

# **BIOPHILIC ARCHITECTURE AND ITS INFLUENCE ON HUMAN BEHAVIOUR AND WELL-BEING**

**A Proposed Urban Multi-use Office Park Development**

**Marjorie Blom**

A Dissertation submitted to the Faculty of Humanities, Development and Social Sciences,  
School of Architecture, Planning and Housing, University of KwaZulu-Natal, completed in  
partial-fulfillment of the requirements for the degree of Master in Architecture

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## **DECLARATION**

This Dissertation submitted in fulfillment of the requirements for the degree of Master of Architecture, in the Graduate Program in Architecture, University of Kwa-Zulu Natal, Durban, South Africa.

I hereby declare that this Dissertation is my unaided work under the supervision of Mr. Lawrence Ogunsanya. All citations, references and borrowed ideas have been appropriately acknowledged. It is being submitted to the University of KwaZulu-Natal, School of Architecture, Planning and Housing in the faculty of Humanities, Development and Social Science, for the degree of Masters in Architecture. This Dissertation has not been submitted before for any degree or examination at any other University.

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MARJORIE BLOM

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Date



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- *"there is a lot of work to be done"* (Glass: 2013)
- *"aint no body got time for that"* (Brown: 2012)
- *"sjo sjo sjo"* (Mthethwa: 2012)
- *"started from the bottom now we're here"* (Drake: 2013)
- *"then do the harlem shake"* (Baauer: 2012)

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## **DEDICATION**

This dissertation is dedicated to my generous, loving and supporting parents, Thys and Mariki Blom. I do apologise for being such a financial burden, I hope to return the favour in the near future. Thank you for believing in me, allowing me to pursue my dream of becoming an Architect. No words could express my deepest appreciation.

## **ABSTRACT**

Dealing with the issue of buildings showing characteristics of sick building syndrome, could result in occupants suffering negative side effects. Healthy living is a primary need for society. Everyday pollution in society has led to these negative outcomes of physical and psychological well-being of space users. When investigating factors such as natural light, colour, fresh air, visual contact with water and nature or noise pollution, it is found that exposure to such natural elements positively influences human behaviour, health and productivity in a live, work and play environment.

This dissertation is aimed at developing an understanding conducted under the hypothesis of how architectural environments, through the theory of environmental psychology: a study of the relationship between natural environments, affect human behaviour and well-being. A healthy environment requires regular contact with nature promoting physical and psychological benefits, crucial to an individual's health and happiness. By reducing sick building syndrome, it could increase performance and improve overall health and well-being.

Occupants of the chosen case studies completed questionnaires through distribution and structured interviews personally conducted, focusing on a qualitative method. Assessing and evaluating the aims, objectives and key questions and understanding of how Biophilic Architecture influences human behaviour and well-being was obtained.

Case (Alexander Forbes and Nedbank Ridgeview) and precedents studies (Prisma Nürnberg and Khoo Teck Paut Hospital) were investigated through Edward, O. Wilson's Biophilia hypothesis theory of man's affiliation with nature and incorporating it into building forms, showing how architectural design can evoke human behaviour through natural design elements. Architectural design is about humanity's 'sense of place' (concept of Genius Loci) in nature and where the natural environment fits into the physical environment. Biophilic designs' sensory rich world affects human health, productivity, emotional, intellectual and spiritual well-being, as well as reducing stress levels and eases pain.

Biophilic Architecture could be the solution through a link of natural and physical environments, positively influencing human behaviour and well-being. Futuristic sustainability should have the combination of biophilic design and low environmental impact, resulting in a restorative nature based design: a true result of a positive psychological environment, a 'sense of place,' people want to experience, that is healthy, nurturing, and delightful to its occupants, improving the experiential quality of architectural space.

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## CHAPTER ONE INTRODUCTION

### 1.1 RESEARCH BACKGROUND

#### 1.1.1 Background

A personal assumption was made that a large population of South Africans is currently working in unhealthy conditions, resulting in making them sick, therefore probably not meeting everyday human health needs. One can also presume that the study of biophilic architecture form would result in conclusions of how to improve the environment resulting in a healthier lifestyle, positive human behaviour patterns and well-being. In investigating these assumptions and issues among communities, one would find evidence to conclude how human behaviour and well-being is affected the built form.

The discussion that follows will predominantly deal with the causes and effects of sick building syndrome (SBS), which is commonly known as a health problem. Sick building syndrome can be defined as psychological and or physical distress which is generated specifically in work scenarios. In general most people do suffer from sick building syndrome without realising (Baker: 1989; 607–624).

Man has evolved over the years, resulting in modern day technological society. Edward O. Wilson stated that the planet is under pressure due to human related factors and that man is contributing to the *“environmental crisis which is threatening the survival of many species, including the human species”* (Sassi: 2006; 2). Nature is being pushed aside for the comfort of making life easy (Day: 2002). Man has forgotten that nature is the source of their existence, slowly becoming disconnected from nature therefore resulting in a concern for well-being (Walker: 2007). An understanding of how surroundings affect man would assist in creating a positive well-being environment (Day: 2002; 9).

Architects have to start with changing the way they design, introducing natural elements into buildings and other environmental issues, related to a better way of living (Wilson: 2013). When looking at the built form, Architecture does not merely reflect on human behaviour and reactions, it also influences them: Dutch architect Aldo van Eyck, who identified architecture with human affects (Smithson, 1962: 87) declared:

*“First, man creates environment, and environment, in its turn, influences man”*

- A Smithson -

Human beings are greatly affected, both physically and mentally, by our surroundings, whether natural or built. Buildings constructed specifically to help with the well-being of its user have a particularly important role to play in this regard. A green environment promotes healthy living. The development of green buildings would promote wellness throughout communities.

According to McCurry, Nanda, and Pati (2009: 116), wellness architecture in general is often neglected when it comes to important design considerations, such as the psychological effects of environmental aesthetics.

### **1.1.2 Motivation / Justification of the study**

Individuals thrive on everyday needs. Shelter is a basic need according to Maslow (1962), provides privacy and security, involving physical, psychological and cultural limits. The question is, how does mans behaviour relate to changing the environment. Human behaviour reflects from the built form. When looking at human needs in the built form such as breathing, we become aware of the internal air quality and natural ventilation needed within the building, and the thermal comfort within a given space. People’s responses to different environments differ from place to place because of changes in social, cultural, ritual, economic and physical factors (Rapoport, 1969: chapter 1).

Smith and Kelly (2006) express that there is an ‘*unprecedented intensification in the pursuit of wellness*’, this explains that, through these specific architectural environments, not only undergo a journey of ‘physical movement’ but also a journey towards a ‘greater sense of self-awareness and contentment’. Meeting your basic needs first builds the grounding for higher needs, resulting in complete mental and physical self awareness and happiness.

It was investigated and concluded that most modern day architectural interventions of ‘healing’ put more emphasis on mental behaviour rather than both the physical and spiritual improvement of an individual (Smith & Kelly: 2006b; 16). The resolution would be a need for an architectural

intervention that focuses not only on the physical behaviour of an individual, but also on spiritual and mental well-being. Thus it is important that the architectural intervention that includes these characteristics give priority to the positive behaviour patterns and well-being of individuals.

## **1.2 DEFINING THE RESEARCH PROBLEM, AIMS AND OBJECTIVES**

### **1.2.1 Definition of the Research Problem**

This dissertation explores human behaviour and well-being, and its influence on Architectural form. It will examine various behaviour patterns within the architectural environment from the broader macro-context down to the intermediate context and considers how they affect human well-being, from both a positive and negative point of view. Emphasis will be placed on sick building syndrome and how natural elements (colour, light, texture, sound, natural lighting & ventilation, thermal comfort, water & water features, landscapes and gardens) can influence well-being through architectural interventions and how these environments can affect human behaviour. The spirit of a particular place is fed by the attitudes and the many actions of the people responsible for the built environment (Day: 2002; 7).

### **1.2.2 Aims**

The main aim of this study is to establish which natural elements affect which behaviour patterns within the built form. Researching nature and its effect on human behaviour could prove a result in well-being within architecture. Exploring the concept of sick building syndrome an accurate investigation can be made as to which design elements result in natural well-being when implemented into social spaces. In designing the proposed building, nature and natural design elements would be taken into account to improve the well-being the user within the built environment.

### **1.2.3 Objectives**

- To discover how the natural physical environment influences human behaviour
- To interpret which human health needs influence positive built environments
- To investigate the definition of sick building syndrome and how it influences productivity
- To acquire appropriate knowledge to create awareness and a response for mental and physical well-being in Architecture through Biophilic design

## **1.3 SETTING OUT THE SCOPE**

### **1.3.1 Delimiting the Research Problem**

The subject of human behaviour and well-being in South Africa is broad and can be adequately investigated in numerous areas and diverse situations affecting different groups of people. Sustainability and Biophilic design has reached South African shores, but in the author's opinion it has much room to develop and be implemented into the designing world. By investigating sick building syndrome and its solution: Biophilic design, one can be confident to design sustainable buildings.

An understanding of how natural elements in Architecture can affect human behaviour through psychological and physical behaviour has to be established. One must investigate numerous areas and diverse situations affecting different groups of people for an accurate conclusion. The group of people chosen to be analysed are the working class in a working environment. The reason for this study is to understand how Biophilia in Architecture can affect human needs (natural lighting & ventilation, water & water features, landscapes and gardens) through psychological behaviour and physical improvement of productivity within the built environment. One must question whether natural environments are beneficial to human behaviour in comparison to building environments that are void of natural stimuli. Through this establishment a design brief for a proposed Urban Multi-use Office Park Development in the Northern Durban area can be established.

Investigating design elements such as bringing nature into the built form, connecting nature with order and green buildings could result in positive behaviour patterns, as well as minimising stress within an urban environment. When investigating natural elements such as internal air quality and natural ventilation needed within a 'healing' building, careful design strategies are necessary to achieve thermal comfort and positive well-being within the given space. Elements such as bringing nature into the built form, connecting nature with order and green buildings will guide an understanding of psychological and physical behaviour patterns of users in the built environment. This would assist in special interior design criteria required for positive enjoyable spaces. Preventing sick building syndrome within the proposed Urban Multi-use Office Park Development would hopefully be the ultimate solution benefiting the well-being of its user.

### 1.3.2 Definition of Terms

By understanding how Biophilic design influences human behaviour and well-being through nature in Architecture, are to be investigated individually. Looking at the definition for each, one will get a clearer understanding of the broader meaning.

- *Well-being*: A good quality of life, a state of being happy, healthy, and successful, psychologically and physically, affected by the environment
- *Biophilia*: An affiliation man has towards nature; the design of natural elements and features in buildings critical to human health, performance, and well-being
- *Environmental Psychology*: Study of the relationship between an environment and how it affects its inhabitants and their behaviour
- *Natural environment*: The geographical area includes all living and non-living things occurring naturally on earth. A natural environment is an environment that is as close as possible to its natural state - one that is relatively unaffected by human activity
- *Sick Building Syndrome (SBS)*: A mental and physical distress, affecting office occupants, resulting in headaches and poor well-being, found when the individual leaves his or her working environment
- *Human Behaviour*: A physical and or psychological reaction one experiences through interaction and effects influenced by nature and the built environment

### 1.3.3 Stating the Assumptions

The assumptions of the dissertation will involve the investigation of human behaviour patterns and what effect nature in Architecture has on our well-being and how it improves the lifestyle of its user, whereby one can say that natural elements in buildings could improve the Architectural form combining Nature and Order.



### **1.3.4 Key Question**

**Main question:**

- How can Biophilic design affect human behaviour patterns and well-being?

**Secondary questions:**

- To what extent is human behaviour (psychological and physical) influenced by natural elements?
- How can the built environment facilitate behaviour patterns, as well as mental and physical well-being?
- What causes sick building syndrome?
- What architectural response would support the theories of behaviour patterns and well-being in Biophilic design?
- Could biophilic design promote health and is there evidence that can support its effectiveness through the relation between built and natural environments?

### **1.3.5 Hypothesis**

The built environment affects the user, positively or negatively. Implementing natural elements into Architectural form improves psychological and physical behaviour patterns and well-being, creating a sense of place, reducing stress levels and informs productivity.

## 1.4 THEORETICAL FRAMEWORK

### 1.4.1 Genius Loci: A 'sense of place'

The 'spirit of place' concept is best described by Genius Loci as a daily reality which people have to live through from day to day. Spaces designed for social interaction to occur provide opportunities for public relaxation in harmonious surroundings. Yi-fu Tuan (1977) has a similar way of thinking as Genius Loci, where he explains how occupants of architectural spaces' behaviour patterns as well as mood gets affected through their personal experience of the space: *"Architectural form is an environment for man... it then influences human feeling and consciousness"* (Tuan: 1977).



Figure 1.1: Asian home, providing a 'sense of place' through a connection between nature and architecture, resulting in a peaceful and tranquil setting ([www.houzz.com](http://www.houzz.com))

The concept of Genius Loci's overall idea is that 'the place' relates to how an individual's physical and mental emotions and feelings are 'stimulated' in a chosen environment. When experiencing a space for the first time a 'feeling of consciousness' emerges, this stirs 'subconscious emotions' about the current surroundings. A special quality, a 'sense of place' of the chosen area gives rise from the building footprint and urban layout connection making up a space.

A 'sense of place' could refer to the 'spirit of a place', which emphasizes the importance of identifying one with the current surroundings, connecting one's spiritual emotions to the area. It directly links psychologically to how an individual feels and interprets an environment; this can be both a negative and positive reaction. The combination of architectural elements, combined with the overall setting of the environment, gives a space balance between design and nature. This proves the importance of positive architectural form.

### 1.4.2 Environmental Psychology

Environmental psychology is a field of study that examines the relationship between environments and how it affects its inhabitants and their behaviour (De Young: 2013). This involves the relationship between a person's state of mind and their physical environment. Spaces should place emphasis on issues such as 'increased sensitivity to chemicals and pollutants; acoustical design; and access to daylight, nature and the outdoors' (refer to figure 1.2) (Guenther & Vittori: 2008; 14).



Figure 1.2: An integration between nature, natural elements and architecture.

How does that affect human behaviour? A peaceful state of mind ([www.houzz.com](http://www.houzz.com))

The problems faced when dealing with human behaviour could be factors such as natural light, colour, fresh air, and a visual contact with water and nature or noise pollution, which affects productivity (refer to figure 1.3). These are common attributes to human behaviour and well-

being. When designing spaces for people it is necessary to know which elements affect human behaviour patterns and to design accordingly to enhance the experiences people come across in these spaces (Maslow: 1962).

*“Territoriality involves the possession and defense of physical space, as well as the exclusiveness of use, marking, personalization, and identity (as a reflection of the self) of that space by the occupant or user. In most civilizations, territories serve to organize human behaviours so that acts of violence, aggression, and overt domination are reduced.”*

- Julian Edney -



Figure 1.3: Human behaviour and productivity gets affected by natural lighting, ventilation, visual connections and noise pollution in an office environment ([www.paragon.co.za](http://www.paragon.co.za))

Architects need to consider the way in which buildings are designed, constructed and maintained to promote healthier built environments and how it can avoid being harmful. The choice of building materials needs to perform for human comfort and have low environmental impact. Achieving a design solution that uses building materials and energy in a sustainable way and meets human needs often involves compromises. Using sustainable materials (such as those made from rapidly renewable resources or those with high recycled content) that also have sound absorbing properties can result in green building design.

An example of the benefits of green buildings in working environments is described by Sally Augustin:

*“Green buildings signal to workers that an organization values its employees’ long-term welfare, which has positive repercussions. They also signal a concern for the public welfare to the general population, which has significant public relations values if the concerns seem legitimate. People working in green buildings are more likely to feel that their workplace meets their needs than people working in other buildings, and they are also less likely to be negative when there is a problem with building operations (e.g., temperature, lighting, noise)”*  
(Augustin: 2009; 183).

A truly positive environmental psychological building is one that endures, which means that it must be a place where people want to be a place that is healthy, nurturing, and delightful to its occupants. Christopher Day reports that improved office environments can increase employee productivity, while improved hospital environments can reduce treatment times (Day: 1990; 1). Nature and natural elements provide the most sufficient environmental care. Perhaps the most purely ‘therapeutic’ environment is a totally natural setting, with no building at all.

#### **1.4.3 Edward, O. Wilson’s Biophilia Hypothesis**

Mans current design strategies and ways of thinking about architecture are insufficient. Designers would need to redefine solutions to architectural problems, through a theoretical natural way of designing, inspired by human behaviour and positive well-being. Edward, O. Wilson, invented the term ‘biophilia’ in his book Biophilia (1984), arguing that ‘human beings have a natural interest and attraction to nature’. He defined the term as *“the connections that human beings subconsciously seek with the rest of life.”* Kellert (1993), defines the concept of biophilia as *“a complex of weak genetic tendencies to value nature that are instrumental in human physical, material, emotional, intellectual, and moral well-being. Because biophilia is rooted in human biology and evolution, it represents an argument for conserving nature based on long-term self-interest.”*



Wilson's biophilia hypothesis states that humans need contact with natural forms, just as much as they require nutrients and air for survival (Kellert: 2005, Kellert and Wilson: 1993). Man benefits from Biophilia's natural resources such as food, water, and shelter, nature also provides emotional and spiritual satisfaction. "*People will fight to keep biophilic features,*" says Kellert, describing how office buildings with views to the outdoors are more dominant. People have an affiliation with nature, when not present, artificial nature such as potted plants, images of nature etc. can also nurture the soul.

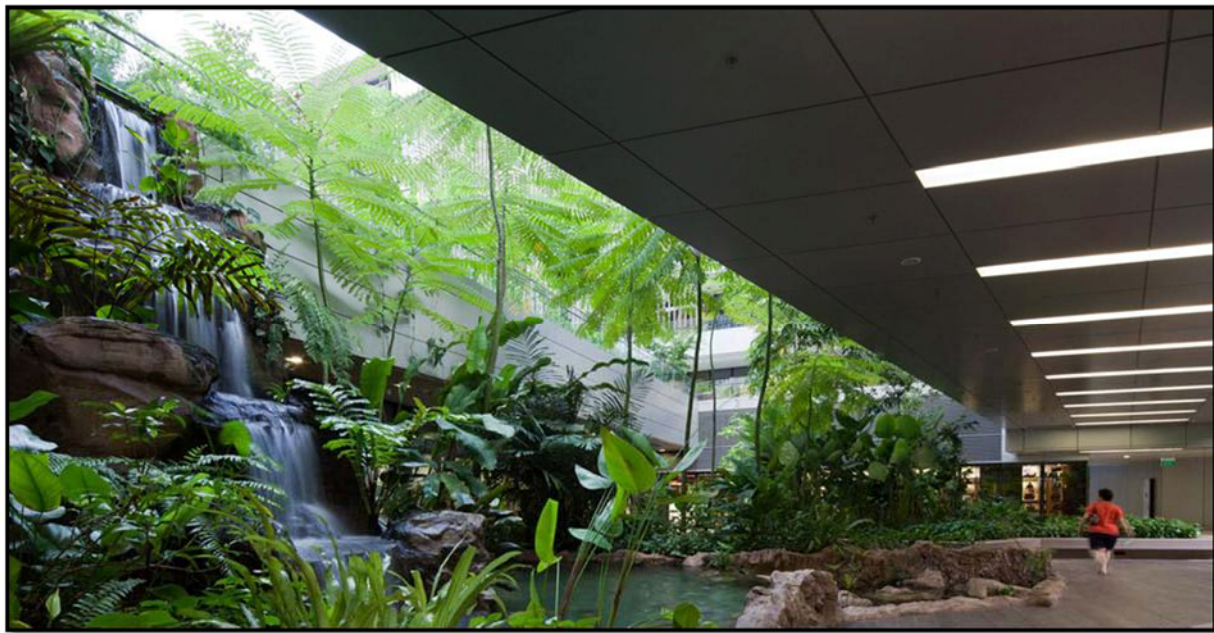


Figure 1.4: Bringing nature into buildings through Biophilic design ([www.alpolic-usa.com](http://www.alpolic-usa.com))

Biophilic architecture is the merging of artificial structures with natural structures, such as bringing nature into buildings, using natural materials and surfaces, vegetation, allowing natural light and ventilation (refer to figure 1.4). It is becoming increasingly well known that biophilic elements (bringing nature into buildings) promotes measurable benefits to human behaviour; performance, productivity, emotional well-being, stress reduction, learning, health and healing (Wilson: 2006 and Kellert: 2005).

## **1.5 RESEARCH METHODS AND MATERIALS**

The research conducted within this dissertation consisted of primary and secondary data collection and analysis. The research gathered and the resultant findings were incorporated into this document which established positive behaviour patterns through the connection between man and nature, exploring two forms of study: empirical and non-empirical study. The empirical study will explore the use of primary data in the form of case studies, surveys, questionnaires and text data. The non-empirical approach will deal with secondary data in the review of literature.

### **1.5.1 Primary Research**

Primary data collection allows for the testing of the validity of the previously stated hypothesis through case studies and self analysis, as they are real life examples of what the concepts and theories mentioned in this document are capable of producing. This analysis and case studies were carried out through sampling (a purposive sample, also commonly called a judgmental sample, is one that is selected based on the knowledge of a population and the purpose of the study. The subjects are selected because of certain characteristics) an in-depth understanding of human behaviour: personal observations, focused interviews, questionnaires and qualitative surveys, site visits, photographing and assessing buildings, obtaining accurate information.

Structured interviews were conducted with professionals in the field of architectural design such as the administrators, urban designers and architects, as well as people using the buildings on a daily basis. Graham Wilson (Director of Osmond Lange Architects & Planners), Dayle Duncan (Facilities Administrator at Nedbank Ridgeview), Amir Livneh (Project Architect at Paragon Architects), and V. Lambert (Facilities Administrator at Alexander Forbes), were personally interviewed to assess and evaluate the previously set aims, objectives and key questions. Their expertise, opinions and practical knowledge regarding Green Architecture and how that influences human behaviour and well-being was required as part of a conclusive discussion, providing an architectural understanding of design criteria required for future development.

The Alexander Forbes Building, Sandton and The Nedbank Ridgeview Building, Umhlanga were chosen based on their 4 Star SA-Green Star Status, being the closest example of Biophilic or sustainable design within an accessible area. By interviewing the designers and occupants,

visiting, photographing and critically assessing buildings or spaces relevant to the chosen case study the author hopes to gain evidence of sick building syndrome or the use of biophilic design which positively influence human behaviour and well-being. This document is largely theoretical in nature and is therefore focused on a qualitative method, clarifying why and how respondents are satisfied within their working / living environment and whether nature is a vital component of well-being. These case studies provided first hand insight, relevant to the topic, their successes and failures. The key was to ask relevant questions to meet the aims and objectives of the thesis.

The case studies were analysed by observation and comparison through the below criteria, based on the theoretical framework supported by research discussed in the literature review:

- Man vs Nature – the human need to affiliate with nature
- Thermal Comfort – indoor air quality and special design
- Natural Elements – vegetation / water / natural ventilation and lighting
- Behaviour Patterns – feelings and reactions in the built form

### **1.5.2 Secondary Research**

Secondary data collection included research by means of existing literature investigation of existing buildings, chosen as case and precedent studies, in terms of theoretical principles, testing the comparison and the evaluation of data obtained. This knowledge helps establish a general understanding around the key research questions and provides information that can determine the outcome of the hypothesis. The sources used include books, journals, electronic sources such as websites, e-books and e-journals, unpublished dissertations, raw data from interviews and questionnaires. Collected materials were in the form of images, diagrams, photographs and sketches. In this research, a qualitative research approach was used. This method was based on a critical analysis of behaviour, attitudes and experiences of users in the built form. The study of various precedents provided practical insight into the existing theories on sick building syndrome and how biophilic design positively influences human behaviour and well-being in architecture.

The research generated an understanding of how biophilic architecture influences human behaviour and well-being. It was vital to logically examine primary and secondary sources, and so conclusions and recommendation were derived within each chapter.



## **CHAPTER TWO                      LITERATURE REVIEW**

### **2.1        HUMAN BEHAVIOUR PATTERNS**

#### **2.1.1    Introduction**

Places speak to us, affecting our mood and behaviour, as investigated by the theory of environmental psychology. If positive our surroundings can nourish, balance and heal, if negative it could result in the complete opposite, thus feeding stress and related depressing emotions. Natural elements such as water stimulate the soul with its calm forceful movements, tempo and power. Air is an element affecting human health, behaviour, emotion and well-being. Our emotions affect how we breathe, speak and even body scent.

Air is the result of transfer of emotions, memories and associations, reinforcing its physiological effects, such as an open window to freshly cut grass. Water influences human behaviour by the natural ripples drawing the mind into a soothing dream, washing away stress and stimulating life's energies. Tranquillity is achieved with still, clean water. The different types of water movements influence moods of the soul. Water has the healing powers that clean both body and soul, generating a sense of belonging and place discussed by Genius Loci's 'sense of place' theory (Tuan: 1977 & Day: 2002; 29-38).

Internally buildings affect human behaviour patterns such as textiles, soft furnishings and landscapes nourish human feelings. Research shows that office workers with a window view of nature reported lower frustration and higher life satisfaction and overall health (Kellert, Heerwagen, Mador: 2008; 98). During this research individuals were divided into two groups, depending on the place in which they would spend their holidays. Either this was in 'free' nature, or in an urban environment. Before and after their holiday, subjects had to undergo a proofreading test. Both studies revealed that subjects who had spent their holiday in nature scored better in proofreading than before their departure. In contrast, individuals who had made a city trip scored lower after their trip than before.

In agreement with these results, Tennessen & Cimprich (1995) showed that students with views of nature from their dormitory windows performed better on attention tasks than students without such views.

We as designers have a responsibility to find a happy medium between natural and physical environments. Individual, cultural and universal responses influence the way we react to our surroundings. These responses are involuntary, touching the deepest part of our being, our humanity (Day: 2002; 112-113).

What psychological influence does the environment have on human behaviour, when walking into a building for the first time? Is it the first impression, the atmosphere of a place and spirit, the smells, lighting, physical form, materials or colour of the interior? All of the above proves Genius Loci's 'spirit of a place' theory. What should a building or room say? What feeling responses should it appeal to? All of these questions answer how the 'spirit of place' should be designed for its specific purpose. Therefore what a place says is more important than how it looks (Day: 2002; 158-159).

### **2.1.2 Stress and its causes**

The qualities around us affect our state of being, which in turn affect the way we react towards others. Disharmonious surroundings promote social disharmony, raising stress levels. Ulrich (2002) defined stress as, *"a process of responding to events, environmental features, or situations that are challenging, exceed coping resources, or threaten well-being."* Stress is crucial in understanding how biophilic design and health care environments can influence outcomes. These outcomes are related to psychological, physiological, and behavioural changes linked to stress. The behavioural effects of stress can be social withdrawal or verbal outbursts in the working environment (Ulrich: 2002).

The question is: how can the built environment improve stress, as well as mental and physical well-being? Environmental stresses can come from environmental degradation associated with pollution (air, water and noise), the lack of public, social and green spaces within a working environment and city framework, concluding in the form of sick building syndrome. An imbalance psychologically or in harmony causes illness to occur. Healthy calm environments result in lower stress levels. Noise can produce direct physiological stress and strain heart muscles, while natural sounds can relieve it (Day: 2002; 112-113, 187-189). Stress breeds, feeds and triggers illnesses. Not everyone gets sick from these symptoms.

*“To understand how environment can make us ill, we need to understand why we get ill”*

- Christopher Day -

Stress affects hormones which in turn give the body the ability to fight disease. The best cure is happiness and laughter. De-stressing involves all our senses of colour, light, sound and smell, working psychologically on our mood, touching the inner soul. By eliminating noise and vibration, changing colour and lighting, softening and harmonising shapes and forms would result in a less stressful environment. This indicates that nature can reduce psychological and physiological stress in individuals (Augustins: 2009; 186-187).

### **2.1.3 Psychological reaction**

Mans feelings and moods are supported by colour, harmony and multi-sensory delight. An environment that provides a journey, beauty and care can nurture spiritual development (refer to figure 2.1). In turn these building principals can nurture the human being as a whole, supporting health physically and spiritually, nourishing the soul (Day: 2002; 187-189).

Day (2002) discusses how the human *“psychological state influences hormonal balance, so strengthening or weakening immunity,”* therefore focusing on self-value, involving spiritual development, connecting with the natural environment (refer to figure 2.1). Places do affect your state of soul, but there’s much more to feelings than behaviourist satisfaction of instincts and survival needs (Day: 2002; 213).

If places and spaces are healthy and pleasant to occupy, employees are more likely to be content (Baker: 1989; 607–624). Therefore there is a link between man’s behaviour and the built form through understanding behaviour patterns, desires, motivations and feelings. The question is, how does mans behaviour relate to changing the environment reflected on the built form. People’s responses differ from place to place because of changes in social, cultural, ritual, economic and physical factors (Rapoport: 1969; chapter 1).



Figure 2.1: Connecting man harmoniously with nature ([www.houzz.com](http://www.houzz.com))

#### 2.1.4 Physical reaction

Rarely does man consciously focus on its surroundings, but it does affect their behaviour. Man experiences its environment through shapes and dimensions in relation to the body scale and proportions. Physical responses can induce feelings like relaxation, dynamism, compulsion, instability, awe, repression or negative levels of resentment, distrust, defensiveness, anxiety and confusion (Ryan & Morrow: 1992; 220-224). There is more to life than what humans need from their surroundings. They need order and organisation as well as proportional relationships. In some places man can't help but feel irritable, tense, cramped and in other places relaxed, sociable and friendly. These physical reactions are subconscious, but the built and natural environment can determine the positive or negative physical reactions (Day: 2002; 184-186).

*“There is no doubt whatever about the influence of Architecture and structure upon human character and action. We shape our buildings, and afterwards our buildings shape us. They regulate the course of our lives”*

- Winston Churchill -

Psychologist Abraham Maslow (1962) stated that basic needs: deficiency needs, are directly related to human coping behaviour, which consists of a human's basic level of survival and coping with everyday life (physically coping).

These basic physiological needs are the physical and actual needs individuals need to sustain everyday life, which includes food, water, shelter, air etc. Maslow (1962) states, *“Unless and until these basic physiological needs are satisfied to the required extent, other needs do not motivate an employee,”* any hungry person, would be incapable of concentrating on anything else except their hunger, which affects their productivity (Maslow: 1962).

For basic survival people need their basic needs, the extrinsic needs, which refer to behavioural and systemic needs of physical homeostasis and social influence. The problems faced when dealing with these needs could be air and noise pollution, which affects productivity. Social alienation can also be a cause of lack of interaction, resulting in social destruction within a space. When designing spaces for people it is necessary to know which basic needs are being affected in these spaces to design accordingly to enhance the experiences people come across in these spaces (Maslow: 1962).

## **2.2 HUMAN WELL-BEING**

Often overlooked is the impact of the physical and built environment on human senses, emotions, sense of community, participation in community life, and general well-being (refer to figure 2.2), relating to the relationship between environments and how it affects its inhabitants and their behaviour: environmental psychology. Designers aim to create sustainable environments that allow for a positive impact on human well-being. Architects have the greatest impact on human behaviour and their well-being through individual building design.



Figure 2.2: Humanity in a holistic context ([www.mecteam.blogspot.com](http://www.mecteam.blogspot.com))

Before a clear understanding of the impact architecture has on human behaviour can be determined, one must first consider the various aspects of human well-being, health and healing. The World Health Organization defines health as:

*“A state of complete physical, mental and social well-being and  
not merely the absence of disease or infirmity”*

- (WHO: 1948) -

The field of human well-being and stress has become a significant research theme for both the medical and psychological professions. When thinking about a person's well-being, one thinks of a natural healthy environment. People have basic needs; physical, mental and spiritual aspects which combine to determine happiness and well-being (Maslow: 1962). The spiritual and psychological point of view can make an important contribution to a person's well-being that impacts mental and physical behaviour patterns (Day: 2002).

As cultural values change and an increasing number of people live in urban areas, people find themselves leading lives that are separate from nature, which has become negative to mans' well-being, behaviour, mental and physical lifestyle. Regular contact with nature promotes physical and psychological benefits, and it can be argued that this relationship is crucial to an individual's health and happiness. Today's society is technologically advanced with high standards of comfort and convenience, therefore the global population chooses to live and work in cities. Architects and planners are working on a solution that accepts society's urban lifestyle while integrating methods of meaningful integration with nature, such as daylight, vegetation, and fresh air, views of nature, and people; that could improve and encourage physical and psychological well-being.

An individual's basic need for well-being is a representation of their own quality of life. These include the quality of relationships, personal achievements, and individual values, relating to Maslow's basic hierarchy of human needs (Diener & Eunkook: 2000; 3-12).

### **2.3 WELL-BEING IN ARCHITECTURE**

Environmental psychology includes contact with nature, promoting psychological well-being and physical health dates back at least two thousand years according to Ulrich (2002). Alexander (2002) states that the physical environment affects an individual's life and the shape of a building affects one's ability to love, one's well-being and one's behaviour. Spaces and environments affect human well-being in a conscious and sub-conscious manner. Special gesture influence physical and mental state of mind. Vertical proportions draw us up, and the horizontals are calming. Spaces are designed to either influence your state of mind by inviting you to stop or allow you to move through freely (Day: 2002; 184).

Nature is an element of healing. Therefore implementing it into design and everyday life would promote healthier living environments (refer to figure 2.3).

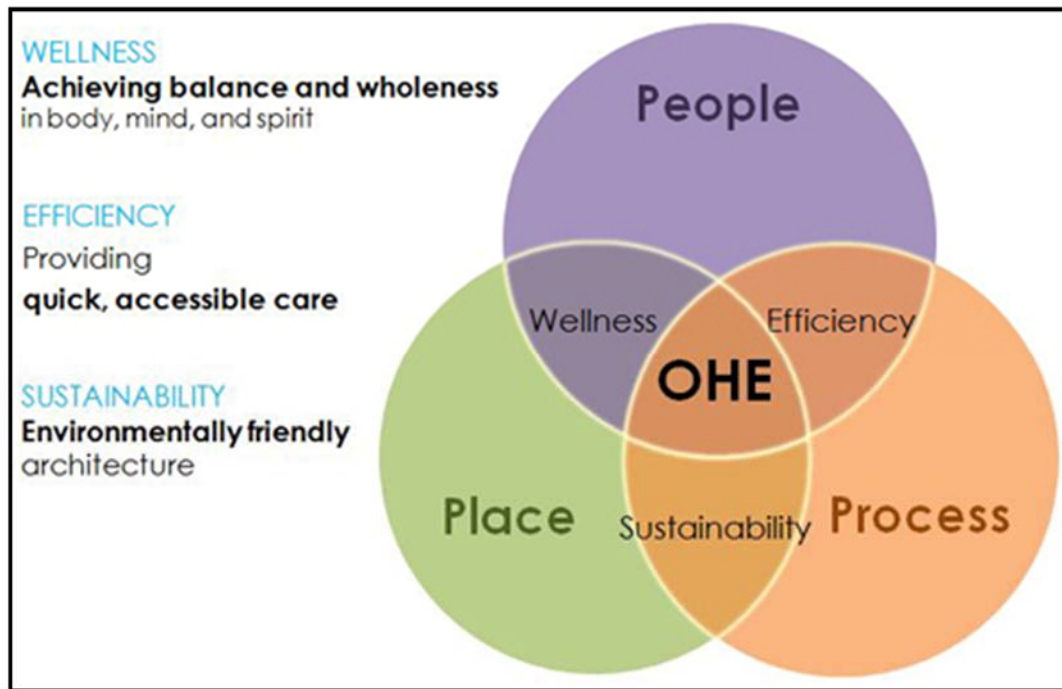


Figure 2.3: OHE: Optimal Healing Environmental strategy ([www.blog.lpainc.com](http://www.blog.lpainc.com))

Day (2002) defines health and well-being as “*a state of renewal, development and balance relation to the world,*” which inform the basic balance of human needs (water, air and warmth) within a man’s physical environment (Maslow: 1962). Butterworth (2000) talks about how people “*prefer environments that support them with safety, food and shelter,*” the basic human needs of Maslow’s theory. Butterworth (2000) also states that people ‘need’ a sense of belonging, as argued by Genius Loci’s theory; people relate to spaces with a ‘sense of place’. The community reflects the symbolic interaction in which people engage as they make use of their physical environment. Architectural form should be designed to encourage a level of social connectivity, through social interaction and engagement to improve the higher esteem needs of individuals (Reynolds, 1990: 101-110).

When dealing with human well-being within a given space one could refer to climatic responses: air quality, thermal comfort of the space, light and ventilation, which are essential to human survival. These elements can be designed for within the architectural built form to improve well-being and lifestyle for humans.



*“Climate-responsive design is based on the way a building form and structure moderates the climate for human good and well-being”*

- Llewellyn van Wyk -



Figure 2.4: Alexandra Hospital, Yishun, Singapore, demonstrates achieving daylighting, natural ventilation and good air quality through courtyard design, promoting well-being in a healthy environment (Guenther & Vittori: 2008)

Clean air is becoming scarce. Outdoor air gets polluted by industrial buildings and traffic and indoor air by furniture and building materials off-gassing, as well as secondary breath and body odours. Most environmental hazards originate in the built environment. Headaches, eyestrain, depression, stress, anxiety, and cancers can all be negative outcomes of poor quality urban environments (Butterworth: 2000; 1).

Ventilation solves most indoor problems. Air quality has to be improved, indoors and out by use of vegetation. Healthy air is vital for well-being in architecture (refer to figure 2.4). Healthy air results in a healthy soul. Plants don't just photo-synthesize CO<sub>2</sub>, giving out oxygen and clears air particles of unwanted chemicals. They improve air quality through re-oxygenation, humidity and temperature moderation, dust anchoring, pollution absorption and ion generation. Vegetation in and around a building also absorbs sound, and are aromatic and soft on the eye (Day: 2002; 42-43).

Man and its environment are seeking to become one. There is nothing living about an industrial building, air-conditioned and chemical factory. Natural materials could bring man closer to nature and the built environment, through living cycles and processes of nature (aging), which is natural to every living thing, including humans (Alexander: 2002). Natural materials minimise

industrial processing when used locally, reducing transport pollution and re-establishes man with their surroundings (Tuan: 1977). A healthier way of design results in a healthier way of living environment. Developing in broader holistic ways through thought and feelings of wellness and vitality would result in buildings as homes of the spirit. By designing with this kind of mind set different buildings would be built and old ones would be modified to support health and even healing (Day: 2002; 187-190).

## 2.4 SICK BUILDING SYNDROME

### 2.4.1 Introduction

Dealing with the issue of buildings showing characteristics of a ‘sick’ building, could result in occupants suffering negative effects. Human beings in general spend almost all of our time in an actual building, whether at home, at work or busy with recreational activities.



Figure 2.5: Sick Building Syndrome in buildings ([www.wci360.com](http://www.wci360.com), [www.lunchtimefitness.com](http://www.lunchtimefitness.com), [www.safetyreport.com](http://www.safetyreport.com))

Sick building syndrome (SBS) can be defined as a, “*psychological and or physical distress,*” which originates particularly in working environments (Baker: 1989; 607–624). What causes sick building syndrome? In general most people do suffer from sick building syndrome without realizing. This condition affects every person within the building, regardless of how healthy they are (refer to figure 2.5). It is said that seated views of nature and proximity to windows are linked to reducing sick building syndrome, increases performance and improves overall health and well-being (Kellert, Heerwagen, Mador: 2008; 120).

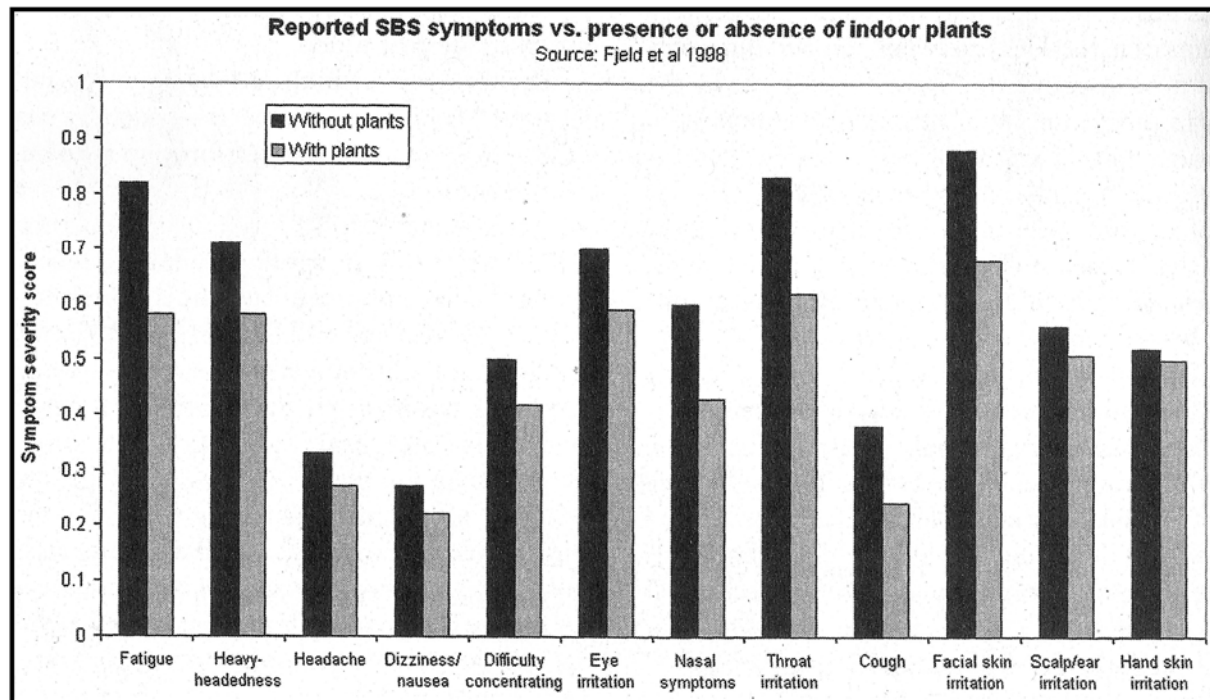


Figure 2.6: Common SBS symptoms with or without outdoor plants (Kellert, Heerwagen, Mador: 2008; 129)

Although sick building syndrome was originally associated with newly constructed and or recently renovated buildings that were designed for energy efficiency (with an inadequate mechanical ventilation system), there are also other environmental conditions that aid in the poorest air quality which is circulated within buildings (Chisholm & Doyle: 1993; 46-47).

#### 2.4.2 Physical and psychological impact

People do not believe a building could be the cause of illness, there is level of disbelief with regards to the environmental and psychological effects. Inhabitants are in an agreement that physical factors, (ventilating, heating systems and organic volatile compounds) play an important role in the psychological, organizational and social impacts that sick building syndrome have on its user (Baker: 1989; 607-624).

Everyday pollution in society has led to the effect of physical and psychological well-being of space users. The psychological and sensual effects of the architectural form are more important than the functional aspect. Stimulating the human senses and relaxation makes spaces pleasurable. Sensual delight is 'the satisfaction of order, variety, rhythm and contrast through the

senses'. It can be achieved by a quality of space that is revitalized with colour, texture, shape and proportion (refer to figure 2.7). Visual sensation and movement in a space create enjoyment, through strong impressions in a space (Lynch, 1982). An open view enables no restriction for an individual to observe and make sense of a scene. Openness depends on a context where people enjoy the defined open spaces as well as panoramas (Nasar, 1998: 68-69).



Figure 2.7: Perspective view of the Millennium Park ([www.jodyforehand.files.wordpress.com](http://www.jodyforehand.files.wordpress.com))

It seems that sick buildings have a long lasting effect on their occupants who over time become unmanageable and irritable, affecting productivity and behaviour patterns. If buildings are healthy and pleasant to occupy, employees are likely to be comfortable. Sick building syndrome is not only associated with the building in isolation. The people working in sick building syndrome buildings were known to have a much higher level of resentment, distrust, defensiveness, anxiety and confusion in comparison to those who worked in non-sick building syndrome buildings (Baker: 1989; 607-624).

## **2.5 BIOPHILIA**

### **2.5.1 Introduction**

Kellert & Wilson (1993), interprets biophilia as a “*positive emotional affiliation of human beings to other living organisms. Innate means hereditary and hence part of ultimate human nature*”, and stated it must be strictly separated from negative or ‘biophobic’ responses to natural entities. When talking about Biophilic Architecture as a general concept and theory of Edward O. Wilson, one starts to analyse the basic behaviours and values of human relationships with nature. The key question is: How can biophilic design affect human behaviour patterns and well-being? As well as: Could biophilic design promote health and is there evidence that can support its effectiveness through the relation between built and natural environments? The problem faced with, is sick building syndrome. Biophilic Architecture could be the solution through a link of natural and physical environments, influencing human behaviour and well-being.

Nature presents the richness and variety of patterns, textures, light and colours that affect human behaviour. A rich sensory environment surrounds us with visual delight, sounds, and variations of temperature as we move through space. The influence of biophilic design can show how architecture and design can evoke human behaviour in the design elements. Many of these elements include the use of light, air, materials, colour, spatial definition, movement patterns, openings and enclosures, volume definition, and interior and exterior connections (Kellert: 2005; 229).

It is clear that biophilic design is not just about nature in architecture and bringing the natural environment into buildings. It is about how humanity relates to aesthetically appealing forms of nature and how the natural environment fits into society (refer to figure 2.8). How can the built environment facilitate behaviour patterns, as well as mental and physical well-being? The idea of biophilic design came from the basic human sensory rich world that affects human health, productivity, emotional, intellectual and spiritual well-being, as well as reducing stress levels and eases pain. Biophilic design aims to create psychological, physical and socially healthful environments (Kellert, Heerwagen, Mador: 2008).





Figure 2.8: Khoo Tech Puat Hospital, integrating and fitting into the natural environment (www.worldarchitecturenews.com)

Futuristic sustainability must have the combination of biophilic design and low environmental impact, resulting in a restorative environmental design (refer to figure 2.8). Lewis Mumford said, *‘the building must... fit its site, harmonize with or stand out from its neighbours, fulfill its own function as a shelter, a work-place, or a play-place, and give a special pleasure to everyone who passes it or enters it’* (Roth: 1993; 135).

*“Biophilic design is the expression of the inherent human need to  
affiliate with nature in the design of built environment”*

- Stephen R. Kellert, Judith H. Heerwagen, Martin L. Mador -

Designers need to compromise and respond to natural conditions such as sunlight, weather, water, plants, animals and landscapes within the physical environment to create a sustainable natural world. Some of the biggest issues faced by the designers are unsustainable energy and resource consumption, air and water pollution, climate change, waste generation, unhealthy indoor environmental conditions, due to human disconnection from nature (Kellert, Heerwagen, Mador: 2008; vii-viii).

Buildings that incorporate biophilia are good-spirited buildings. Biophilic design elements affect the built environment; green networks within urban design schemes, as well as provide natural light to interior spaces for human comfort. What designers can do is design beautiful spaces to invite the spirit in (refer to figure 2.9). Places affect how its user behaves, relate to one another, their mood, spirit and the way they think. If these spaces are designed with biophilia in mind ‘beauty’ and urban sustainability could be achieved (Guenther & Vittori: 2008).



Figure 2.9: Melrose Arch, elements of nature incorporated into urban design creating a ‘sense of place’ (Source by Author)

Tranquillity, delight, human-vitality and social warmth are biophilic elements to de-stress renews, re-integrate and enliven design. It frees us from the elements that cause stress, such as noise. A tranquil place needs to be soothing, calm environment, healing to the soul. A healing or natural environment is not for the ill. Man benefits from healing surroundings, which leads to growth towards wholeness. Day (2002), describes wholeness as: *“a balanced integration of the four levels of our being – body, life-energy, soul and individuality”* inner growth being a process of spiritual development, derived from how its user feel in that given place and how they value it. He also asks the questions: *“How can we create places so meaningfully shaped that they inevitably feel in harmony with their surroundings? Places so linked into the living ecology around them that they root, enliven nurture and inspire those who live in them?”* ...guidance for biophilic architectural designers, linking man with nature (refer to figure 2.10) (Day: 2002). To



what extent is human behaviour (psychological and physical) influenced by natural elements? People working inside of buildings each day desire an office with windows overlooking park-like settings, people build vacation homes at higher elevations with views of water, as well as choosing to go for runs/walks in a park rather than an indoor gym track, to improve their lifestyle psychologically (Wilson: 1993). This creates a response for mental and physical well-being in Architecture through Biophilic design.



Figure 2.10 & 2.11: Healthpark Medical Centre, Florida, biophilic elements linking man with nature (www.flickr.com)

There is so much potential in Architecture to heal and enrich humanity, but there is never one ‘right’ design. Some spaces need stimulation, or to be peaceful and harmonious, some warm and sociable, others cool and tranquil, so focusing our attention to the exterior or interior, all related to basic health in well-being (Day: 2002; 221-240).

### 2.5.2 Restorative environmental and Biophilic design

*“An approach that aims at both a low-environmental-impact strategy that minimises and mitigates adverse impacts on the natural environment and a positive environmental impact or biophilic design approach that fosters beneficial contact between people and nature in modern buildings and landscapes”*

- Steven R. Kellert, Judith H. Heerwagen, Martin L. Mador -

The objectives that restorative environmental and biophilic design follows are energy saving and efficiency, sustainable materials, safe waste generation and disposal, pollution reducing, and indoor environmental quality (Kellert, Heerwagen, Mador: 2008; 5-6). Biophilic qualities exist in



the human built environment, as they do in nature. A building, courtyard, neighbourhood and city have biophilic attributes in materiality, form, space and connectivity to nature, which in turn proves Genius Loci's 'sense of place' theory to be essential in biophilic design (Kellert *et al*: 2008; 235).

Environmental features	Light and space	Place-based relationships
Colour	Natural light	Geographic connection to place
Water	Filtered and diffused light	Ecological connection to place
Air	Light and shadow	Cultural connection to place
Sunlight	Reflected light	Indigenous materials
Plants	Warm light	Landscape orientation
Natural materials	Light as shape and form	Integrated culture and ecology
Views and vistas	Spaciousness	Spirit of place
Facade greening	Spatial variability	Avoiding placelessness
Geology and landscape	Space as shape and form	
Habitats and ecosystems	Spatial harmony	
	Inside outside spaces	

Table 1: Basic human survival needs inform biophilic design, resulting in environmental attributes as design elements (Kellert, Heerwagen, Mador: 2008; 15).



Figure 2.12: Mercato Sport Plaza, Amsterdam, integration with the natural environment (Schittich: 2007; 829)



Figure 2.13: Harrington Grove Country Club, Australia, visual indoor and outdoor special connection (www.archdaily.com)

In restorative environmental design, the emphasis is not on leaving the built environment alone completely, but on '*reconciling it with the natural environment in a way that is psychologically, culturally, and ecologically sound*' (refer to figure 2.12) (Kellert *et al*: 2008; 141). Architects need to create a diversity of spaces linking outdoors and indoors where people have the opportunity to meet between the public and private realms, this will improve the connection of the physical environment, 'that aspect with which the organism, individual, community or

population is in direct contact' (Smithson, 1962: 44). To link the indoors with outdoors a buildings transparency and street accessibility is essential for man vs nature interaction (refer to figure 2.13).

Since every opening in a building has the potential to connect man with nature, the importance of those connections should be equally addressed (Roth: 1993). The challenge is to integrate the natural environment of climate, seasons, textures, sounds, smells and diversity of landscapes with the built environment, creating spaces referred to by Kellert (2008) as *'life style centers'*. Features can be incorporated, such as *'water elements, village-type settings, pleasant landscaping with large trees, meandering pathways, multiple places to see and be seen, and a multiplicity of shops and restaurants'* to create a pleasantly appealing area (Kellert *et al*: 2008; 232).

Applying biophilic design to architecture leads to the conclusion: as much nature as possible should be incorporated into everyday environments, leading towards energy efficiency and sustainability. Nature is the source of mans being. If architecture eliminates nature it would cause negative consequences for man's physiology, mental health and sense of well-being. A clear explanation of how natural environments influence human behaviour has to be investigates to understand what effect that information has on man's physiology (Ulrich: 1993 & Kellert *et al*: 2008; 64-71).

In conclusion Kellert, Heerwagen, Mador (2008) describes the ideal imaginary Restorative environmental and Biophilic design journey of Living Architecture:

*"...walking on a delightful urban street full of flowering native plants, shaded with street. We hear a songbird and rustling leaves. The geometric sidewalk planters are part of a natural drainage system, cleaning the rainwater from the public realm and the building before it heads to a stream.*

*The building's exterior walls are carved in materials that remind one of the mountains nearby, casting fine shadows in the textural detail. Its form seems to be reaching for the sun, while*

*delicate screens guard against the hot rays. We turn, step on local stone and get a glimpse of the lobby. We sense safety, place our hand on a warm wooden door handle, and enter.*

*The light in differential within the comfortable two storey space, as sunlight from above and behind casts a pattern on the wall and floor. The air inside is fresh. We feel a passing breeze and look to see a moving ceiling fan and open windows. The structure of the space is clear, much like a tree, as the forces of nature are expressed within the concrete columns and raw steel beams.*

*The lobby's walls have a subtle random pattern formed from wood with a bronxe patina, and we see a small note about its origin from an old warehouse on this site. We smell coffee, see bright red tulips, and hear a fountain nearby. We look forward across the native stone floor, and seeing our friend through the glass walled elevator, we smile.*

*Another breeze, a warm ray of sun, and movement.*

*Attributes of nature, inside... ”*

(Kellert, Heerwagen, Mador: 2008; 241).

## **2.6 MAN vs NATURE**

Man has evolved over the years, resulting in modern day technological society. Nature is being pushed aside for the comfort of making life easy. Man uses technology, but what is good for us isn't necessarily good for nature. A new way of thinking has to be established to accommodate both nature and new age technology, to provide a healthier future. Environmental psychology links man and nature's relationship, affecting behaviour patterns and well-being (De Young: 2013). A reconnection of wholeness of life and freedom of spirit could heal man, as well as its natural and built environment. An understanding of how surroundings affect man would assist in creating a positive healing environment (refer to figure 2.14) (Day: 2002; 9) & (Kellert, Heerwagen, Mador: 2008; vii).



Figure 2.14: Accommodating man and nature, providing a healthier future ([www.dreiseitl.com](http://www.dreiseitl.com))

*“Our environment influences us and we it”*

- Christopher Day -

Humanity is part of nature and the life in our body, the air in our lungs, the spirit and fire that motivates us. The material world inspires and motivates man through substance, flow, mood spirit and the principals of earth, water, air and fire. Those natural elements connect man with nature physically and qualitatively. Man is warm blooded with two thirds water, making us part of nature, linked with the air we breathe. A lively healthy human and natural balance is created through the elemental proportions of dryness, solidity, fluidity, moisture, air, openness, warmth and sunny aspects of a place. To create healthy places of wholeness and balance these elements must exert their form-giving influences on mans consciousness (Day: 2002; 15-30). Man has the need to experience nature both as an escape from a complex and technical society, escaping everyday issues. The natural environment is unusually effective in terms of the development of mental clarity (Kaplan & Kaplan: 1989 & Kaplan: 1995).

Christopher Alexander's books have a common thread of the need to connect man with nature, looking to nature as a source of mental and physical nourishment (Alexander: 1977). Is the need to connect with nature the course of evolution? Wilson's (1984) theory of biophilia proves that access to nature is a basic human need, not just a preference. Looking at the physical connection between man and nature as a form of beauty that fulfils the soul's basic needs (Day: 2002; 91).

*“Access to nature and green environments yields better cognitive functioning, more self-discipline and impulse control, and greater mental health overall. Less access to nature is linked to exacerbated attention deficit/hyperactivity disorder symptoms, higher rates of anxiety disorders, and higher rates of clinical depression”*

- Rachel Kaplan -

All aspects of the environment shape and influence man, through all our senses, all levels of being and on a social scale. Man responds to its surroundings physiologically through colour, noise level, air quality or temperature (Day: 2002; 111-114 & Kellert *et al*: 2008; 3).



Figure 2.15 & 2.16: Pietro Russo's ECOMO Home: Fitting into its context, creating a 'sense of place' ([www.inhabitat.com](http://www.inhabitat.com))

*“Sense of place refers to the feeling of attachment to a physical environment, such as a place or neighbourhood, and the sense of personal and collective identity that comes from this sense of belonging”*

- Iain Butterworth -

Earth supports living systems, gives rise to social life and enriches the spirit. Being divorced from nature would result in unhappiness and illness.



Reconnecting with nature's energies brings about the outdoor rooms of seasonal breathing (refer to figure 2.15 & 2.16). Living gardens give energy and receive life, which in turn is fulfilling and therapeutic for the soul. For the benefits of social and personal health, creating one's personal food garden assists with self-esteem and motivation (Day: 2002; 146-147). The key is to find a balance between man and nature. Balance is about control of forces, physical and emotional.



Figure 2.17: Melrose Arch, working in close proximity to a positively influenced natural setting (Source by Author)

Most of man's emotional, problem solving, and critical thinking breakthrough skills when in close association with nature, which in turn enhances human health, maturation, motivation and productivity. A true result of a positive environmental psychological environment creates a 'sense of place' where people want to be, that is healthy, nurturing, and delightful to its occupants. People living in proximity to open spaces tend to live healthier lifestyles and have fewer social problems (refer to figure 2.17). Even limited amounts of vegetation such as grass and a few small trees is enough to enhance coping and adaptive behaviour (Kellert *et al*: 2008; 4).

## **2.7 INTEGRATION WITH NATURE RESULTING IN WELL-BEING**

### **2.7.1 Introduction**

In the following sections architectural design interventions will be proposed that can help in overcoming the discrepancy between the current modern living environments and man's sustainable environmental preferences. The central question is how nature, such as planting, can be architecturally integrated in the built environment. According to Stephen Kellert (2005), an

obvious strategy is to offer the possibility of a ‘direct experience’ of nature. This direct experience can be accomplished according to different design interventions:

- Natural lighting and ventilation
- Integrating plant life in the built environment (vegetation or vertical green walls)
- Providing views of the exterior (natural) environment
- Exposure to water near or within buildings (e.g. fountains or water features)
- Incorporating greenery on the building façade (e.g. vines or ‘green roofs’)

In the chapters below we discuss how exposure to water features, vegetation, natural lighting and ventilation and views can positively influence the psychological and physiological well-being of the building occupants. These contents are found to dampen stress, lead to higher pain tolerance, and are associated with positive emotions, psychological and physiological well-being.



Figure 2.18: The gardens of Frank Gehry’s Disney Hall in Los Angeles, providing outdoor meeting spaces for office users, an excellent example of Genius Loci’s ‘sense of place’ theory (Kellert, Heerwagen, Mador: 2008)

Figure 2.19: Alexander Forbes, Sandton, incorporating nature in buildings improves well-being, mental and physical behaviour ([www.paragon.co.za](http://www.paragon.co.za))

### 2.7.2 Green spaces

People believe that contact with nature provides a level of release from stress and improves their well-being, mental and physical behaviour (refer to figure 2.19). When people are stressed and overworked and want to be clearing their heads, escape from civilization, they are motivated to seek out natural green areas (refer to figure 2.18). Green space, both interior and exterior, are essential to architecture promoting a connection with nature. The buildings can start to provide areas rich in vegetation, utilizing a variety of plant life. Kenneth Yeang believes that vegetation should become part of the built environment and an important part of Biophilic design (Jencks & Kropf: 1997; 164). These green spaces soften the built environment creating more inviting and relaxed places while reducing the risk of sick building syndrome and aid in a person's psychological well-being (Beelman: 2005; 53).



Figure 2.20: A harmonious natural environment, for relaxation and socializing ([www.fetemusicians.wordpress.com](http://www.fetemusicians.wordpress.com))

*“Our task must be to free ourselves...  
by widening our circle of compassion to embrace  
all living creatures and the whole of nature and its beauty”  
- Albert Einstein -*

Kaplan & Kaplan (1989), explains that nature gives a person the ‘sense of being’ away from their daily routines, demands and stresses. Natural environments should be relaxing areas for



occupants to socialize, often intrinsically fascinating: keeping the mind interested without effort (refer to figure 2.20). Green spaces are designed for recreation and enjoyment as well as improving the quality and beauty of the local environment, through operable windows or skylights to allow fresh air into the space if the climate allows. Great green spaces are really great public places, such as multistory atriums, which can serve several purposes: providing greenery and daylight to multiple floors creating a visual connection between those floors.

*“Nature is my manifestation of God.*

*I go to nature every day for inspiration in the day’s work.*

*I follow in building the principles which nature has used in its domain”*

- Frank Lloyd Wright -

Green spaces offers direct health benefits such as reducing air pollutants, ozone, and nitrogen dioxide. Trees reduce greenhouse warming by fixing carbon dioxide during photosynthesis, reduces the demand for air conditioning during hot summer days, shades outdoor public areas for comfort and serves as a noise barrier in urban areas (Kellert, Heerwagen, Mador: 2008; 115). This creates a sense of space, which is viewed as an experience in terms of images, sounds, materials and the quality of light valued in their cities and towns as places that nurture the larger community, connecting man with its surroundings (Hertzberger: 2002; 31-32).



Figure 2.21: In an office setting it is not always possible to integrate actual natural elements. A solution is to integrate realistic representations of nonthreatening nature (Source by Author)

Basic interventions such as integrating greenery (refer to figure 2.21), and the below central guidelines, seem to be capable of dampening sources of stress, and can make people immune to future sources of stress.

- Offer the occupants and visitors direct views of nature
- Integrate potted plants and flowers in the office environment
- Design green user-spaces
- Provide pictures and images of nature, if direct contact with nature is not possible

### 2.7.3 Thermal comfort

Charnofsky (2012) stated that: “*thermal comfort is influenced by four environmental conditions that affect the body simultaneously: air temperature, humidity, air movement, and mean radiant temperature,*” these environmental factors are influenced by materials in buildings, as well as the amount of glazing provided within a space, windows sizing, the number of occupants and their activity level (refer to figure 2.22) (Kopec: 2006; 194 & Zomorodi: 2012). Relative humidity indicates how much moisture air can hold. Dry air can readily absorb moisture from the skin which cools the body, while moist air is less able to cool the body which increases the perceived temperature. Air movement (which provides ventilation) has a pronounced effect on heat loss and is generally an asset in the summer and a liability in the winter (refer to figure 2.23) (Lenchner: 2009; 60).

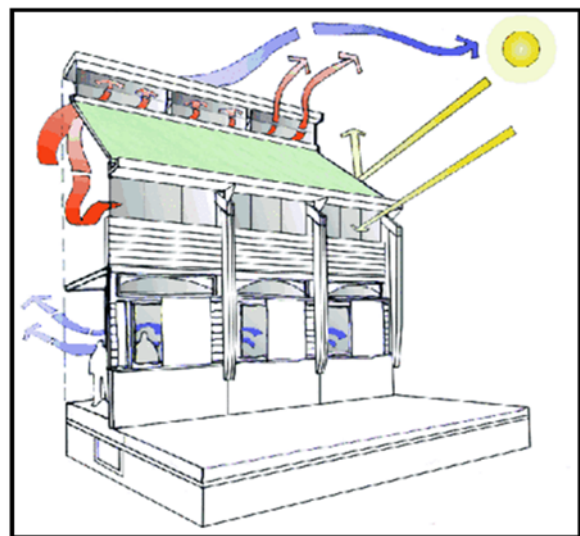
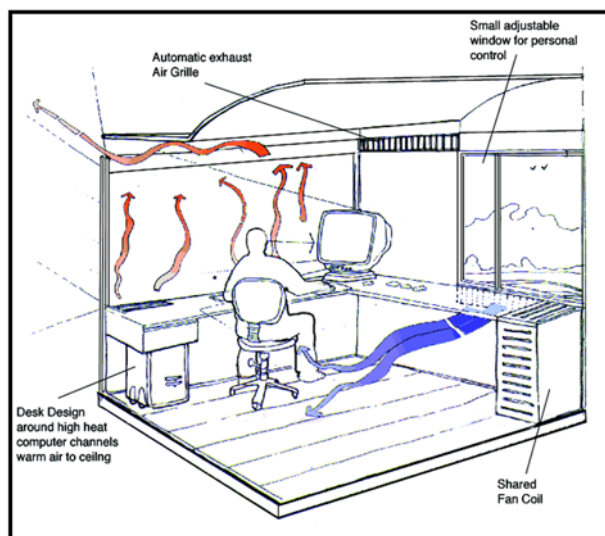


Figure 2.22: The building uses cooling corridors to maintain a comfortable environment ([www.saman3230.wordpress.com](http://www.saman3230.wordpress.com))

Figure 2.23: The office is being controlled with automatic exhaust grills: circulating air ([www.saman3230.wordpress.com](http://www.saman3230.wordpress.com))

Health and Safety Executive guidance cited British Standard BS EN ISO 7730, defining thermal comfort as *“a state of physical ease and the condition of mind which expresses satisfaction with the thermal environment”* (www.hse.gov.uk). However, the comfort zone is defined as the range of climatic conditions within which the majority of people would not feel thermal discomfort, either of heat or cold. Comfort is affected by many other parameters including lighting, noise, culture, habit, personal preferences, and the ability to control the environment, clothing and activities. Buildings can determine many of the physical parameters listed above and influence some of the psychological behaviour of its user.

It is very difficult to pin point thermal comfort's exact definition. Health and Safety Executive guidance stated that: *“a thorough investigation would need to be conducted on a range of environmental and personal factors before concluding what is known as the ‘human thermal environment.’ Thermal comfort is not measured by the air temperature, but by the number of occupants complaining of thermal discomfort.”* (www.hse.gov.uk). Thermal discomfort is a result of heat gain or loss within a given space.

Thermal comfort can increase positive human behaviour and most likely improve self-confidence and productivity as well as contributing to well-being. Therefore, it is important that the indoor environment should be designed and controlled so that occupants' comfort and well-being are assured.

*“Organic architecture seeks superior sense of use and  
a finer sense of comfort, expressed in organic simplicity”*

- Frank Lloyd Wright -

#### **2.7.4 Lighting and natural lighting**

Lighting comes from two primary sources, the sun and electric lighting. Electric lighting started in 1897, when Thomas Edison invented the first ever light bulb. People typically misconceive the justification that the electricity consumption and the brightness of the bulb is related to the watts of the bulb, more watts do not produce more brightness (refer to figure 2.25). In a working environment the occupants assume brighter lighting is more desirable, but it can lead to too much wastage of electricity. This could affect the occupant's emotional and physical discomfort. Too

much light in an office space could deteriorate your health (refer to figure 2.24). Having a constant luminance of 500 when only 100 is needed, could make the user feel lazy and tired, therefore affecting productivity (refer to figure 2.25) (Lim: 2012).

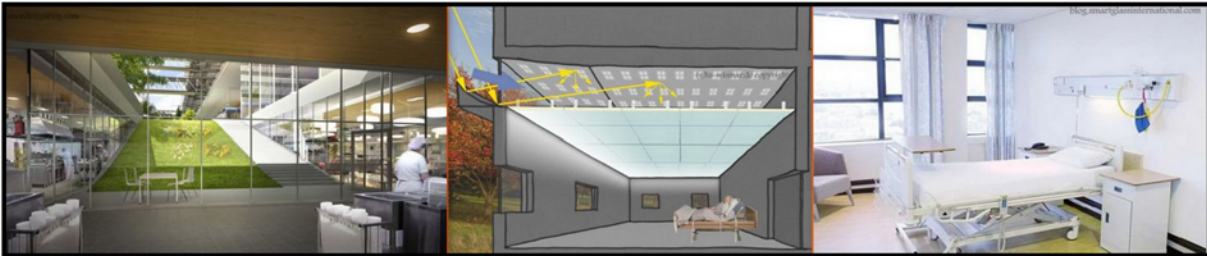


Figure 2.24: The importance of bright day lit spaces in view of the natural environment ([www.blog.japhethlim.com](http://www.blog.japhethlim.com))

Daylight is the most pleasing illumination available to human well-being and environmental needs. Taking advantage of natural light minimizes the need for electric lighting during the daytime, saves energy, saves money and lifts the spirits of building occupants. People crave sunlight. When that craving is not met occupant's behaviour become depressive, lacking energy, increasing appetite, irritability, also known as (SAD) Seasonal Affective Disorder (Lim: 2012). Therefore natural lighting is essential for life and central to health. When appropriately controlled at various times of the day and year to avoid glare, streaks, and excessive heating, as well as complemented by good views, the combination is a powerful component of positive interiors (refer to figure 2.24). A positive experience impacts the occupants' behaviour and mood when the design has been done appropriately, when not; a negative experience is impacted onto the occupants. Daylight's effects on humans are physiological, psychological and physical, relating to the hormone melatonin, which influence levels of energy, alertness and activity (Day: 2002; 193-200).

Building with natural daylighting are more environmentally, technologically and anthropologically aware of green design. Daylit buildings make a statement about their designer: they know their building science and put it into the best possible use by investigating in buildings that use less energy, are more comfortable, and protect our environment.

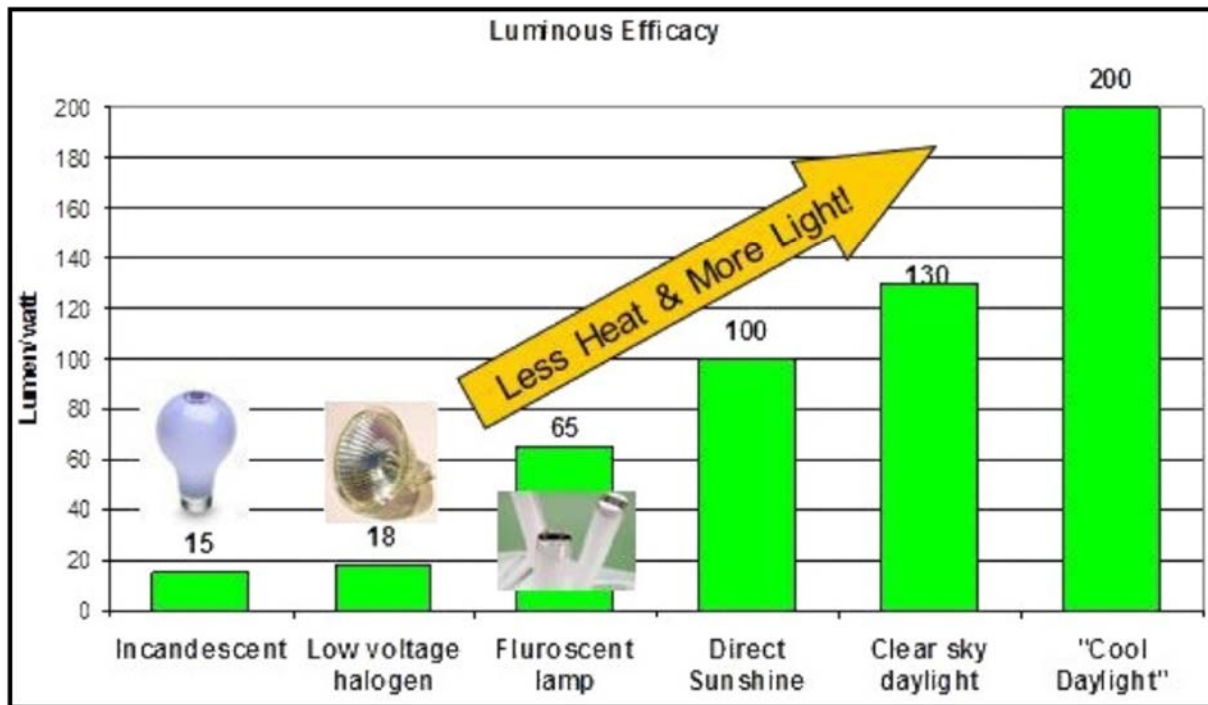


Figure 2.25: The comparison between artificial light and importance of bright day light efficacy ([www.blog.japhethlim.com](http://www.blog.japhethlim.com))

Designing daylighting into buildings can have lasting benefits, including environmental quality and energy savings. Physiologically, sunlight accelerates toxin elimination. It's vital for calcium absorption, vitamin D production and liver processes, therefore essential to human health (Day: 2002; 201). Building orientation and geometry give a solid foundation in quality daylighting design. Glazing size and location will determine daylight quantity. Taking advantage of views will add to occupant satisfaction. An orientation that favours maximum northern and southern exposures minimises solar heat gain and glare in the morning and late afternoon. Tall ceilings and high windows will allow the deepest daylighting penetration into areas. Allowing daylight to come into an area from more than one direction will deeply penetrate the space and provide better uniformity. The aim is to optimize daylight and bring natural light as deep into the building as possible (refer to figure 2.26). A typical window opening can deliver light into a depth of 5 meters with 1% daylighting, but if the designer makes use of channelling of daylight, one can deliver light as deep as 8 meters (Lim: 2012). While daylight can provide better lighting levels that support and improve performance, it can also create glare that compromise work performance (Kellert, Heerwagen, Mador: 2008; 121). Therefore, architects should strive to



provide daylighting to every space of the building, to prevent unnecessary glare in unwanted spaces.

Windows on the north and south facades will provide the best quality daylight. The next step in daylighting design is to select an appropriate glazing type, provide shading to minimize direct sun penetration and integrate the design with the needed electric lighting and controls. Most windows and skylights require shading internally or externally. Vertical shading and landscape features on the north side, helping to reduce penetration (Bonda, 2007: 164-168).

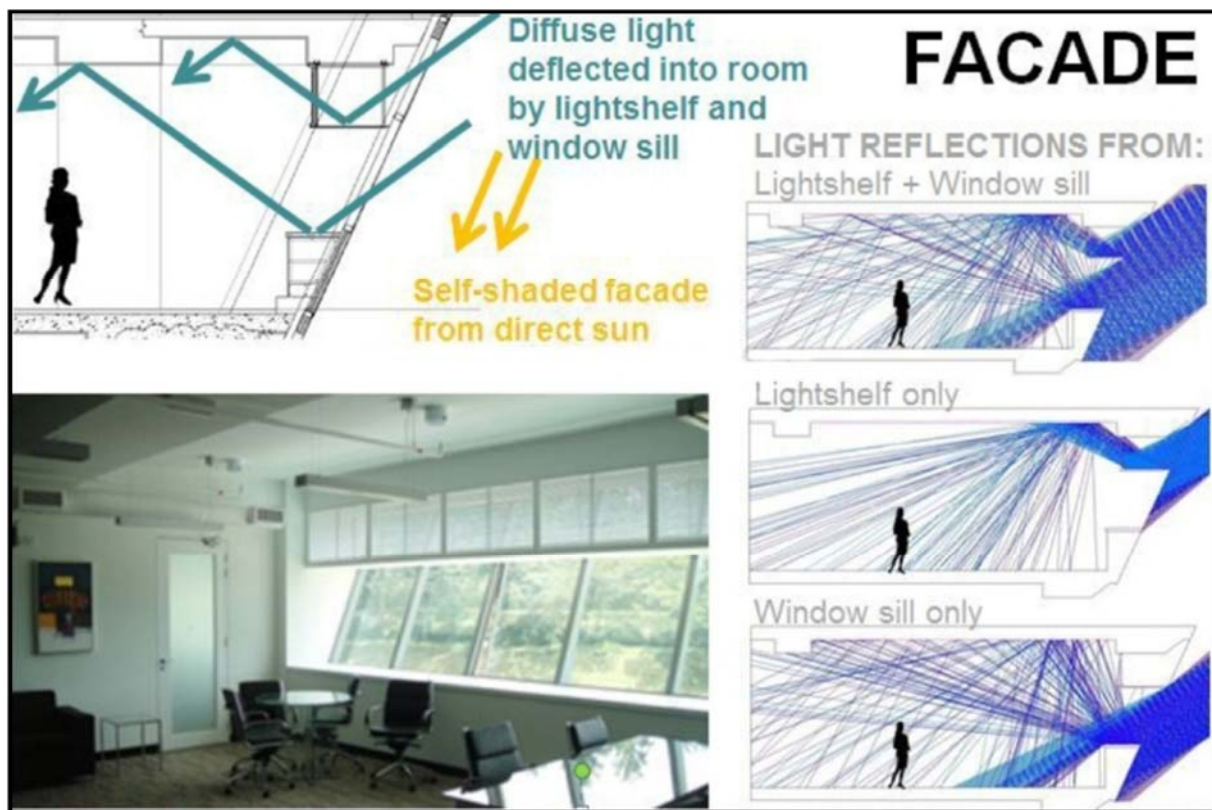


Figure 2.26: Controlling and channelling light deeper into a building, lighting it by 50% (www.blog.japhethlim.com)

*“Daylighting means absorbing diffused light”*

- Japheth Lim -

Daylit rooms from more than one direction can reduce gloom or glare contrasts. The room or building may feel more three-dimensional instead of flat-lit. A variety of colours and intensity

can be pleasing on the eye, stimulating health senses. The more living the light, the more appealing are the places. Daylight comes from the entire sky and gets reflected all around a room this affects the tone, colour and texture of surfaces. Positive lighting in a space nourishes hormone regulating organs such as the pituitary, pineal and hypothalamus. People at work or at home crave daylight or a sunny room, as well as natural views and orientation in place, time and weather. Sunlight influences social, as well as physical and psychological health (Day: 2002; 201-206).

### **2.7.5 Natural materials**

Today's natural material criteria include environmental sustainability. Natural green materials require no toxic chemicals for its production, use and disposal. It is sustainably grown and harvested or includes postconsumer recycled content and it is reusable, recyclable or compostable (Guenther & Vittori: 2008; 297). Natural materials should also be low in Volatile Organic Compounds (VOC's), therefore less toxic, be manufactured locally, have reduced environmental impact and perform for human comfort (Heath: 2009; 175). These materials are also more likely to use organic glues, resins, and sealants and can therefore be recycled. The qualities of materials have their own effect on the mental and physical well-being of people. Considering material toxicity and its impact on air quality is important for creating healthier living spaces. Natural materials as well as the configuration of the space play an important role in an individual's experience to a positive space.

Warmth in material form would relate to wood (recycled wood, sustainably harvested wood, cork, straw, bamboo), people perceive wood to have 'life,' because it's derived from trees (refer to figure 2.27). The texture has a physical aesthetic in materials, and would relate to bricks, because of its rough sense of 'touch'. Bricks can also be placed under the warmth category due to the heat that is given off by the kiln when the bricks are baked. A cool and hard material such as steel is giving off a feeling of clean crisp lines of a powerful industrial machine. Concrete appears to have a cool feel to it, as well as a rough texture aesthetic (refer to figure 2.28). These visual quality materials have on its user influence the mental and physical behaviour of that user within the space, instinctively making them feel 'happier' and more 'emotionally' warmly in a room with unpainted wood, in comparison to a hard and cold concrete room.



Figure 2.27: Natural wood and stone, giving an overall warm, inviting feeling ([www.homegallerydesign.com](http://www.homegallerydesign.com))



Figure 2.28: Steel and concrete in Architecture, portraying a colder less inviting feeling ([www.weburbanist.com](http://www.weburbanist.com))

Natural materials should especially be used on those surfaces that occupants come into immediate contact with such as walls, floors, and furniture. Occupants should be able to appreciate the physical qualities of each material, such as a rough cut stone, or the texture of wool. Other natural materials to serve such functions in architecture are:

- Earthen: plaster, earth, soil
- Animal: silk, wool, leather
- Natural: mud, clay, wood, thatch, stone
- Synthetic: brick, block, concrete, glass, plastic, ceramics
- Mineral: marble, sandstone, granite, flagstone, slate

‘Materials are the raw ingredients of art, but they affect our emotions’, so if a building design was finished in timber or brick the building would more than likely be seen in a positive light, in comparison to the same design finished in concrete, where it would feel cold and unwelcoming (refer to figure 2.27 & 2.28) (Day: 1990; 112-113). It is therefore important that the materials are delicately chosen for the architectural form to positively influence the manner in which the building is perceived by the person on the street as well as its inhabitants.



### 2.7.6 Natural ventilation

Window Master states that, “*Natural ventilation regulates a buildings indoor climate by exploring the temperature differences between the interior and exterior environment, thermal displacement within the building and winds around the building.*” Natural ventilation, in comparison to traditional ventilation systems, is environmentally-friendly, energy-efficient and more economical to maintain. Natural ventilation systems rely on pressure differences to move fresh air through buildings (refer to figure 2.29). Fresh air is required in buildings to reduce bad odors, to provide oxygen for its user and to increase the overall thermal comfort (Walker: 2010).

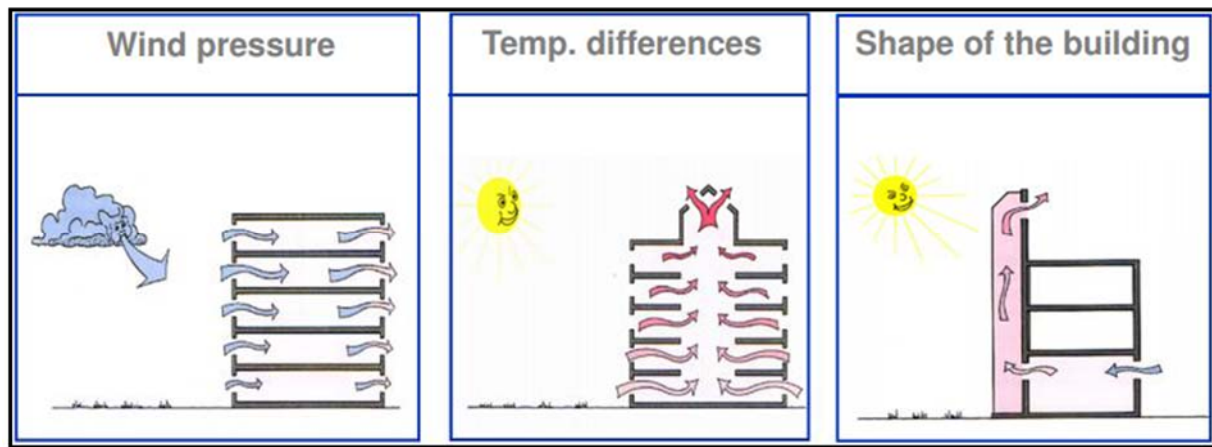


Figure 2.29: Natural ventilation is achieved through controlled openings, influenced by wind pressure, temperature differences and the orientation of the building (www.cibse.org)

A building that is mechanically ventilated will generally have more workers with health-related complaints than buildings with natural ventilation. Natural ventilation has been proven to prevent sick building syndrome, a problem that arises from the gasses given off by toxic building materials which are continuously cycled through the tightly sealed spaces. The benefits of natural ventilation results in reduction of headaches, colds, coughs, circulation problems and sick building syndrome (Kellert, Heerwagen, Mador: 2008; 123). There seems to be a clear understanding of human well-being, the efficacy of the ventilation system and of equal importance, the extent of naturally ventilated or fresh air circulating through the building. Natural ventilation allows fresh air exchange, preventing a build up of toxic gasses and the circulation of airborne germs (Beelman, 2005: 54 & Gissen, 2002: 8, 185). Natural ventilation as well as reducing or eliminating VOCs from their sources can improve the well-being of building

users. To further improve well-being, buildings should provide access to outside spaces such as balconies, terraces, and patios. Each space could also have operable windows to facilitate natural ventilation. Operable windows could be placed in locations that will produce the appropriate amount of airflow, to limit the use of air-conditioning (Beelman: 2005; 54).

There is not always a clear causal link between air-conditioning, heating and ventilation systems and sick building syndrome (SBS). These symptoms surrounding sick building syndrome often continue to persist even after the ventilation issues have been remedied (Chrisholm & Doyle: 1993; 47-19).

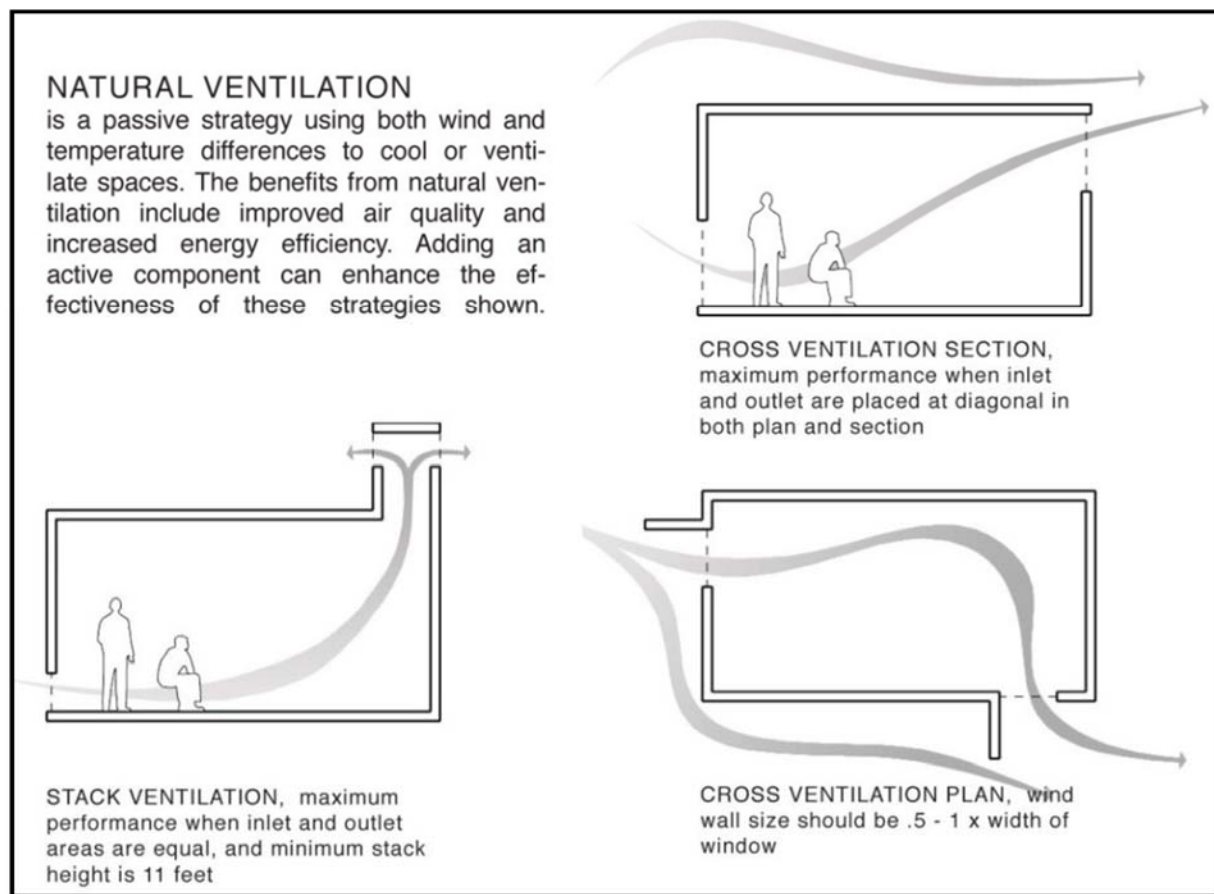


Figure 2.30: Natural ventilation strategies (www.cibse.org)

It is difficult for architects to effectively design for natural ventilation and natural cooling in a building (refer to figure 2.30). Operable windows and vents are challenging to incorporate. One must understand the systems of cross ventilation, stack ventilation and thermally induced ventilation for the chosen region and site (Kellert, Heerwagen, Mador: 2008; 125).

Design recommendations:

- Natural ventilation in buildings
- Windows should be operable
- Skylights
- Internal air movement
- Mechanical ‘cooling’ systems
- Fan-assisted cooling strategies
- Stack effect ventilation systems (Walker: 2010).

### **2.7.7 Conclusion**

In conclusion, it can be argued that architectural environments have a direct psychological impact on people’s everyday life, health and well-being. It is necessary to understand the psychological implications of natural materials, natural ventilation, natural light, thermal comfort, and green spaces for people and architecture should function as a positive medium between people and their environment.

In office environments, glare and discomfort should be avoided by using light shelves, reflective walls, skylights, atriums, or other forms of shading and indirect lighting. Natural ventilation requires a good understanding of cross-ventilation, stack ventilation, and thermally induced ventilation.

It is not only the spaces which are important but the materials and textures of the space as well. Similar to the spaces, the more ‘natural the state’ of the building material the more positive these environments will appear to an individual. Therefore it can be said that architectural environments have a direct lasting impact on its user’s behaviour and reaction patterns, whether it is emotional, spiritual, positive, or negative.

## CHAPTER THREE PRECEDENTS STUDIES

### 3.1 INTRODUCTION

The theoretical framework and literature review have explored the behaviour patterns and well-being of humans in the built environment and design elements influencing such reactions. The selected precedent studies in this chapter are chosen for the purpose to identify criteria discussed in these previous sections. The buildings chosen to review are of different typologies, serving as appropriate examples of architectural responses to prove the symbolic relationship between man and nature. The aim is to develop an understanding of how nature influences the built form, improving the issue of sick building syndrome in order to inspire a relevant building typology, which enhances human productivity, through the below criteria:

- Man vs Nature - (*environmental psychology*)
- Thermal Comfort - (*sense of place*)
- Natural Elements - (*biophilia hypothesis*)

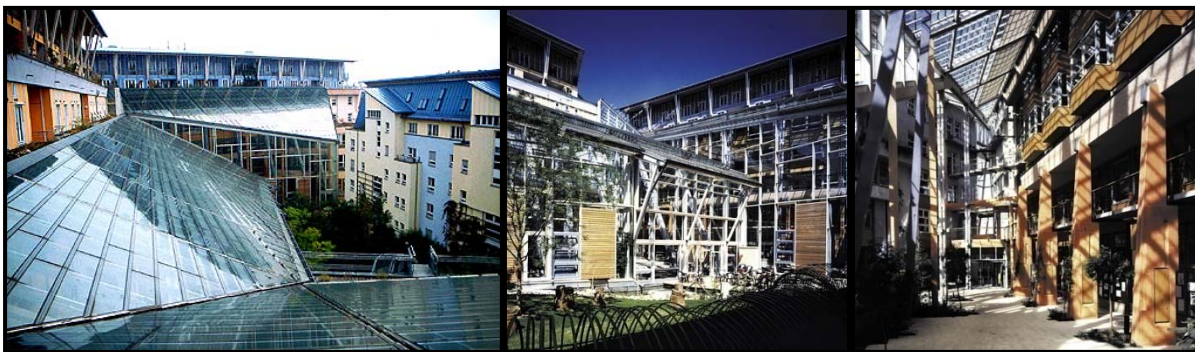


Figure 3.1 & 3.2: Prisma Nürnberg, Nuremberg, Germany ([www.dreiseitl.net](http://www.dreiseitl.net) & [www.benngiles.blogspot](http://www.benngiles.blogspot))



Figure 3.3 & 3.4: Khoo Tech Puat Hospital (KTPH), Yishun, Singapore ([www.cooper.edu](http://www.cooper.edu) & [www.flickr.com](http://www.flickr.com))

The intention of investigating precedent studies is to reveal the purpose of theoretically informed research to modern day building design. Through these precedent studies one hopes to find motivation relevant to facilitate and promote physical and mental human well-being through biophilic design and improve behaviour patterns in future proposed developments and help inform a new typology.

### 3.2 PRISMA NÜRNBERG (NUREMBERG, GERMANY)

Architects: Joachim Eble, project architect G. Richter, Tübingen

Location: Nuremberg, Germany

Client: Karlsruher Insurance Company, Karlsruhe

Completion date: July 1997

Total floor area: 18 000m<sup>2</sup>

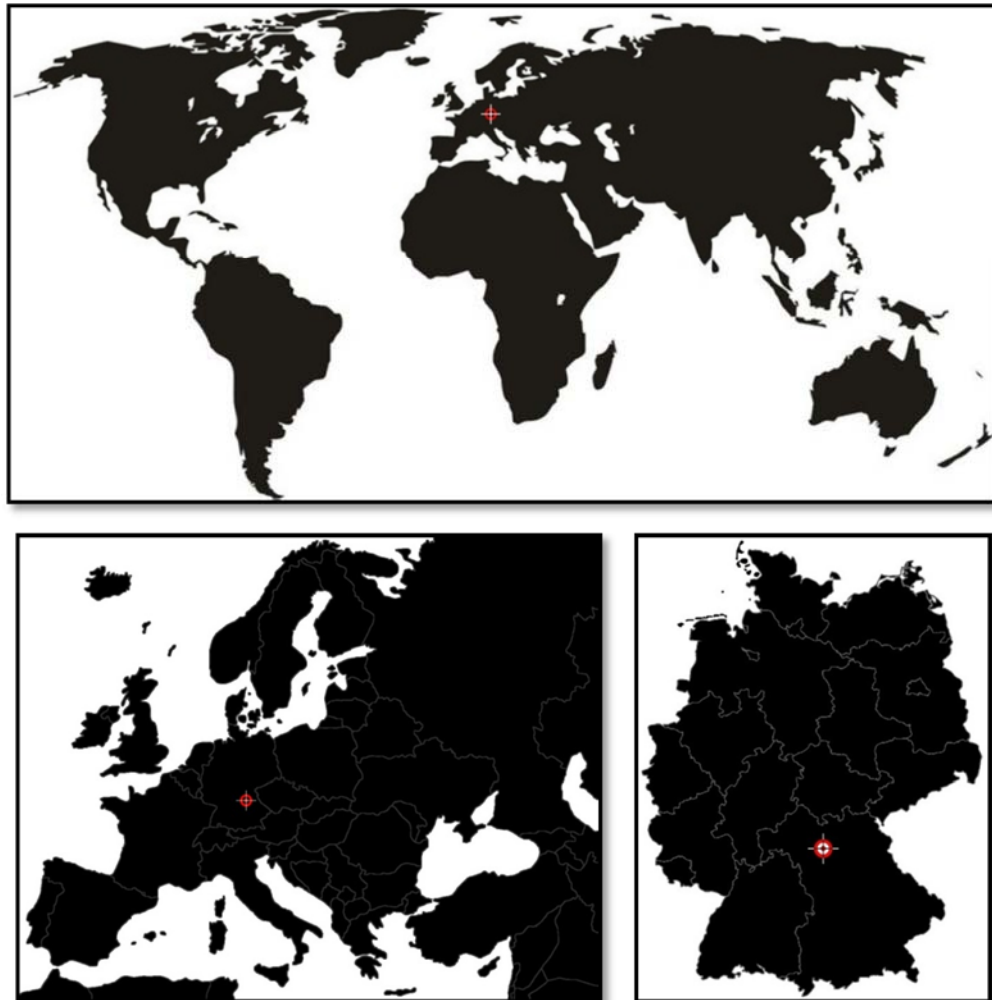


Figure 3.5, 3.6 & 3.7: Site Location: Prisma Nürnberg, Nuremberg, Germany (Source by Author)



### 3.2.1 Introduction

Prisma Nürnberg, a socially balanced (cost-efficient and sustainable) energy-saving revitalizing Urban Mixed-use Complex, located in the centre of Nuremberg, Germany. The three buildings and green courtyard complex are an architectural improvement of the surrounding environment, fitting into its urban context. The design intention was to combine a living and working environment, bringing nature into the building, allowing semipublic access through the atrium, urban relaxation shopping mall (Löhnert: 1998). The mixed-use complex consists of 32 offices, 9 stores, a coffee house, 61 residential units and a kinder garden, all under a peaceful paradise atrium surrounded by plant life and running water features, creating a natural aesthetically appealing and comfortably fitting context.



Figure 3.8: Prisma Nürnberg: Inner atrium courtyard features flowing streams and rich vegetation (Dreiseitl & Grau: 2001)



Figure 3.9: Prisma Nürnberg: An energy revitalization mixed-use urban city complex ([www.lowimpacthousing.com](http://www.lowimpacthousing.com))

Emerson (2010) noticed that, *“the falling water draws down fresh air, pulled in from a slit in the wall, and moist air blows gently into the space at a speed of about ten feet per second,”* this system cools and heats up the building throughout the different season of the year. This building combines the elements of storm water collecting, rain water treatment, daylight harvesting, creating a comfortable indoor environment (Emerson: 2010; 136-138).

### 3.2.2 Man vs Nature (the human need to affiliate with nature)

Natural environments can psychologically and successfully influence the behaviour patterns of its users. The success of the urban building concept is a result of the people who have accepted the building qualities, urban services and functions. The environmental psychology concept of the building was to create a pleasant atmosphere in the centre of the city through waterfalls, luxurious vegetation, fresh air and a healthy positive naturally lit environment that moderates the indoor climate, creating a 'sense of place'. The entire roof design guide rain water into cisterns for the buildings future use (refer to figure 3.10, 3.11 & 3.12). Prisma Nürnberg's design inspiration was drawn from Frank Lloyd Wrights 'Fallingwater' house, imitating forest design, the sound of rushing water, natural smooth stone and vast vegetation adds to natures' influence of Biophilic design, blending the inside of the building with the natural exterior environment, linking indoors with the outdoors (Dreiseitl & Grau: 2001; 53).

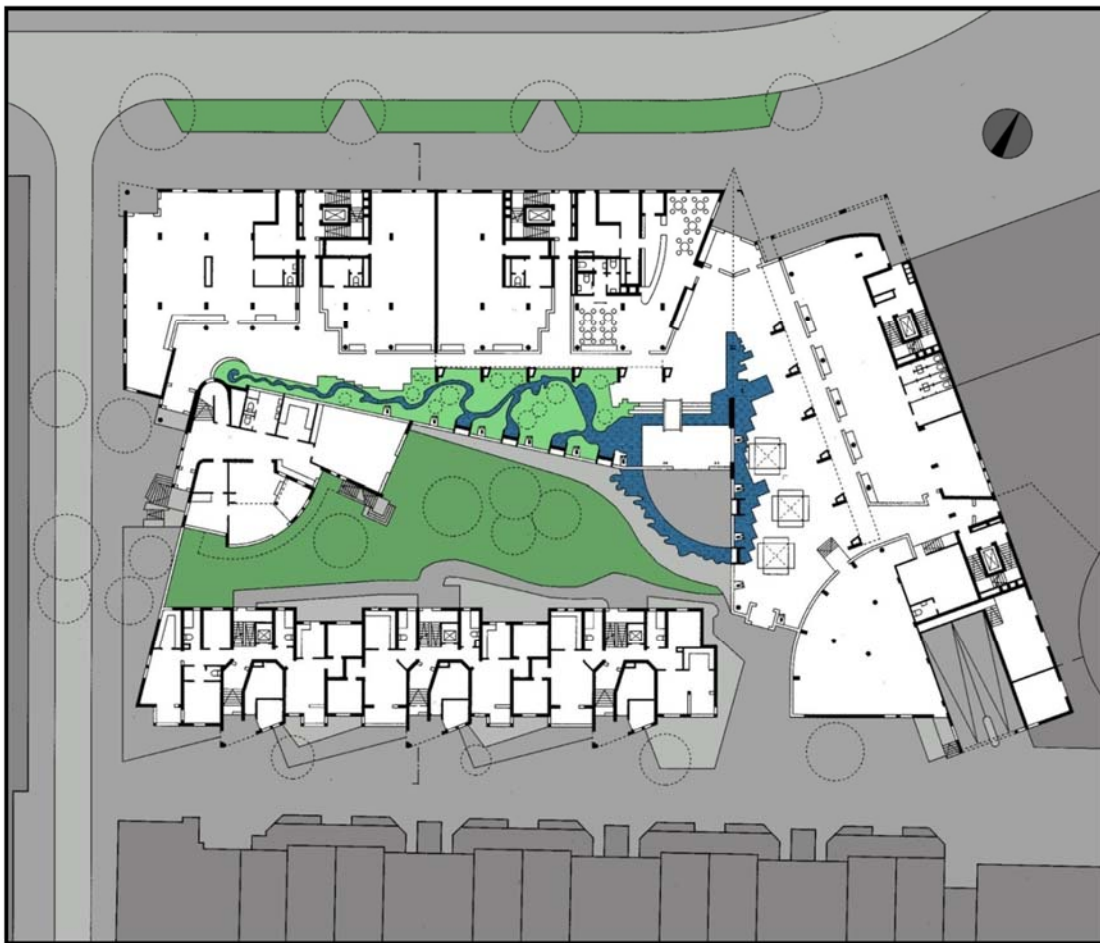


Figure 3.10: Ground Floor Plan of Prisma Nürnberg, identifying the natural elements connecting the interior with the exterior, linking man with nature, creating a sense of comfort within the built form (Löhnert: 1998 & by Author)

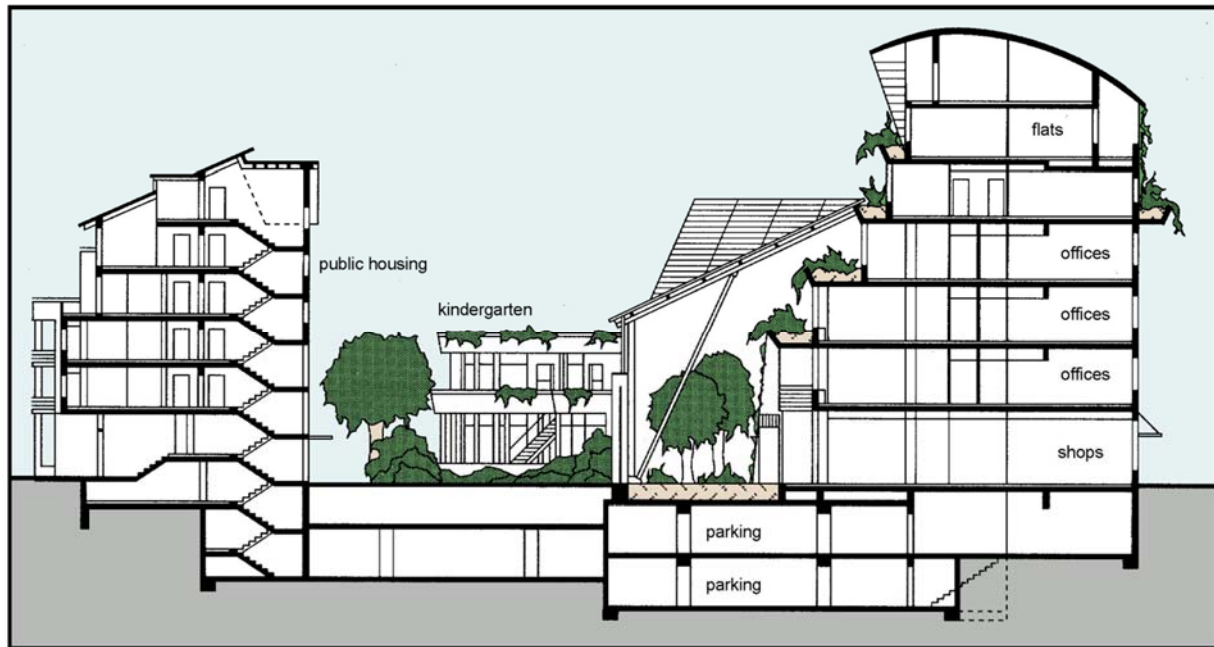


Figure 3.11: Section of the South-West block: multi-storey housing, elevation of the two-storied kindergarten, the landscaped courtyard garden and play ground, four-storied atrium space and the terraced main office building topped by two floors of flats (Löhnert: 1998 & by Author)

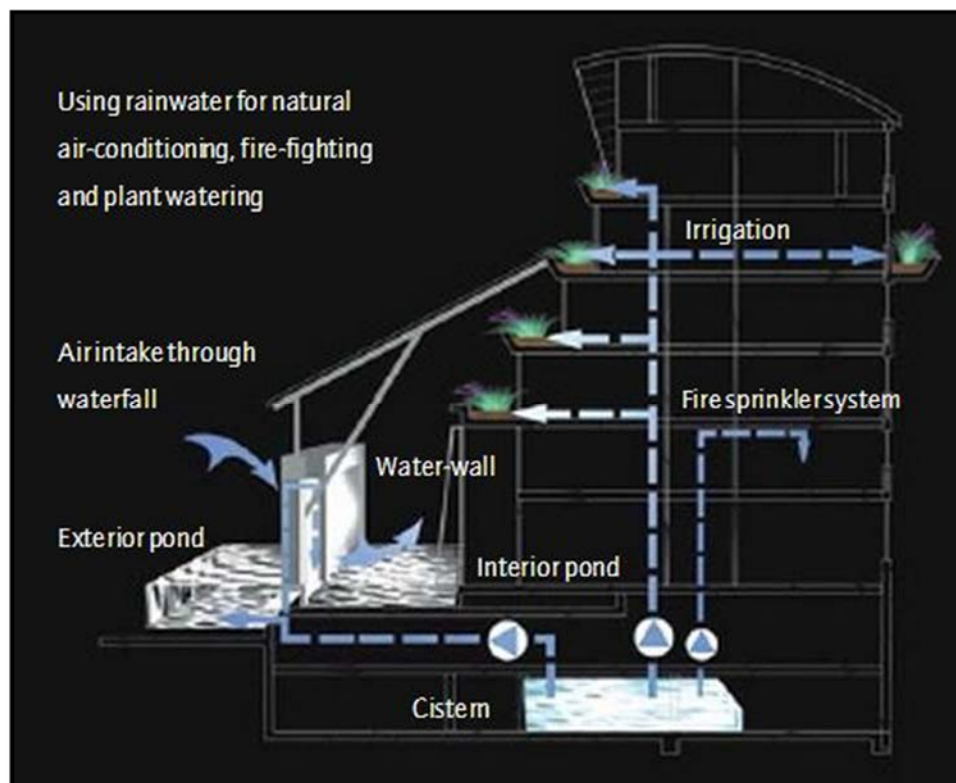


Figure 3.12: Rainwater concept: collection, storage, purification, infiltration & irrigation system (Dreiseitl & Grau: 2001; 53)



### 3.2.3 Comfort (indoor air quality and spatial design)

The Prisma Urban Mixed-use Complex was designed directly for human well-being requirements, through implementing an indoor environment. Design solutions such as natural light, air treatment, natural building materials and surface treatment, noise, odor and electric climate was taken into consideration to guarantee comfortable indoor conditions (refer to figure 3.13, 3.14 & 3.15).



Figure 3.13: Interior atrium Café, bursting with natural light and ventilation ([www.curt.de](http://www.curt.de))



Figure 3.14: Interior atrium Café, bringing nature into the building through biophilic design ([www.in-goho.de](http://www.in-goho.de))



Figure 3.15: Interior atrium Café, incorporating warm natural elements such as wooden tables and chairs ([www.curt.de](http://www.curt.de))

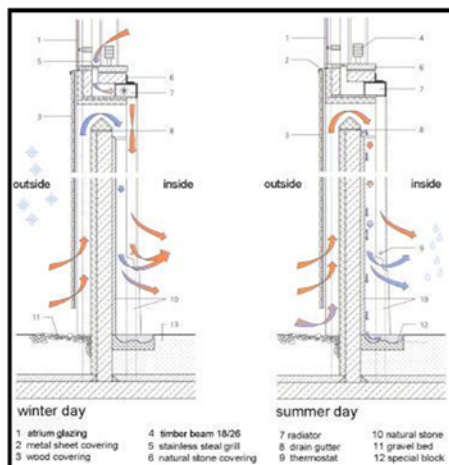


Figure 3.16: Sections of bioclimatic natural air conditioning wall system construction (Löhnert: 1998)



Figure 3.17: Southern road side view into the Prisma Nürnberg, Urban Mixed-use Complex ([www.vi.sualize.us](http://www.vi.sualize.us))

In figure 3.17, the urban neighbourhood is linked to the semi-public space with a vast atrium space of 1000m<sup>2</sup>, the connecting spatial element within the building development (Löhnert: 1998). This concept of ‘sense of place’ of Genius Loci relates to how the users of the buildings’

physical and mental emotions and feelings are ‘stimulated’ in each different environment through the Prisma Nürnberg, Urban Mixed-use Complex. A bioclimatic wall construction supplies the building with natural air conditioning from the outside the air intake system is hidden by a timber screen covering. Additional natural ventilation vents provide high air change rates in summer (refer to figure 3.16).

### **3.2.4 Natural Elements** (water / gardens / natural ventilation & lighting)

According to Edward, O. Wilson’s biophilia hypothesis, ‘*human beings have a natural interest and attraction to nature,*’ such as bringing nature into buildings, using natural materials and surfaces, vegetation, allowing natural light and ventilation. Natural design elements such as rainwater treatment and the design of indoor and outdoor planting help with the balance of negative influence of soil sealing, as well as improve the internal environment (refer to figure 3.18 & 3.20) (Löhnert: 1998). Rainfall is processed through small wetlands on the building shell, to an interior pool, and then moved to a cistern beneath the building and an exterior pond. The water then supplies on-site greenhouses. Interior waterfalls create and cool the air in summer (refer to figure 3.18 & 3.19) (Kellert, Heerwagen, Mador: 2008; 54).

The glazing elements of the atrium roof can be opened almost completely to provide sufficient natural ventilation, but when the atrium is closed in winter it acts as a buffer space. Therefore fresh air supply will be preheated passively by solar gains. Interior shading roller blinds prevents overheating. Operable windows supply fresh pre-cooled air, forced displacement ventilation and natural views for the offices facing the atrium, whereas northern office spaces avoid open able windows, due to city noise and street pollution (refer to figure 3.21 & 3.22). In summer the building is ventilated by the night air, cooling down the heavy mass construction of the building (Löhnert: 1998).

Within the atrium of the building two different types of water irrigation cycles are used. One irrigates the vegetation in the greenhouse, where as the other pumps water 5meters up into six glass walls for purification (refer to figure 3.12 & 3.19), cooling the building for thermal comfort (Yudelso: 2009; 74).



Figure 3.18: In bedded water-feature: water storage for internal irrigation (Löhnert: 1998)



Figure 3.19: 5 metre high glass purification water-feature wall (Löhnert: 1998)



Figure 3.20: Internal planting in auditorium (Löhnert: 1998)



Figure 3.21: Northern entrance into the Prisma Nürnberg, Urban Mixed-use Complex ([www.barexchange.com](http://www.barexchange.com))



Figure 3.22: Northern offices avoid open able windows, due to city noise and street pollution ([www.eng.archinform.net](http://www.eng.archinform.net))

Prisma Nürnberg is a good example of a building that incorporates the design criteria of Biophilic Architecture. The mixed-use complex was designed to link man with nature to promote health and well-being. The naturally lit facility which incorporates indoor landscaping includes the benefits of water as a means of creating a psychologically relaxing environment, which in turn would positively affect the behavior patterns of its users.



### 3.3 KHOO TECK PUAT HOSPITAL (YISHUN, SINGAPORE)

Architects: Partners & Associates, CPG Consultants Pty. Ltd., Executive Architect

Location: Yishun, Singapore

Client: Alexandra Hospital

Completion date: June 2010

Total floor area: 105 000m<sup>2</sup>

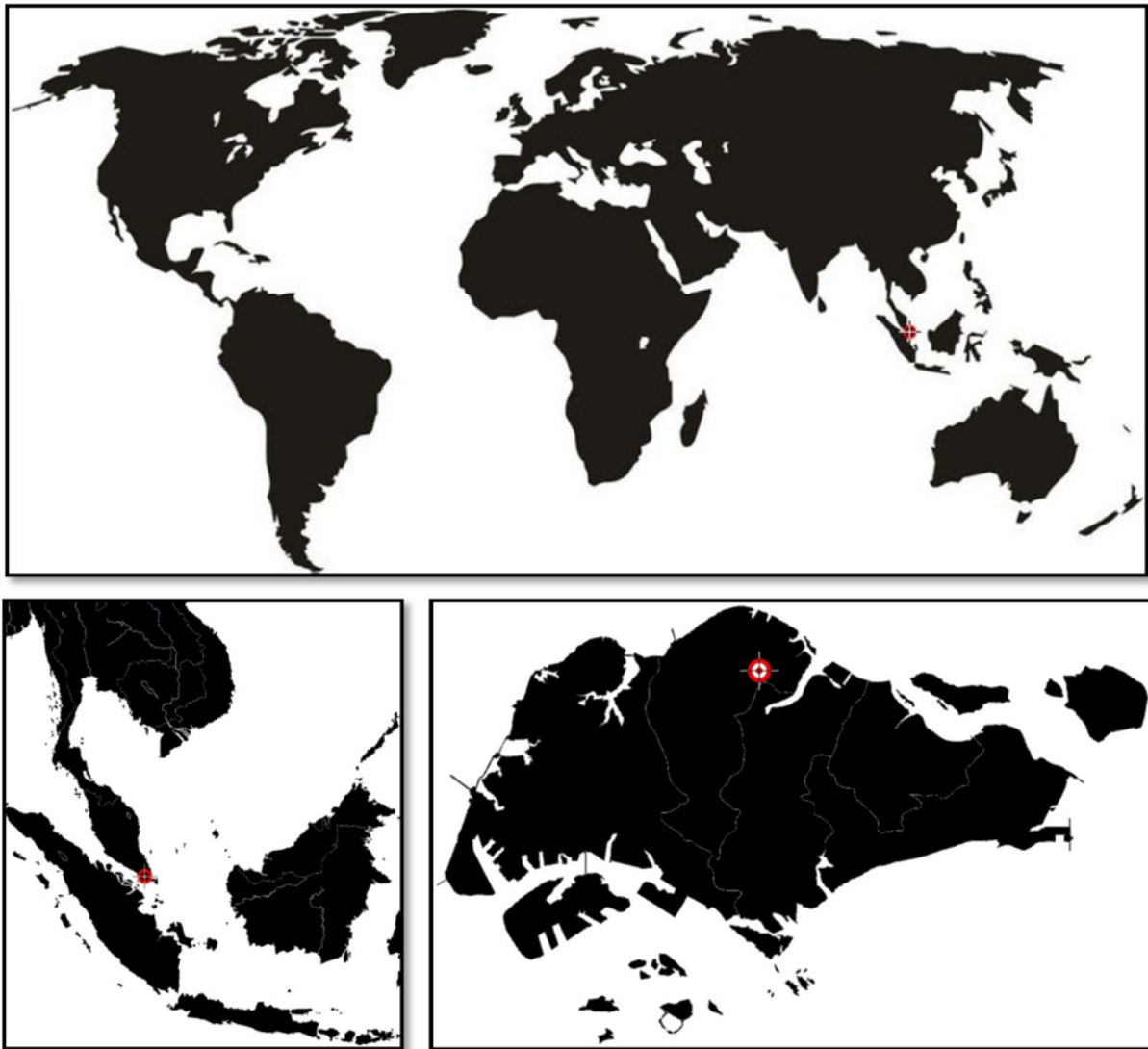


Figure 3.23, 3.24 & 3.25: Site Location: Khoo Tech Puat Hospital, Yishun, Singapore (Source by Author)

### 3.3.1 Introduction

Khoo Tech Puat is Singapore's first green hospital, with an energy efficient reduction costs of 50% and provide 70% of the floor area with natural ventilation, the energy efficiency comes to 27% (index (EEI) of 220kWh/m/year), designed for patient and staff comfort, achieved through daylighting, air and temperature control and heat recovery to reduce their carbon footprint. KTPHs' three block, garden courtyard, terraced gardens and planter box ward layout is situated next to a scenic natural pond in central Yishun. The design of KTPH brings together the elements of accessibility, comfort and convenience (Teoh: 2011).



Figure 3.26: Areal view of Khoo Tech Puat Hospital (KTPH), Singapore (www.worldarchitecturenews.com)

### 3.3.2 Man vs Nature: (the human need to affiliate with nature)

*"The garden courtyard is the heart of the hospital. One can see the whole hospital from the courtyard and enjoy the view of the Yishun Pond, serving as a catchment for rainwater that is subsequently used to irrigate the hospital gardens. The courtyard also brings light and greenery into the basement,"* says Jerry Ong, a Designer of KTPH, who believes the gardens cool the hospital and aid in patients' recovery (Teoh: 2011). The environmental psychological influence of ample natural vegetation has on these patients increase their behaviour patterns, assists with their recovery time and improves their health and well-being (refer to figure 3.27 & 3.28).



Figure 3.27 & 3.28: The garden courtyard: Heart of Khoo Tech Puat Hospital (KTPH) ([www.worldarchitecturenews.com](http://www.worldarchitecturenews.com))

The three block KTPH wards allow for maximum transparency and natural views, through an open facade design, connecting man with the surrounding natural setting (refer to figure 3.29). “*Our design concepts are underpinned by the desire to create a healing environment...*” which is central to the design idea that “*nature would nurture,*” explains Mr Lee Soo Khoong, the Architect of KTPH (Design Singapore Council: 2013). The KTPH’s design has been sensitive in terms of scale and height, communicating to its surrounding public housing blocks by opening outwards, towards the adjacent Yishun Pond, drawing nature into the building (Design Singapore Council: 2013).



Figure 3.29: The garden courtyard: allowing for natural views, connecting man with nature ([www.geolocation.ws](http://www.geolocation.ws))



### 3.3.3 Thermal Comfort: (indoor air quality and spatial design)

KPTH's private wards are air-conditioned for consistent comfort, while additional wards are naturally ventilated. Passive shading strategies such as, sunshades over windows, were carried out to control glare and heat gain, as well as enhance the brightness of wards and save energy usage (refer to figure 3.30 & 3.32). Jerry Ong says, *“specially-designed sunshades on the east and west facades, and glazing and thermal insulation for an opaque facade with low U-value have resulted in KPTH enjoying 23.6% less heat gain from its facades,”* ensuring thermal comfort for its user, through a special quality, a ‘sense of place’ (Teoh: 2011).

Well-ventilated public areas, such as roof solar panels: fitted to heat water for the hospitals’ use, exterior louvers: block out direct sunlight and cooling systems: to channel prevailing winds throughout the interior (Design Singapore Council: 2013).

Teoh (2011) established that *“Low-VOC paints and adhesives were used indoors, UVC treatment eliminates airborne bacteria and viruses, and carbon dioxide and carbon monoxide sensors monitor air quality,”* therefore ensuring a comfortable healthy environment.

### 3.3.4 Natural Elements: (water / gardens / natural ventilation & lighting)

KTPH's facilities overlook a central garden courtyard, rain harvesting rooftops and a main transparent entrance atrium landscaped with natural greenery and water features, and multilevel patient ward designer planter boxes, incorporating biophilic design strategies into the building, nurturing man's affiliation with nature (Design Singapore Council: 2013).



Figure 3.30, 3.31 & 3.32: Window design strategies allow for natural airflow and reduces glare, providing clear storey lighting into basement parking below, angled screens controlling sunlight (www.greenprospectasia.com)

Designers orientated the building to take advantage of the north and southeast wind speed of at least 0.6m/s. Wind tunnel tests performed at the National University of Singapore found that the ‘fins’ designed on the exterior of the building, guiding and enhancing air flow by 20 - 30%. This ‘wing wall’ design reduces the need for fans by 60%. Operable modular jalousies windows allow for natural airflow and controls the incoming rain, tinted glass reduces glare and heat gain, while multi level planter boxes connects man with nature throughout the building (refer to figure 3.30 & 3.32). Light shelves help reduce glare, as well as penetrate sunlight deep into the interior. This complements the effect of a 30% cut in use of artificial lighting (Teoh: 2011).

Roof gardens and community gardens are designed for residents and occupants of the building (refer to figure 3.31), while Mr Lee Soo Khoong, a Designer of KTPH, noted that members of the public also use the hospital facilities such as the gym to exercise, come admire the greenery and a view of the pond, or have their daily meals or study at the food court. He believes that KTPH represent a ‘public interest’ in the design approach of a communal ‘sense of space’, in cities where privacy confine and exclude public spaces. *“Building design should be inclusive in approach, and whenever possible, spaces should be opened up and shared,”* says Mr Lee Soo Khoong (Design Singapore Council: 2013).

Wilson’s biophilia hypothesis states that humans need contact with natural forms, promoting positive human behaviour; performance, productivity, emotional well-being, stress reduction, health and well-being, through emotional and spiritual satisfaction (Wilson: 2006 & Kellert: 2005). A truly positive environmental psychological building such as this endures, resulting in a place where people want to be, a place that is healthy, nurturing, and delightful to its occupants. Nature and natural elements provide the most sufficient environmental cure.

## CHAPTER FOUR CASE STUDIES

### 4.1 INTRODUCTION

This chapter comprises of primary research in the form of case studies, with dimensioned drawings, photographs and a critical evaluation of first hand information gathered from the employees and users, which will ultimately inform the design of the proposed development. The purpose of the case studies was to assess the performance of a single built environment holistically – in terms of all the issues that have been discussed. A major problem concerning biophilic design is the lack of appropriate examples in South Africa. Therefore, green star sustainable buildings have been chosen to assess according to the below criteria:

- Thermal Comfort - indoor air quality and spatial design
- Man vs Nature & Natural Elements - the human need to affiliate with nature
- Behaviour Patterns - feelings and reactions in the built form



Figure 4.1, 4.2, 4.3 Alexander Forbes, Sandton, Johannesburg, South Africa ([www.paragon.co.za](http://www.paragon.co.za))



Figure 4.4, 4.5, 4.6 Nedbank Ridgeside, Umhlanga, KwaZulu-Natal ([www.gbcsa.org.za](http://www.gbcsa.org.za), Orientation Booklet, by Author)

Through using the above guidelines an understanding of each architectural environment can be achieved, in relation to the human behaviour and well-being in biophilic design.

In light of this understanding, the most appropriate examples have been chosen. The reason for choosing these examples is that each has a connection with nature and some form of sustainable design, which in turn influences human behaviour patterns. Although the selected building does not represent an exact topological example of what is needed, it certainly provides the opportunity to identify and analyse specific environmental factors in terms of the research.

#### 4.2 ALEXANDER FORBES (SANDTON, JOHANNESBURG)

Architects: Paragon Architects

Location: 115 West Street, Sandton,  
Johannesburg, Gauteng, South Africa

Client: Zenprop Property Holdings

Completion date: October 2012

Total floor area: 100 000m<sup>2</sup>

Cost: R950 million



Figure 4.7: Site Location: 115 West Street, Sandton,  
Johannesburg, Gauteng, South Africa (Source by Author)



Figure 4.8: Alexander Forbes, 4 Star SA-Green Building Council - Office v1 Design rating, Sandton ([www.gbcsa.org.za](http://www.gbcsa.org.za))



#### 4.2.1 Introduction

Alexander Forbes Headcounters in Sandton consists of eight floors of dedicated office space, housing 2200 employees, above six floors of parking. The ground floor includes a canteen, training spaces and an auditorium, with the front wing providing two levels of dedicated meeting space. The building also provides facilities such as a crèche, gymnasium, restaurant, shower facilities, coffee shop and convenience stores promoting a comfortable environment for its users. The 4 Star Green Star SA Office v1 Design building achieved its status in October 2012. Total points allocated for Green design is 48, where the majority is a result of energy sufficiency and indoor environment quality design, creating pleasant spaces by blending into the urban fabric of society (GBCSA: 2012).

#### 4.2.2 Thermal Comfort (Indoor air quality and spatial design)

Edward Kieswetter, CEO of Alexander Forbes states, *“our staff will enjoy a more natural and healthy environment, with increased circulation of fresh air, reduced heat loads, numerous pause and other plant-filled break-out areas, combined with state of the art work stations and the latest information and building technology,”* (Dimmer: 2013) the main aim of this building design was to ensure its users thermal, mental and physical comfort, achieved by incorporating Genius Locis’ ‘sense of place’ theory, affecting their behaviour patterns.

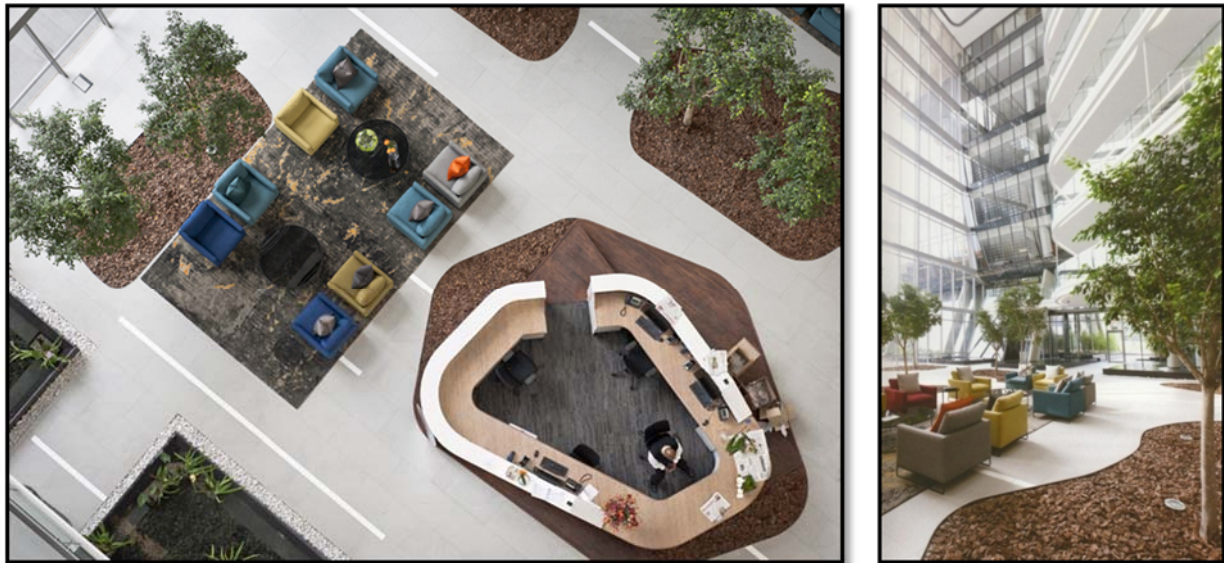


Figure 4.9 & 4.10: The ground floor waiting area ([www.paragon.co.za](http://www.paragon.co.za))

The ground floor waiting area is carefully positioned near natural greenery and external views to make the public feel comfortable while waiting to pass through tight security into the building (refer to figure 4.9 & 4.10). The elegantly designed food court social mixed-use spill out onto a timber landscaped outdoor relaxation deck, linking a visual connection through the two wings of the building, as well as provide a calm and restful atmosphere by incorporating natural elements (biophilic design) into the interior design of the space, such as stone countertops, bamboo panelling, stimulating wallpapers etc.



Figure 4.11 & 4.12: Floating bridges connecting the N&S blocks, with designated 'pause areas' of different style and design, on each floor (www.paragon.co.za, by Author)

There is a sense of 'floating' internally, created by steel bridges that connect the north and south blocks across the two atriums, this open space allows for natural lighting, connecting internal with external views (refer to figure 4.14 & 4.15) (Dimmer: 2013; 41-45). Break away or pause areas are provided on every floor, as well as on each wing of the building, creating areas for socialising and relaxation, enhancing a comfortable 'sense of space' (refer to figure 4.11 & 4.12).

#### **4.2.3 Man vs Nature & Natural Elements**

Indigenous low water consumption planting connect the interior and exterior spaces of the building, creating a forest like canopy. Slow moving water features give a calming feeling to the interior and add a natural element to the harsh exterior of Sandon's busy streets (refer to figure 4.13). Two atria provide sufficient natural daylight and visual connection within the building to its surroundings (refer to figure 4.14 & 4.15).





Figure 4.13: Calm slow moving interior water features (Dimmer: 2013)

Figure 4.14: Transparency allows for natural light and visual connection through large glazed atria ([www.paragon.co.za](http://www.paragon.co.za))

Figure 4.15: Skylight cones above atriums provide light in deeper spaces (Source by Author)

Eight glazing formats were used throughout the building, such as skylight cones above the atriums, escalators and central lobby (refer to figure 4.15). Achieving the balance between the right amounts of light versus heat gain, the glass façade on the ground and first floor meeting areas, sloping inward at an angle of 67.37 degrees, have been fitted with integrated motorised blinds, which functions as an internal design feature (refer to figure 4.2).

The internal finishes have a low volatile organic compound content, ensure a healthy indoor environment. Hugh Fraser of Paragon Architects talks about the “*columns and scallops, the movement of light and shading, floating and organic shapes of the building,*” giving it a life like quality (Dimmer: 2013; 40-41). A sense of transparency has been achieved with the inclusion of 22 000m<sup>2</sup> of glazing which allows natural light to fulfil 58% of lighting needs and provides 64% of office areas with views and natural ventilation, these strategies connects man with nature through biophilic design, inside and outside (refer to figure 4.16) (Lambert: 2013).



Figure 4.16: Large windows visually connecting the interior with natural surroundings (Source by Author)

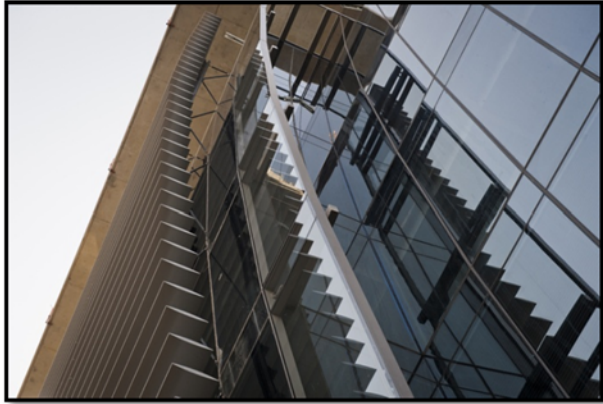


Figure 4.17: Cleverly orientated, remote controlled, façade shutters (www.paragon.co.za)

The energy efficiency of the building is achieved through special heating and cooling systems, motion-sensitive fluorescent lighting fittings and cleverly orientated façade shutters, saving up to 40% of the building's energy cost (refer to figure 4.17). The building saves 67% of portable water use, reducing cost saving. Water recycling is achieved through harvesting grey water, treated and combined with filtered rainwater for toilet and urinal flushing as well as watering ground floor internal and external planting. The atrium also holds reflecting ponds clad in black 5mm porcelain tiles (Dimmer: 2013; 47).

#### 4.2.4 Behaviour Patterns (Feelings and reactions in the built form)

Brian Wilkinson, CEO of GBCSA, said *“Green building, healthy buildings are also a nicer place to work, and studies have shown that people are 20% more productive in a green building, with less sick days being reported”* (Wait: 2012). Edward Kieswetter, CEO of Alexander Forbes, stated that their *“key objective was to ensure the health and well-being of our employees, whom we consider to be the company's greatest asset,”* by incorporating convenient and comfortable special design, resulting in positive staff productivity (refer to figure 4.18) (Dimmer: 2013; 40-41). Kieswetter describes breakaway or pause rooms, informal and formal energy centres for people to work, think and play, these social spaces create a social atmosphere within the building, connecting man with its surroundings (Dimmer: 2013; 41-45).

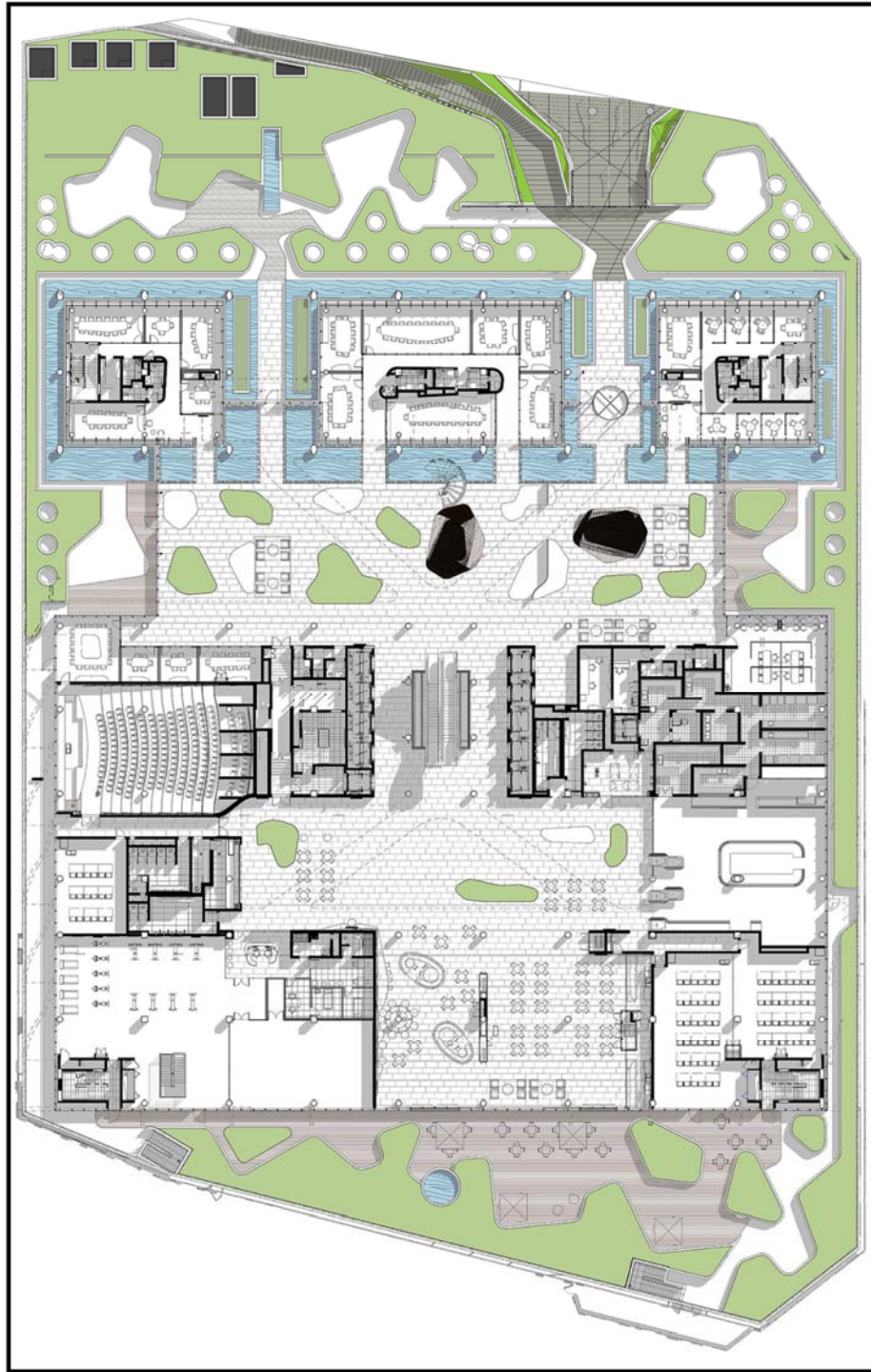


Figure 4.18: Ground Floor Plan of Alexander Forbes, ([www.paragon.co.za](http://www.paragon.co.za))

An aesthetically beautiful building such as the Alexander Forbes building contributes huge factors towards the comfort of its occupants, which results in positive behaviour patterns and increased productivity. The interior fixtures and finishes of the building throughout combine



natural colours and soft design lines, creating a calm aesthetic and atmosphere of restful tranquillity, creating an environment of health and well-being (refer to figure 4.19 & 4.20). Although the building enhances its user's behaviour and well-being it disconnects itself from the public, appearing intimidating to the everyday pedestrian, due to its plinth design, elevating it from street level (refer to figure 4.21).

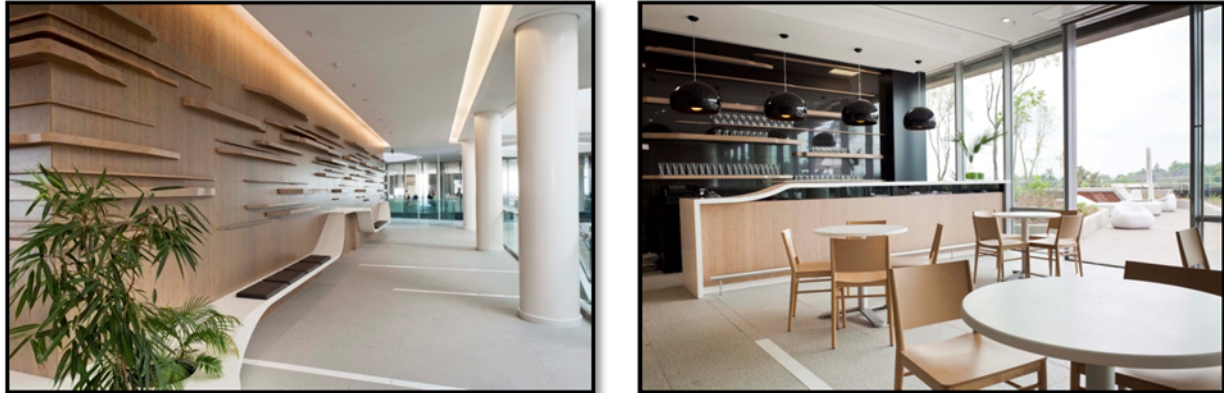


Figure 4.19 & 4.20: Interior fixtures and finishes creating a sense of environmental psychology (Source by Author)

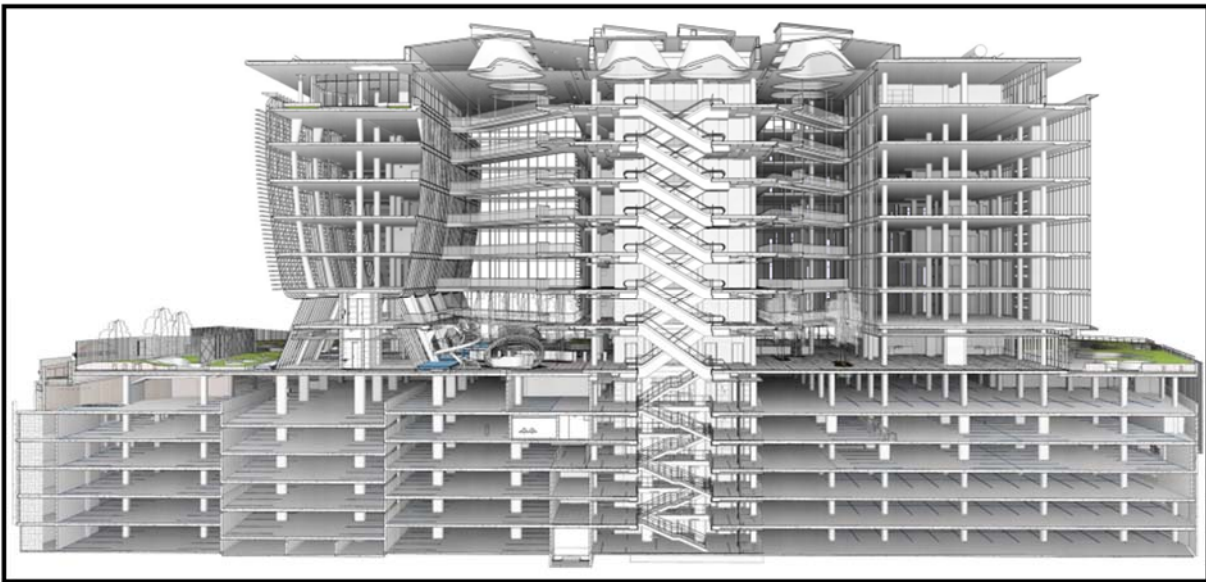


Figure 4.21: Cross Section of Alexander Forbes ([www.paragon.co.za](http://www.paragon.co.za))

The natural psychological environmental design throughout the building creates a pleasurable, relaxing atmosphere for the occupants. The provision of natural elements provides relief from the everyday stresses experienced. Through personal observation it was found that most of the Alexander Forbes building occupants feel positively comfortable and healthy within their office

environment, and do not suffer from the lack of concentration, motivation and positive productivity. This clearly indicates that natural views, natural ventilation and the implementation of natural elements on all levels, through Biophilic design improve the occupants' behaviour patterns on an everyday basis. The building provides a practical example for sustainability on a societal as well as environmental level through its incorporation of sustainable technologies and design strategies of nature in architecture, natural ventilation and lighting providing a level of comfort to the interior.

#### 4.3 NEDBANK RIDGESIDE (UMHLANGA, KWAZULU-NATAL)

Architects: dhk Architects

Location: 2 Ncondo Place, Ridgeside,  
Umhlanga, KwaZulu-Natal, South Africa

Client: Zenprop Property Holdings

Completion date: November 2010

Total floor area: 20 000m<sup>2</sup>



Figure 4.22: Site Location: 2 Ncondo Place, Ridgeside,  
Umhlanga, KwaZulu-Natal, South Africa  
(Source by Author)



Figure 4.23: Nedbank Ridgeview, 4 Star SA-Green Building Council - Office v1 Design rating, Umhlanga (Source by Author)

#### 4.3.1 Introduction

Nedbank Ridgeview is an environmentally sustainable office development, constructed by Zenprop Property Holdings (PTY) Ltd, obtaining a 4 Star Green Star rating from GBCSA, at a score of 55points. Both client and developer made a commitment to create a building which will provide a sustainable environment that result in higher levels of comfort, productivity and well-being of its 600 occupants.

#### 4.3.2 Thermal Comfort (Indoor air quality and spatial design)

Healthy indoor environments contribute to improving productivity, thermal comfort and general well-being of building occupants (refer to figure 4.24). Office spaces have a suspended insulated ceiling which contributed towards the reduction of energy usage (air conditioning system), preventing temperature transfers between inside and outside (refer to figure 4.25). Different factors contribute to good indoor air quality. Interior finishes in buildings contain high levels of Volatile Organic Compounds, found in adhesives, sealants, paints and carpets, which have a negative impact on human health. For this building low VOC material was used to ensure a healthy indoor environment (Duncan: 2013).



Figure 4.24: Healthy indoor environments contribute to health and well-being (Source by Author)

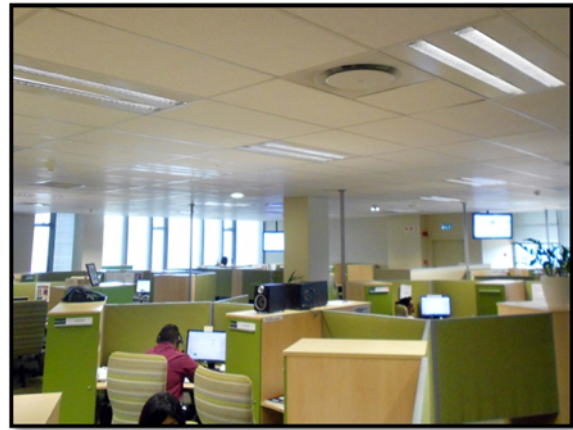


Figure 4.25: Suspended insulated ceiling ensuring a healthy indoor environment (Source by Author)

Nedbank Ridgeview was designed to maintain a comfortable internal noise level for offices, which was recommended by the South African National Standards (SANS), which does not exceed 45nBA. A noise level between 40 - 45dBA is considerable for a comfortable, productive working environment (Duncan: 2013).





connection to external environments, lowering eyestrain through relaxation and refocus on natural elements (refer to figures 4.27 & 4.28). The exterior of the building materials (concrete panels, brickwork and double glazing) is well insulated, creating a comfortable working environment, requiring less mechanical ventilation and lighting, reducing energy usage, through the use of thermal mass (refer to figure 4.27). Shading and insulation on the South East double glazing prevent glare and heat gain into office spaces (for thermal benefits), where maximising views were considered (refer to figure 4.28).



Figure 4.27: Exterior facades of the building to maximise visual connection to external environments (Source by Author)



Figure 4.28: Shading, insulation and double glazing prevent glare and heat gain into office spaces (Source by Author)

Nedbank Ridgeview's water strategies control stormwater run-off and reduce water consumption through low flow flushing toilets, sinks, basin and shower mixers, waterless urinals and landscape irrigation, through rainwater harvesting (190m<sup>3</sup> on site), which minimises municipal potable water intake (Duncan: 2013).

The office lighting system was designed to dim or switch off lights when spaces are unoccupied through motion sensing, as well as when sufficient daylight is provided, referred to as daylight harvesting. Office lighting provides sufficient Lux levels at the lowest possible energy consumption, achieved at a power density of 1.78 W/m<sup>2</sup> per 100 Lux (Duncan: 2013).

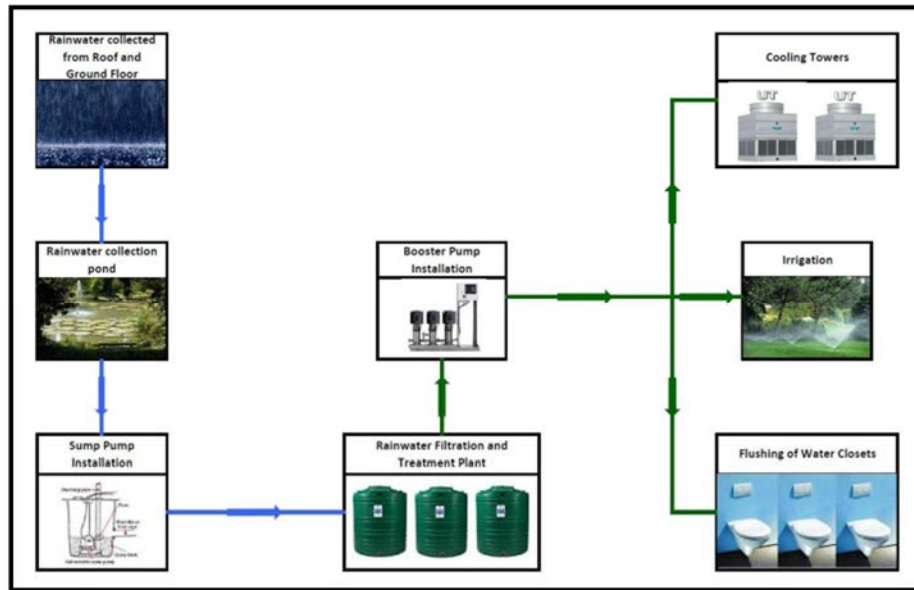


Figure 4.29: Rainwater harvesting and re-use schematic (Nedbanks' Building users guide: 2012)

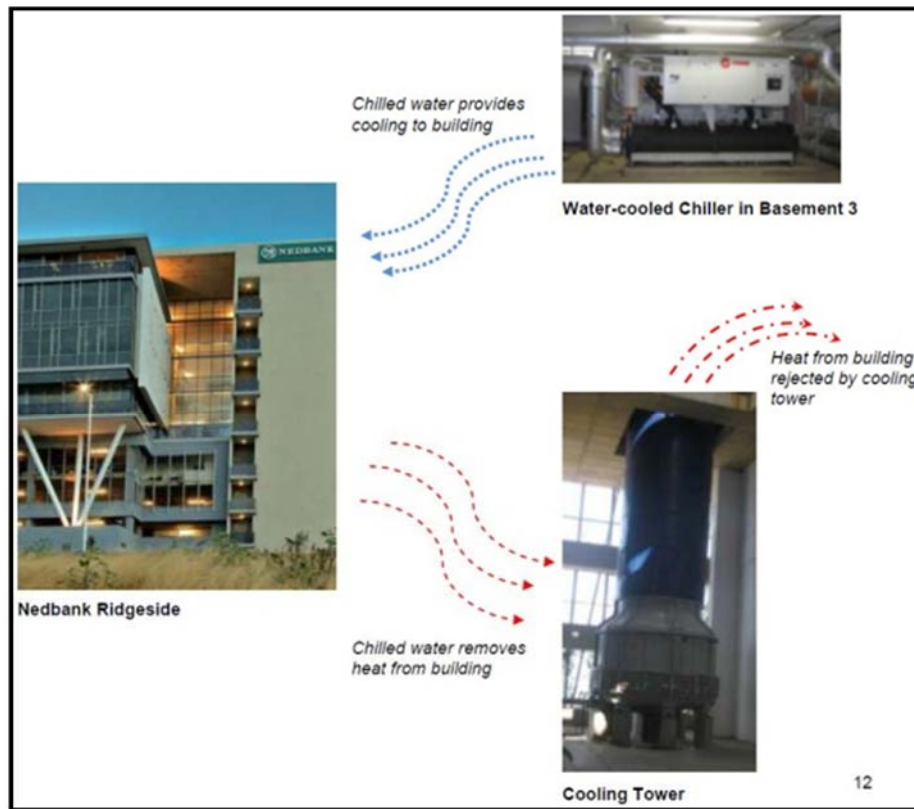


Figure 4.30: Typical office area cooling air-conditioning system (Nedbanks' Building users guide: 2012)

An energy efficient chilled water pumps and air chiller have been installed in the building, which is 20%, contributing to the reduction of energy usage (refer to figure 4.29). A cooling tower fan

contributes to building ventilation, controlled by a variable speed drive pump (refer to figure 4.30). Nedbank Ridgeview's energy consumption target is set for the ventilation and air-conditioning system at 35VA/m<sup>2</sup> (Duncan: 2013). Over and above the cost saving in energy through water harvesting, lighting control etc, Nedbank Ridgeview's 4 Star Green Star rating costs the building R53 000 per month to maintain (Duncan: 2013).

#### 4.3.4 Behaviour Patterns (Feelings and reactions in the built form)

Workspace within an office building influences behaviour patterns, therefore individual stations affect productivity levels (refer to figure 4.31). Brian Steinhobel designed Nedbank Ridgeview's Hybrid desk, which offers practicality in terms of flexibility, mobility and space efficiency, as well as the Ditulo 'form chair', which is 57% recycled, to improve the occupants working environment (refer to figure 4.32).

Individual offices offer privacy by the use of nature based 1 way glass as well improving comfort through wall graphics that capture the beauty of natural landscapes connecting man with nature. A double volume naturally lit, glass façade atrium allows for maximum lighting to penetrate all levels of the building, generating internal and external visual connections between man and nature. A food court on ground level, as well as two designated pause areas on each level is provided to increase the comfort and well-being of the occupants.



Figure 4.31: Low panel work stations, allowing natural light deep into the interior (Source by Author)

Figure 4.32: Old and New improved Ditulo chair design, increasing occupants health and well-being (Source by Author)





Figure 4.33: Entrance foyer naturally lit multi storey atrium (Source by Author)

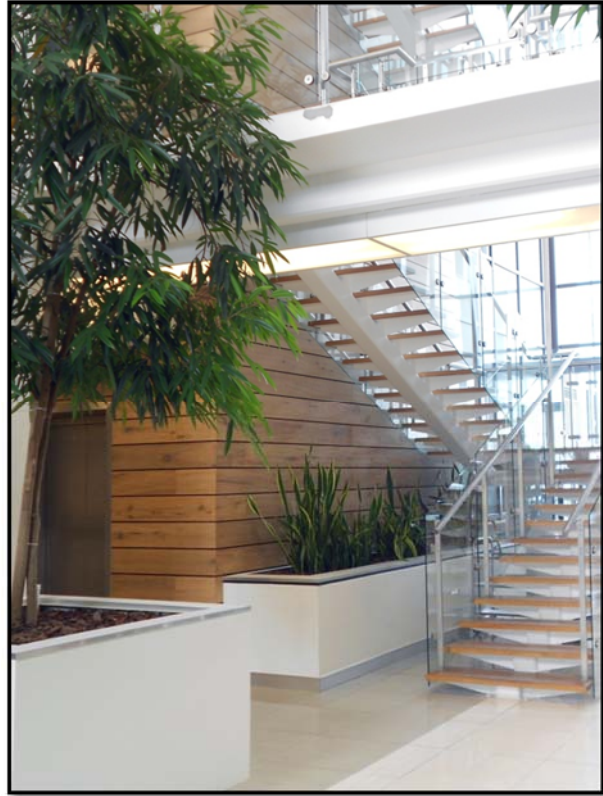


Figure 4.34: Natural elements connect man with nature (Source by Author)

Natural vegetation and water features are present in the exterior and interior design of the Nedbank Ridgeview building, connecting nature and natural elements with man and space (refer to figures 4.33 & 4.34). These features enhance positive behaviour patterns of users.

The psychological, physical and social needs of man meet with a welcoming, natural and friendly environment of the office building. Green spaces create friendly circulation providing a positive healthy and comfortable office environment. Occupants do still suffer from lack of concentration, motivation and positive productivity. Natural views, natural ventilation, lighting and a connection with the natural environment make for a welcoming atmosphere, through improving the comfort levels of its everyday user. Stimulation of a psychological environment for outdoor and indoor nature improves occupants' responsive behaviour patterns in their environment, which reinforces the Biophilic value of nature.

## CHAPTER FIVE ANALYSIS AND DISCUSSIONS

This chapter consists of the development of the theoretical framework in the context of the case study research findings through interviews and analysis of various local buildings, chosen for relevance to the criteria discussed, and therefore is most applicable to this dissertation.

Questionnaires were sent out to relative personnel within the building industry as well as users of the chosen case studies. The aim of undertaking these questionnaires was to determine whether the current users of the Alexander Forbes Building in Sandton and the Nedbank Ridgeside Building in Umhlanga believe that their architectural environment have an effect on human behaviour patterns and an individual's well-being. The results showed the majority of building occupants admires positive green spaces within and around their building, experiencing it through direct contact and viewing.

A small percentage of the questionnaires sent out via email and hard copies of the relevant case studies were returned, due to busy times in each building. The data obtained prove to be useful to my discussion. The number of questionnaires returned was around (40%) of the amount sent out.

### 5.1 INTERVIEWEES

Looking at the raw data; (70%) of the users questioned was female and (30%) were male, responding from both the Alexander Forbes Building and the Nedbank Ridgeside Building. Figure 5.1 shows (50%) of the respondents being in the age group of 21-30 years, (30%) between the age of 31-50 years and (20%) falling in the age group of 50 years and over.

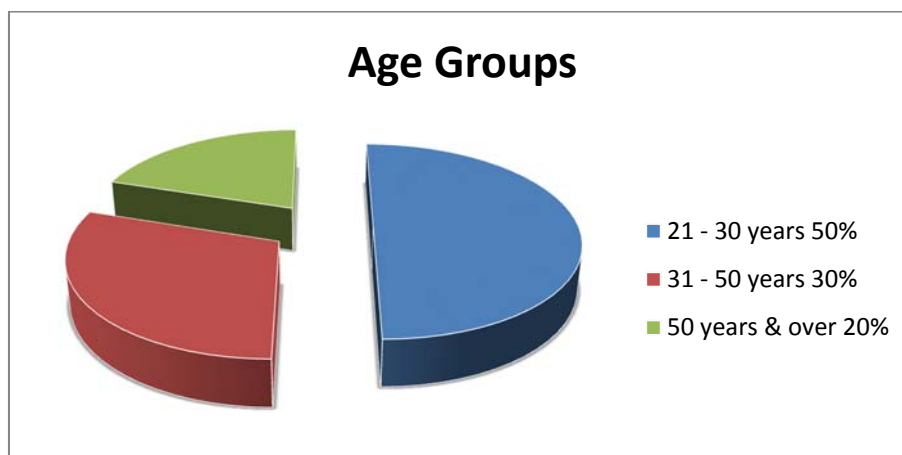




Figure 5.1: Shows the percentage of respondents' age groups

The figure on the previous page show that there are more young adults working in the built environment and the over 50 years of age lead the built environment, meaning wisdom comes with age.

## 5.2 HEALTHY ENVIRONMENT

When the building occupants were asked if their selected buildings made them feel positive and full of energy, (70%) said yes. Amir Livneh, one of the Architects of the Alexander Forbes Building stated that his building is, *“very positive: it is filled with light and has a lot of spaces designed for integration.”* Hugh Fraser, another Architect of the Alexander Forbes Building stated that he, *“enjoys the openness and natural lighting, the circulation works well and it’s a comfortable building to work in.”* The (30%) that said no to a positive building work in a small area of the building that does not allow for natural lighting to penetrate their station for the majority of the day. The two buildings investigated appears to be a healthy environment to work in with (89%) of occupants stating yes, due to the construction of low VOCs (no new building smells), its natural air flow cooling system, as well as natural light penetrating majority of the buildings workstations and (11%) commented their building is not a healthy environment, probably due to their allocated work stations or lack of personally enjoying their job.

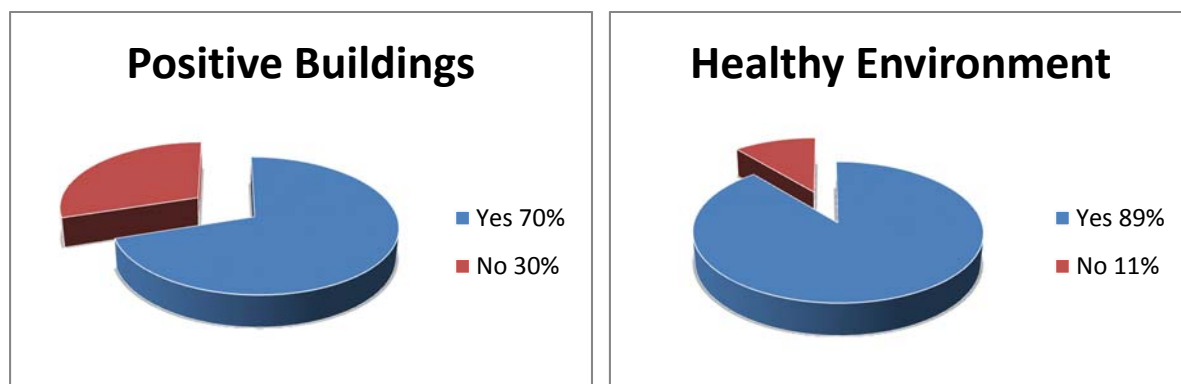


Figure 5.2: Shows if occupants thought their building made them feel positive

Figure 5.3: Shows if building users thought their built environment has a healthy interior quality

## 5.3 NATURAL ELEMENTS

Overall the responses were as expected, with a high proportion of respondents indicating that natural elements contribute to human well-being. Building materials do affect the health of its

users with (93%) of people agreeing, *“especially absorbent materials that we touch, as they store germs. HVAC is equally important for fresh air,”* another respondent commented that, *“asbestos, air-conditioning and poor material design have already proven to affect health and performance,”* while only (7%) disagree, probably due to lack of knowledge about the effects of building materials.

In Wilson’s Biophilia Hypothesis he acknowledges mans natural interest and attraction to nature. It is those connections that subconsciously influence the human physical, material, emotional, intellectual, and moral well-being. Humans need contact with nature, just as much as they require nutrients and air for survival. (96%) of the questioned occupants of the two buildings commented that they think natural elements incorporated into the building improve their health, whereas (4%) did not think so, perhaps once again due to lack of awareness.

A wider knowledge on this matter could allow occupants the understanding of green building design and how it influenced their behaviour patterns and well-being. (85%) of building occupants feel comfortable at work due to natural lighting, ventilation and natural vegetation, *“due to its predominantly glass design with great views and ample lighting, in the Alexander Forbes Building,”* whereas (15%) does not, *“lack of close proximity exterior landscaped areas and no atrium designed near work station, in the Nedbank Ridgeside Building.”* One would again assume that the occupants being negatively influenced are stationed away from these natural elements, as a majority of the respondents agreed to a healthy environment.

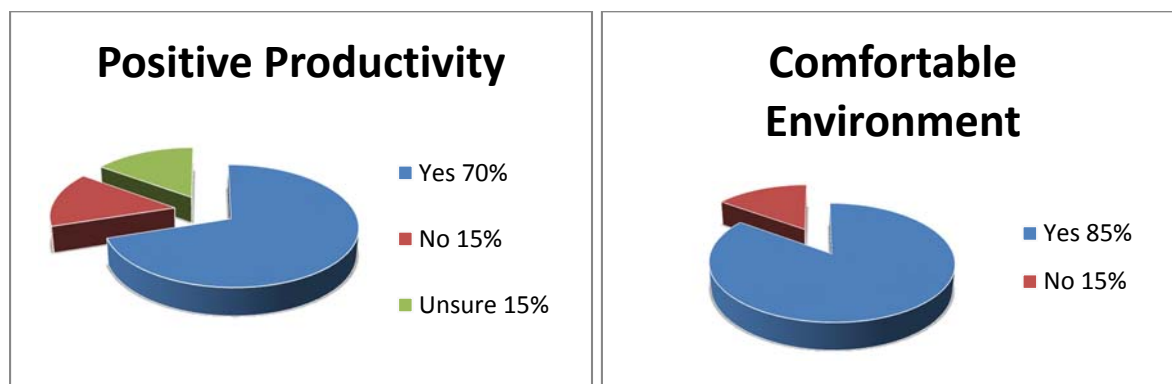


Figure 5.4: Shows if occupants thought their building them to work productively

Figure 5.5: Shows if building users thought they work in a comfortable built environment

According to the collective data, (70%) of users argue that their buildings affect their productivity positively, (15%) negatively and (15%) didn't comment. The natural elements incorporated into buildings have a direct influence on the productivity of its users, proven by similar results of the previous questions asked.

The buildings analysed to confirm its occupants suffer from headaches, lack of concentration and motivation, but do feel positive and full of energy in their 'comfortable healthy' working environment. Environmental Psychology is about understanding the social and behavioural needs of the people using the environment and how it affects their behaviour patterns. This involves the relationship between a person's state of mind and their physical environment, a place where people want to be a place that is healthy, nurturing, and delightful. It is clear that the respondents could not differentiate between a comfortable healthy environment and how it affects their productivity and behaviour.

Due to all the above assessments the following elements could improve the well-being of users in working environments:

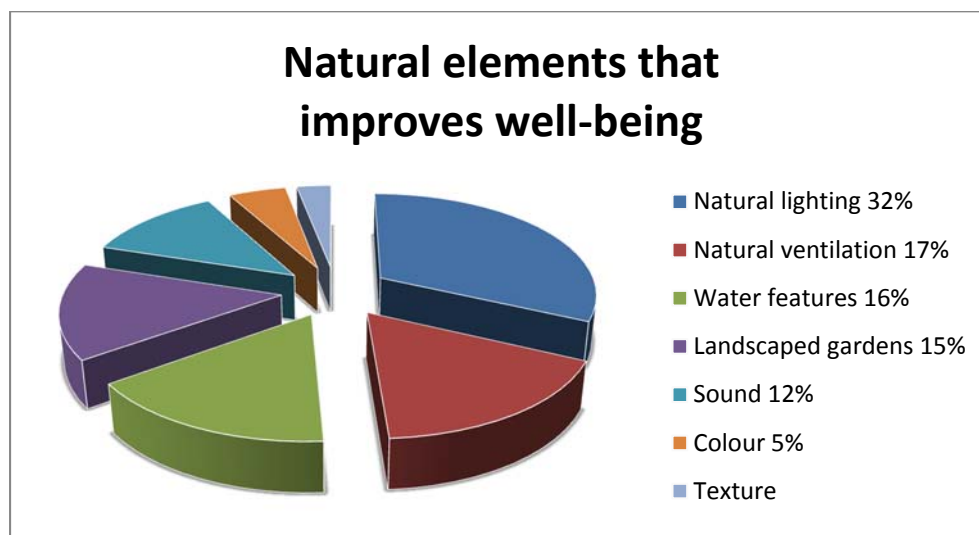


Figure 5.6: Elements chosen by questioned occupants as most health improving

However, occupants are well aware that natural materials such as water features, vegetation, natural ventilation and lighting could positively influence their productivity and well-being.

According to Genius Loci's 'sense of place' theory designing spaces for social interaction, providing opportunities for public relaxation in harmonious surroundings, relates to how an individual's physical and mental emotions and feelings are stimulated. In the occupants experiencing the above natural elements rate most effective for implementing well-being and aesthetically appealing in the built environment.

Due to the investigation of users within buildings an appropriate response to the investigated criteria of natural elements was concluded. These natural features achieve a positive and emotional connection with nature. Within the investigated case studies it was found that, in interior spaces, of the office development, the presence of plants and water features found to increase the aesthetic attractiveness and psychological well-being of the setting. When urban environments are equally compared, then those urban settings that also contain some vegetation (especially trees) or a water feature are most preferred.

Therefore as an architect it is important to create spaces and environments which are well perceived and experienced by its occupants, please the client and design budget, creating buildings and spaces with the below theories in mind, for the well-being of the inhabitants of these spaces.

## **CHAPTER SIX CONCLUSIONS AND RECOMMENDATIONS**

### **6.1 CONCLUSIONS**

The main question posed how biophilic design affects human behaviour patterns, productivity and well-being? Edward O. Wilson biophilia theory analyses human behaviour and values of their relationships with nature: aiming to create psychological, physical and socially healthy environments. Nature is the source of mans being. The influence of biophilic design can improve human behaviour in architecture, through natural elements such as, natural light, ventilation and materials, colour, spatial definition, interior and exterior connections with nature resulting in Genius Loci's 'sense of place' theory.

Secondary questions established the causes of sick building syndrome, which are related to physical factors, such as: ventilating, heating systems and organic volatile compounds, as well as poor air quality, lack of ventilation and pleasant views of nature, which causes the occupants to have a much higher level of resentment, distrust, defensiveness, anxiety and confusion, they become unmanageable and irritable, affecting their productivity and behaviour patterns within their buildings. By connecting man with nature, through implementing natural elements in buildings and providing adequate views and natural lighting, human behaviour pattern would increase according to the above investigations. It has been proven that environmental psychology includes contact with nature, promoting psychological well-being and physical health.

The aim of this study was to establish that implementing natural elements affect behaviour patterns within the built environment. By exploring the concept of sick building syndrome it was found that natural elements improve well-being when implemented into social spaces. It was found that the objectives were proven through the investigation of sick building syndrome and concluded how incorporating natural elements positively influence the environmental psychology of man's mental and physical health and well-being.

Biophilic architecture is the solution to the problem: a responsive design to affect human behaviour and well-being in a nature based built environment. An earlier assumption was made that the majority of South Africans is currently working in unhealthy conditions, making them sick. Buildings such as Alexander Forbes and Nedbank Ridgeview have taken these issues into



consideration and implementing design strategies to improve the natural and physical built environments. The issues dealt with in the hypothesis of implementing natural elements into architectural form, improve psychological and physical behaviour patterns and well-being, resulting in a 'sense of place', reduces stress levels and informs productivity.

## **6.2 RECOMMENDATIONS**

### **6.2.1 Introduction**

Some of the biggest issues faced by the designers are unsustainable energy and resource consumption, air and water pollution, climate change, waste generation, unhealthy indoor environmental conditions, due to human disconnection from nature.

Man has this common need to connect himself with nature, looking to nature as a source of mental and physical nourishment. Architects and planners should be working on a method of meaningful integration with nature, such as daylight, vegetation, and fresh air, views of nature and thermal comfort of the space that could improve and encourage physical and psychological well-being, which is essential to human survival. We as designers have a responsibility to find a happy medium between natural and physical environments. Creating a 'sense of place' involves indoor as well as outdoor greenery and public spaces, giving people an opportunity to feel comfortable and relax, providing physical and mental relief from the everyday harsh environmental threats of pollution and stress. An enjoyable environment can be experienced in terms of natural vegetation, nature based images, natural sounds and materials, as well as the quality of natural light to enhance positive feelings and behaviour patterns. Break away or pause areas could also be provided, creating areas for socialising and relaxation, enhancing a comfortable 'sense of space.'

Architects need to produce a diversity of spaces linking outdoors and indoors where people have the opportunity to meet between the public and private realms; this will improve the connection of the physical environment. Architectural form should be designed to encourage a level of social connectivity, through interaction and engagement. If places and spaces are healthy and pleasant to occupy, users are more likely to be content. Stimulating the human senses and relaxation makes spaces pleasurable. It can be achieved by a quality of space that is revitalized

with colour, texture, shape and proportion. Visual sensation and movement in a space create enjoyment, through strong impressions.

Futuristic sustainability must have the combination of biophilic design and low environmental impact, resulting in a restorative environmental design. The objectives that a restorative environment and biophilic design follows are energy saving and efficiency, sustainable materials, safe waste generation and disposal, pollution reducing, and indoor environmental quality. Applying biophilic design to architecture leads to the conclusion: as much nature as possible should be incorporated into everyday environments, leading towards energy efficiency and sustainability. Natural environments should be relaxing areas for occupants to socialize, often intrinsically fascinating: keeping the mind interested without effort. One should consider combining living and working environment, allowing semipublic access through a peaceful paradise atrium. When designing spaces one must consider activity levels in different rooms and placement of spaces of activity in relation to solar and wind paths for human comfort. Urban relaxation surrounded by plant life and running water features fits into the site context through sensitive scale and height, communicating to its surrounding buildings, opening outwards, towards the natural environment, drawing nature into the building, combining the elements of accessibility and convenience.

*“Design is a healing art that provides the opportunity to  
enhance people’s lives using elements of nature as a gift”*

- Clodagh -

(Kellert, Heerwagen, Mador: 2008; 341)

Sustainability incorporates natural elements into buildings improving the well-being of its user and prevents sick building syndrome. The green building movement has successfully brought daylighting, low-impact and natural materials into current and future developments. The main focus has been to lower energy consumption and costing as well as environmental impact. The current outlook on green buildings is to improve productivity through design life-enriching, restorative buildings and landscaping of a positive nature and well-being (biophilic architecture).

### **6.2.2 Indoor and outdoor natural vegetation**

Biophilic design blends the inside of the building with the natural exterior environment, linking indoors with the outdoors, improving the connection of mans affiliation with nature, through natural materials and internal landscaping. This link with nature promotes physical and psychological benefits. Recreational outdoor public spaces are essential for improving the connection between man and nature. Nature presents the richness and variety of patterns, textures, light and colours that affect human behaviour. A rich sensory environment surrounds us with visual delight, sounds, and variations of temperature as we move through space.

Great green spaces are really great public places, such as multistory atriums, which can serve several purposes: providing greenery and daylight to multiple floors creating a visual connection between those floors. Man cannot be dissociated from the natural environment. By reducing air pollutants, ozone, and nitrogen dioxide, it is clear that nature is beneficial to health and well-being. To further improve well-being, buildings should provide access to outside spaces such as balconies, terraces, courtyards and patios. People in close proximity to open spaces tend to live healthier lifestyles.

Green spaces, both interior and exterior, are essential to architecture promoting a connection with nature. Integrating luxurious vast indigenous low water consumption vegetation such as grass, plant life and a few small trees, vertical green walls in the built environment or spilling out onto a timber landscaped outdoor relaxation deck, linking a visual connection, providing a calm and restful atmosphere is enough to enhance human behaviour and well-being.

Designing green user-spaces such as, public food gardens assists with self-esteem and motivation. Waiting areas could be carefully positioned near natural greenery and external views to make the public feel comfortable while waiting. Incorporating greenery on the building façade such as growing vines, green roofs, garden courtyards that brings light and greenery into the basement, terraced gardens and planter boxes in and around a building absorbs sound, and are aromatic and soft on the eye.

### **6.2.3 Thermal comfort**

Thermal comfort is influenced by four environmental conditions that affect the body simultaneously: air temperature, humidity, air movement, and mean radiant temperature. These environmental factors are influenced by natural building materials, natural light from the amount of glazing provided within a space, windows sizing, air treatment, and surface treatment, noise, and climate change. The exterior of building materials such as concrete panels, brickwork and double glazing are to be well insulated and would create a comfortable working environment. Low-VOC paints and adhesives used indoors, UVC treatment eliminating airborne bacteria and viruses, and carbon dioxide and carbon monoxide sensors monitor air quality, can also ensure a comfortable healthy air quality environment (Teoh: 2011) established in Khoo Tech Puat Hospital design.

Air quality has to be improved, indoors and out by use of vegetation. Outdoor air gets polluted by industrial buildings and traffic and indoor air by furniture and building materials off-gassing, as well as secondary breath and body odours. Fresh internal air movement can be created by mechanical fan-assisted ‘cooling’ systems. An open plan structure through spatial design combined with the cooling system of spaces ensures an even distribution of airflow throughout the building.

Designers orientate buildings to take advantage of the north and southeast wind speed, reducing the need for fans, minimising solar heat gain and glare in the morning and late afternoon. Passive vertical interior shading roller blinds over windows on the east and west facades and landscape features on the north side can help reduce daylight penetration and overheating, glazing and thermal insulation strategies, could also control glare and heat gain, as well as enhance the brightness of the interior and save energy usage.

### **6.2.4 Natural ventilation**

Natural ventilation requires a good understanding of cross-ventilation, stack ventilation, and thermally induced ventilation. In comparison to traditional ventilation systems, natural ventilation is environmentally-friendly, energy-efficient and more economical to maintain, allowing fresh air exchange, preventing a build up of toxic gasses and the circulation of airborne

germs. Natural ventilation reduces or eliminates VOCs improving the well-being of building users, through moving ceiling fans, naturally cooling the building. Instead energy efficient chilled water pumps and air chiller could be installed in buildings, which is 20% more efficient than conventional chillers, contributing to the reduction of energy usage. A cooling tower fan also contributes to ventilation throughout the building.

#### **6.2.5 Window design**

Operable modular jalousie windows supplying fresh pre-cooled air of newly cut grass and controlling incoming rain could be placed in locations that will produce the appropriate amount of airflow, to limit the use of air-conditioning. Operable windows should be avoided in situations, where city noise and street pollution is present. It is said that seated views of nature and proximity to windows are linked to reducing sick building syndrome, increasing performances and improves overall health and well-being. (Kellert, Heerwagen, Mador: 2008; 120). Kellerts, Heerwagen and Madors' research shows that building users with a window view of nature reported lower frustration and higher life satisfaction and overall health. Maximising views for over 60% of building spaces provides a visual connection to external environments, lowering eyestrain through relaxation and refocus on natural elements, linking the indoors with the outdoors through building transparency and street accessibility, which is essential for man vs nature interaction.

#### **6.2.6 Lighting and natural lighting**

Daylight is the most pleasing illumination available to human well-being. Taking advantage of natural light minimizes the need for electric lighting during the daytime, saves energy, saves money and lifts the spirits of building occupants. Lighting system could be used to dim or switch off lightings when spaces are unoccupied through motion sensing, as well as when sufficient daylight is provided, referred to as daylight harvesting, avoiding glare, streaks, and excessive heating, resulting in positive interiors.

In building environments, glare and discomfort should be avoided by using light shelves, reflective walls, skylights, atriums, or other forms of shading and indirect lighting. Too much light in an indoor space could deteriorate your health. Having a constant luminance of 500 when



only 100 is needed, could make users feel lazy and tired, affecting their productivity. Allowing daylight to come into an area from more than one direction will deeply penetrate the space and provide better uniformity, through the channelling of daylight. The room or building may feel more positively three-dimensional instead of flat-lit.

Building orientation and geometry give a solid foundation in quality daylighting design. Windows on the north and south facades will provide the best quality daylight. Glazing size and location will determine daylight quantity. Tall ceilings and high windows will allow the deepest daylighting penetration into required areas.

#### **6.2.7 Natural elements**

A lively healthy human and natural balance are created through the natural elements integrated into the natural environment of views, textures, sounds, smells and diversity of landscapes with the built environment. By eliminating noise, changing colour and lighting, softening and harmonising shapes and forms would result in a less stressful environment. Other features can be incorporated such as water elements, pleasant landscaping with large trees, meandering pathways, multiple shops and restaurants to create an aesthetically appealing area.

#### **6.2.8 Water in architecture**

Incorporating the sound of water in architecture therapeutically and aesthetically stimulates healing to the soul mentally, physically and visually, through slow moving water features giving a calming, soothing feeling to a tranquil interior and adds a natural element to mask harsh exterior noise. Interior waterfalls cools and heats up the buildings during different seasons.

Water recycling can be achieved through rainfall processed through small wetlands on a building shell or perforated concrete pavers to control stormwater sun-off, then guided to an interior pool, and then moved to a cistern beneath the building and an exterior pond. These strategies reduce water consumption through harvesting grey water, treated and combined with filtered rainwater for low flow flushing toilets, sinks, basin and shower mixers, waterless urinals and internal and external landscape irrigation, which minimises municipal portable water intake.

### **6.2.9 Natural materials**

Today's natural material criteria include environmental sustainability. Natural green materials require no toxic chemicals for its production, use and disposal. These materials should be low in Volatile Organic Compounds (VOC's), therefore less toxic, be manufactured locally, have reduced environmental impact and perform for human comfort. Natural materials minimise industrial processing when used locally, reducing transport pollution and re-establishes man with their surroundings. These materials are also more likely to use organic glues, resins, and sealants and can therefore be recycled.

Similar to the spaces, the more 'natural the state' of the building material the more positive these environments will appear to an individual. Natural materials should be used on those surfaces that occupants come into immediate contact with such as walls, floors, and furniture. Occupants should be able to appreciate the physical qualities of each material, such as a rough cut stone, or the texture of wool. The interior fixtures and soft finishes in buildings should combine natural colours, soft textiles, creating a calm aesthetic and atmosphere of restful tranquillity, an environment affecting human behaviour patterns and well-being.

### **6.2.10 Site selection criteria**

Location: (situated within a public precinct)

It should be a site that offers opportunities for development that will benefit the micro and macro context. The immediate area should be near if not in the city, making use of existing infrastructure and facilities; thereby creating a symbiotic relationship between similar functions or interests. Adjacent community spaces add social value to a site. The site should be in an area that has the greatest need of renewal.

The existing 'spirit of place' is also important in site selection as environments with an existing spirit amongst the community, enhancing one's experience within the space. A busy and noisy atmosphere is not an appropriate location to enhance human behaviour patterns and improve well-being.

Site size: (a generous size site accommodating a multi-use development)

The size should be adequate for the new mass of the urban multi-use development and able to accommodate sufficient parking.

Accessibility: (linking to surrounding attractions)

There should be easy access to the site and it should be integrated in the broader urban context of the area and its surroundings. It should be easy to access the site from various points through numerous modes of transport, as well as pedestrian friendly accessibility, to maximise convenience for the local population. The convenient walking distances and accessibility to public transport would help facilitate a pedestrian orientated precinct. The site should not be far from a major urban hub, it needs to have a visual prominence to be easily identified in its context, offering distinct strong links to its context from various angles.

Natural Environment: (walking access to nature based areas)

Climatic conditions are very important, the low diurnal variation of Durban is best in catering for green urban areas and multi-use developments on a year-round basis, however due to this fact; specific wind patterns need to be carefully considered. The site must have a natural landscape or the latter must be suitable to be implanted in the context to enhance the existing fabric.

Vegetation in proximity to the building is very effective, when improving the well-being of building users and incorporating natural lighting and ventilation. The high coastal water table may allow for opportunities of reintegrating the river back into the city. Any existing vegetation and structures on site needs to be considered. The site should offer an opportunity to enhance the natural ecosystem while aiding in natural human well-being.

Orientation: (nature influencing light, wind, water, cooling etc)

Solar and wind orientation provides natural lighting and ventilation for human comfort while views of the natural environment improve the aesthetic appeal of the site. Therefore the site should be orientated in such a way as to promote a healthy and vibrant site, not overly shaded by neighbouring buildings.

Good cross ventilation is essential. Its orientation should allow views from the site to the surrounding context. A north to north east orientation will make it easier to achieve optimum building performance with regards to thermal comfort and lighting levels. If located within a public domain the building should address the public space.

#### **6.2.11 Conclusions**

This research shows that society can benefit mentally, physically and socially from buildings designed with nature, improving the health and well-being needs of people and the need for responsible public architecture. The design method of biophilia is an appropriate approach to well-being, community architecture and the built environment, providing healthier built environments. The above approaches incorporated into architecture, connection man with nature can be used to encourage well-being when engaging in a place, through thoughts, actions and behaviour. Based on the outcomes of the researches' theoretical framework, literature review and relevant case studies, these recommendations could be used as a guideline to biophilic architecture and human sensitive environments, for a proposed design in the near Durban area, implemented in Part Two of this study.

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**GRAHAM WILSON** (Director of Osmond Lange Architects & Planners) interviewed by M. Blom. 15 March 2013, Johannesburg

**JOSEF QURASHI** (Head of sustainability at Amdec Property Development) interviewed by M. Blom. 18 March 2013, Melrose Arch, Johannesburg

**ROZENA MAART** (Acting Director, Centre for Critical Research) interviewed by M. Blom. 28 March 2013, UKZN

**DAYLE DUNCAN** (Facilities Administrator at Nedbank Ridgeview) interviewed by M. Blom. 27 March 2013, Umhlanga

**AMIR LIVNEH** (Project Architect of Paragon Architects) interviewed by M. Blom. 15 April 2013, Johannesburg

**V. LAMBERT** (Facilities Administrator at Alexander Forbes Sandton) interviewed by M. Blom. 15 April 2013, Johannesburg

**CHAPTER EIGHT                      APPENDICES:                      INTERVIEW QUESTIONNAIRE**

1. Name and Surname?  
\_\_\_\_\_
2. Gender? (Male or Female) \_\_\_\_\_
3. Race? (Black, White, Indian, Coloured, Other) \_\_\_\_\_
4. Age? \_\_\_\_\_
5. Which space is your favourite or worst space in the building and why?  
\_\_\_\_\_
6. Does your building make you feel positive and full of energy?  
\_\_\_\_\_
7. Would you say your building has a healthy environment?  
\_\_\_\_\_
8. Do you believe that building materials can affect your health?  
\_\_\_\_\_
9. Would you say that natural elements (water, vegetation, fresh air) within a building can result in a healthier environment?  
\_\_\_\_\_
10. Have you ever felt ill with headaches or lack of concentration and motivation at work?  
\_\_\_\_\_
11. Would you say your building affects your productivity positively or negatively?  
\_\_\_\_\_
12. Do you feel comfortable within your building with regards to natural lighting, ventilation, natural views or vegetation present?  
\_\_\_\_\_
13. In your experience which of the following elements would affect your well-being? (colour, light, texture, sound, natural lighting & ventilation, water & water features, landscapes and gardens)  
\_\_\_\_\_

Interview carried out on \_\_\_\_\_ at \_\_\_\_\_



**PART TWO**  
**DESIGN REPORT**  
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## 1.0 INTRODUCTION

### 1.1 INTRODUCTION

Based on the theoretical study of how Biophilic Architecture can influence human behaviour and well-being, one is made aware of the issue of sick building syndrome and the stresses that the architectural environment places on productivity and well-being of the users.

Looking at the discussed literature review, it is evident that many built environments do contribute to the issue of sick building syndrome and that Biophilic Architecture positively influences human behaviour, productivity and well-being.

Part Two of the study documents the design proposal of an 'Urban Multi-use Office Park Development for the Umgeni Business Park precinct, Durban' to demonstrate how Biophilic Architectural environment can enhance the behaviour patterns and well-being of its users. The purpose of this report is to apply the research findings to architectural design. When paying attention to the 'Analysis and Discussions' as well as 'Recommendations and Conclusions' in Part One of the document the theoretical background establishes the concept behind the Urban Multi-use Office Park Development.

## **1.2 DESIGN BACKGROUND**

### **1.2.1 The Problem Statement**

A personal assumption was made that a large populations of South Africans are currently working in unhealthy conditions, resulting in making them sick, therefore probably not meeting everyday human health needs. Human beings are greatly affected, both physically and mentally, by our surroundings, whether natural or built, this involves ones human well-being, physical and emotional or ones spiritual self (Day: 2002; 9).

Dealing with the issue of buildings showing characteristics of sick building syndrome, could result in occupants suffering negative side effects. Everyday pollution in society has led to these negative outcomes of physical and psychological well-being of space users. When investigating factors such as natural light, colour, fresh air, visual contact with water and nature or noise pollution, it is found that exposure to such natural elements positively influence human behaviour, health and productivity in a live, work and play environment.

### **1.2.2 Issues and Motivation for the Proposal**

Human behaviour and well-being is influenced by Architectural form. Various social behaviour patterns within the architectural environment affect human well-being, from both a positive and negative point of view. Sick building syndrome: natural elements (colour, light, texture, sound, natural lighting & ventilation, thermal comfort, water & water features, landscapes and gardens) can positively influence well-being through architectural interventions and these environments can in turn affect human behaviour.

### **1.2.3 The Working Hypothesis**

The built environment affects the user, positively or negatively. Implementing natural elements into Architectural form improves psychological and physical behaviour patterns and well-being, creating a sense of place, reducing stress levels and informs productivity.

### **1.2.4 Key Questions**

How can Biophilic design affect human behaviour patterns and well-being?

What causes sick building syndrome?

## **1.3 THE ARCHITECT**

### **1.3.1 The Role of the Architect**

The key question is how biophilic architecture can promote positive human behaviour and well-being and whether it can reduce sick building syndrome. Architects have the greatest impact on human behaviour and their well-being through individual building design. Therefore, architects have a responsibility to the environment, they have to start with changing the way they design, introducing natural elements into buildings and other environmental issues, related to a better way of living (Wilson: 2013).

Architects need to consider the way in which buildings are designed, constructed and maintained to promote healthier built environments and how it can avoid being harmful, through working on a solution that accepts society's urban lifestyle while integrating methods of meaningful integration with nature.

Architects need to create a diversity of spaces linking outdoors and indoors where people have the opportunity to meet between the public and private realms, this will improve the connection of the physical and natural environment (Smithson, 1962: 44).

- É Design sustainable architectural environments that support public social facilities
- É Design architectural environments allowing users to identify with their surroundings
- É Design a unique "sense of space" of the site through good urban and architectural design
- É Design green spaces that connects man to nature and soften the harsh urban environment
- É Design in close proximity to water and natural environments, introducing tranquility

- É Design healthy buildings with natural ventilation and day lighting strategies
- É Design buildings that allow for free public movement
- É Design buildings that connects man to the environment, through planting, good ventilation and lighting
- É Design interior spaces through the correct choice of colours, materials, as well as natural lighting and ventilation requirements that support human well-being and positively influence behaviour patterns and productivity

### **1.3.2 The Vision**

An urban multi-use office park development and urban framework providing social public facilities within a Biophilic designed environmental conscious building, promoting well-being, positive behaviour patterns and productivity. The building is to be located near or within the natural environment, creating easily accessible opportunities to the site via vehicular and pedestrian movement.

## **1.4 THE NATIONAL CLIENT**

### **1.4.1 The Clients' Organisation**

Fruit and Veg City and Food Lovers Market have established a company called Love Health, whom will be the clients of my design. The Love Health Organisation is an organic foods business specializing in bringing fresh produce to the public of South Africa. They currently have an operation in Cape Town and are looking to move their headquarters to the Durban area. This client sponsors a series of -healthy and activeøevents. Living a healthy and active lifestyle is important, especially with todayø's busy lifestyles.

The main aim with Love Health is to supply each and every one of their customers with not only the freshest fruit and vegetables, but also to help them embrace the outdoors and get active. You've often heard the saying -You are what you eatøand while this isn't exactly true, what you eat does have a major effect on your general wellness as the foods you consume will determine the nutrients your body gets. Food Lover's Market is very conscious of the positive effects a healthy nutritious diet can have on your general wellness. The nutrients in our diet give us energy and are necessary to improve your behaviour patterns development.

### **1.4.2 The Clients' Requirements and Brief**

The Love Health Organisation values human health as a basic principal of well-being, which in turn would improve one's lifestyle. Health is wealth. Incorporating Biophilic design into buildings enhances the vision of wellness. The client propose to develop a 15 000sqm headquarters space within a nature based urban design framework, which will consist of a multi-use program and include office space, retail space and outdoor public space with specific focus on well-being and wellness in the workplace. They require a sustainable design ensuring a building responding to a healthy lifestyle for its occupants and visitors, acting as a catalyst for future developments in the area. They have requested for the first building to be designed as a Multi-Use Office Building Headquarters. The design is to represent the company values and principals and should symbolize what the company stands for.

The client acquires a 20 000sqm site in the Umgeni Business Park precinct in Durban which bears the potential to develop the aforementioned work. A north-facing site needs to make use of views of natural vegetation and have direct access to the water's edge.

#### 1.4.3 Accommodation Schedule

The schedule of accommodation was determined mainly by the analysis of precedent and case studies, as well as the requirements of The Love Health Organisation requirements. The accommodation schedule for the ground floor plan was to consist mainly of public spaces to activate and draw the general public to the area. Therefore the commercial and retail component would best be suited for the ground floor. The first floor was to consist of semi private space, raised above the public realm, namely a gym, crèche, multi-use hall etc. The last component being the office headquarters was considered to be on the second floor and higher, as these facilities are considered private. Taking into account the clients requirements the office headquarters was to have maximum views, lighting and ventilation, emphasizing the connection of man and nature, improving the behavior patterns and well-being of the users.

Refer to the table below for a proposed schedule of accommodation:

**SITE AREA:** 47 323m<sup>2</sup>

<u>SPACE DESCRIPTION</u>	<b>AREA (m<sup>2</sup>)</b>
<b>LOWER LEVEL:</b>	



Gymnasium Lower Level	423m <sup>2</sup>
Crèche	347m <sup>2</sup>
<b>BASEMENT PARKING:</b>	
Lift Lobby	133m <sup>2</sup>
Parking	4 083m <sup>2</sup>
Gymnasium Upper Level	289m <sup>2</sup>
Security Office	30m <sup>2</sup>
Ablutions	60m <sup>2</sup>
Water Storage	139m <sup>2</sup>
Mechanical Plant Room	46m <sup>2</sup>
<b>GROUND FLOOR:</b>	
Entrance & Foyer	74m <sup>2</sup>
Information / Reception	327m <sup>2</sup>
Kitchenette	89m <sup>2</sup>
Waiting Area	81m <sup>2</sup>
Ablutions	191m <sup>2</sup>
General Storage & DB Room	30m <sup>2</sup>
Service entry & Delivery	226m <sup>2</sup>
Urban Design Layout	47 323m <sup>2</sup>
Agricultural Gardens	5 765m <sup>2</sup>
Urban Green Parking Area	2058m <sup>2</sup>
Courtyards	368m <sup>2</sup>
Circulation Core	133m <sup>2</sup>
Ablutions	191m <sup>2</sup>
Refuge Area	226m <sup>2</sup>
Restaurant: Indoor & Outdoor	921m <sup>2</sup>
Cafés	365m <sup>2</sup>
Take Away Food Court	247m <sup>2</sup>
Retail Outlets & Commercial Shops	517m <sup>2</sup>
Formal Food & Craft Market	652m <sup>2</sup>

Fire Escape Cores	55m <sup>2</sup>
<b>FIRST FLOOR:</b>	
Circulation Core	133m <sup>2</sup>
Break away / Pause Area	100m <sup>2</sup>
Kitchenette	10m <sup>2</sup>
Ablutions	81m <sup>2</sup>
Atriums	848m <sup>2</sup>
Indoor & Outdoor Balconies	650m <sup>2</sup>
Roof Garden	1 239m <sup>2</sup>
Fire Escapes Cores	55m <sup>2</sup>
Rentable Office Space	1 942m <sup>2</sup>
<b>SECOND FLOOR:</b>	
Circulation Core	133 m <sup>2</sup>
Fire Escapes Cores	55m <sup>2</sup>
Break away / Pause Area	100m <sup>2</sup>
Kitchenette	10m <sup>2</sup>
Ablutions	81m <sup>2</sup>
Atrium	848m <sup>2</sup>
Indoor & Outdoor Balconies	m <sup>2</sup>
Roof Garden	816m <sup>2</sup>
Rentable Office Space	1 709m <sup>2</sup>
<b>ROOF LEVEL:</b>	
Circulation Core	133m <sup>2</sup>
Break away / Pause Area	100m <sup>2</sup>
Kitchenette	10m <sup>2</sup>
Ablutions	60m <sup>2</sup>
Indoor & Outdoor Balconies	233m <sup>2</sup>
Roof Garden	396m <sup>2</sup>

**TOTAL SQUARE METRES FOR ACCOMODATION SCHEDULE: ±10 000m<sup>2</sup>**

## **2.0 SITE SELECTION, SURVEY AND ANALYSIS**

### **2.1 SITE SELECTION CRITERIA**

Location: (situated within a public precinct)

It should be a site that offers opportunities for development that will benefit the micro and macro context. The immediate area should be near if not in the city, making use of existing infrastructure and facilities; thereby creating a symbiotic relationship between similar functions or interests. Adjacent community spaces add social value to a site. The site should be in an area that has the greatest need of renewal.

The existing 'spirit of place' is also important in site selection as environments with an existing spirit amongst the community, enhancing one's experience within the space. A busy and noisy atmosphere is not an appropriate location to enhance human behaviour patterns and improve well-being.

Site size: (a generous size site accommodating a multi-use development)

The size should be adequate for the new mass of the urban multi-use development and able to accommodate sufficient parking.

Accessibility: (linking to surrounding attractions)

There should be easy access to the site and it should be integrated in the broader urban context of the area and its surroundings. It should be easy to access the site from various points through numerous modes of transport, as well as pedestrian friendly accessibility, to maximise convenience for the local population. The convenient walking distances and accessibility to public transport would help facilitate a pedestrian orientated precinct. The site should not be far from a major urban hub, it needs to have a visual prominence to be easily identified in its context, offering distinct strong links to its context from various angles.

Natural Environment: (walking access to nature based areas)

Climatic conditions are very important, the low diurnal variation of Durban is best in catering for green urban areas and multi-use developments on a year-round basis, however due to this fact; specific wind patterns need to be carefully considered. The site must have a natural

landscape or the latter must be suitable to be implanted in the context to enhance the existing fabric.

Vegetation in proximity to the building is very effective, when improving the well-being of building users and incorporating natural lighting and ventilation. The high coastal water table may allow for opportunities of reintegrating the river back into the city. Any existing vegetation and structures on site needs to be considered. The site should offer an opportunity to enhance the natural ecosystem while aiding in natural human well-being.

Orientation: (nature influencing light, wind, water, cooling etc)

Solar and wind orientation provide natural lighting and ventilation for human comfort while views of the natural environment improve aesthetic appeal of the site. Therefore the site should be orientated in such a way as to promote a healthy and vibrant site, not overly shaded by neighbouring buildings.

Good cross ventilation is essential. Its orientation should allow views from the site to the surrounding context. A north to north east orientation will make it easier to achieve optimum building performance with regards to thermal comfort and lighting levels. If located within a public domain the building should address the public space.

Revitalisation: (bringing people to the precinct)

Warehouse jungle, light commercially zoned no activity in night and motor industries dominate leaving the area unvisited. Lack of shade, trees, urban furniture (unfriendly pedestrian environment), and lack of public social spaces demonstrate a need for a precinct revitalization.

## **2.2 SITE SELECTION OPTIONS**

Durban is situated on the eastern coastline of Kwa-Zulu Natal within the South Africa. It is situated adjacent to the Indian Ocean on the east coast and stretches to the east along its harbour to the south.



Figure 1: Location of potential site in South Africa (Author:2013)



Figure 2: Location of potential sites in Kwa Zulu-Natal (Author:2013)

The city's main position as a port of entry onto the southern African continent has led to a development of national roads around it. On the western side the N3 Western Freeway links Gauteng to the city and the N2 outer ring road links the Eastern and South Coast to the South and Mpumalanga on the North to Durban (<http://en.wikipedia.org/wiki/Durban>).

### 2.2.1 Site Option 1:

ANALYSIS CRITERIA	CRITERIA EVIDENT
MAN VS NATURE: (environmental psychology)	X
NATURAL ELEMENTS: (biophilic hypothesis)	
ORIENTATION: (nature influencing light, wind, water)	X
ACCESSIBILITY: (linking to surrounding attractions)	X
LOCATION: (potential for creating a sense of place)	X



Figure 3: Site option 1 in Durban CBD (Author:2013)

### 2.2.2 Site Option 2:

ANALYSIS CRITERIA	CRITERIA EVIDENT
MAN VS NATURE: (environmental psychology)	X
NATURAL ELEMENTS: (biophilic hypothesis)	X
ORIENTATION: (nature influencing light, wind, water)	
ACCESSIBILITY: (linking to surrounding attractions)	X
LOCATION: (potential for creating a sense of place)	X





Figure 4: Site option 2 in Umhlanga business precinct (Author:2013)

### 2.2.3 Site Option 3:

ANALYSIS CRITERIA	CRITERIA EVIDENT
MAN VS NATURE: (environmental psychology)	X
NATURAL ELEMENTS: (biophilic hypothesis)	X
ORIENTATION: (nature influencing light, wind, water)	
ACCESSIBILITY: (linking to surrounding attractions)	X
LOCATION: (potential for creating a sense of place)	X

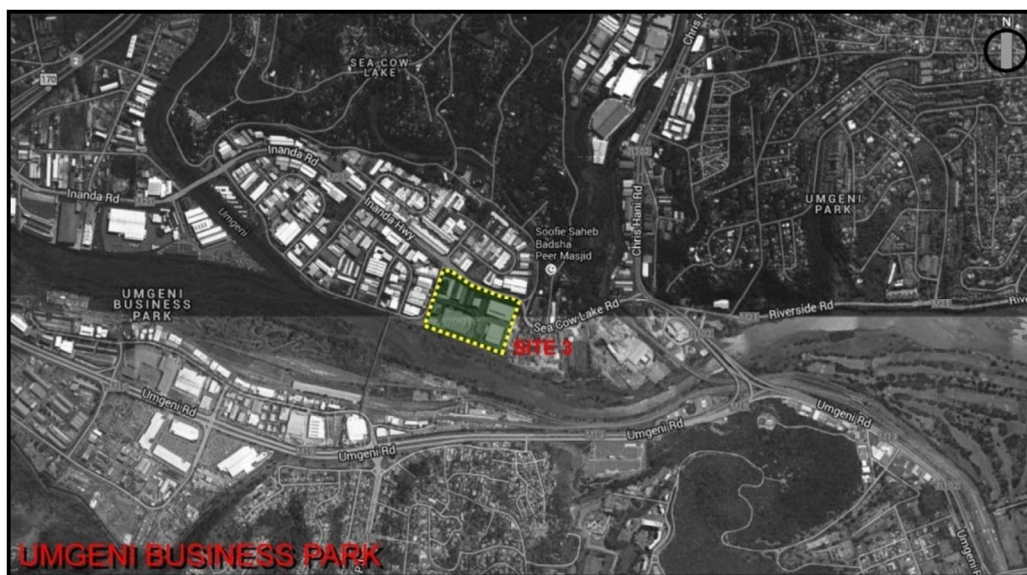


Figure 5: Site option 3 in Umgeni business precinct (Author:2013)

SITES ANALYSED	ANALYSIS OUTCOME
SITE 1: DURBAN CBD	XXXX

SITE 2: UMHLANGA BUSINESS PARK	XXXX
SITE 3: UMGENI BUSINESS PARK	XXXXX

### 2.3 LOCATION AND ANALYSIS OF SELECTED SITE

After applying the urban area criteria, site 3 received the highest overall rating and has therefore been selected as the preferred urban area. Site 3 has the greatest potential of creating the biggest possible impact upon Durban's inhabitants. Its central location and deteriorating environment justify its selection to rejuvenate this area to bring life back to the city and create a city environment that is more conducive to both social interaction and wellbeing.



Figure 6: Site SELECTED option 3 in Umgeni business precinct (Author:2013)

The surrounding environment has a direct impact on the location of the proposed building. The proposed site is located opposite the Umgeni Business Park area near a Major transport node, inside a warehouse storage business precinct. The building has close access to natural greenery and the Umgeni River, ideal for urban farming and pedestrian friendly walkways. The chosen site promotes a free movement environment. The orientation of the proposed site faces north, which is ideal for incorporating maximum North light, entering the majority of the site. Sensory views from the site indicate positive points of interest or value in the



surrounding area. Views to the site from areas outside the site boundaries indicate traffic coming into the site from major routes.



Figure 7: Site analysis: transport & pedestrian nodes and roads (Author:2013)

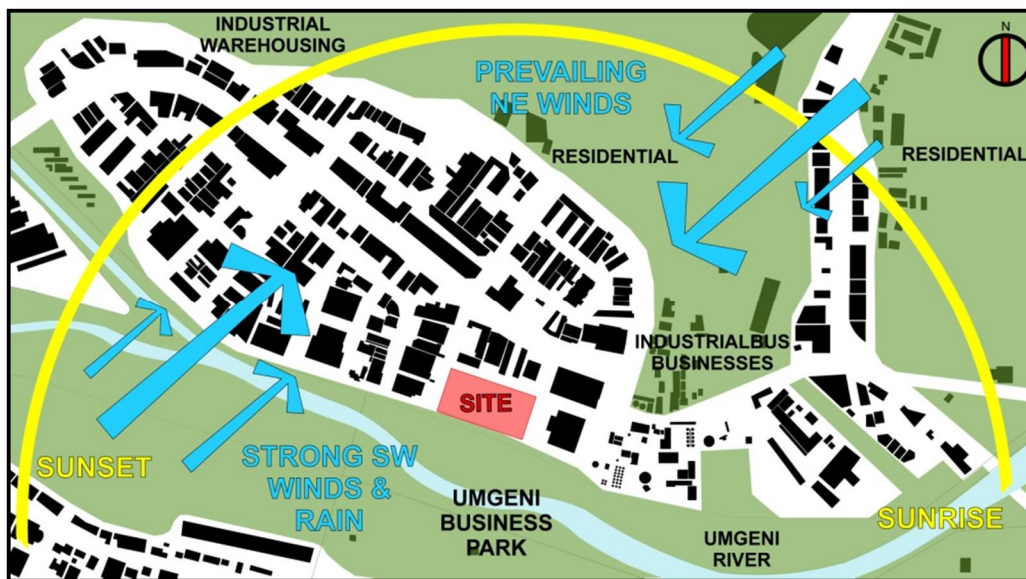


Figure 8: Site analysis: environmental analysis (Author:2013)

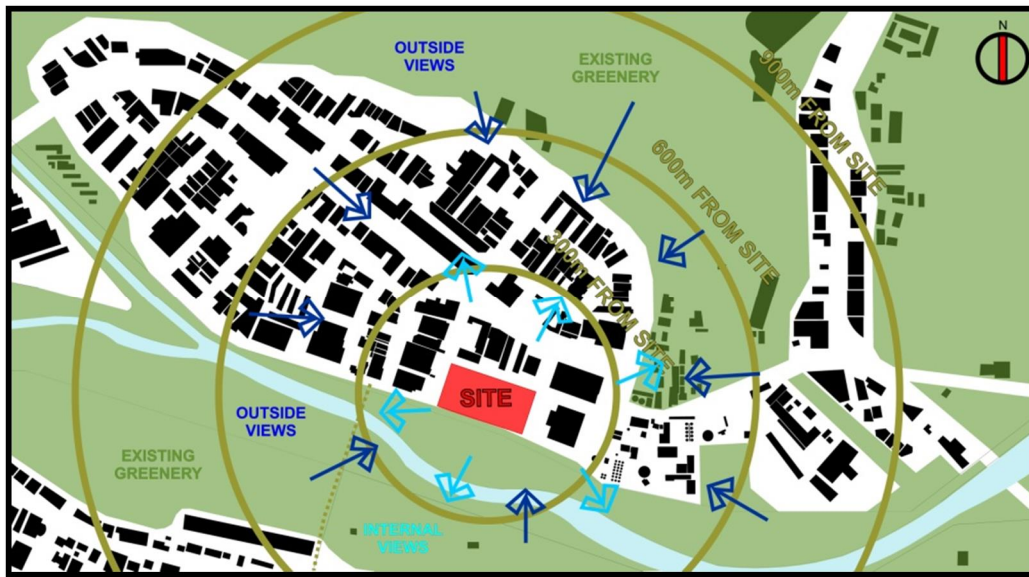


Figure 9: Site analysis: pedestrian movement, internal & external views (Author:2013)

Potential pedestrian movement around the site was analyzed to determine the public use of the chosen area. Pedestrians tend to walk no further than approximately 300m, which give opportunity for community spaces to be designed within the site, drawing the public into the site.

### 3.0 THE DESIGN BACKGROUND AND PROPOSAL

#### 3.1 THEORIES

##### 3.1.1 Edward, O. Wilson's Biophilia Hypothesis

Edward O. Wilson biophilia theory analyses human behaviour and values of their relationships with nature: aiming to create psychological, physical and socially healthy environments. Nature is the source of mans being. People have an affiliation with nature, a natural interest and attraction to nature, a need to contact with nature, just as much as they require nutrients and air for survival. Edward O. Wilson biophilia theory analyses human behaviour and values of their relationships with nature: aiming to create psychological, physical and socially healthy environments. The influence of biophilic design can improve human behaviour in architecture, through natural elements such as, natural light, ventilation and materials, colour, spatial definition, interior and exterior connections with nature.

Bringing nature into buildings through Biophilic design, promotes measurable benefits to human behaviour, performance, productivity, emotional well-being, stress reduction, learning, health and healing (Wilson: 2006 and Kellert: 2005).

### **3.1.2 Environmental Psychology**

Integration between nature, natural elements and architecture is a field of study that examines the relationship between environments and how it affects its inhabitants and their behaviour. This involves the relationship between a person's state of mind and their physical environment. It was found that environmental psychology including contact with nature proved that the investigation of sick building syndrome concluded how incorporating natural elements positively influence the environmental psychology of mans mental and physical health and well-being. A truly positive environmental psychological building is a place that is healthy, nurturing, and delightful to its occupants (Guenther & Vittori, 2008).

### **3.1.3 Genius Loci: A 'sense of place'**

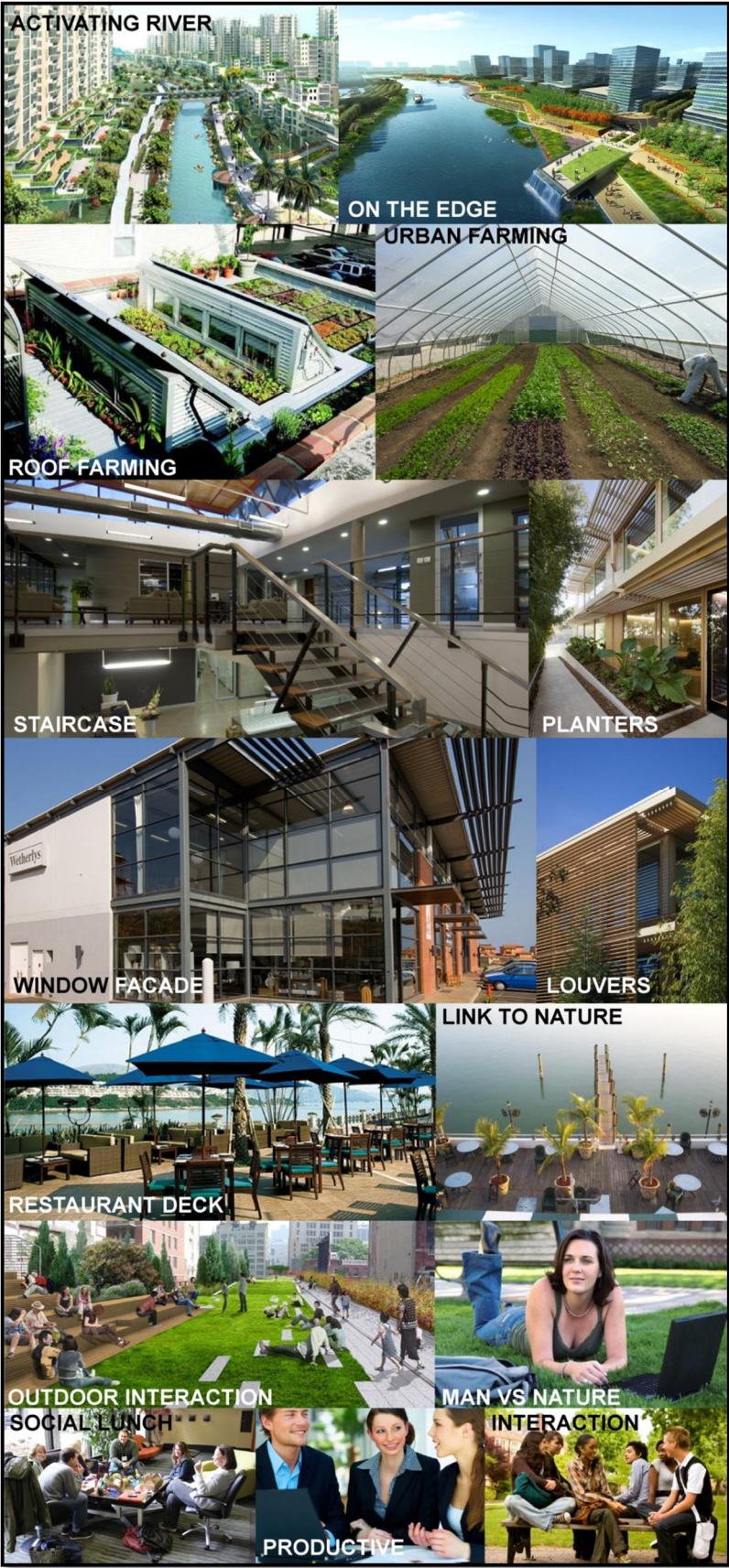
A 'sense of place' is proven through a connection between nature and architecture, resulting in a peaceful and tranquil setting. A place relates to how an individual's physical and mental emotions and feelings are 'stimulated' in a chosen environment. Occupants of architectural spaces behaviour patterns as well as mood get affected through their personal experience of the space. The issue of sick building syndrome could be solved by implementing natural elements into architectural form, improving psychological and physical behaviour patterns and well-being, creating a 'sense of place', reducing stress levels and inform productivity. Spaces designed for social interaction to occur also provide opportunities for public relaxation in harmonious surroundings (Tuan: 1977).

## **3.2 CONCEPT**

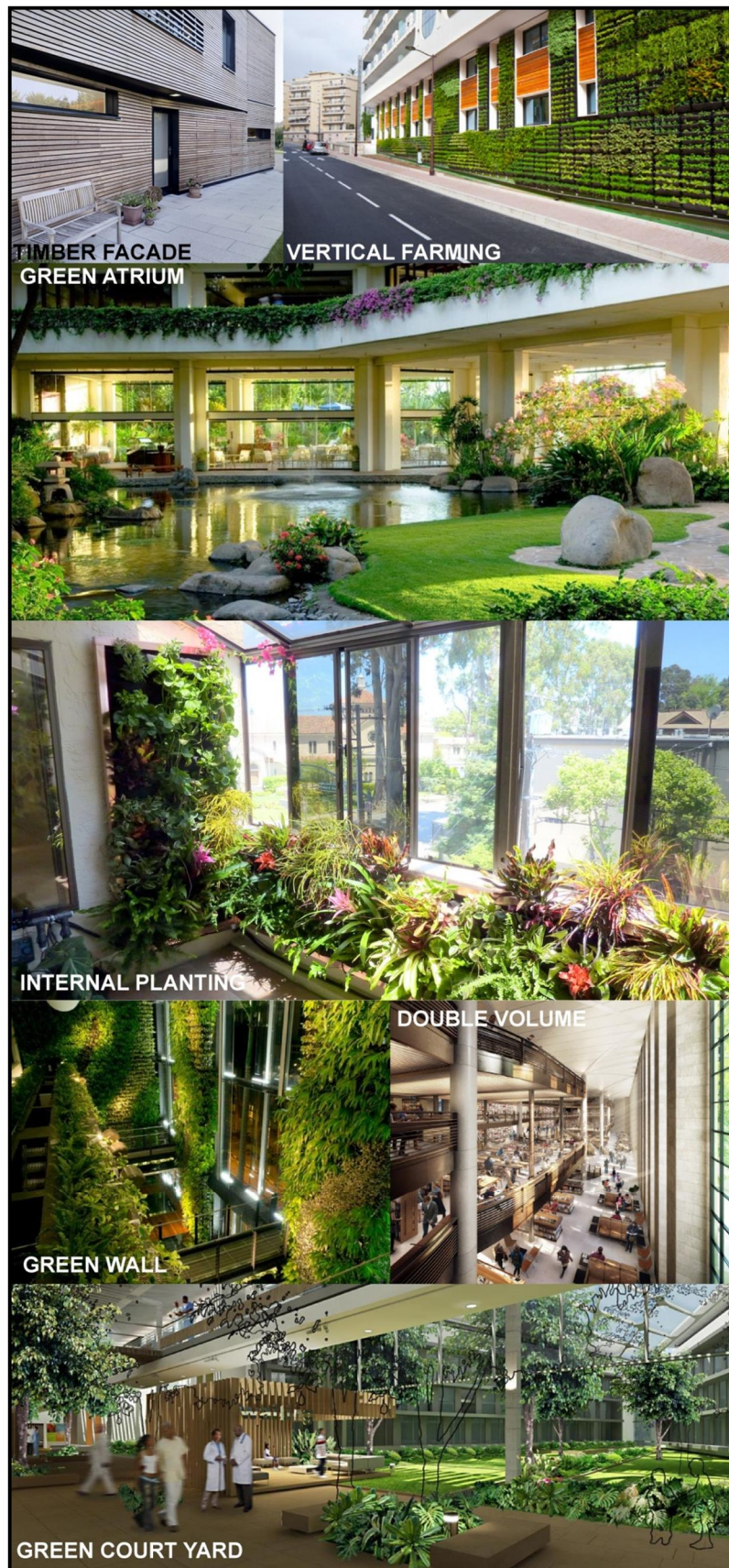
Connecting man and nature through Biophilic Architecture. Through the use of sustainable design strategies, choice of natural materials and the creative manipulation of the buildings form, an architectural environment will be created that will connect people to nature which will ultimately create a sense of place, enhancing thermal comfort, well-being and behaviour patterns.



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### 3.3 KEY PRECEDENT STUDY

#### 3.3.1 KHOO TECK PAUT HOSPITAL (YISHUN, SINGAPORE)

Architect: CPG Consultants Pty. Ltd. | Location: Yishun, Singapore | Typology: Hospital

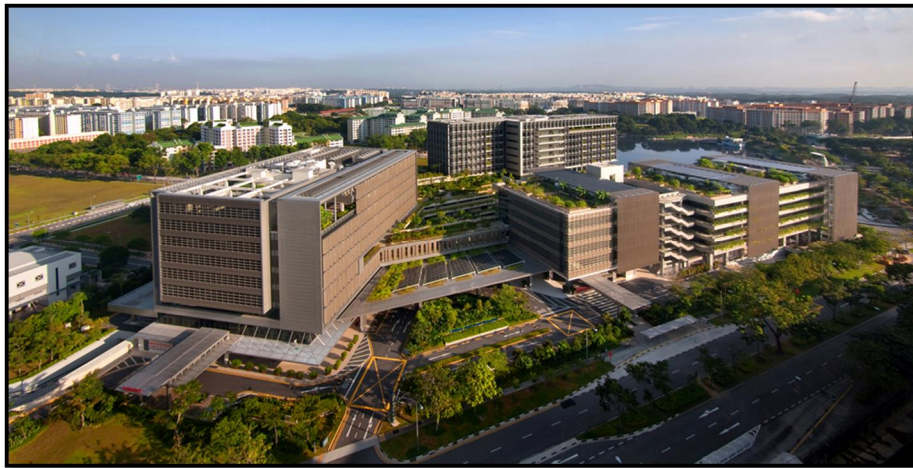


Figure 10: Site option 3 in Umgeni business precinct ([www.worldarchitecturenews.com](http://www.worldarchitecturenews.com))

The three block KTPH garden court yard, terraced gardens and planter box ward layout allow for maximum transparency and natural views, through an open facade design, connecting man with the surrounding natural setting of a scenic natural pond. The garden courtyard is the heart of the hospital, brings light and greenery into the building.

The design has been sensitive in terms of scale and height, communicating to its surrounding blocks by opening outwards, drawing nature into the building. Multi level patient ward designer planter boxes incorporate biophilic design strategies into the building, nurturing mans affiliation with nature. The environmental psychological influence of ample natural vegetation has on these patients increase their behaviour patterns, assists with their recovery time and improves health and well-being.

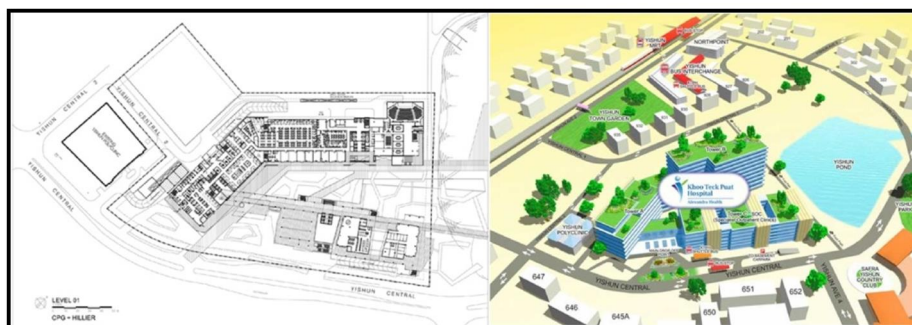


Figure 10: Plan and artists areal massing layout ([www.worldarchitecturenews.com](http://www.worldarchitecturenews.com))





Figure 11: The garden courtyard: Heart of Khoo Tech Puat Hospital ([www.worldarchitecturenews.com](http://www.worldarchitecturenews.com))

### 3.4 DESIGN PRECEDENT STUDIES

#### 3.4.1 GENZYME CENTER (CAMBRIDGE, USA)

Architect: Stefan Behnisch | Location: Cambridge, MA, USA | Typology: Headquarters



Figure 12: Genzyme Center exterior night view (Author:2013)

The building accommodates about 920 individual workplaces over 12 floors, combining innovative design and cutting-edge technology to create an exciting, healthy and productive workplace. The building's central atrium acts as a light shaft as well as a return air duct that allows sufficient natural ventilation to the entire building. The interior is flooded with daylight, all workstations are naturally illuminated through a combination of re-directional blinds at the building's perimeter and the top-lit central atrium. Lighting is further enhanced by reflecting light of internal reflective surfaces and the prism chandeliers. The open staircase

forms part of a 'vertical boulevard', starting at the ground floor lobby before proceeding upwards through various neighbourhoods with open workstations and separate offices. Eighteen interior gardens and seven accessible outdoor garden terraces increase the workers connection to nature and enhance social interaction in the workplace.

The building envelope is a high-performance curtainwall glazing system with operable windows on all 12 floors. More than 32% of the exterior envelope is a ventilated double-facade that blocks solar gains in summer and captures solar gains in the winter. Steam from a nearby power plant is used for central heating and cooling.

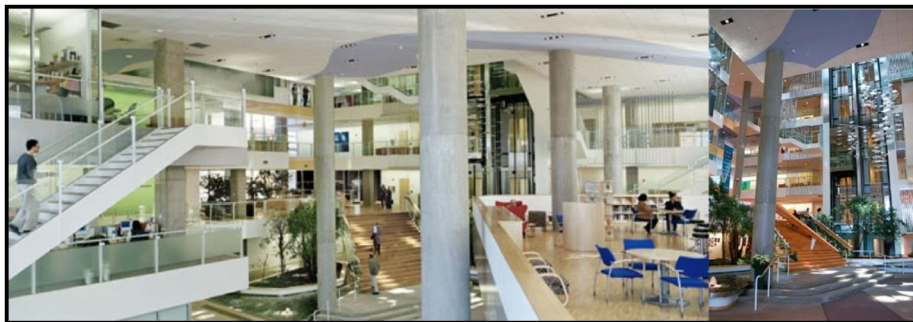


Figure 13: Interior naturally lit atrium (Author:2013)



Figure 14: Plan and natural ventilations system sections of atrium design (Author:2013)

### 3.4.2 INSTITUTE FOR FORESTRY AND NATURE RESEARCH (WAGENINGEN, NETHERLANDS)

Architect: Stefan Behnisch | Location: Wageningen, Netherlands, | Typology: Institute





Figure 15: Interior Biophilic architectural design linking man with nature (Author:2013)

The design brief was for a functional, user-friendly research facility working in harmony with nature; versatile and ecologically sound. The design strategy was developed that drew on the few remaining ecological qualities of the landscape to create a diverse new habitat with vegetation which could sustain insects and animal species and be hospitable to the organizations staff. The building was designed to embrace the landscape, with all workplaces in direct contact with indoor and outdoor gardens. Two indoor gardens provide the focus for daily activities and function as informal meeting areas, an integral component of the energy concept, they serve as the lungs of the building, improving the performance of the external envelope. The production, management, and harvesting of timber is a major field of research at the institute, therefore subsequent occupation followed the motto of human and environmentally friendly building for the future, by using timber for the building facades.

The degree of standardization of the industrial roof components ó together with ventilation openings and tailor-made, adjustable sun-shading devices ó result in a near-optimal relationship between resource consumption and product performance.

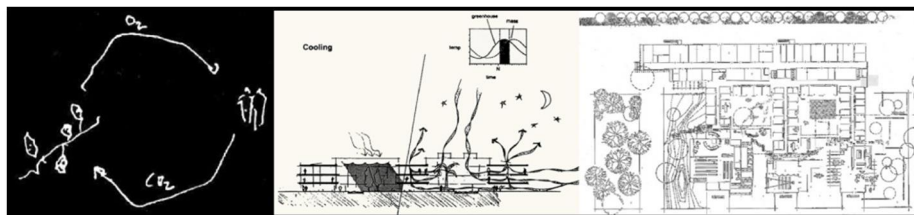


Figure 16: Concept sketches and basic plan (Author:2013)



Figure 17: Model and exterior views (Author:2013)



Figure 18: Interior warm natural materials used (Author:2013)

### 3.5 KEY CASE STUDY

#### 3.5.1 ALEXANDER FORBES (SANDTON, JOHANNESBURG)

Architect: Paragon Architects | Location: Sandton, SA | Typology: Multi-use Office Building



Figure 19: Alexander Forbes Artist impression and ground floor plan ([www.paragon.co.za](http://www.paragon.co.za))

Alexander Forbes consists of eight floors of dedicated offices space, housing 2200 employees, above six floors of parking. The ground floor includes a canteen, training spaces and an auditorium, meeting space, facilities such as a crèche, gymnasium, restaurant, shower facilities, coffee shop and convenience stores to promote a comfortable environment.



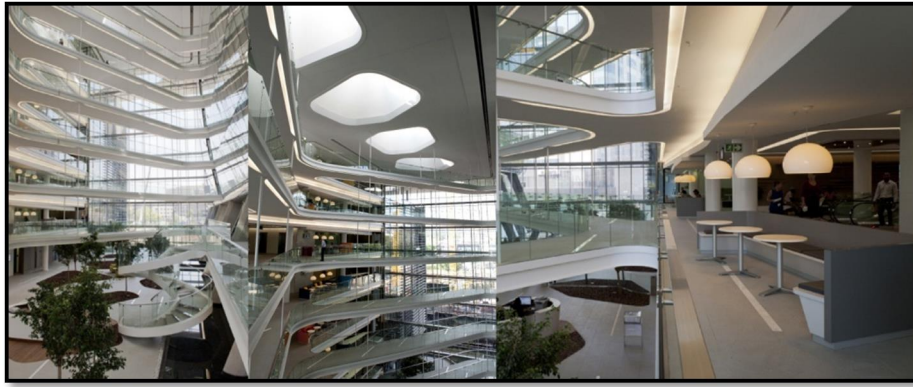


Figure 20: Floating bridges connecting the N&S blocks, with designated pause areas of different style and design, on each floor ([www.paragon.co.za](http://www.paragon.co.za))

Energy sufficiency and indoor environment quality design, create a 'sense of place' by blending into the urban fabric of society. A natural and healthy environment, increased circulation of fresh air, reduced heat loads, plant-filled pause areas. This building design ensure its users thermal, mental and physical comfort, achieved by incorporating Genius Loci's 'sense of place' theory, affecting their behaviour patterns. Two atria provide sufficient natural daylight and visual connection within the building to its surroundings, connecting internal with external views.

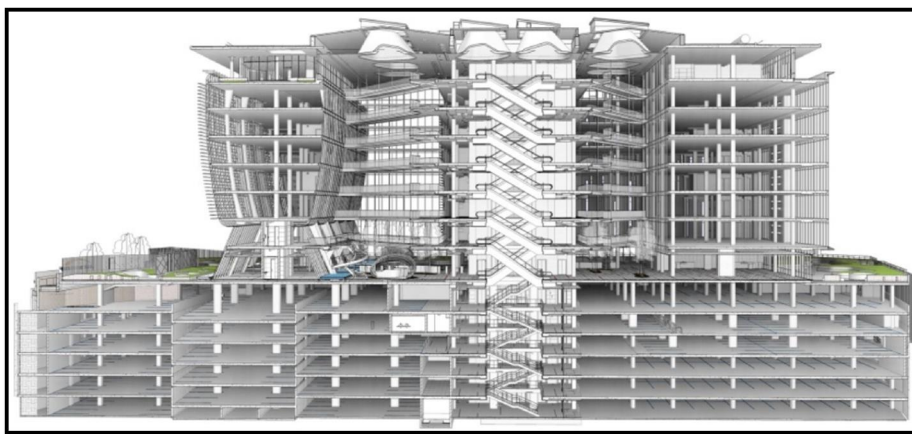


Figure 21: Cross Section of Alexander Forbes ([www.paragon.co.za](http://www.paragon.co.za))

#### 4.0 URBAN DESIGN PROPOSAL

The theoretical study of the relevant literature, its application in both local and international building precedents has created a solid foundation on which to base the urban and building design proposals. The following urban design proposal was created as a response to both the client's requirement as well as rejuvenating the current hard surface of the surrounding site conditions that are apparent in the Umgeni Business Park precinct. It is through this urban

design vision that rejuvenation will occur and Durban's Umgeni Business Park will become a greener area. Not only is this important but it is the start of the rejuvenation process of this business precinct and the urban design proposal can be seen as a catalyst to kick start this process.

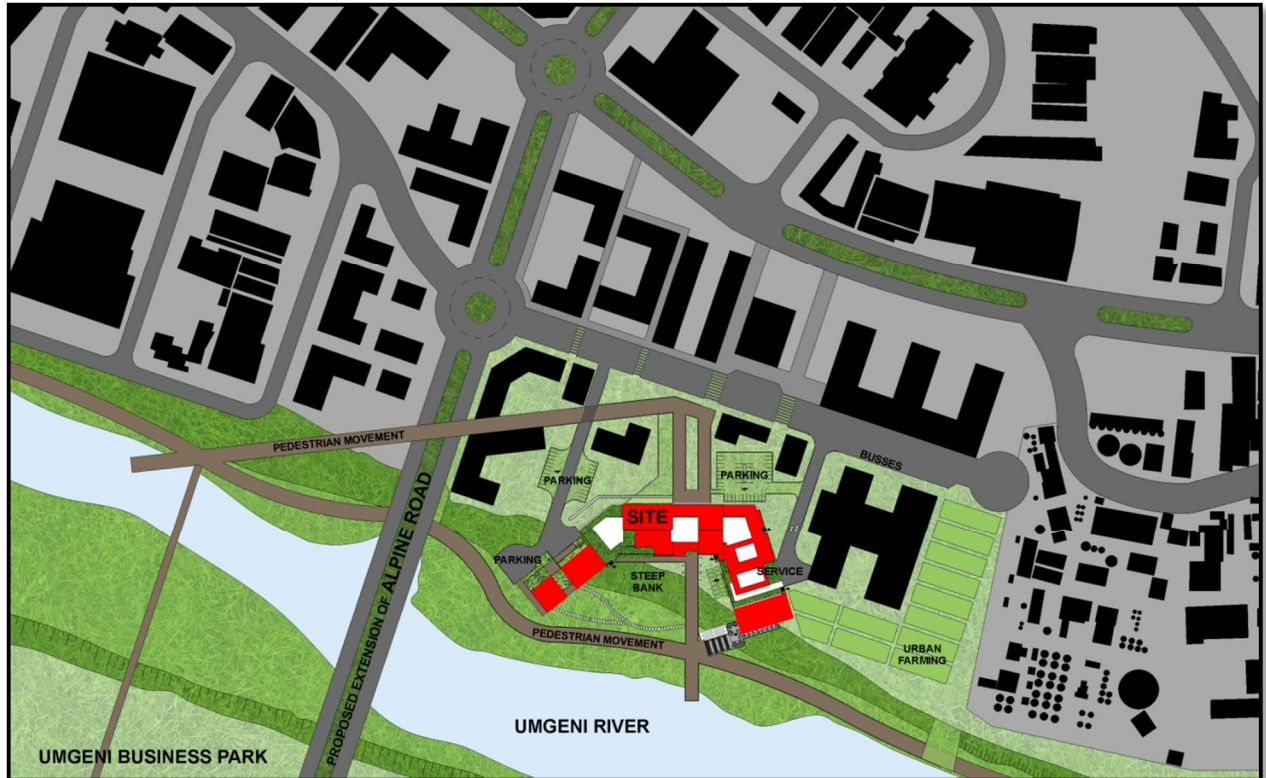


Figure 22: Urban site plan (By Author: 2013)

The proposed urban design aims to revitalise a part of the Durban Umgeni Business Park precinct, with the intention of linking this precinct to the natural urban green environment and Umgeni River. This will therefore create an environment that enhances one's well-being and gives the inhabitants of Durban more opportunities to socially interact with one another, improving their behavior patterns.

## 5.0 DESIGN RESOLUTION

The design concept for the proposed urban office building is to connect people and nature through architecture by enhancing physical health. The architectural layout creates opportunities for people to socially and visually interact. The design connects people to nature by using Biophilic design strategies such as natural lighting and ventilation, planting, water, material selection as well as spontaneous and repeated contact with nature. Architecture that is designed with the occupants' best interest in mind is important in achieving well-being in the architectural environment.

- É The use of Biophilic nature based elements creates a connection to the natural world and enhances human behavior and well-being in public spaces.
- É Design is focused on functionality, comfort and a connection to the natural environment.
- É Human scaled building form on public façade.
- É Public spaces through the use of courtyards and atriums.
- É The use of natural lighting, ventilation and the use of planting and water features.
- É Narrow floor plates and the careful manipulation of building form to encourage natural ventilation and lighting and to create visual communication between spaces and the natural surrounding environment.
- É Warm and cooler, interior and exterior materials are natural and tactile: appropriate for the specific function of spaces.
- É A building that enhances ones well-being and enhances behavior patterns and increases productivity on many levels.

The theoretical framework of Biophilia used in the design of the building has proved that through using nature based design attributes architects are able to design buildings that enhance human well-being and improve human behavior patterns. It was therefore imperative in the design process that the building was designed to best achieve each of the Biophilic attributes in order to create an architectural environment that enhances well-being. These attributes are namely natural lighting and ventilation, planting, water features, selection of non-toxic materials and finishes to enhance well-being and to connect people to nature.



BIOPHILIC ARCHITECTURE AND ITS INFLUENCE ON HUMAN BEHAVIOUR AND WELL-BEING  
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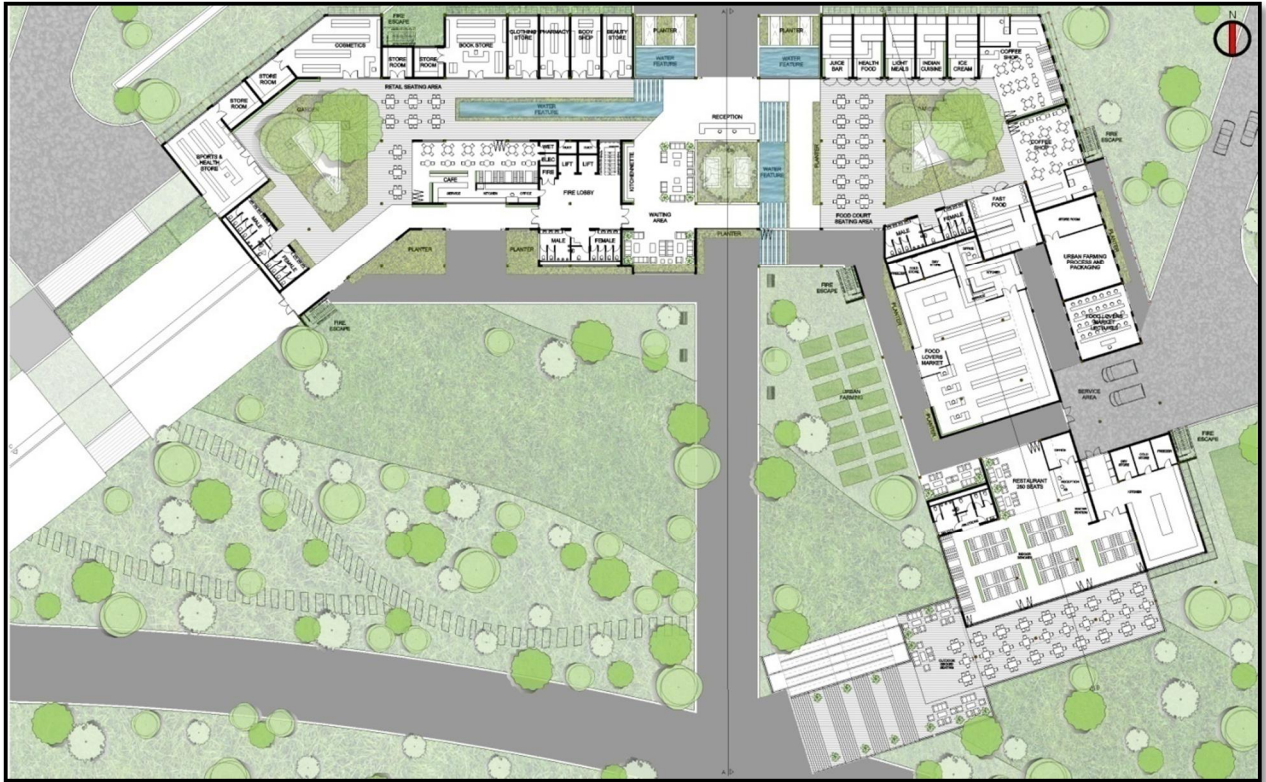


Figure 23: Ground floor plan (By Author: 2013)



Figure 24: Artist impression North Eastern exterior view (By Author: 2013)

The form of the proposed building was carefully manipulated in order to hug the natural environment such a way as to creating spaces for social interaction to occur as well as allowing for effective natural lighting and ventilation into all spaces. The design of the

building is further enhanced by the use of water features, health based vegetation and trees both within the building and on the building's exterior roof gardens. Through creating large public courtyard atriums the building was effectively split up to allow for all the Biophilic attributes to be incorporated into the design. The atrium knuckles was designed to ensure that effective natural ventilation and lighting was achieved into the building spaces.

The architectural language of the building was created bearing in mind the Biophilic attributes. The use of trees on all levels is evident of this as well as the manipulation of the buildings form to achieve natural lighting and ventilation. When designing for natural lighting it is important that adequate solar shading devices are used so that one can reduce glare and direct sunlight into building interiors, as this can have negative effects on people's well-being. It was from this that horizontal louvers as well as planter boxes were placed on the buildings facades to provide solar protection. The use of light shelves became another important method in terms of reflecting natural light deeper into building interiors.

Sustainable design strategies were used to ensure the maximum benefit from the natural elements and to cut down costs on artificial lighting and air conditioning. A building that uses natural ventilation strategies allows an abundance of fresh air into building interiors which improves human well-being. The incorporation of the atrium also allows for the stack effect to occur whereby the cool air is drawn in the building through the pivot windows and the hot air escapes through the louvers at the top of the atrium.

## **6.0 CONCLUSION**

The built environment affects the user, positively or negatively. Implementing natural elements into Architectural form improves psychological and physical behaviour patterns and well-being, creating a sense of place, reducing stress levels and informs productivity. The aim of this study was to establish that implementing natural elements affect behaviour patterns within the built environment. By exploring the concept of sick building syndrome it was found that natural elements positively influence the environmental psychology of man's mental and physical health and well-being when implemented into social spaces. The design proposal demonstrates clearly how one can design for social interaction and well-being. The literature and the theoretical framework have successfully been applied to the design proposal



and as a result an architectural environment has been created that enhances both well-being and positive behaviour patterns.

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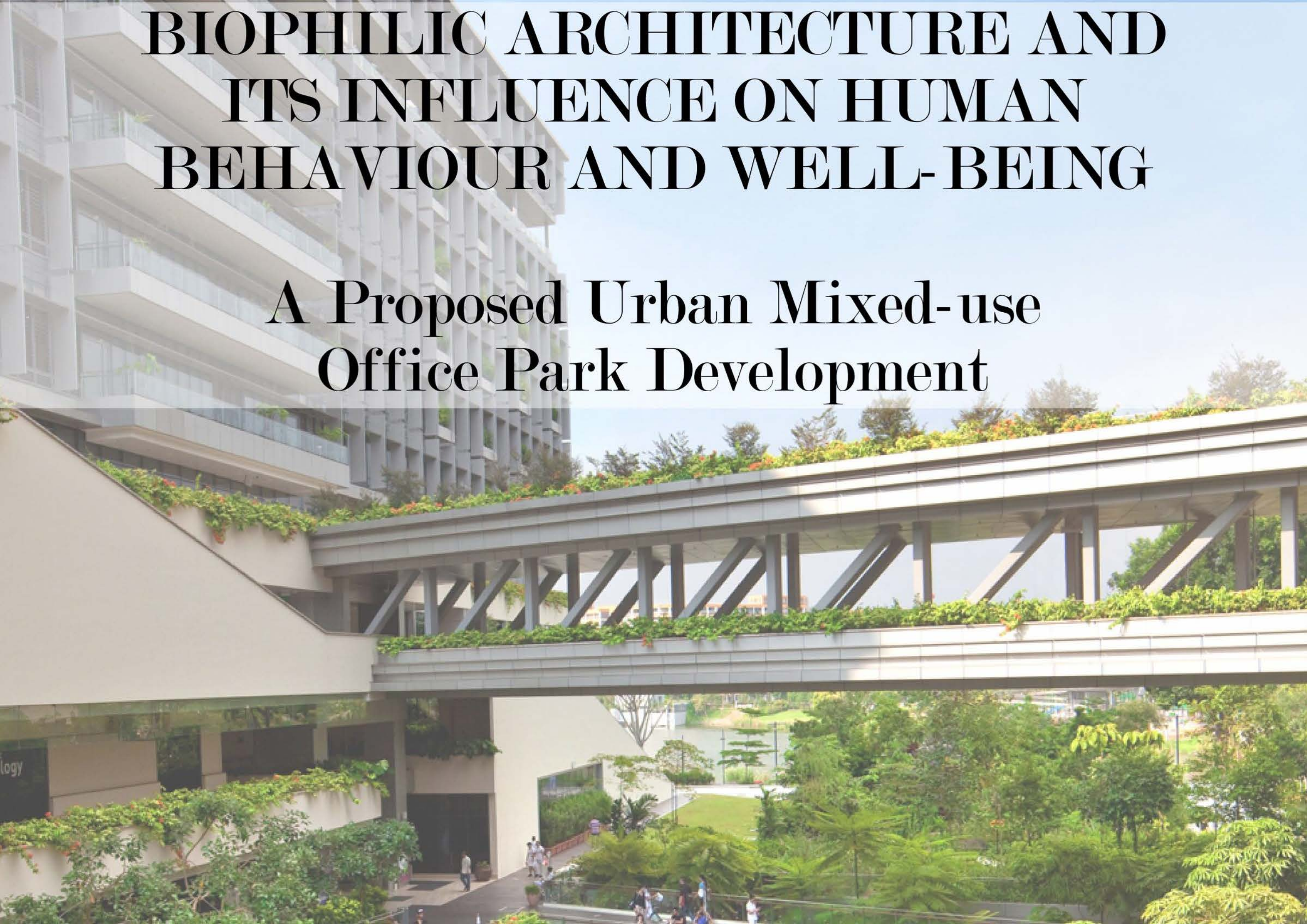
### **7.4 PERSONAL COMMUNICATION**

**GRAHAM WILSON** (Director of Osmond Lange Architects & Planners) interviewed by M. Blom. 15 March 2013, Johannesburg



# BIOPHILIC ARCHITECTURE AND ITS INFLUENCE ON HUMAN BEHAVIOUR AND WELL-BEING

## A Proposed Urban Mixed-use Office Park Development





# RESEARCH\_BACKGROUND

A personal assumption was made that a large populations of South Africans are currently working in unhealthy conditions, resulting in making them sick, therefore probably not meeting everyday human health needs.

Human beings are greatly affected, both physically and mentally, by our surroundings, whether natural or built. This involves ones **HUMAN WELL-BEING**, physical and emotional or ones spiritual self.

Dealing with the issue of buildings showing characteristics of **SICK BUILDING SYNDROME**, could result in occupants suffering negative side effects. Healthy living is a primary need for society. Everyday pollution in society has led to these negative outcomes of physical and psychological well-being of space users. When investigating factors such as natural light, colour, fresh air, visual contact with water and nature or noise pollution, it is found that exposure to such **NATURAL ELEMENTS** positively **INFLUENCE HUMAN BEHAVIOUR**, health and productivity in a live, work and play environment.

*"First, man creates environment, and environment, in its turn, influences man"*  
- A Smithson -

## AIMS:

The main aim was to establish which natural elements affect behaviour patterns within the built form. Researching nature and its affect on human behaviour proved a positive result in well-being within architecture. Exploring the concept of sick building syndrome an accurate investigation was made as to which design elements result in natural well-being when implemented into social spaces.

## OBJECTIVES:

- To discover how the natural physical environment influence human behaviour
- To interpret which **human health needs** influence positive built environments
- To investigate how sick building syndrome influence productivity
- To create a response for **mental and physical well-being** in Architecture through Biophilic design

## RESEARCH PROBLEM:

Human behaviour and well-being is influenced by Architectural form. Various **social behaviour patterns** within the **architectural environment** affect human well-being, from both a positive and negative point of view. Sick building syndrome: natural elements (colour, light, texture, sound, natural lighting & ventilation, thermal comfort, water & water features, landscapes and gardens) can positively influence well-being through **architectural interventions** and these environments can in turn affect human behaviour.



## KEY QUESTIONS:

- How can **Biophilic design** affect human behaviour patterns, productivity and well-being?
- What causes sick building syndrome?
- What **Architectural response** would support the theories of behaviour patterns and well-being in Biophilic design?

## ARCHITECTURAL RESPONSE:

- Design sustainable architectural environments that support public interaction and incorporate social facilities
- Design architectural environments allowing users to legibly identify with their surroundings
- Design a unique 'sense of space' of the site for social interaction through good urban and architectural design
- Design green spaces that connect people to nature and soften the harsh urban environment
- Design in close proximity to natural elements such as water and green environments to introduce tranquility
- Design healthy buildings with natural ventilation and day lighting strategies
- Design buildings that allow for free public movement
- Design buildings that connect people to the natural world, through planting and good ventilation and lighting
- Design interior spaces through the correct choice of colours, materials, as well as natural lighting and ventilation requirements that support human well-being and positively influence behaviour patterns and productivity



## HYPOTHESIS:

The built environment affects the user, positively or negatively. Implementing natural elements into Architectural form improves psychological and physical behaviour patterns and well-being, creating a **sense of place**, reducing **stress levels** and informs productivity.

# THEORETICAL\_FRAMEWORK

## 1. WILSON'S BIOPHILIA HYPOTHESIS

Edward O. Wilson biophilia theory analyses human behaviour and values of their relationships with nature: aiming to create psychological, physical and socially healthy environments. Nature is the source of mans being. People have an affiliation with nature, a natural interest and attraction to nature, a need to contact with nature, just as much as they require nutrients and air for survival. Edward O. Wilson biophilia theory analyses human behaviour and values of their relationships with nature: aiming to create psychological, physical and socially healthy environments. The influence of biophilic design can improve human behaviour in architecture, through natural elements such as, natural light, ventilation and materials, colour, spatial definition, interior and exterior connections with nature resulting in Genius Loci's 'sense of place' theory

Bringing nature into buildings through Biophilic design, promotes measurable benefits to human behaviour, performance, productivity, emotional well-being, stress reduction, learning, health and healing

## 2. ENVIRONMENTAL PSYCHOLOGY

An integration between nature, natural elements and architecture is a field of study that examines the relationship between environments and how it affects its inhabitants and their behaviour. This involves the relationship between a person's state of mind and their physical environment. It was found that environmental psychology including contact with nature proved that the investigation of sick building syndrome concluded how incorporating natural elements positively influence the environmental psychology of mans mental and physical health and well-being. A truly positive environmental psychological building is a place that is healthy, nurturing, and delightful to its occupants

## 3. GENIUS LOCI: A 'SENSE OF PLACE'

A 'sense of place' is proven through a connection between nature and architecture, resulting in a peaceful and tranquil setting. A place relates to how an individual's physical and mental emotions and feelings are 'stimulated' in a chosen environment. Occupants of architectural spaces' behaviour patterns as well as mood gets affected through their personal experience of the space. The issue of sick building syndrome could be solved by implementing natural elements into architectural form, improving psychological and physical behaviour patterns and well-being, creating a 'sense of place', reducing stress levels and inform productivity. Spaces designed for social interaction to occur also provide opportunities for public relaxation in harmonious surroundings



## VISION:

An **URBAN MULTI-USE OFFICE PARK DEVELOPMENT** and urban framework providing social public facilities within a Biophilic designed environmental conscious building, promoting well-being, positive behaviour patterns and productivity

The building is to be located near or within the natural environment, creating easily accessible opportunities to the site via vehicular and pedestrian movement

## CLIENT & REQUIREMENTS:

Fruit and Veg City and Food Lovers Market have established a company called Love Health, whom will be the clients of my design. The Love Health Organisation is an organic foods business specializing in bringing fresh produce to the public of South Africa. They currently have an operation in Cape Town and are looking to move their headquarters to the Durban area. This client sponsors a series of 'healthy and active' events. Living a healthy and active lifestyle is important, especially with today's busy lifestyles.

The main aim with Love Health is to supply each and every one of their customers with not only the freshest fruit and vegetables, but also to help them embrace the outdoors and get active. You've often heard the saying 'You are what you eat' and while this isn't exactly true, what you eat does have a major effect on your general wellness as the foods you consume will determine the nutrients your body gets. Food Lover's Market are very conscious of the positive effects a healthy nutritious diet can have on your general wellness. The nutrients in our diet give us energy and are necessary to improve your behaviour patterns development.

This client values human health as a basic principal of well-being, which in turn would improve one's lifestyle. Health is wealth. Incorporating Biophilic design into buildings enhances the vision of wellness. The client propose to develop a 15 000sqm headquarters space which will consist of a multi-use program and include office space, retail space and outdoor public space with specific focus on well-being and wellness in the workplace. They require a sustainable design ensuring a building responding to a healthy lifestyle for its occupants and visitors.

The client acquires a 20 000sqm site in the Springfield Park area in Durban which bears the potential to develop the aforementioned work. A north-facing site needs to make use of views of natural vegetation and have direct access to the water's edge.



## CONCEPT:

Connecting man and nature through Biophilic Architecture. Through the use of sustainable design strategies, choice of natural materials and the creative manipulation of the buildings form, an architectural environment will be created that will connect people to nature which will ultimately create a sense of place, enhancing well-being and behaviour patterns.

# RESEARCH\_CASE\_STUDY

## KEY\_CASE\_STUDY

ALEXANDER FORBES HEADCOURTERS

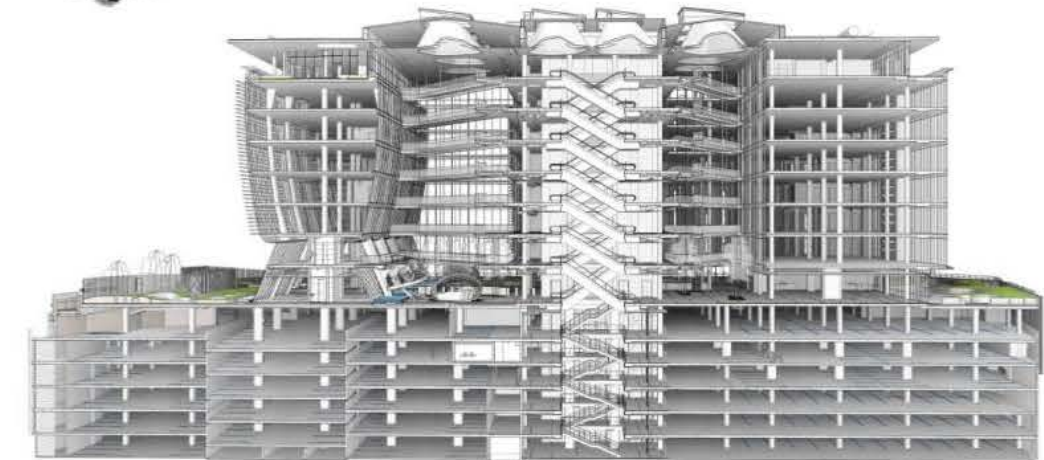
Architect: Paragon Architects | Location: Sandton, South Africa |

Typology: Multi-use Office Building



Eight floors of dedicated offices space, housing 2200 employees, above six floors of parking. The ground floor includes a canteen, training spaces and an auditorium, meeting space, facilities such as a crèche, gymnasium, restaurant, shower facilities, coffee shop and convenience stores to promote a comfortable environment

Energy sufficiency and indoor environment quality design, create a 'sense of place' by blending into the urban fabric of society. A natural and healthy environment, increased circulation of fresh air, reduced heat loads, plant-filled pause areas. This building design ensure its users thermal, mental and physical comfort, achieved by incorporating Genius Loci's 'sense of place' theory, affecting their behaviour patterns. Two atria provide sufficient natural daylight and visual connection within the building to its surroundings, connecting internal with external views



## BIOPHILIC ARCHITECTURE AND ITS INFLUENCE ON HUMAN BEHAVIOUR AND WELL-BEING

### A Proposed Urban Multi-use Office Park Development

Fruit & Veg City and The Food Lover's Market

LOVE HEALTH ORGANISATION

marjorie  
blom

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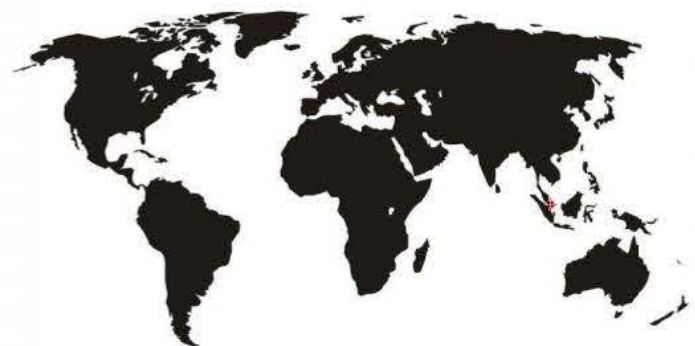




# RESEARCH\_PRECEDENT\_STUDY

## KEY\_PRECEDENT\_STUDY

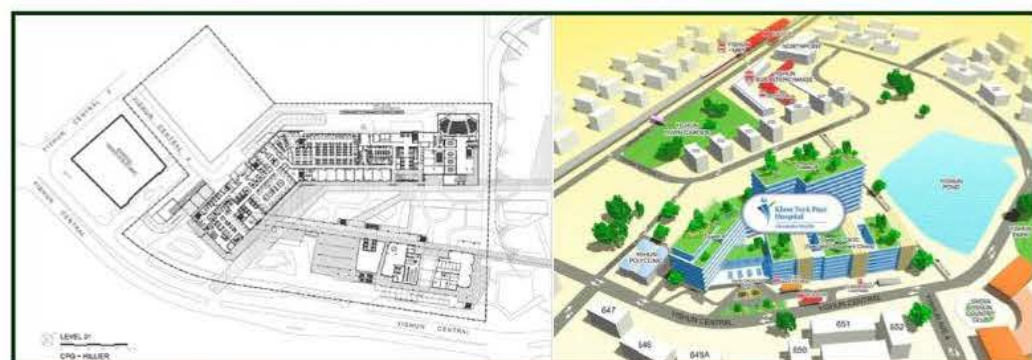
**KHOO TECK PUAT HOSPITAL**  
Architect: CPG Consultants Pty. Ltd. | Location: Yishun, Singapore | Typology: Hospital



The three block KTPH garden court yard, terraced gardens and planter box ward layout allow for maximum transparency and natural views, through an open facade design, connecting man with the surrounding natural setting of a scenic natural pond. The garden courtyard is the heart of the hospital, brings light and greenery into the building

The design has been sensitive in terms of scale and height, communicating to its surrounding blocks by opening outwards, drawing nature into the building

Multi level patient ward designer planter boxes incorporates biophilic design strategies into the building, nurturing mans affiliation with nature. The environmental psychological influence of ample natural vegetation has on these patients increase their behaviour patterns, assists with their recovery time and improves health and well-being



# DESIGN\_PRECEDENT\_STUDY

## PRECEDENT\_STUDY

**GENZYME CENTRE**  
Architect: Stefan Behnisch | Location: Cambridge, MA, USA | Typology: Headquarters

The building accommodates about 920 individual workplaces over 12 floors, combining innovative design and cutting-edge technology to create an exciting, healthy and productive workplace. The building's central atrium acts as a light shaft as well as a return air duct that allows sufficient natural ventilation to the entire building. The interior is flooded with daylight, all workstations are naturally illuminated through a combination of re-directional blinds at the building's perimeter and the top-lit central atrium. Lighting is further enhanced by reflecting light of internal reflective surfaces and the prism chandeliers. The open staircase forms part of a 'vertical boulevard', starting at the ground floor lobby before proceeding upwards through various neighbourhoods with open workstations and separate offices. Eighteen interior gardens and seven accessible outdoor garden terraces increase the workers connection to nature and enhance social interaction in the workplace

The building envelope is a high-performance curtainwall glazing system with operable windows on all 12 floors. More than 32% of the exterior envelope is a ventilated double-facade that blocks solar gains in summer and captures solar gains in the winter. Steam from a nearby power plant is used for central heating and cooling



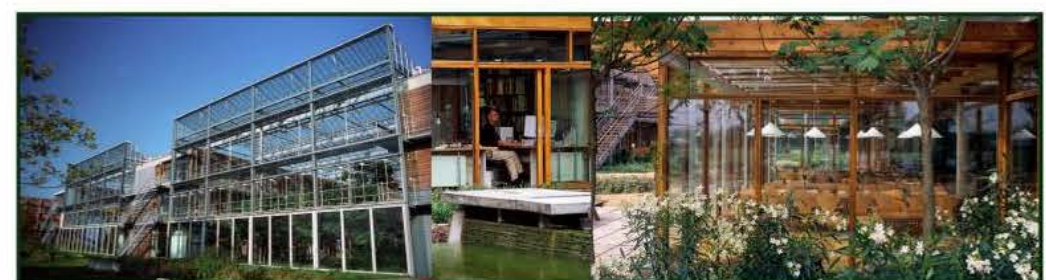
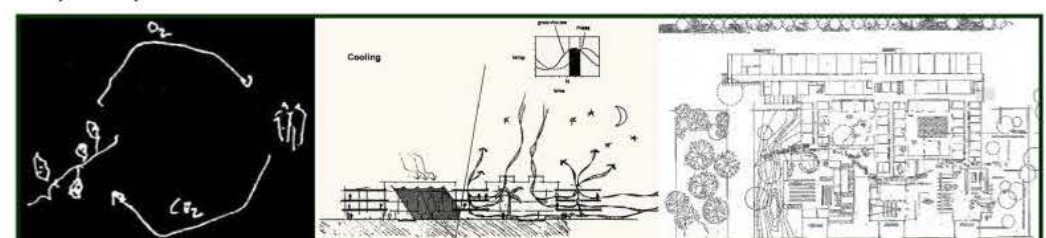
# DESIGN\_PRECEDENT\_STUDY

## PRECEDENT\_STUDY

**INSTITUTE FOR FORESTRY AND NATURE RESEARCH**  
Architect: Stefan Behnisch | Location: Wageningen, Netherlands, | Typology: Institute

The design brief was for a functional, user-friendly research facility working in harmony with nature; versatile and ecologically sound. The design strategy was developed that drew on the few remaining ecological qualities of the landscape to create a diverse new habitat with vegetation which could sustain insects and animal species and be hospitable to the organizations staff. The building was designed to embrace the landscape, with all workplaces in direct contact with indoor and outdoor gardens. Two indoor gardens provide the focus for daily activities and function as informal meeting areas, an integral component of the energy concept, they serve as the lungs of the building, improving the performance of the external envelope. The production, management, and harvesting of timber is a major field of research at the institute, therefore subsequent occupation followed the motto of human and environmentally friendly building for the future, by using timber for the building facades

The degree of standardization of the industrial roof components – together with ventilation openings and tailor-made, adjustable sun-shading devices – result in a near-optimal relationship between resource consumption and product performance



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**LOVE HEALTH ORGANISATION**

marjorie  
blom

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# SITE\_SELECTION\_CRITERIA

**LOCATION:** (situated within a public precinct)  
It should be a site that offers opportunities for development that will benefit the micro and macro context. The immediate area should be near if not in a natural setting, creating a symbiotic relationship between man and its surroundings. The site should be in an area that has the greatest need of renewal

**SITE SIZE:** (a generous size site)  
The size should be adequate for a new urban multi-use office development and able to accommodate sufficient parking

**ACCESSIBILITY:** (linking to surrounding attractions)  
There should be easy access to the site and it should be integrated in the broader urban context of the area and its surroundings. It should be easy to access the site from various points through numerous modes of transport, as well as pedestrian friendly accessibility, to maximise convenience for the local population

**CONNECTIVITY:** (bridging between two divided area)  
Provides excellent connectivity to surrounding areas, connecting many activity nodes, revitalising the Umgeni Business Park precinct

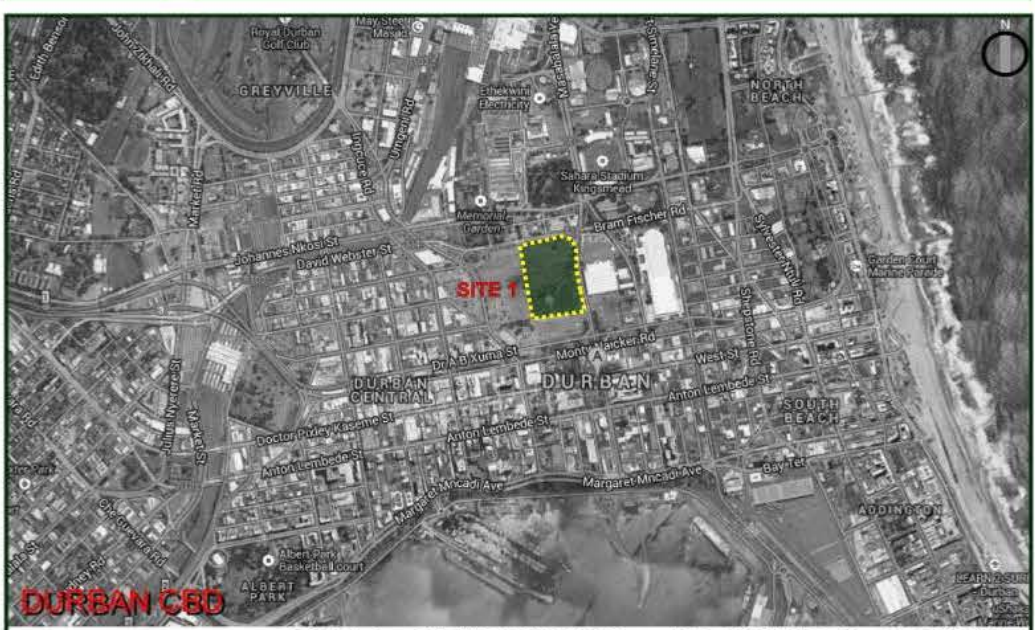
**NATURAL ENVIRONMENT:** (access to nature based areas)  
The site must have a natural landscape or the latter must be suitable to be implanted in the context to enhance the existing natural fabric. Vegetation in proximity to the building is very effective, when improving the well-being of building users and incorporating natural lighting and ventilation. The site should offer an opportunity to enhance the natural ecosystem while aiding in natural human well-being

**ORIENTATION:** (nature influencing light, wind, water, cooling etc)  
Solar and wind orientation provide natural lighting and ventilation for human comfort while views of the natural environment improve aesthetic appeal of the site. Therefore the site should be a north to north east orientated promoting a healthy and vibrant site, achieving optimum building performance with regards to thermal comfort and lighting levels

**REVITALISATION:** (bringing people to the precinct)  
Warehouse jungle, light commercially zoned, no activity in night and motor industries dominate leaving the area unvisited. Lack of shade, trees urban furniture (unfriendly pedestrian environment), Dilapidated buildings and lack of public social spaces. This demonstrates the need for the revitalisation of the urban area



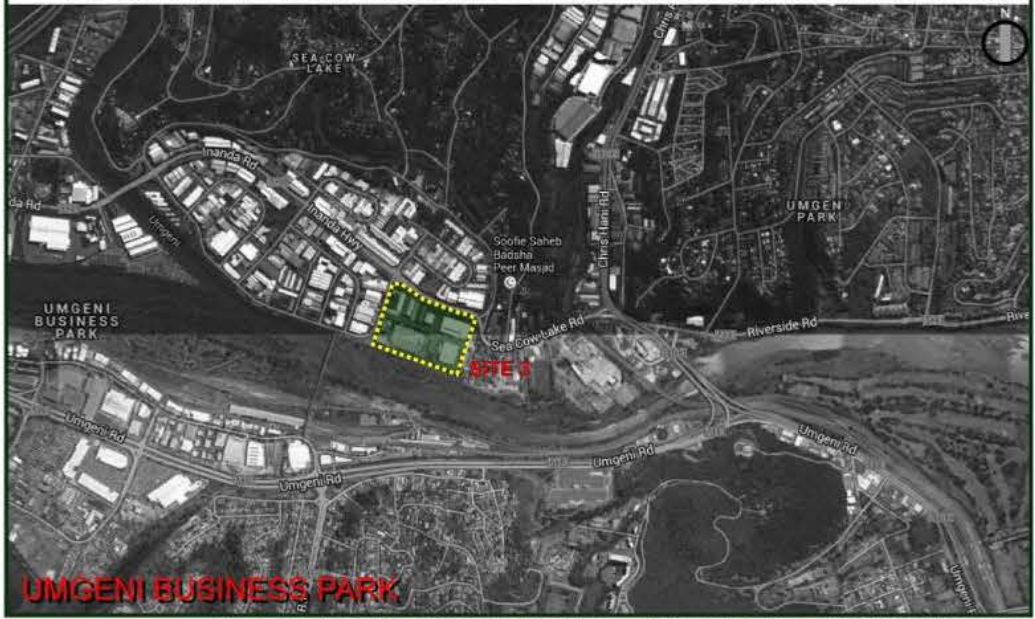
# SITE\_SELECTION



SITE 1: CITY CENTRAL + NO NATURAL CONTEXT



SITE 2: BUSINESS PRECINCT + SEMI NATURAL SURROUNDINGS



SITE 3: LIGHT INDUSTRIAL + NATURAL ENVIRONMENT

# SITE\_SELECTION\_ANALYSIS



SITE 1: AREAL + PEDESTRIAN VIEW

The following criteria were found to be vital when selecting a site which was best suited for a Urban Multi-use Office Park Development in the Durban area: A Headquarters for the Love Health Organisation

ANALYSIS CRITERIA	CRITERIA EVIDENT
MAN VS NATURE: (environmental psychology)	x
NATURAL ELEMENTS: (biophilic hypothesis)	
ORIENTATION: (nature influencing light, wind, water)	x
ACCESSIBILITY: (linking to surrounding attractions)	x
LOCATION: (potential for creating a sense of place)	x



SITE 2: AREAL + PEDESTRIAN VIEW

The following criteria were found to be vital when selecting a site which was best suited for a Urban Multi-use Office Park Development in the Durban area: A Headquarters for the Love Health Organisation

ANALYSIS CRITERIA	CRITERIA EVIDENT
MAN VS NATURE: (environmental psychology)	x
NATURAL ELEMENTS: (biophilic hypothesis)	x
ORIENTATION: (nature influencing light, wind, water)	
ACCESSIBILITY: (linking to surrounding attractions)	x
LOCATION: (potential for creating a sense of place)	x



SITE 3: AREAL + PEDESTRIAN VIEW

The following criteria were found to be vital when selecting a site which was best suited for a Urban Multi-use Office Park Development in the Durban area: A Headquarters for the Love Health Organisation

ANALYSIS CRITERIA	CRITERIA EVIDENT
MAN VS NATURE: (environmental psychology)	x
NATURAL ELEMENTS: (biophilic hypothesis)	x
ORIENTATION: (nature influencing light, wind, water)	x
ACCESSIBILITY: (linking to surrounding attractions)	x
LOCATION: (potential for creating a sense of place)	x



# SITE\_LOCATION

SITES ANALYSED	ANALYSIS OUTCOME
SITE 1: DURBAN CBD	XXXX
SITE 2: UMHLANGA BUSINESS PARK	XXXX
SITE 3: UMGENI BUSINESS PARK	XXXXX

## SELECTED SITE 3:



## SITE ANALYSIS: (chosen site assessment)

Therefore the surrounding environment has a direct impact on the location of the proposed building. The proposed site is located opposite the Umgeni Business Park area near a Major transport node, inside a warehouse storage business precinct. The building has close access to natural greenery and the Umgeni river, ideal for urban farming and pedestrian friendly walkways. The chosen site promotes a free movement environment. The orientation of the proposed site faces North, ideal for incorporating maximum North light entering the majority of the site. Sensory views from the site indicate positive points of interest or value in the surrounding area. Views to the site from areas outside the site boundaries indicate traffic coming into the site from major routes

Potential pedestrian movement around the site was analyzed to determine the public use of the chosen area. Pedestrians tend to walk no further than approximately 300m, which give opportunity for community spaces to be designed within the site, drawing the public into the site

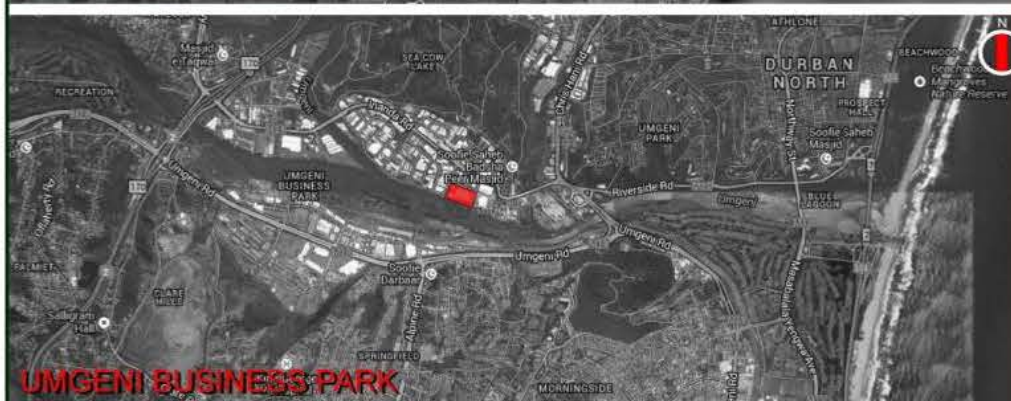


## EXISTING AND POTENTIAL MAIN ROADS

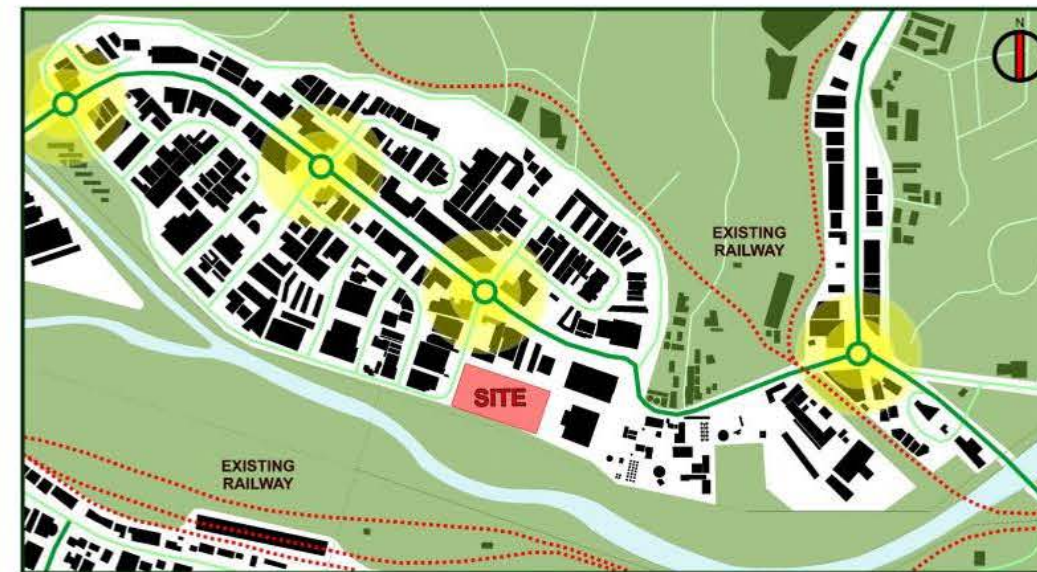


## EXISTING AND NEW MAIN ROAD

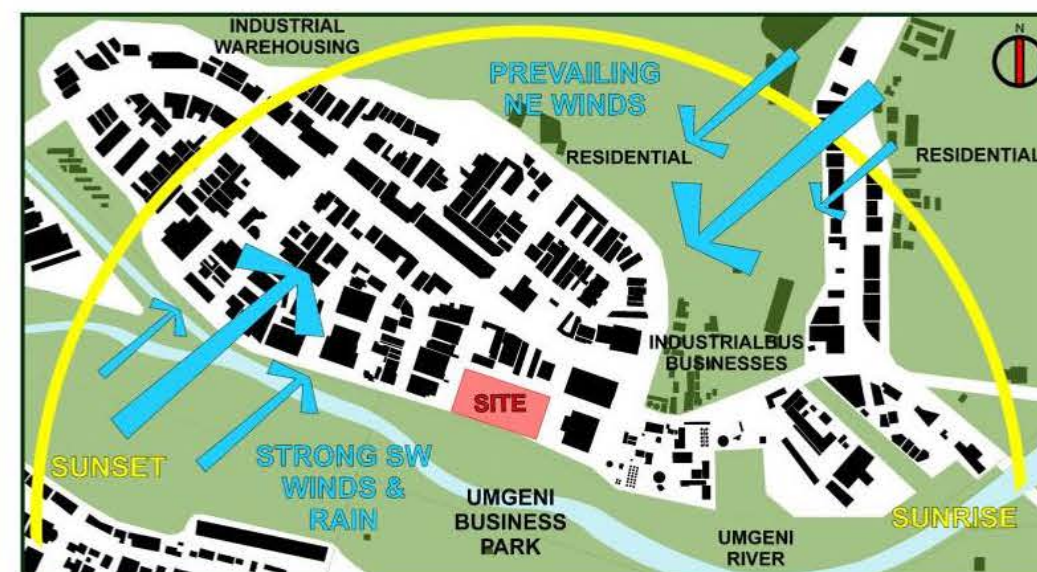
# URBAN+\_SITE\_ANALYSIS



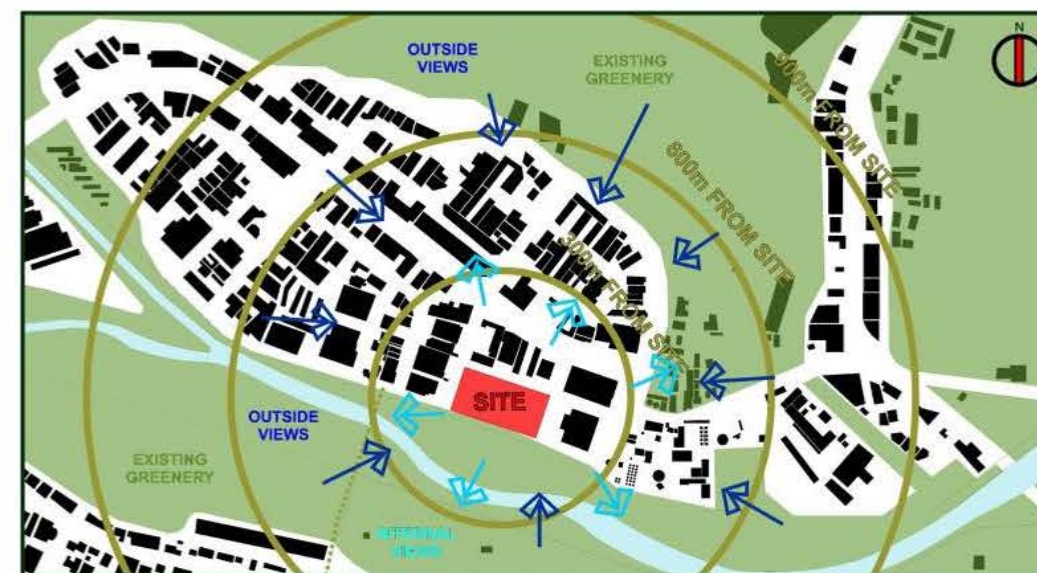
# SITE\_ANALYSIS



## TRANSPORT & PEDESTRIAN NODES AND ROADS



## ENVIRONMENTAL ANALYSIS



## PEDESTRIAN MOVEMENT, INTERNAL & EXTERNAL VIEWS



## BIOPHILIC ARCHITECTURE AND ITS INFLUENCE ON HUMAN BEHAVIOUR AND WELL-BEING

### A Proposed Urban Multi-use Office Park Development

Fruit & Veg City and The Food Lover's Market

LOVE HEALTH ORGANISATION

marjorie  
blom

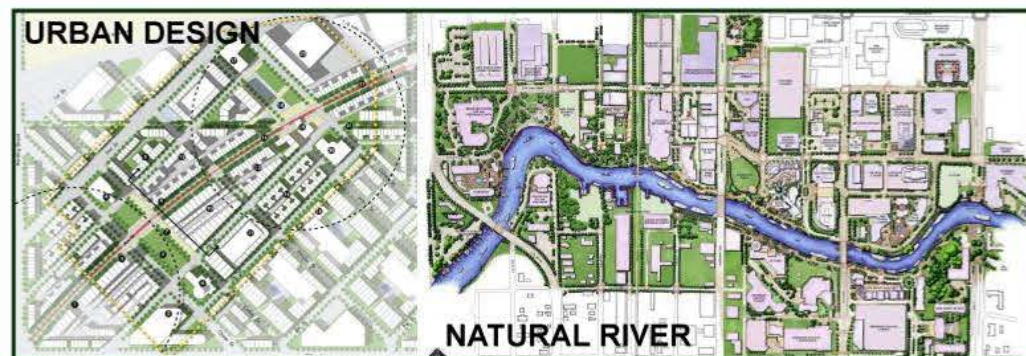
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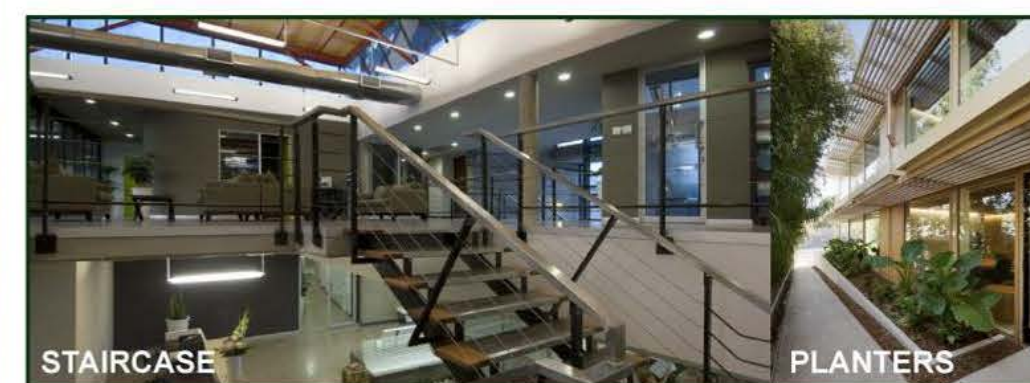
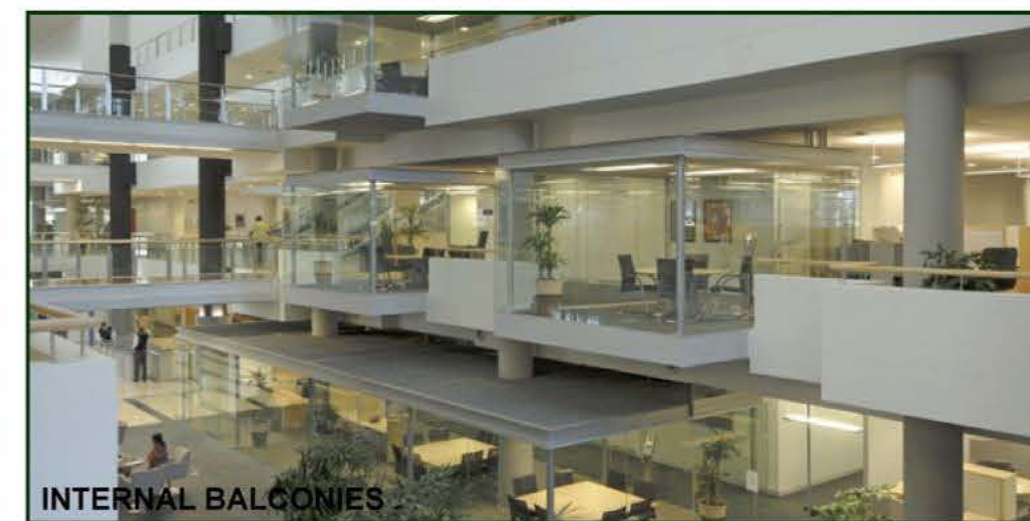
# CONCEPT\_URBAN\_DESIGN



# CONCEPT\_DESIGN



# CONCEPT\_DESIGN



BIOPHILIC ARCHITECTURE AND ITS INFLUENCE ON HUMAN BEHAVIOUR AND WELL-BEING  
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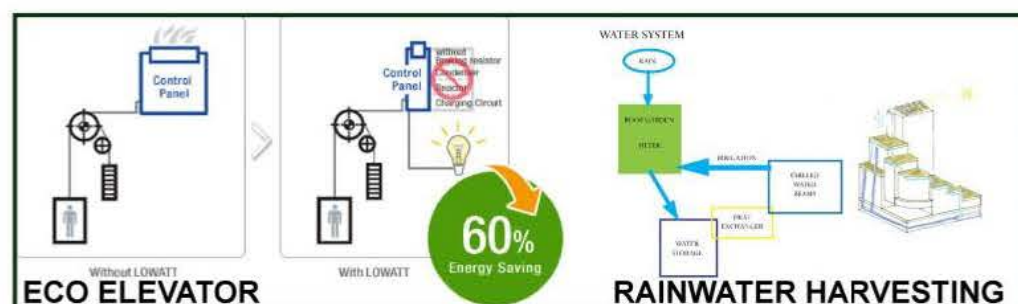
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# CONCEPT\_DESIGN\_ELEMENTS



**BIOPHILIC ARCHITECTURE AND ITS INFLUENCE ON HUMAN BEHAVIOUR AND WELL-BEING**  
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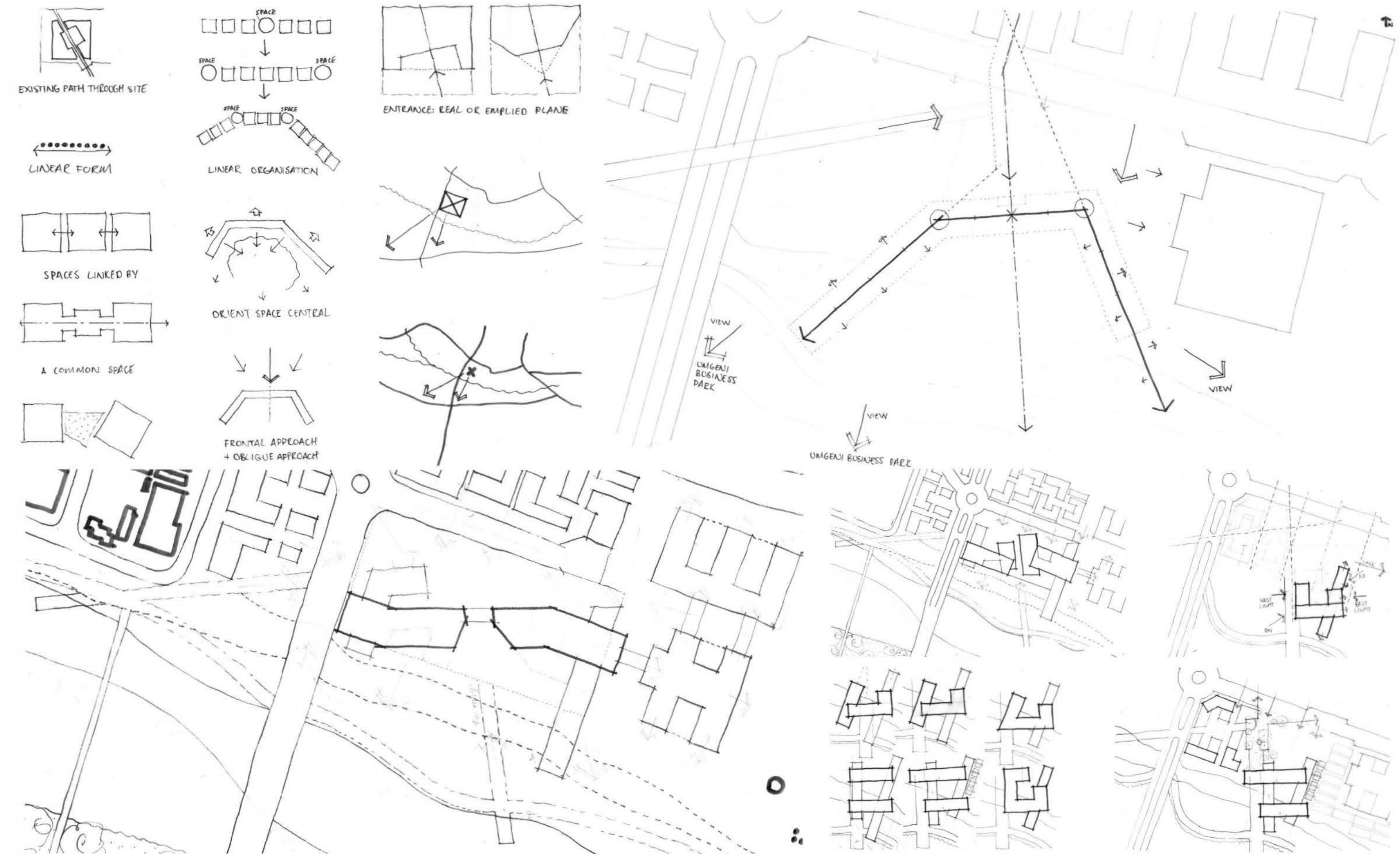
**LOVE HEALTH ORGANISATION**

marjorie  
blom

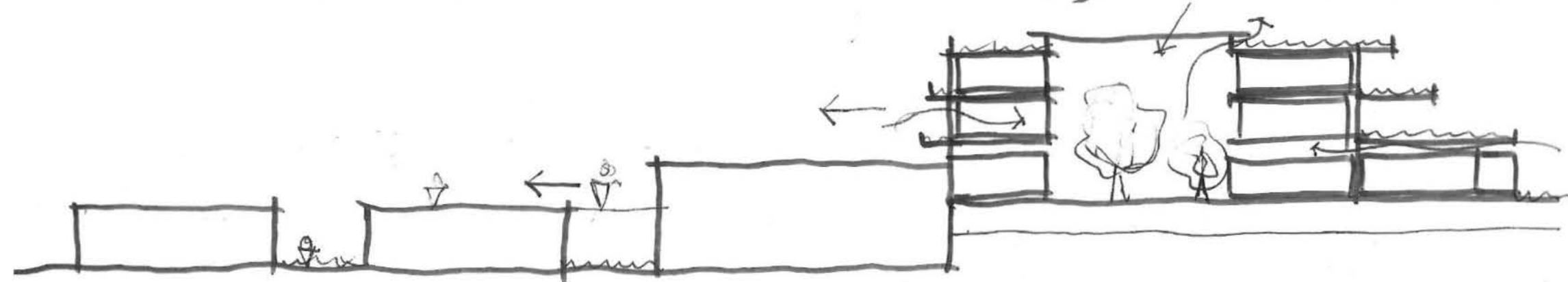
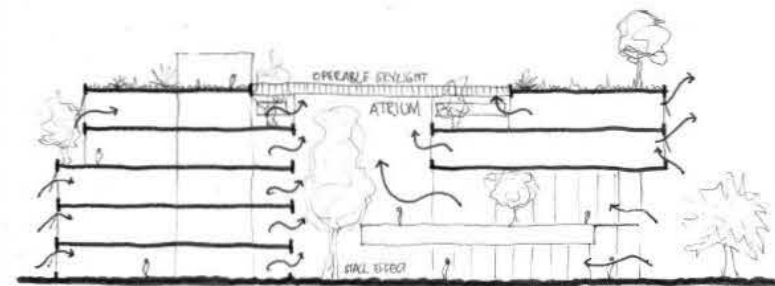
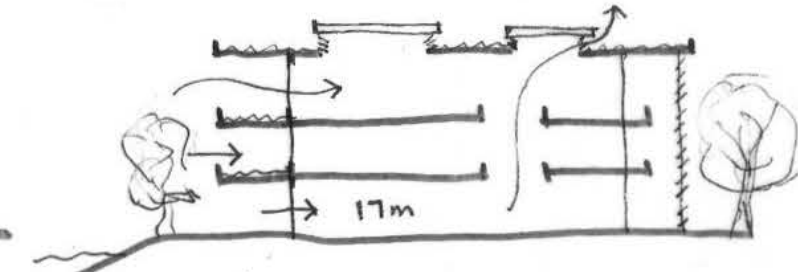
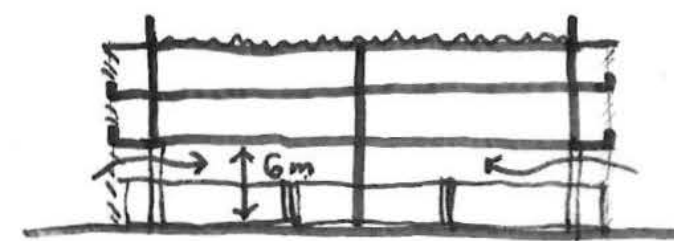
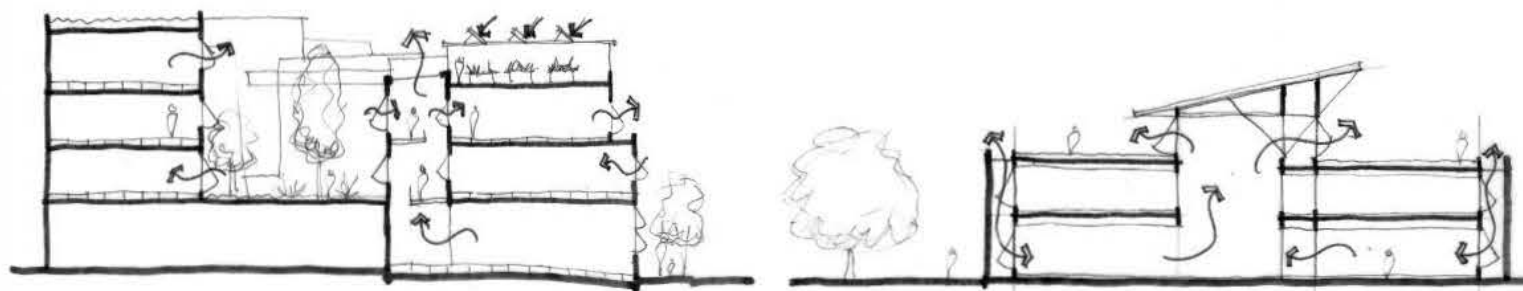
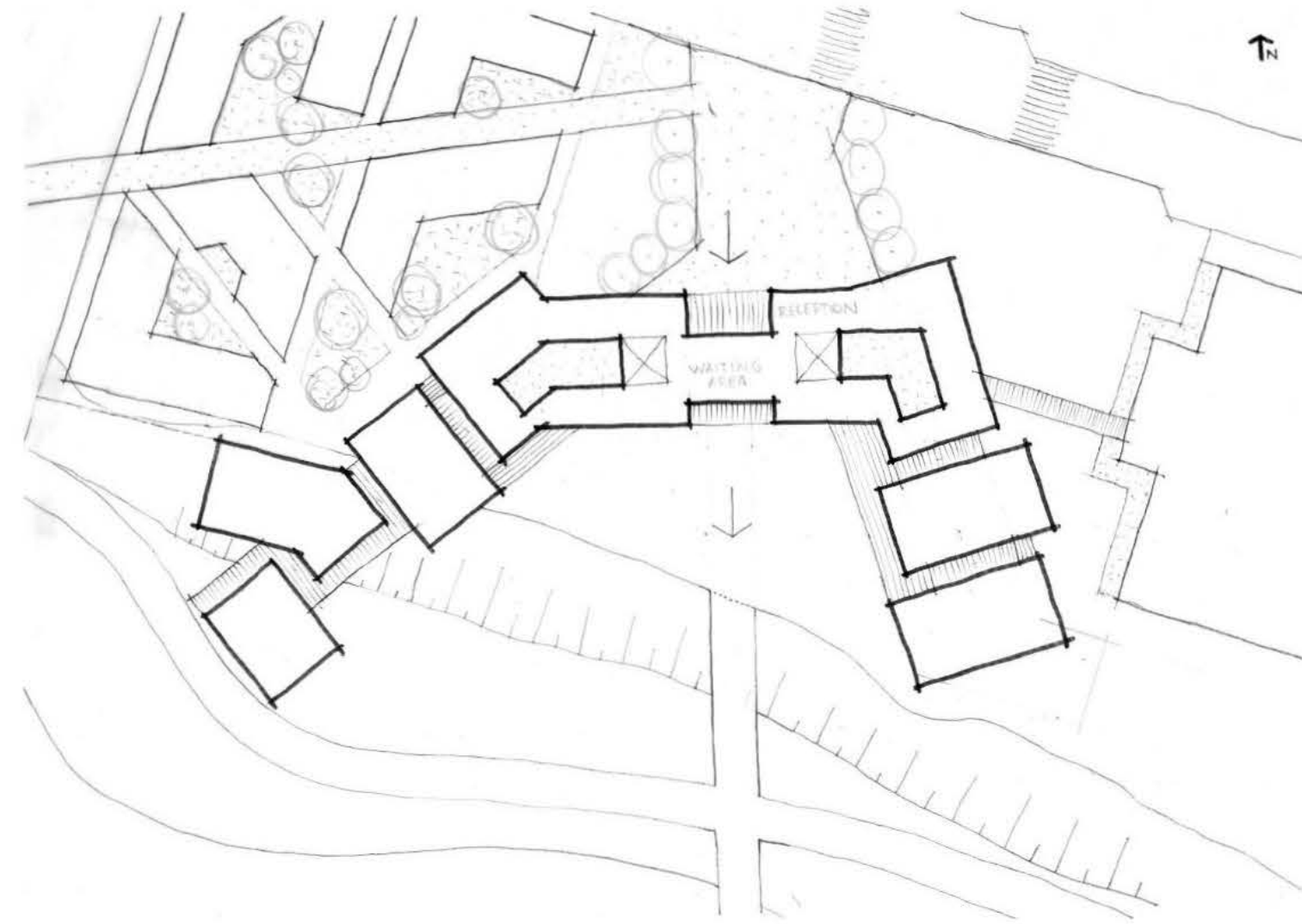
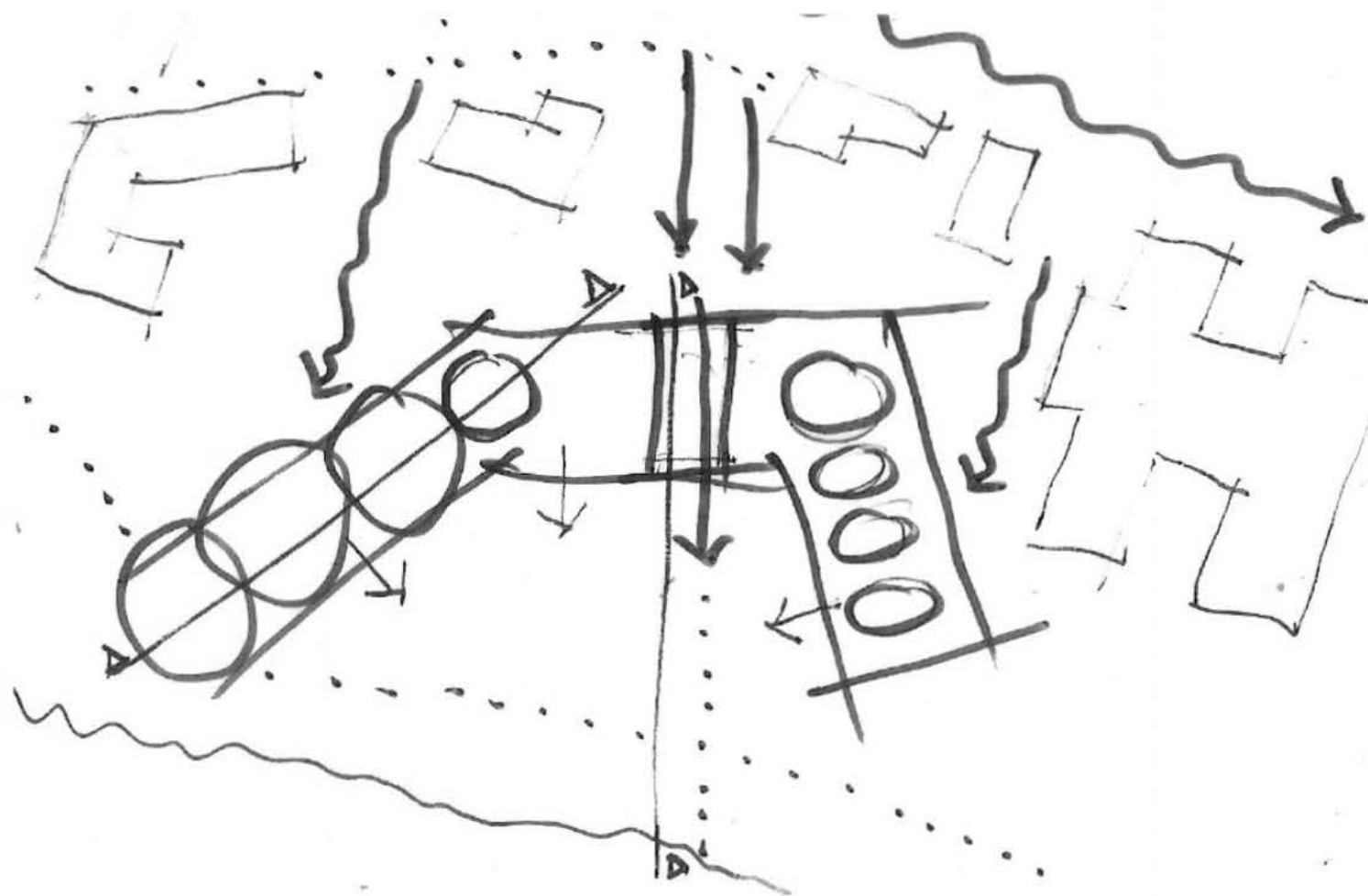
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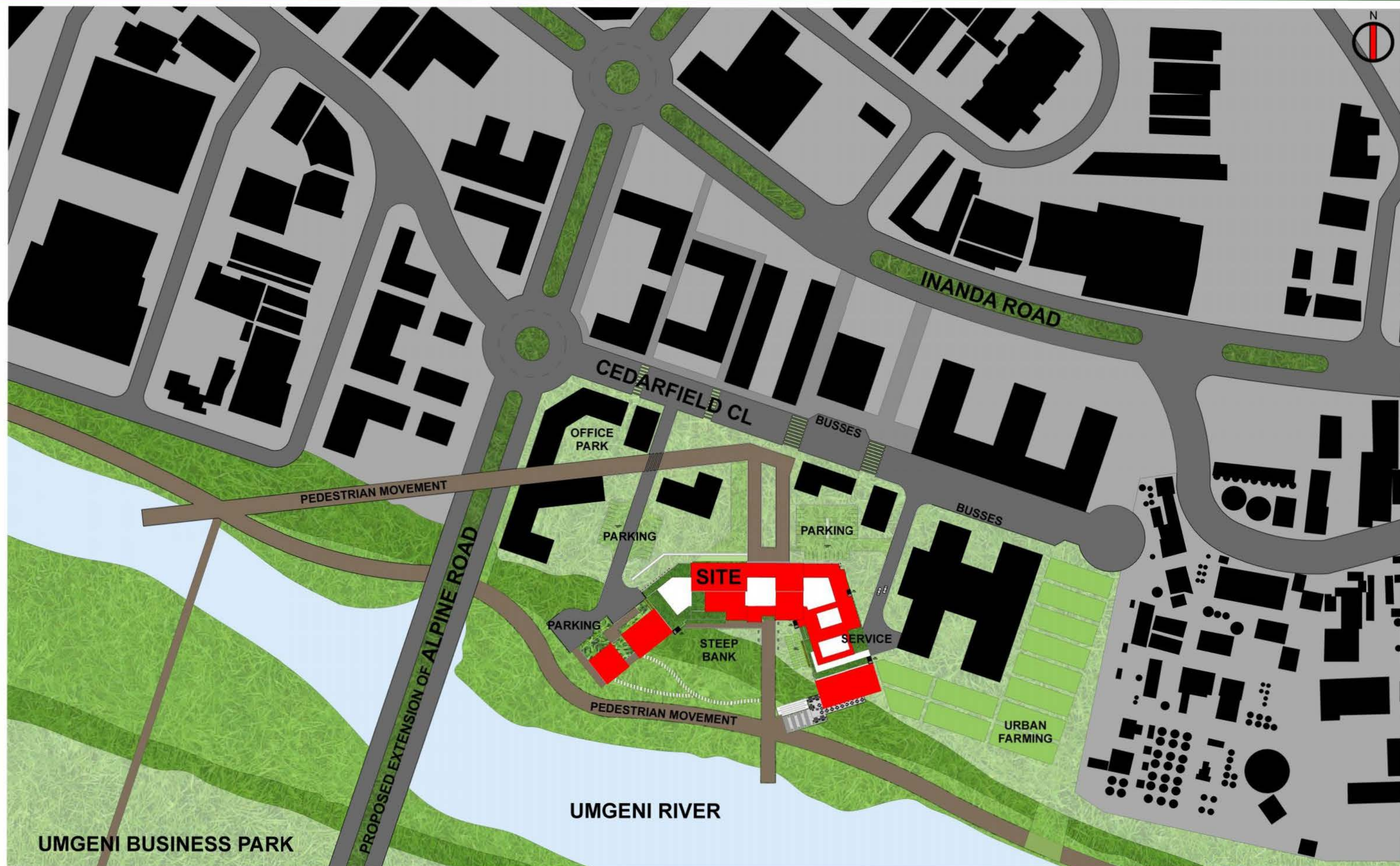












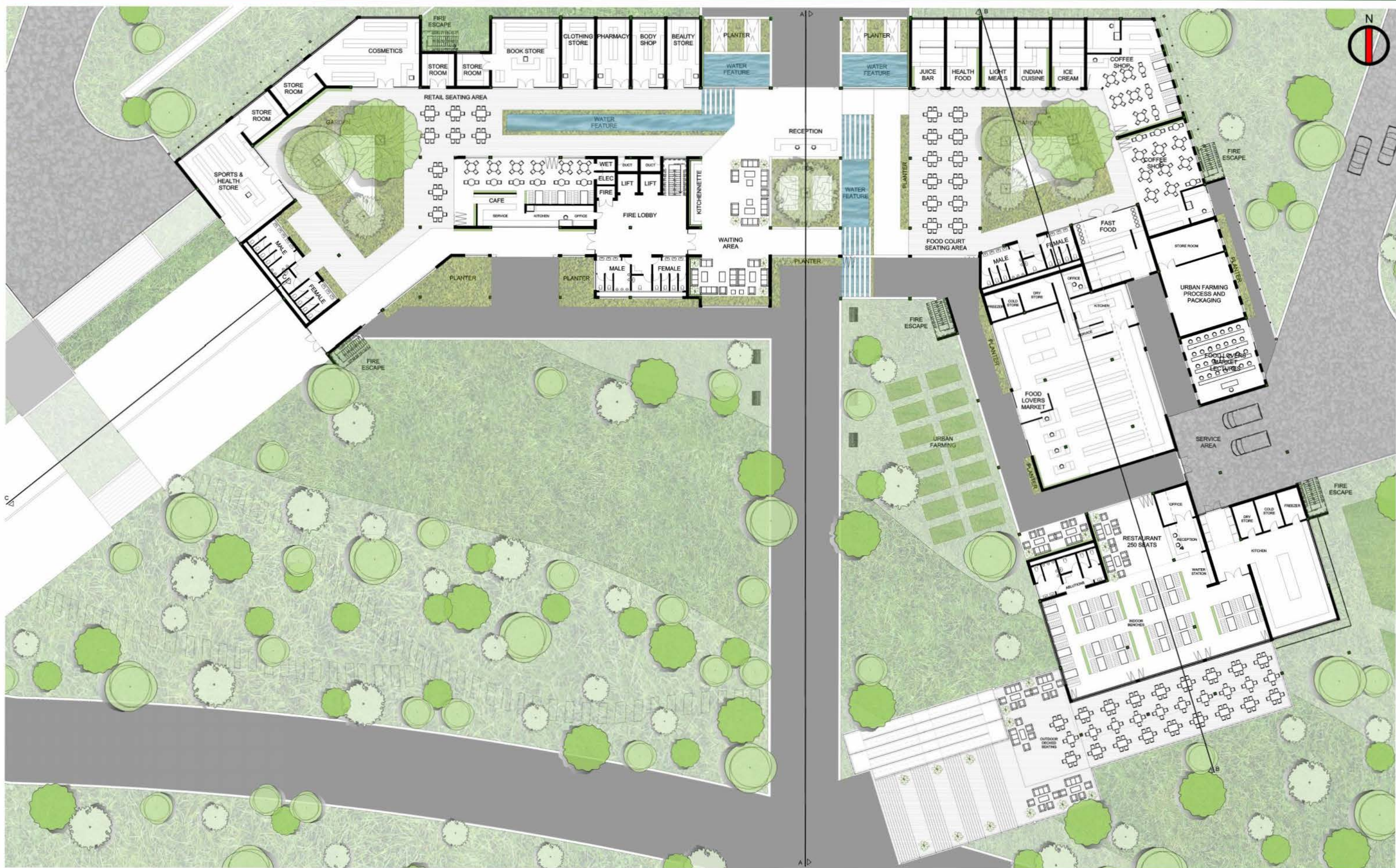












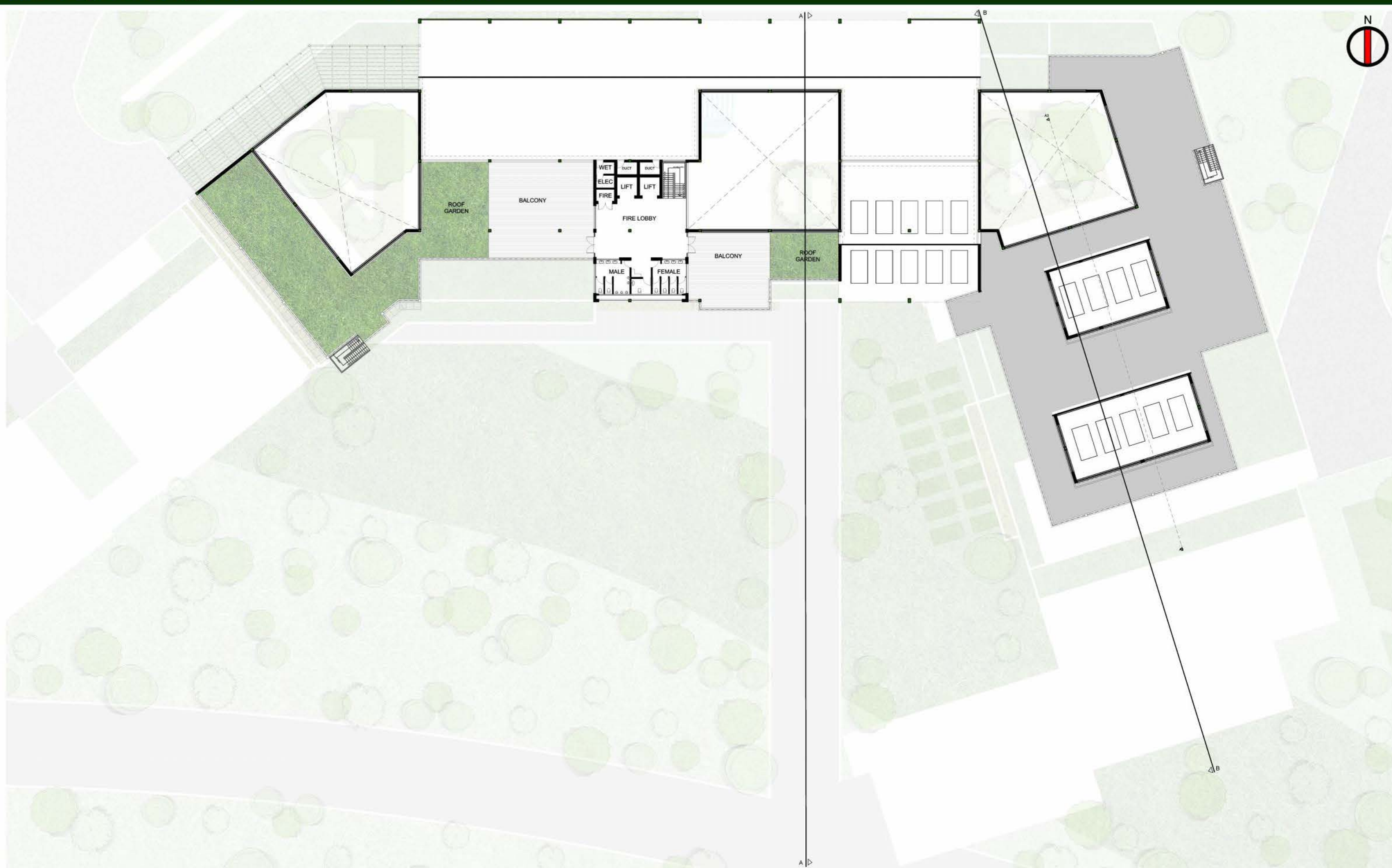




















CROSS SECTION: AA AND PART ELEVATION



CROSS SECTION: BB AND PART ELEVATION







NORTH-WEST ELEVATION AND PART SECTION



NORTH-EAST ELEVATION



NORTH ELEVATION



SOUTH ELEVATION





NORTH EASTERN EXTERIOR VIEW



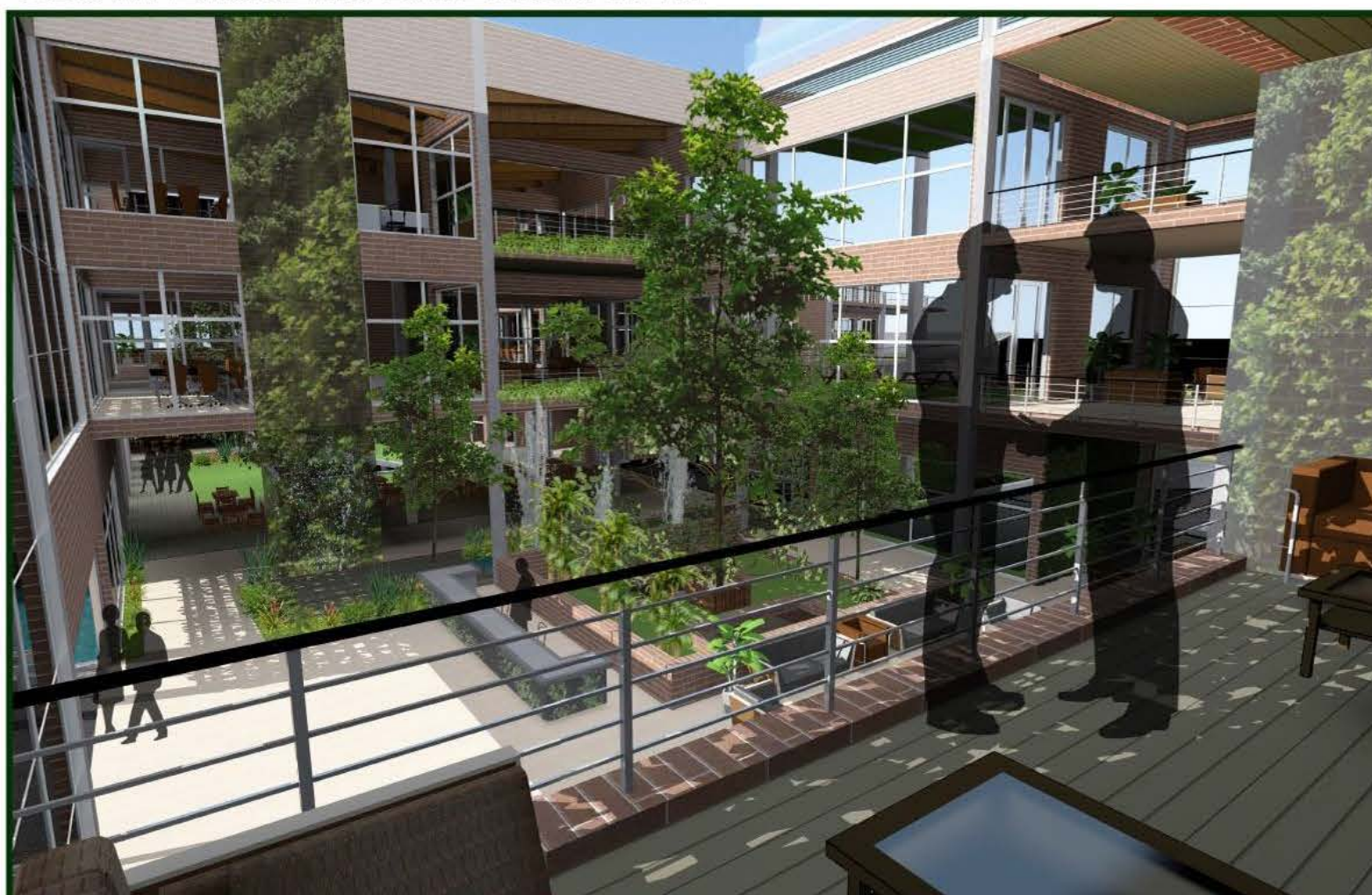




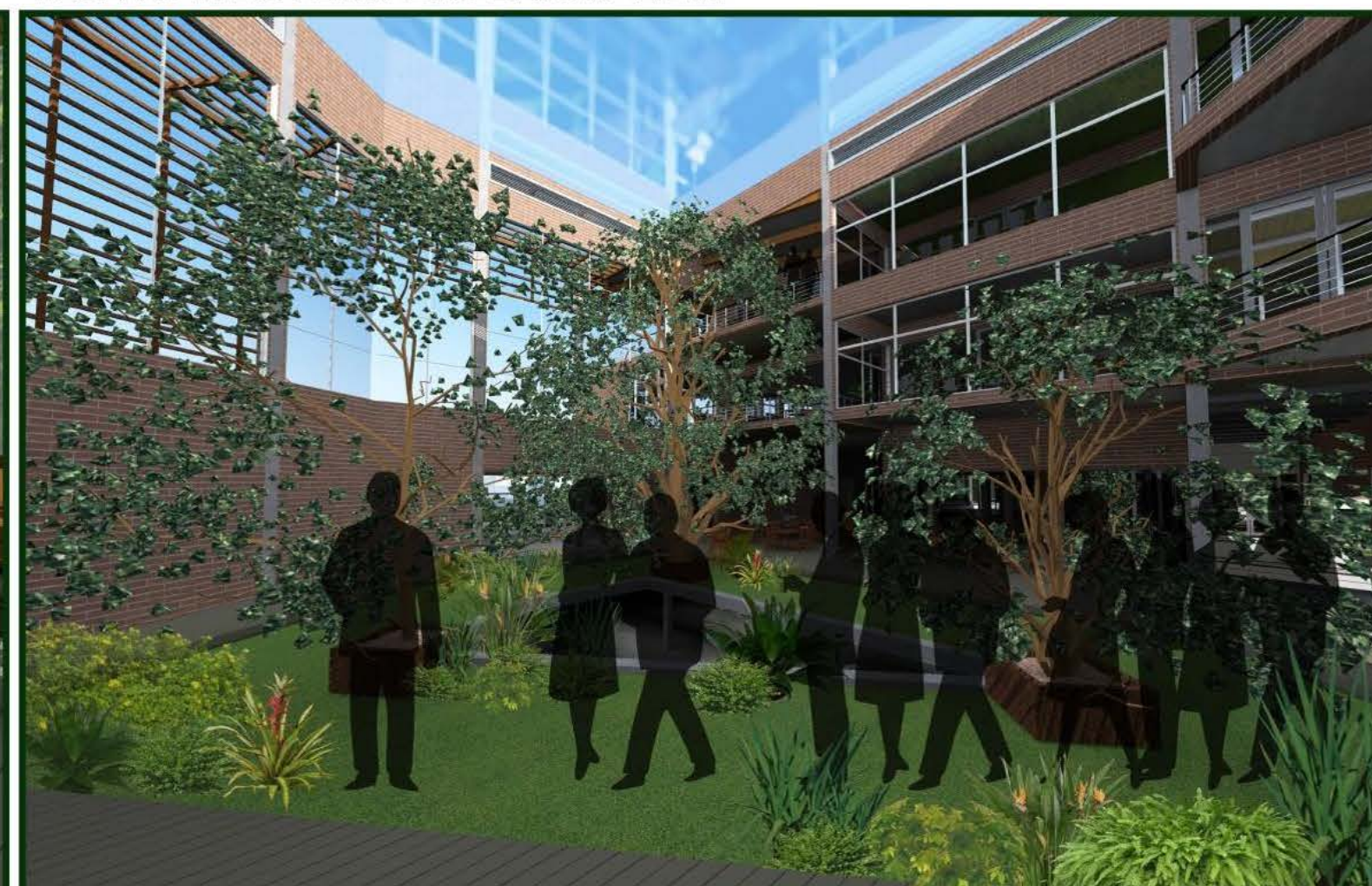
SOUTH EASTERN EXTERIOR VIEW



NORTH WESTERN EXTERIOR VIEW



RECEPTION FOYER INTERIOR VIEW



COURT YARD INTERIOR VIEW



[illegible][illegible]

NOTE: CERTIFICATE OF STABILITY TO BE ISSUED ON COMPLETION.

**FIRE PROTECTION NOTES:**

1. OCCUPANCY CLASSIFICATION: G1.
2. ALL WORK AND MATERIALS TO COMPLY WITH SABS 007, 008, 009, 010, 011, 012, 013, 014, 015, 016, 017, 018, 019, 020, 021, 022, 023, 024, 025, 026, 027, 028, 029, 030, 031, 032, 033, 034, 035, 036, 037, 038, 039, 040, 041, 042, 043, 044, 045, 046, 047, 048, 049, 050, 051, 052, 053, 054, 055, 056, 057, 058, 059, 060, 061, 062, 063, 064, 065, 066, 067, 068, 069, 070, 071, 072, 073, 074, 075, 076, 077, 078, 079, 080, 081, 082, 083, 084, 085, 086, 087, 088, 089, 090, 091, 092, 093, 094, 095, 096, 097, 098, 099, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819,

**FIRE ESCAPE AND FIRE FIGHTING EQUIPMENT:**

[illegible]

**FIRE EXTINGUISHERS:**

NUMBER OF PORTABLE FIRE EXTINGUISHERS RELATIVE TO FLOOR AREA PER 200 MF

VENTILATION NOTES:

1. AIR IS TO BE EXTRACTED FROM AN INTERNAL NORMAL OCCUPANCY AREA AT A RATE OF 7.5% PER PERSON.
2. AIR IS TO BE EXTRACTED FROM AN INTERNAL TOILET AREAS TO THE EXTERIOR AT A RATE OF 20% PER FITMENT.
3. ALL MECHANICAL EXTRACTION IS TO BE DESIGNED, INSTALLED AND MONITORED BY THE PROJECT MECHANICAL ENGINEER.
4. FRESH AIR SUPPLY TO BE AT A RATE OF 7.5% PER PERSON. AIR SUPPLY TO HABITABLE AREAS IS NOT TO EXCEED 0.6m/s AND IS NOT TO BE LESS THAN 0.2m/s - EVEN DISTRIBUTION TO BE ENSURED.
5. ALL OFFICES TO HAVE MIN. 500 LUX, WITH MAXIMUM GLARE INDEX 19.

## LEGEND

- [illegible]

OWNER	RESPONSIBLE ENGINEER	DATE	SCALE
DATE ISSUED	MARDORIE BLOM (MARCH)		AS SHOWN
DATE			PROJECT NO.
DATE			AD

CLIENT INFORMATION	
PROJECT INFORMATION	
PROPOSED NEW URBAN MULTI-USE OFFICE PARK DEVELOPMENT for Durban Ungwen Business Park PROPOSED WELL-BEING BUILDING AS A CATALYST FOR HEALTH IMPROVEMENT UNGWEN BUSINESS PARK, DURBAN LIGHT INDUSTRIAL BUSINESS PRECINCT DRAWING OF GRANTION	
DRAWING TITLE TECHNICAL DRAWINGS STRIP SECTIONS	SHEET NO.



