013:5). With this in mind, Mamelodi was investigated through an intensive mapping process that led to the following conclusions:

1. As Mamelodi was designed for ease of access control as a self-contained area, it has limited accessibility, thus causing it to function separately from the city of Pretoria.

2. Due to the vast distance between Mamelodi and the rest of the city, the urban poor are forced to live in low-cost accommodation and commute for long hours at great cost.

3. The current single-use zoned residential typology is not just causing urban sprawl, but also spatial, social and economic fragmentation (Steyn 2005:1).

4. From observation through the field research, it was apparent that the street is the most important public space, where ceremonies are held, public gatherings emerge, pedestrians walk, 'spaza shops' appear and cars are serviced.
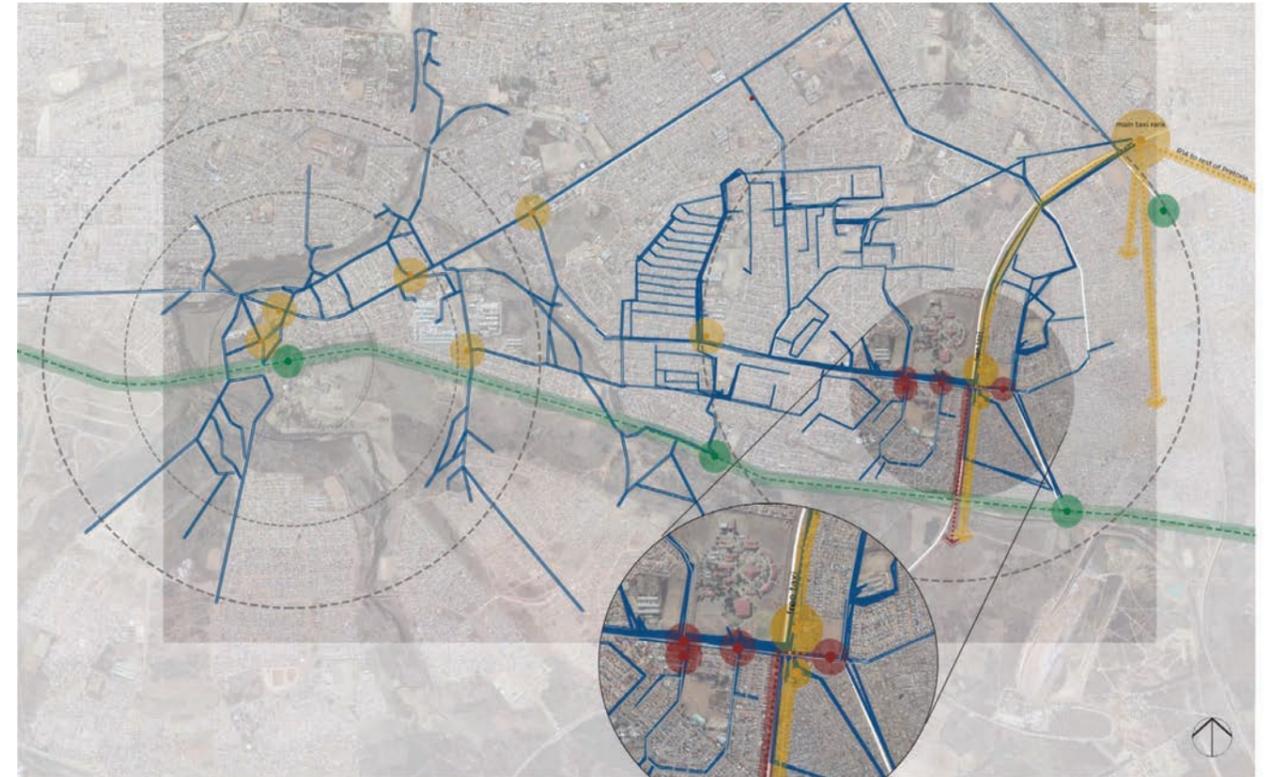
TRANSPORT + PEDESTRIAN NETWORKS
MICRO SCALE

SCHOOL-GOING PEDESTRIANS [7-8am/2-4am] — TRAIN STATION — TAXI RANK — BUS STOP

1. Strengthen Networks
Strengthening existing economic, environmental and social networks. Relying on locally-based networks will create complete communities of resilience and accessibility. These networks need to become complete and integrated, realising the connections between economic, environmental and social well-being.

2. Celebrate Uniqueness
The unique street-culture and vibrancy of Mamelodi can begin to inform methods of place-making and identity on an urban scale.
The day-to-day character of Mamelodi can contribute to the engagement of communities and the ownership of the urban fabric as a collective and individual.

3. Densify and Diversify
The densifying of nodes within the Urban fabric will contribute to the resilience of neighbourhoods. Bringing economic choice and diversity through mixed-use precincts will combat the mono-funtional nature of suburban Mamelodi, allowing for effective use of space and nodes of economic, social and cultural activity.

4. Infrastructure Upgrade
Upgrading existing and redundant infrastructure to become durable and reliable.
Infrastructure and service delivery are pertinent to the development of emerging cities. The economic, social and cultural health of communities rely on the efficiency and sustainability of infrastructural systems.

3.3   Principles of the urban framework for Mamelodi. (UP MArch(Prof) 2017)

3.5   Map of healthcare facilities in Mamelodi. (UP MArch(Prof) 2017)

It was observed that the street edge is negotiated by the users and the conditions are adapted according to need, depending on the time of the day/week/month/year. The streets are generally perceived as active spaces where children and many others enjoy the community spirit and associated street life, as communal public space is in some cases limited and in others inaccessible or unsafe (Steyn 2005:3).

The urban vision, as a result, focuses its attention on the uniqueness of character found in Mamelodi street culture, aiming to restructure the township typology into a good, sustainable neighbourhood through interventions placed along the negotiated street edge.

The proposed catalytic nodes of intervention within the urban vision framework. (UP MArch(Prof) 2017) **3.6**
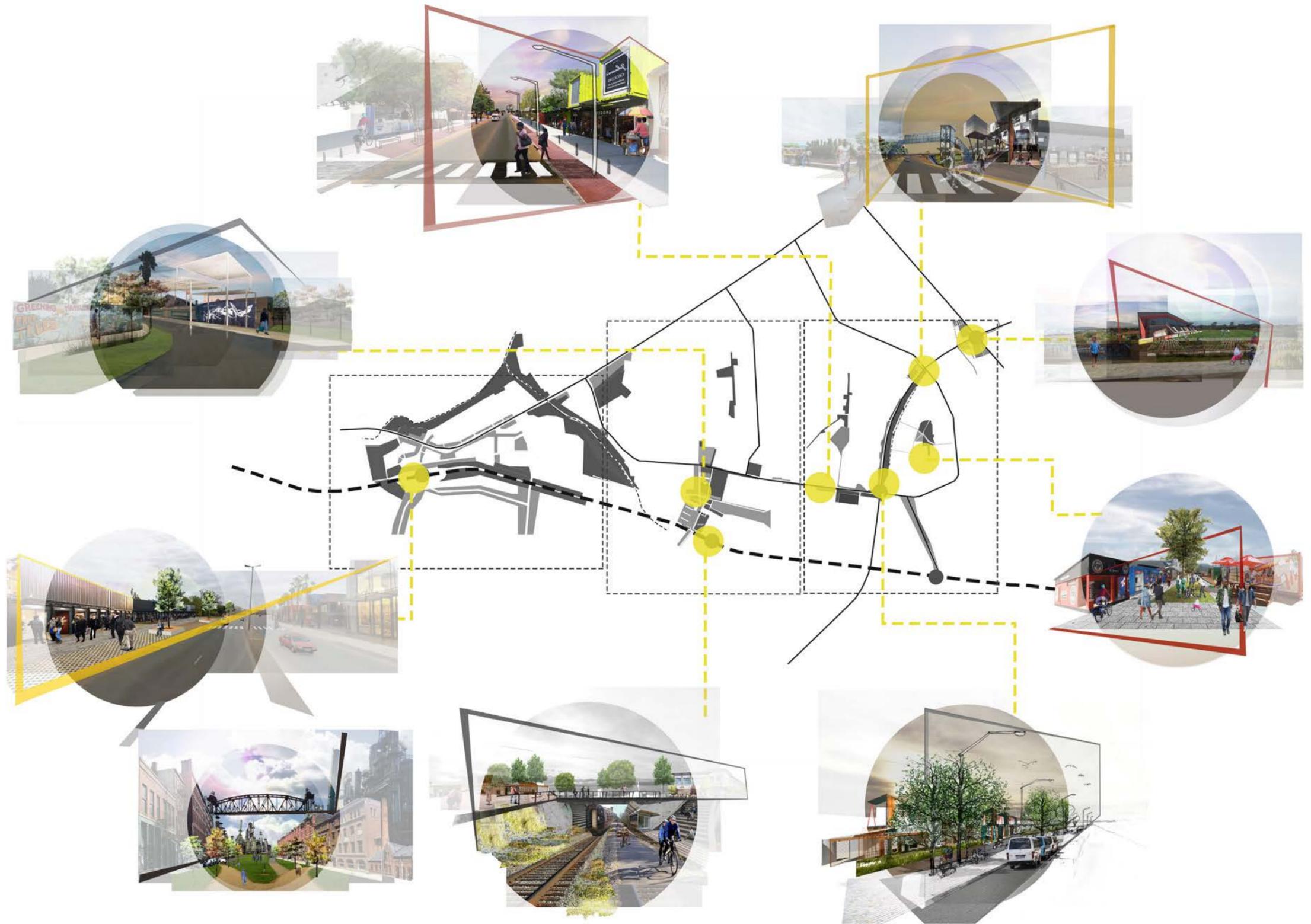
The urban vision collages depict actual street views in Mamelodi re-imagined for a future condition, exploring the qualities which, according to Hertzberger (2008:13), make up a successful urban condition: compact, accessible, walkable and mixed-use with a high level of economic self-sufficiency.

The framework proposes that townships and informal settlements are here to stay, therefore it presents a preliminary exploration focusing attention on the strengths found through the mapping to pre-empt new nodes of development that could increase accessibility and offer economic choice.

Urban vision map indicating existing conditions. (UP MArch(Prof) 2017) **3.7**

GREEN SPACE   INDUSTRY   COMMERCIAL
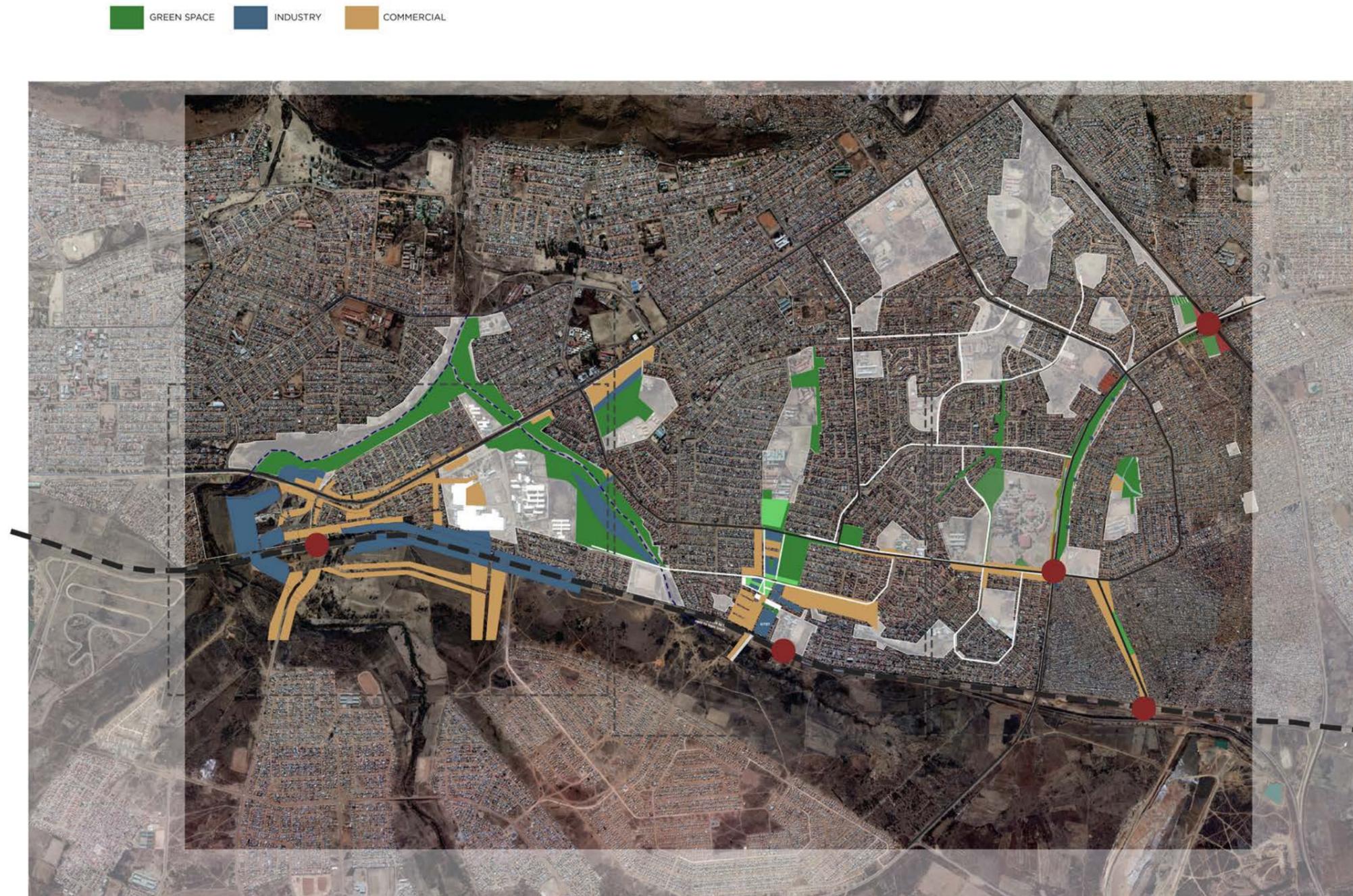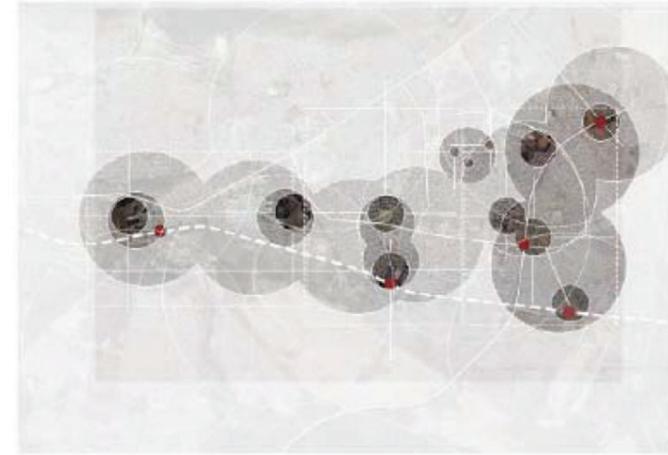
3.8 Development phasing proposed in the urban vision, pre-empting new nodes of development. (UP MArch(Prof) 2017)

3.2 SITE SELECTION

The densification and space limitations identified through the mapping indicate that, according to the CSIR guidelines (2000), a shortage of educational facilities exists in Mamelodi. Ward 15 in Mamelodi has 1962 children aged five years and younger, according to the information from Wazi-ECD (2017), resulting in a density of 912,3 children per square kilometre, more than double the figure in both Gauteng and South Africa. In the age group of three to five years, Wazi-ECD (2017) indicates that only 69.6% of these children are enrolled at ECD centres, of which 86.62% receive early learning subsidies. These ECD centres consist of ten community-based centres and seven home-based centres, of which only 47% are fully registered.

ECD demographics within Ward 15, Mamelodi. (Wazi-ECD 2017)   3.9

Early childhood age groups

1 962
Children 5 years and younger

Gauteng: 1 394 617
South Africa: 6 741 428

Breakdown of children aged 0-5
52%   48%
0-2   3-5
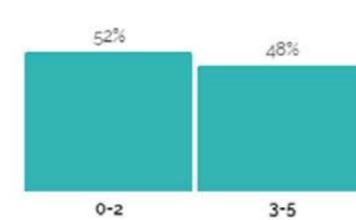
Gender of children under the age of six
Female 52%
- Female
- Male
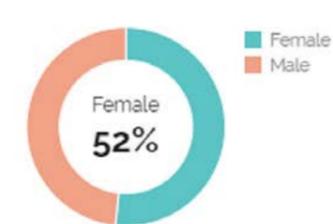
Child population density

912.3
Children (0-5 years) per square kilometre

more than double the figure in Gauteng: 76.701091192

more than double the figure in South Africa: 5.4637716446

Children per square kilometre
478.03   434.32
0-2   3-5

ECD centres overview

17
Number of ECD centres

Gauteng: 3 774
South Africa: 76 052

Breakdown of ECD centres by registration status
Registered 47%
- Registered
- Registration conditional
- Registration in process
- Registration incomplete
- Not registered
- Unspecified

Breakdown of ECD centres by registration status (Table ECD_CENTRES_BY_REGISTRATION)

Column	Ward 15 (79900015)		Gauteng		South Africa	
Registered	47.1%	8	28.7%	1,082	41.9%	31,878
Registration conditional	23.5%	4	2.4%	90	10%	7,584
Registration in process	17.7%	3	13.2%	498	13.5%	10,297
Registration incomplete	0%	0	11.6%	437	5.3%	4,019
Not registered	11.8%	2	40.6%	1,532	27.9%	21,226
Unspecified	0%	0	3.6%	135	1.4%	1,048

Hide data

Table   Map   Distribution

Breakdown of ECD centres by type of centre

Community based 59%
- Community based
- Home based
- School based
- Other
- Not specified

Show data / Embed

Breakdown of ECD centres by type of centre (Table ECD_CENTRES_BY_TYPE)

Column	Ward 15 (79900015)		Gauteng		South Africa	
Community based	58.8%	10	29.1%	1,092	61.6%	46,267
Home based	41.2%	7	48%	1,801	20.9%	15,728
School based	0%	0	6.5%	243	9.5%	7,120
Other	0%	0	1.7%	62	1.7%	1,248
Not specified	0%	0	14.7%	553	6.4%	4,786

Table   Map   Distribution

Breakdown of ECD centre types within Ward 15, Mamelodi. (Wazi-ECD 2017)   3.11

- ● PRIMARY SCHOOLS
- ● SECONDARY SCHOOLS
- ● TERTIARY INSTITUTIONS

1 KM RADIUS

2 KM RADIUS

TEACHER
TRAINING
COLLEGE

UNIVERSITY
OF
PRETORIA

CURRENT SITUATION
13 PRIMARY SCHOOLS
4 SECONDARY SCHOOLS

POPULATION SIZE = 81 265
(STATS 2011)

SCHOOLS REQUIRED
20 PRIMARY SCHOOLS
10 SECONDARY SCHOOLS
(CSIR RED BOOK)
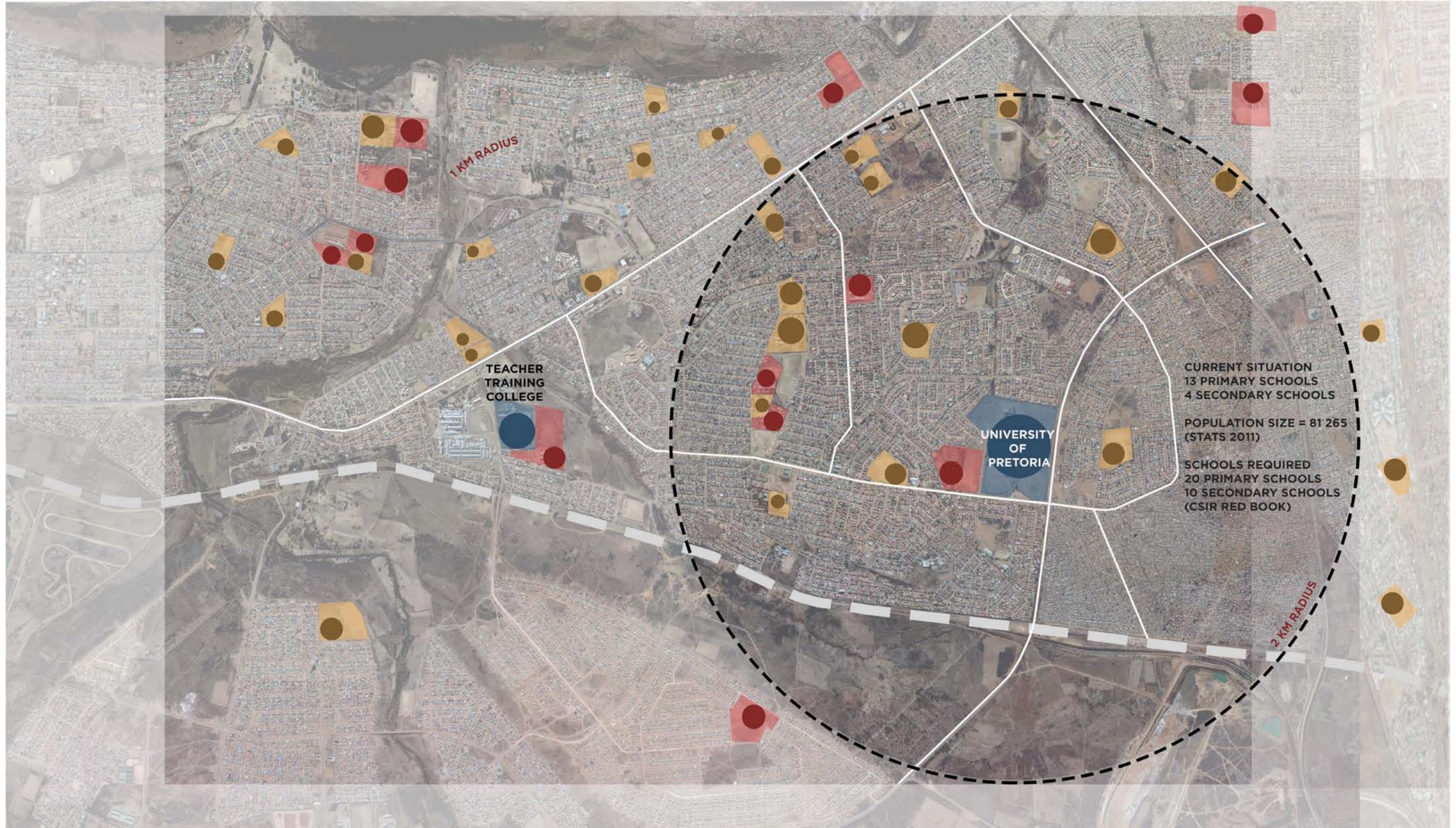
Map of educational institutions in
Mamelodi. (UP MArch(Prof) 2017) **3.12**

A strong network of these ECD centres exists in Extension 4, Mamelodi East, including five centres that cater for a total of 278 children on 1406m² of land (Bopape 2017).

A thorough analysis of each of these centres (see images) indicates a variety of needs, relating to both infrastructure and operations, with the most prevalent need that of space constraints. These facilities are accommodated within residential properties with erf sizes of between 260m² and 350m², and consist of a private home, ECD facilities and minimal yard space. The result is an average of well below 1,5m² accessible space per child, which consequently fails to meet the desired minimum requirements of 1,5m² indoor play space and 2m² outdoor play space per child, as set out by the Department of Basic Education (2012:39). These facilities further require improvements such as added ablutions, sufficient space for the storage of records and medical history records of each child, adjustments to the weather-proofing, and well-ventilated structures (Department of Basic Education 2012:39).

Map of the ECD network in extension 4, Mamelodi East (Author)   3.13
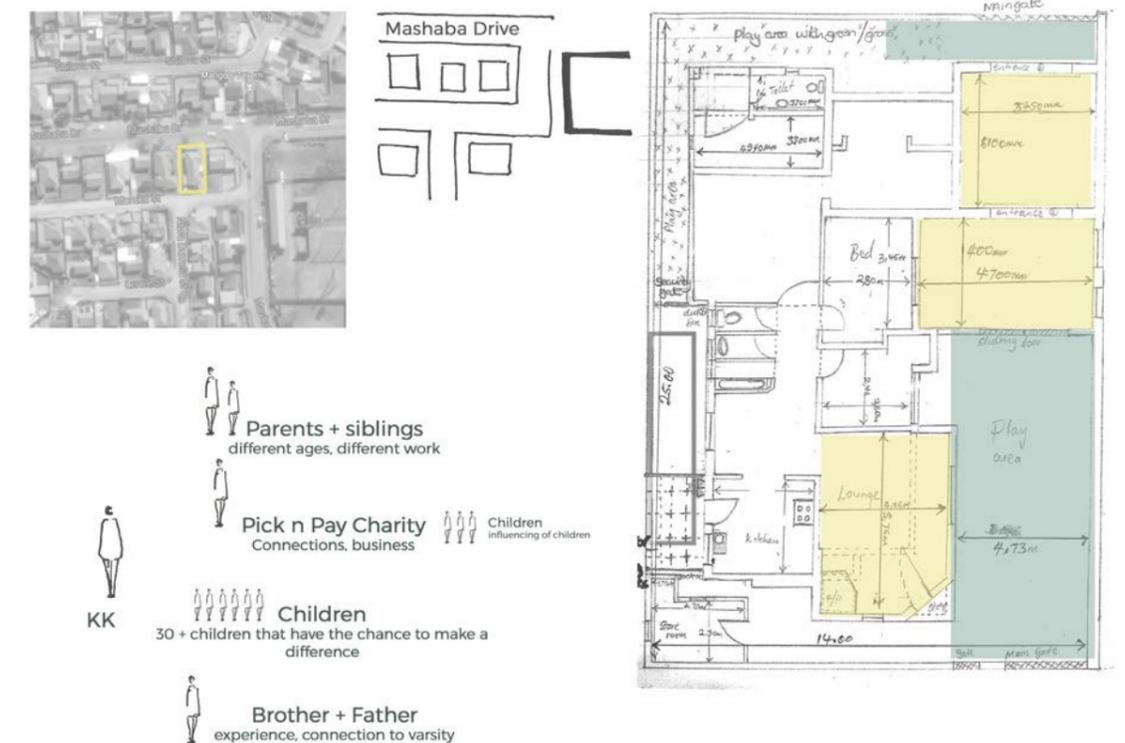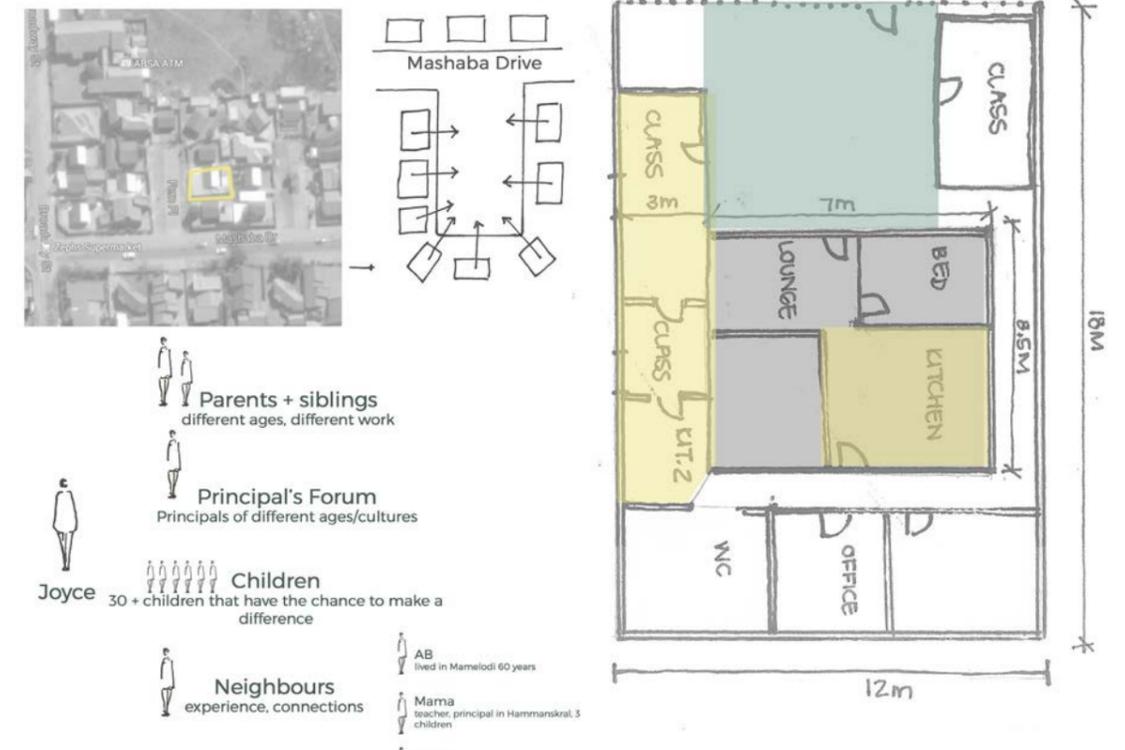
Even though these facilities are in extremely close proximity to each other and hypothetically in business competition, they rather operate as a strong network working together to share their knowledge and resources in order to improve their mutual educational services. These centres also form part of a greater ECD forum, where mutual support is provided through cross collaboration (Bopape 2017).

From the urban study it can be seen that Mamelodi is rapidly densifying, and from the active research within Extension 4, Mamelodi East, it is clear that the only accessible public recreational space is situated central to the ECD network, providing an excellent opportunity to act as extension to the ECD centres. However, this park lacks adequate playground facilities and has a strong presence of drug dealers, thus making it unsafe for children. Yet, the recreational park is walking distance from the ECD centres, situated next to a primary school and in close proximity to the police station. It is evident that the park presents an opportunity for becoming a new node of development, as proposed in the urban vision, and for its accessibility and safety to possibly be increased so as to strengthen existing community networks.

It is proposed that a shared resource centre is developed to frame the existing recreational park, support the shortcomings of the existing ECD centres, and strengthen the existing network between these centres and the community.

Conceptual sketch of a shared resource centre. (Author 2017) **3.16**
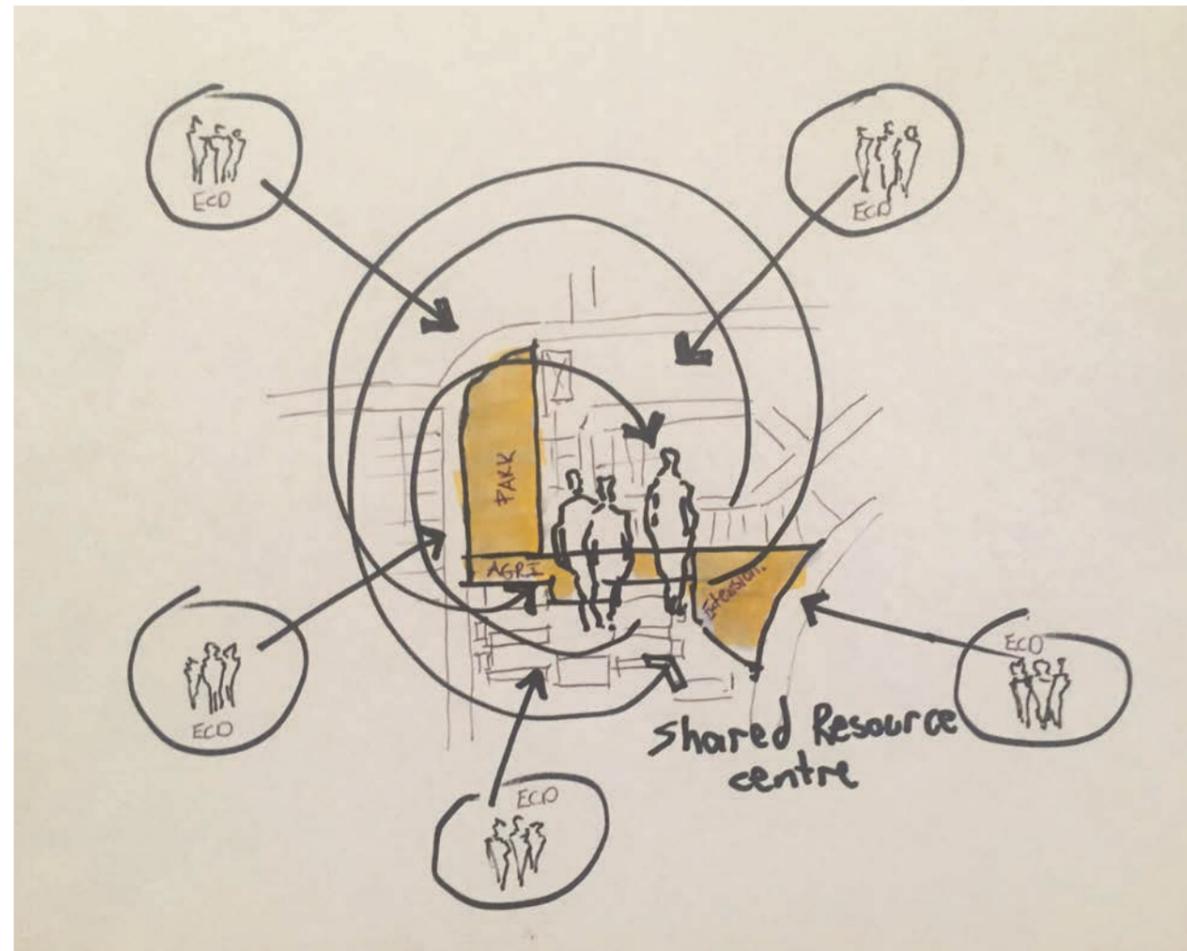
3.3 CONCEPTUAL INTENTION

Conceptually, the proposed facility aims to support and strengthen early childhood development through both didactic space and the programming of the facility. Furthermore, it aims to strengthen the social exchange between children and the community. It is proposed that this could be achieved through the application of the design principles and guidelines, as developed in the previous chapter, translating them into a spatial relationship between the building, its spatial qualities, the tactile environment and the surrounding urban fabric. The aim of the facility is to move away from individualised ECD education that takes place in isolation and hidden away from the public eye, to rather suggest a communal support space that integrates early childhood development in the public realm, thereby placing children at the centre of the community.

It is proposed, in support of the urban vision, that attention is focused on the uniqueness of character found in Mamelodi street culture, and to therefore structure the design of the facility through interventions that extend from the street edge into a safe and accessible community environment. This follows and supports the notion of 'learning streets' described by Hertzberger (2008:13), where the streetscape allows the widest variety of interactions to occur among the community that consists of people of varying ages and cultures. The resultant public interaction becomes an educational environment where children learn how to act within society. From this, as well as from the developed design principles and guidelines, the design vision and intent is developed.

3.4 DESIGN VISION AND INTENT

The design intent is to create a nurturing environment where children form the centre of the development of the community. It is aimed at addressing physical and emotional development through proposing an accessible tactile environment. An inclusive community is proposed, where children can assimilate the values of such inclusivity by learning through hands-on activities. Grounding the children in a safe space of familiarity that is centred on experiential education encourages the development of imagination and social awareness (Plan International & ARUP 2016). The overall goal is to make children the building blocks of the community.

Conceptual intention sketch. (Author 2017 **3.17**
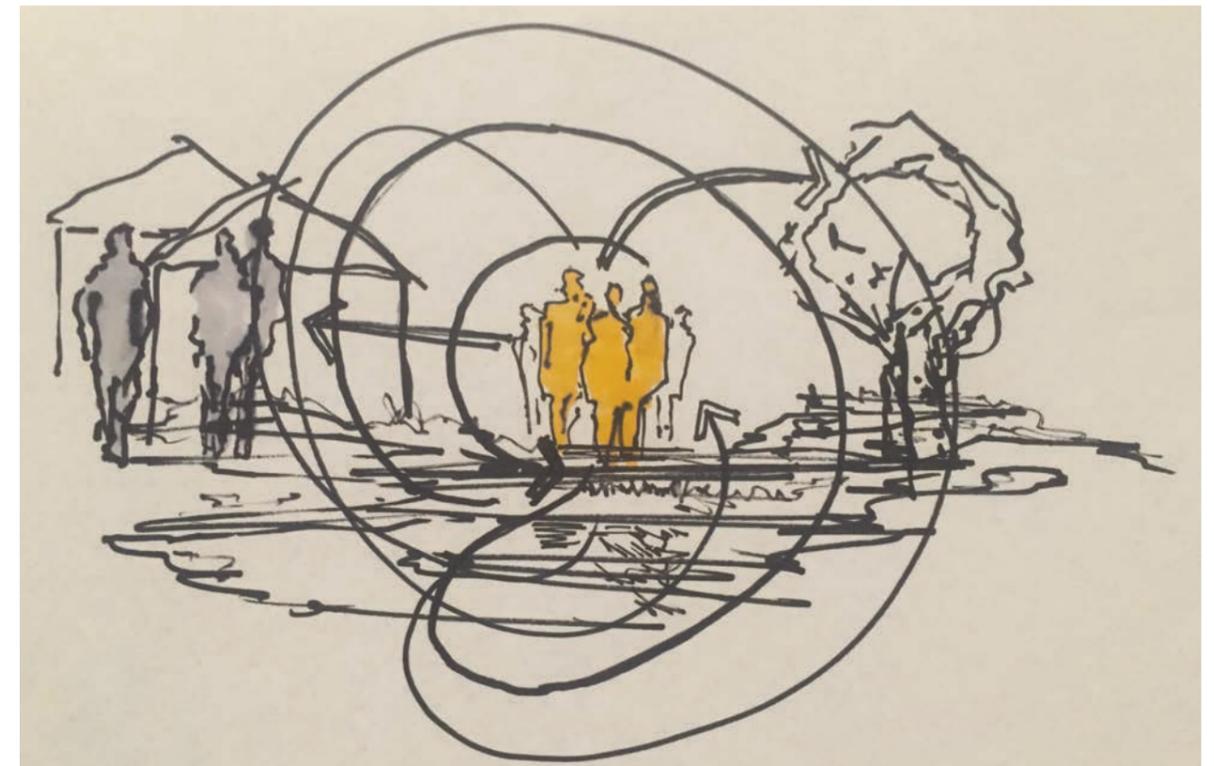
3.5 SITE & PROGRAMME

The proposed programme aims to provide in and support the shortcomings of the existing early childhood development centres within the area. These crèches have varying needs, therefore flexible and multi-use spaces will be developed. From the design principles and guidelines the programme is divided into three zones: contained space, filter space and high-stimulus zones.

The contained spaces provide an extended educational environment that the crèche network can utilize for activities that they cannot accommodate in their own facilities. These spaces will be flexible so that a vari-

ety of activities can be accommodated, as required by the ECD centres.

The filter spaces act as critical thresholds between the high-stimulus and low-stimulus programmes, encouraging the recalibration of the children's senses as they move from one level of stimulus to the next.

The high-stimulus zones provide areas of play and physical activity. A cultivation space provides a platform where the community can produce fruit and vegetables to feed the children, helping to solve the issues of malnutrition in the areas surrounding

the existing crèche facilities.

It is proposed that the precinct is developed in phases that introduce the community to the idea of a child centred community and create a sense of local ownership, rather than impose a major change onto their environment. The precinct will be developed in the following phases:

1. Phase One – *Initial occupation*

This phase proposes the development of a resource facility for the ECD network on the southern unutilised part of the site.
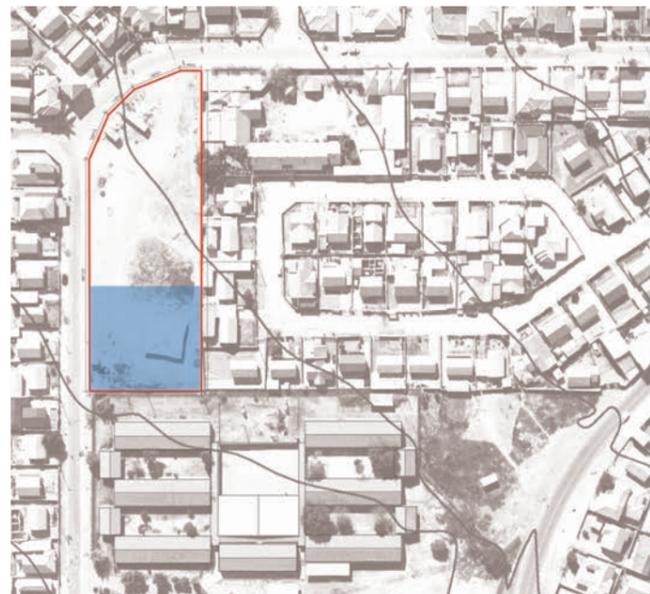
Phase One – Initial Occupation. (Author 2017)   **3.18**

2. Phase Two – *Agricultural connection*

This phase aims to utilize the unused landscape behind the school yard as an extension of community recreational space in the form of agricultural and educational gardens.

Phase Two – Agricultural connection. (Author 2017)   **3.19**

3. Phase three – *Additional recreational space*

The addition of recreational space on the vacant plot next to the primary school on Marishane Street will act as a secondary node of development and will connect to the existing park through the connection of the agricultural garden.

Phase Three – Additional recreational space. (Author 2017)   **3.20**

4. Phase four – *Connecting with private partnerships*

As a result of the initial strengthening of community networks in the previous phases, this phase proposes to connect the existing private partnerships to the greater community network. This can be achieved through proposed shared facilities on the north-eastern periphery of the site, as well as through the alteration of the boundary between the park and the Meetsa A Bophela Centre for children.

Phase Four – Connecting with private partnerships. (Author 2017) **3.21**

5. Phase 5 – *Strengthen community connections*

The last phase pre-empts the possibility that the newly developed nodes could increase community interest in the park, and attract higher levels of economic activity to the existing economic network on the northern part of the site.
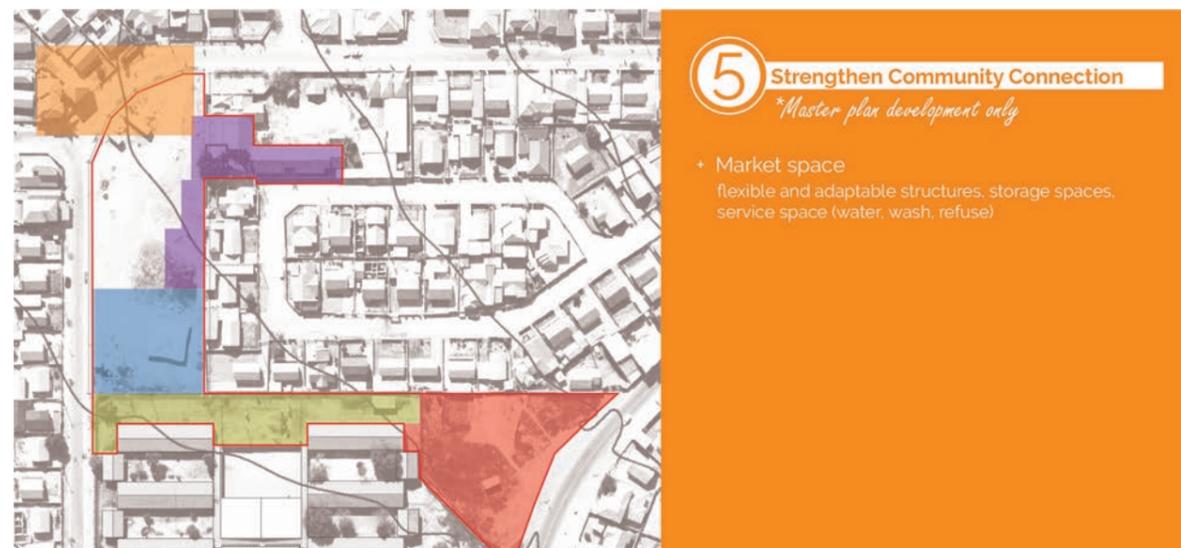
Phase Five – Strengthening community connections. (Author 2017) **3.22**

The proposed primary stakeholders are the Mamelodi Early Childhood Development (ECD) Forum in association with the Gauteng Department of Education, the local municipality, and ASIDI (Accelerated Schools Infrastructure Delivery Initiative). The focus will be on the network of crèches within Ward 4, which becomes the main client.

Through the creation of a child-centred community and the use of the public park, the community of Ward 4 becomes a secondary stakeholder. Further to this, the existing private partnerships between the crèche network and the different departments at the University of Pretoria will also become part of the group of secondary stakeholders.
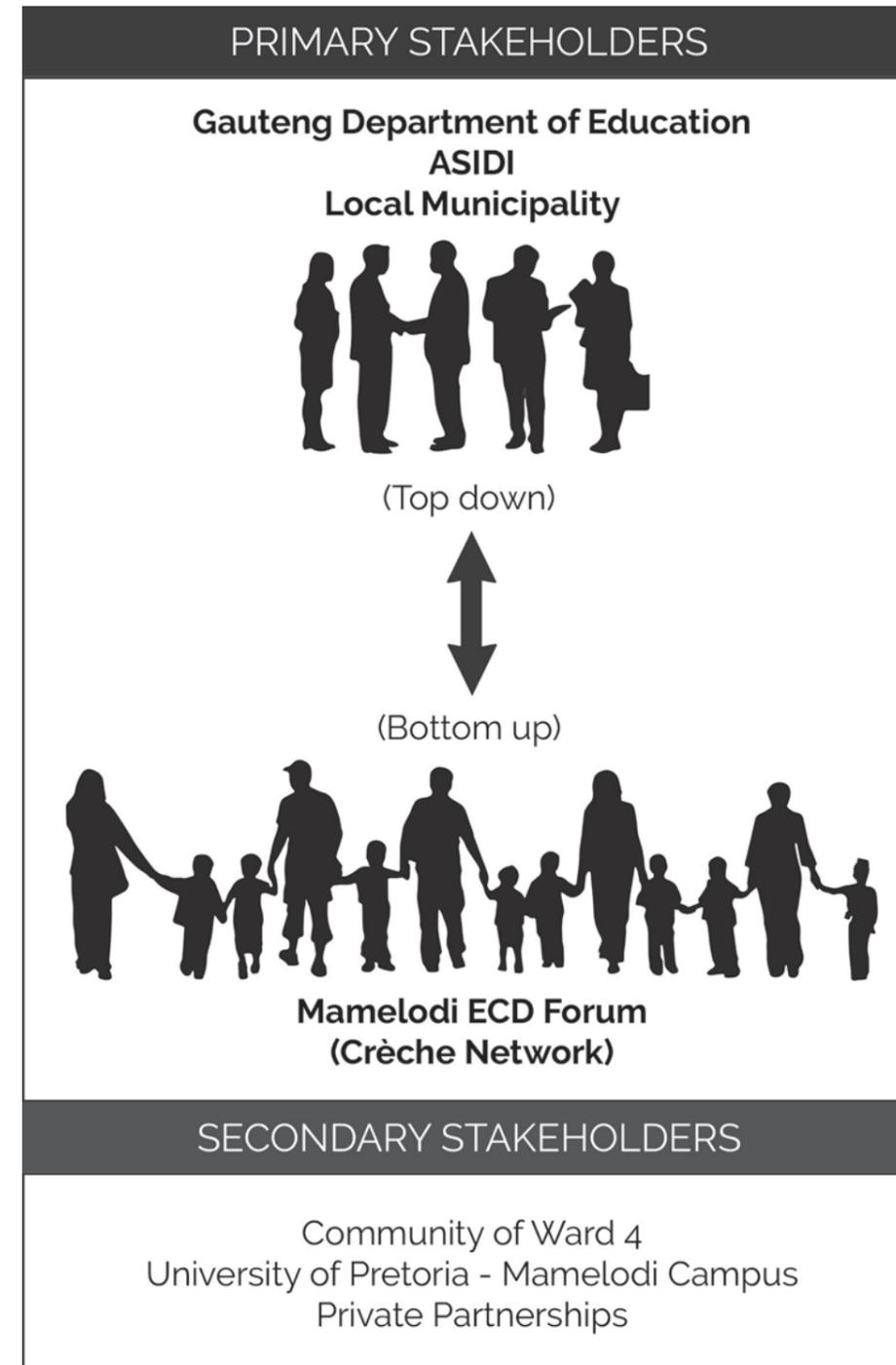
3.23

Client and stakeholders.
(Author 2017)

CHAPTER FOUR
DESIGN DEVELOPMENT

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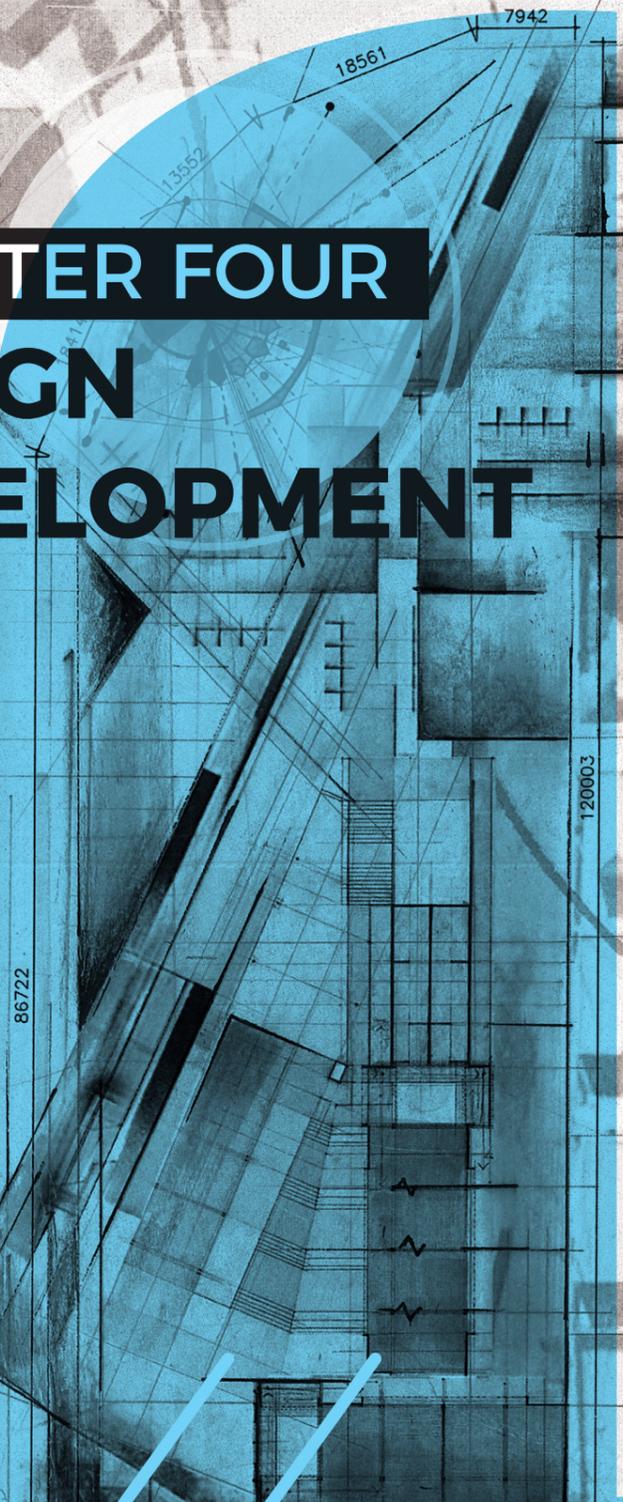
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Conceptual site sketch (Author 2017)

The design process was informed by an understanding of early childhood development, the generation of design principles and guidelines, and an understanding of the context and the programmatic requirements. The design approach should also resonate with the intention of the project, which is to create a new relationship between architecture and early childhood development. From this a design was developed through an exploration of the site and an iterative design process.

4.1 SITE EXPLORATION

The initial design explored the connection and merging of the three sites (see figure 1.3), as well as the link between the sites and the community context, linking to the notion from Steiner Waldorf Education (2014), that everything that surrounds a child, both visible and invisible, has an influence on that child. The site investigation has shown that the northern part of the park is currently the most active space, possibly due to the economic node that has formed between the spaza shop across the street, Warwick's Club on the northern periphery of the site, and the adjacent Meetse A Bophelo Missionary Centre for children; therefore, the conceptual sketch explores the link of this node to the rest of the site and community, suggesting that this active node be strengthened and supported through the site development. This consideration relates to the pedagogy theory of the interconnectedness of the emotional, spiritual, social and physical development of children (Whitebread 2009), where children learn through their actions, experiences and imitation in order to develop good motor, social and practical skills; therefore, practical application is important. Young children need to be exposed to normal everyday living in order to experience the relevance and meaning of their world.

From the field research it is evident that the southern part of the park is mostly unused by the community and, based on this, the initial intention is to utilize this part of the site for the ECD support spaces. The aim is to frame the park and to create a more accessible community space where the children can become the most important users, integrating them with their surrounding environment. The importance of this approach is highlighted by the Reggio Emillia approach (Edwards 2012) in the belief that children best create meaning out of their world through environments that provide for interaction, exploration, respect and community.

The site is explored through a gradual transition from public to semi-public spaces, and from uncontrolled to controlled environments. In essence, the park versus building relationship is explored, strongly linking to the principle of the natural environment within ECD, where children have a close relationship to the natural environment according to Edwards (2012).

The unutilised northern part of the primary school grounds is developed as a controlled and semi-public connection between the park and the currently empty south-western site, through establishing urban agriculture and educational gardens (see figure 4.2). The adjacent primary school playground and classrooms are connected to the agriculture garden, creating an extended educational environment with the aim to support the transition of the children from ECD to primary school education.

The south-western site is explored as an extended park environment that also provides community facilities such as a community hall, multi-functional meeting spaces and clinic spaces, supporting the notion of the integration of the children with a social and cultural environment (Dudek 2012). The improved park environment and provision of community facilities aims to create a sense of local ownership for the community, and is one of the key principles developed from the field research (UP MArch(-Prof) 2017).
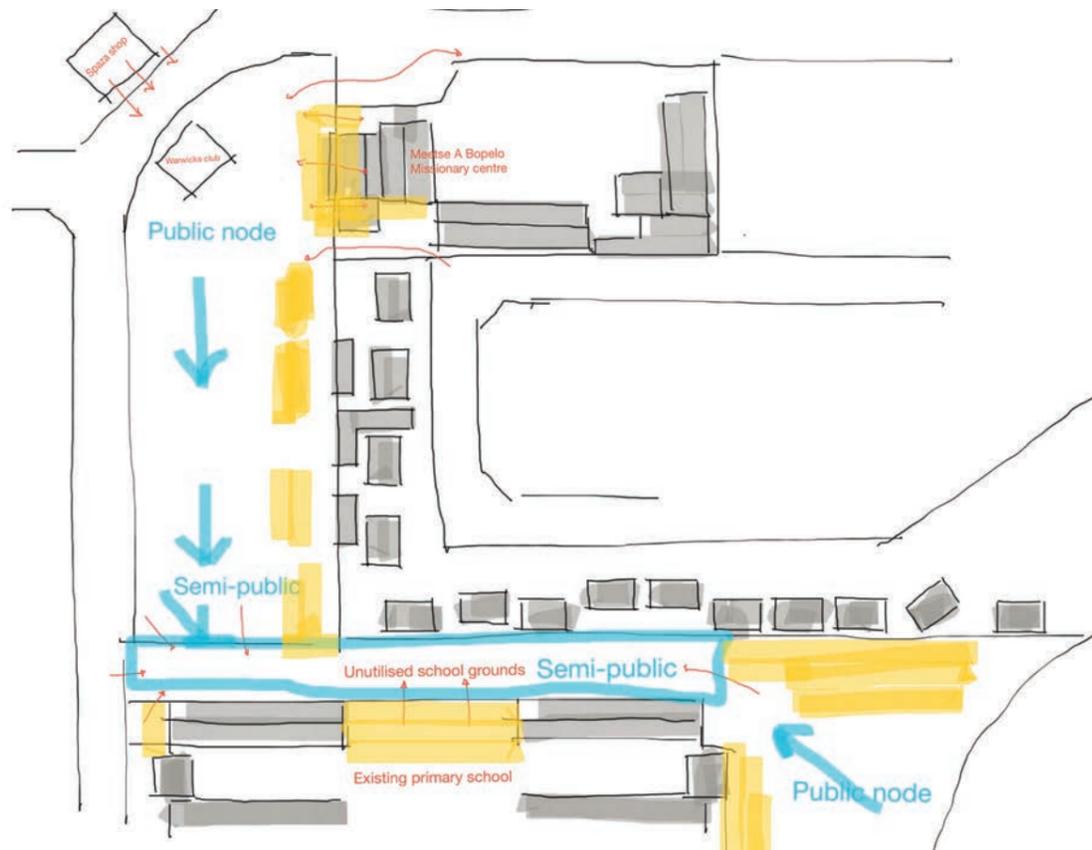
Sketch of the economic nodes and transition between public and semi-public spaces. (Author 2017)

4.1

4.2 Initial exploration of the site. (Author 2017)

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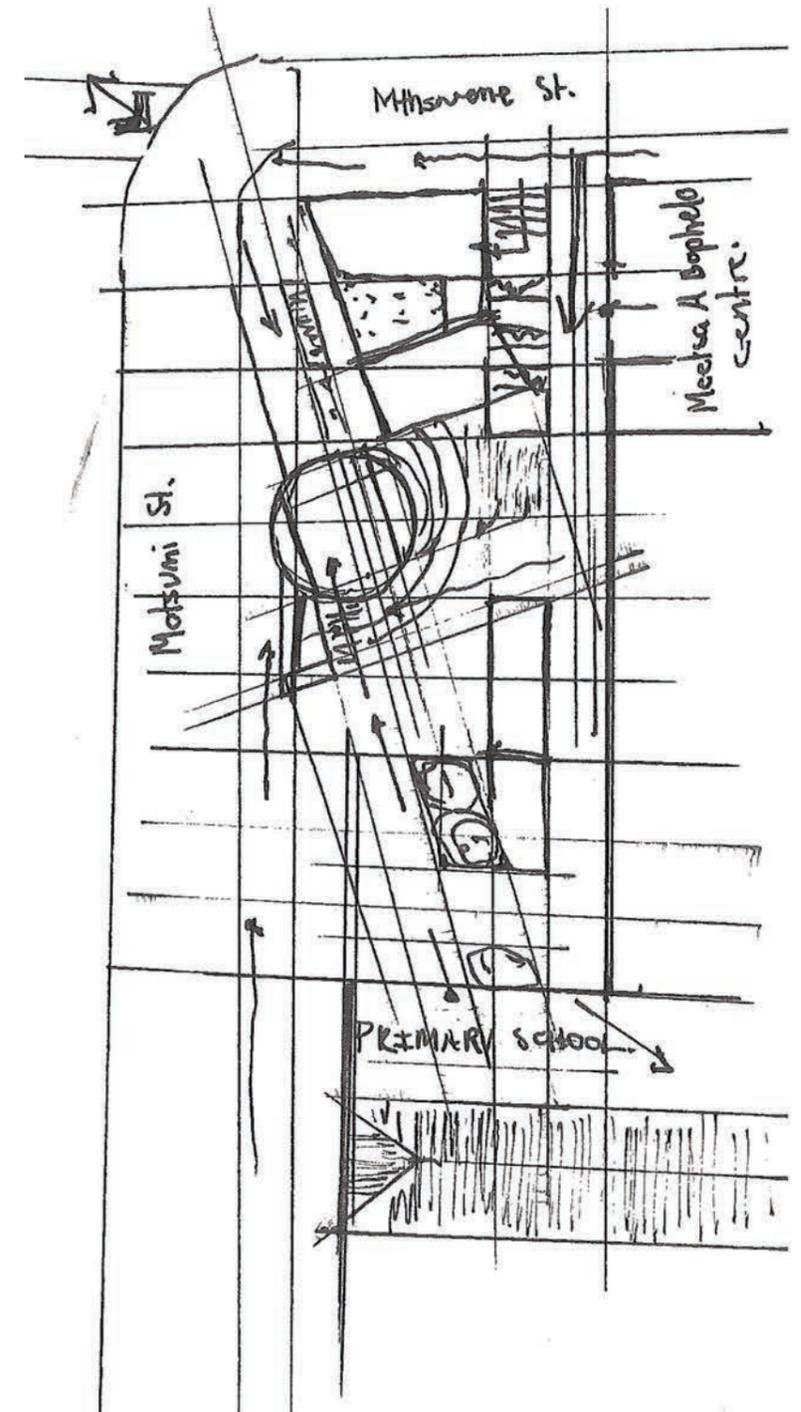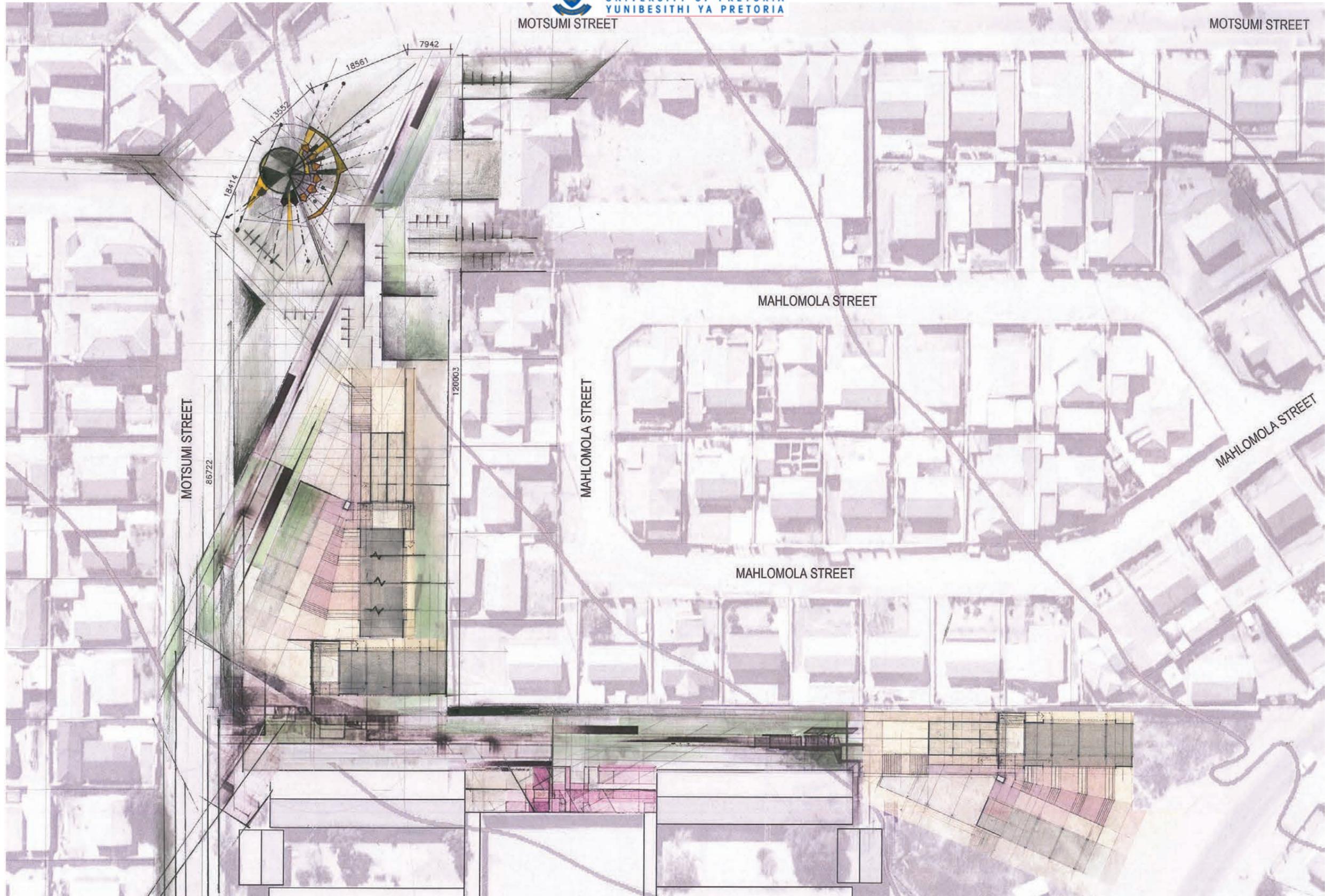
4.3 Conceptual exploration of the site.
(Author 2017)

The initial models explored the site through a series of scenarios in which different scales of architecture were explored. The possibility of a multi-functional tower was investigated, instilling the idea of the park becoming an important node within the community, and ultimately aiming towards the creation of a child centred community. A tower can be used to instil a sense of direction, familiarity and safety in the children (Lillard 2013 & Steiner Waldorf Education 2014), as it will be visible throughout the site, enabling the children to explore their environment while always knowing where they are.

Model development of the site. (Author 2017) **4.4**
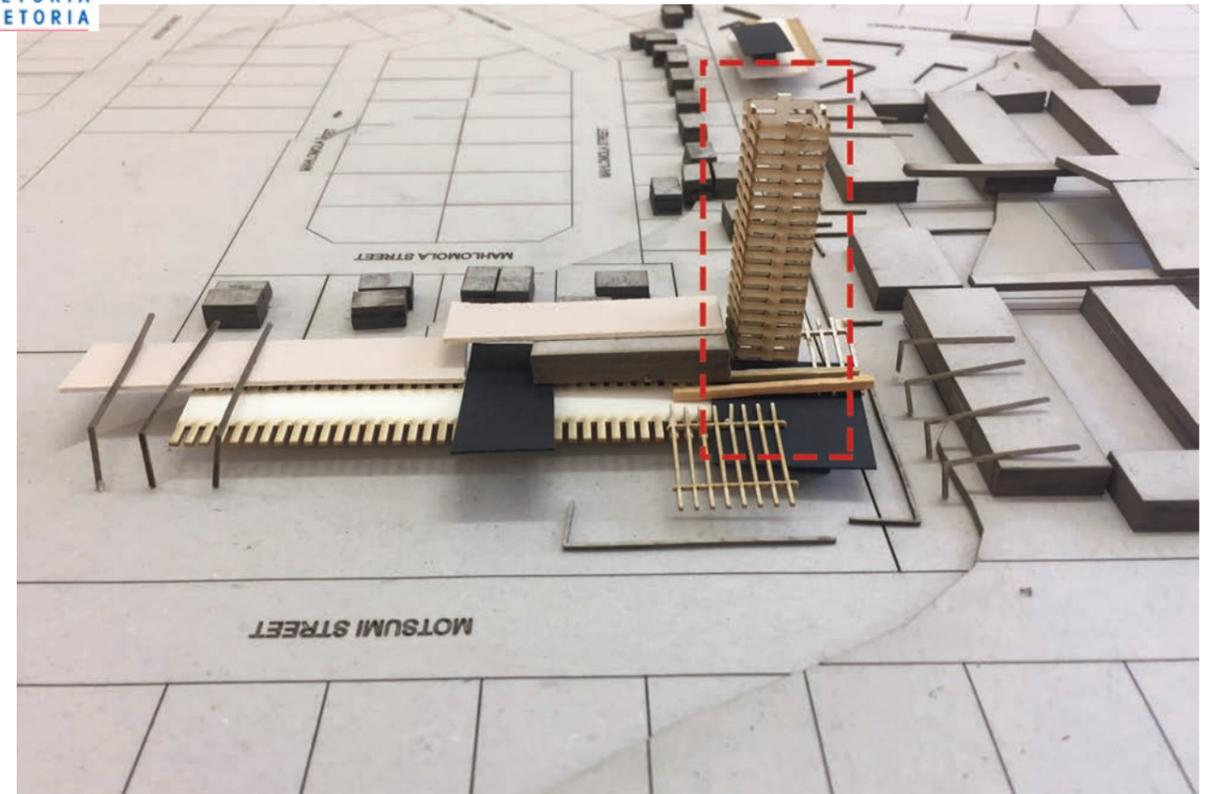
4.5 Model exploration with a tower element. (Author 2017)
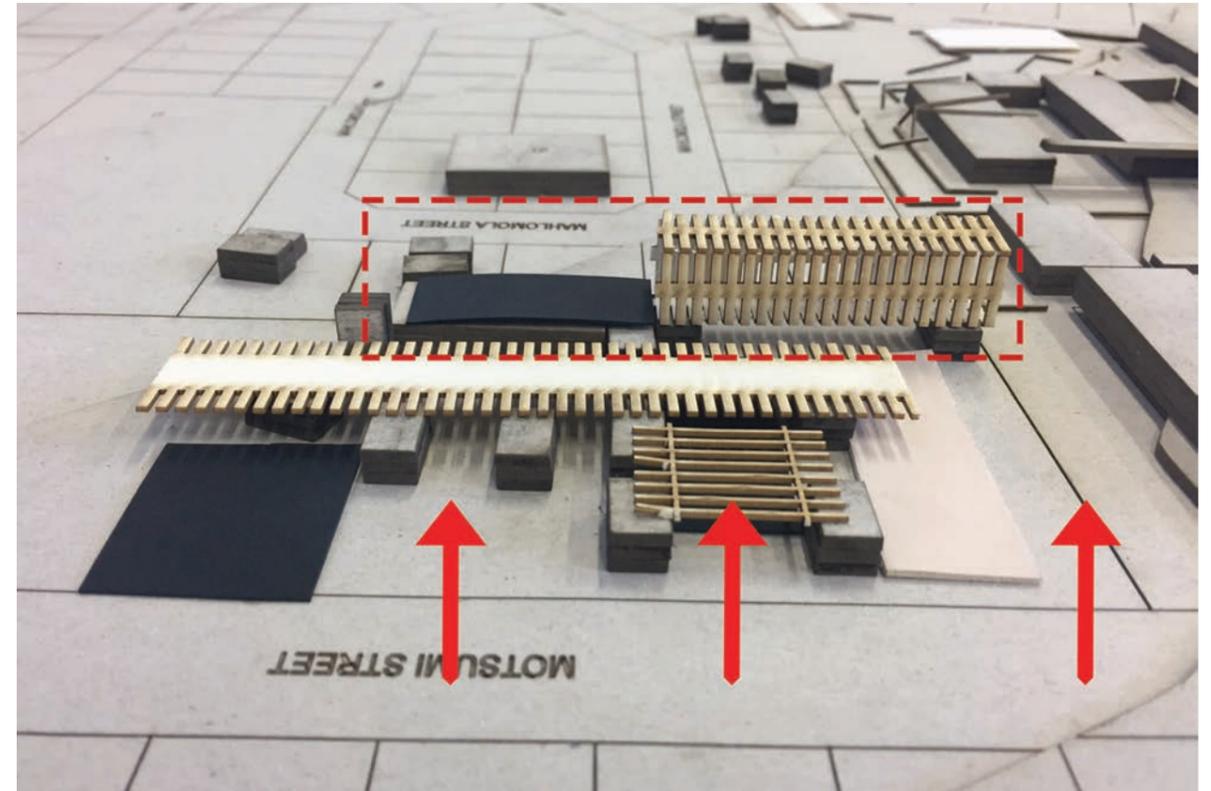
Model exploration with a larger scale to the back of the site and a connection to the street. (Author 2017) **4.6**
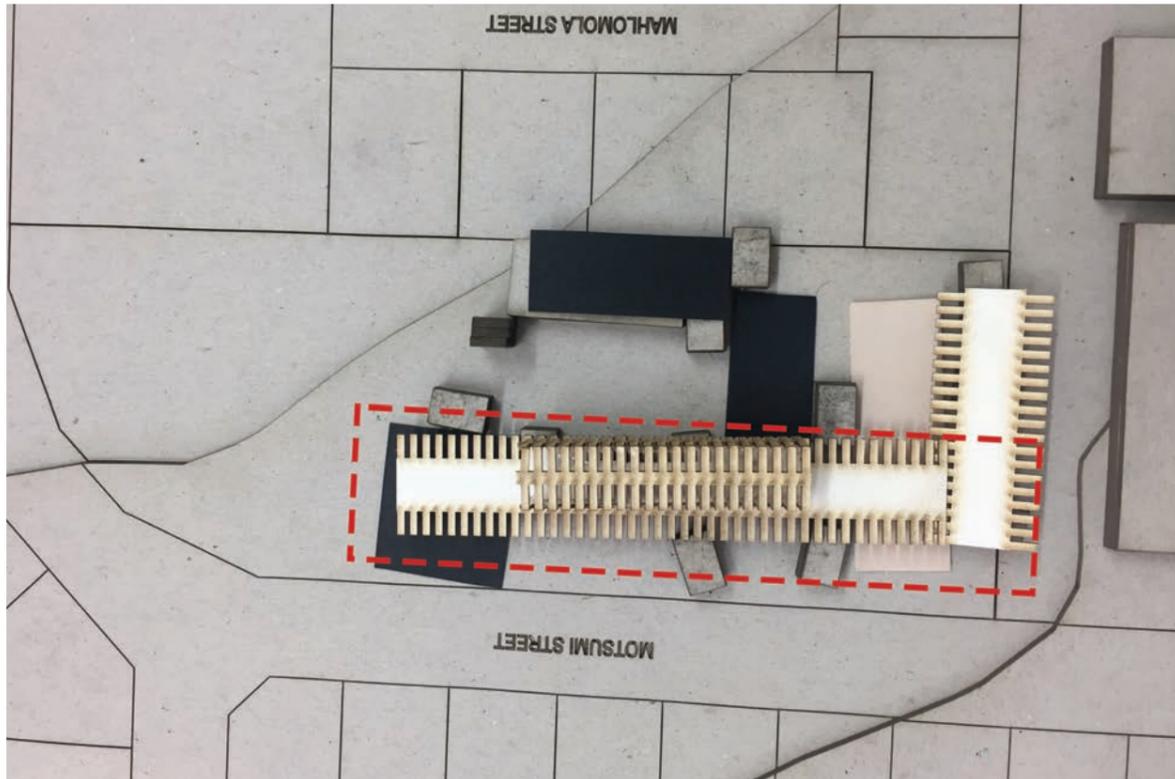
Model exploration with buildings on the street edge. (Author 2017) 4.7

Critique

The site needs to be explored further in terms of the edges and how these activate and link the spaces in order to achieve social interaction, encourage exploration and a connection to the community (Edwards 2012). The footprint occupies too much space within the park and does not frame the park, as intended. The relationship between building and landscape, which is not evident yet, should also be explored further, and the play space should be integrated with the building to encourage learning through play (Dudek 2012 & Lillard 2013).

The tower in the models should be explored through the lens of solving environmental problems, thus serving multiple functions. The spatial zoning (Mostafa 2014) and layering of spaces is not evident and should be used to create hierarchy. The roof should be explored as a tool to create space, and the material usage in the architecture should be integrated with the educational aspects. The importance of this is supported by the concept of affordances from Harry Heft (Dudek 2012) where the sensory qualities of materials have an impact on the way the child experiences and acts within an environment.

4.2 EXPLORATION TWO

Following the critique on the initial iteration, the site, the architectural form, and the relationship between the buildings and the context began to be explored through another series of models. In addition, the idea of active play was investigated through a series of structures that became part of the architecture, where children could enhance their physical development through the active use of the play environment.

This active play shifts the focus to self-directed experiential learning within a spatial relationship driven environment (Edwards 2002). The integrated structures provide the opportunity for self-led free play, both indoors and outdoors, through the child's own observation of life, giving them the opportunity to integrate socially and re-imagine their experiences. This self-led free play is still guided towards the achievement of

specific goals (Lillard 2013:157-180), with these play structures requiring fine detail development in order to include both the gross and fine motor skills, as well as the development of various senses (Malnar & Vodcarka 2003).

Model exploration of the park, and the building versus park relationship. (Author 2017) 4.8
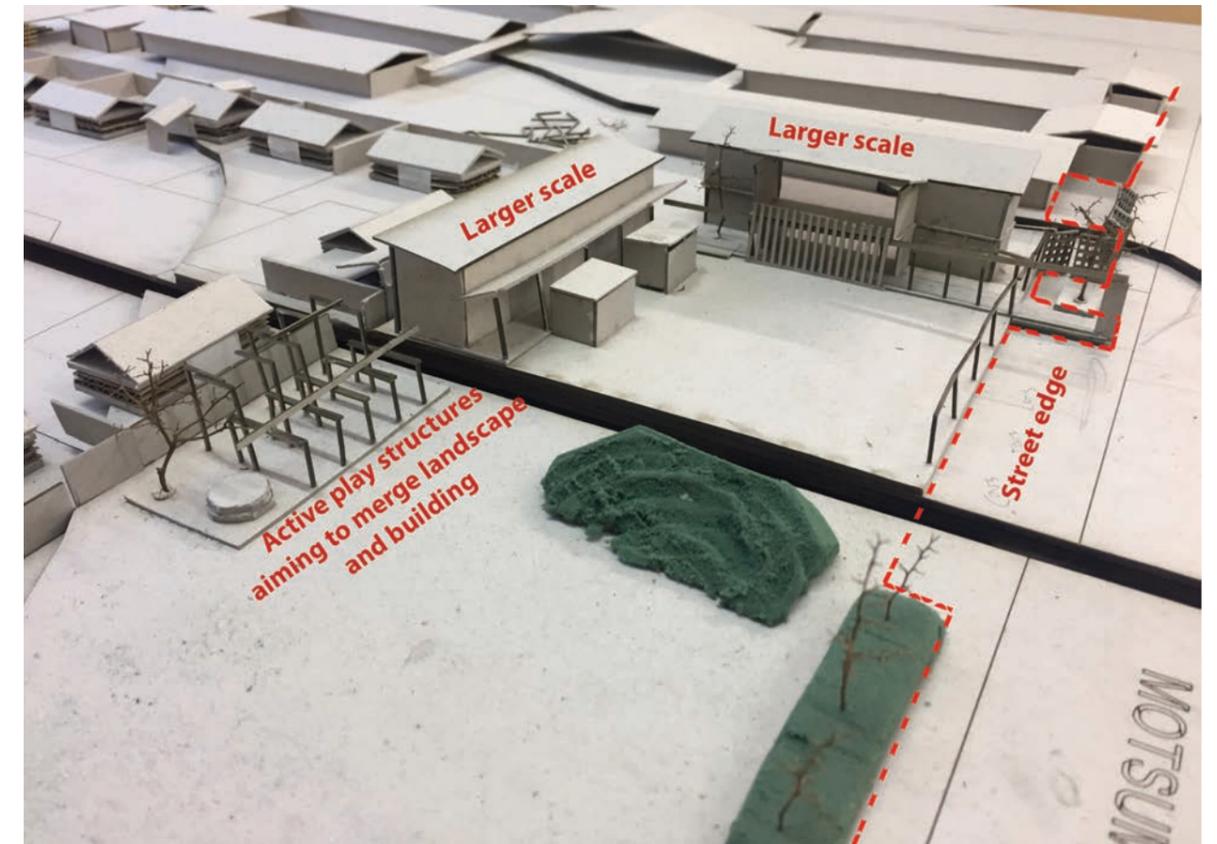
Model of the south-western site, exploring the community hall. (Author 2017) — 4.9

Model exploration of the occupation of the park. (Author 2017) — 4.11

4.10 — Model exploration of the street edge condition. (Author 2017)

4.12 — Exploration of the economic node and connection to the Meetse A Bopela Centre. (Author 2017)

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Existing spaza shop

Economic Hub

Meetse A Bopela Centre

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Existing primary school
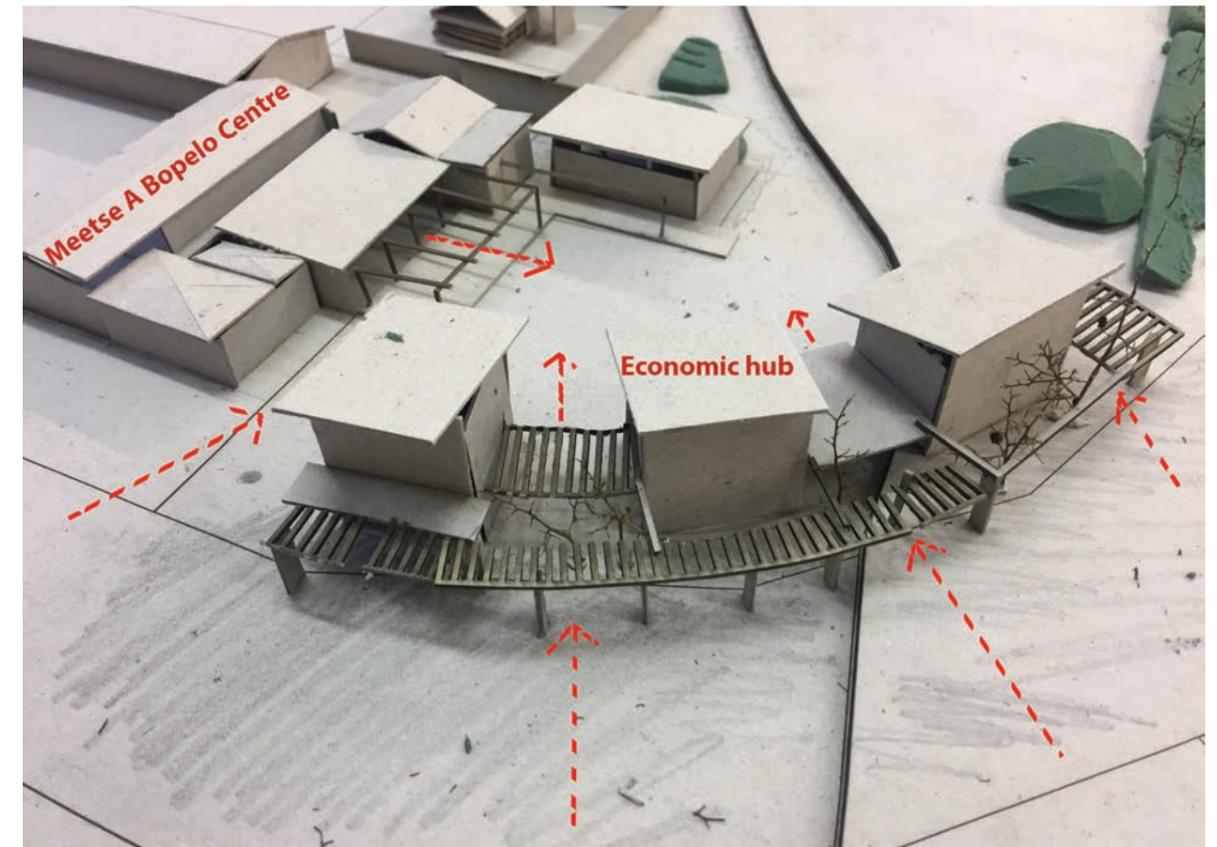
Model exploration of the park site. (Author 2017) 4.13

Section-elevation exploring of the resource centre next to the surrounding homes (Author 2017) 4.14
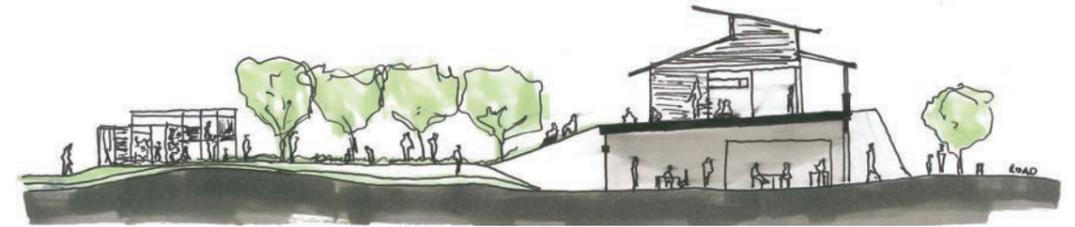
Section-elevation exploring the possible conditions of the economic hub with different levels (Author 2017) 4.15
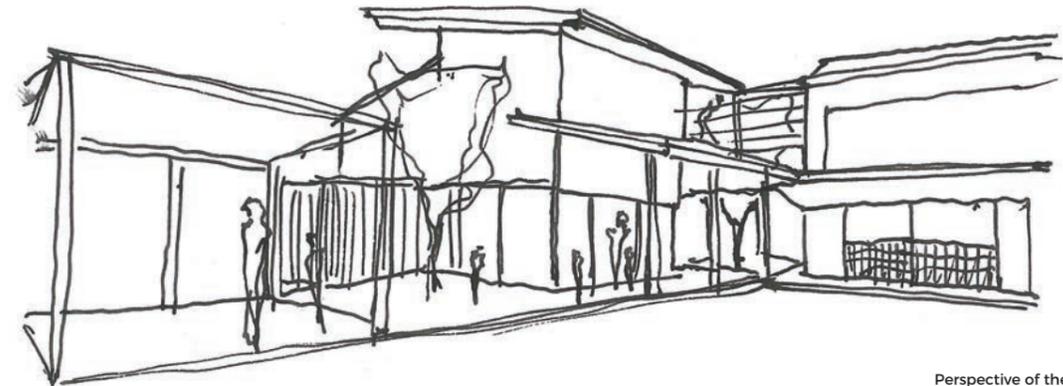
Perspective of the resource centre. (Author 2017) 4.16
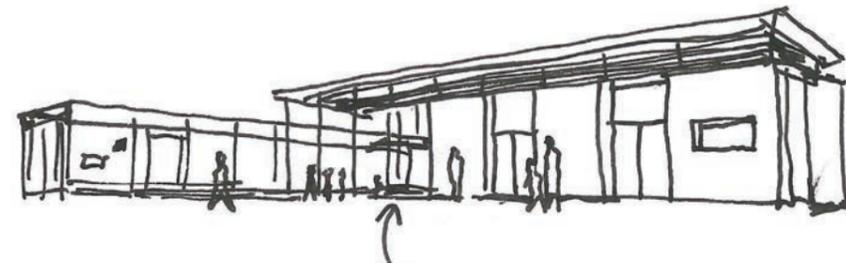
Perspective of the resource centre. (Author 2017) 4.17
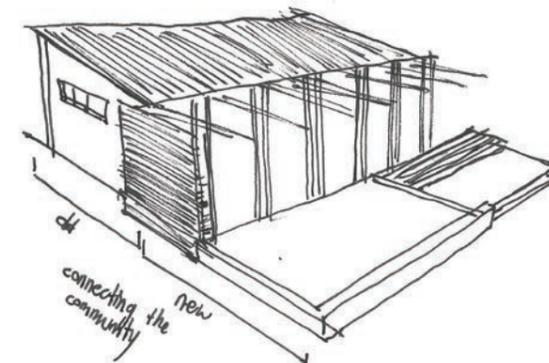
Exploration sketch. (Author 2017) 4.18

connecting the new community

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Ground Floor Plan
N   nts
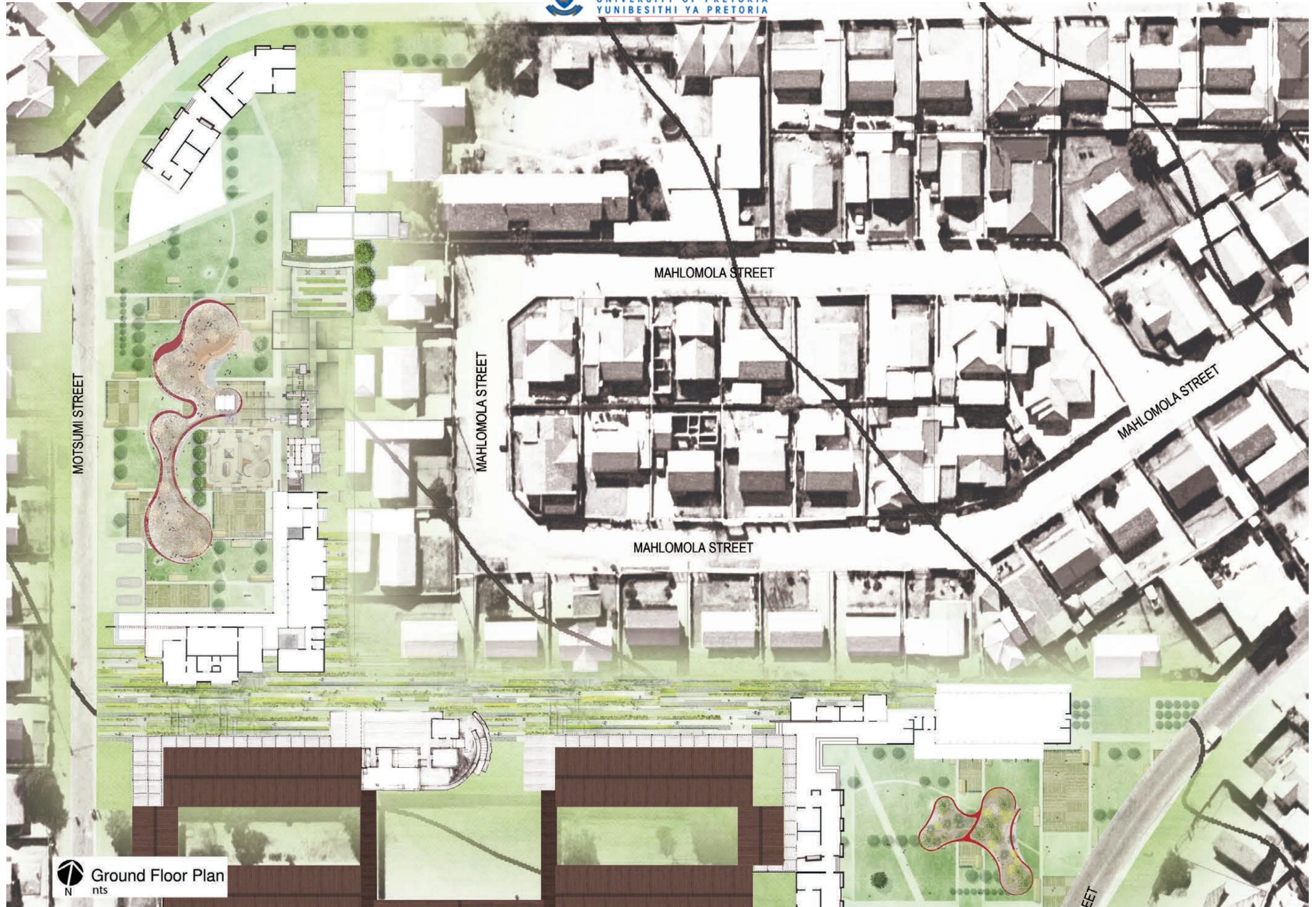
4.19   Site plan development.
       (Author 2017)
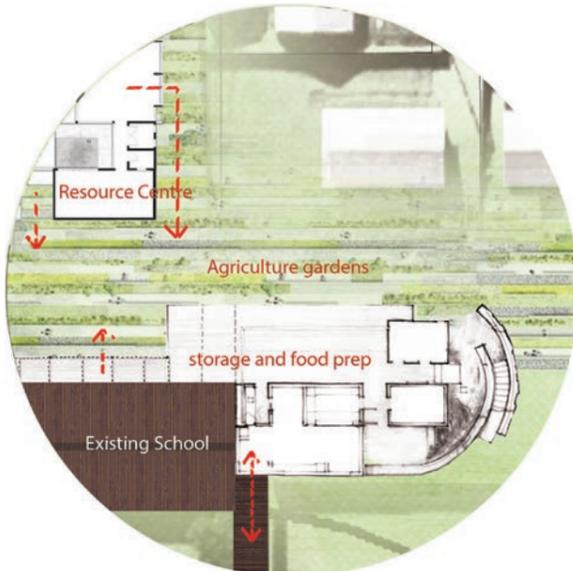
4.20 The connection between the school, resrouce centre and urban agriculture is explored (Author 2017)

Exploration of the links between the school, the urban agriculture and the south eastern site is explored in more detail (Author 2017) 4.21

4.22 The relationship between park and building is starting to be explored in the design. (Author 2017)

4.23 The strengthening of the economic hub is explored through additional economic points on the northern periphery. (Author 2017)

Street edge exploration. (Author 2017) 4.24

Critique

The design should be explored further to celebrate the thresholds that will ultimately allow for the transition between the different zones. The building starts to link to with the landscape, however this needs to be explored at a much deeper level. The design should be explored in terms of the children's use of the spaces, and this should be shown within the plans and sketches. The roof and walls should be explored through a didactic experience and refer to the design principles that are developed. The site seems to have very little controlled spaces for the children and spatial barriers should be explored and designed. On the whole the design seems very segregated with too many independent pieces that does not form a whole. A better layering of child space required and the street edge needs better definition.

4.3 EXPLORATION THREE

Here the relationship between the park and the building is explored through a series of courtyards that create spaces on various scales for both children and adults (Mostafa 2014). These layers of courtyards provide a variety of sensory gardens, in order for the children to experience a transition between different interior and exterior environments, linking to the notion of affordances referred to in the theory chapter (Dudek 2012). They also allow for filter spaces that aid in the transition between different spatial environments, such as between high-stimulus and low-stimulus zones. In this way more intimate spaces are created for the children to break away from situations where they may feel overwhelmed (Mostafa 2014).

4.25 Sections of the design development. (Author 2017)

public space - uncontrolled

West Elevation - Street Elevation

permeable walls for visual connection

Intimate courtyard

Section A-A

Uncontrolled → Controlled

Filter space

Section B-B

Merging of playground and building

PERSPECTIVE
COURTYARD SPACE

Larger courtyard

Intimate courtyard

Intimate courtyard

Section C-C

Filter space

Landscape vs. building relationship

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Multifunctional hall

Office
Screening rooms

Office
Storage
Storage

Reception
& Admin

Play yard

Resource Library

Classroom

Classroom

Courtyard

Private courtyards

Childrens Library

Courtyard

Classroom

Audio Visual Library

Staff Kitchenette

Music centre

Performance space

Urban agriculture

Greenhouse and tool shed

Ground Floor Plan
nts
N

4.27 The indoor versus outdoor relationship. (Author 2017)
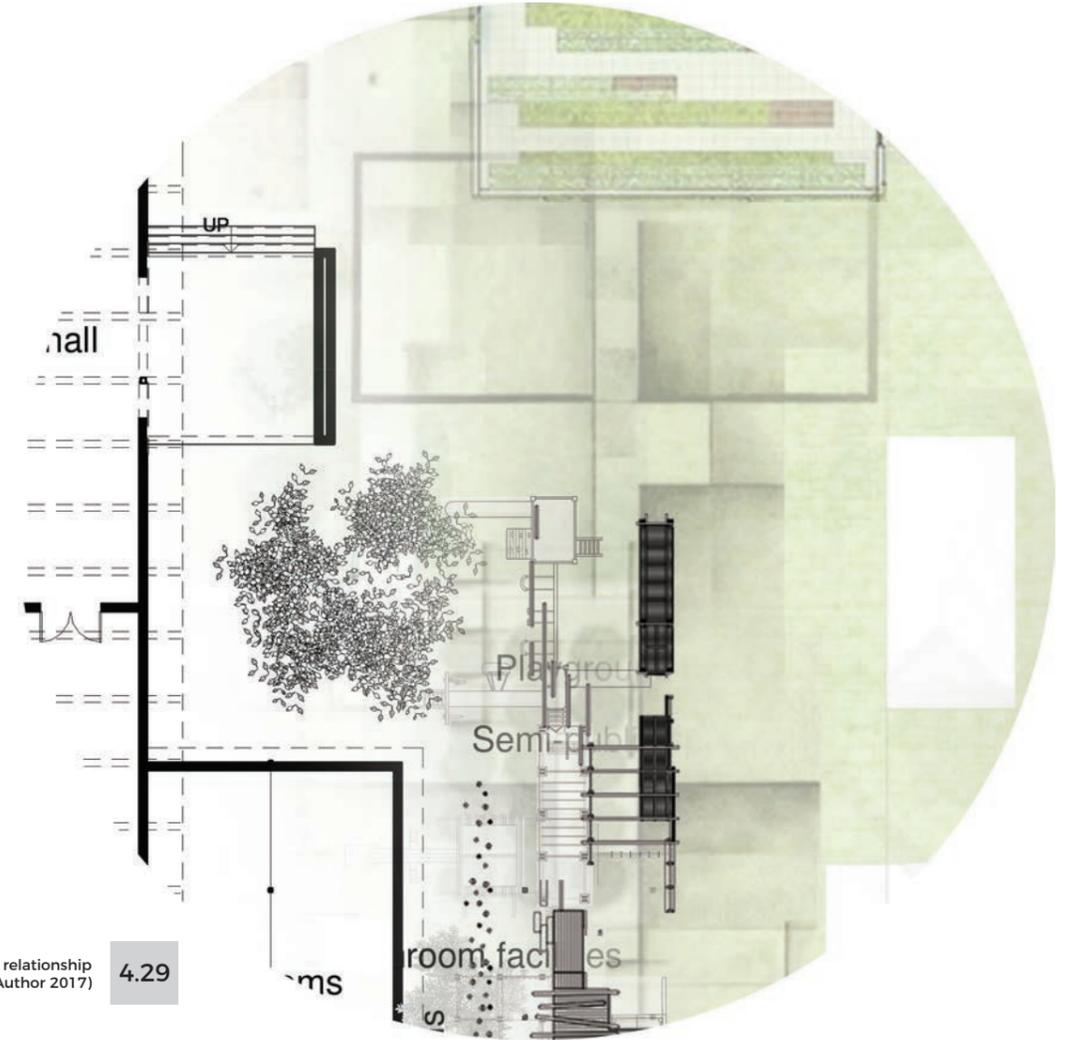
Park versus building relationship (Author 2017) 4.29
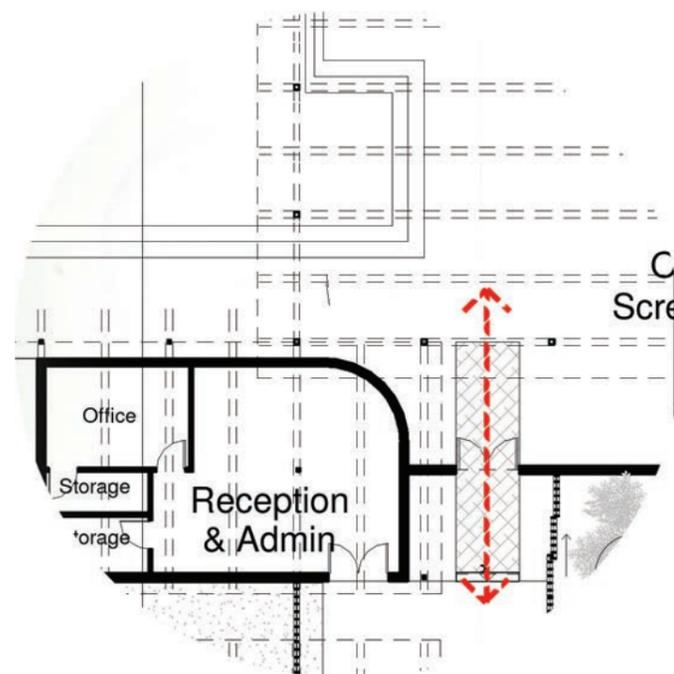
Controlled transition spaces. (Author 2017) 4.28

The layering of the courtyard allows for more controlled spaces between the park and the ECD resource centre, in essence creating a transition from the public park to a semi-public resource centre, and to a controlled private urban agriculture garden between the resource centre and the school. This aims to create an accessible community environment through various spatial hierarchies that allows for the important social and cultural interaction of these young children on different scales (Dudek 2012).

A series of extended roofs and pergolas allow for flexible outdoor spaces that teachers can utilise for various ECD activities, protecting the children from harsh sun or rain. The northern edges of the multi-functional classrooms are aimed at merging the indoor and outdoor environments, allowing for the important connection between young children and their environment (Edwards 2012).

The classrooms and private play courtyards can, through a series of screens, be enlarged to cater for a bigger group, or closed off to become more intimate. The aim here was to allow children to best create meaning out of their world through environments that provide for interaction and exploration (Edwards 2012).

The materials proposed aim to enable sensory experiences for the children when they move through the spaces, aiding in their sensory development (Abraham et al 2015 & Isbell et al 2007), therefore creating an experience of their environment that is ingrained in their memory (Pérez-Gómez 1994).

The technical development of this exploration is discussed in the next chapter as the first exploration towards the development of the tectonic concept and intention.

Perspective of covered walk-way and courtyard. (Author 2017)
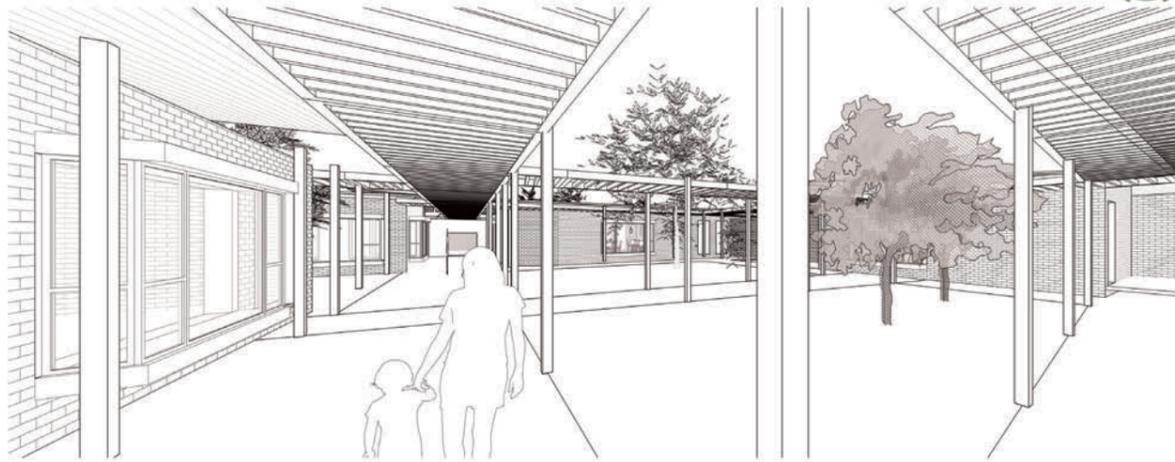
Axonometric perspective (Author 2017) 4.31

4.32 Proposed material palette. (Author 2017)

4.4 EXPLORATION FOUR

This exploration follows the critical development of the design guidelines as discussed in the theory chapter. Within this design exploration the spatial zoning is broken up into three space; contained space, filter spaces and high-stimulus environments.

From this zoning, each of the elements of scale, wall, ground plane as well as roof & ceilings are explored through their didactic qualities in relation to the design principles and guidelines.
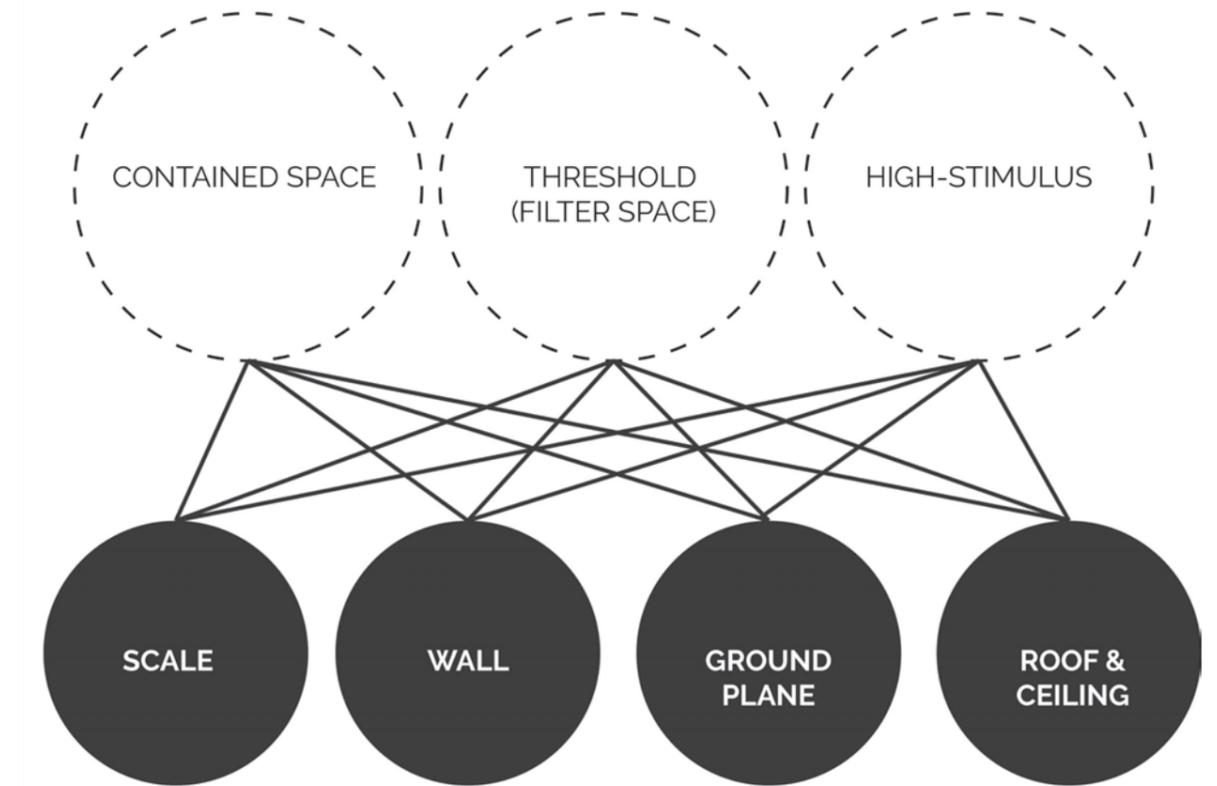
4.33 Illustration of spatial zoning and elements within the design guidelines. (Author 2017)

Critique

There needs to be greater consideration to the difference between stereotomic and tectonic construction methodologies. It is unclear as to what parts of the park are accessible or not. The design should be explored through the introduction of multiple stories and levels, thus, creating a more dynamic space. The elevation design needs attention in regards to windows and openings. There are many "dead" edges that need attention. Environmental strategies and services systems should be demonstrated. The drawings and sketches should better explore the material use. The community hall is far too conventional for the context and functional needs.

4.34 Development of section and elevation.
(Author 2017)

Habitable wall - Active Play - Accoustic mitigator

West Elevation - Street Elevation
Scale 1:100

filter space

High stimulus zone

High stimulus zone

Agriculture

High stimulus zone

Public ← — — — → Semi-public
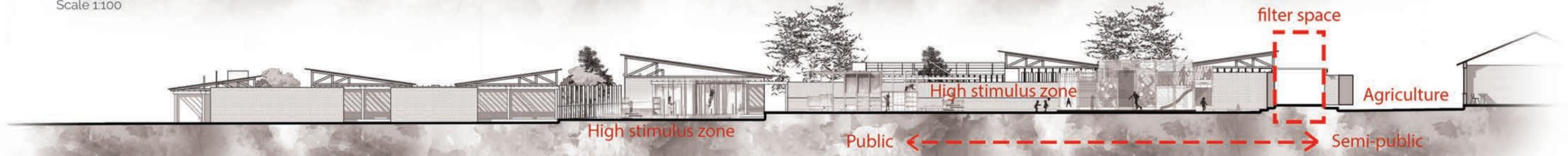
Section A-A
Scale 1:100

Section through filter space - circulation

Agriculture

Section B-B
Scale 1:100

Contained courtyard

Filter space

Contained courtyard

Filter space

Agriculture

Contained space

Contained space
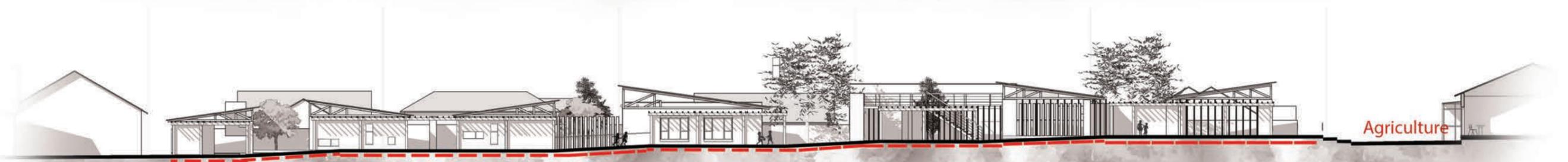
Contained space
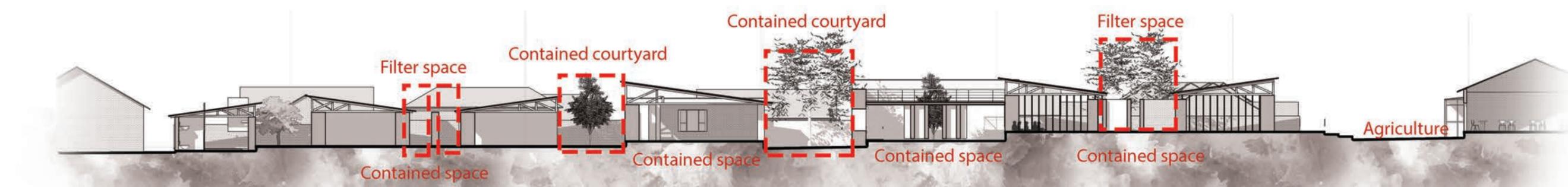
Contained space

Section C-C

The main circulation route through the site acts as a filter space between the contained spaces and the high-stimulus zones, with more intimate filter spaces created at the entrance to each contained space. These allow the children to recalibrate their senses whilst transitioning between the different zones, limiting any possible sense of being overwhelmed (Mostafa 2014).

The arrangement of the contained spaces allows for a connection with the natural environment through various courtyards and permeable walls. These contained spaces are open and flexible, allowing for various activities to take place within, aiming towards the independence of, where children have free choice of activities while being subtly guided by the educator and didactic environment

towards the achievement of specific goals (Lillard 2013:157-180).

Space is extended into thickened inhabitable walls, where children can experience places/nooks where they can crawl, break away, touch, hear and actively play within child-scales spaces. This incorporates a variety of the developed ECD principles such as breakout zones, active play,

scaled spaces, and exploration. The permeability of these walls also allows for a visual connection between the different spaces.

Through the use of gabion walls, the playground is shielded from background noise and reverberation caused by the adjacent road, strongly considering the spatial acoustical control that is stressed by Uys & Se-

lesho (2017). The gabion walls also block the transfer of high noise levels from the high-stimulus zones to the contained spaces. Further to the acoustical qualities of these gabion walls, they also create a more controlled playground area through spatial boundaries and add to the notion of walls that children can inhabit and occupy through various openings.

The transition from public to semi-public and controlled spaces is more open in this exploration where the playground becomes part of the park and the urban agriculture garden becomes the most controlled space. The playground is controlled through a layering of levels and spatial boundaries, which allow for a stronger social and cultural connection (Edwards 2012).

Ground floor plan. (Author 2017) **4.35**
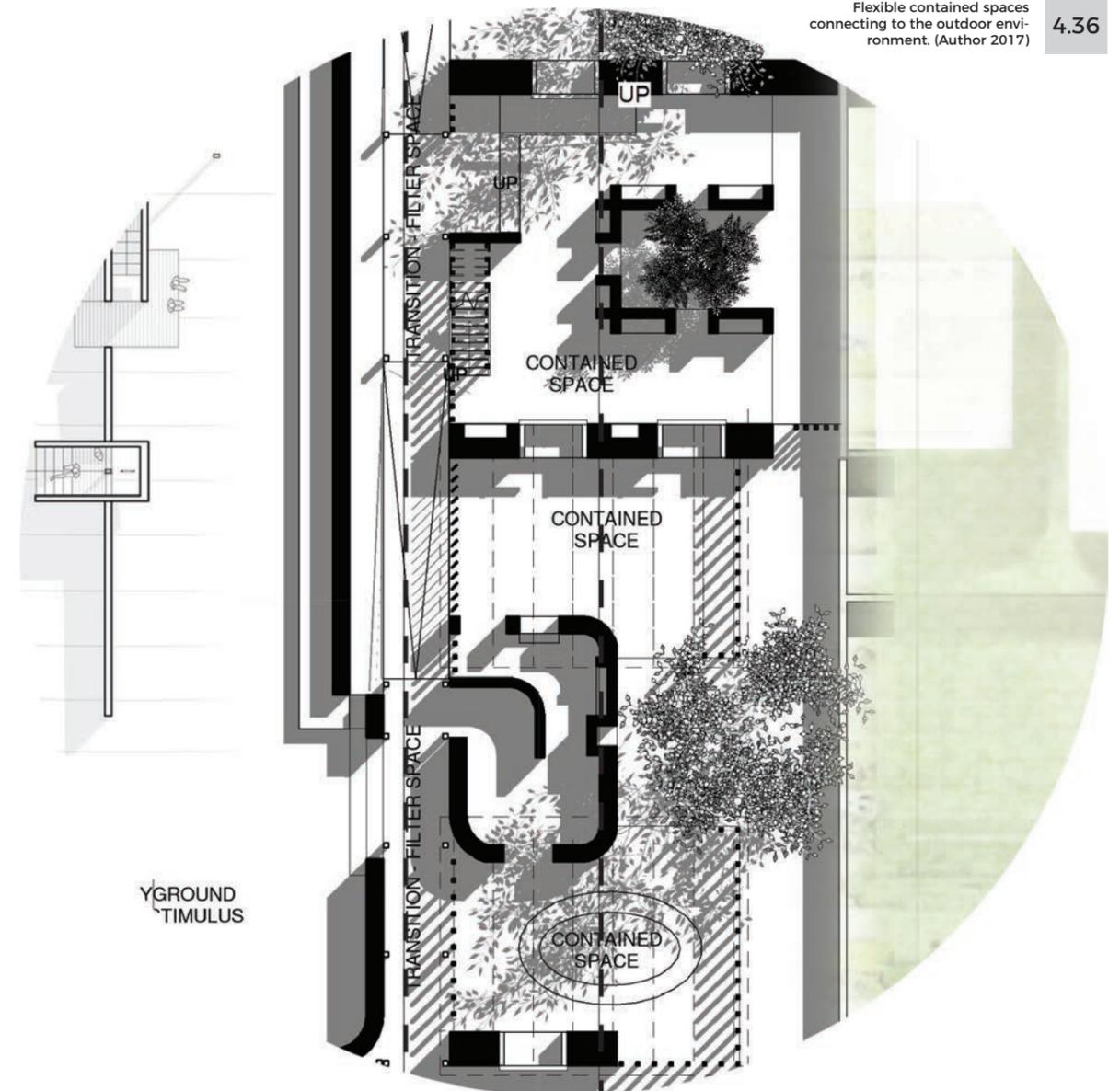
Flexible contained spaces connecting to the outdoor environment. (Author 2017) **4.36**

4.37 Thickened walls that become habitable. (Author 2017)

Transition from public to private space. (Author 2017) 4.38

Critique

The design intention talks about the spatial control, hierarchy and order (Edwards 2012), however this is not completely evident within the presentation and needs to be clearly defined. The material palette appears to be the same for all three spatial zones and needs to be defined differently in relation to the three zones developed in the design guidelines. The user experience is not made clear in the presentation, and a

stronger link should be visible between the effects of the immediate environments on the children (Steiner Waldorf Education 2014). The tactile experience is not apparent and the landscape design is not defined sufficiently to support the application of sensory design. Sun shading should be explored and the interior climate should be explored. The roof and overhangs should be explored more as to link to the principles and

guidelines, therefore, extending the didactic qualities of the space into the roof zones. More of the phasing should be explored and resolved to show the creation of a child centred design that aims in creating a child-centred community.

4.5 TOWARDS THE DESIGN REFINEMENT

From the iterative design development process, the developed principles and design guidelines, a better understanding of the effect of the spatial environment and didactic space on early childhood development is formed. This understanding will translate into the development of a refined design that should include the following notions:

Hierarchy should be created in the spatial layering of the park through various level changes, within landscape elements as spatial boundaries, and permeable walls. These will allow for a transition from non-space to space as well as from public space to semi-public space – rather than from non-space to private space – allowing users to experience the architecture and environment (Edwards 2002). This spatial layering will further create various controlled environments for the children, yet still allows for an open public and accessible environment that is centred around the children. A variety of textured materials should be used in the circulation areas, at changes in level, and for the creation of stimulating sensory experiences, particularly within the high-stimulus environments (Mostafa 2014).

The public and semi-public high-stimulus zones should provide areas of play and physical activity, facilitating outdoor learning opportunities. These spaces need to be layered with sensory gardens, where the chil-

dren can explore and enhance their critical early childhood development within a natural environment, and while improving their motor skills (Nienaber 2017).

The contained spaces should provide an extended educational environment that the crèche network can utilize for activities that they cannot accommodate in their own facilities. These spaces should be flexible and organised to create various contained open-air spaces and courtyards that extend the educational environment to accommodate a variety of activities, as required by the ECD centres. An intimate scale must be created where children can interact socially in smaller groups and in a familiar environment (Mostafa 2014). Exposure to noise is to be kept to a minimum and reverberation levels in the high-stimulus areas should be lowered through a series of noise absorbers (Uys et al 2017).

Varying ceiling heights can allow for multiple scales of intimacy and openness and roof overhangs allow for extended covered space, aiding in the transition between indoors and outdoors. The ceilings and roofs will become a second level, but at a scale familiar and comfortable to the children (Lillard 2013).

From the principles and guidelines we understand that the filter spaces act as critical thresholds between the high-stimulus and low-stimulus pro-

grammes, encouraging the recalibration of the children's senses as they move from one level of stimulus to another (Mostafa 2014). Therefore, the children will not only be exposed to a didactic environment, but also to an environment that enhances their emotional and mental preparation for the various high-stimulus or low-stimulus activities. Therefore, the contrasting of materials in the floors, walls and ceilings within this zone should be incorporated to further define and visually differentiate space, while however avoiding over-stimulation.

It is hoped that with the inclusion of these notions within the design refinement, that a didactic environment is created that can influence the development of young children.

CHAPTER FIVE
TECTONIC DEVELOPMENT

5.1 INITIAL EXPLORATION

The initial tectonic consideration was an intuitive exploration of tectonic resolution as a response to the third design exploration discussed in the previous chapter. The central structural idea in this exploration is that the building consists of a self-supporting roof with non-structural walls, allowing for the use of alternative wall systems and materials and leaving the spaces flexible and adaptable.

Roofing and steel structure:

The structural and roof system is combined into a singular steel-frame structure, freeing the rest of the building elements from their structural function and reducing their dimensioning and cost.

Wall construction:

The wall construction is unconstrained as a non-structural element and can be made from less expensive materials, such as half-brick walls, non-structural cladding, as well as sustainable and recycled materials such as old glass bottles, old tyres, sandbag walls, recycled roof sheeting.

Floor plan design:

The design of the building is optimized on plan through utilizing circulation spaces as extensions of the space programmes, and to accommodate the educational principles requiring filter zones, active play (Dudek 2012, & Jackson 1998:5), break-out zones and sensory experiences (Malnar et al 2003); thus the need for wasted areas in the form of circulation passages is reduced and inside and outside are merged (park vs. building relationship). Further to this, the building is also responsive to programmatic and climatic changes, as spaces can either be enlarged or divided into more intimate spaces through movable screens, allowing for larger group spaces as well as smaller group and individual spaces.
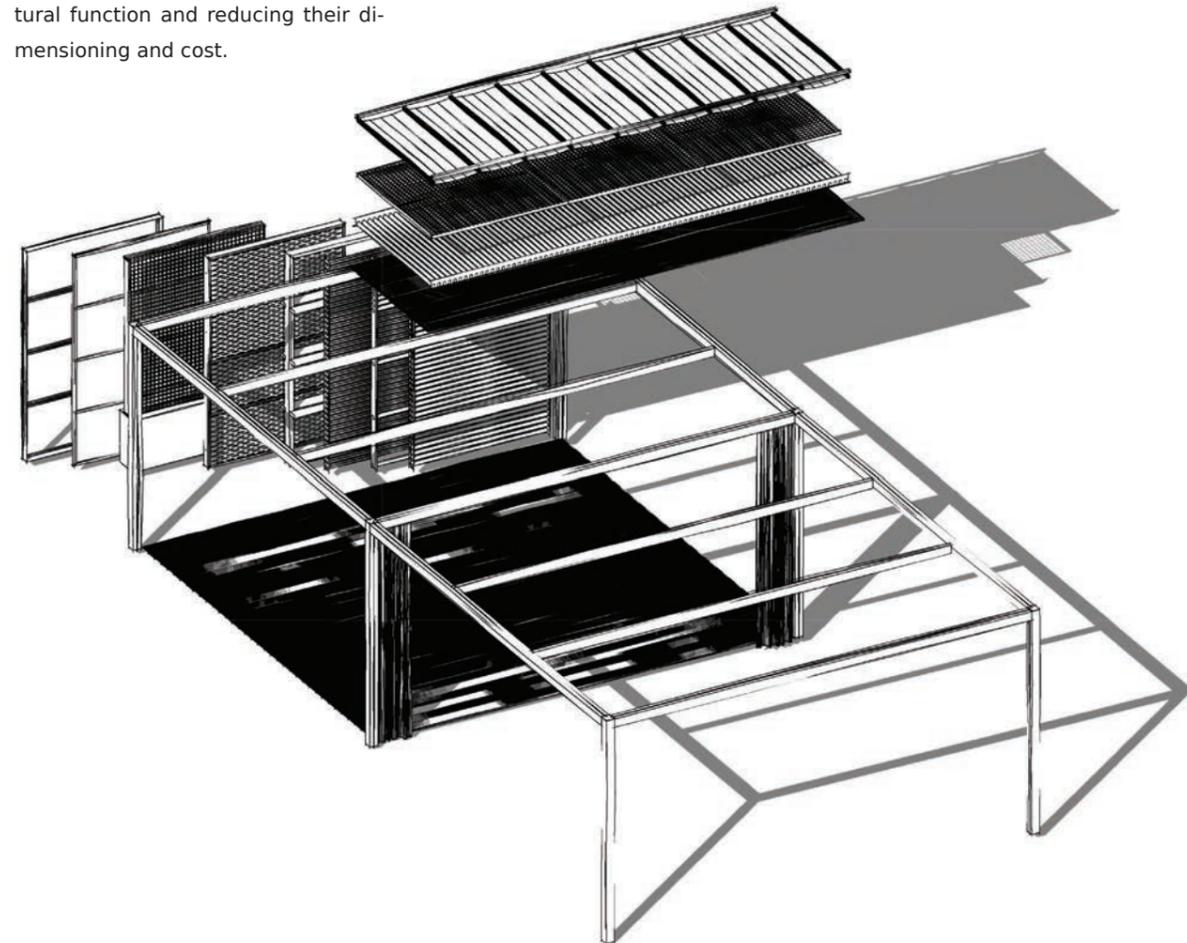
5.1 Initial structural exploration. (Author 2017)
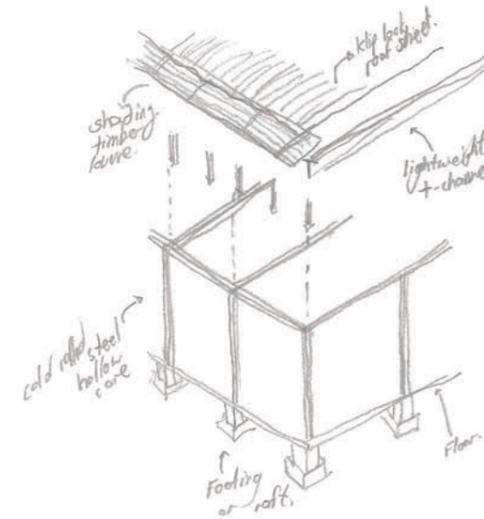
5.2 Structural exploration of steel portal frames. (Author 2017)
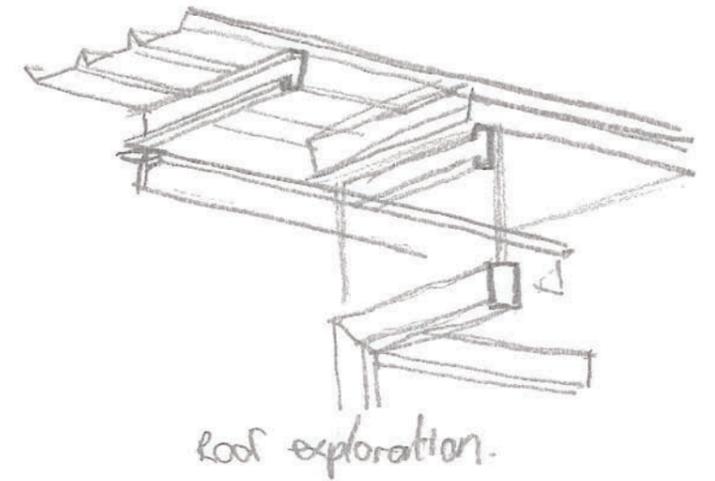
5.3 Exploration of steel roof connections and joints. (Author 2017)
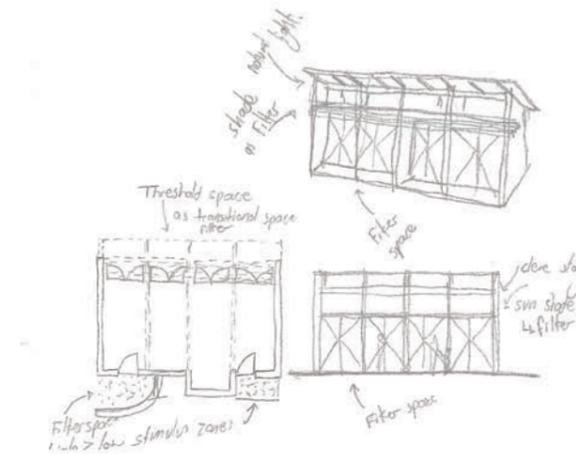
5.4 Tectonic exploration sketch. (Author 2017)
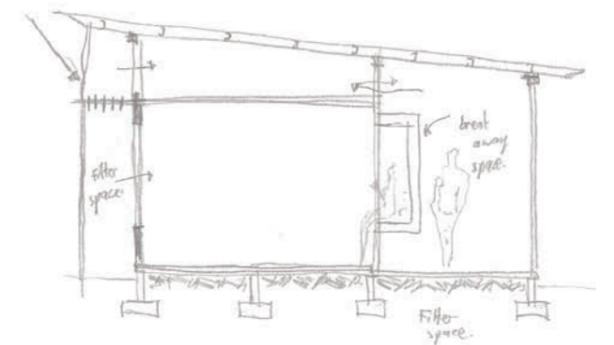
5.5 Section exploration. (Author 2017)

5.2 EXPLORATION TWO

Critically reflecting on both the design and tectonic investigations up to this point in relation to the research theory, it was evident that there was a gap in translating the design principles, that were developed in chapter two, into the design and tectonic development. The structural exploration does not fully support the theory and the principles, and is developed in isolation. The tectonic investigation should link strongly to the notion of didactic space related to the theory of phenomenology (Meyers 2013).

At this point it had become evident that the design principles should be interpreted into a set of design guidelines that illustrate potential spatial and built environments, allowing the designer to visualise how architecture can directly influence ECD through didactic space. These guidelines (see figure 2.17) direct the designer towards possible solutions that can be implemented in their design in a contextual manner; therefore, the architect is assisted to generate architecture that is didactic and positively influences the early childhood development of the user.

Within these guidelines the spatial zoning is broken up into three types of spaces: contained spaces, filter spaces and high-stimulus environments. From this zoning, each of the elements of scale, wall, ground plane as well as roof and ceiling are explored for their didactic qualities in relation to the design principles. This tectonic investigation, therefore, investigates the initial application and translation of these ECD guidelines into the structural design.

Critique

The steel frame proposed is unnecessary for a building with such short spans. The idea of infill wall panels does not complement the intention and research questions. These panels should be explored for their fire resistance, durability through the continuous active play of children, and their environmental performance. Greater consideration needs to be given to the difference between stereotomic and tectonic construction methodologies. The elevation design needs attention with regard to windows and openings that relate to the importance of a scale that relates to children as referred to by Mostafa (2014) and Dudek (2012).

5.6   Proposed material palette of the first tectonic exploration. (Author 2017)

5.7   Spatial zoning diagram. (Author 2017)
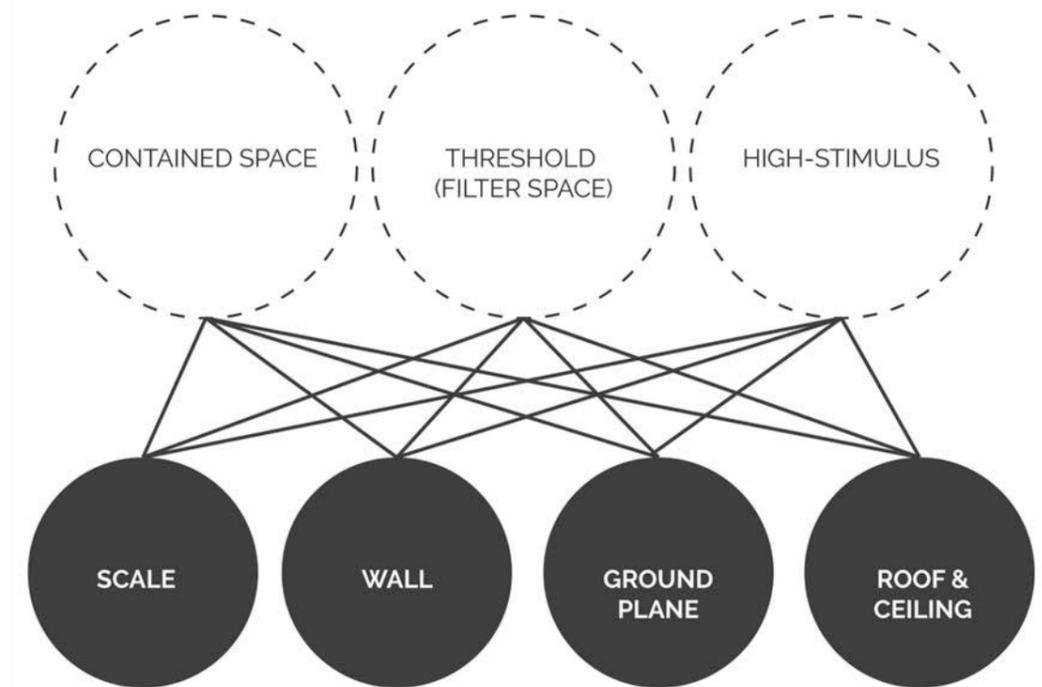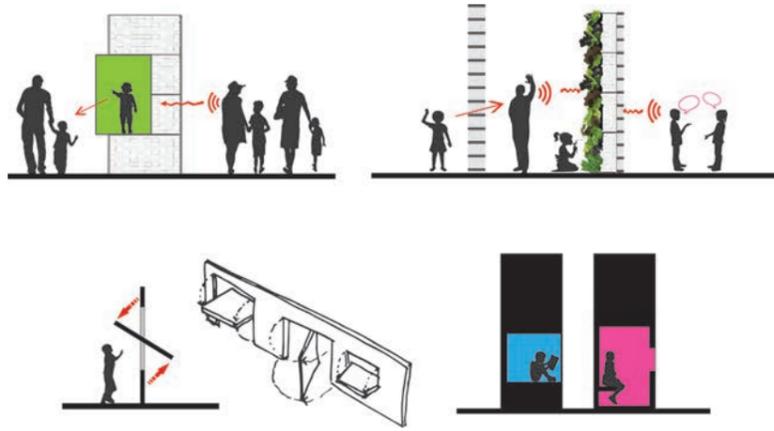
5.8 Initial design guideline diagrams.
(Author 2017)
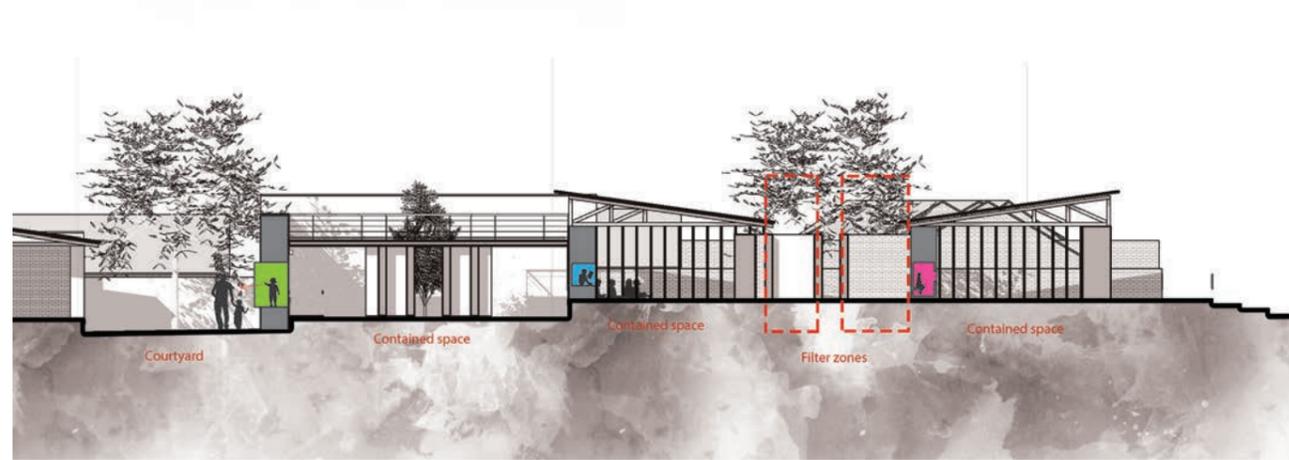
5.9 Section showing structural exploration.
(Author 2017)

Critique

The material palette appears to be the same for all three spatial zones and each zone needs to be defined in a different way to resonate with the intended haptic experience and didactic qualities of these zones (Mostafa 2014). The tactile experience of the spatial environment is not shown, and the landscape design is not defined sufficiently. The sun shading as well as the interior climate should be explored. Consideration should be given to adapting the open spaces to wind conditions and the roof and overhangs should be explored in order to create spaces. The control of the children seems to be undefined and the accessibility of the spaces should be explored through the spatial hierarchy (Dudek 2012). The use of sandbag walls does not complement the intention and the idea of habitable walls can be better achieved through other construction methods.

As a result of this exploration and the critique received, the tectonic intention was refined, in accordance with the design principles and guidelines.
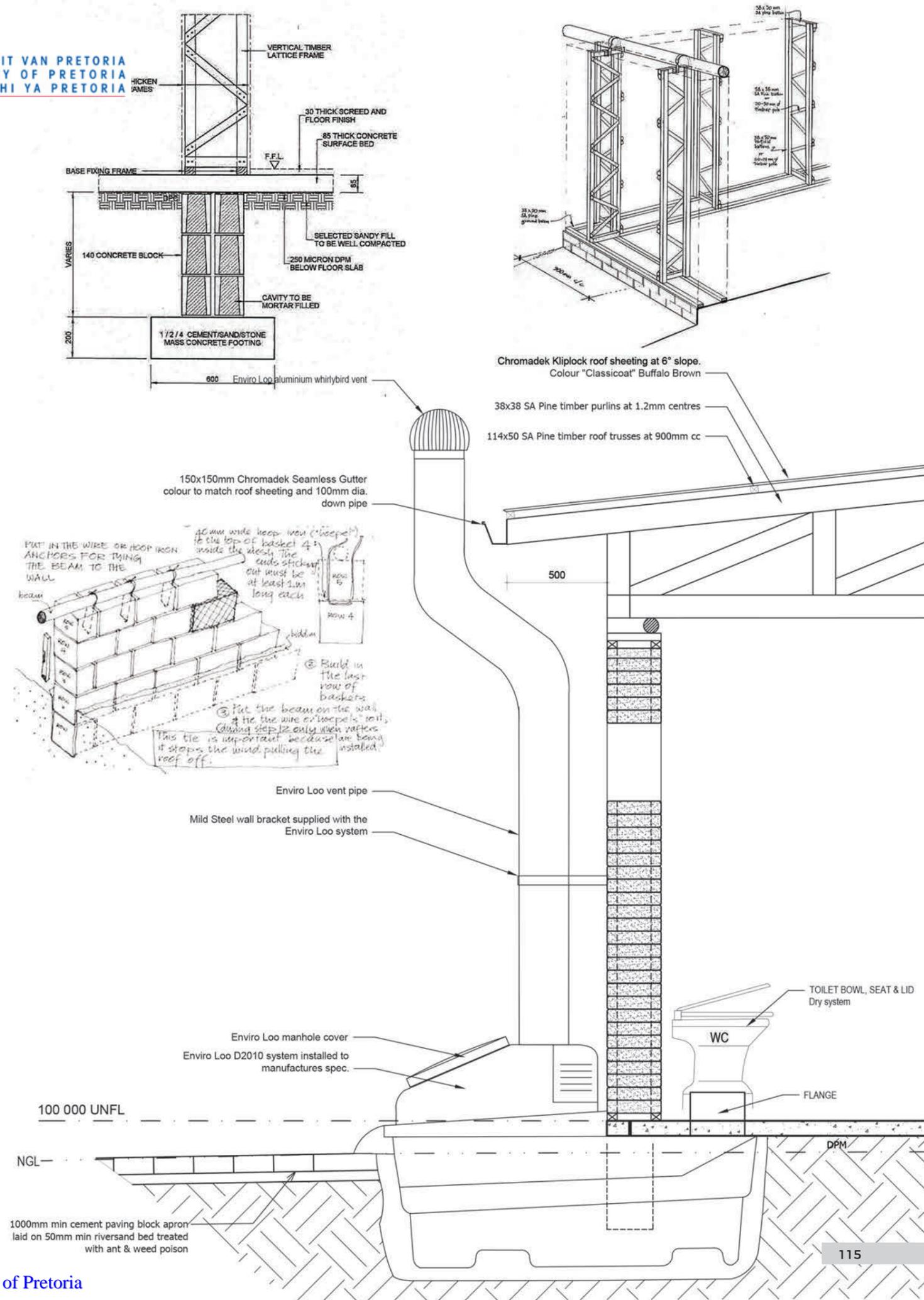
Exploration of sandbag wall detail.
(Author 2017) 5.10

Roof & Ceiling Materials

Wall Materials

Ground Plane Materials
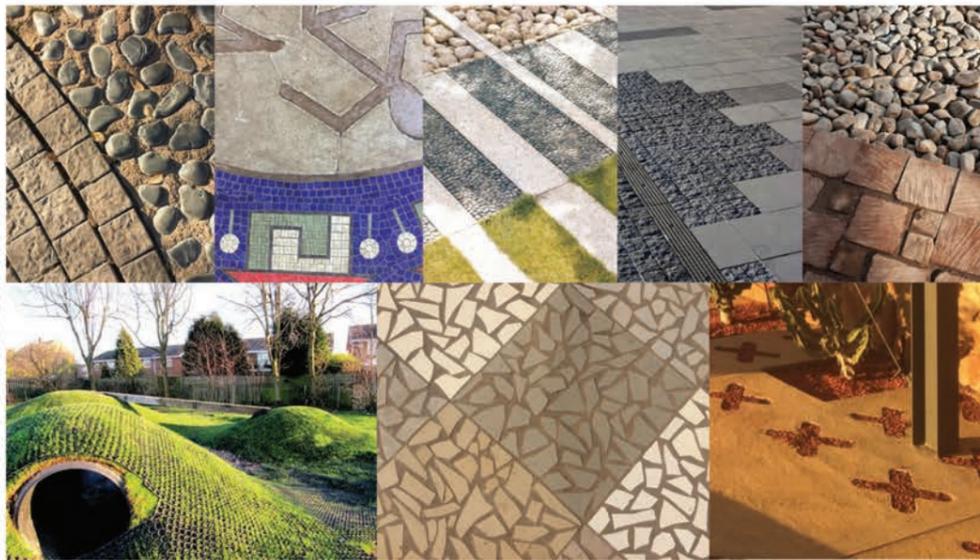
5.11 Proposed material palette of the second tectonic exploration. (Author 2017)

5.3 INTEGRATED TECTONIC INTENTION

The design intent addresses the physical and emotional development of children through an accessible tactile environment, where they can make discoveries through experiential education and hands-on activities (Tigran et al. 2014). In this way the young children would be allowed to develop through their everyday experiences of the architecture, linking to the idea of phenomenology and John Dewey's philosophy of experimentalism (Meyers 2013:33). In a similar way the tectonic intent encourages imagination and development by exploring the technical expression of interfaces through materiality, construction, systems and detailing. In addition, the notions of spatial flexibility and adaptability become important influences, where the users can alter their experience or use of a space as required (Nienaber 2017; UP MArch(Prof 2017). The technical exploration, therefore, draws from the experiential interface of child experience and ECD education.
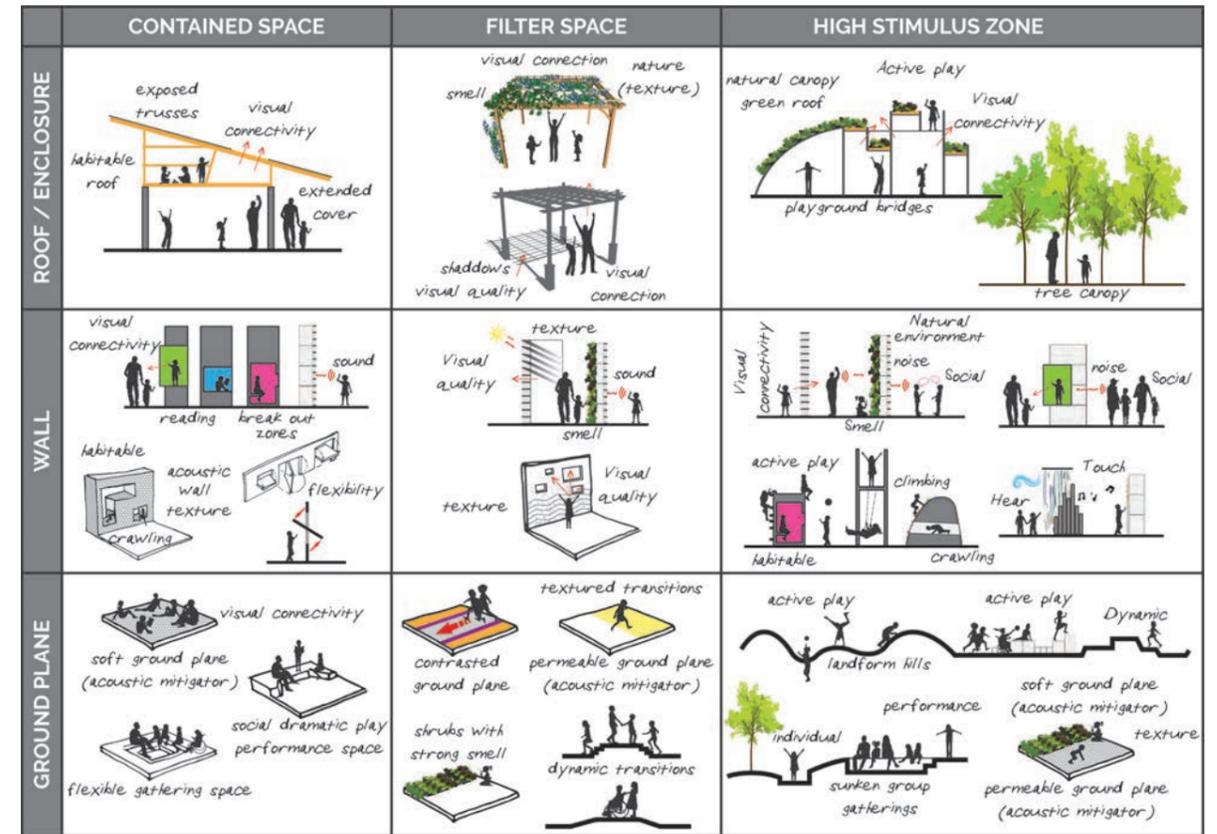
5.12 Diagram of the integrated tectonic intention. (Author 2017)
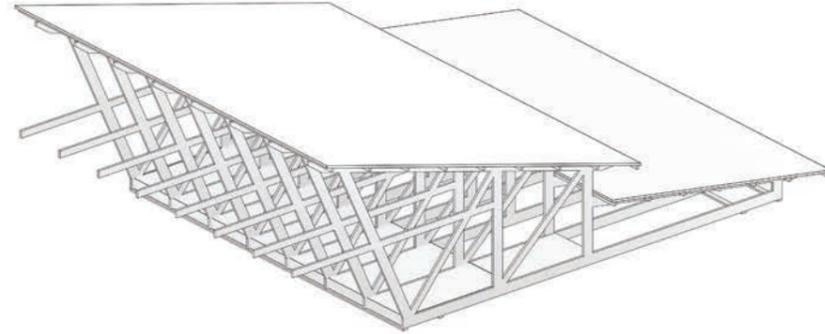
Habitable roof space

An extention of the contained space at an intimate scale, through the creation of habitable roof spaces that have flush ceilings and safe for children to play in.
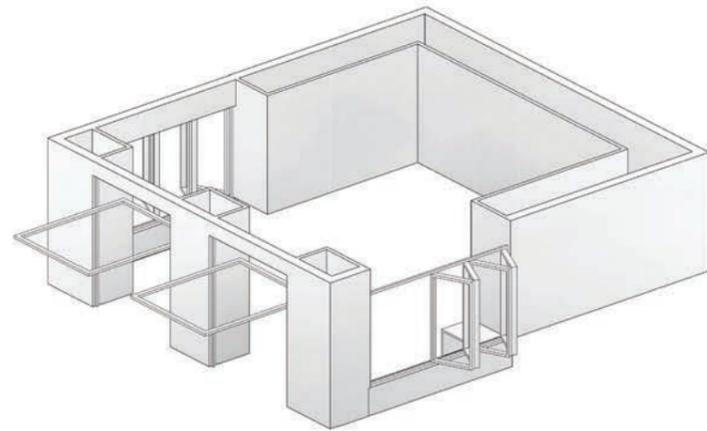
Habitable walls

Walls become habitable through the addition of wide cavities and various openings, allowing for spaces to crawl, play, escape, perform, etc. This allows for an extended didactic experience.
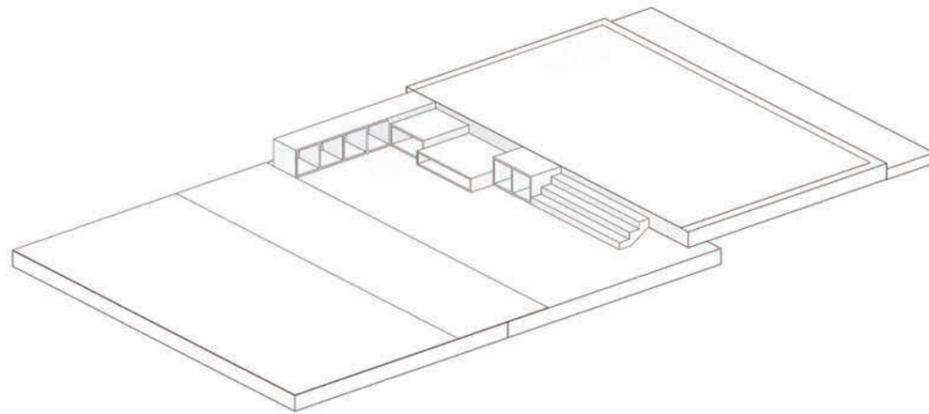
Dynamic floors

Floors are dynamic within their various levels, allowing for gathering spaces, social dramatic play, active play, individual space, etc. This also functions as a level of spatial control and hierarchy within the flexible spaces.

5.13 Structural intention diagram. (Author 2017)

GROUND PLANE | **WALLS** | **ROOF & CEILING**

CONTAINED SPACE

1. Recycled rubber floor tiles absorb sound, minimizing echoes and reverberation (Uys & Selesho 2017).
2. Recycled plastic composite flooring that is soft and warm enough for children to sit on.

1. Facebrick with a simple pattern that does not allow for distraction or over-stimulation.
2. Smooth plastered and painted walls encourage high concentration on the activities (Nienaber 2014).
3. Subtle use of colour to highlight the habitable walls and create spatial hierarchy (Mostafa 2014).

1. Corrugated steel roof sheeting.
2. Exposed timber trusses that encourages critical thining and creates habitable roof spaces. (Dudek 2012)
3. Wattle bark ceiling screens as an acoustic mitigator, as well as a subtle sensory experience within the habitable roof (Uys & Selesho 2017).

FILTER SPACE

1. Mosaic floors made out of recycled broken tiles, creating a visual and tactile experience. (UP MArch(Prof) (2017).
2. A screed floor surface with pattern inlays that allows for an accesible walkway and encourages critical thinking through patterns and repitition (Edwards 2012).

1. Permeable brick walls create visual connection, as well as a sensory exprience through the patterns created by the shadows.
2. Vertical educational gardens aim to encourage a sensory experience (Nienaber 2017).
3. Plaster finishes such as combed plaster, bagged plastered walls and broom-finished plaster also aim to create a haptic experience that encourages a sensory recalibration within the filter spaces (Mostafa 2014).

1 & 2. Timber pergolas with flowering climbers such as Jasminum multipartitum, encouraging a natural sensory recalibration (Mostafa 2014).

HIGH STIMULUS ZONE

1. Paving patterns contrasted against pebbles, encouraging the development of fine motors skiils through the nerve endings on the children's bare feet (Nienaber 2017).
2. Recycled brick paving layed in patterns that encourage critical thinking (Edwards 2012).
3. Transitions between hard surfaces, various stones and natural ground covers, aiming to create a haptic experience within high stimulus zones.

1. Brick pattern walls made from locally manufactured facebrick walls, creating haptic wall surfaces.
2. Gabion walls act as acoustic mitigator, absorbing the background noise, echoes and reverberation (Uys & Selesho 2017).
3. Vertical gardens extend the natural environment.

1. Coloured translucent roof sheeting for visual stimulation.
2. Diciduous tree canopies allow for shading during summer and create a sensory experience in autum when children walk over the dry leaves that crack (touch and sound).

5.14 Material Palette. (Author 2017)

5.6 SYSTEMS AND ENVIRONMENTAL STRATEGIES

5.6.1 THE CLIMATIC CONTEXT:

South Africa is separated into six climatic zones, as stipulated in the SANS 204 (Schmidt, Pinheiro and Architective 2013:104), with Mamelodi situated in Zone Two: Temperate Interior. Based on this, the climatic design responses are investigated in relation to the design principles, with the following appropriate design responses:

- East and west openings minimized to assist with the passive design, with north-facing walls and openings maximised in order to create an environment that considers both the ECD principles of the natural environment and visual connectivity. It is important for the children to have a connection to the natural outdoor environment, yet still creating visual comfort where children do not experience glare, high contrast, or losing their sense of privacy.

- Adjustable shading that not only aids in the protection from the sun, but is also used as a tool to create a haptic experience within the different spatial zones.

- No auxiliary heating or cooling is required through good passive design, therefore allowing the development of

children within their close relationship with the natural environment (Edwards 2012). This will be explored through cross ventilation and convective ventilation. The notion of passive design also lowers the running costs of the resource centre as no mechanical systems are implemented.

- The optimal building orientation for Pretoria is +15°E to +10°W (Schmidt et al 2013:104).

- Protection from cold winds within the outdoor high stimulus and filter zones, therefore allowing the full use of these zones throughout the year.
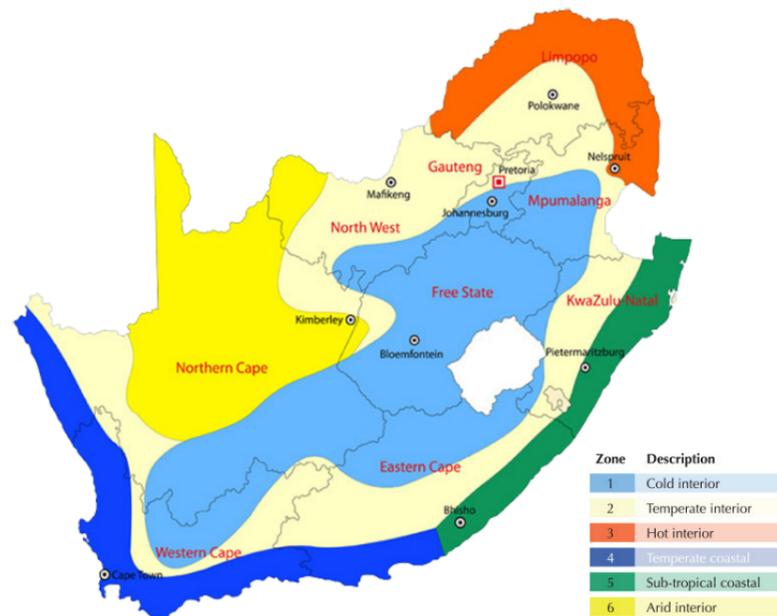
5.6.2 WATER EFFICIENCY:

Immersing a child within the natural environment is extremely important for their development (Edwards 2012), where sensory gardens allow children to explore and enhance their critical early childhood development within a natural environment, and while improving their motor skills (Nienaber 2017). The urban agriculture garden also provides a platform where the community can produce fruit and vegetables to feed the children, addressing the issues of malnutrition in the areas surrounding the existing crèche facilities (Bopape 2017). Further to this, the gardens can also improve the vocational training of the children through actively taking part in the upkeep of

these agricultural and sensory gardens, strengthening their sense of achievement. The sensory and urban agriculture gardens are consequently extremely important within the facility, and requires sufficient water to maintain.

Rainwater is harvested off all available roof surfaces, from both the new buildings and the existing primary school, filtered for debris and stored in two separate reservoirs as shown in the water management diagram. The rainwater is then used for the watering of the agricultural and educational gardens through gravity-fed drip irrigation. Drip irrigation is an efficient water wise system that allows

the delivery of a limited volume of water to the soil situated just above the root of each plant, ensuring minimal waste (Bio-Systems S.A. 2017). A solar powered booster pump is utilised for the irrigation of the lawns and planting areas where drip irrigation cannot be utilised. Gravity-based grey water systems are implemented next to the bathrooms and kitchens, providing irrigation to the adjacent systems of planters, as illustrated in the greywater diagram (Lindstorm 2000).

5.16 Water management diagram. (Author 2017)

5.15 Climatic zone map. (Schmidt et al 2013:104)
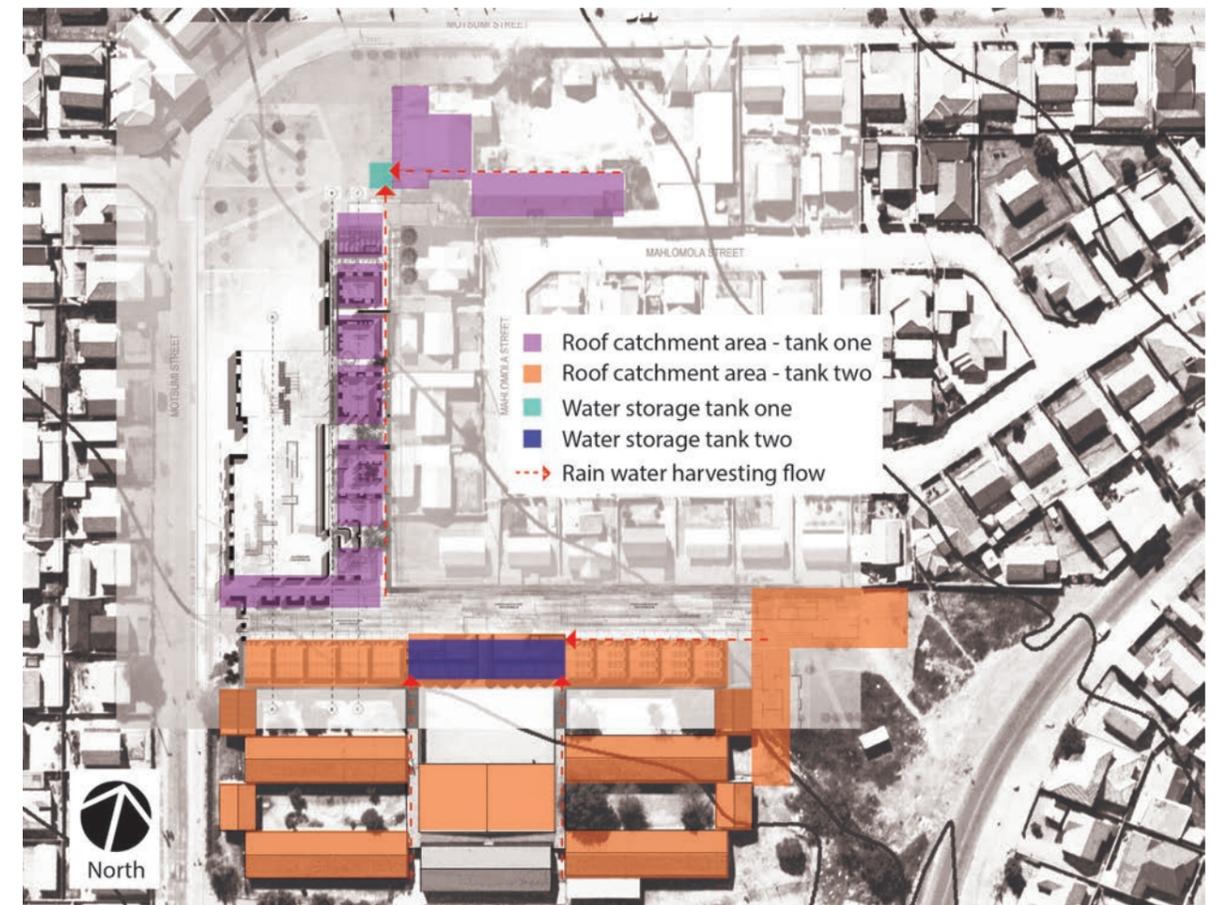
Water Demand Tank One
Park Grounds & Garden

WATER DEMAND

LANDSCAPE IRRIGATION DEMAND (m³)

DESCRIPTION:	LAWN (m²):	500	AGRI (m²):	0	PLANTING (m²):	180	
MONTH	WEEKLY IRR. (m)	MONTHLY DEMAND (m³)	WEEKLY IRR. (m)	MONTHLY DEMAND (m³)	WEEKLY IRR. (m)	MONTHLY DEMAND (m³)	TOTAL MONTHLY IRR. DEMAND (m³)
January	0,02	40	0,025	0	0,005	3,6	43,6
February	0,02	40	0,025	0	0,005	3,6	43,6
March	0,02	40	0,025	0	0,002	1,44	41,44
April	0,02	40	0,025	0	0,002	1,44	41,44
May	0,01	20	0,025	0	0,002	1,44	21,44
June	0,01	20	0,025	0	0	0	20
July	0,01	20	0,025	0	0	0	20
August	0,02	40	0,025	0	0	0	40
September	0,02	40	0,025	0	0,005	3,6	43,6
October	0,02	40	0,025	0	0,005	3,6	43,6
November	0,02	40	0,025	0	0,005	3,6	43,6
December	0,02	40	0,025	0	0,005	3,6	43,6
ANNUAL TOTAL		420		0		25,92	445,92

TOTAL WATER LOSS & DEMAND
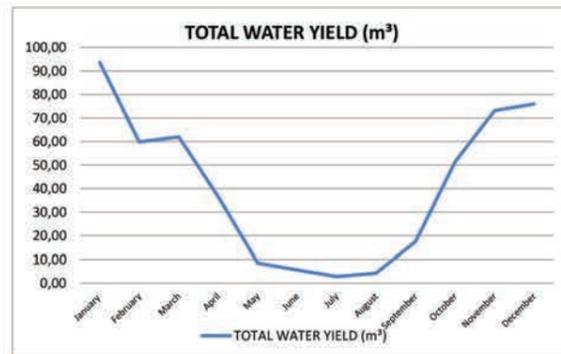
TOTAL DEMAND (m³/month)

TOTAL WATER YIELD

TOTAL WATER YIELD (m³)

WATER RESOURCE INFORMATION (YIELD, m³)

RAIN WATER HARVESTING DATA

DESCRIPTION	AREA (m²)	RUNOFF COEFF. (C)
Roof structures	782	0,9

TOTAL WATER YIELD

MONTH	AVE RAINFALL , P (m)	CATCHMENT YIELD (m³) (Yield = PxAxC)	TOTAL WATER YIELD (m³)
January	0,13	93,61	93,61
February	0,09	59,82	59,82
March	0,09	61,93	61,93
April	0,05	36,60	36,60
May	0,01	8,45	8,45
June	0,01	5,63	5,63
July	0,00	2,82	2,82
August	0,01	4,22	4,22
September	0,03	17,60	17,60
October	0,07	51,38	51,38
November	0,10	73,20	73,20
December	0,11	76,01	76,01
ANNUAL AVE.	0,70	491,25	491,25

WATER BUDGET

TANK CAPACITY (m³): 121,5
MIN VOLUME (m³): 0

WATER BUDGET — INNITIATION PHASE

MONTH	YIELD (m³/month)	DEMAND (m³/month)	MONTHLY BALANCE	POTENTIAL VOLUME (m³)	VOLUME IN TANK (m³)
September	17,6	43,6	-26,0	0,0	0,0
October	51,4	43,6	7,8	7,8	7,8
November	73,2	43,6	29,6	37,4	37,4
December	76,0	43,6	32,4	69,8	69,8
	218,2	174,4	43,8		

WATER BUDGET — YEAR 1

MONTH	YIELD (m³/month)	DEMAND (m³/month)	MONTHLY BALANCE	POTENTIAL VOLUME (m³)	VOLUME IN TANK (m³)
January	93,6	43,6	50,0	119,8	119,8
February	59,8	43,6	16,2	136,0	121,5
March	61,9	41,4	20,5	156,5	121,5
April	36,6	41,4	-4,8	151,7	116,7
May	8,4	21,4	-13,0	138,7	103,7
June	5,6	20,0	-14,4	124,3	89,3
July	2,8	20,0	-17,2	107,1	72,1
August	4,2	40,0	-35,8	71,3	36,3
September	17,6	43,6	-26,0	45,3	10,3
October	51,4	43,6	7,8	53,1	18,1
November	73,2	43,6	29,6	82,7	47,7
December	76,0	43,6	32,4	115,1	80,1
ANNUAL AVE.	491,3	445,9	45,3		

Innitiation Phase — POTENTIAL VOLUME (m³), VOLUME IN TANK (m³)

Operational Phase - Y1 — POTENTIAL VOLUME (m³), VOLUME IN TANK (m³)

5.17 Water calculations for tank one (Author 2017. & Fourie 2016)
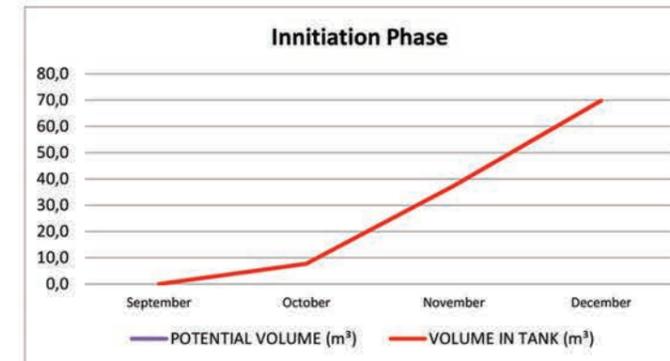
Water Demand Tank Two
Urban Agriculture Gardens

WATER DEMAND

LANDSCAPE IRRIGATION DEMAND (m³)

DESCRIPTION:	LAWN (m²):	1030	AGRI (m²):	512	PLANTING (m²):	702	
MONTH	WEEKLY IRR. (m)	MONTHLY DEMAND (m³)	WEEKLY IRR. (m)	MONTHLY DEMAND (m³)	WEEKLY IRR. (m)	MONTHLY DEMAND (m³)	TOTAL MONTHLY IRR. DEMAND (m³)
January	0,02	82,4	0,025	51,2	0,005	14,04	147,64
February	0,02	82,4	0,025	51,2	0,005	14,04	147,64
March	0,02	82,4	0,025	51,2	0,002	5,616	139,216
April	0,02	82,4	0,025	51,2	0,002	5,616	139,216
May	0,01	41,2	0,025	51,2	0,002	5,616	98,016
June	0,01	41,2	0,025	51,2	0	0	92,4
July	0,01	41,2	0,025	51,2	0	0	92,4
August	0,02	82,4	0,025	51,2	0	0	133,6
September	0,02	82,4	0,025	51,2	0,005	14,04	147,64
October	0,02	82,4	0,025	51,2	0,005	14,04	147,64
November	0,02	82,4	0,025	51,2	0,005	14,04	147,64
December	0,02	82,4	0,025	51,2	0,005	14,04	147,64
ANNUAL TOTAL		865,2		614,4		101,088	1580,688

TOTAL WATER LOSS & DEMAND
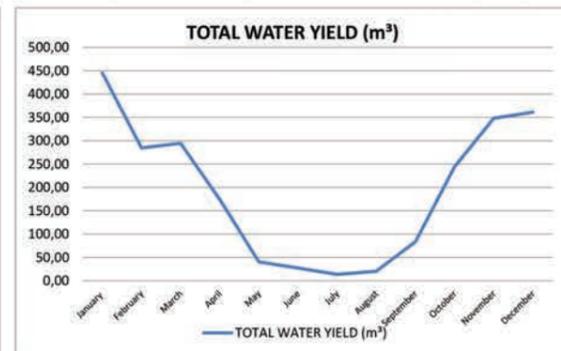
TOTAL DEMAND (m³/month)

TOTAL WATER YIELD

TOTAL WATER YIELD (m³)

WATER RESOURCE INFORMATION (YIELD, m³)

RAIN WATER HARVESTING DATA

DESCRIPTION	AREA (m²)	RUNOFF COEFF. (C)
Roof structures	3716,2	0,9

TOTAL WATER YIELD

MONTH	AVE RAINFALL , P (m)	CATCHMENT YIELD (m³) (Yield = PxAxC)	TOTAL WATER YIELD (m³)
January	0,13	444,83	444,83
February	0,09	284,29	284,29
March	0,09	294,32	294,32
April	0,05	173,92	173,92
May	0,01	40,13	40,13
June	0,01	26,76	26,76
July	0,00	13,38	13,38
August	0,01	20,07	20,07
September	0,03	83,61	83,61
October	0,07	244,15	244,15
November	0,10	347,84	347,84
December	0,11	361,21	361,21
ANNUAL AVE.	0,70	2334,52	2334,52

WATER BUDGET

TANK CAPACITY (m³): 403,2
MIN VOLUME (m³): 0

WATER BUDGET — INNITIATION PHASE

MONTH	YIELD (m³/month)	DEMAND (m³/month)	MONTHLY BALANCE	POTENTIAL VOLUME (m³)	VOLUME IN TANK (m³)
September	83,6	147,6	-64,0	0,0	0,0
October	244,2	147,6	96,5	96,5	96,5
November	347,8	147,6	200,2	296,7	296,7
December	361,2	147,6	213,6	510,3	403,2
	1036,8	590,6	446,3		

WATER BUDGET — YEAR 1

MONTH	YIELD (m³/month)	DEMAND (m³/month)	MONTHLY BALANCE	POTENTIAL VOLUME (m³)	VOLUME IN TANK (m³)
January	444,8	147,6	297,2	807,5	403,2
February	284,3	147,6	136,6	944,1	403,2
March	294,3	139,2	155,1	1099,2	403,2
April	173,9	139,2	34,7	1133,9	403,2
May	40,1	98,0	-57,9	1076,1	345,3
June	26,8	92,4	-65,6	1010,4	279,7
July	13,4	92,4	-79,0	931,4	200,7
August	20,1	133,6	-113,5	817,9	87,1
September	83,6	147,6	-64,0	753,8	23,1
October	244,2	147,6	96,5	850,3	119,6
November	347,8	147,6	200,2	1050,5	319,8
December	361,2	147,6	213,6	1264,1	403,2
ANNUAL AVE.	2334,5	1580,7	753,8		

Innitiation Phase

— POTENTIAL VOLUME (m³) — VOLUME IN TANK (m³)

Operational Phase - Y1

— POTENTIAL VOLUME (m³) — VOLUME IN TANK (m³)
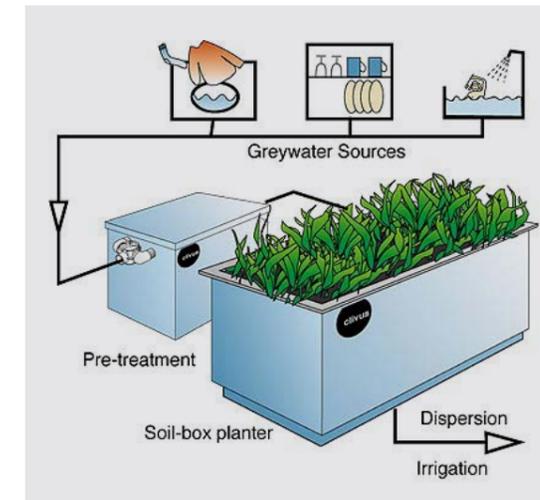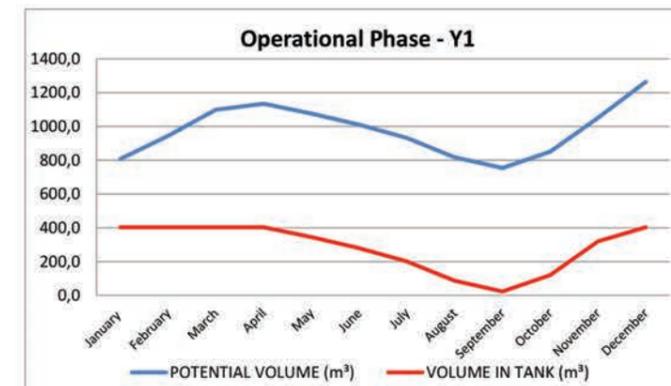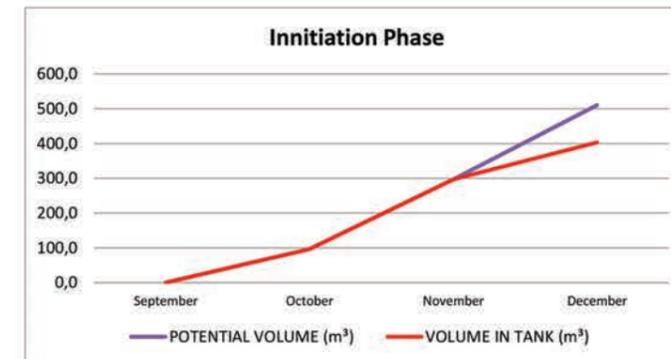
5.18 Water calculations for tank one (Author 2017, & Fourie 2016)

5.19 Greywater harvesting from hand wash basins and kitchen basins to water soil-box planters. (Lindstorm 2000)

5.6.3 ELECTRICAL EFFICIENCY:

The energy philosophy in this dissertation is to cut usage to the bare minimum, creating an energy-efficient building that operates with a small electrical requirement. This will lower the running cost of the resource centre and allow the ECD forum to make use of the facilities to improve the development of the young children, even if there are no funds available for the upkeep of facilities as currently evident within the ECD network (Bopape 2017). The use of courtyards next to the contained spaces not only allows for an important extended natural outdoor environment as referred to by Edwards (2012), but also allows for maximised northern facades. Due to the short east to west axis of the park, a series of courtyards are created between the contained spaces, taking full advantage of the sunlight in winter, yet creating a cool space in summer through the thickened habitable walls and extended roof overhangs.

5.20   Building orientation illustrated on plan. (Author 2017)

Courtyards allow for
maximised northern facades

■ Building envelope

North
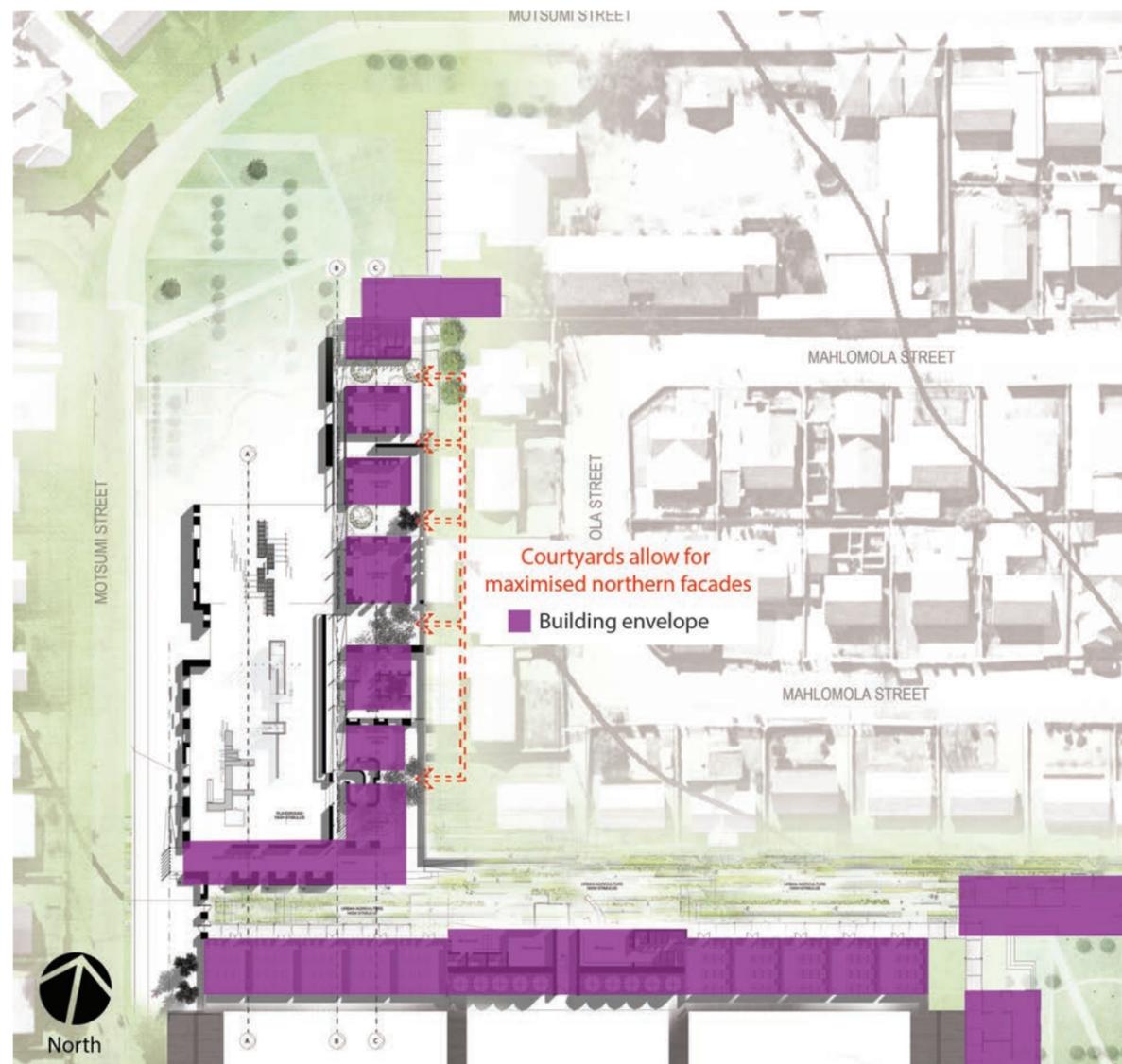
The combination of roof angles and window placement further allows for ample natural light to stream into the spaces, minimising the need for artificial lighting. From the theory chapter it is evident that effective natural light, especially the even southern light (Isbell et al 2007), is extremely important for the development of children's visual system (Abraham et al 2015). The spaces are supplemented with LED lighting when the natural lighting levels are not adequate due to overcast weather conditions that can result in high contrast or under light spaces. The day lighting of the contained spaces will be tested through the Light Analysis Revit plug-in, to ensure that it meets a minimum of 300 lux set by the Department of Basic Education (2012) and does not cause glare or high contrast (Nienaber 2017). This will be included in the final tectonic presentation.

It is proposed that the energy requirements of the building can effectively be catered for through the use of solar geysers and solar PV panels, therefore, limiting the running costs of the facility. This will enable the ECD network to utilize their limited funds towards the educational development of the children and not on the running and maintenance of the facility (Bopape 2017). The following diagram illustrates the electrical appliances that can be accommodated by the solar panel system:

Electrical Appliances	Kilowatt rating	Quantity you use	Peak load in watts	Hours item is used in 24 hrs	Energy used in 24hrs
LED Lights bulbs	7	136,0	952	6,0	5712
LED Tube light	18	125,0	2250	6,0	13500
Laptop	70	12,0	840	8,0	6720
Modem	10	1,0	10	12,0	120
Network Router	15	1,0	15	12,0	180
Small Fridge	110	1,0	110	24,0	2640
Large Top-load Freezer	160	1,0	160	24,0	3840
Kettle	2000	1,0	2000	1,0	2000
Booster Pump	0,37	2,0	0,74	4,0	2,96
Totals: The Calculator gives maximum/peak load needed in watts, and daily power needed to power everything you want to use, plus 20% fixed/system power losses. Final figure has to be generated by the solar system every day.	Peak power in watts =		6337,7	Daily consumption in watts =	34715,0
	Plus 20% losses = energy needed:				**41658,0**

Solar panel system required:

• 53 x 200 watt (10.6kW peak) solar panels (A-Grade) with 25 year performance guarantee

• Bi-directional/grid interactive pure sine wave inverter, Solar charge controller and battery charge regulator and wet cell batteries

5.21   Daily energy consumption. (Author 2017)

5.6.4 SEWERAGE:

From the field research (Bopape 2017, & UP MArch(Prof) 2017) it is evident that the money received by the ECD network, either through subsidy or ECD fees, is barely enough to cover their running costs, with no money left for maintenance to their facilities. This makes it critical that the resource centre is designed in such a way to ensure continued future use of the facility, even if no funds are available. The Enviro-Loo (Anon 2017, & Enviro Loo 2013) toilet & urinal systems will be used in the new bathrooms; therefore, no connection to the municipal sewerage system is required. The system is also waterless and requires no electricity. Both the liquid and solid waste generated from the system can be sold to external companies where the waste can be turned into safe fertilisers and compost. The money generated from this can be utilised for the maintenance and upkeep of the facility. The research by UP BArch(Hons) (2016) compared various off the grid sewerage systems in regards to odour, cost, maintenance, safe sanitation, installation restrictions, water requirements as well as job creation, and has shown that the Enviro Loo system performs the best.

The Enviro Loo – ticking the box for environmental sustainability, economic viability, longevity, safety and convenience

✓ The Enviro Loo is a "dry or waterless sanitation system"

✓ This means no water is required for its operations

✓ The Enviro Loo is a permanent installation

✓ The design of the Enviro Loo is such that it is a self-contained, all in one unit

✓ The Enviro Loo uses no chemicals and has zero environmental impact

✓ There are three factors to its 100% environmentally friendly credentials

✓ The Enviro Loo enables the conservation of precious water resources as it uses zero water for its operation

✓ The Enviro Loo has a sealed unit that captures and treats waste through the natural processes of dehydration and evaporation with no contact or contamination of the waste to either the immediate or surrounding environment

✓ The Enviro Loo requires no electricity or power source to function, it utilises wind and sun

✓ The Enviro Loo system requires minimum maintenance and servicing, with minimal associated cleaning costs which are also necessary for more conventional and traditional systems

Benefits and advantages

There are considerable advantages of the Enviro Loo over other dry sanitation systems. Alternative solutions cannot deliver a number of benefits that Enviro Loo can. These benefits should be non-negotiable for all systems. Enviro Loo benefits and characteristics:

✓ Odourless

✓ Minimum maintenance and servicing costs

✓ Non-polluting zero discharge system

✓ Long term sustainable solution – life span in excess of 50 years

✓ Once off capital investment

✓ Conserves water resources

✓ No chemicals used

✓ Permanent installation, no relocation

✓ No expensive reticulation and sewage treatment plant required

5.22 Benefits and advantages of the Enviro-Loo system. (Anon 2017)
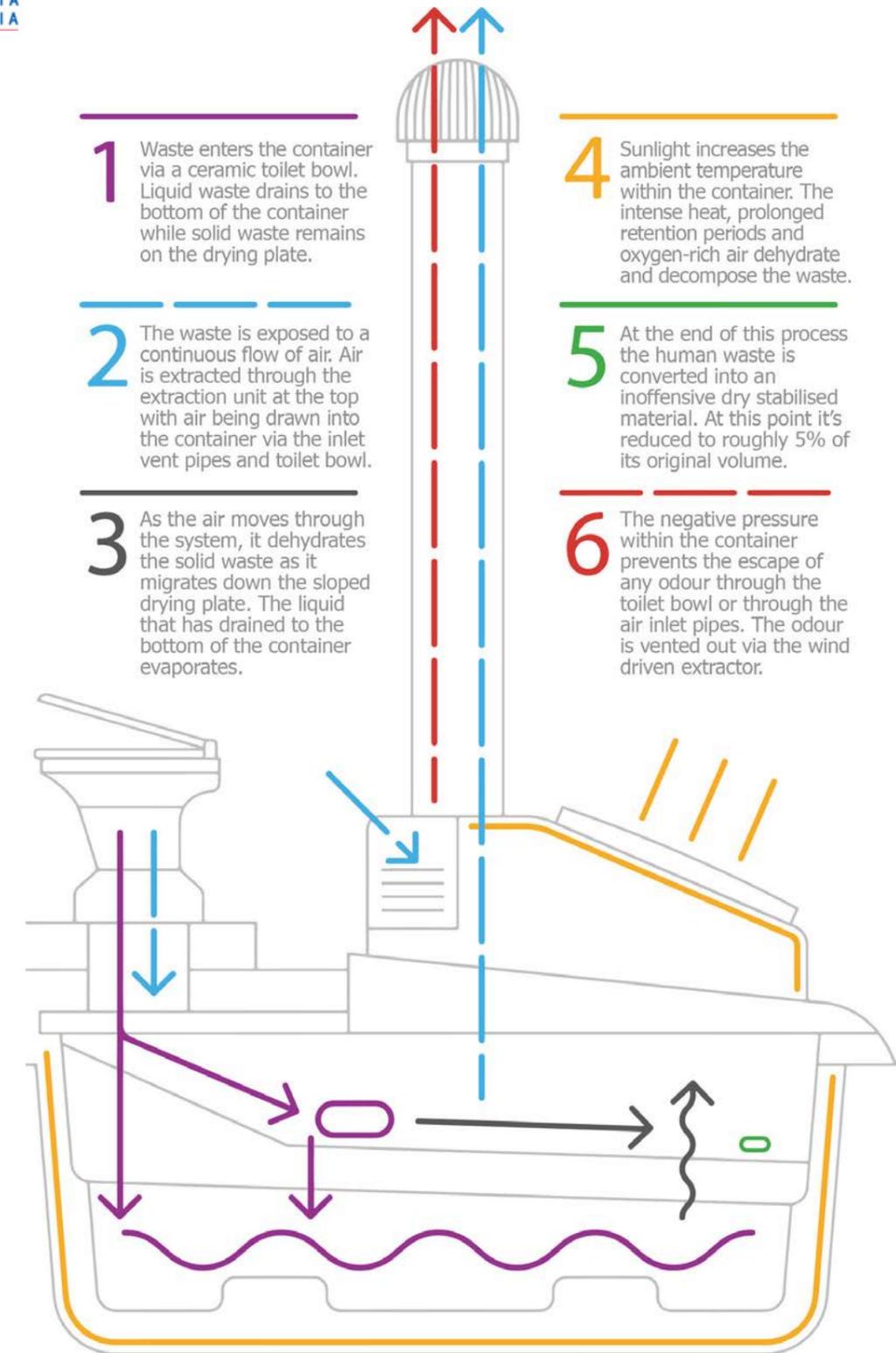
1. Waste enters the container via a ceramic toilet bowl. Liquid waste drains to the bottom of the container while solid waste remains on the drying plate.

2. The waste is exposed to a continuous flow of air. Air is extracted through the extraction unit at the top with air being drawn into the container via the inlet vent pipes and toilet bowl.

3. As the air moves through the system, it dehydrates the solid waste as it migrates down the sloped drying plate. The liquid that has drained to the bottom of the container evaporates.

4. Sunlight increases the ambient temperature within the container. The intense heat, prolonged retention periods and oxygen-rich air dehydrate and decompose the waste.

5. At the end of this process the human waste is converted into an inoffensive dry stabilised material. At this point it's reduced to roughly 5% of its original volume.

6. The negative pressure within the container prevents the escape of any odour through the toilet bowl or through the air inlet pipes. The odour is vented out via the wind driven extractor.

5.23 Diagram illustrating the process of the Enivro-Loo system. (Anon 2017)

MODELS

INDUSTRIAL I1040
20-40 users per day

URINAL
20-40 users per day

5.24 Enviro-Loo models to be used. (Anon 2017)

5.6.5 ACCOUSTICS

It is important that childhood spaces be adapted to limit echoes and reverberations, as acoustics impact learning and listening skills, which in turn affect children's language and speech development (Uys & Selesho 2017). Three factors that are kept in mind when designing are noise, reverberation and distance. This was implemented in the spatial layering of the site through the three spatial zones: contained space, filter space and high-stimulus zones.

The level of the acoustical control that is to be implemented varies according to the focus level required for the activity taking place within the space. Outdoor environments should also receive high acoustic consideration according to Uys (2017), due to the existence of background noise. Children with a delay in the development of their communication skills can easily be misunderstood in the presence of background noise, and this may result in social exclusion of

the child (Uys & Selesho 2017). The aural control within the high stimulus environment will therefore be explored through tectonic details that consider limiting reverberation, background noise from the street and park, as well as echoes. These will be included in the final tectonic presentation.

5.25 Spatial layering in terms of acoustical zoning. (Author 2017)
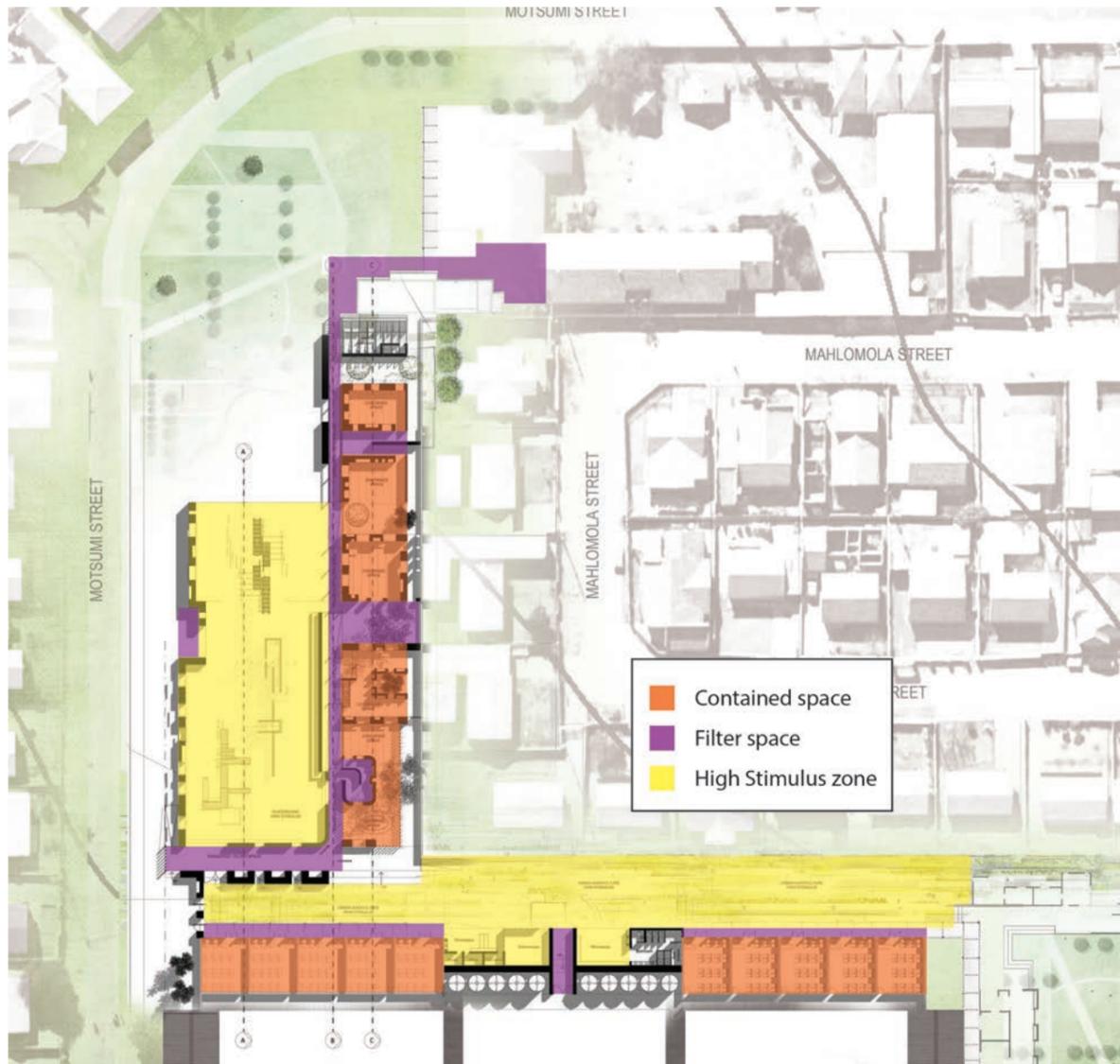
5.6.6 SUSTAINABLE BUILDING ASSESSMENT TOOL (SBAT-P)

The sustainable performance of the last design iteration was assessed with the SBAT tool with the aim of achieving a building that the ECD network will accept and take local ownership of, ultimately creating a child-centred community. This is done through the holistic approach of the tool in regards to the issues of

sustainability in three different categories: social, economic and environmental. This assessment comprises of a series of questions relating to the building, whereby points are allocated in order to achieve a holistic sustainable assessment. The results of this assessment can be seen in the graph.

The final design will take into consideration the shortfalls as a result of this assessment and will aim to improve on these figures when re-assessed.

5.26 Results of the sustainable building assessment. (Author 2017)

5.7 DETAILS

37mm CORRUGATED PROFILED METAL ROOF SHEET

228x50mm TIMBER TRUSS

75x50mm TIMBER BATTENS

50x100mm SUSPENDED CEILING BRACKET

30x1.6mm GALVANISED HOOP IRON TIE

SEAMLESS GUTTERS AND DOWNPIPES CONNECTED TO RAIN WATER CATCH SYSTEM

240x140x92mm BLOQUE TERMODISIPADOR STRUCTURAL CLAY BRICK

222x90x114mm COROMAXI 90 CLAY BRICK

3mm WIRE CEILING SUSPENDERS

22mm SUSPENDED CEILING

50x50mm POLYETHELENE BRAID CARGO CLIMBING NET INLAY FIXED TO HOOP SCREWS

114x38mm TIMBER PLATFORM FIXED AND SUPPORTED TO INTERNAL SUBSTRUCTURE WITH SELF TAPPING SCREWS

50x50mm POLYETHELENE BRAID CARGO CLIMBING NET INLAY FIXED TO SELF TAPPING HOOP SCREWS

30MM DIA STRIPPED TIMBER LATTES FIXED TO INTERNAL SUBSTRUCTURE WITH SELF TAPPING SCREWS

WOVEN MESH SCREENS FIXED TO INTERNAL SUBSTRUCTURE WITH SELF TAPPING SCREWS

72X32MM PLANED TIMBER PLANKS FIXED TO 114 X 38MM TIMBER BEARERS, SUPPORTED BY 114 X 38MM TIMBER JOISTS

75X38MM TIMBER FLOOR STRUTS COVERED WITH 22X102 TIMBER FLOOR PLANKS

375 MICRON DAMP PROOF COURSE

REINFORCED CONCRETE RAFT FOUNDATION TO ENG SPEC

375 X 470 X 1200MM PRECAST CONCRETE RAINWATER CHANNEL COVERED WITH 300 X 500 X8 GALVANISED MILD STEEL MENTIS GRATING

375 MICRON WATERPROOFING MEMBRANE ON CONSOLIDATED FILLING COMPACTED IN MAX 150MM LAYERS

HABITABLE WALL

CONTAINED SPACE

NGL

5.27 Detail 1: Habitable Wall, not to scale. Learning through active play and the use of your five senses. (Author 2017)
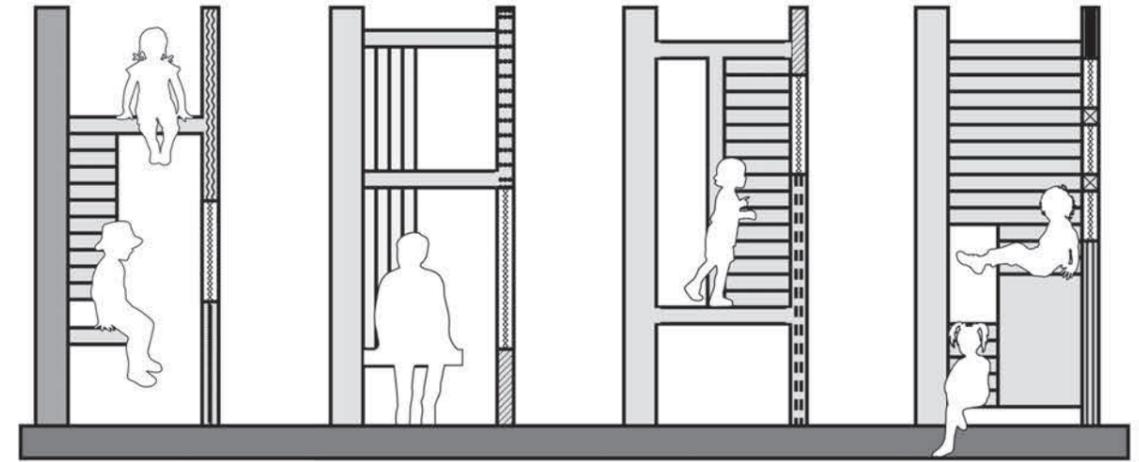
5.28 Habitable wall section diagrams indicating variations of the spaces. (Author 2017)
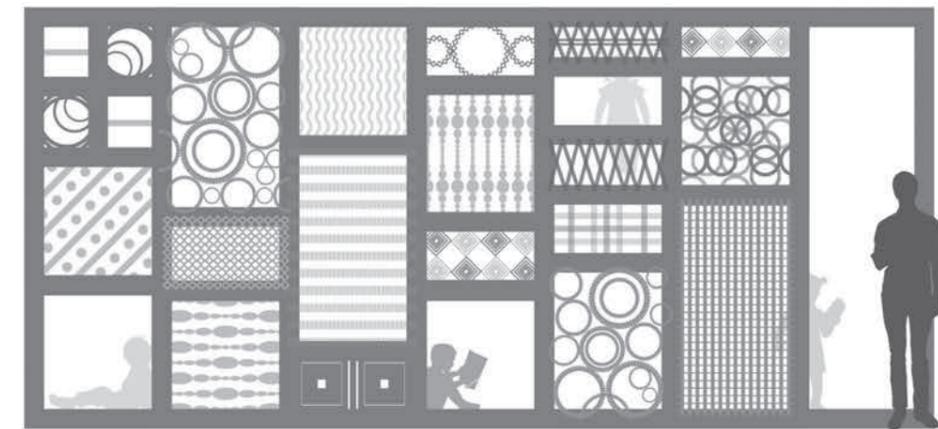
5.29 Habitable wall elevation diagram showing variations of permeable screens. (Author 2017)
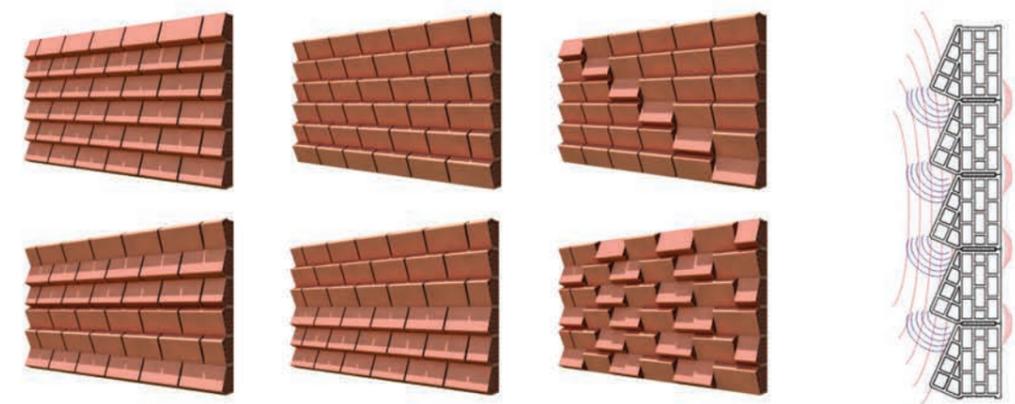
5.30 Acoustical properties of the Bloque Termodisipador clay brick to be manufactured locally. (Author 2017)

ROOF NOTE:
0,58mm THICK CORRUGATED PROFILED METAL ROOF SHEET GALVANISED STEEL ROOF SHEETING @ 16° PITCH, FIXED TO 76 × 50MM TIMBER PURLINS ON 152 × 50mm TIMBER RAFTER SPACED AT 1,2M C/C MAX, BY SPECIALIST TO MANUFACTURER'S REQUIREMENTS AND ENGINEERS SPECIFICATIONS.

SA PINE ROOF TRUSSES ON MAX 1200M C/C
228X50 SA PINE RAFTERS
228X50 SA PINE TIE BEAM
152X50 SA PINE KING POST
75X50 SA PINE WEB MEMBERS

3MM NYLON ROPE NETTED @ 80X80MM SPACING FIXED TO 50X50 SQUARE STEEL TUBING FIXED TO ROOF FRAME WITH GALVANISED MILD STEEL NUT AND BOLT WITH WASHER

CUSTOM MADE STEEL PLATE FIXED TO ROOF STRUCTURE WITH GALVANISED MILD STEEL NUT AND BOLT WITH WASHER

76X50MM SA PINE TIMBER FLOOR JOISTS

RHINO WOOD TIMBER DECK WITH 100X20MM DECKING BOARDS, FINISH: LIGHT DISTRESS. TO SPECIALIST DETAILS.

50X50 SQUARE STEEL TUBING FIXED TO ROOF FRAME WITH GALVANISED MILD STEEL NUT AND BOLT WITH WASHER

114X38MM SA PINE WALL PLATE

ROOF NOTE:
0,58mm THICK CORRUGATED PROFILED METAL ROOF SHEET GALVANISED STEEL ROOF SHEETING @ 10° PITCH, FIXED TO 76 × 50MM TIMBER RAFTER SPACED AT 1,2M C/C MAX, BY SPECIALIST TO MANUFACTURER'S REQUIREMENTS AND ENGINEERS SPECIFICATIONS.

SA PINE ROOF TRUSSES ON MAX 1200M C/C
228X50 SA PINE RAFTERS
228X50 SA PINE TIE BEAM
152X50 SA PINE KING POST

CUSTOM MADE STEEL PLATE FIXED TO ROOF STRUCTURE WITH 12MM GALVANISED MILD STEEL NUT AND BOLT WITH WASHER

114X38MM SA PINE WALL PLATE

Overhang 800
Overhang 800
Overhang 800
16.00°
10.00°
1700
1574
2240
9599

DOUBLE VOLUME
PLAY AREA

5.31 Detail 2: Habitable Roof, not to scale. Learning through active play, various scales and levels. (Author 2017)

5.32 Illustration of the contained space, showing the dynamic floor, habitable walls and habitable roof spaces. (Author 2017)

5.33 Section perspective through the contained space showing the active play spaces. (Author 2017)

5.34 Perspective of the contained space. (Author 2017)

5.35 Section perspective of the contained space showing the various scales of interaction. (Author 2017)

EXISTING ROOF TRUSS

EXISTING BATTENS

152x50mm GALVANISED MILD STEEL TRUSS HANGER

NEW SEAMLESS GUTTERS AND DOWNPIPES CONNECTED TO RAIN WATER CATCH SYSTEM

210x19mm PLANED ALL ROUND TIMBER SLATS

SOLSTICE SUN ANGLE

WINTER SUN ANGLE

63.5°

40.3°

EX. LINTEL

EXISTING PRIMARY SCHOOL

PLANT WIRE INLAY WITH CREEPER

152x38mm CUSTOM PERGOLA SUPPORTS

DAMP PROOF MEMBRANE OR CEMFLEX WATER PROOFING

100x40x3mm GALVANISED MILD STEEL BRACKET

22x114mm PLANED TIMBER PLANKS RAISED 10mm WITH SPACERS

SOIL INFILL / PLANTER INFILL

WEEP HOLES AT 1000MM CC

1060x200mm REINFORCED CONCRETE FOUNDATION

NGL

EX DPC

EX.DPM

EX. FOUNDATION

5.36 Detail 3: Connection to the existing primary school, not to scale. (Author 2017)

CHAPTER SIX
DESIGN
RESOLUTION
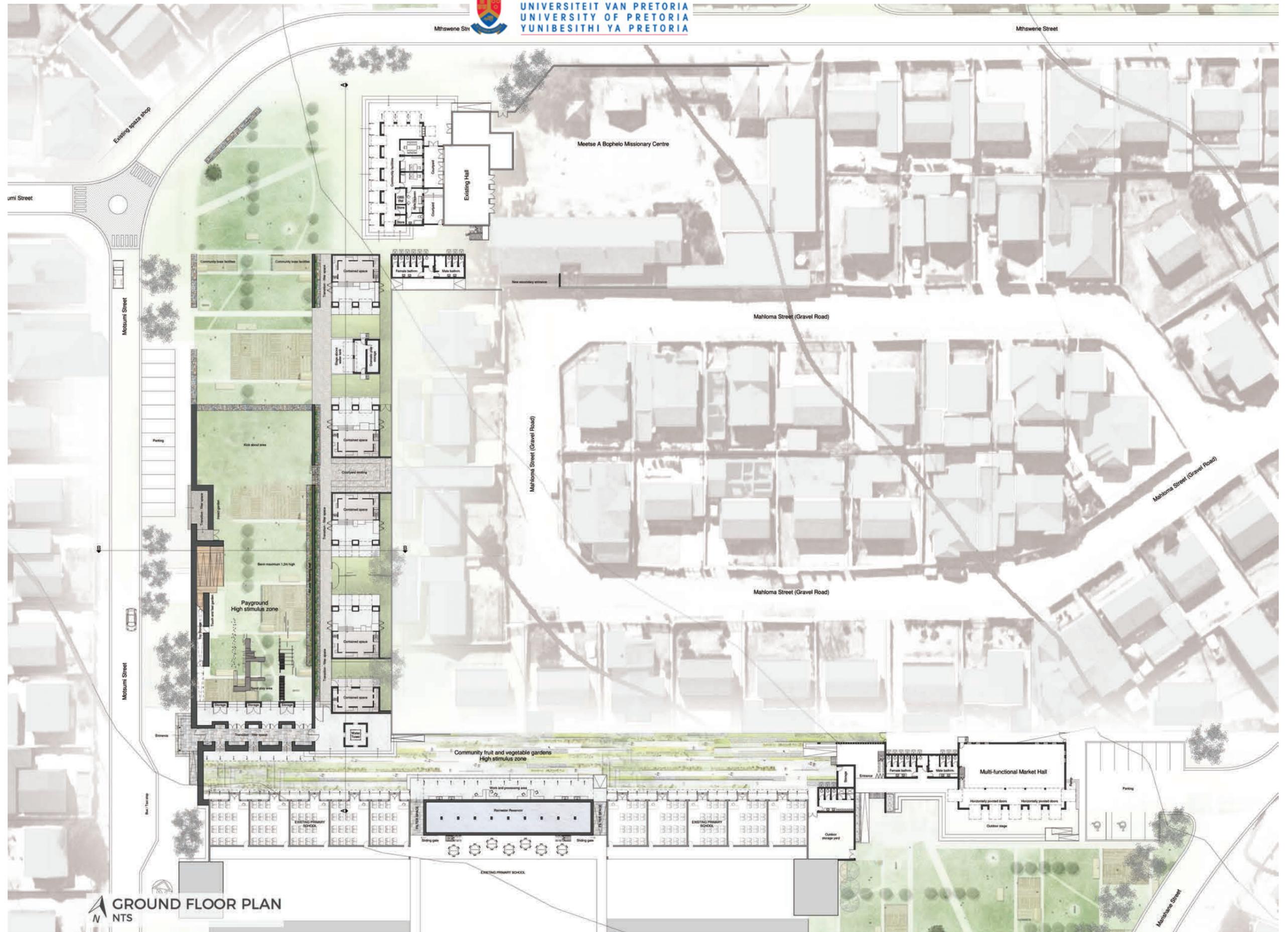
6.1
Ground floor plan, not to scale.
(Author 2017)

GROUND FLOOR PLAN
NTS

6.2

Perspective of the high-stimulus zone. (Author 2017)
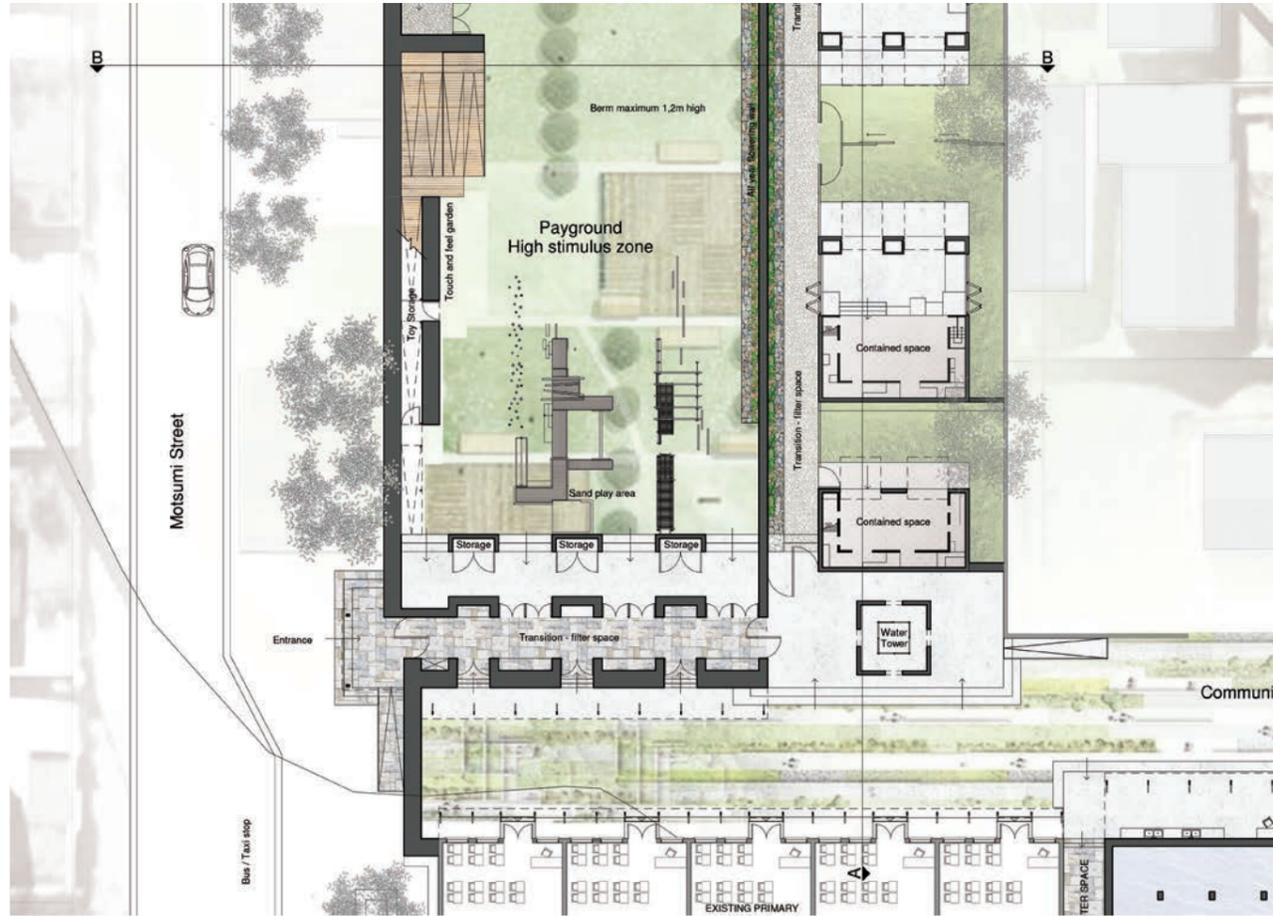
6.3   Zoomed-in ground floor plan showing the three zones. (Author 2017)
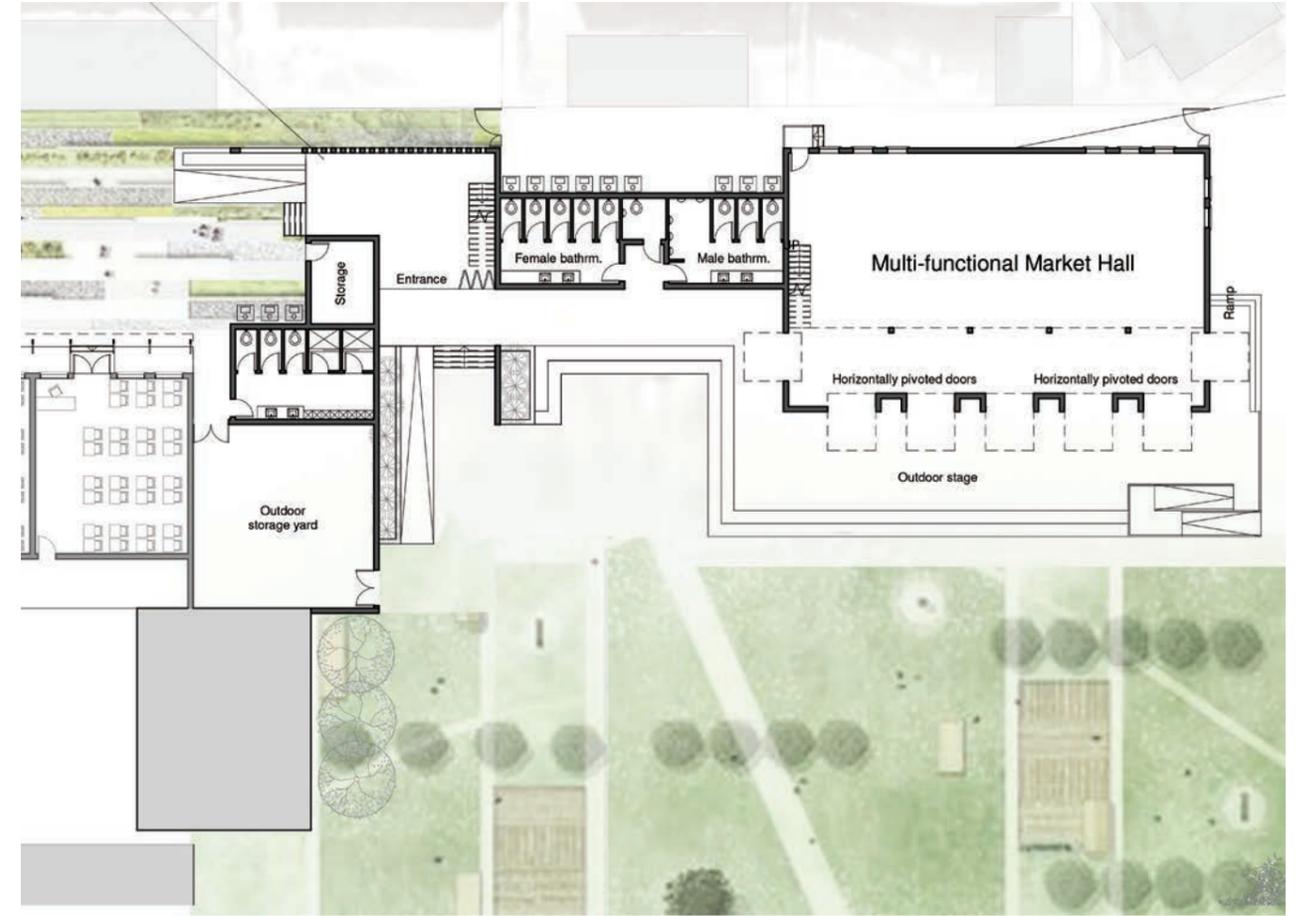
6.4   Zoomed-in ground floor plan of the site extension. (Author 2017)

6.5   Section A-A, not to scale. (Author 2017)

6.6 Section of contained space, not to scale. (Author 2017)

6.7 Section showing the water tower and connection to the existing school, not to scale. (Author 2017)

CONTAINED SPACE   FILTER ZONE   HIGH STIMUUS PLAYGROUND   SIDE WALK   STREET

6.8 Section B-B not to scale. (Author 2017)

6.9

Perspective of the community garden and connection to the existing school. (Author 2017)

6.10   Section perspective of the contained space showing the habitable wall and roof space. (Author 2017)
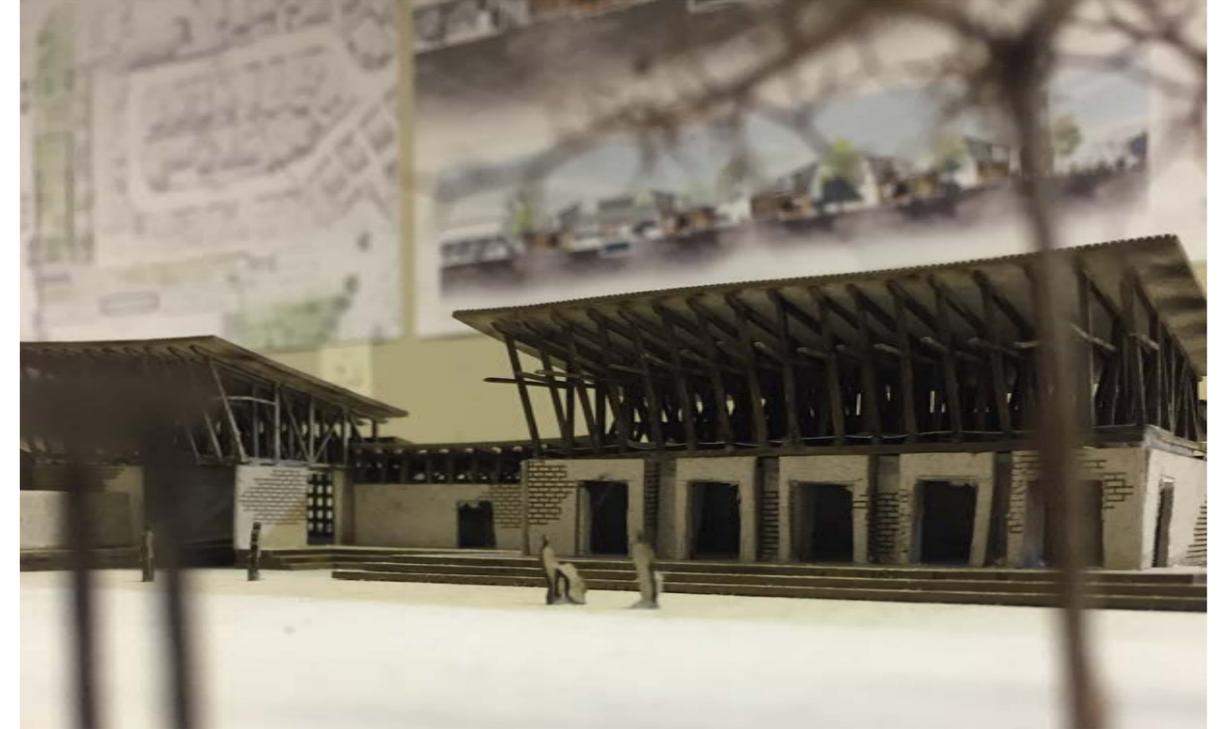
6.12   Photo of the model showing the view of the extended site. (Author 2017)

6.11   Interior perspective of the contained space showing. (Author 2017)

6.13   Photo indicating the top view of the model. (Author 2017)

6.14 Photo of the model showing the outdoor stage above the water tank. (Author 2017)

6.15 Photo of the model indicating the connection to community partnerships. (Author 2017)

6.16 Final presentation and speech. (Author 2017)

CONCLUSION

ARCHITECTURE AS CATALYST FOR
EARLY CHILDHOOD DEVELOPMENT

The early development of children is a critical period of their development and forms the foundation for their future well-being and learning, having a lasting impact throughout their lives. In an attempt to contextualise the educational environment, the intention with this dissertation is to create a new relationship between architecture and early childhood pedagogy, as well as to solve the transitioning from early childhood development into primary education.

The power of our spatial environments, and their impact on people, is evident in the theories discussed in this dissertation, making it extremely important for this evidence to be taken into cognisance when designing for children. It can therefore be said that architecture has the power to effect change through empowering young children to become protagonists in their own learning and development through the facilitation of didactic space.

This notion of our spatial environments as a third teacher gives a heightened role to architecture as a medium for child development, allowing children to engage in their spatial environments through active play and everyday use. Further to this, such a design approach has the capacity to educate children about society, social engagement, the economy, nature, and sustainability, informing them about their cultural identities and heritages and affirming their sense of community and identity. Ultimately, child-centred design supports the vision of improving society through assisting children to realize their full potential as intellectual persons, and therefore to enhance their early childhood development through spatial arrangement and reconfigured experiential built environments.

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

I further state that no part of my dissertation has already been submitted for any such degree, diploma or other qualification.

I further declare that this dissertation is substantially my own work. Where reference is made to the works of other, the extent to which that work has been used is indicated and fully acknowledged in the text and list of references.

Jason Oberholster