(Eco)Design for a Revitalized Built Environment: Towards a New Model for an Active Mixed-Use Architecture for the Rejuvenation of the City of Durban.

A dissertation submitted to the School of Architecture, Planning and Housing, University of Kwa-Zulu Natal, Howard College campus, in partial fulfilment towards the degree of Master of Architecture.

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DECLARATION

Submitted in partial fulfilment of the requirements for the degree of Master of Architecture, in the Graduate Programme in Architecture, University of Kwa-Zulu Natal, Durban, South Africa.

I declare that this dissertation is my own work unaided work. All citations, references and borrowed ideas have been duly acknowledged. I confirm that and external editor was not used. It is being submitted for the degree of Master in Architecture in the faculty of Humanities, Development and Social Science, University of Kwa-Zulu Natal, Durban, South Africa. None of the present work has been submitted previously for any degree or examination in any other University.

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22 October 2017

Contents

Abstract

The purpose of this research document was to determine a relevant and responsible architecture that could act as a model of an active mixed-use building typology that would contribute towards the rejuvenation of the Durban inner city, utilising biodiversity as an active component of building design to improve the built environment as well as the livelihood of the urban user. The nature of this architecture was generated through the investigation of current literature, case and precedent studies and personally conducted interviews with informed professionals that would provide knowledge and insight to ultimately confirm the hypothesis; that the integration of nature with the built environment can utilise ecological system services to contribute towards urban sustainability and resiliency targets, whilst simultaneously connecting the urban user with biodiversity and effectively providing a positive influence on their physical, mental and psychological well-being. Ultimately, the data gathered in this document would inform an appropriate architecture that will meet the requirements of the eThekwini 2040 Inner City Local Area Plan and act as a model for future projects within the Durban built environment.

Acknowledgments

First and foremost, I give thanks to Jesus Christ for blessing me with the strength and courage to have undertaken such a life-altering journey, for being beside me every step of the way, and for helping me to persevere when things seemed impossible.

Secondly, to my entire family your incredible support throughout this entire endeavour. You have all provided so much encouragement and have helped to keep me going through some of my toughest moments, and I appreciate each and every one of you for never doubting in my ability.

To all my friends, for your understanding and support when I very often had to say 'no', and for never giving up on me, you have all been amazing.

I would like to thank my supervisor Juan Solis, as well as Bridget Horner, for their selfless contribution in assisting me with the compilation of this document. Your guidance over the last two years, along with other architectural and academic staff, has been invaluable.

To Paul Wygers, thank you for lending me your time and for offering such valuable insight that would help towards my understanding and the shaping of this document.

And lastly, but most importantly, thank you to my amazing wife. You have been my strength throughout possibly the most difficult time of my life, and none of it would have been possible without the love, dedication, encouragement and belief that you have shown me. I can honestly say they I would not have been able to get through this degree if it wasn't for you. Thank you.

<u>Gareth Knox</u>

CHAPTER 1: Introduction

The Research Problem

"Lack of Biodiversity in the Durban Inner City".

Statistical data reveals that globally cities are continuing to grow, both in form and population, and as of 2007 are now the primary environment in which people live. This is evident by the steady growth of urban footprints, the establishment of new cities and continued migration of people into urban environments (Wu, 2010: p1). In the case of Durban, the "discovery" of the Durban bay is credited to Vasco Da Gama in 1497 however, it was only formally settled in 1824 with the arrival of the British who sought to establish a secure port from where they could trade with Southern Africa as well as with passing vessels en route towards India and Asia (www.sahistory.org.za). The topography of Durban's landscape in the early 1800's was characterised by a number of defining features that hindered the growth of the community that settled in the region. The city's primary sand dune situated along the coast from the Umgeni River Estuary to the bay formed a natural barrier to the coast line, whilst to the north, growth was restricted by the Umgeni River and coastal estuary. Two streams, one called Cato Creek, and their associated vleis known as the Eastern and Western Vleis, flowed from the Umgeni River into the Durban Bay, parallel to the primary dune. These vleis formed an integral part of the landscapes natural ecosystem however, they presented many challenges to the early settlers, including regular flooding of streets and thoroughfares in the city centre. To the west, development was restricted by a natural ridge, known today as the Berea Ridge. The Durban Bay itself provided a natural protected bay for vessels and was a haven for a variety of different animal species, including a host of bird and marine species as well as larger mammals. Thick coastal bush and mangroves covered the Berea Ridge and the coastal dune from the Umgeni River to the Point (Ellis, 2002 cited in the eThekwini 2040 Inner City LAP: p24). Whilst this natural topography and ecology formed a self-sustaining ecosystem that could support a host of wildlife species, since the arrival of the early settlers in the 1800's it has been drastically altered and diminished in order to facilitate the development of an initial trading post into a flourishing city. Some of the most significant changes have been the draining of the two vleis and removal of the mangrove trees in the Durban Bay for building and firewood, making major hard infrastructural engineering changes to Durban Bay and neighbouring landscape to facilitate the growth of the port and the Durban city grid, and developing the low lying marshy areas between the Umgeni River and the Durban bay (eThekwini 2040 Inner City LAP: p24). This steady urban development from the early 1800's to present day Durban has seen the city influenced by various different planning policies, all of which prioritised the development of hard infrastructure over the natural ecosystems that preexisted it. The result has been that as the city continues to grow, it slowly erodes the presence of nature in the built environment and gradually creates a number of problems, some of which include the city's ability, or lack thereof, to manage stormwater runoff, air quality due to increased emissions, and significantly, the degradation of the urban experience.

1.2. Background

(Eco)Design for a Revitalized Built Environment: Towards a New Model for an Active Mixed Use Architecture for the Rejuvination of the City of Durban.

As mentioned previously, cities around the world have experienced a massive increase in their rate of expansion, in all of building scale, urban area and urban population, due to industrialisation and modernism. The global human population has grown exponentially since the Industrial Revolution in the late 1700s, rising from 1 billion around 1800 to 2 billion in 1927, 4 billion in 1974, and 8 billion by 2025 (United Nations 2004a). The world urban population has increased much faster than the rural population, rising from 14% in 1900 to 29.1% in 1950, 47% in 2005, and is predicted to be as high as 70% percent by 2050 (Wu, 2010: p1). As a result cities have had to prioritise efficiency in their development, utilising available space within the city to accommodate the increasing urban population, along with the "necessary" infrastructure to enable their continued economic growth. In Durban's case, the early urban development in the 1800's was focussed on enabling access to the natural port and facilitating trade with Southern Africa, which required a drastic alteration of the landscape to accommodate a new town centre, roads and railway services. Unfortunately, nature and the environment never formed an integral part of this urban growth and as a result has been gradually eroded by the expanding urban periphery. The implementation of apartheid planning policies in the early and mid-1900's sought to segregate the population along race lines and, as a consequanse, it resulted in a further seperation of some of the urban population from the natural environment. Despite concerted efforts since the first democratic elections in 1994 and the abolishment of apartheid, the city remains segregated and as such, because of their seperation, areas within the city have begun to experience a drastic decline (eThekwini 2040 Inner City LAP: p25). The absence of nature within the decaying urban environment compounds the negative issues surrounding the city of Durban, from both a systems perspective (sustainability and resiliency) as well as from the perspective of the urban user and their connection with the built environment and the space between. This lack of biodiversity within the urban environment is essentially a key problem to cities around the world, and especially so for Durban whose growing economy and population require a built environment that is environmentally, economically and socially sustainable in order to sustain its continued growth (Wu, 2010: p2). "Sustainability" is a concept that emerged in the late 1980's due to increased pressure from environmentalists and socio-economic activists around the world and was seen as a concept that is especially relevant to the problems that cities present as the primary drivers of the economy as well as heavy contributors towards climate change and global warming. Attempts have been made more recently to improve the presence of nature within the urban environment however, due to little to no returns for the capital investment, deliberate urban green space has been diluted to an aesthetic "add on" that is as sterile and controlled as the city and offers little to no connection to the urban dweller. Nature however has enormous potential to contribute towards urban sustainability and resiliency and, if properly implemented and integrated with the existing urban fabric, can provide a renewed connection of man with nature within the urban environment.

1.3. Hypothesis

Integrating nature with architecture has two fundamental effects:

1. Ecological system services can contribute towards urban sustainability targets
2. Nature with the built environment connects the urban user with nature which enables a positive physical, mental and psychological response to the environment

Therefore, an appropriate architecture for the city is one which integrates ecology into its fabric and is accountable for the social, economic and environmental aspects of its design, never over emphasising one, in order to harness the potential of nature to achieve urban sustainability whilst creating a connection with nature within the built environment.

In order to prove this hypothesis the research will look firstly at core issues surrounding the existing built environment of Durban, identifying negative experiential elements and areas where the city is unsustainable. Secondly, it will analyse the systematic benefits of nature to the built environment along with the qualitative benefits to the urban user and determine how the two approaches are in fact interrelated, ultimately to determine how to integrate nature back into the existing urban environment in a broad urban scale, and how to integrate nature with the architecture to form the link between spaces within the city and rejuvenate the urban environment.

1.4. Aims and Objectives

1.4.1. To study the development of the city of Durban to understand how, where and why natural ecosystems have altered to suit the built environment.

1.4.2. To explore the connection of man with nature and compare this with man's connection with the built environment.

1.4.3. To examine the Durban city area and determine where and how best to integrate nature into the existing built environment.

1.4.4. To determine how nature can contribute towards urban sustainability as part of the urban fabric.

1.5. Primary Research Question

- How can nature be effectively integrated into the built environment as an active component of the city?

1.5.1. Secondary Research Questions

1.5.1.1. Why is it important to have nature in the city?

1.5.1.2. What is an ecologically responsible architecture and how can it resolve environmental issues?

1.5.1.3. How can nature have a positive effect on the urban user?

1.6. Theory and Concepts

The primary theory for this study will be the *Biophilia Hypothesis,* and using this theory as a lens through which to analyse concepts which will be Urban Sustainability, "EcoArchitecture"/Green Design and Adaptive Reuse, all of which will be explored further in the Literature Review chapter.

1.7. Research Methodology

This study will primarily feature a qualitative approach to research that will involve primary and secondary forms of data collection. It will seek to use the data collected to answer the research questions and provide insight to the theories and concepts related to the topic.

Primary Research

There are various tools that could be used to gather the required data, and for this study the focus will be on using the following methods:

1.7.1.Interviews

1.7.2.Case Studies

Interviews will focus primarily on the main actors that shape the urban environment: architects and developers. Architects act as the agents for developers in the shaping and revitalising of the city in such a way as to provide a meaningful experience to the urban user. The interviews will involve collecting, analyzing, and interpreting data by observing what people do or what their opinion is about the integration of nature with the urban environment and their understanding of how people experience space. Furthermore, environmental researchers and other similar academics can provide information regarding what natural ecosystem services could assist in achieving urban sustainability. Selective and snowball sampling of architects and researchers will provide insight into their approach to the city and what opportunities are presented by the city, along with what role nature has to play in the urban environment.

The principle case study to be conducted will be a study of the city of Durban. The purpose of this case study is to provide a critical analysis of the city in its current form, including detailed drawings, maps and photographs, with the aim of determining spatial relationships, processes and functions within the city, along with highlighting key locations within the city where the research problem(s) exist and where the proposed topic can intervene. This case study will look at the physical attributes of the Durban city area, as well as the experiential quality of space and place within the city, and seek to determine how, by implementing the proposed topic, the existing nature of the city can be improved.

Secondary Research

The secondary research will be formed primarily by the findings of the literature review, including data that has been explored by other specialists in their respective fields that relate to the research topic. A comprehensive study of the concepts and theories surrounding the topic will also predominantly influence the primary research methods, with the findings of the literature review informing the principal theories and concepts to be investigated, who best to interview to provide the necessary data on the topic, and by providing a better understanding of the theoretical and conceptual framework of the research.

Precedent studies that are based on the concepts of urban regeneration and highlight the intention of re-integrating nature into the built environment will be examined to investigate particular issues surrounding the proposed topic. By comprehensively analysing information gathered through the use of published articles, journals, books and drawings, selected precedents that offer the most valuable information towards the topic will be selected, whether they be large precincts or an individual building, the selected precedents will provide an indication on how to resolve the research problem and insight how to achieve the aims and objects of the study.

1.8. Conclusion

As stated, the aims and objectives of this study are essentially to determine what architectural form and typology can provide a catalyst to an urban regeneration that incorporates biodiversity and takes advantage of sustainable, passive ecosystem services to not only make the existing Durban built environment more sustainable and resilient, but fundamentally a better in which to live, work and socialise. Research conducted will seek to answer the proposed questions and provide a methodology for how to adapt existing architecture to prolong its lifespan and incorporate multi-functional uses to current single use spaces, whilst simultaneously facilitating a regeneration of the existing Durban inner city using biodiversity.

CHAPTER 2: Literature Review

2.1 Introduction

This chapter will discuss the key theoretical perspective that informs this study, namely the theory of "Biophilia", and will aim to provide a framework to address the research questions through the analysis of relevant published, peer reviewed sources. The framework will examine selected literature surrounding the concepts of urban sustainability, ecological and green building design and adaptive reuse, from which these concepts will be examined through the lens of the Biophilia hypothesis. This chapter will further aim to provide a background to the origins of cities and their development and the role nature has played in the built environment up to today and seek to determine why nature has not formed an integral part in the planning of cities and how it can be re-integrated into an existing urban framework. It will seek to determine the benefits of nature to both the urban user and to the city itself from a sustainability perspective, as well as the effect nature has on the urban experience. Ultimately, it will seek to underline the importance of nature to the built environment and to human well-being and provide a foundation for a framework for how to properly utilize nature within the urban environment.

2.2 The Biophilia Hypothesis

Figure 1: Natural elements combined with man-made spaces (Source: www.keppellandlive.com)

Definition: *"the innate human tendency to focus on and affiliate with life forms and life like processes."*
(Joye & de Block, 2011: p190)

The term "Biophilia", meaning the "love of life or living systems" was first introduced by German psychologist and philosopher Erich Fromm (Fromm, 1964) in his reference to the human psychological tendency to be attracted to all that is alive and vital however, it was not until 1984 when Harvard myrmecologist and socio-biologist Edward O. Wilson coined and popularised the term in his book *Biophilia* (Wilson 1984 in Beatley & Newman, 2013: p3329). He hypothesized that humans co-evolved with nature by natural selection in a cultural context over millennia and that we carry with us our ancient minds that first developed a need to connect and affiliate with nature by repeated contact with, and dependence on, life and life-like processes that were crucial for hominine survival (Kellert & Wilson, 1993). Wilson (1984) further expands to define Biophilia as "the innately emotional affiliation of human beings to other living organisms". He argued that biophilic tendencies were adaptive because an organism had clear evolutionary benefits when it was hardwired to focus on and to respond emotionally to certain survival-relevant living elements (Joye & De Block, 2011: p190). Many consider the evidence to support Wilson's interpretation of Biophilia as circumstantial and difficult to test and yet, despite this and the fact that Fromm's original definition of Biophilia lacked any statement of heritability, it is Wilson's version that has gained popularity (Simaika & Samways, 2010: p1). Since its initial introduction further interest in Biophilia received a prominent boost from the publication of *The Biophilia Hypothesis* (Kellert & Wilson, 1993), a collection of works with contributions from various researchers in a number of different disciplines. As a result, the Biophilia hypothesis has become prominent in developmental psychology, preventative medicine and in particular, architectural theory. Furthermore, Biophilia is seen to be intimately related to the study of environmental ethics, in particular to conservation biologists who view the Biophilia hypothesis as an important stepping stone towards an anthropocentric environmental ethics that not only focuses on the material benefits living nature can provide but also its positive psychological influence on human mental and emotional well-being, all of which will be explored further in this chapter (Joye & De Block, 2011: p190).

As mentioned previously, both Fromm and Wilson had slightly varying definitions of the Biophilia hypothesis however, the fundamentals and beliefs of both definitions remains the same: that humans have a tendency respond to nature in either a positive or negative manner, and that contact with nature is somehow good and/or beneficial to human beings and their environment (Ulrich RS in Kellert & Wilson, 1993: p73). While Fromm's definition was simply regarding a general "love of living things", Wilson's view of Biophilia as a learned, "inherited" response as a result of a person's contextual (heritage, family and place) upbringing and allowed for varying states towards nature ranging from attraction to aversion, or to put it another way, peacefulness to fear-driven anxiety. Roger Ulrich (Ulrich 1993) simplifies Wilson's views and considers Biophilia as a positive emotional affiliation, strictly separated from the negative, or "Biophobic" response (Joye & De Block, 2011: p192).

Figure 2 (Above Left) and 3 (Above Right): Comparison of different conditions of the same forms of nature and the emotions they invoke (Source: Vary – refer to List of Figures)

For most phobias there exists sufficient evidence to suggest that most phobic responses involve strong fears and/or anxiety with respect to certain objects and situations that have threatened humans throughout history. In essence Biophobia is a negative response to nature, from more common phobias such as a fear of snakes or spiders to more subtle anxieties caused by overly wild and untamed forms of nature (Manning O in Laurie I.C. 1979: p14). "Biophobia", the opposite of biophilia, has received support from numerous experiments performed in different countries around the world to suggest that biologically prepared learning plays a role in the phobic response to natural systems and organisms and therefore, it is assumed that the same could be said for biophilia (Ulrich, 1993: p77). However, while current evidence does suggest that biophobic responses can be a result of cultural and historical experience of the environmental context, the evidence suggests a more asymmetrical relationship between biophobia and biophilia (Joye & De Block, 2011: p205). Therefore, further evidence is required in order to determine the validity of the Biophilia hypothesis, and evidence can be found by exploring the relationship between man and nature, along with the material, psychological and emotional benefits nature has to offer.

"Biophilic design is not about greening our buildings or simply increasing their aesthetic appeal through inserting trees and shrubs. Much more, it is about humanity's place in nature and the natural world's place in human society…"

(Kellert & Heerwagen cited in Salingaros, 2015: p4)

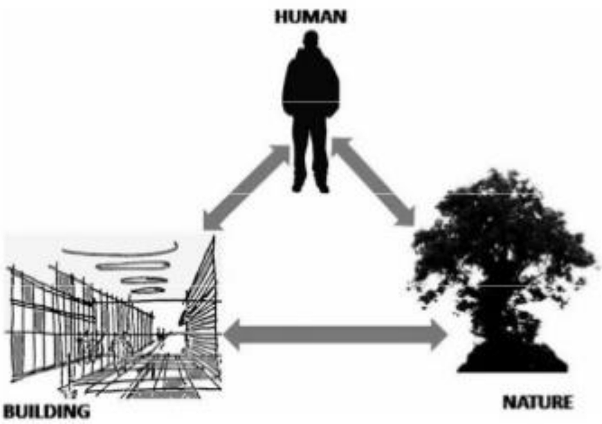


Figure 4 (Left): Graphic depicting the connection people have to both the built and natural environment (Source: www.slideshare.net)

As the above quote states, biophilia and biophilic design goes beyond simply increasing the ecological density of our surroundings for the sake of doing so.

Moreover, it's about creating a connection between human beings and their positive response to natural elements and systems by the careful design and thoughtful implementation of nature within our regular environment (Salingaros, 2015: p6). It is widely believed that the presence of certain forms of nature within our built environment have a far greater effect than simply an improved aesthetic appeal. As mentioned previously, nature that is properly integrated with the built environment, what authors call "biophilic cities", offer benefits from a sustainability perspective (material benefits or a systems approach) as well as benefits to the urban user providing a meaningful, positive impact to human health (psychological, mental an emotional well-being) (Ulrich, 1993: p90). From an urban sustainability perspective, biophilic design can help contribute towards certain sustainability goals in all three key sustainability areas: ecological, economic and social, more of which will be discussed later in this chapter. In short, the proper integration of nature within the built environment can help reduce urban temperatures (the "urban heat island" phenomenon), reduce the ecological footprint of the built environment and provide an enhanced quality of life within the built environment with expanding economic opportunities for the disadvantaged (Beatley & Newman, 2013: p3331).

Nature and biophilic design also offer benefits to human well-being within the built environment, a benefit which is probably as important as the contributions nature makes towards urban sustainability goals. Countless studies have concluded that greenery and green elements within the built environment help facilitate improved mental and psychological health (reduction in stress and anxiety levels), as well as even providing an environment that improves the physical health of the user (cleaner air, reduced heat and the positive physical effects of reduced stress and anxiety). Moreover, research indicates that there exists a strong positive relationship between the presence of natural daylight, fresh air and ventilation with improved productivity, creativity and happiness (Salingaros, 2015: p6 and Beatley & Newman, 2013: p3329).

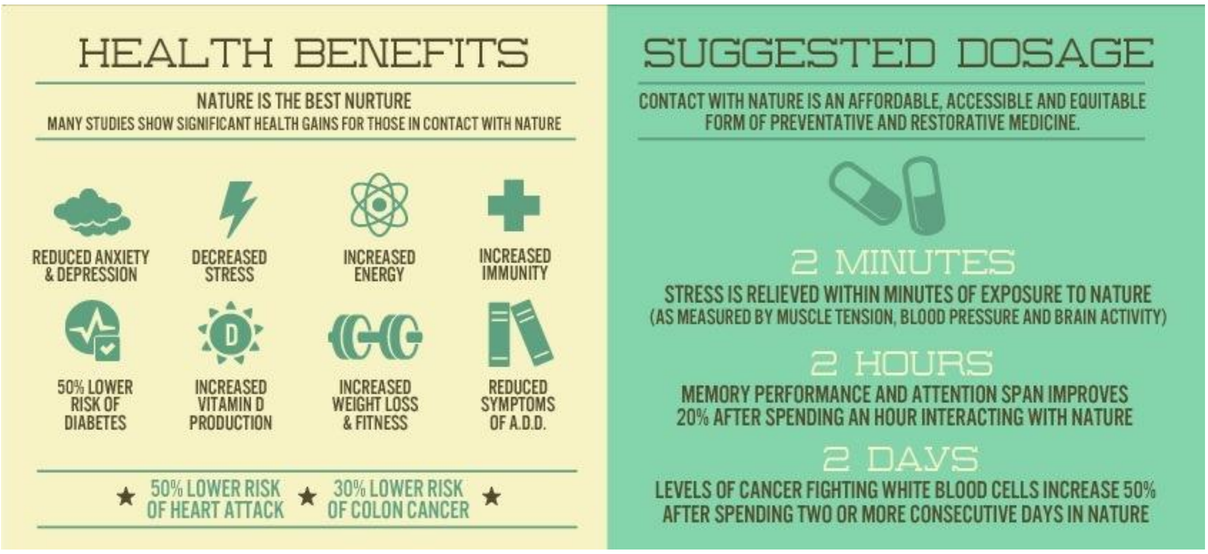


Figure 5: Graphic depicting the health benefits of a connection with the natural environment (Source: http://islandeducators.weebly.com)

2.3 Urban Sustainability

Figure 6: Graphic depicting the 17 U.N. Sustainable Development Goals (Source: https://en.unesco.org/sdgs)

"*Sustainability*" is a concept that has gained momentum in recent times, built off the concept of sustainable development. A broad definition of Sustainable Development that emerged from the Brundtland Commission in 1987 stated:

"*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" – (WCED, 1987: p41).

A more specific definition was developed by the International Council for Local Environmental Initiatives for use by local authorities in a capacity as 'environmental service providers' that defines Sustainable Development as:

"*Development that delivers basic environmental, economic and social services to all without threatening the viability of the natural, built and social systems upon which these services depend*" - (ICLEI, 1995:12 cited in Seminar 6 on Sustainable Cities by Catherine Sutherland, 04 November 2016).

Thus, the term Sustainable Development contains within it three key principles:

1. "Social" Sustainability – this highlights people as part of the 'system' for development and their basic human needs, as well as the aspirations of people to climb out of the poverty cycle through equal opportunity.
2. "Economic" Sustainability – this speaks towards the need for current economic structures to adapt and change; to move away from a linear capitalist system of extraction-production-**consumption**-disposal towards a circular system of **reduced** consumption of materials and the adaptive **re-use** and **recycling** of resources, developing manufacturing systems towards a more socio-ecologically friendly approach.

3. "Environmental" Sustainability – possibly the most commonly referenced form of sustainability with a focus on protecting the ecological resources upon which development depends and ensuring development occurs within the capacity of environmental systems.

A fourth, lessor known principle to Sustainable Development is a principle that has developed in recent discussions and focusses on the role of governance in the implementation and regulation of policies that strive to achieve socio-economic and ecological sustainability (DEAT, 2012: p18-19).

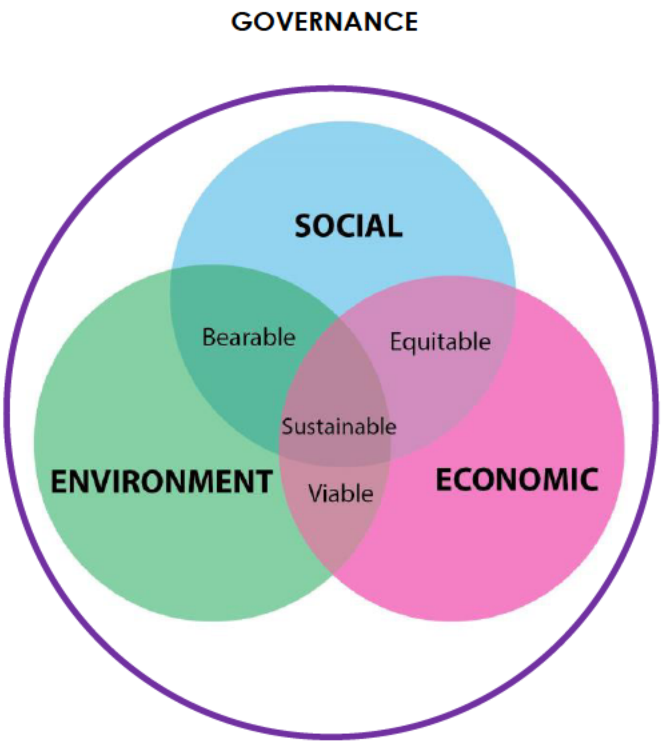


Figure 7: Nested model of Sustainable Development which indicates true sustainability is when the environment, society and the economy are given equal prominence in development, made possible through proper governance. (Source: DEAT, 2012: p19).

Thus, achieving true sustainability requires meeting these three characteristics, with no one taking preference over another, with the express aim of making human environments more environmentally friendly, continuing economic growth and providing a positive urban experience to the user. (Wu, 2010: p2).

Urbanisation (the spatial expansion of the built environment densely packed by people and their socio-economic activities), has played an increasing role in global environmental issues. In the 1800's only 2% of the global population lived in urban areas. This figure increased to 14% by the 1900's and by 1950 it had increased to 30%. In 2007 more than 50% of the world's population resided in urban areas, which marked a point where the city has become the primary human habitat and thus where sustainability needs to be made a reality (Wu, 2010: p1).

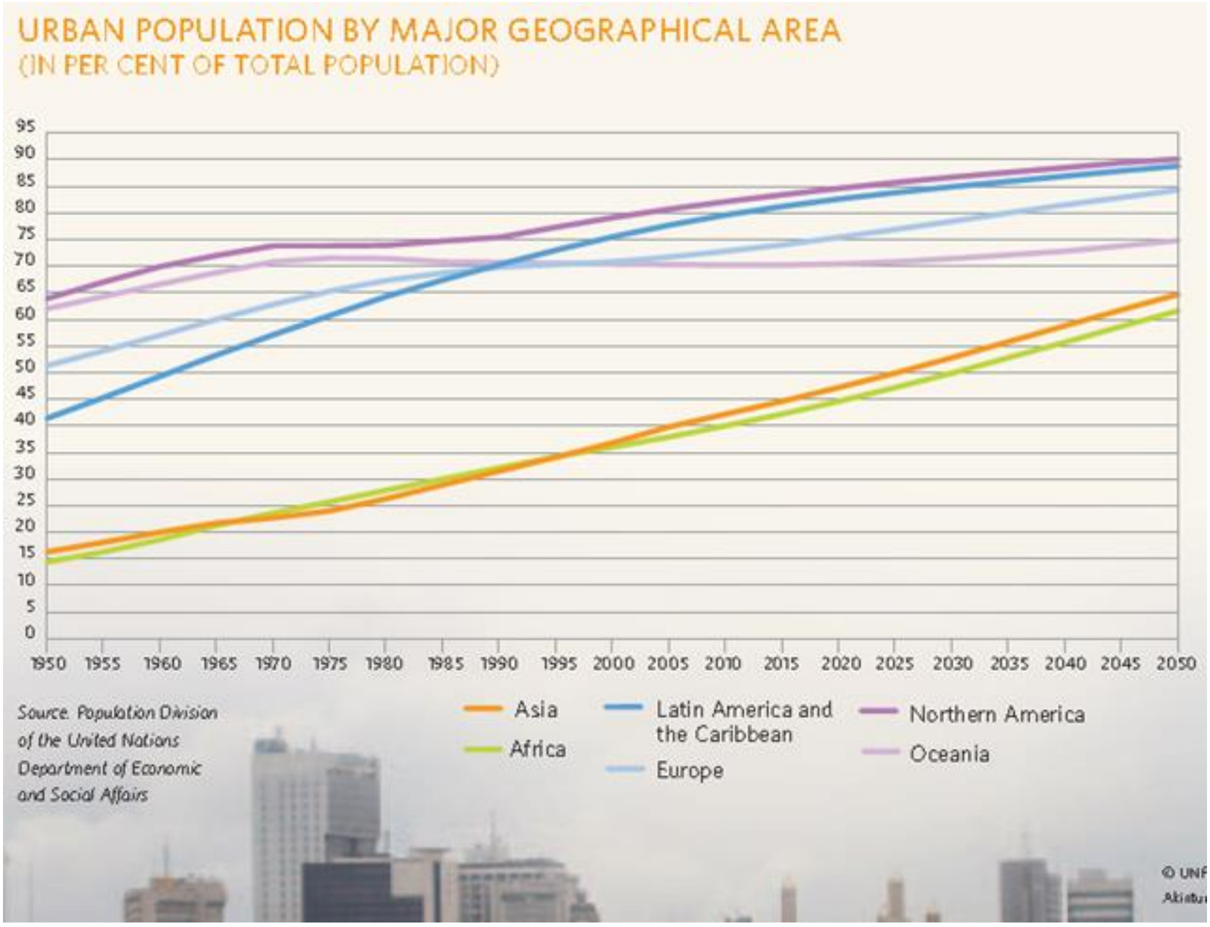


Figure 8: Graph indicating the current and projected growth of urban populations. (Source: http://www.desdemonadespair.net).

Today, urban areas account for 80% of carbon emissions, 60% of residential water use and 80% of wood use for industrial purposes, whilst accommodating more than half the world's population and occupying approximately only 2% of the world's land area (Grimm NB et al, 2008: p756). Additionally, the increased urban development, which is a result of increased urban activity, has resulted in a series of adverse environmental effects such as: poor air quality (as a result of vehicular and built environment emissions), excessive noise, traffic congestion, consumed natural landscape and resources, hard surfaces which cause excessive stormwater run-off and the "urban heat island" effect, all of which have an adverse effect on the living and working conditions within the urban environment (De Ridder K et al, 2004: p489-490). Based off these statistics, that the global trend shows more and more people are migrating from rural to urban areas and that the majority of environmental stress is caused by urban function, there is the ever increasing need to properly implement a more sustainable urban environment without compromising the functional capabilities of the city. Additionally, due to their population density and resource requirements, the "ecological footprint" of cities; the land and water area required to sustain the urban environment's energy and material requirements (consumption) as well as the area required to absorb waste generated, is often much larger than the area of the city itself (Rees W & Wackernagel M, 1996: p227). The influence of intense and geographically concentrated human activity and technology extends far beyond the physical or administrative boundaries of cities, impacting on people and the environment across the globe, meaning that cities that cannot meet the resource requirements available by their own land area rely off the carrying capacity of other countries being imported to cover their shortfall. The decision of nations to import carrying capacity needs to be balanced by the willingness to export however, it does still beg the question if this approach is truly sustainable; eventually resource exporters will rely on the excess they offer to other countries, and slowly but surely the Ecological footprint of more and more regions begin to exceed their Biocapacity, as depicted by the following images and graphs (Costanza R, 2000: p343).

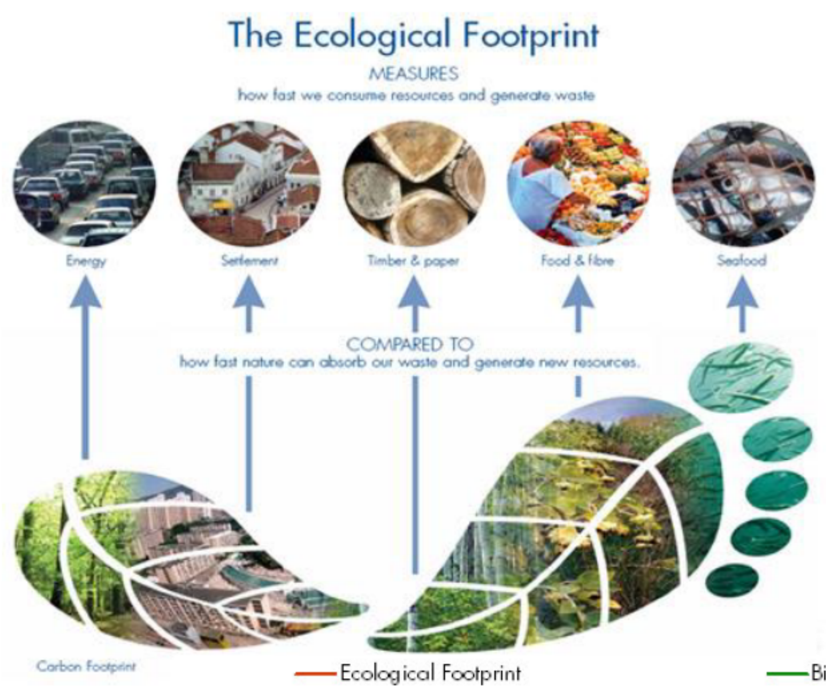


Figure 9: Graphic description of the "Ecological Footprint" concept. (Source: Seminar 6 on Sustainable Cities by Catherine Sutherland, 04 November 2016)

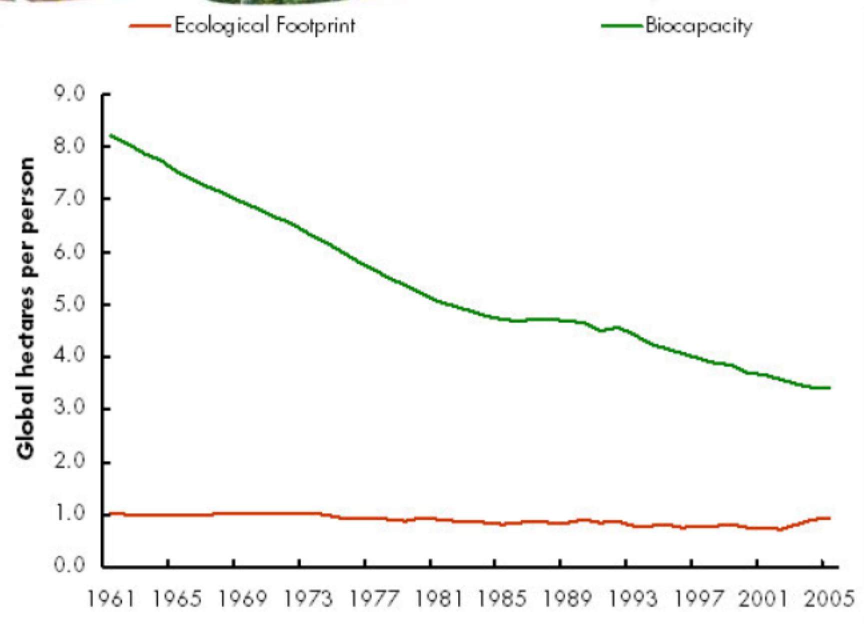


Figure 10: Graph depicting the Ecological Footprint of Mozambique, a "3rd World" country, in relation to the Biocapacity of the environment. The graph indicates that while the demands per capita have remained constant, the capacity for natural resource provision has still declined, indicating that natural resources for this region are being used to supplement the increasing needs of other regions. (Source: Seminar 3 on Ecological Modernisation and Sustainable Development by Catherine Sutherland, 05 October 2016)

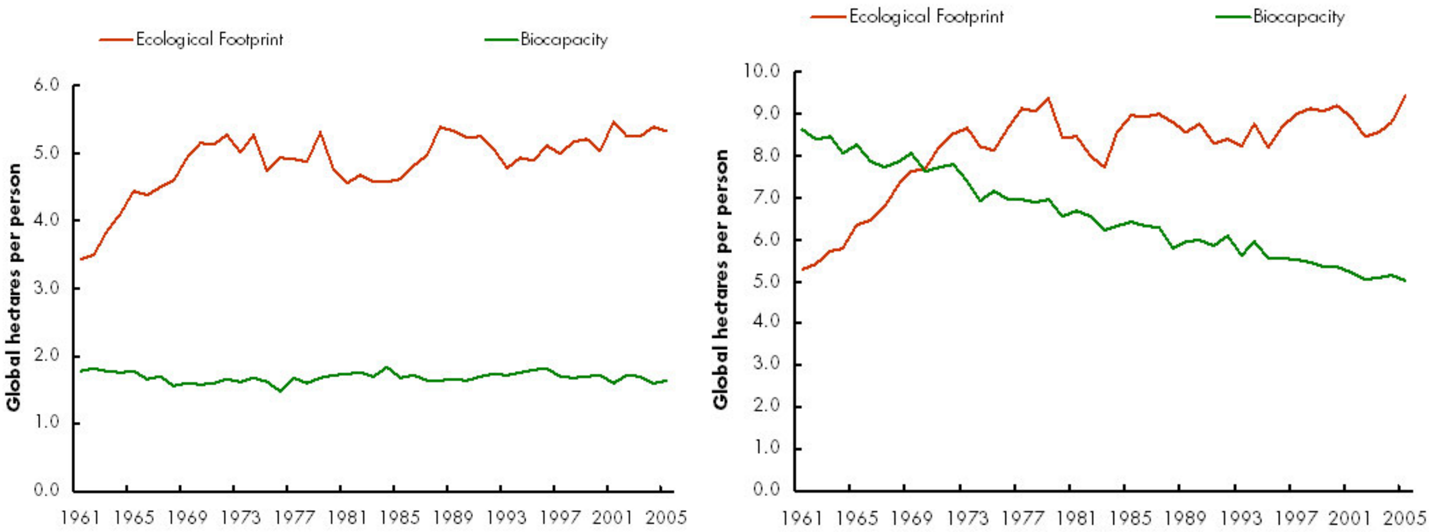


Figure 11 (Above Left) and Figure 12 (Above Right) depict the Ecological Footprint in relation to Biocapacity for the United Kingdom and United States of America respectively. Figure 4 indicates that, due to high urban density, the U.K. requires more than 2.5 times the natural resources available. Figure 5 indicates that as the Ecological Footprint of the U.S.A. has increased, the available natural resources has decreased, resulting in the U.S.A. being dependant on natural resources from other regions. (Source: Seminar 3 on Ecological Modernisation and Sustainable Development by Catherine Sutherland, 05 October 2016)

The biggest contributor to the global shift from rural to urban habitation has been the industrialisation of global economies, a result of the industrial revolution. The expansion of the global economy and the rise in production and consumption required a more efficient "machine" in which to facilitate this growth, resulting in the cold, hard urban landscapes that dominate global urban environments, spoilt by poor design, economic dispersal and social polarisation. At the turn of the 21st century three factors offer an opportunity for an "urban renaissance":

1. The emergence of a new *Technical Revolution* (information and technology exchange)
2. The ecological threat urbanisation poses, based off our greater understanding of the implications of our rapid consumption of natural resources and the

subsequent importance of integrating sustainability into new and existing cities

3. The "social transformation", resulting from increased life expectancies and new lifestyle choices

(DETR, 1999: p4).

Figure 13: Air being heavily polluted by industrial processes. (Source: http://www.borgenmagazine.com)

Two schools of thought that have featured prominently in global discussions centred on mitigating the effects of current ecologically insensitive practices whilst sustaining economic development have been Ecological Modernisation and Sustainable Development. Whilst some may argue the two concepts fairly similar, if not identical, many would argue that the two concepts should not be conflated as there are in fact significant differences between the concepts. The different ways in which these concepts frame the various approaches to environmental policy affect not only the scope but also the goals, targets and level of ambition that environmental policy-makers should aim at (Langhelle O, 2000: p1). Ecological Modernisation is essentially both theory and practice that focusses on the positive relationship between economic growth and environmental concern. At its core it suggests that science and technology hold key contributions to facilitate economic development whilst simultaneously addressing threats to ecological integrity (Hajer, 1995 cited in Wright, J & Kurian, P. 2009: p6). A more narrowly defined definition of Ecological Modernisation, identifying its core or constituent elements with a focus on material impacts, was offered by Milanez & Buhrs (2007) as:

"…the implementation of preventative innovation in production systems (processes and products), that simultaneously produces environmental and economic benefits" - (Milanez & Buhrs cited in Wright, J & Kurian, P. 2009: p7).

Essentially, Ecological Modernisation suggests that economic and environmental goals are not mutually exclusive, but it assumes that well designed technological interventions, which would not hinder economic growth, would instead stimulate new and more efficient industries as replacements to ecologically threatening and "dated" industrial processes whilst maintaining, even expanding the Capitalist system and status quo (Howes, D; McKenzie, M; Gleeson, B; Gray, R; Byrne, J; & Daniels, P. 2009: p2). This approach is often considered a weak form of sustainability as it strives to maintain and even expand the linear system of the current industrialized economy and simply counteract the harmful processes with new technological "improvements" to the system. Essentially, the Ecological Modernist approach, or the "expansionist" approach, simply views the environment as an infinite source of resources and energy for a growing global economy, with infinite space in which to discard waste produced by this system, when in actual fact we exist in an environment that is very much bound by limits (Guy S & Farmer G, 2001: p141).

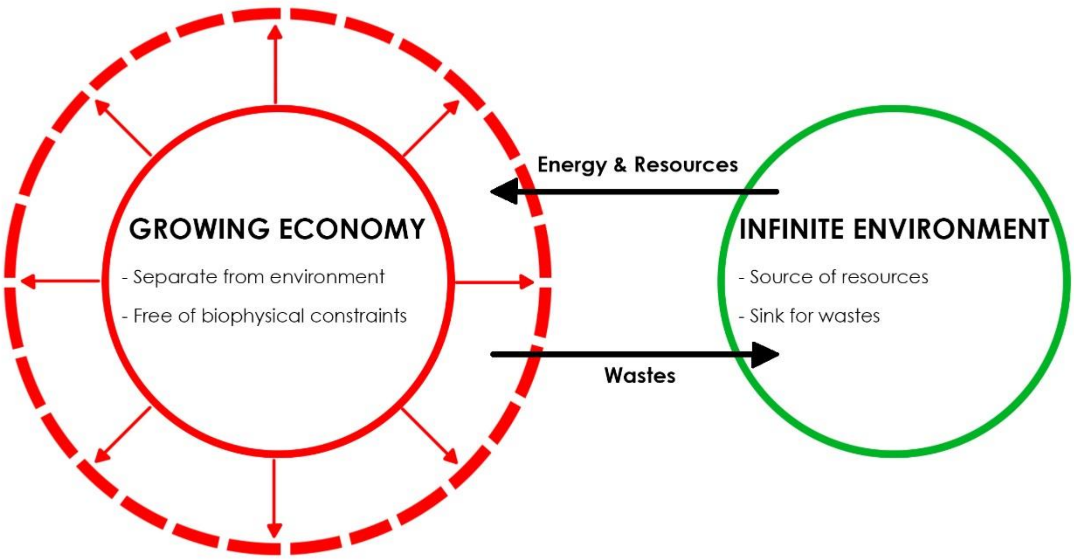


Figure 14: Graphic description of the linear system represented by Ecological Modernisation. (Source: Author)

As mentioned previously, the other concept to feature prominently in global discussions as a tool to mitigate the global effect of ecologically insensitive practices is Sustainable Development. As discussed earlier in this chapter "Sustainable Development" requires a system that achieves the three key criteria of Ecological, Economic and Social sustainability simultaneously, with the assistance of good governance and policy making, and as just discussed Ecological Modernisation is an approach that holds a striking resemblance to "weak sustainable development". This then begs the question: what then is "strong sustainable development"? Strong sustainability demonstrates that natural capital cannot be viewed simply as an infinite stockpile of resources but rather as a set of complex systems consisting of elements that interact in ways that determine the environment's ability to provide a wide array of services to human society. Advocates of strong sustainability highlight several reasons to demonstrate why an over dependence on natural capital is not sustainable:

1. There is a significant difference between manufactured and natural capital. Manufactured capital is able to be reproduced and its destruction is rarely

irreversible, whereas the destruction of natural capital usually is irreversible. Also, due to the complex functions of natural systems we cannot fully understand the effects on human well-being when we destroy natural resources that form part of an ecological system.

2. An increase in future consumption is not an appropriate response to the losses of natural capital. For example, asking future generations to breath polluted air in exchanged for a greater capacity to produce goods and services restricts the freedom of future generations to choose between clean air and more goods and services. This highlights the key issue of preserving natural capital for the sake of future generations.
3. Since natural resources are required in the production of manufactured capital they can never truly substitute for the loss of ecological structures that contribute to human well-being in a multidimensional manner. These contributions can be seen through the identification of four types of requirements for human well-being: security, basic materials for a good life, health, and good social relations. Thus, natural capital is essential to the proper continued functioning of ecosystem services that in turn are vital to human well-being and freedom of choice.

(Brief for GSDR, 2015: p1-2)

Simon Guy and Graham Farmer (2001) discuss the "Eco-centric" logic (buildings and the place of nature) in sustainable architecture, highlighting that the earth and its natural resources are not commodities to be bought and sold, but rather it is a community in which humans play an integral role as stewards to the environment, dictated by the limits and constraints that come from within nature itself and arguing that exceeding these limits has global consequences to immediate and future generations. This approach not only requires the development of more efficient technologies but also poses a wider questioning of what constitutes sufficient technology. The Eco-centric approach determines that where building is essential (as buildings and the urban environment pose the biggest threat to the ecology), the aim should be to radically reduce the ecological footprint of the building, drawing analogies with ecological systems as efficient, living, closed loop, recurring processes which directly opposes the current linear, inefficient, open systems of conventional buildings (Guy S & Farmer G, 2001: p143). This logic is essentially the fundamental stance of strong sustainable development: A closed loop system emphasizing the use of clean, renewable energy sources to sustain a growing economic system contained within a non-growing finite ecosystem, reducing waste matter by reusing and recycling products and materials whenever and wherever possible.

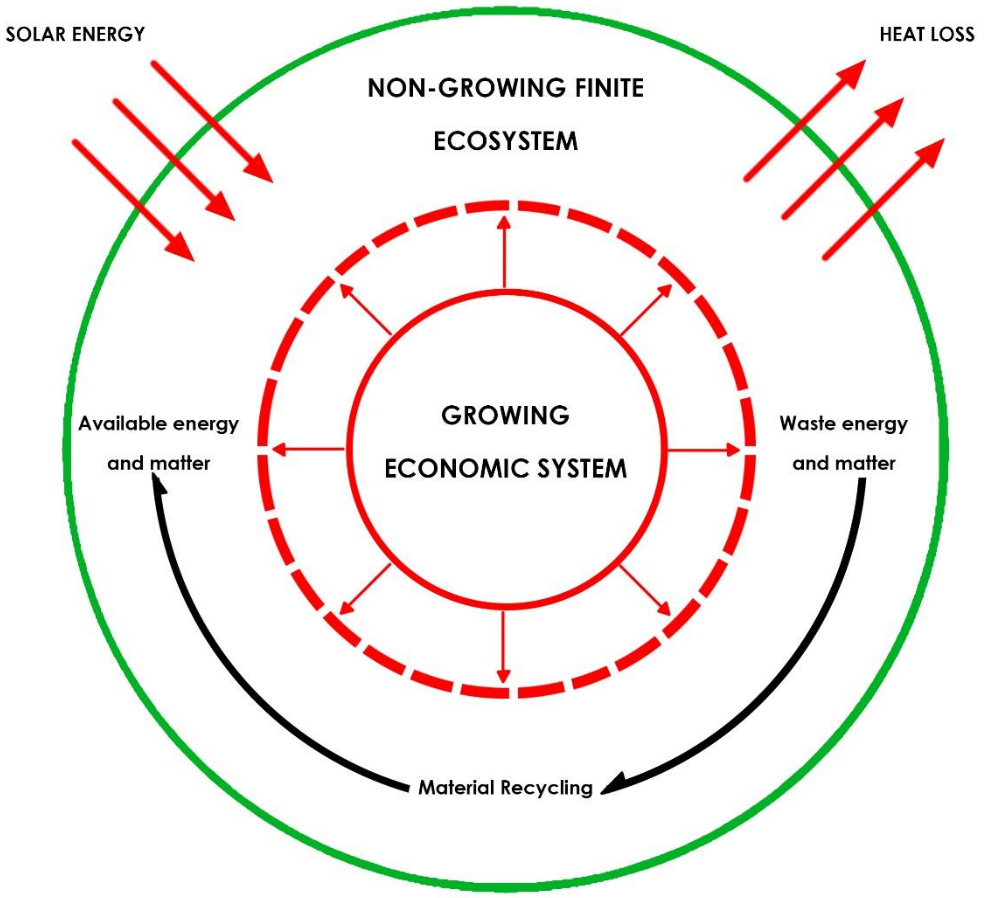


Figure 15: Graphic description of the closed loop, cyclical, "transformative" system, placing a growing economy within a finite ecosystem, representing strong sustainable development. (Source: Author)

2.4 (Eco)Logical Design – Going Green

Figure 16: Initial renderings of integrated biodiversity of WOHA Architects' Park Royal Hotel in Singspore (Source: https://inhabitat.com)

As discussed previously the current pattern of urban development and population growth is resulting in increased carbon emissions, which is in turn contributing towards climate change on a global scale, as well as having more localised effects such as poorer air quality, the "urban heat island effect", increased traffic and congestion, excess stormwater run-off and a poorer living environment due the absence of nature and biodiversity within the built environment (Wells M, et al: p14). This negative effect of current urban growth on environmental and socio-economic well-being resulted in the emergence of the concept of sustainability in the 1980's and with it came an urgent need to align architecture and future urban development with this concept. This gave rise to the concept of "Green Architecture" (Horn A, 1998: p1). Possibly one of the only people who can truly claim the title of "ecologist-architect" is Ken Yeang, an architect who earned a PhD in ecological design at Cambridge University in the early 1970's and has subsequently undertaken his own research into climatically sensitive vernacular structures and by the 2000's he had become the architect of choice for ecological master plans and projects around the world, placing Yeang at the forefront of other "green" architects (Hart S, 2011: p12).

Figure 17: Artist's impression of EDITT Tower by Ken Yeang (Source: https://inhabitat.com)

"Understanding ecology changed my perception of the world and humbled my own role within it, where humans are simply one species among thousands in the biosphere each functioning as part of an ecological nexus." – Ken Yeang (Hart S, 2011: p12).

Ken Yeang defines ecological architecture as "a designed system that seeks to minimize and at the same time is responsive to the negative impacts that it has on the earth's ecosystems and resources", which at its core holds a deep respect and care for the earth (Yeang K, 1995: p73). Another term for ecological architecture is *"green architecture"* however there are currently many misconceptions surrounding this terminology. If you had to ask most architects what they thought about green architecture and design you'd get a fairly typical response – the use of photovoltaic cells (solar panels), wind generators, the integration (albeit fairly weakly as aesthetic afterthoughts in most cases) of natural elements with the building design and compliance with certification systems such as the Green Building Council of South Africa, or the GBCSA. Green architecture and design is however far more complicated than that as it involves a number of design strategies that can be adopted to get as close as we can to our goal of balance with the natural environment in our built environments (Yeang K, n.d.: p8). Whilst aiming to achieve environmental responsiveness, resource efficiency, community and cultural sensitivity and healthy, non-polluting environments, green design provides additional benefits to the built environment and building owners and occupants such as reduced operating costs for both the built environment and surrounding landscapes, better health and therefore improved productivity for building occupants, increased occupancy rates, higher property values due to the improved aesthetic appeal and building performance, lower ecological impact and subsequently a sustainable form of development (Horn A, 1998: p1).

A key component for an effective green design is the design and implementation of appropriate green infrastructure however, in order for green infrastructure to be not viewed as a "greenwash", the weak integration of natural elements that lack functionality, all disciplines involved in the design of urban environments need a deeper understanding of the functional performance and values of green infrastructure (WellsM, et al, n.d.: p14). This green infrastructure in fact forms part of a broader holistic strategy that seeks to interweave four 'strands' of infrastructure; the 'grey' (the engineering infrastructure, being eco-sustainable engineering systems and utilities), the 'blue' (water management and closing of the water cycle with sustainable drainage), the 'green' (the green infrastructure, or nature's own systems and utilites) and the 'red' (our built systems, spaces, hardscapes, society and regulatory systems). Green design is therefore the blending of these four strands into a seamless system (Yeang K, n.d.: p8).

THE FOUR STRANDS OF ECO-INFRASTRUCTURES
GREEN
Ecological Eco-Infrastructure: Nature's Utilities, Biodiversity balancing, ecological connectivity, etc.
GREY
Engineering Eco-Infrastructure: Renewable Energy Systems, Eco-Technology, Carbon Neutral Systems, etc.
BLUE
Water Eco-Infrastructure: Sustainable Drainage, "Closing the Loop", Rainwater Harvesting, Water Efficient Fixtures, etc.
RED
Human Eco-Infrastructure: Enclosures, Hardscapes, Use of Materials, Products, Lifestyle and Regulatory Systems

Figure 18: Green design as the weaving and integration of four eco-infrastructures into a system and outlining the components of each strand. (Hart S, 2011: p8)

It is often the misconception that green infrastructure is equated with the general 'greening' of the urban environment with limited focus on creating biodiversity when in actual fact biodiversity has a significant role to play in alleviating the effects of climate change, such as carbon footprint reductions, reducing urban heat island effects (and hence the carbon cost of cooling) and reduced flood risk, whilst also benefiting itself as climate change is threatening urban biodiversity through overheating and the spread of disease (Wells M, et al, n.d.: p16). In order to achieve a proper implementation of green infrastructure designers need to create a seamless integration of the artificial (the man-made) with the natural environment in order to fully appreciate the ecological benefits available and create symbiotic and compatible relationships with the natural environment (Yeang K, 1995: p85).

"We must biologically integrate the inorganic aspects and processes of our built environment with the landscape so that they become mutually eco-systemic. We must create 'man-made' eco-systems compatible with the ecosystems in nature. By doing so, we enhance man-made eco-systems' abilities to sustain life in the biosphere" – (Yeang K, n.d.: p12)

As mentioned previously, up until recently proponents of urban densification have paid little attention to the benefits and potential contributions to sustainability of green space and wildlife habitats in urban areas. Reasons for this have included the idea that towns and cities are areas where nature is controlled, even suppressed, the lack of appreciation of the full potential value of green space to urban areas and the conceptual divisions between what is 'town' and 'country' with perceived higher land values within urban environments 'squeezing out' green spaces from cities and towns. However, the benefits that people and urban environments in fact derive from "ecosystem services" can be assigned to the following categories:

1. 'Supporting' – primary production and soils
2. 'Provision' – food, fibre, water, fuel, medicines, etc.
3. 'Regulating' – relating to climate, water, disease
4. 'Cultural' – spiritual, aesthetic, recreational & educational

(Wells M, et al, n.d.: p17).

Therefore, the goal of green design is not technological solutions to environmental problems caused by the built environment, nor is it the 'greenwashing' of the urban environment as an aesthetic afterthought. Rather, it is the aspiration towards something more than technologies and performance standards, it is the harmonisation of the man-made, inorganic built form with the natural environment and the ecological systems that can be utilised to enhance urban performance. It is akin to an attitude, as sensibility about the role and responsibility of the designer (Hart

S, 2011: p19). Yeang (2011) underpins this with four definitions of what green design should aspire to be:

1. Green Design should aspire to be considered as bio-integration – physical, systemic and temporal. Like his analogy that architecture and the built environment is a collection of prostheses requiring bio-integration with the host organism (i.e.: the ecosystems present within the biosphere); failure to properly integrate will result much like a human prosthesis, dislocation, separation.
2. Green Design involves the conservation of non-renewable resources and care of renewable resources to ensure the sustainable availability of renewable resources for future generations.
3. Green Design is "ecomimetic" – imitating the properties, processes, structure, features and functions of natural ecosystems (similar to the 'biomimicry' concept).
4. Green Design as monitoring and reacting to the ecological interactions over the life span of built systems. This includes the study of human impact and environmental devastation, assuming a sense of human environmental stewardship and an aim for environmental stability

(Yeang K, n.d.: p8-12).

2.5 Adaptive Reuse

Figure 19: Adaptive Reuse of building remains in a new design. (www.archdaily.com)

"Adaptive Re-Use" is defined by the Department of Environment and Heritage (2004) of the Commonwealth of Australia as "a process that changes a disused or ineffective item into a new item that can be used for a different purpose", and has since become an integral strategy to improve the financial, social and environmental performance of the built environment (DEH, 2004: p3). In architecture it denotes "the process of building conversion so as to accommodate new functional requirements" (Eyuce & Eyuce, 2010: p419). The concept was first introduced by architect Raynor Warner in 1978 where he described it as "a truth become tolerable", and elaborated that "We are so quick to adapt to changed circumstances that we may not recognize how much has changed" (Warner, 1978: p. vii). Williams (1983) stated that the adaptive reuse concept is "a demonstration of the simple fact that buildings left behind by changing economic and social forces could be rehabilitated for contemporary functions", and the concept has since been developed by various authors and professionals in varying capacities over the decades, specifically due to the increasing influence of climate change. Climate change has become an ever increasing topic of concern globally over the past few decades and has prompted the urgency to reduce carbon emissions and motivated towards the planning of low carbon cities. The construction of new buildings, which take up vacant, natural land as a start, consume significant amounts of raw materials and energy and generates high carbon emissions. Buildings are responsible for more than 40% of the global energy use and contribute one third of global greenhouse gas emissions (Yung & Chan, 2011: p352). Therefore, it stands to reason that, due to the global expansion of urban environments as discussed previously in this chapter, focussing efforts to reduce carbon emissions within the built environment is an important requirement towards achieving global sustainability targets. As discussed previously, the concept of sustainability as defined by the Brundtland Commission in 1987 stated that "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" - (WCED, 1987: p41). Furthermore, there are three key target areas, a "triple bottom line", which needs to be simultaneously met in order to truly achieve the objective of sustainable development:

1. Environmental protection
2. Economic development
3. Social wellbeing

In addition to these three there exists a fourth, lessor known aspect of sustainable development that is slowly gaining prominence in the form of governance, where it proposes that good political support can help facilitate the successful implementation of the three core sustainability objectives (DEAT, 2012: p19). Thus, the concept of adaptive reuse needs to be able to contribute to all areas of sustainability.

In order to determine the contribution adaptive reuse makes towards urban sustainability goals there needs to be a thorough understanding of the benefits adaptive reuse offers. First and foremost, by adapting existing building stock for new and/or additional purposes as opposed to building from new, the lifespan of the existing building can be increased significantly, as well as having lower material, transport and energy consumption and producing less pollution in comparison to demolishing and building new, which in turn makes a significant contribution towards environmental sustainability (Bullen & Love, 2011b: p33). In addition, current research promotes an integration of green environmental design into the adaptive reuse of buildings, which would further enhance the environmental benefit of the building (Yung & Chan, 2012: p352). It should be noted that to adapt and reuse a building can sometimes be a costly process, particularly listed heritage buildings, in order to get them to comply with local government by-laws however, there is a growing perception that it is cheaper to convert old buildings than to demolish and rebuild (Bullen & Love, 2010: p216). In parallel with increasing the lifespan, by adapting and reusing an existing building creates the opportunity to reuse and reinvigorate the existing embodied energy of the building, particularly for structures that hold significant heritage values to local communities. A sense of belonging to a certain place and a sense of place are identified as the key motivational factors behind the desire for the preservation and reuse of buildings as they help us maintain a connection to our roots, reinforce our sense of cultural identity and make the built environment more liveable. Thus, the reuse of socially significant buildings can help facilitate the endurance of social life which contributes towards the cultural significance of a place by enhancing cultural diversity and a solidification of cultural traditions and forms (Yung & Chan, 2012: p356). This then indicates that existing buildings hold potential to create social inclusiveness and cohesion through the reuse of the existing connection between people and place, and that this aspect of adaptive reuse can successfully achieve the social aspect of sustainability. Lastly, and in order for the adaptive reuse of buildings to be a truly sustainable process, they need to contribute towards economic sustainability. While capital investment is one of multiple criteria that are used to examine adaptive reuse decision making, that is the construction cost from the developer's/building owner's perspective, there are other economic factors at play beyond construction and maintenance costs that influence the decision to reuse or demolish (Bullen & Love, 2011a: p32). New builds are generally marketed at a higher rental value and thus the adaptive reuse of older properties offers an opportunity to enable occupiers at the lower end of the rental market in areas where they would normally only have the choice of new builds that are not as affordable (Bullen & Love, 2011b: p37). In addition and as previously mentioned, adaptive reuse extends the functional lifespan of existing buildings and maintains their economic viability, which in turn provides income generation for both the owner and the tenants for longer periods, providing opportunity for new and/or additional usages with the same building and, by incorporating green design elements with the adaptive reuse strategy improves the operational efficiency of a building with lower carbon emissions and improved cost efficiencies (Yung & Chan, 2012: p353).

2.6 Conclusion

As discussed, the current state of the built environment and urban development continues to propagate the capitalist vision of a consumer driven society with high levels of resource consumption, pollution and wastefulness that have characterized urban development of the 20th century, creating an urgency for all to realize that the current trajectory can only result in the collapse of the natural ecosystem that sustains humankind. Additionally, the current state of "disconnectedness" of the urban environment from natural ecosystems has further contributed to the inefficiencies of cities as well as created cities that are cold, hard, barren landscapes that have a negative effect on human health and well-being. The concept of urban sustainability is widely accepted to be the ultimate solution to minimise and even reverse the effects of climate change, to which cities are one of the primary contributors however, early "sustainability" solutions were predominantly technological responses that essentially "covered over the cracks" of environmental degradation and were responsive to the symptoms of climate change, never really capable of treating the cause. As mentioned, what is critically required is a drastic change in global thought towards the role of humans and the built environment as systems **within** their ecological context. Green and ecological design concepts have progressed over the last few decades to try redirect urban development towards a more environmentally sensitive and ecologically integrative approach, combining technological and ecological systems to create a "closed loop" built environment. Additionally, by integrating the systemic capabilities and biodiversity of the natural environment designers are simultaneously reintegrating urban dwellers with nature and subsequently creating biophilic environments that have the potential to improve the mental, emotional and even physical health of people within the city. However, even though cities only occupy about 2% of the earth's surface to accommodate more than 50% of the population, it is completely unsustainable and unfeasible to simply build new cities that are green and allow existing urban environments to continue along the path of environmental destruction. Therefore, designers need to instead focus on the 'reduction' of new builds on vacant, natural land and instead focus on the reuse and recycling of existing urban environments, using the concept of "adaptive reuse" as a tool to implement green design strategies towards more sustainable, environmentally friendly cities that have a reduced dependency on natural resources and to safeguard the environment for future generations.

CHAPTER 3: Precedent and Case Studies

3.1 Introduction

The following chapter will critically analyse one internationally published example of a project as a precedent and one local project as a case study which demonstrate the theories and ideas discussed in the previous chapter. While it is acknowledged that a foreign precedent may lack the contextual responsiveness of Durban and other South African cities, examples of ecological architecture and biophilic design are not common within South Africa as a whole. Therefore, this precedent will reveal issues or design principles relevant to the proposed concepts and theories which could then be addressed from the perspective of a more locally contextual response in the design proposal.

3.2 Precedent Study – Sino-Italian Ecological and Energy Efficient Building (SIEEB), Tsinghua University

Figures 20 (Above Left) and 21 (Above Right): General views of the south façade and environment. (Source: Yang W, 2012: p24 & 26)

Location: Beijing, China

Gross Floor Area: 20,000m^2

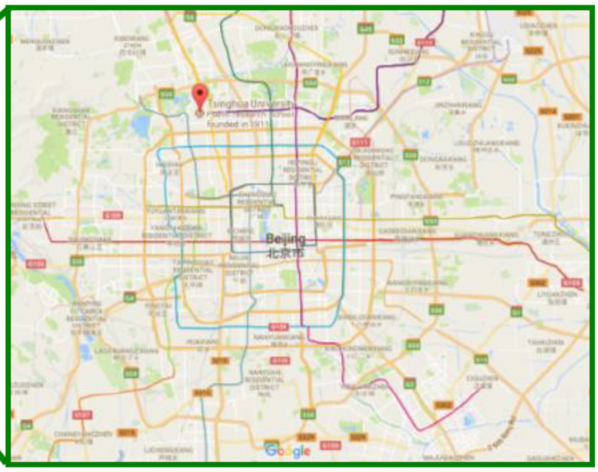
Completion Time: 2006

Architect: Mario Cucinella Architects

3.2.1 Introduction

The Sino-Italian Ecological and Energy Efficient Building (SIEEB) is a result of the collaboration between the Ministry for Environment and Territory of the Republic of Italy and the Ministry of Science and Technology of the People's Republic of China. The SIEEB was designed and built to showcase the possibilities of energy efficient building design and construction, maximising passive solar capabilities and fitted with state-of-the-art active solar elements, as well as incorporating green design features to maximise natural lighting, ventilation and cooling to reduce the energy demand of modern architecture and subsequently reduce CO^2 emissions (Yang W, 2012: p22).

3.2.2 Contextual Analysis

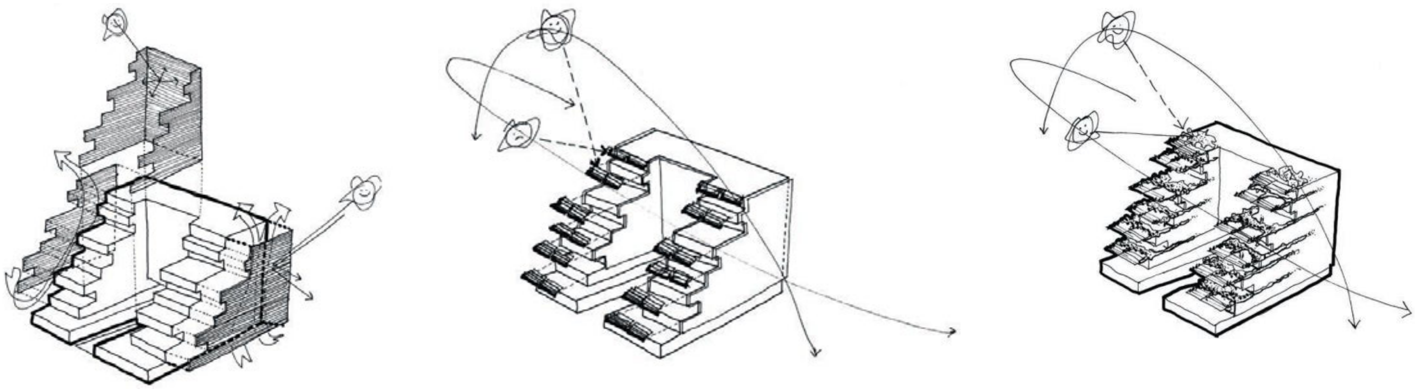


Figures 22 (Above Left) and 23 (Above Right): inidcating the proximity of the Tsinghua University to the capital of Beijing (Source: Google Maps)

The SIEEB building is part of a university campus that lies north-west of the city of Beijing, the capital city of China that has in recent years experienced a massive growth in technological and urban advancement. The SIEEB is confronted with the enormous challenge of responding to China's well documented reputation of being not just the fastest growing economy, but rather to its reputation as being one of the largest contributors to climate and carbon emissions due to its rapid industrialisation and urbanisation (Zhang YJ, 2011: p2197). Similarly, Durban as a city has historically relied heavily on an industrialised economy and as a result experienced similar urban growth around the port. This has resulted in an urban grain that is as dense as other cities around the globe, with low to medium rise structures built over the entirety of their plots, though not quite reaching the scales of other global cities like Beijing, New York, London, etc. The climate of Beijing is described as a temperate and continental monsoon climate, with warm, humid summers and cold, dry winters with large differences in temperature between day and night. Durban's climate, while being classified as "sub-tropical", also experiences warm and humid summers with cool, dry winters, though the fluctuations between high and low temperatures is not as drastic. Therefore, similarities can be drawn between Beijing and Durban where the architecture should make use of passive design methods that maximises solar energy in winter and provides solar protection in summer. Bearing in mind that the current global school of thought is to develop more sustainable urban environments in order to safeguard the future of the planet, the design philosophy requires a combination of sustainable design principles and state-of-the-art technologies that are responsive to the climatic, environmental and architectural context in order to provide a healthy indoor environment for the occupants (Yang W, 2012: p22).

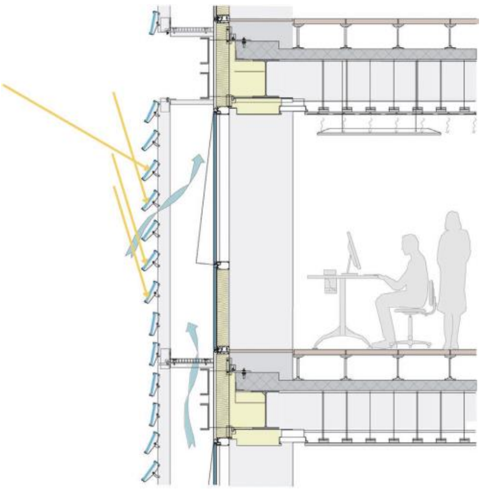
3.2.3 Technological v Ecological Solutions

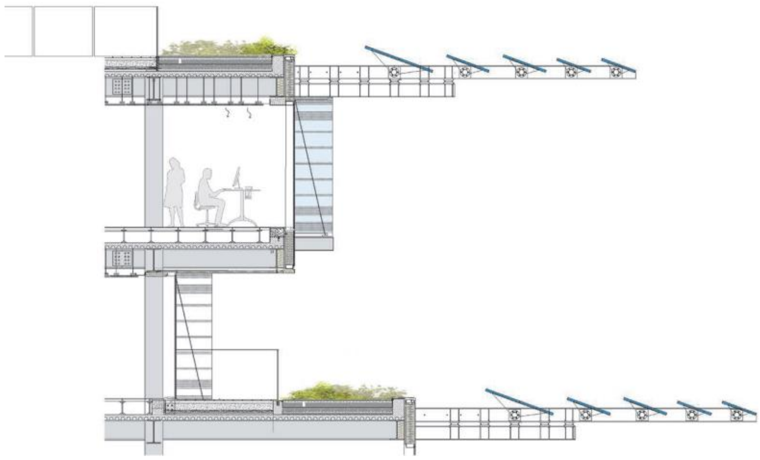
As stated previously, China has earned the unfortunate reputation as being one of the largest producers of CO^2 emissions globally and have therefore been forced to implement radical strategies to try reduce the effects of climate change despite their heavy reliance on an industrialised economy. Durban is in a similar position in that, as stated previously, the city was established and grew on an economy of industry and trade, and as such the resultant urban environment today is unsustainable and, through the energy demands and waste generated by urban processes, the Durban urban environment is a key contributor to carbon emissions and climate, though on a smaller scale to that of Beijing. It is widely accepted that achieving more sustainable urban environments is a key strategy to reduce carbon emissions however, what seems to be up for debate is the manner in which cities are made more sustainable. As mentioned in the previous chapter the two main schools of thought to achieve targets of "urban sustainability" in cities is Ecological Modernisation and Sustainable Development, and in China's case there is a strong preference towards technological advancements to improve the efficiency of the built environment. In the case of the SIEEB, the architecture presents an opportunity to showcase examples of how to make a building more environmentally friendly, by either using passive design solutions or technological and/or ecological systems, whilst still enabling the core functional requirements of the building to be successfully accommodated. Studying these systems and methods can potentially provide solutions to determine how to fully utilise ecological system services with good architectural design that can provide more sustainable, environmentally friendly urban environments. The design of the SIEEB integrated the use of passive sustainable design principles such as natural daylighting and natural ventilation, as well as taking into consideration the building's shape and orientation to control the external environment to create the optimum indoor environment.



Figures 24: Sketch designs of solar shading elements to protect the internal spaces from harsh light (Source: Yang W, 2012: p28)

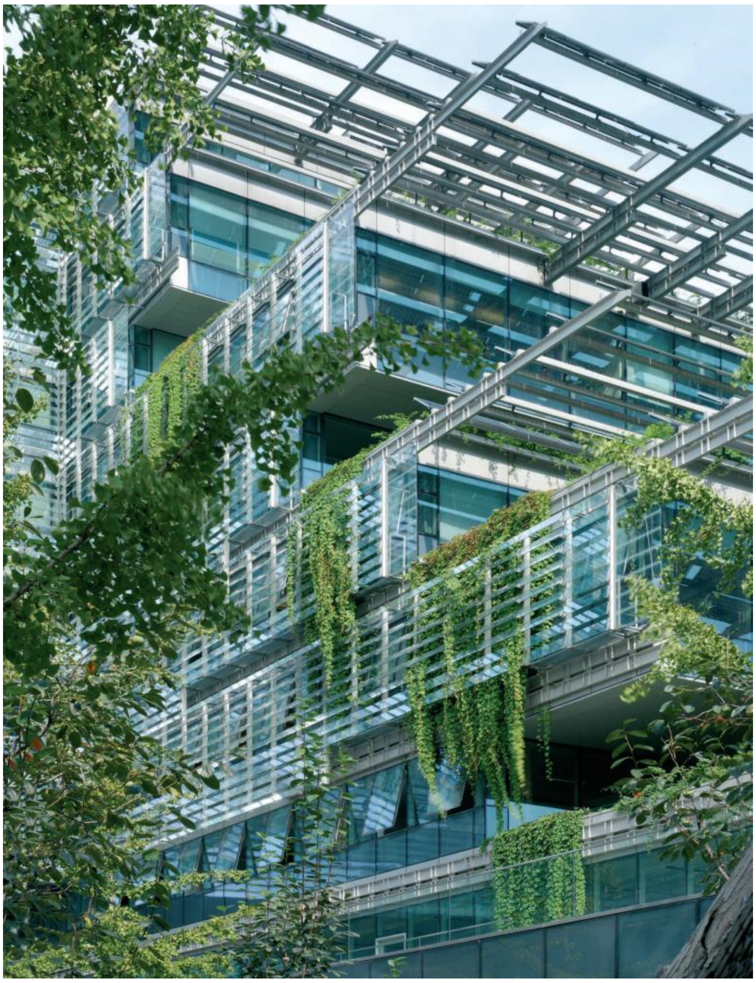
The building shape has been derived from an analysis of the site and specific climatic conditions of Beijing with the orientation providing the optimum use of solar energy in winter and solar shading with integrated reflecting elements to limit solar energy in summer. A permeable dual skin façade with reflective, adjustable louvers provides additional solar protection whilst enabling natural ventilation to provide fresh air and additional cooling to the interior. This means the building has a lower dependence on mechanical heating and cooling systems that therefore results in lower energy consumption, meeting one of the main aims and objectives of the urban sustainability concept. Over 1000m^2 of solar panels are integrated with the solar shading devices to provide the primary building energy needs, with supplementary energy being provided by a gas powered electric generator. Artificial lighting uses high efficiency lamps to supplement natural daylight and controlled with dimmers and motion sensors that turn lights off when the room is empty, further reducing he energy requirements of the building. Thermal comfort conditions are provided by a primary air distribution system utilising thermal displacement of air within the dual skin air space where air is warmed by solar energy, causing the now warmed air to rise which draws the internal air through and out the building which then gets replaced by new fresh air. The radiant ceiling and slab system utilises this natural air flow to provide further passive heating and cooling systems to the building to maintain a healthy and comfortable internal environment. A suspended ceiling and raised floor traps warm air heated by the sun in winter that radiates into the spaces above and below, and in summer air is channelled through the voids to draw heat out and cooling the spaces. This combination of good architectural design with passive systems minimises energy consumption in pumps, fans and other mechanical forms of lighting and ventilation, reducing the ecological footprint of the building and meeting the needs of the urban sustainability concept (Yang W, 2012: p25).



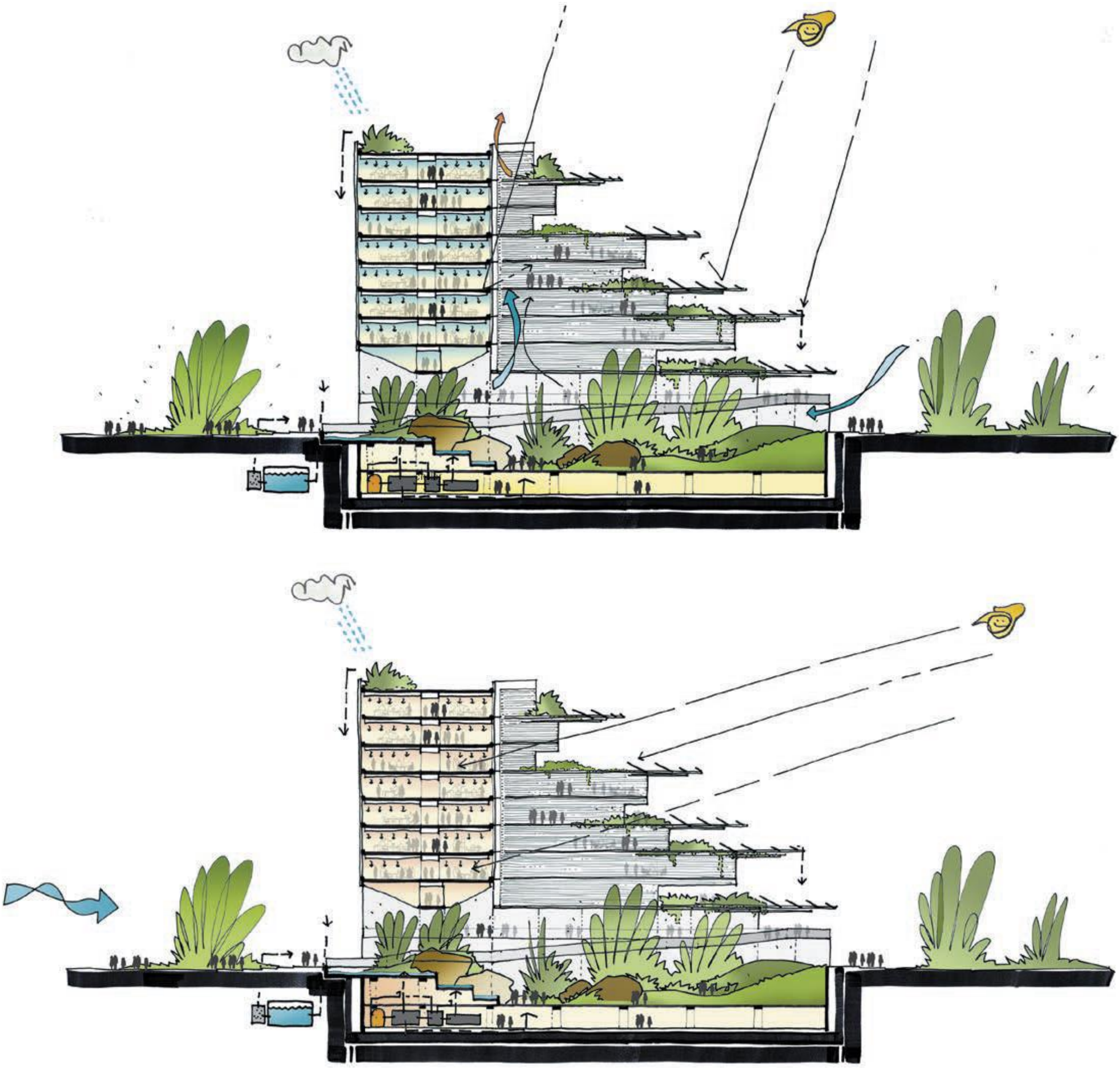


Figures 25 (Above Left): Sketch section of adjustable reflective louvers that reflect solar energy yet allow for natural ventilation. Figure 26 (Above Right): Sketch section of solar panels integrated with shading elements (Source: Yang W, 2012: p27 & 29)

Essentially, the SIEEB has implemented various technological solutions that improve the efficiency and performance of the building however, there are also several passive design and ecological systems that complement the technological systems to reduce energy and resource requirements as well as to reduce carbon emissions. Each south terrace has dense foliage that is allowed to grow over the side of the building to complement the reflective louvers and create a dappled lighting effect internally, further contributing towards the passive cooling of the internal spaces. Additionally, the planted terraces and further planting on the roof help control stormwater run-off, with rainwater being harvested to be used in toilets and irrigation systems. The U-shape of the building encloses a central planted courtyard that is open to prevailing winds. This area helps to clean and purify the air before it is directed up the south facade and into the building, providing clean fresh air for the occupants that is regulated using CO_2 and presence sensors to ensure adequate air quality at all times (Yang W, 2012: p27 & 33). Critically, this deliberate integration of natural elements with the site, as well as with the structure, not only provides passive ecological system services to the building's functional capabilities but also enables a biophilic connection with biodiversity for the building occupants across all level, softening the building within an already dense built environment.



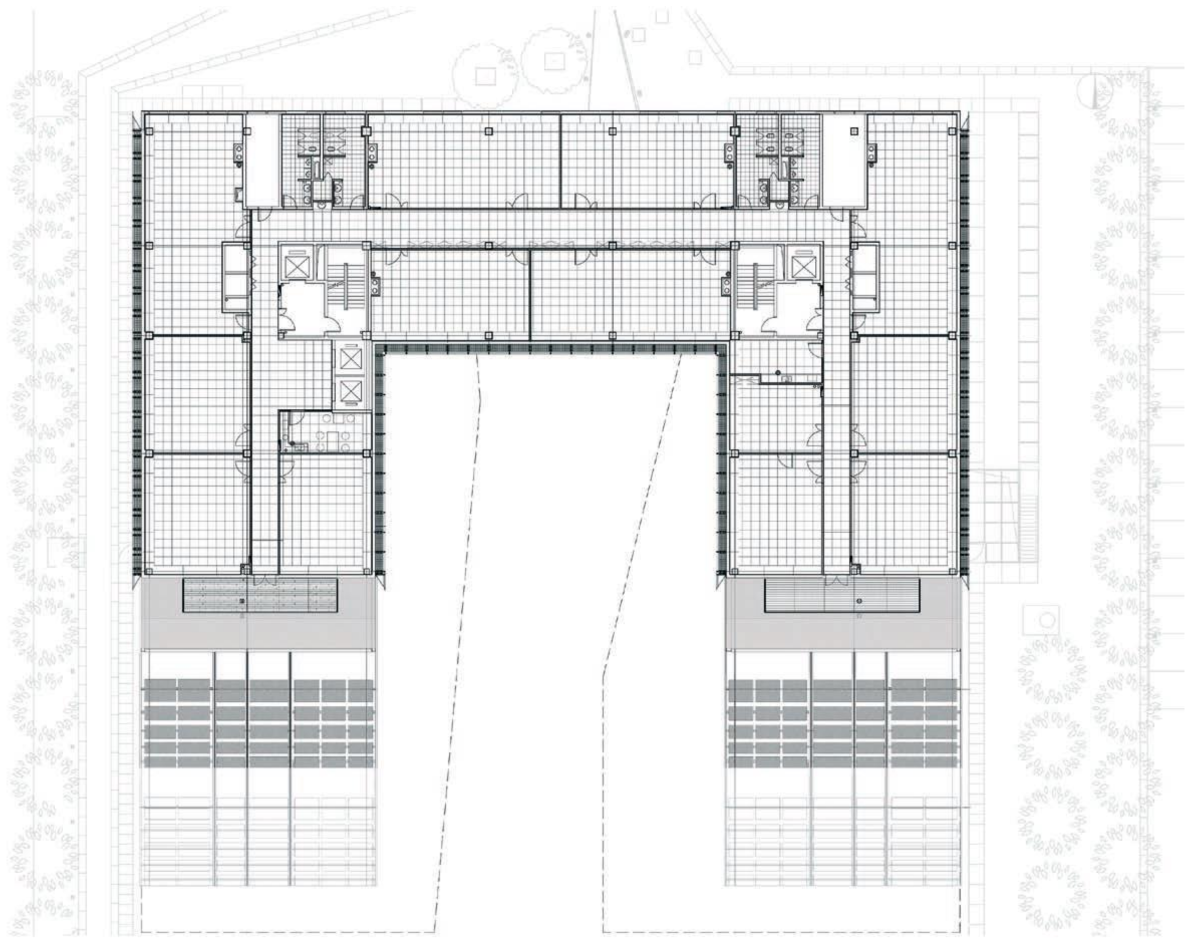
Figures 27: Picture of foliage growing over the side of the SIEEB (Source: Yang W, 2012: p23)



Figures 28 & 29: Sketch section of passive heating and cooling elements and fresh air flow through the landscaped courtyard. (Source: Yang W, 2012: p33)

3.2.4 Spatial Planning

The SIEEB is constructed predominantly on a 7.5m x 7.5m structural grid of reinforced concrete columns and floor slabs that allows for flexibility on each floor, whether the user requires an open plan space or individual offices, all would have access to natural daylighting and ventilation through the steel and glass façade. Services are clustered together to limit how much space they would accommodate and are aligned across all floors to ensure continuity and ease of construction. Escape stairs are integrated with the vertical circulation cores to again limit how much space they take away from the rest of the floor area. As mentioned previously the shape and orientation allows for maximum natural daylighting and ventilation with two outdoor terraces at each floor providing occupants with a shaded, landscaped space to escape the interior and connect with nature from a level above ground. These terraces give the occupants further views of the open air landscaped courtyard space enclosed by the building's U-shape. This ground floor landscaped space is softened by trees, plants and water to provide a calm and peaceful environment (Yang W, 2012: p25).



Figures 30: Typical Floor Plan of the SIEEB. (Source: Yang W, 2012: p25)

Figure 31 (Above Left): View from one of the east terraces showing the dense foliage growing on the edges of the building & Figure 32 (Above Right): Ecological features that are a part of the landscaped courtyard. (Source: Yang W, 2012: p26 & 32)

3.2.5 Conclusion

The SIEEB is a building that expresses a positive step towards more sustainable buildings that rely less on non-renewable sources of energy produced from fossil fuels. The technological systems integrated with passive design elements help create an indoor environment that is continuously monitored and ventilated to maintain the desired CO^2 levels and temperatures to ensure improved indoor health. However, where the SIEEB falls short is that, while it's an excellent example of passive green design that integrates technological and ecological systems to contribute towards building efficiency and performance, the SIEEB has been built as a "new build" and fails to address the issues of climate change and carbon emissions produced by other, older buildings that have over the decades been the cause of today's environmental problems. The technological systems, while effective for any new build, would more than likely be very expensive options to try and retrofit to existing buildings and most developers would more than likely avoid such options. Additionally, the materials used for the SIEEB's façades (glass and steel) are traditionally not the best when analysing thermal properties and generally require specialist glazing to prevent too much solar energy penetrating into the interior. It is also questionable whether the SIEEB has achieved the ideal balance between ecological and technological systems, with perhaps the design leaning towards an over-reliance on technology to achieve it green targets.

3.3 Precedent Study – The Edith Green – Wendell Wyatt Building

Location: Portland, OR. U.S.A.

Gross Floor Area: 47,610m^2

Completion: Original Building: 1974, Redevelopment: 2013

Architects: SERA Architects and Cutler Anderson Architects

Figure 33: View of the west facing façade with solar shading elements. (Source: SERA Architects & Cutler Anderson Architects, Photograph by Nic Lehoux).

3.3.1 Introduction

The Edith Green - Wendell Wyatt Federal Building is an existing 18 storey building conceived as a model for low energy buildings in the U.S.A., to adapt existing buildings that were previously viewed as energy "hogs" to energy and resource efficient buildings capable of achieving the highest LEED rating, whilst simultaneously revitalising the aesthetic contribution to the existing built environment.

Figure 34 (Above Left): Before image of the west façade, a typical modernist style. (Source: SERA Architects). Figure 35 (Above Right): After image of the west facing façade with reed-like solar shading elements. (Source: SERA Architects & Cutler Anderson Architects, Photograph by Nic Lehoux).

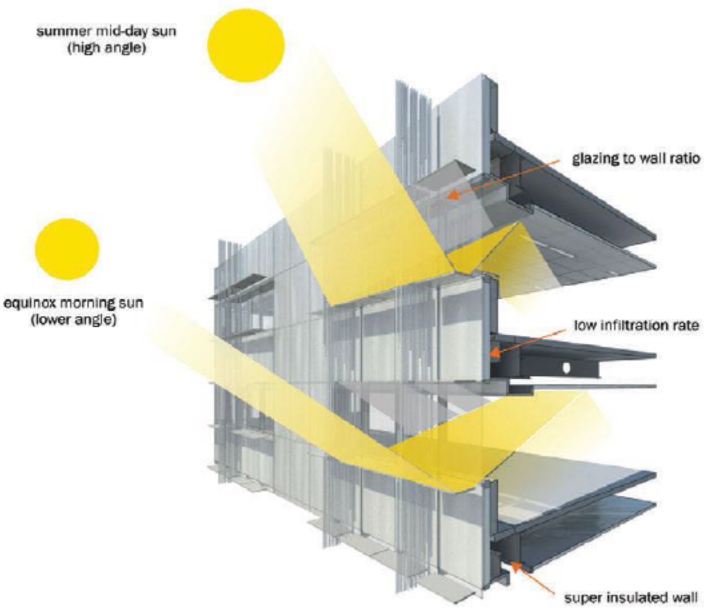
3.3.2 Adaptive Reuse and Ecological Design

The brief set out to the architects was to adapt and revitalise the existing building to accommodate 16 federal agencies, all with various different functional requirements, updating the building's systems and services, improving the indoor environmental health quality to improve work productivity and improving accessibility whilst meeting the strict energy and resource efficiency requirements of the local and national building regulations. Additionally, the architects were tasked with transforming the aging symbol of modernism to a modern icon of efficient building design. Technical design innovations include the façade of reeds which reduces solar heat gain as well as provides support for indigenous planting to grow up the building, transforming and softening the building at street level, whilst the new roof canopy supports the 180kW photovoltaic array and doubles to collect rainwater for use in the building. Additionally, the lush planting selected not only helps to connect the building to the ground plane and surrounding landscape, but has been specifically chosen to adapt to different climatic conditions (i.e.: deciduous vines specifically chosen to allow winter light into the interior whilst providing shading for summer) whilst a mixture of deciduous and evergreen planting in the surrounding landscape helps to create a varying habitat for a diverse mixture of species, improving the biodiversity of the landscape.

Figure 36 (Above Right): View of foliage from inside. (Source: SERA Architects & Cutler Anderson Architects, Photograph by Nic Lehoux).

Figure 37 (Above Left): Deciduous vines growing up the “reed” façade. Figure 38 (Above Right): Landscaping at the main entrance. (Source: SERA Architects & Cutler Anderson Architects, Photograph by Nic Lehoux).

The architects have also utilised bioclimatic design elements to contribute towards the buildings overall energy efficiency by transforming the un-insulated elevations to high performance curtain walls that integrate elevation-specific shading devices. As mentioned previously, the "reed" structure on the west façade eliminates 50% of the solar heat gain to the interior, whilst the south and east façades incorporate a combination of shading and reflective fins that either shade the windows from direct light or reflect light deeper into the interior. This careful control of heat and light means the building can maximise natural day lighting of the interior, meaning there is less reliance on artificial lighting, as well as utilizing solar energy to provide heat for the interior in certain months of the year. These solar control measures are vital because of the importance natural daylight has in human health and comfort whilst providing the occupants with a valuable connection to the outdoors, as well as for the success of the building's primary energy conservation measure: a radiant heating and cooling system.



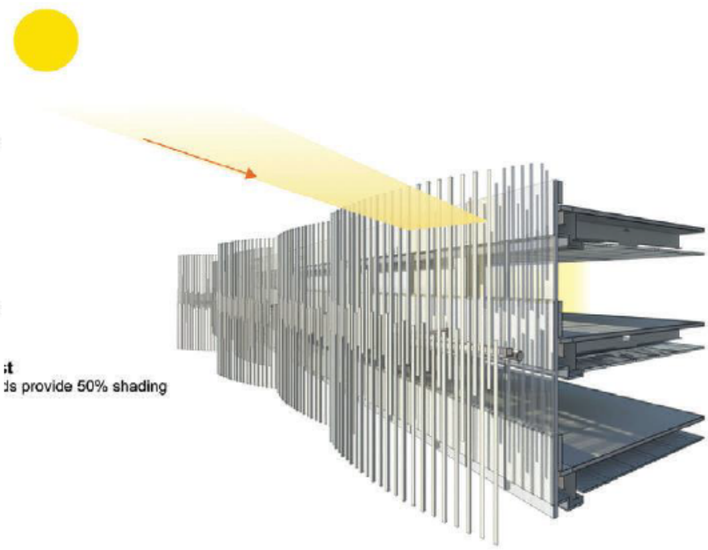


Figure 39 (Above Left): Horizontal fins shade the windows as well as reflect light deeper into the building. Figure 40 (Above Right): Vertical "reeds" structure filters direct light.

Figure 41 (Below): Section showing penetration of natural daylight and the use of ambient and task lighting that together reduces lighting energy requirements by 50-60%. (Source: SERA Architects & Cutler Anderson Architects).

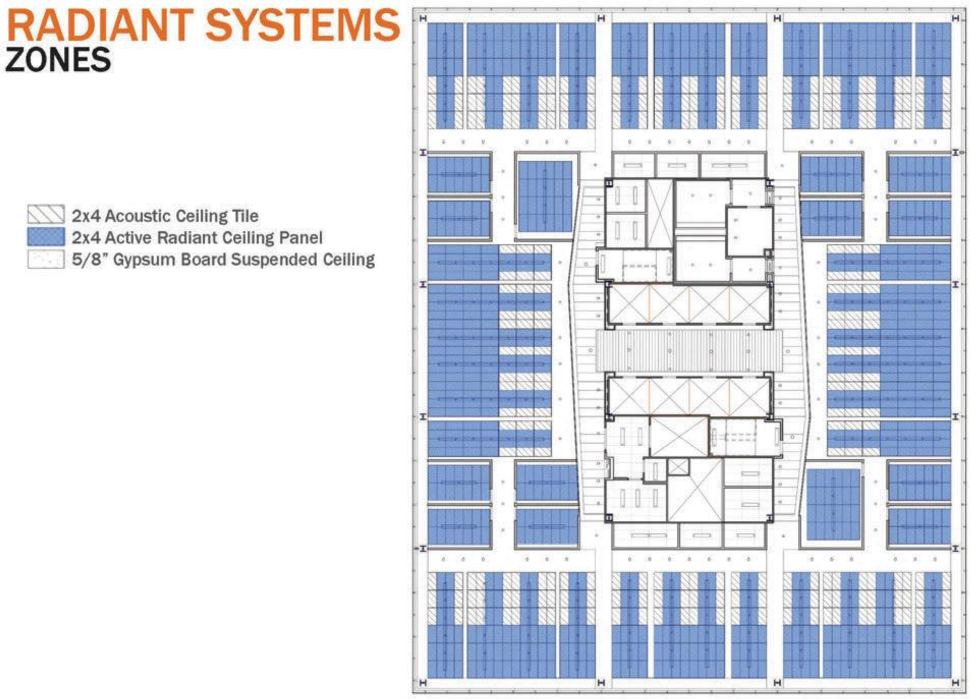


Figure 42: Plan of the radiant ceiling zones that, together with natural lighting and ventilation, help regulate internal air temperatures (Source: SERA Architects & Cutler Anderson Architects).

As mentioned previously, the building incorporates a photovoltaic array mounted on the roof utilizing the sun's rays to generate about 180kW of clean, renewable energy for use in the building and which accounts for about 4% of the building's energy requirements. Additionally, the rainwater from the roof surface is collected and stored in a 600,000L reservoir to be utilised in the toilets, irrigation and mechanical cooling system. This, combined with water saving fixtures and low water planting, results in an overall reduction of water usage by 60% in the entire building.

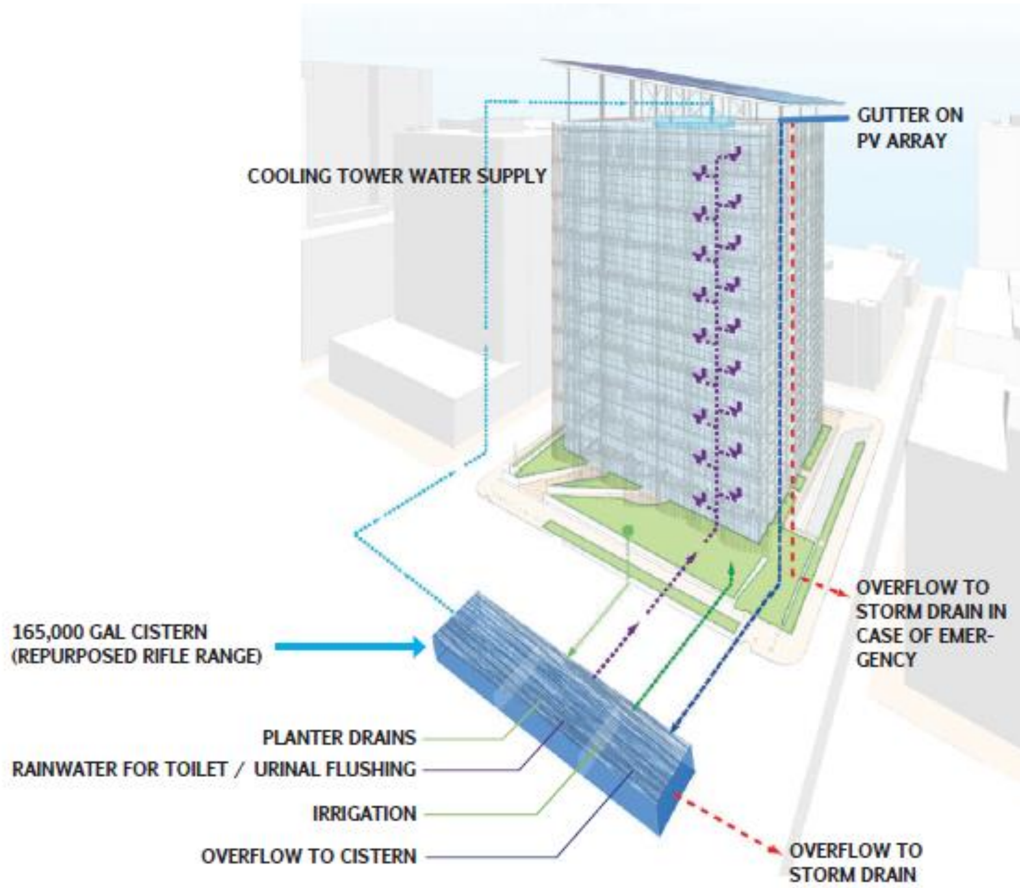


Figure 43: Diagram of water harvesting and reuse (Source: SERA Architects & Cutler Anderson Architects).

3.3.3 Conclusion

Ultimately, the adaptive reuse of the existing building, incorporating ecological and bioclimatic design principles, has helped transform this building into an iconic example of architecture, utilizing good, contextually responsive design and ecological systems in conjunction with technological solutions to drastically improve building efficiency and reduce carbon and other waste emissions. Additionally, the revitalisation and lightening of the building envelope and integration of flexible floor and ceiling configurations has helped extend the lifespan of the building, rather than demolishing the entire structure which would only add strain to landfill sites and increase transport costs and emissions. This approach to building design within an existing built environment is an ideal way to increase the value of building stock whilst offering the opportunity to preserve buildings of architectural significance however, this approach is not necessarily applicable to all buildings and a careful analysis should be conducted to determine the viability of an adaptive reuse and ecological design approach.

3.3 Case Study – The Rivertown Beer Hall, Durban

Location: 102 Florence Nzama Street, Durban

Gross Floor Area: 873m^2 Internal, approximately 1322m^2 External

Completion: Phase 1 completed for UIA 2014, Durban; Phases 2 & 3 underway

Architects: Choromanski Architects

(It must be noted that all information, images, drawings and other resources are courtesy of Rodney Choromanski and Choromanski Architects who maintain a copyright on all designs which may not be reproduced).

Figure 44: South east corner of the existing beer hall. (Source: Choromanski Architects)

3.3.1 Introduction

The Rivertown Beer Hall is a historical building constructed in 1914 to function as a municipal beer hall for black labourers until 1968, after which it was leased to various tenants until occupation by the Durban Art Gallery as a technical centre in 1994 (McGee J, 2014: p140-141). At the time the government had recently banned African women from brewing traditional African beer, or 'Umqombothi', and instead decided to construct the municipal beer halls where labourers would spend their wages, essentially giving their money back to the government. The main focus of the redevelopment is the establishment of a facility that could become the nucleus for the program leaders of art, culture and heritage in Durban and serve as a sustainable and creative catalyst that would rejuvenate and uplift the entire Rivertown precinct.

3.3.2 Contextual Analysis

As stated previously Durban's industrial economy sparked the urbanisation of the inner city which has, since the development of the original city grid, has taken preference to an expanding built environment over the existing biodiversity. Located on 102 Florence Nzama Road (formally Milne Street), the immediate context of the Beer Hall is characterised by the wide street that runs at an acute angle to the conventional urban grid of Durban, accentuated by a concrete slab that runs the length of the street. Beneath this slab is in fact 'Milne's Drain', what was formally an open channel that drained the eastern vlei and enabled the city's northern development, and was given its concrete cover that exists today. The neighbouring built environment includes various other low to medium rise commercial and light industrial buildings, some of which are also listed heritage buildings that have been earmarked for new developments, built to create a dense urban grain of fully developed and covered city blocks bounded by wide streets that currently prioritise vehicular traffic. To the west of the Beer Hall is the Inkosi Albert Luthuli ICC Complex (Durban ICC), and towards the east is the Durban beachfront and promenade. The Beer Hall therefore is a central point between these iconic features of Durban that enables a walkable connection between the two. Analysing the broader context highlights existing green spaces in the vicinity of the Beer Hall however, much of this green space is either restricted or is simply left over space that has never been formally developed or maintained to maximise the biodiversity within the inner city. In fact, what stands out is the density of the built environment that has eradicated large portions of biodiversity to prioritise urban development and severed the connection people have with nature, resulting in a cold, hard urban environment that is now causing problems such as excessive resource and energy consumption, high carbon emissions, the urban heat island effect, excess stormwater runoff and high levels of waste and noise pollution, all of which were non-existent when nature and ecosystem services managed and maintained the inner city region. Therefore, biodiversity and ecosystem services hold the potential to assist the city and reduce the adverse effects of urban development and subsequently improve the experiential quality of the city.

Figure 45: Contextual map showing the vicinity of the Beer Hall to other key urban features within a 500m walkable radius. (Source: Choromanski Architects)

3.3.3 Environmental Challenges

The Beer Hall complex, located within a dense commercial and light industrial precinct, is subject to a number of environmental issues, mainly due to Durban's steady urbanisation and growth in its industrial economy. Florence Nzama Street, an extension of the M4 freeway forms the western boundary of the site, meaning high volumes of vehicular traffic passing by the site during peak hours and throughout the day and resulting in high levels of noise and carbon emissions. Milne's Drain defines the site's eastern boundary and presents its own environmental issues. Uncontrolled disposal of waste and refuse by neighbouring property owners, along with excess refuse and litter from the neighbouring precincts that gets washed into the channel with rains results in a very poor quality of water that presents a health hazard and contaminates the harbour (where the drain discharges). Tidal movement restricts refuse from flushing out the drain which draws vermin and pest as well as the informal use of the channel by cardboard pickers and other homeless people cause the channel to be a constant health risk. Additionally, the channel was initially created to drain the eastern vlei, a natural wetland that controlled the flow and drainage of stormwater. Draining this wetland and subsequently covering most of the ground with hard surfaces has resulted in excess runoff that needs to be constantly controlled to prevent flooding. This further highlights the compounding issues created by man infringing on and altering the existing biodiversity and ecosystem services that were present before the first settlers landed in Durban. The question of how to reintegrate biodiversity and ecosystem services into the urban fabric is complicated by the density of the built environment with little room left in the inner city for large areas of biodiversity however, the presence of urban features like Milne's Drain does offer opportunities to create ecological corridors that permeate the urban framework and potential integrate into the urban fabric.

Figure 46: Image showing the poor water quality in the drain, indicating an intervention is required if this is to become a feature of the Rivertown precinct. (Source: Choromanski Architects)

3.3.4 Built Fabric

The structure and architecture of the Beer Hall is in accordance with the building practices of the early 20th century. Built predominantly out of clay facebrick, in all likelihood sourced from the brickyard situated in the drained eastern vlei in the late 1800's, the low rise, gable end structure featured glazed windows to most facades to allow for natural daylight and ventilation into the interior with brick arch headers to the windows that were capable of carrying the load of the brickwork above. On the south elevation there are six ventilation stacks that were probably to ventilate a kitchen back when the build functioned as a beer hall with a stepped roof pitch that could ventilate heat that rises to the top of the roof space. The redevelopment of the building has endeavoured to preserve the original building aesthetic and for phases 1 and 2 most of the work is focussed on upgrading the interior spaces whilst refurbishing the exterior condition. Preserving the use of facebrick makes use of the materials thermal mass properties, coupled with the use of natural daylight and ventilation to try maintain a comfortable internal environment. The approach by the architects to adapt and reuse the existing building rather than demolish and build new has achieved two important criteria: firstly, reusing the existing building has saved costs resources on material, as well as on what it would have cost to demolish and remove the rubble which also reduces the emissions created by the construction machinery. Secondly, reusing the building has helped to preserve and extend the lifespan of an important piece of Durban's architectural heritage, transforming the building from what was originally a tool of oppression to a landmark that celebrates the diversity and creativity of the city, and providing opportunities for a broader and more efficient use of space within the dense urban environment.

Figure 47 & 48: Images of facebrick architecture in the Rivertown Precinct. (Source: Choromanski Architects)

Figure 49: Florence Nzama Street elevation. (Source: BESETDurban)

3.3.5 Spatial Planning

As mentioned previously the Beer Hall refurbishment project is being constructed in phases, the first phase being predominantly focussed on the interior and certain external improvements. Internally, the existing workshops and technical areas at the centre of the complex were removed, creating a central, multi-purpose open courtyard space at the heart of the complex. The two halls that make up the Beer Hall are to be converted into gallery and exhibition spaces, with 'Hall B' (the former eatery) being the main exhibition area addressed for the initial phase, with 'Hall A' earmarked as an additional gallery and multipurpose facility with the relocation of the Durban Art Gallery.

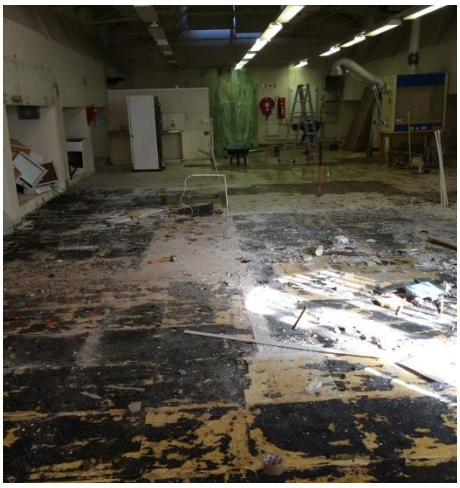


Figure 50 (Above Left): "Before" image of the eatery hall. Figure 51 (Above Right): "After" image of the hall converted to a gallery space. (Source: Choromanski Architects)

Externally the architects focus was to create a pedestrian friendly environment that would act as a catalyst to rejuvenate the whole precinct. A portion of the concrete cover to Milne's Drain was removed to expose the historical channel below and to test the viability of converting the drain into a canal. The cover was removed in sections that were later reused as benches on top of and alongside the remaining cover, with planting added along the open edges of the channel to create a softened green zone amongst the hard, industrial facades of the surrounding context, and serving as a reminder of the former wetland that preceded this section of the city. A portion of the John Milne Road boundary wall was then demolished to allow the public to be drawn into the central courtyard area creating a seamless integrating between adjoining public spaces. As mentioned previously, this adaptive reuse of the existing building has helped to preserve and extend the life span of an important piece of heritage architecture in the Durban inner city, making use of passive design systems and features to create a flexible, multipurpose space that increases the functional capabilities of the building.

Figure 52 (Above Left): "Before" image of the eatery hall. Figure 53 (Above Right): "After" image of the hall converted to a gallery space. (Source: Choromanski Architects)

Figure 54 (Above Left): Sections of the former concrete drain cover reused as benches. Figure 55 (Above Right): The demolition of the boundary wall to connect the public street to the internal courtyard space. (Source: Choromanski Architects)

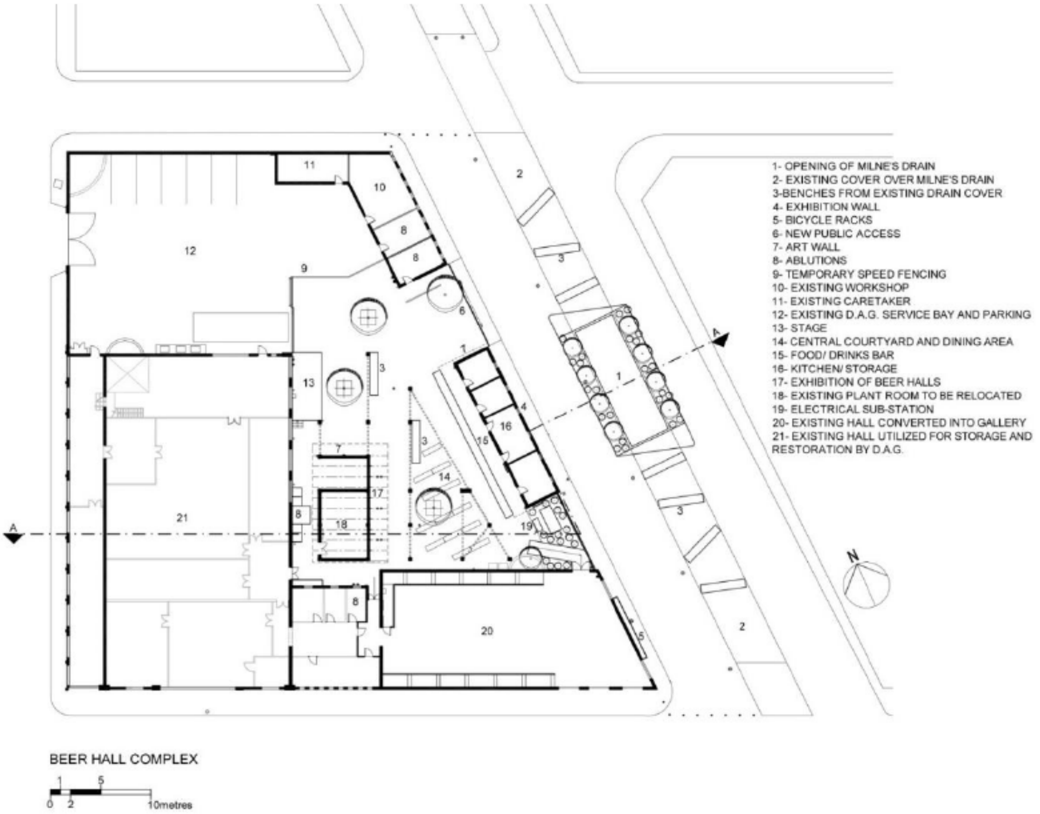
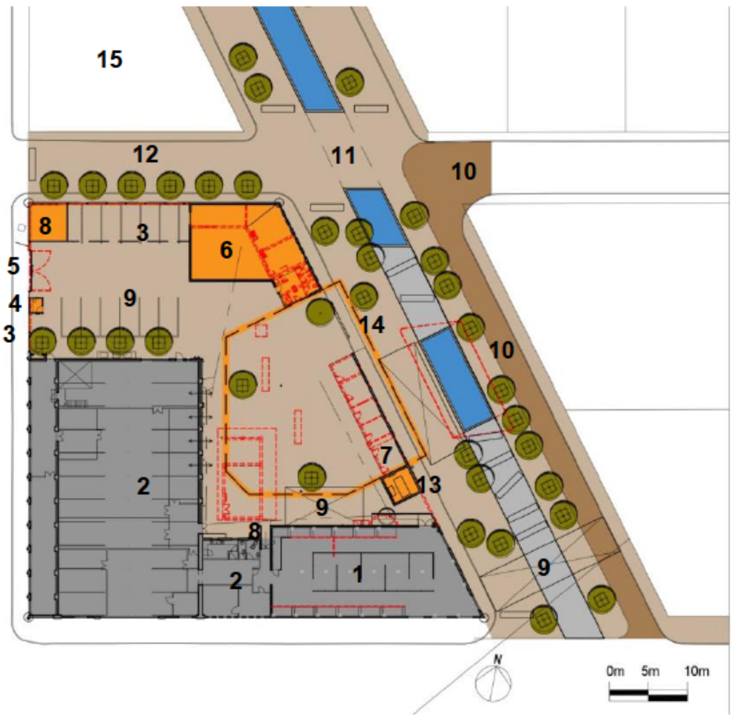


Figure 56: Floor plan of the changes implemented for the UIA 2014.



Phase 3 development of the facility into a key public events space:

1. Renovate existing gallery
2. Relocate D.A.G. and convert into multi-purpose facility that links to courtyard
3. New permeable boundary to promote site line and visual links
4. New guard house
5. Existing gates replaced
6. Existing o/b extended to form new kitchen and toilet facility constructed from recycled bricks
7. Existing o/b removed to make way for performance area / stage
8. Plantroom relocated to entrance
9. New hard surfaces: precast concrete slabs to match the process of deconstructing the drain
10. Reduced vehicular lane
11. Closure and pedestrianisation of John Milne Street
12. Closure and pedestrianisation of North Lane
13. New structure to enclose sub-station
14. New canopy over central courtyard
15. Future proposals

Figure 57: Proposed future Phase 3 plan (Source: Choromanski Architects)

3.3.6 Conclusion

As mentioned in the introduction the Beer Hall project aims to be a sustainable and creative catalyst that would rejuvenate and uplift the entire Rivertown precinct, feeding off the heritage architecture that is such a key feature of Durban's built environment. The Beer Hall has throughout its history been adapted and reused from its original, darker purpose as a tool for segregation and control of the African population, to industrial purposes to suit the city's growing industrialised economy. This latest adaptive, as a celebration of the city's history and preservation of its future, is a good example of how designers and developers can extend the life span of existing buildings rather than demolishing structures completely, which creates waste and rubble that needs to be disposed of, or continuing urban sprawl that consumes vacant green land. Whilst this adaptive reuse of structures is a sustainable method of incorporating new functions within the urban environment, it seems the Beer Hall has done little else to contribute towards reduced energy needs and carbon emissions within the city. The building still relies on conventional energy supplied by the city grid and hasn't made use of the utilising stormwater runoff or the channel to supplement water needs within the building, as well as failing to integrate any technological systems that would improve the building's efficiency (this is probably due to budgetary constraints). The green planting added to the courtyard and channel edges, while improving the appeal of the immediate environment, is integrated purely for aesthetic purposes and has failed to truly reintegrate the ecosystems services of the former wetland that pre-existed the Rivertown precinct.

3.4 Conclusion

The two projects analysed have both utilised systems and construction methods that have been widely accepted as the preferred approach to building within the city to achieve a more sustainable urban environment to safeguard natural resources for future generations. However, each project has its own shortfalls, still impacting on the environment in some way or another, and therefore neither could be considered as being truly sustainable. In the case of the SIEEB, the building is a good example of how technological advancements and the integration of systems with good design can improve the efficiency of the building, as well as the integration of certain ecological systems to supplement the technological. However, the building has failed to address the concerns and issued caused by the existing built environment and has, in the process of coming into being, taken up space within the city that could've been utilised for green space and purely ecological systems. The Beer Hall on the other hand has strived to adapt and reuse an existing building in an effort to extend its lifespan and protect existing green space within the city from being consumed by "new builds" however, where the building has succeeded in this area, it falls short in terms of implementing systems that improve the building's efficiency and reliance of man-made infrastructure. It should be noted however that both buildings have made an effort to integrate green elements within the design which helps to improve the experiential quality of the indoor and outdoor space, softening the hard urban environments that have become synonymous with industrialised urban development. Therefore, the ideal approach of urban development in the 21st century, with increased pressure from climate change and environmental degradation, should be to focus on improving the efficiency of the existing urban environments rather than building new structures that simply contribute further towards urban sprawl. Technological advancements in more efficient systems and practices should be combined with ecological systems to complement each other and work together to reduce the carbon emissions of our current urban environments. Additionally, the integration of nature and natural ecosystem services will improve the urban environment, not just from the perspective of emissions and pollution reduction, but also the environmental quality and aesthetic, making the city more liveable and reconnecting people with biodiversity in what has globally become the new home for human beings.

CHAPTER 4: Research Findings

4.1 Introduction

This chapter will define the research approach and methodology used in the dissertation to gather data with the aim of providing answers to the research questions posed earlier in Chapter 1. It will outline the procedures for data collection and it will also identify the techniques and methods used.

4.2 Research Questions

Primary Research Question

- How can nature be effectively integrated into the built environment as an active component of the city?

Secondary Research Questions

- Why is it important to have nature in the city?
- What is an ecologically responsible architecture and how can it resolve environmental issues?
- How can nature have a positive effect on the urban user?

4.3 Research Data

This study will primarily feature a qualitative approach to research that will involve primary and secondary forms of data collection. The primary data will be collected through the use of structured and/or semi-structured interviews with professionals who specialise in the built and natural environment utilising a selective sampling method. Additionally, data gathered by conducting a case study of Durban will help assist in highlighting critical areas that require intervention to revitalise the Durban inner city. This analysis can then be compared to the Local Area Plan (LAP) adopted by the eThekwini Municipality to determine to how the LAP plans to revitalise the Durban inner city and how the proposed architectural intervention can achieve the aims and objectives of the LAP.

The secondary research will be formed primarily by the findings of the literature review, including data that has been explored by other specialists in their respective fields that relate to the research topic. A comprehensive study of the concepts and theories surrounding the topic will also predominantly influence the primary research methods, with the findings of the literature review informing the principal theories and concepts to be investigated, who best to interview to provide the necessary data on the topic, and by providing a better understanding of the theoretical and conceptual framework of the research.

Additionally, a case study of the city of Durban will analyse the city from its foundation to present day and seek to determine how the city has developed the way it has, ultimately highlighting areas in the city that are in a period of decline and require urgent intervention for the upliftment of the built environment.

4.4 The Durban Inner City and the Local Area Plan of eThekwini Municipality

Analysing the existing Durban built environment shows that decades of urban growth has resulted in an urban sprawl, starting from the current CBD alongside the port and growing steadily west to north-west on the high grounds of Morningside and Berea. As stated previously in Chapter 1, since the arrival of settlers in the early 1800's there has been significant growth of the Durban inner city at the expense of natural ecosystems. North of the early Durban CBD was what used to be the eastern vlei, an area of natural wetland that, along with the western vlei situated where Greyville Race course exists today, helped create a natural storm water management system for the environment (eThekwini 2040 Inner City LAP). Essentially, these vleis would retain rainwater that flowed down towards the coastal dunes and slowly released the water into the ground water system, ultimately preventing flash flooding of the region.

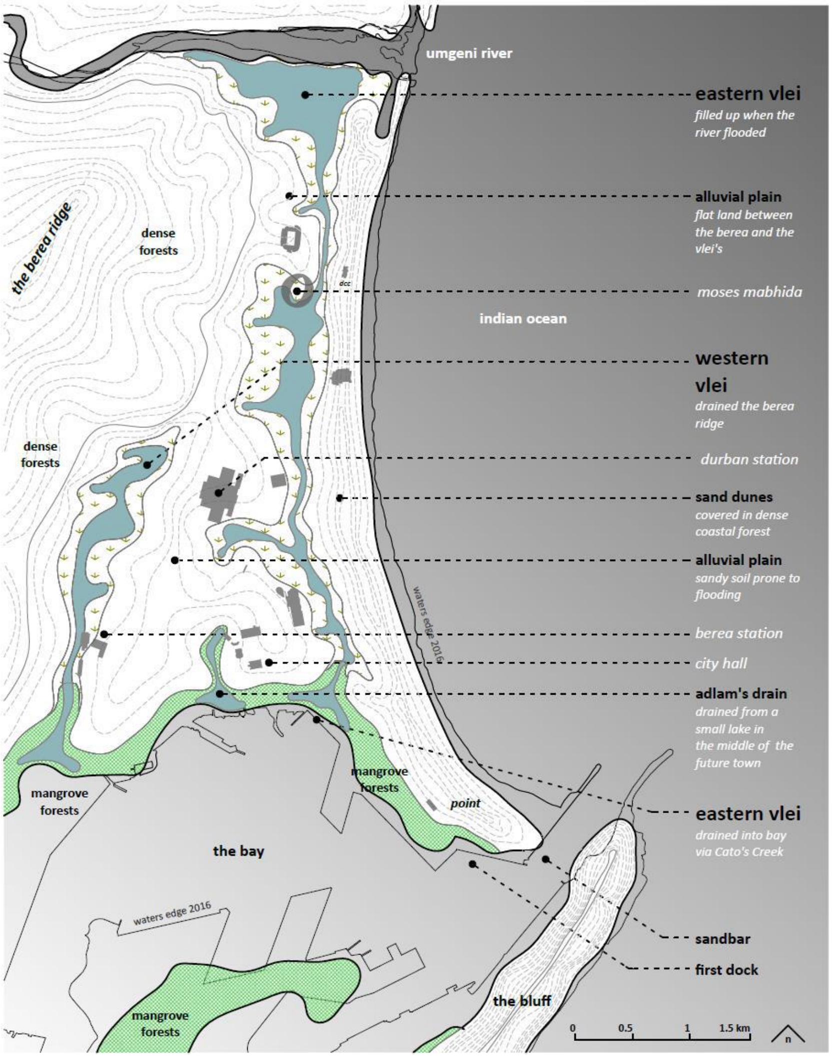
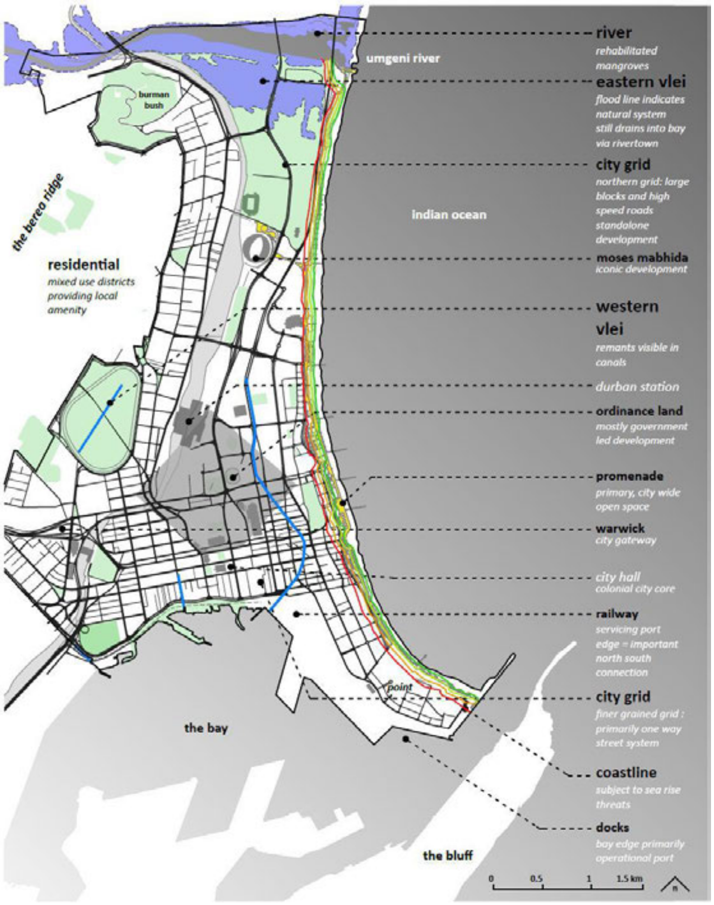


Figure 58: 1823 map of the eThekwini Municipality indicating ecological systems that pre-existed the city. (Source: eThekwini 2040 Inner City LAP).

The problem however is that early settlers and urban planners saw these natural wetlands as problems that hindered the transport of trade goods and made accessibility to the CBD difficult from the east (coast) and west (inland). It was then decided to drain the vleis by constructing channels that would divert storm water into the harbour. The draining of the eastern and western vleis had a drastic effect on urban growth, enabling the rapid expansion of the built environment. Moreover, where it was previously thought these wetlands segregated the city from neighbouring regions, colonial and the later apartheid governments only reinforced the segregation of the CBD by constructing a road and rail network that isolated the inner city in an effort to control the CBD and port region, the main driving force of Durban's early economy (eThekwini 2040 Inner City LAP).



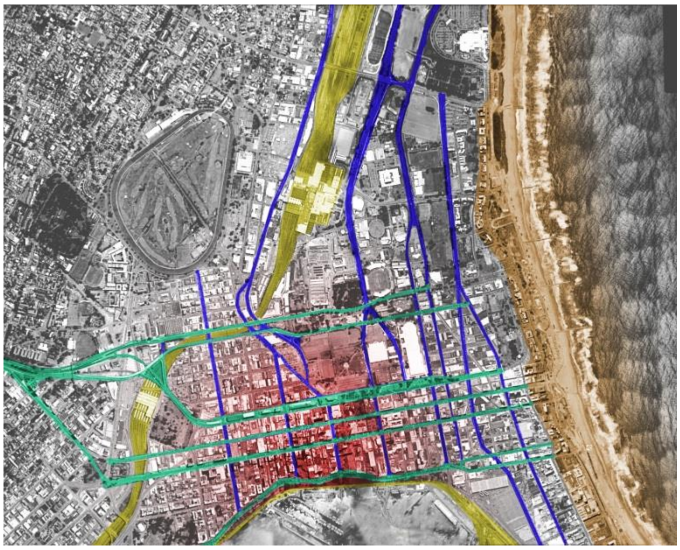


Figure 59 (Left): 2016 map of the eThekwini Municipality indicating how urban expansion has taken preference over natural ecology and altered the natural environment. (Source: eThekwini 2040 Inner City LAP). Figure 60 (Above): Aerial view of the Durban inner city highlighting sprawl to the north-north west and segregation of the CBD by current transport networks. (Source: Author)

The paradox created was that in order for the city and its economy to flourish, the city required a labour force to work the port, railway and other areas within the city which was primarily made up of native Africans however, the implementation of various planning policies, particularly under the apartheid government, prohibited native Africans from living permanently with the urban environment as the city, port and coastline was "reserved for whites" (Hansmann, 1993). This resulted in various housing developments being built to house native Africans in areas that were closer to the inner city in order to "regulate labour supply" however, these were still deliberately kept seperated from the city. Additionally, these housing developments, mostly hostel type arrangements, were never offerd as a permanent home to native Africans and as such, it meant that the occupants were in a perpetual state of transition, away from their rural roots and never truly a part of the urban environment (Hansmann, 1993). The result meant that, because these housing developments were kept segregated from the rest of the city, since the abolishment of apartheid, these segregated areas are now isolated from a bustling, modern inner city and have fallen into a state of decay. Many of these hostels are still being utilised by rural and foreign migrants as a gateway into the Durban inner city and thus maintaining their temporary nature. Additionally, the segregation of the urban environment has meant that, as the city has progressed into the modern era, areas of trade and industry have been segregated and isolated from the rest of the built environment which means that, they are not only falling into a state of disrepair but, their ability to form a part of the city's economy is starting to decline as well.

Figure 61: The Local Area Plan recently adopted by the eThekwini Municipality. (Source: Urban Solutions Architects and Urban Designers).

The Local Area Plan (LAP) that has been adopted by the eThekwini municipality is a document that outlines a (re)development goal for the Durban inner city, highlighting the problems represented by the current built environment and proposing a strategy to transform the city into a revitalised, sustainable and resilient city based off lessons learnt by analysing and observing successful and unsuccessful cities around the world (eThekwini 2040 Local Area Plan). Developed through collaborative research and design input from various professionals and consultants, such as architects and urban designers (Lees & Short Architects, Urban Solutions Architects and Urban Planners and Town Planning Initiative), economists (Urban Econ), public participation and input from various other engineer's, the main aim of the LAP is to densify the Durban inner city, providing more space to accommodate people and accommodate socio-economic opportunities, essentially to create a more integrated city. Additionally, the LAP also seeks to simultaneously solve environmental issues caused by the existing built environment such as the "urban heat island" effect, excess storm water runoff, high carbon emissions and high energy and resource consumption. To do this the LAP identifies the importance ecology and biodiversity have as potential "role players" within the built environment, beyond aesthetic treatments to the horizontal ground plane. It outlines the importance of engaging a building, not just with the street edge to create links between buildings and spaces, but also with sun, wind and other elements to utilise natural sources of heating and cooling, and creates a structure that forces architects and developers to look beyond the boundaries of their site and create integrated, walkable networks of varying spaces throughout the Durban inner city (eThekwini 2040 Inner City LAP). Overall, the purpose of the LAP is to provide stability and certainty to development within the Durban inner city, which fundamentally provides potential developers and investors an image of where the city is working towards. This then enables and facilitates a successful partnership between private and public development that ultimately improves the experience and potential of Durban's built environment. However, where the LAP succeeds in providing an overall vision for the Durban inner city, it neither prescribes where certain urban amenities should be located, particularly elements such as security and waste management, nor does it define what the ideal architectural form and/or typology would be to best suit the LAP, it merely provides a framework that is reliant on architects and developers, along with the city, designing and constructing buildings that are “in line” with the requirements of the LAP. The LAP does however identify that biodiversity and ecological system services play a vital role in revitalising the Durban built environment, as well as providing the means to improve the resilience of Durban.

In comparison to the existing Durban inner city, the LAP is proposing to free underutilised land for densification and development in order to accommodate more people and socio-economic opportunities. Moreover, it aims to provide a strategy to revitalise the existing built environment of the Durban inner city by using lessons learned from the past and from observing successful global cities, and by highlighting key projects such as waste management, policing and security to provide certainty for private investors and developers to get on board with city’s overall vision. A primary aim of the LAP is to create an integrated city, rectifying the mistakes of previous urban planning policies and truly repairing the city from the seperatness of the city and its people that is the continued legacy of apartheid. This involves providing practical and dignified housing within the city to offer permanence and stability to foreign and rural migrants, whilst properly integrating communities with space for social integration and economic opportunities (eThekwini 2040 Inner City LAP).

Figure 62: An example of the condition of many of the buildings in the Durban inner city, this one near Albert Park. (Source: Author).

In saying that, there needs to be a plan for the integration of public service elements within the built environment as a part of these new mixed use neighbourhoods, making elements such as policing, security, health care and waste management as accessible to the urban population as housing and socio-economic opportunities. This will not only provide the urban population with the benefit of having these services readily available, but will also enable and empower people with the means to be a formal part of the urban economy. Waste management services, in particular an urban recycling strategy, can play a fundamental role in the rejuvenation of the built environment, as well as in the lives of various people within the city. A waste management centre located within the inner city, rather than on the periphery as is the norm, can help control waste from its source. By being in close proximity to homes and businesses, a centre that will sort waste into recyclables and compact them for formal recycling can help streamline the process and help reduce the volume of waste that has to be collected and transported to dumpsites and recycling centres on the periphery. Essentially, the urban waste centre mimics the natural wetland by capturing, filtering and distributing waste as part of a broader system.

Figure 63: An indication of how a large volume of recyclable waste can be compacted to a more efficient size, making it easier to manage the volume of waste generated from within a confined built environment. (Source: Google Images).

For the urban poor, waste picking has become a means by which they can alleviate their economic situation by providing an invaluable service to the city and its occupants. Currently considered an informal process, the waste pickers within Durban, as is the case globally, are forming a vital part of the city's metabolism and have begun to establish their own identity within the built environment (Stols, D. 2013: p97).

Figure 64: An informal cardboard collector gathers cardboard in the built environment to sell. (Source: Thomas Ferreira from www.urban earth.co.za).

Waste pickers are often subjected to cultural bias and poor work conditions, frequently harassed as "scavengers" that are deemed unsightly however, their value to the built environment as contributors to the city's waste management strategy cannot be ignored, and as such it would benefit the city to formalize and incorporate waste pickers as a functional part of the broader urban system (Stols, D. 2013: p97). While there currently exists waste buy back centres in Durban, these are located on the urban periphery, maintaining the segregation of space and "reserving" the inner city for more lucrative or desirable uses. This means that many waste picking have to either travel long distances to sell the recyclables they have collected, often having to carry up to 75tons per day, or the centres have to utilize vehicles that move throughout the city to collect the waste from the pickers, only adding to the built environments carbon emissions. Incorporating the waste sorting and buy back centre(s) within the inner city can have varying benefits to the city and its inhabitants, including: reduced transport costs and emissions by the centres being more accessible to formal and informal recyclers, creating education and awareness to the urban population of the importance of effective waste management strategies, and essentially managing waste closer to its source to ease the pressure on landfill sites and prevent waste ending up in the streets and clogging up the stormwater and sewer networks. Additionally, it can assist in creating a truly integrated built environment by combining a waste management centre, along with the formal and informal workers that support it, alongside other areas of socio-economic opportunity.

4.5 Conclusion

From the outset of this document the primary and secondary research questions were identified to aid the direction of the research and subsequently provide answers that would inform the eventual proposed design. The primary research question, "How can nature be effectively integrated into the built environment as an active component of the city", studied the concepts of adaptive reuse and ecological architecture to identify how and where biodiversity can be integrated into the built environment but utilising existing elements of the city, particularly along primary transportation routes and inorganic elements such as Milne's Drain, to potentially create green 'corridors' that allows nature to permeate into the heart of the city from the periphery. Answering the secondary questions highlighted the benefit of biodiversity to both the urban environment and the urban user, offering ecological system services that makes the city more sustainable and resilient, as well as improving the conditions of the built environment that positively effects the well-being of the user. It was hypothesised in Chapter 1 that integrating nature with the built environment offered benefits to both the city and the user however, nature also stands to benefit as it will now share space with the city and offer greater opportunity for the survival of biodiversity in the built environment.

CHAPTER 5: Conclusion and Recommendations

5.1 Introduction

This chapter will discuss the research which set out to explore the significance of ecology and biodiversity to both the urban environment, and to the urban user and the effect that it has on each. The hypothesis was; *"Integrating nature with architecture has two fundamental effects:*

- *Ecological system services can contribute towards urban sustainability targets*
- *Nature with the built environment connects the urban user with nature, which enables a positive physical, mental and psychological response to the environment"*

Further, it will discuss how the aims and objectives and hypothesis have been responded to throughout this document to answer the research questions which focussed from a broad context, to a narrower, more specific objective.

5.2 Findings

5.2.1 Biophilia/Biophilic Design

As stated in Chapter 2, 'Biophilia' is the *"innate human tendency to focus on and affiliate with life forms and life like processes",* and as outlined in the literature review it signifies the importance of having nature in close proximity to people, especially within the urban environment which is now the primary habitat for human beings around the world. This new anthropocentric era requires new environmental ethics, once previously defined and dominated by modernism and industrialisation, now having to counteract and mitigate the contribution urban environments have towards climate change and global worming whilst compensating for the continued growth of urban environments. Therefore, the fundamentals of the *Biophilia Hypothesis* is seen as an important stepping stone to redefine the nature of the urban environment and a way to make cities more 'liveable', which is crucial considering the growth of urban populations. As stated previously, Biophilic design is *"not about* *greening our buildings or simply increasing their aesthetic appeal through inserting trees and shrubs. Much more, it is about humanity's place in nature and the natural world's place in human society…"*

As the above quote states, biophilia and biophilic design goes beyond simply increasing the ecological density of our surroundings for the sake of doing so. Moreover, it's about creating a connection between human beings and their positive response to natural elements and systems by the careful design and thoughtful implementation of nature within our regular environment.

5.2.2 Urban Sustainability

The fundamentals of urban sustainability, as discussed previously, is development that "*meets the needs of the present without compromising the ability of future generations to meet their own needs*". This, as mentioned, requires meeting three specific criteria of social, economic and ecological sustainability, with no one taking preference over another. A fourth, and probably equally important component for the implementation of urban sustainability is the governance and regulation of policies that can successfully achieve the three criteria of urban sustainability. The global shift to making urban environments more sustainable is a direct result of two key phenomena:

1. Globally, more and more people are moving into the city and as a result, the UN predicts that by 2050 about 70% of the world's population will live in urban environments
2. Since the advent of modernism and the industrial revolution, cities have grown rapidly as efficient "machines" that form part of a global economy and as a result have become cold, hard environments that consume large amounts of energy and resources whilst being one of the primary contributors to carbon and greenhouse gas emissions.

Therefore, in response to these two phenomena, it is critical to develop urban environments that provide better socio-economic opportunities to the urban users whilst making a concerted effort to protect and preserve the natural environmental. This is where the Local Area Plan recently adopted by the eThekwini Municipality aims to provide a strategy for the revitalisation and development of the Durban inner city, to transform the city from a segregated, industrialised environment to a more integrated and diverse city. The LAP outlines the importance of ecology within the urban environment and identifies the benefits of properly integrating biodiversity to both the city and the urban user which has been explored further in this document.

5.2.3 The Nature Effect:

5.2.3.1 On the Built Environment

One of the core outcomes of this research, in validating the hypothesis made previously, was that *"Ecological system services can contribute towards urban sustainability targets"*, essentially stating that biodiversity has the ability to contribute positively to the built environment beyond the aesthetic appeal of the city, and can actually make a meaningful, functional contribution to urban efficiency. By studying the current city of Durban in comparison to other successful and unsuccessful cities around the world, it becomes apparent that Durban exhibits many of the same problems present in other cities around the world, namely: the 'urban heat island' effect, excess stormwater runoff as a result of the area of hardened surfaces in the city, high resource and energy requirements and subsequently high levels of carbon and greenhouse gas emissions. Further, like other modernist cities, the development of Durban was prioritised around the motor vehicle which has resulted in wide streets with high levels of vehicular traffic flow, most of which are private vehicles that commute from outside the city, which contributes to the segregation of the city as a result of the earlier colonial and later apartheid style of urban planning. Therefore, by integrating nature with the built environment and prioritising public open space and pedestrians within the city over cars, the city can be properly integrated through a diverse network of walkable neighbourhoods. Additionally, the presence of nature within the city adds not just an aesthetic appeal to the built environment, but also contributes functionally, utilising ecosystem services to make the city cleaner, more efficient and more manageable, reducing the "urban heat island" effect and helping to manage stormwater runoff as the vleis that pre-existed the city once did.

5.2.3.2 On Human Well-Being

As stated previously, the Biophilia Hypothesis suggests that human beings have an *"innate human tendency to focus on and affiliate with life forms and life like processes",* and studies conducted have generated findings that do suggest humans have positive and negative reactions to varying forms of nature. While a negative, or '*Biophobic',* response to nature can be easily verified by studying the well documented cases of various phobias (i.e.: fear of snakes, spiders, etc.), the opposite, '*Biophilic*' response can be supported by studying the effects nature has on human mental, emotional, psychological and even physical well-being. By analysing the before and after effects of buildings and cities that have integrated biodiversity and ecological design principles it becomes clear that ecology has the potential to improve human happiness, productivity, comfort, sense of security and sense of place, and as such it should be a priority of all urban environments.

5.2.4 Adaptive Reuse

.As discussed in chapter 2 the *"adaptive reuse"* concept is *"the process of building conversion so as to accommodate new functional requirements*", essentially it is to take existing buildings within the context of an established yet transitioning built environment and transform the functional capabilities of the building. This process allows for the life span of existing built stock to be extended rather than demolishing entire buildings, which offers the potential to not only utilise structural components and saving on building costs but also allows for buildings of architectural significance to be preserved and reintegrated into a more contemporary built environment. Additionally, the socio-economic and ecological problems caused by the existing urban environment will continue to exist, if not be made worse, if new developments are built on vacant land and the existing built environment ignored. In fact, this is one issue that Durban currently experiences with the development of new 'town centres' north of the existing inner city drawing investment from developers to more 'prestigious' locations and neglecting the existing built environment. Adaptive reuse of existing buildings in the inner city is also a more sustainable approach to building as it reduces waste that has to be transported to landfill sites, as well as reducing the amount of resources required in the construction process.

5.2.5 The Durban Inner City Redevelopment Plan

The Durban Inner City LAP is a viable strategy for the rejuvination and densification of the built environment, whilst simultaneously aiming to improve the 'inter-connectedness' of the city, breaking down the barriers that still exist from previous urban planning policies that sought to segregate people based on the colour of their skin. It identifies the importance of a soci-economic and environmentally responsible architecture that prioritises people and strives to provide a framework to architects, engineers and developers, whether they be part of the public or private sector, to work towards the common goal of making the city more resilient and liveable. In saying that, the LAP identifies that biodiversity can have a role to play in rejuvinating the built environment, contributing towards urban sustainability targets and making the city more resilient, whilst simultaneously improving the experience of the built environment for the urban user. As the priority of the LAP is to observe and determine a strategy for the improvement of the broader urban environment, it merely offers a broad guideline for the type of architecture that should be implemented. Part of the aim of this document is to provide an example of an architecture that meets the needs of the LAP, offering a building typology that could be implemented tomorrow and still be a part of the broader future city as defined by the LAP, as well as providing a strategy for the formal integration of nature with the built environment because, as stated previously, nature has far more to offer the built environment than just being an aesthetic addition to rooftops and the ground floor plane.

5.3 Concluding Remarks

Throughout this dissertation document the research has investigated the primary aims and objectives and sought to verify the hypothesis by resolving the research questions. The research investigated the development of the Durban inner city and its effect on the pre-existing ecology as well as analysing the state of the current Durban inner city in order to determine the significance nature and ecological system services have to the urban environment and to the urban user. The findings responded to the hypothesis and sought to reaffirm the contribution biodiversity can make to the built environment as well as towards the health and well-being of the urban user, ultimately using the findings of this research to derive a brief, schedule of accommodation and in the end, an appropriate architecture for the revitalisation of the Durban inner city.

CHAPTER 6: Site Selection and Analysis

6.1 Introduction

The following chapter will outline the selection of the proposed site using various criteria and subsequently conducting a thorough analysis to inform the proposed architectural intervention. Additionally, a SWOT analysis carried out on both sites will test the validity of constructing a waste sorting and distribution centre as well as determine the potential to integrate biodiversity and ecological system services with the proposed architecture.

6.2 Site Selection Criteria

The main criteria used for the final site selection are as follows:

6.2.1 Location

As seen in both precedent studies the location of the architectural interventions are within the context of existing built environments and are responsive to the issues and opportunities prevalent in each context, serving as icons for good building design within the urban environment. Thus, the proposed intervention should ideally be situated within the existing Durban built environment, utilising existing urban infrastructure and serving as a model for the transformation and revitalisation of the Durban inner city in accordance with the eThekwini Local Area Plan. Furthermore, the site and subsequent architecture should facilitate and enable connections to both elements of biodiversity and integrative public spaces in order to satisfy the "triple bottom line" of urban sustainability: ecological, economic and social sustainability.

6.2.2 Accessibility

A major goal of the Local Area Plan is to create a network of integrated walkable neighbourhoods that are interconnected and prioritises the movement of pedestrians around the city rather than private motorised transport travelling into the inner city.

The site and proposed design should seek to accommodate multiple occupancies and create connections across spaces within the inner city whilst still being able to integrate into a formal public transport system. Additionally, whilst the end goal of the LAP is to reduce private motorised transport within the city and prioritise the space between buildings for pedestrians, the reality is that such an urban environment cannot become a reality overnight, especially when it involves "re-planning" an existing built environment. Therefore, provision should be made to initially accommodate private motor vehicles however, the space this occupies can and will be adapted and reused further in the future to provide additional socio-economic, ecological and/or residential space for the growing population in the Durban inner city. The site should take into account the requirements of a waste sorting and distribution centre, providing accessibility for the delivery and collection of waste matter, as well as delivery and collection of the necessary goods and by products of a multi-functional mixed use development within the inner city. However, as stated previously and in accordance with the LAP, movement of pedestrians should always take priority over forms of motorised transport.

6.2.3 Site Area

The proposed site must be able to accommodate the core functional requirements of a waste sorting and distribution centre whilst also being able to accommodate additional socio-economic and ecological scheduling.

6.2.4 Physical Features and Environmental Conditions

Response to the subtle variances in climatic conditions is an important consideration in good building design and Durban is fortunate to experience favourable weather throughout the year. Site and building orientation should maximise natural day-lighting to reduce energy dependency and harness solar energy and natural ventilation to passively regulate and maintain a comfortable internal air temperature.

A site on uniform grade within a built up environment would be ideally suited to enable the core function of a waste sorting and distribution centre whilst it should be located so as to enable a connection between potential areas of rich biodiversity within the inner city.

6.2.5 Orientation

As mentioned previously the site should be orientated in such a way as to promote a healthy and vibrant site, not overly shaded by neighbouring buildings with good cross ventilation being essential to provide healthy air quality for all occupants. 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 and create linkages across and through to other public open spaces within the inner city, prioritising the space between buildings for the movement and integration of pedestrians within the inner city.

6.3 Site Selection

Two sites were considered for selection within the existing built environment of the Durban inner city, with a SWOT analysis providing an initial analysis highlighting the strengths, weaknesses, opportunities and threats posed by each site. A table was drawn up using the site selection criteria of Location, Accessibility, Site Area, Physical Features and Environmental Conditions and Orientation. Each site gets analysed using this criteria and given a rating to determine the overall site performance in each category. This analysis ultimately facilitates in the selection of an appropriate site for the design of a mixed use waste sorting and distribution centre.

6.3.1 Site Option 1:

Site option 1 is situated south of the ICC, bordered by Monty Naicker Road on its northern edge and Dr Pixley Kaseme Street on its southern edge. The eastern boundary is defined by Stalwart Simelane Street while the western edge is defined by Union Street. This city block is divided in half by Palmer Street that links Union Street to Stalwart Simalane Street. The city block comprises of 23 plots that in total measure just over 14,000m^2.

Figure 65: Site Option 1. (Source: Author)

Strengths:

- Predominantly north orientated for good use of natural daylight
- Site is bordered by 3 busy streets which makes for easier accessibility and higher visibility
- Existing taxi rack with pedestrian crossings provides easy access to public transport networks
- Site topography is flat

Weaknesses

- Site is fragmented by too many smaller plots
- Site area of 14,000m^2 is too large
- Proximity to 3 major roads, while providing high visibility, also poses a problem of noise for the residential component.
- Minimal space to accommodate urban biodiversity
- Fairly weak connections to urban green spaces

Opportunities

- Access to Exhibition Centre and ICC
- Multiple points for vehicular access to the waste sorting facility

Threats

- Narrow roads to the sites western boundary and through the centre have poor public supervision and offer potential security risks.
- Major roads are wide and currently have high volumes of private motorised transport which poses a potential threat to pedestrians

Conclusion

Site 1's main advantage is accessibility due to its proximity to 3 main roads however, these same roads also create a potential problem for noise to the building occupants. Another main advantage is the site's orientation which is predominantly north-south which enables the proposed building to maximise solar energy and natural day-lighting and ventilation. A major drawback for the site is how fragmented the site is by smaller plots, each with a low to medium rise building that would make it extremely difficult to consolidate the smaller sites into one holistic design. Also, the site area of just over 14,000m^2 is extremely large and will present a major challenge to develop.

6.3.2 Site Option 2:

Site 2 is located south-east of the ICC, midway between the ICC and the Durban promenade. It is bordered by Monty Naicker Road on its southern edge and Shepstone Road to its western edge. The northern boundary is defined by Milne Street while the western edge is defined by John Milne Road which has a prominent concrete surface cutting through city at an angle to the standard city grid. This city block is divided by South Lane that links Shepstone Road to John Milne Road. The city block comprises of 8 plots that in total measure approximately 3,463m^2.

Figure 66: Site Option 2. (Source: Author)

Strengths:

- Predominantly north orientated for good use of natural daylight
- Site is bordered by 2 busy streets which makes for easier accessibility and higher visibility
- Site topography is flat
- Existing collection point of recyclable waste from informal pickers

- Site is close to existing public open space
- 8 sites are currently developed by only 2 buildings, making the adaptive reuse of the existing buildings easier
- Site area is manageable for a multi-storey development
- Existing wide verges provide lots of space for pedestrian prioritised movement

Weaknesses

- Proximity to 2 major roads, while providing high visibility, potentially poses a problem of noise for the residential component, however can be mitigated by reducing the volume of vehicular traffic flow to prioritised pedestrians and non-motorised forms of transport.

Opportunities

- Access to Exhibition Centre, ICC and the promenade; both landmark destinations are within a 5min walk of Site 2
- Multiple points for vehicular access to the waste sorting facility
- Access to existing public open space that can accommodate additional biodiversity
- Potential to convert Milne's Drain into a canal that can provide additional biodiversity; Site 2 can then forma connection between the existing public open space and the new canal
- Ground floor volume can accommodate waste sorting and processing functions as well as necessary volume for retail
- Wide streets and verges provide space for additional street level public open space.

Threats

- There are no inherent threats to this site

Conclusion

Site 2's main strength is its location, situated in a central, connecting position between 2 key landmarks of Durban's inner city; between the ICC and the promenade. Also, the site offers huge potential to connect the existing public open space to the proposed canal being created by adapting Milne's Drain and providing a link between biodiversity that exists on the ground plane. Additionally, the site has sufficient street and verge widths to create public integration spaces around the building and falls within an existing network of informal waste gathering and collection by recycling organizations. A minor drawback is the site's shape, which is more square than rectangular, which means the site has as much east-west solar exposure as it does north-south however, this creates the opportunity to create vertical green surfaces that act as solar screens as well as soften then building aesthetic.

6.3.3 Site Selection Table

A table has been drawn up to demonstrate the comparisons between the 2 selected sites and a rating out of ten has been given for each site for their performance under particular criteria.

SITE SELECTION		
SITES		
1	South of ICC	
2	South-east of ICC on Milne's Drain	
Site Selection Criteria	**Site 1**	**Site 2**
Location	7	10
Accessibility	8	8
Site Area	6	9
Environmental Conditions	7	9
Orientation	10	8
Total	**38**	**44**

Figure 67: Table comparing the two possible sites. (Source: Author).

6.3.4 Final Site Selection

After applying the criteria, Site 2 received the highest rating and is as such the chosen site. The main of advantage of Site 2 is its close proximity to key areas of potentially rich biodiversity and the potential connections that the building can create to link spaces within the inner city. Being in close proximity to both the ICC and the Durban promenade means the site forms an important link between the two. The existing road network and verges means the site is easily accessible to both vehicles as well as for pedestrians and non-motorised forms of transport whilst still providing sufficient space for the proper integration of ecology within the built environment.

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Part Two

Design Report

CHAPTER 7: Determination of the Brief

7.1 Introduction

The information gathered from the literature review, precedent studies, case studies and interviews will derive a brief to facilitate the design of mixed use building with a primary function of a waste sorting and distribution centre in the Durban inner city. The outcome of this chapter will formulate guidelines which will result in the design of the proposed architectural intervention. This chapter will further seek to define the client, the client's requirements, users, building requirements and site requirements and restrictions. This will lead to the drafting of a schedule of accommodation which will further guide the architectural design for the site chosen in chapter 6.

7.2 The Brief Derivation

7.2.1 The Notional Client

The eThekwini Municipality has adopted a Local Area Plan that outlines a strategy for the redevelopment and revitalisation of the Durban inner city which includes the provision of certain key urban services that the city aims to provide as part of their 2040 vision such as security, policing and waste management. However, the LAP is also a guideline for private investment into urban development and as such there is also an opportunity for a joint venture between public and private development within the inner city. Therefore, for the purpose of this design, the 'client' is a combination of the eThekwini Municipality (for the development of a waste sorting and distribution centre) and a private developer.

7.2.2 Urban Requirements

As discussed previously, the development of Durban's built environment has manipulated and degraded nature, reducing the presence of biodiversity in the inner city and, as a result, has caused the urban environment to experience various problems due to the lack of sufficient natural management systems. Additionally, with the urban population predicted to increase from 20 000 to 450 000 people, the presence of nature, or lack thereof, plays a vital role in determining how people will experience the built environment as well as impact the city's ability to withstand the pressure of an increased urban population. Therefore, it is critical that the city not only densifies the built environment to accommodate the influx of new urban migrants, but that it also does so in a way to improve urban resilience to the effects of climate change and the stresses caused by the increased resource requirements and emissions that result from a drastically increased urban population. As mentioned in previous chapters, ecological systems have the potential to negate certain urban issues such as excess stormwater runoff and the "urban heat island" effect whilst simultaneously 'softening' the built environment and provide a renewed connection with nature for the urban user. When studying the Durban inner city from an aerial perspective two things become prominent: firstly, the inner city has developed outward from the dense city centre, forming a compact urban grain and has, over time, given priority of the spaces between buildings to the movement of cars into and out of the city. In contrast, green space and biodiversity in the Durban inner city is inversely proportional to the built environment; sparse and segregated within the city centre and becoming more prominent towards the urban periphery. From an urban perspective the aim is to reintegrate nature into the built environment, utilising existing features such as roads, railways, channels and buildings to create "green corridors" that allows nature to penetrate into the inner city from the periphery and to link existing green spaces to create an integrated and connected network of biodiversity within the city.

7.2.3 Building Requirements

One of the key objectives of this study is to determine a design that achieves certain sustainability targets for the Durban inner city and delivers on the three requirements of urban sustainability – social, economic and environmental sustainability.

7.2.3.1 Social Requirements

As the design aims to accommodate future urban expansion it is difficult to design for an existing community as, in all likelihood, the characteristics of the community will change as the city grows and develops. However, by analysing successful spaces in the city it is possible to determine what constitutes a 'good' public space that facilitates and enable social interaction and cohesion. One such example is the Durban promenade; a publically accessible open space that stretches the length of the Durban inner city and enables the integration of people from varying socio-economic backgrounds. It provides a connection to various points along the city's coastline and its openness allows for constant public observation, creating a sense of security and ownership over the space. Unfortunately, the current urban environment prioritises the movement of cars into and around the city which segregates and hampers the promenade's, along with other public open spaces, ability to integrate the urban population. Therefore, it is imperative for the success of the Durban inner city to prioritise space in the city, the space between buildings, for pedestrians, and the same approach should be taken when determining how the building engages with its context and with people at street level. Space for social interaction and engagement should be prioritised whilst using the building to connect areas of biodiversity within the city. In the same breath, user comfort is of critical importance at all levels of the building. The building must be fully accessible to persons with disabilities and should maximise the use of natural daylight and ventilation. Harvesting natural resources like rain water and solar energy will improve the building's resource efficiencies whilst creating a healthy living and working environment for the users.

7.2.3.2 Economic Requirements

The building's primary function at ground level is as a waste sorting and distribution centre and aims to create a broad range of economic opportunities. Informal waste pickers already operate in the Durban inner city, gathering recyclable material that is then collected at various points throughout the city centre and transported to formal recycling centres. These informal, micro-entrepreneurs will be integrated into the design of the facility along with larger companies that deal in the buying and selling of recyclable material. At the same time, the centre will create jobs in the inner city whilst simultaneously performing waste management services for the municipality. Retail outlets and trading/workshop stalls will be further integrated at ground level to provide further economic opportunities along with potential rental income to the building. Further commercial and residential spaces above street level can provide rental income to the building whilst the flexibility and adaptability of the commercial spaces allows for a greater diversity of uses.

7.2.3.3 Environmental Requirements

As discussed previously, urban environments are some of the largest consumers of resources and energy as well as being the largest producers of carbon and other waste emissions. The building should therefore aim to reduce its carbon footprint by reducing waste and emissions, as well as reduce its ecological footprint by harnessing resources that are readily available such as rainwater harvesting and solar energy. The architecture should optimise passive design strategies (bioclimatic design) before depending on artificial systems and integrate ecological systems to improve building efficiencies. The integration of nature with the existing architecture fuses the inorganic aspects and processes of the urban environment and creates a symbiotic relationship between biodiversity and the built environment that extends beyond the ground plane and provides a positive increase in biomass through green façades, roof gardens and other planting. This increase in biodiversity in the building will not only provide the ecological systems that helps improve the building's resilience, but also enables a positive connection with nature for the user which in turn creates a healthier environment in which to live, work and socialise. Recycling of grey and black water, through a combination of technological and ecological systems, will reduce the building's dependency on the municipal supply, whilst the planting of indigenous plants and reed beds in the canal (Milne's Drain) will reduce the buildings fresh water demands whilst simultaneously assist in keeping the channel clean and control the flow of waste matter through the drain.

7.2.4 The Site and Site Restrictions

7.2.4.1 Description

The chosen site is located south-east of the ICC, roughly midway between the ICC and the Durban promenade. All site boundaries are defined by existing roads, three of which are one way, with an additional road separating the site into 2 distinct city blocks. The northern block (65 John Milne Road) is made up of three plots, all of which have been consolidated and currently accommodated a 2-storey facebrick and concrete/plaster light industrial building (Capricorn Parts). The southern block (38-40 Monty Naicker Road) is made up of five plots which have a single, multi-storey building consolidating all five plots and is currently being utilized as a VW dealership, service centre and parts and vehicle storage.

Figure 68: Existing buildings that make up the chosen site – A motor spares distributor (Capricorn Parts) and a VW dealership. (Source: Author)

7.2.4.2 Area

The chosen site is made up of 8 plots that are divided by South Lane, 3 to the north and 5 to the south. The total area of the sites is 3 993m² and the proposed building should in total be approximately 20 000m².

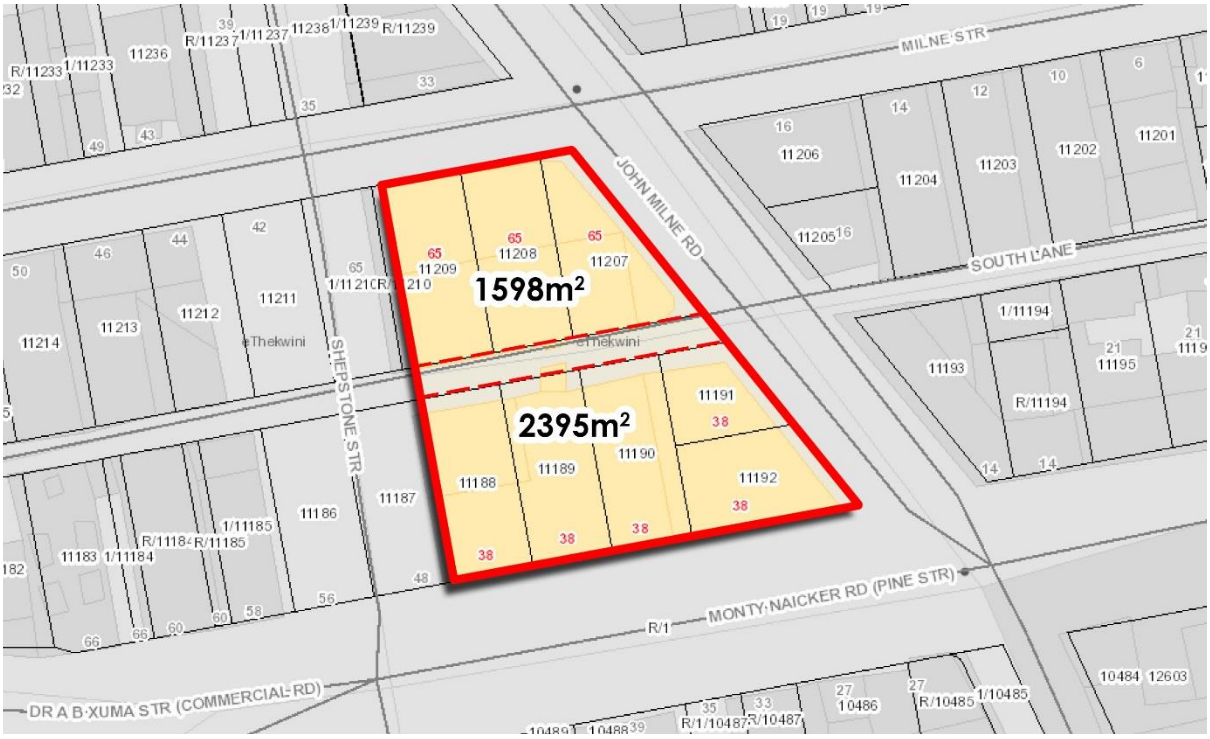


Figure 69: Area of the selected site. (Source: eThekwini GIS Maps & Author)

7.2.4.3 Zoning and Zoning Restrictions

The current zoning of the chosen site and its context is as "General Business" however, with the implementation of the Local Area Plan the future aim of the city is to create diverse, multi-functional buildings that facilitate the creation of mixed-use building typologies. For the purpose of this design, it is assumed that certain zoning restrictions such as building height, FAR, Coverage and parking will continue to apply and are as follows:

ADDITIONAL CONTROLS

- *Flat not permitted on the ground floor.
- ***Parkade:**
  1. Parking shall be read in conjunction with the Durban CBD Plan (see section 8.6 of this scheme);
  2. Within the area indicated on Figure CBD Durban, Parkade shall be permitted from the street indicated, subject to the following restriction:
     - the site shall have a minimum street frontage of 45.0m;
     - there shall be minimum spacing between access point of 45.0m; and
     - there shall be a maximum of 450 bays served by each access point.
     - Notwithstanding the provisions of Sub-section 8.5 within District B, bonus bulk shall be applicable and an amount representing not more than 20% of the total permissible floor area (PFA) shall not be taken into account where such amount is to be used for the parking of motor vehicles.

DEVELOPMENT PARAMETERS

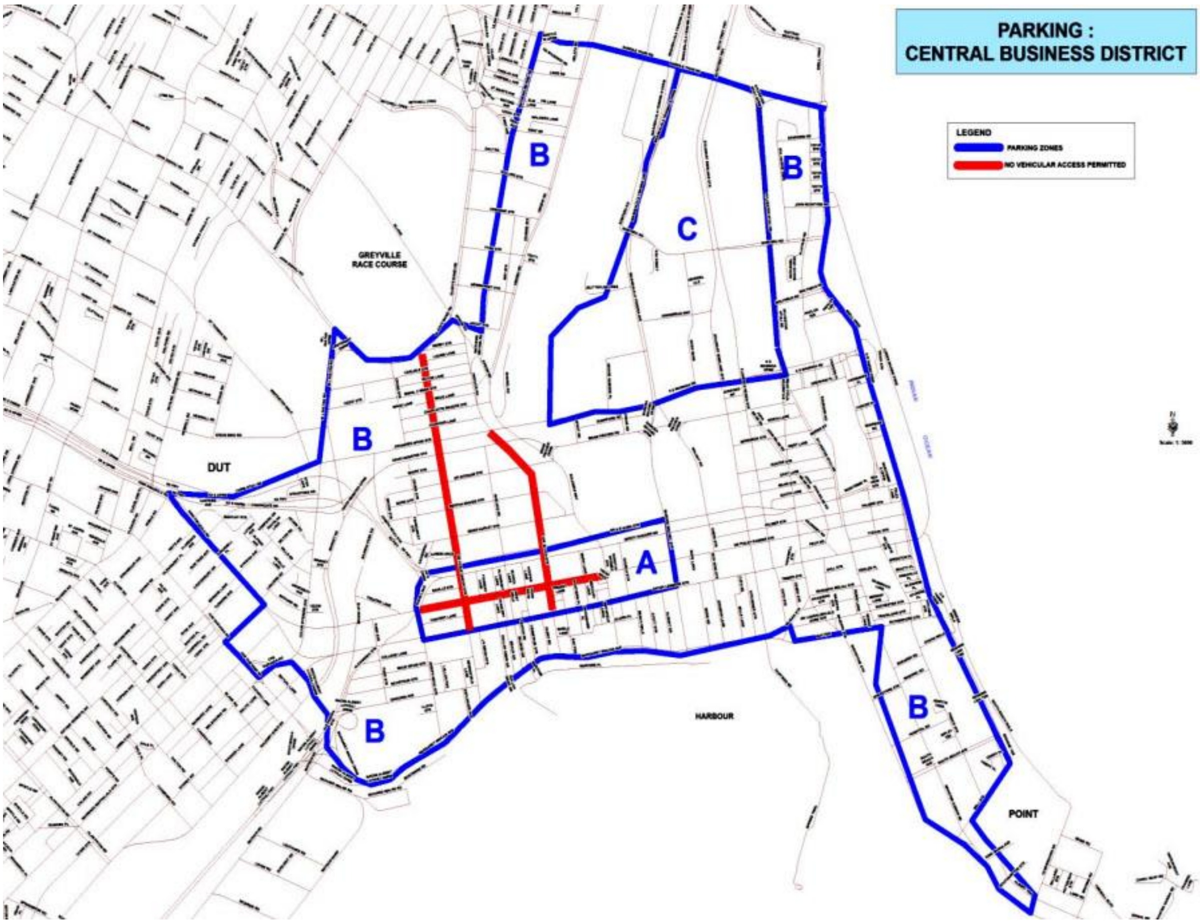
SPACE ABOUT BUILDINGS		DWELLING UNITS PER HECTARE	MINIMUM ERF SIZE (m^2)	MAXIMUM HEIGHT	COVERAGE	FLOOR AREA RATIO
BUILDING LINE	SIDE AND REAR SPACE					
Nil	Nil	N/A	240m^2	59° angle from opposite side of street (max. width 30m) or 110m with a 5.0m setback at 15.0m] (see section 5.3.2 of this scheme)	N/A	A maximum of 8.0 for the entire site, of which 4.0 may be used for residential purposes

ADDITIONAL CONTROLS – DEVELOPMENT PARAMETERS

- Except as specified in **Section 8.3,** in **Zones B and C** hereof, an amount representing not more than 20% of the total permissible floor area (PFA) shall not be taken into account where such amount is to be used for the parking of motor vehicles.

Figure 70: Town Planning Controls as defined for General Business zoning of the eThekwini Municipality Durban Scheme – Central Region. (Source: eThekwini Municipality)

As outlined in the town planning controls the chosen site falls within District B for parking requirements and as such the Central Scheme makes no allowance for minimum parking requirements within District B however, in order to improve the market viability of the proposal, some parking should be provided until such time as the municipality can reduce the reliance on private motor vehicles travelling into and out of the city, i.e.: walkable neighbourhoods



DISTRICT B	
1.	No minimum parking requirement within this district.
2.	When a proposal involves the provision of on-site parking, such parking provided, in terms of the number of bays provided, accessibility, and ingress / egress, shall be to the satisfaction of the Head: eThekwini Traffic Authority.
3.	Within this district, in General Business (Central), bonus bulk shall be applicable and an amount representing not more than 20% of the total PFA shall not be taken into account where such amount is to be used for the parking of motor vehicles.

Figure 71: Figure 1 from Section 8 of the eThekwini Municipality Durban Scheme – Central Region defining the 3 inner city districts and the an extract outlining the parking requirements of District B. (Source: eThekwini Municipality)

7.2.4.4 Existing Conditions and Features

As mentioned previously the selected sites are fully developed and occupied by two existing buildings. The northern building is a 2-storey facebrick and concrete/plaster and paint structure that houses a motor spares and distribution business. The architectural aesthetic is similar to other structures within the immediate context, which is made up of various other light industrial buildings, and holds certain historical significance as an example of the functional architecture dating from the Union Period (1910-61).

Figure 72: West elevation of the existing facebrick building on the three northern plots. (Source: Author)

Figure 73: North elevation of the existing facebrick building on the three northern plots. (Source: Author)

The southern building, the VW Durban dealership, is more utilitarian in nature, with only the showroom at ground level receiving particular attention to attract potential customers, whereas the remainder of the building is kept as low maintenance and functional as possible with the outer façade comprising of brick infill with grey plaster and paint and standard steel windows.

One of the notable features is the sky bridge that connects the two buildings over South Lane. This hints at the building's history, where previously both buildings served as a dealership and service centre for VW Beetles and vehicles were transported between the buildings via the bridge.

Figure 74: The existing sky bridge that links the two existing buildings. (Source: Author)

The ground floor around the buildings is characterised by wide verges, which are completely paved, however the space around the buildings is dominated by wide streets, three of which are one-way, and which signifies the priority that has been given to cars in the Durban inner city.

Figure 75: Image highlighting the roads that surround the chosen site, all of which are currently one-way, from busiest (red) to quietest (green). The blue line indicates the concrete cover over Milne's Drain. (Source: Author)

Perhaps though, one of the most noticeable features of the ground level is the concrete slab that cuts through the city at an angle to the conventional city grid. This slab is in fact a cover to Milne's Drain, a concrete channel that was built in the late 1850's to drain the eastern vlei, a natural ecosystem that managed the seasonal flooding of the Umgeni River as well as being a source of rich biodiversity.

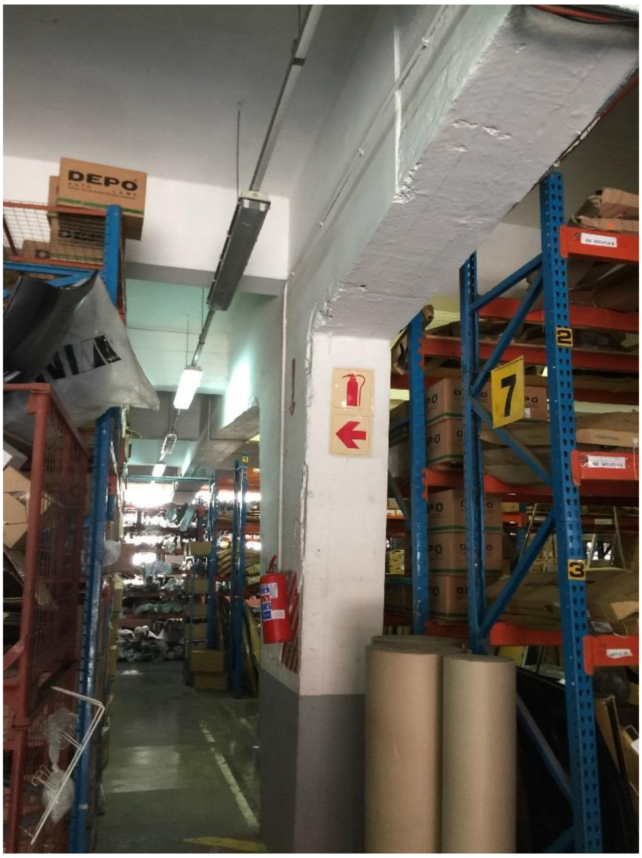
Figure 76: The existing concrete cover over Milne's Drain. (Source: Author)

7.2.5 Construction and Materials

Part of this study is to develop an approach for how to revitalise existing buildings in the Durban inner city and to determine the viability for the adaptive reuse of existing buildings to prolong their lifespan, to minimise the effect of construction on the environment and improve the environmental performance of existing building stock. Essentially, the intention is to play on the conceptual notion of a recycling centre being housed within a recycled building. The notion of Adaptive Reuse is a key architectural concept being adopted to realise the proposed architectural intervention, another of which is known as "Parasitic Architecture", which as will be described further, shows a contrast or change to the "host" architecture, which in this case is the existing buildings. As such, when considering the materials to be used in the new architecture, materials chosen aim to reflect this juxtaposition of the old fused with the new, which further plays on the fusion of biodiversity with the inorganic nature of the built environment. With that being said, the first step in the design process is to analyse the existing buildings and determine what elements should be retained in the new architecture and to what extent the building needs to be demolished in order to accommodate the new materials recovery facility along with the multi-functional mixed use typology.

7.2.5.1 Structure

The primary structure of both buildings is predominantly reinforced concrete columns and beams with conventional reinforced concrete slabs. As the buildings were originally intended to accommodate a motor dealership and service centre, the structural columns, beams and slabs are thicker than conventional systems and therefore should easily carry the load of additional elements, be it dead loads such as walls, slabs, planters and gardens (both vertical and horizontal), as well as the live load of people moving in and around the buildings.



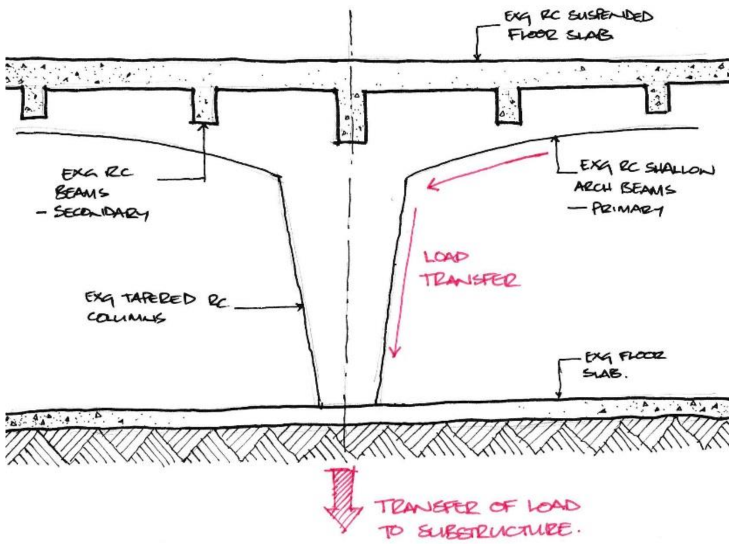


Figure 77 (Left): Existing structural columns, beams and slab. Figure 78 (Above): Sketch section of the existing structural system. (Source: Author)

7.2.5.2 Roof

The existing roofs to both existing buildings is made up of structural steel trusses covered with a decaying corrugated fibre cement sheeting. Considering the two buildings occupy the full extent of the chosen site, the run-off from these hard surfaces combined with the rest of the built environment places major strain on the urban infrastructure and poses a high risk of flash flooding. Additionally, the existing roofs offer very little thermal insulation and as a result it is difficult to maintain a comfortable building temperature during peak summer and winter periods.

Figure 79: Existing fibre cement roof of Capricorn Parts. (Source: Author)

One of the principle methods for improving urban resiliency, a target of the LAP and commitment of the eThekwini Municipality when they were included in the *100 Resilient Cities* movement, is to improve the city's ability to respond to and recover from adverse events, which includes flooding. Flooding in urban environments is often a major issue and is caused by the excess of hard surfaces created by roads, pavements and roof surfaces which often causes stormwater runoff that exceeds the capacity of the infrastructure. Particularly in Durban's case, the city has developed and all but eradicated the natural wetlands that enabled the environment to manage adverse weather events. A strategy to improve urban resiliency is to integrate planting onto the horizontal surfaces, in particular by developing roof gardens that help retain and manage stormwater runoff as well as provide thermal mass to insulate building interiors and create opportunities for urban farming, which in turn creates jobs and helps provide access to food for a growing urban population.

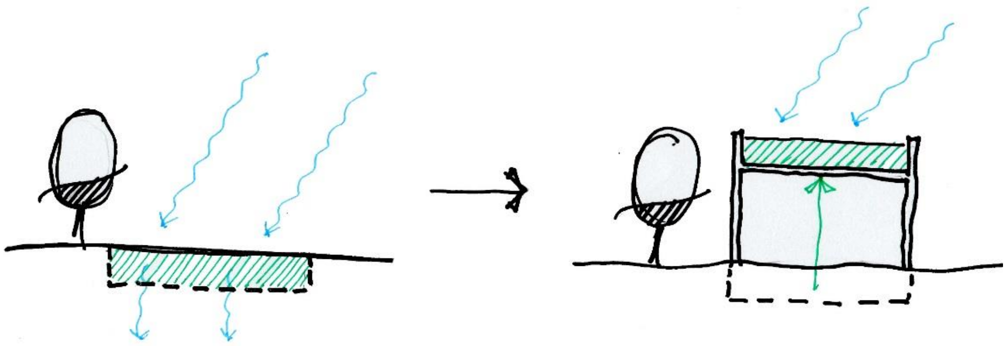


Figure 80: Sketch describing the concept that, ideally, a building's footprint should preserve the natural ground it covers by placing the same area of green space on its roof. (Source: Author)

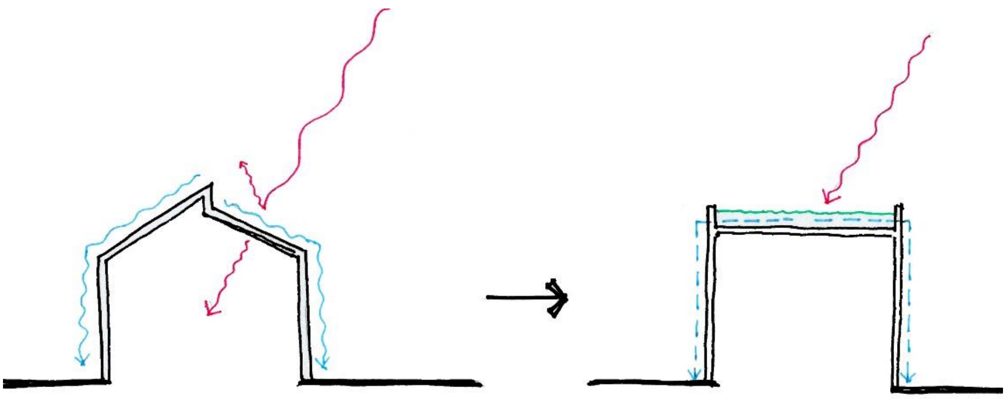


Figure 81: Sketch describing how roof gardens can reduce the rate of stormwater runoff, insulate the building interior as well as reduce reflected solar energy from roof surfaces which will reduce the "urban heat island" effect. (Source: Author)

7.2.5.3 Walls

As mentioned, the existing Capricorn Parts building is typically 'Durban style' in terms of its architectural aesthetic; the red facebrick combined with white plaster and paint portray a certain robustness suited to the light industrial nature of the precinct whilst providing some variety in the texture of the building envelope. By contrast the VW Durban building, up to 5 storeys of grey plaster and paint, is utilitarian in nature, probably due to budget constraints during the original construction, and not worth upcycling into the proposed adaptation of the two buildings.

Figure 82 (Above Left): Red facebrick and white plaster and paint. Figure 83 (Above Right): Grey plaster and paint. (Source: Author)

One of the eventual outcomes of the proposed design is to unify the buildings by incorporating a common architectural language, which is supported by the integration of common building materials. As the northern building (Capricorn Parts) holds some architectural significance to Durban's built environment, it is decided to retain certain sections of this external envelope and to integrate the red facebrick and white plaster and paint into the southern building to tie the two together. Additionally, incorporating off-shutter concrete, another traditional building material, to the external façades matches the robustness of the red facebrick as well as being a material that, because it can be cast and moulded into practically any form, symbolises the fusion between the natural and man-made environment.

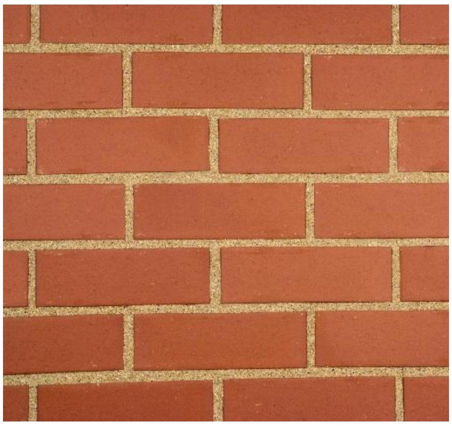


Figure 84 (Above Left): Corobrik 'Roan Satin' facebrick (Source: www.corobrik.co.za).
Figure 85 (Above Right): An example of off shutter concrete construction in the Galeria Lygia Pape, Brazil, cast in an organic geometric form. (Source: Leonardo Finotti)

In contrast, the "parasitic" architecture will be a juxtaposition of old and new materials, with the new comprising of predominantly steel, glass and timber. While steel and glass construction is seen as more modern, timber is a material that has utilised for centuries however, the application of timber in the proposed design, along with the steel and glass, will be much lighter than the heaviness of the brick and concrete, and the form will be far more organic in nature compared to the regularity of brick construction and the orthogonal grid of the existing buildings.

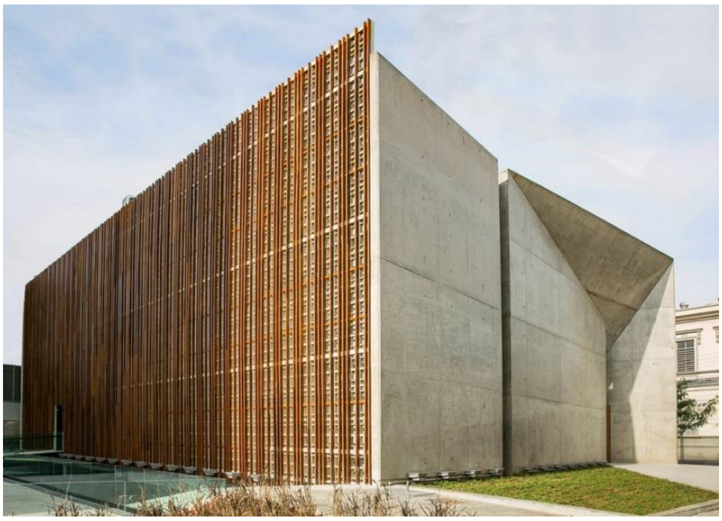
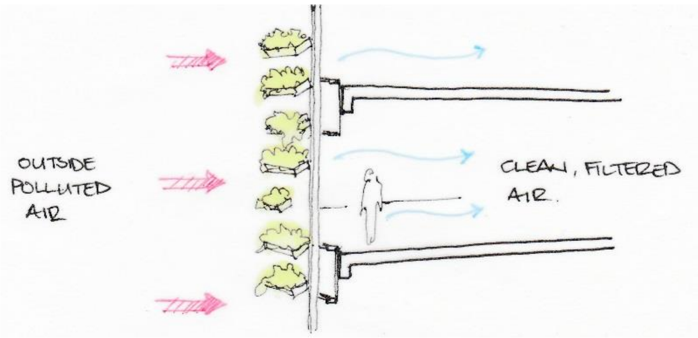


Figure 86 (Left): Facetted off shutter concrete walls in contrast with the light weight timber screen of the Espaço Cultural Porto Seguroto (Source: São Paulo Arquitetura).

Finally, a primary objective of the design is to integrate biodiversity as part of the building envelope, as well as utilising passive design elements to improve the building's efficiency. Vertical green walls, besides softening the 'hardness' of the building perform two fundamental tasks: firstly, they provide a vital connection to nature for the user within the built environment which, as mentioned, has a positive effect on the occupants' health and well being. Secondly, they can assist in cleaning carbon emissions out the air, improving the indoor air quality, as well as shading the building from solar radiation making it easier to control indoor air temperatures.



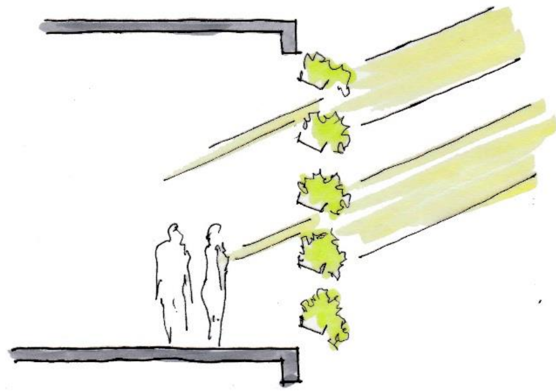


Figure 87 (Above Left) & Figure 88 (Above Right): Sketches indicating how a permeable green wall can filter air and sunlight (Source: Author).

7.2.5.4 Floors

The floors for this project will predominantly be made up of the existing slabs that are being reused with new surface finishes to suit the intended use of each area. Areas like the waste sorting centre and retail spaces should be treated with hard wearing and robust surfaces such as epoxy/cement screeds and public open spaces should ideally have a hard wearing surface that is permeable to prevent excess surface runoff, where rain water can drain through the surface and either drain into ground water or into a sub-soil drain (with the proximity to the coast the water table is in all likelihood quite high and the latter would be preferable).

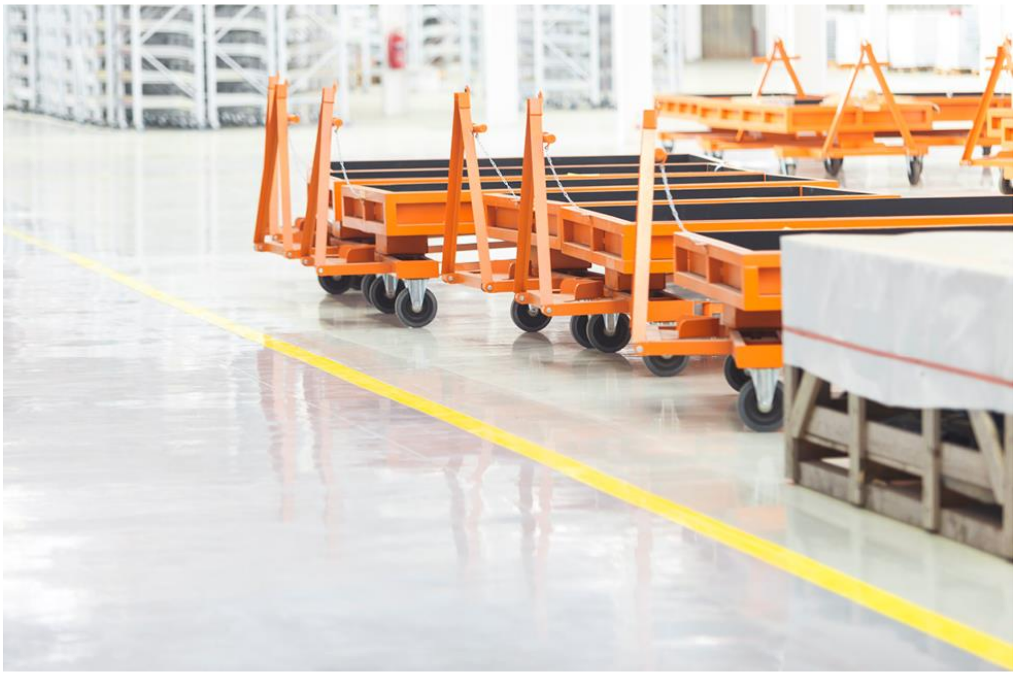


Figure 89: Industrial screed (Source: www.flowcretesa.co.za).

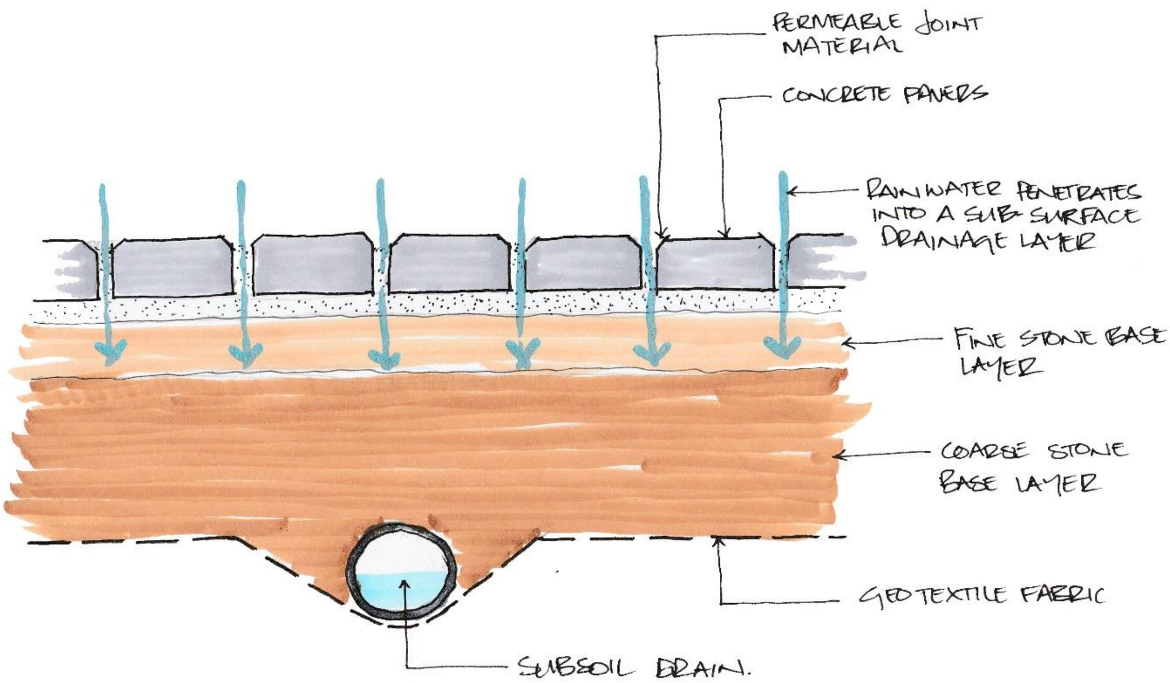


Figure 90: Sketch section of a permeable pavement system that controls surface runoff of rainwater (Source: Author).

The commercial and residential spaces, which encounter lower volumes of foot traffic, should offer warmer finish that is easy to maintain such as vinyl or carpet tiles. Common areas like lobbies and walkways should also receive a finish that is low maintenance and fairly robust such as floor tiles.



Figure 91 (Above Left): 600x600 floor tiles (Source: Author). Figure 92 (Above Centre): Carpet and Figure 93 (Above Right) vinyl floor finishes (Source: www.belgotexfloors.co.za).

The roof gardens at the upper levels will predominantly be built on new reinforced concrete slabs that are waterproofed and screeded to falls to allow for drainage of excess water and will have to accommodate the soil depth required to grow planting as well as an adequate drainage and root barrier system to prevent water penetrating the slab into the building below.

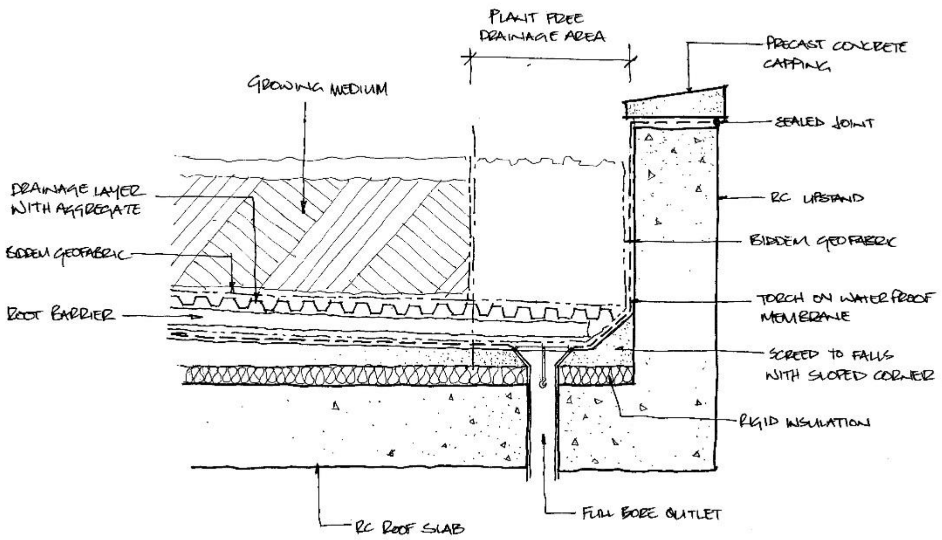


Figure 94: Sketch detail of flat roof garden layer works (Source: Author).

7.2.6 Design Objectives

The objectives for the proposed design are:

1. To integrate nature with the built environment and form connections between new and existing green spaces
2. To improve the building's efficiencies and reduce the carbon and ecological footprint
3. To provide space for social and economic interaction
4. To develop a multi-functional mixed use building
5. To determine how and where to upcycle the existing buildings
6. To create space for the user to connect with nature

7.3 The Brief

7.3.1 Building Functions

7.3.1.1 Primary

The building essentially has two primary functions: Firstly, as a materials buy back centre, where recyclable waste is delivered, sorted, prepared for transport and eventually collected to be taken to formal recycling centres to be processed and reused. This centre has certain spatial and operational requirements that need to be taken into account when developing the schedule of accommodation. Secondly, the building aims to connect existing and potential areas of biodiversity within the urban environment as well as provide a link to nature for the user. Integrating public, semi-public and private green spaces at multiple levels provide the meaningful connection with nature for the users whilst simultaneously ecological systems to improve building efficiencies.

7.3.1.2 Secondary

The secondary function of the building is as a mixed use development. Retail spaces are integrated with the public spaces of the ground floor and provides economic opportunities as well as rental income to the building. Commercial spaces accommodate businesses that are less reliant on passing foot traffic and also provides additional rental income. Residential units could offer either rental or sectional title options for people to live in the city, preferably for people who work in close proximity, eliminating the dependency on motor vehicle transport. All these functions need to be accessible, serviceable and be provided with the required amenities to function.

7.3.2 Concepts

The following section will identify architectural concepts that will be incorporated into the proposed design, and will aim to build on precedents that have been discussed previously.

7.3.2.1 Ecological Architecture

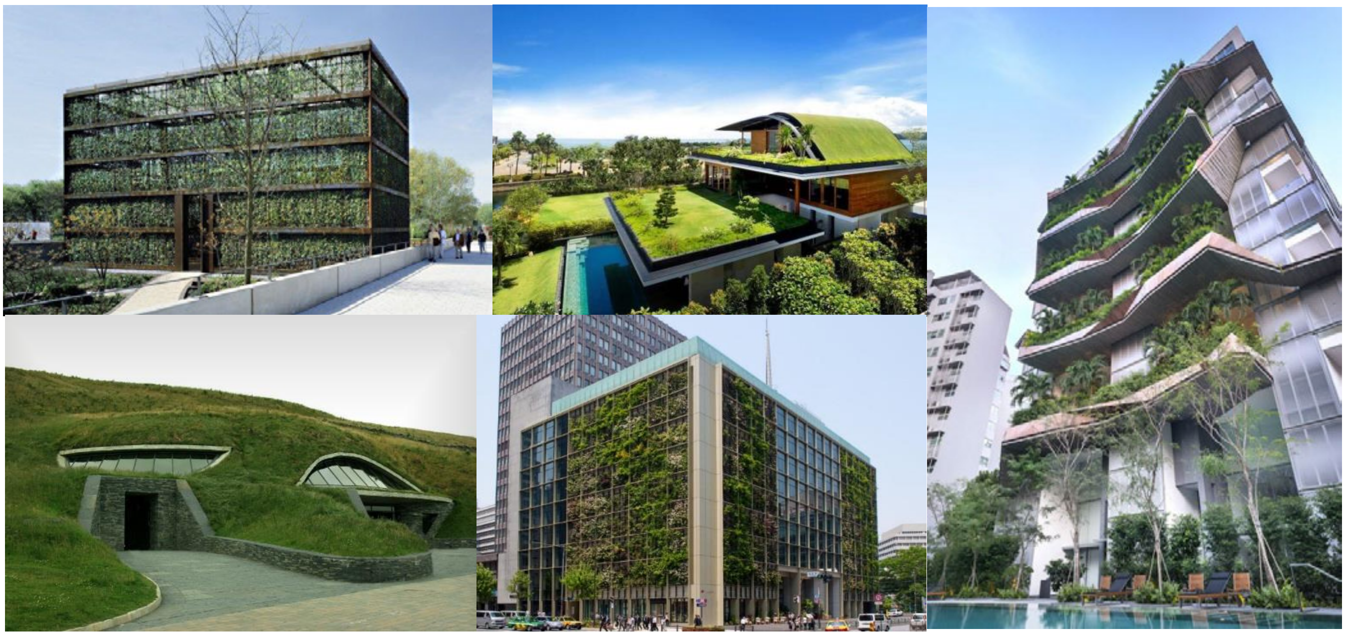


Figure 95: Various examples of successful Ecological Architecture (Source: Varying – refer to list of figures).

As discussed in Chapter 2, 'Ecological Architecture' is defined as "*a designed system that seeks to minimize and at the same time is responsive to the negative impacts that it has on the earth's ecosystems and resources*", and ultimately, at its core, it strives to achieve balance with the natural environment within the built environment. A more common term for Ecological Architecture is 'Green Architecture', though this terminology is often misinterpreted as a 'greenwash' of the built environment; the weak, aesthetic treatment of buildings by the simple addition of green elements and meeting the simple requirements of "green building councils", which in actuality falls short of the objectives of Ecological Architecture. Instead, Ecological Architecture aims to achieve environmental responsiveness, resource efficiency, community and cultural sensitivity and healthy, non-polluting environments, as well as provides additional benefits to the built environment and building owners and occupants such as reduced operating costs for both the built environment and surrounding landscapes, better health and therefore improved productivity for building occupants, increased occupancy rates, higher property values due to the improved aesthetic appeal and building performance, lower ecological impact and subsequently a sustainable form of development

7.3.2.2 Adaptive Reuse

Figure 96: Various examples of successful Adaptive Reuse Architecture (Source: ArchDaily).

Adaptive Reuse is one of the core concepts being used to implement the propose design as it aims to upcycle the existing built environment and reduce the strain of demolition and re-building, which generates high volumes of building rubble and has increased resource and transportation requirements. Defined as "a process that changes a disused or ineffective item into a new item that can be used for a different purpose", the intention is to rehabilitate a built environment left behind by changing social and economic forces. In the case of the chosen site and its immediate context, most buildings are still a single occupancy, and unless the precinct is revitalised and given multi-functional capabilities, it will continue to be left behind and fall deeper into disrepair. A further parameter that supports the Adaptive Reuse concept is, by preserving the urban fabric, the identity and memory of a place is preserved as well. In dense urban environments architecture and symbolism become methods of way finding and identification, and by reusing the architecture there is a preservation of the city's identity. Historically, the adaptive reuse concept has been economically driven without any regard for the history of character of the space however, in more modern times it is seen as a strategy to preserve buildings of historical significance whilst accommodating the modern functions the new city requires.

7.3.2.3 Parasitic Architecture

Figure 97: Various examples of successful Parasitic Architecture (Source: www.dezeen.com).

"Parasitic architecture can be defined as an adaptable, transient and exploitive form of architecture that forces relationships with host buildings in order to complete themselves. Parasites cannot sustain their own existence without siphoning energy from the surplus supply demonstrated in host buildings"

- (http://parasitic-architecture.webs.com)

Although there is no clear definition to what constitutes "Parasitic Architecture", the theory behind the concept is, to put it simply, *"an organism which lives in or on another organism (its host) and benefits by deriving nutrients at the other's expense"* (Oxford Dictionary). In the case of the chosen buildings, it is proposed that both buildings are upcycled and converted from spaces that have for years prioritised the needs of cars, a fundamental flaw of the broader Durban inner city, and transfer priority for space within the city to the users. For the proposed design, the waste sorting and distribution centre is the primary function of the building, symbolising the "urban wetland" however, there is surplus space to what the waste centre requires and as such the surplus is adapted further to multi-functional mixed use and social space, allowing people and nature to benefit alongside the regular day-to-day functioning of the building.

7.3.3 Schedule of Accommodation

STOREY	ROOM	AREA (m²)
Sub-Surface	**Water Storage and Treatment**	
	Water Reservoir	500
	Grey Water Treatment	100
	Black Water Treatment	100
	Subtotal	**700**
Ground	**Waste Sorting and Buy Back Centre**	
	Deliveries and Weigh Stations [Formal]	170
	Material Skips	112
	Material Storage	7
	Bin & Bin Wash Area	18
	Deliveries and Weigh Stations [Informal]	8
	Security	10
	Material Sorting Line	180
	Waste Baling Area	560
	Staging Area	84
	Loading Bays (3no)	120
	Ablutions	72
	Kitchenette & Canteen Area	35
	Storage	10
	Services	35
	Display Area	40
	Entrance Lobby	48
	Operations	20
	Circulation (min 1.5m aisles)	200
	Subtotal	**1729**
	Public Areas	
	Retail/Trader/Workshop Areas	1400
	Public Open Space [Landscaped]	+/- 2500
	Entrance Lobbies	80
	Subtotal	**3980**
First	**Waste Sorting and Buy Back Centre**	
	Reception	15
	General Open Plan Offices	130
	Individual Offices	80
	Boardroom	60
	Store	15
	Breakout Areas	100
	Display/Exhibition Space	200
	Conference Centre	400
	Toilets	40
	Balconies	50
	Subtotal	**1090**
	Parking	
	Parking and Circulation Area	1300
	Planters	500

	Subtotal	**1800**
Second	**Rooftop Area**	
	Restaurant	250
	Kitchen	75
	Bar	50
	Store (Cold, Freezer and Dry)	25
	Office	5
	Toilets	20
	Garden	1000
	Store	30
	Lobby	40
	Subtotal	**1495**
	Commercial	
	Office Spaces	750
	Toilets	22
	Lobby	40
	Reception	10
	Balconies and Planters	50
	Subtotal	**872**
	Residential	
	Lobby	40
	Atrium Space	60
	Residential Units	375
	Services	20
	Subtotal	**495**
Third	**Commercial**	
	Office Spaces	500
	Toilets	22
	Lobby	40
	Reception	10
	Roof Garden, Balconies and Planters	300
	Subtotal	**872**
	Residential	
	Lobby	40
	Atrium Space	60
	Residential Units	375
	Services	20
	Subtotal	**495**
Fourth	**Residential**	
	Lobby	40
	Atrium Space	60
	Residential Units	375
	Services	20
	Roof Garden	500
	Subtotal	**995**
Fifth	**Residential**	
	Lobby	40
	Atrium Space	60
	Residential Units	375
	Services	20
	Subtotal	**495**
	TOTAL	**15018**

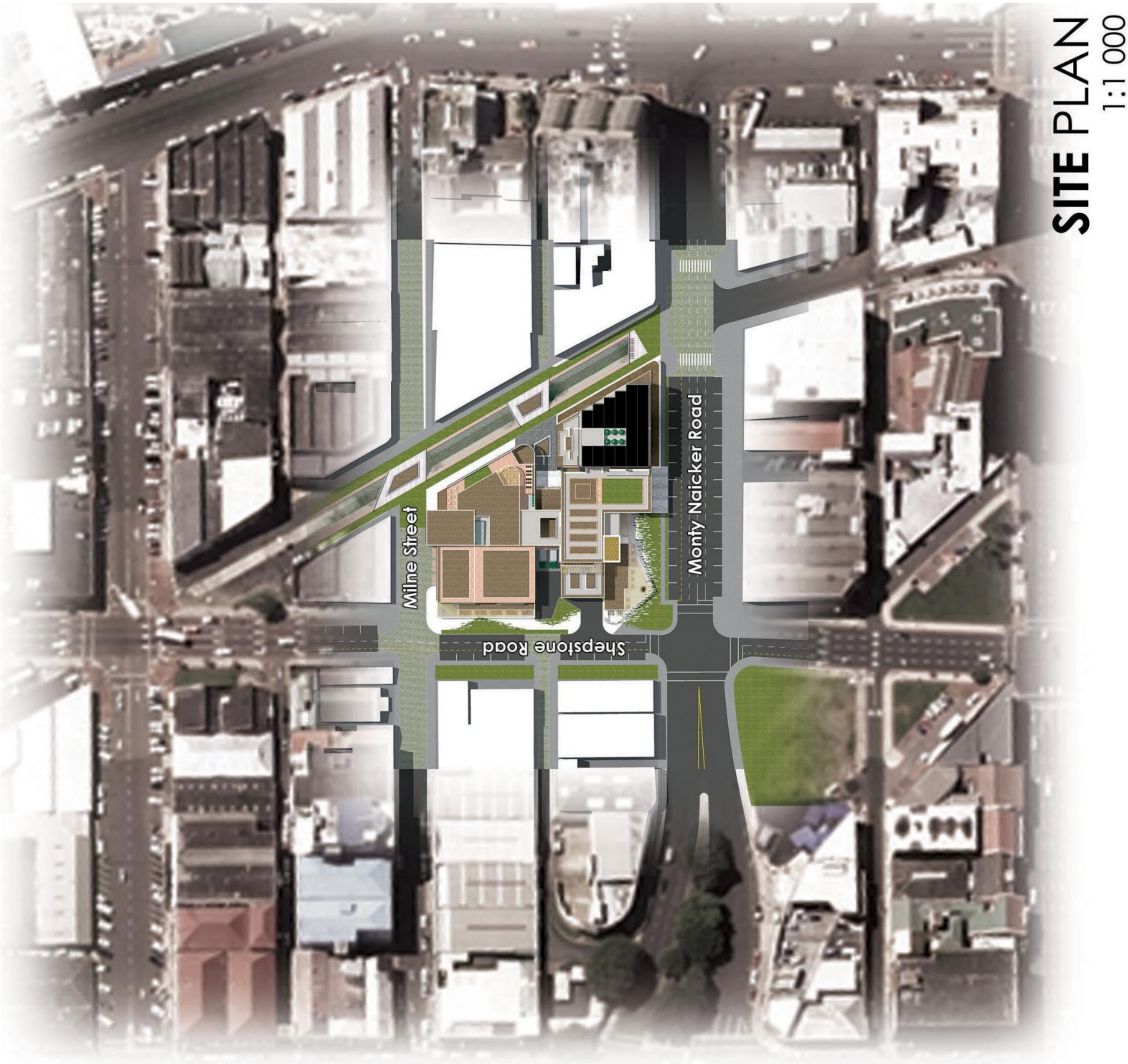
CHAPTER 8: Architectural Design Drawings

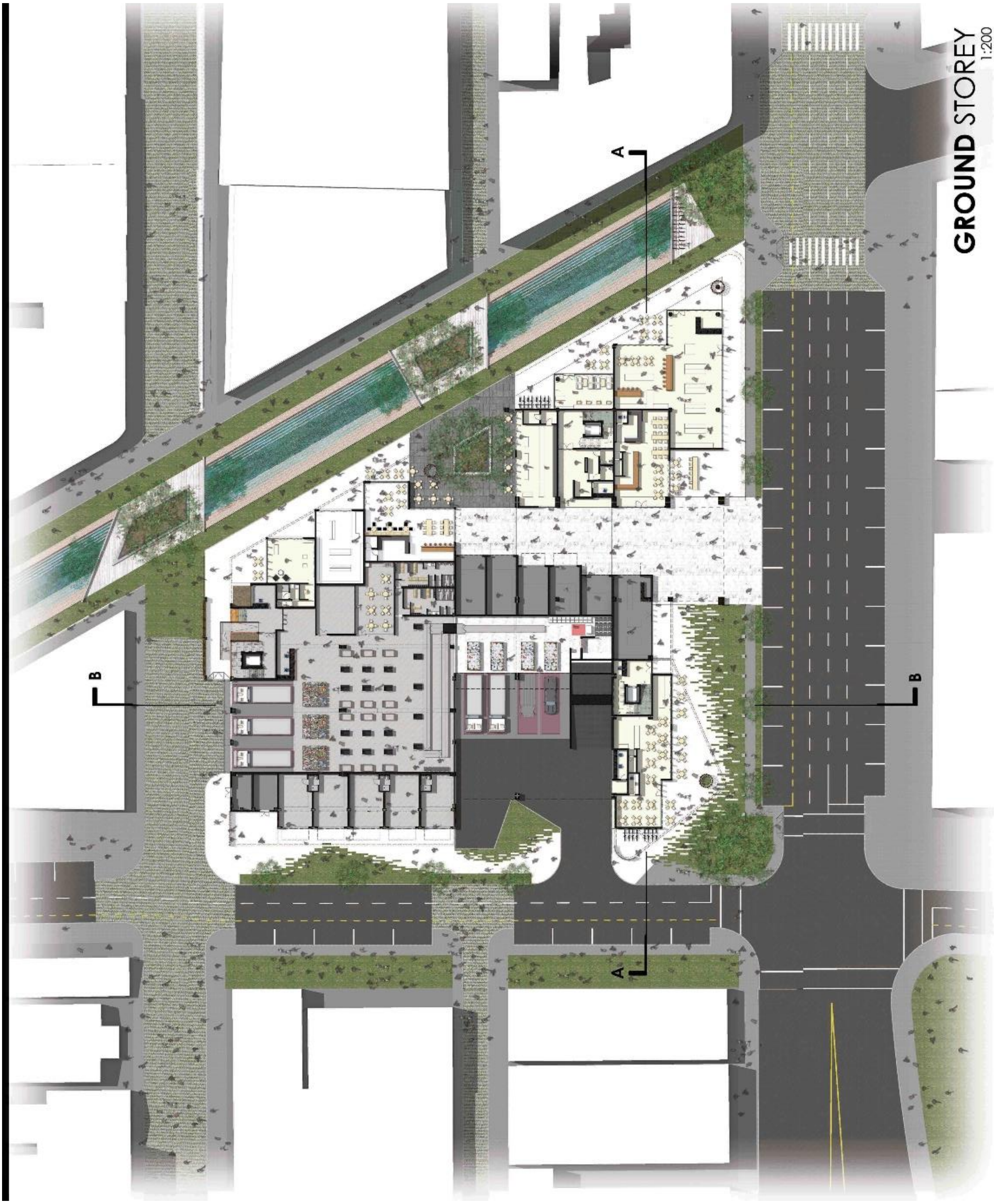
8.1 Introduction

The following pages document the architectural design drawings of the proposed model for an ecologically sensitive mixed-use architecture as well as the technical resolution thereof. It must be noted that all drawings have been scaled to fit the document, and as such scale has not been preserved. For accurate representation please refer to the printed architectural design drawings.

8.2 Design Drawings

Figure 98: Artists impression of the proposed intervention with inset of the existing building (Source: Author)

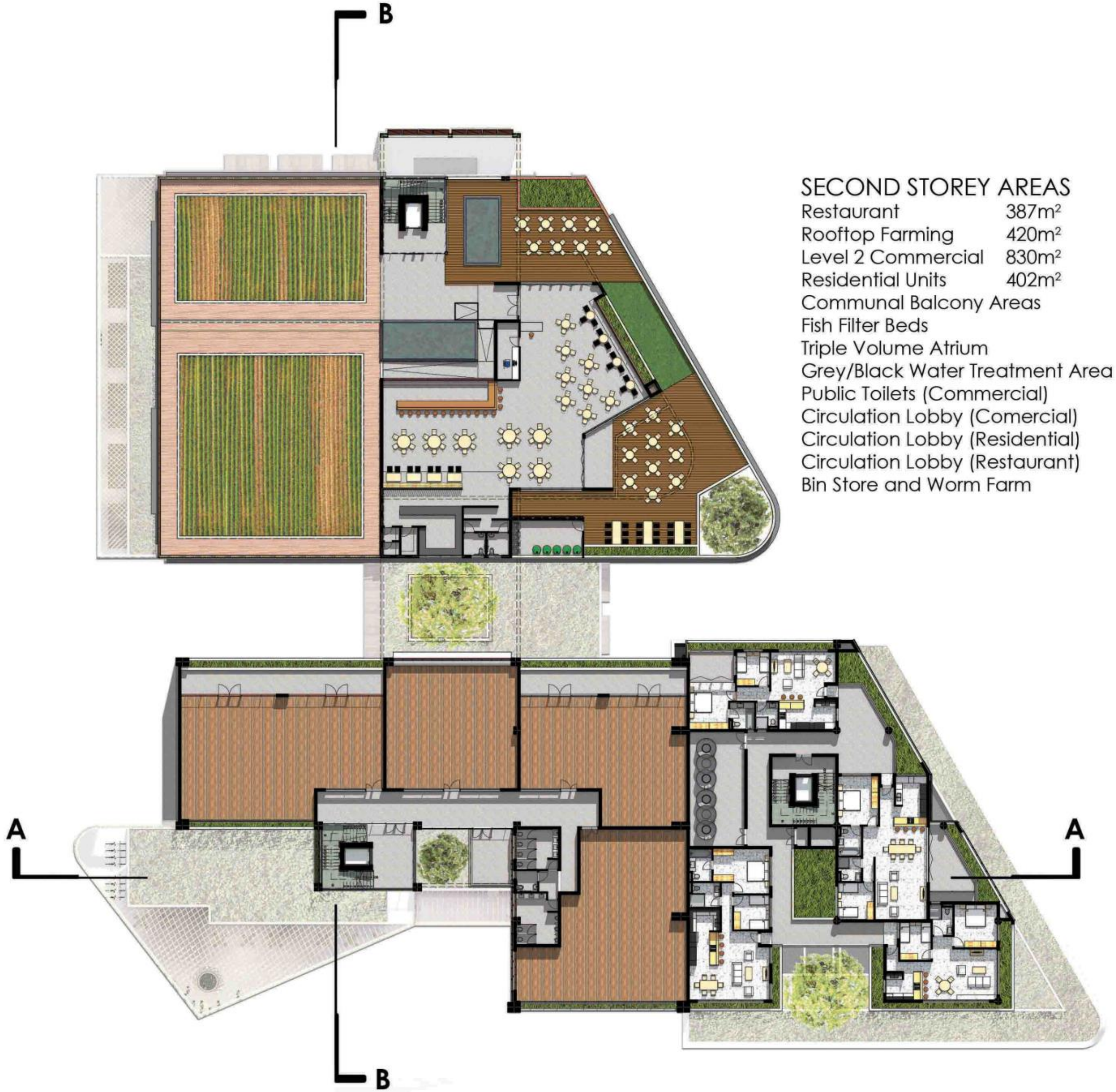

SITE PLAN
1:1 000
Milne Street
Monty Naicker Road
Shepstone Road


GROUND STOREY
1:200
A
A
B
B

FIRST STOREY
1:200

SECOND STOREY AREAS

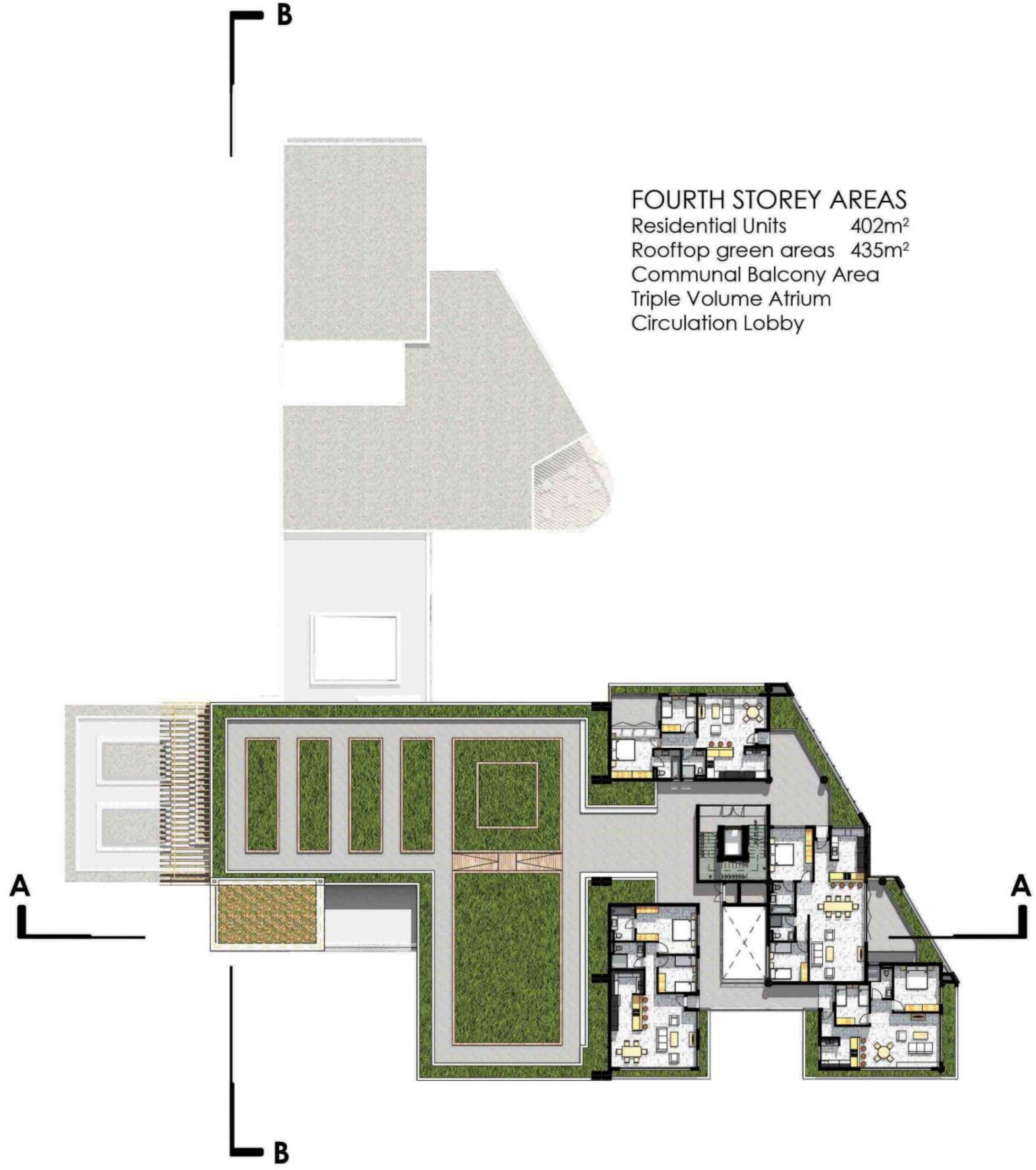
Restaurant	387m²
Rooftop Farming	420m²
Level 2 Commercial	830m²
Residential Units	402m²
Communal Balcony Areas	
Fish Filter Beds	
Triple Volume Atrium	
Grey/Black Water Treatment Area	
Public Toilets (Commercial)	
Circulation Lobby (Comercial)	
Circulation Lobby (Residential)	
Circulation Lobby (Restaurant)	
Bin Store and Worm Farm	



SECOND STOREY
1:200

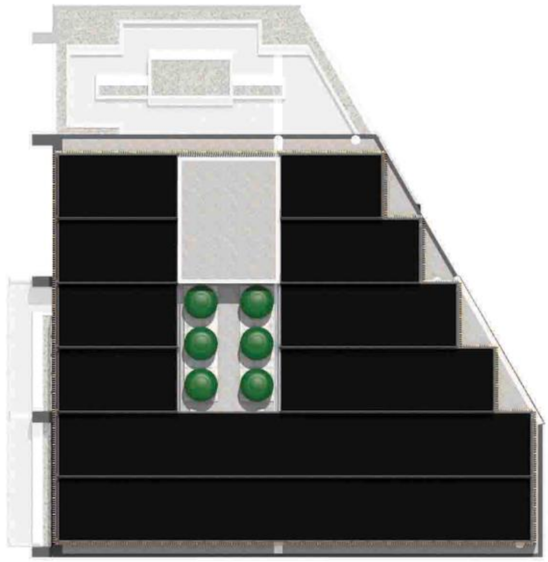
THIRD STOREY AREAS
Residential Units 402m²
Level 3 Commercial 500m²
Landscaped Roof Garden
Communal Balcony (Commercial)
Communal Balcony (Residential)
Triple Volume Atrium
Grey/Black Water Treatment Area
Public Toilets (Commercial)
Circulation Lobby (Commercial)
Circulation Lobby (Residential)

THIRD STOREY
1:200



FOURTH STOREY AREAS
Residential Units 402m²
Rooftop green areas 435m²
Communal Balcony Area
Triple Volume Atrium
Circulation Lobby

FOURTH STOREY
1:200



ROOF PLAN
Solar Panel Array
Storage Tanks

FIFTH STOREY AREAS
Residential Units 304m²
Communal Balcony Area
Triple Volume Atrium
Circulation Lobby

ROOF PLAN
1:200

FIFTH STOREY
1:200

NORTH ELEVATION - MILNE ROAD 1:200

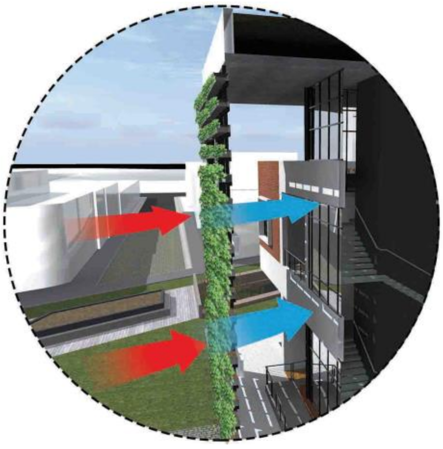
NORTH ELEVATION - SOUTH LANE 1:200

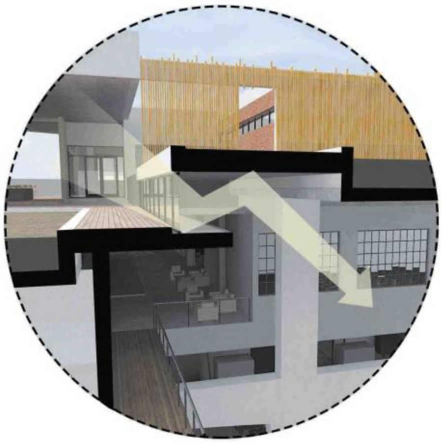
SOUTH ELEVATION - MONTY NAICKER ROAD 1:200

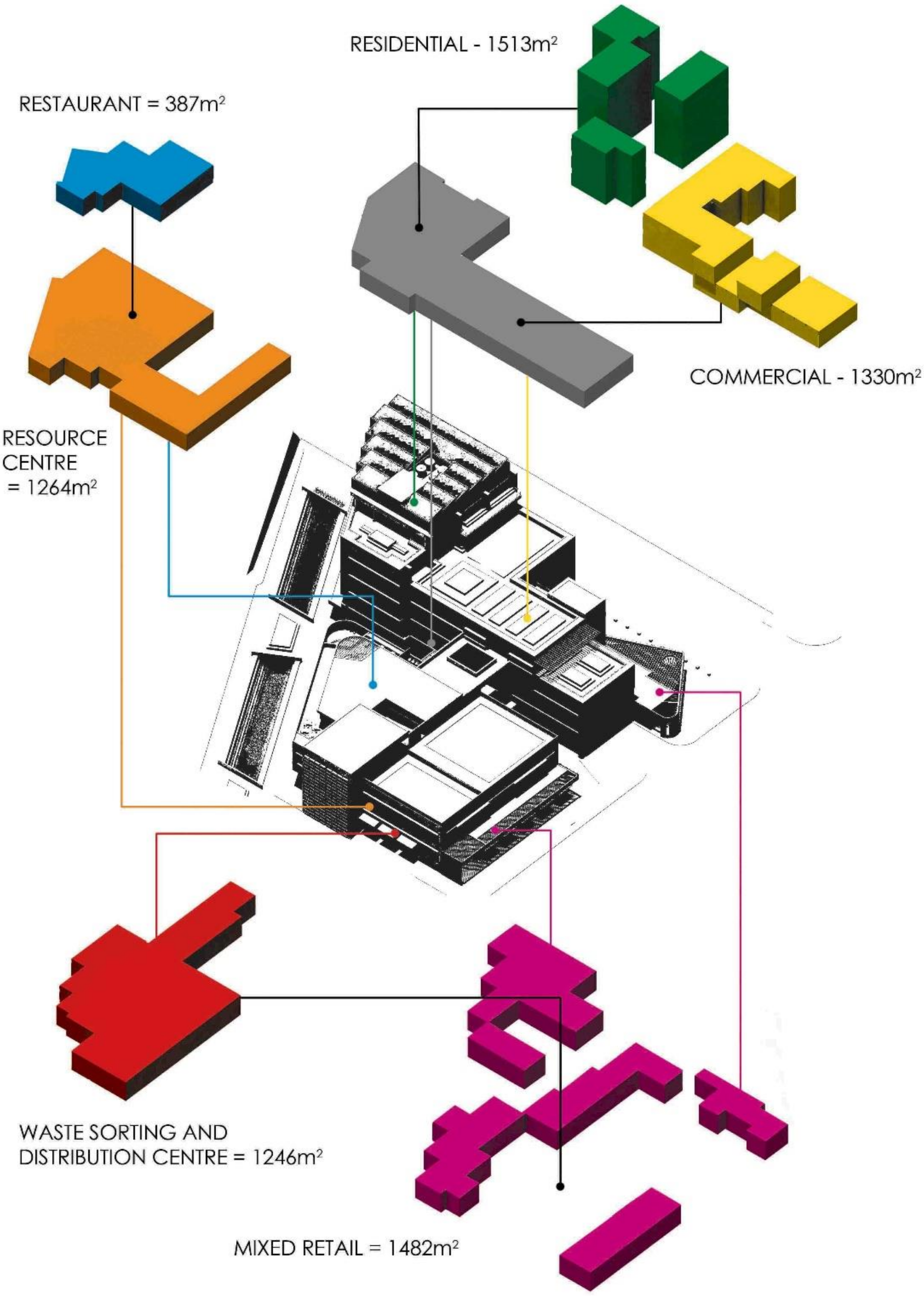
NORTH-EAST ELEVATION - JOHN MILNE ROAD 1:200

SECTION A - A 1:100

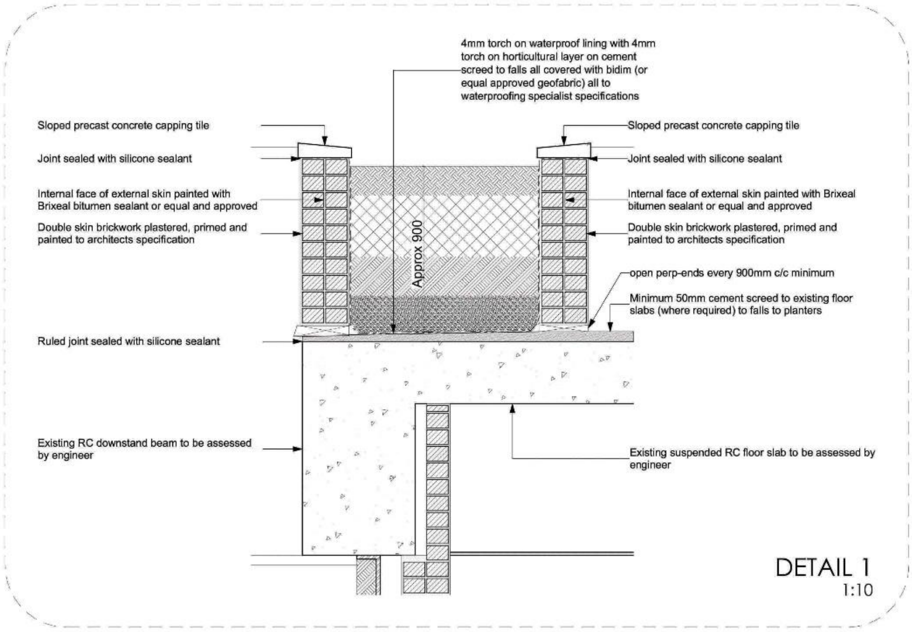
SECTION B - B 1:100

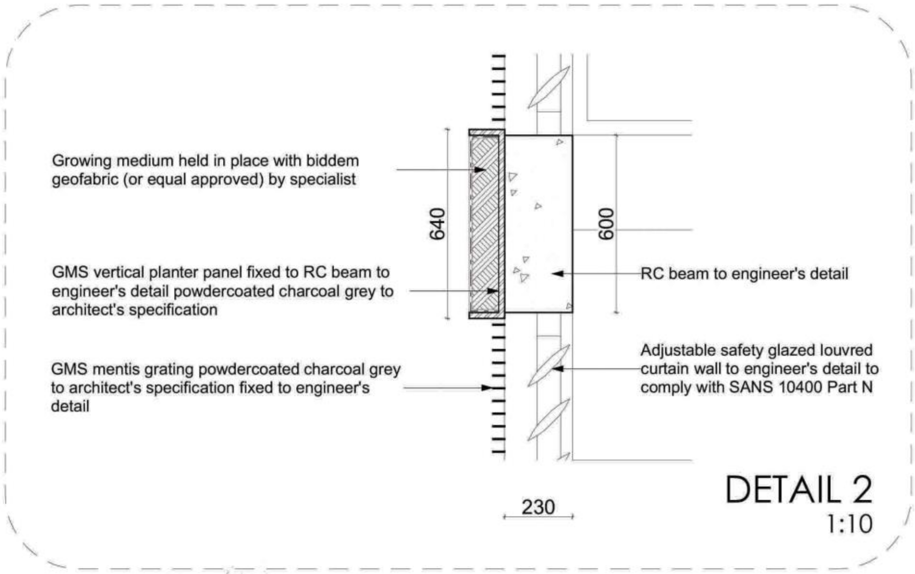


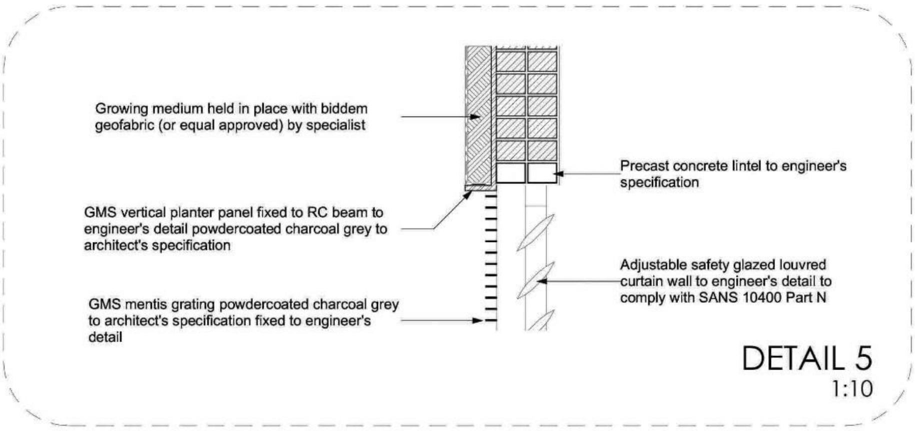


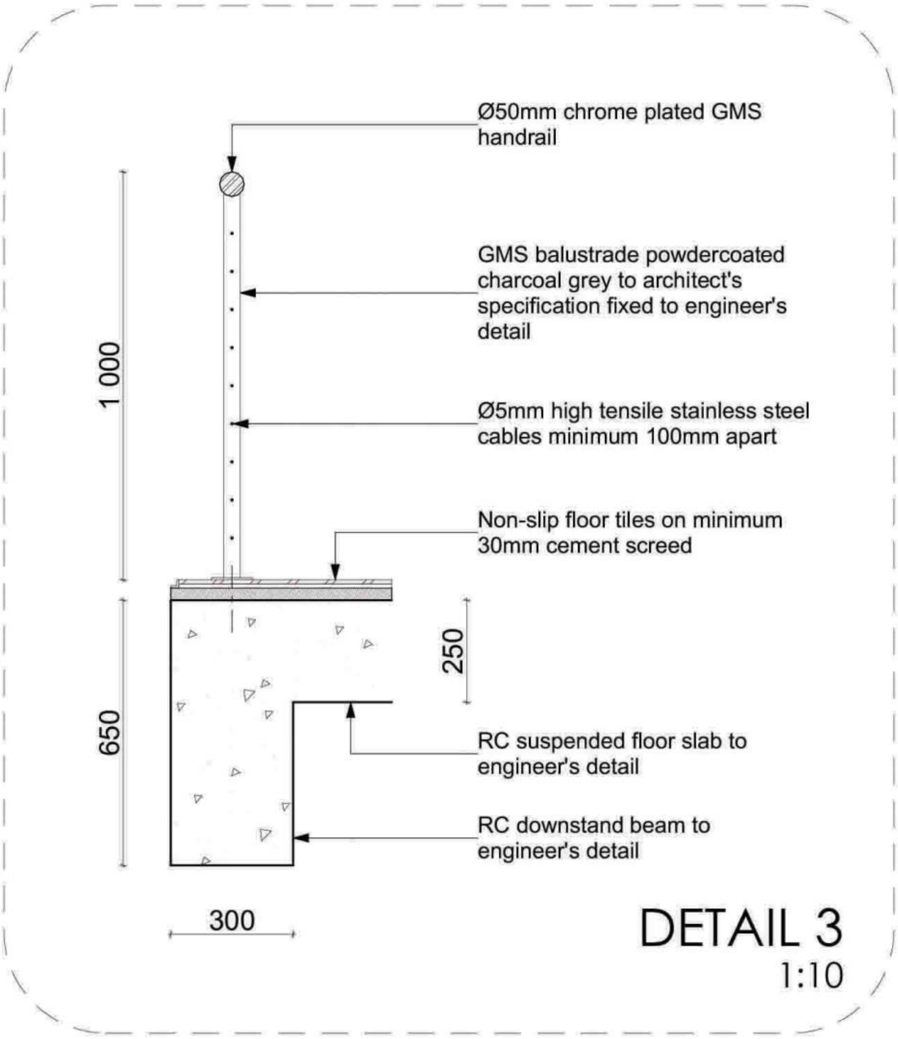

RESIDENTIAL - 1513m²
RESTAURANT = 387m²
COMMERCIAL - 1330m²
RESOURCE CENTRE = 1264m²
WASTE SORTING AND DISTRIBUTION CENTRE = 1246m²
MIXED RETAIL = 1482m²

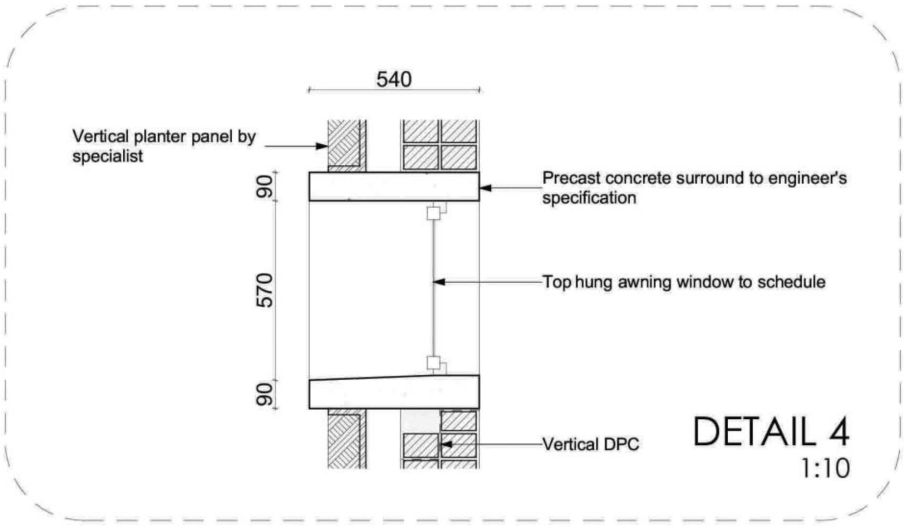
STRIP SECTION
1:25
RC concrete beam to engineer's detail skimmed, primed and painted to architect's specification
Precast concrete lintel to engineer's specification
RC lift shaft to engineer's detail
Adjustable safety glazed louvred curtain wall to engineer's detail to comply with SANS 10400 Part N
RC beam to engineer's detail
Steel members grate structure to support vertical green wall to engineer's detail
Edge planter - refer to Detail 1
RC concrete beam to engineer's detail skimmed, primed and painted to architect's specification
RC window surrounds to engineer's detail
Vertical planter panels by specialist fixed to masonry walls to engineer's detail
Aluminium louvres powdercoated charcoal grey to architect's specification
Safety glazed curtain wall glazing to comply with SANS 10400 Part N to engineer's detail with aluminium frame powdercoated charcoal grey to architect's specification
Suspended RC floor slab to engineer's detail
RC downstand beam to engineer's detail
1m high steel balustrade by specialist powdercoated charcoal grey to architect's specification
Exg suspended RC floor slab to be assessed by engineer with no 50mm self levelling epoxy floor screed
RC stair with 26 Risers @ 170mm 25 Treads @ 350mm and 1m handrail all to engineer's detail
RC stair with 26 Risers @ 172mm 25 Treads @ 350mm and 1m handrail all to engineer's detail


4mm torch on waterproof lining with 4mm torch on horticultural layer on cement screed to falls all covered with bidim (or equal approved geofabric) all to waterproofing specialist specifications
Sloped precast concrete capping tile
Joint sealed with silicone sealant
Internal face of external skin painted with Brixeal bitumen sealant or equal and approved
Double skin brickwork plastered, primed and painted to architects specification
Approx 900
Sloped precast concrete capping tile
Joint sealed with silicone sealant
Internal face of external skin painted with Brixeal bitumen sealant or equal and approved
Double skin brickwork plastered, primed and painted to architects specification
open perp-ends every 900mm c/c minimum
Minimum 50mm cement screed to existing floor slabs (where required) to falls to planters
Ruled joint sealed with silicone sealant
Existing RC downstand beam to be assessed by engineer
Existing suspended RC floor slab to be assessed by engineer
DETAIL 1
1:10


Growing medium held in place with biddem geofabric (or equal approved) by specialist
640
600
GMS vertical planter panel fixed to RC beam to engineer's detail powdercoated charcoal grey to architect's specification
RC beam to engineer's detail
GMS mentis grating powdercoated charcoal grey to architect's specification fixed to engineer's detail
Adjustable safety glazed louvred curtain wall to engineer's detail to comply with SANS 10400 Part N
230
DETAIL 2
1:10


Growing medium held in place with biddem geofabric (or equal approved) by specialist
Precast concrete lintel to engineer's specification
GMS vertical planter panel fixed to RC beam to engineer's detail powdercoated charcoal grey to architect's specification
Adjustable safety glazed louvred curtain wall to engineer's detail to comply with SANS 10400 Part N
GMS mentis grating powdercoated charcoal grey to architect's specification fixed to engineer's detail
DETAIL 5
1:10


Ø50mm chrome plated GMS handrail
GMS balustrade powdercoated charcoal grey to architect's specification fixed to engineer's detail
Ø5mm high tensile stainless steel cables minimum 100mm apart
Non-slip floor tiles on minimum 30mm cement screed
RC suspended floor slab to engineer's detail
RC downstand beam to engineer's detail
1 000
650
250
300
DETAIL 3
1:10


540
Vertical planter panel by specialist
Precast concrete surround to engineer's specification
Top hung awning window to schedule
Vertical DPC
90
570
90
DETAIL 4
1:10

LIST OF FIGURES

Figure 9: Description of the Ecological footprint of urban environments. Source: Seminar 6 on Sustainable Cities by Catherine Sutherland, 04 November 2016

Figure 10-12: Graphs of the ecological footprints of various different countries Source: Seminar 3 on Ecological Modernisation and Sustainable Development by Catherine Sutherland, 05 October 2016

Figure 13: Air pollution due to industrial processes (Photograph) Available online at: http://www.borgenmagazine.com/5-worst-cities-air-pollution/ (Accessed 22 October 2017)

Figure 14: Ecological Modernisation description (Graphic) (Source: Author)

Figure 15: Graphic description of the closed loop, cyclical, "transformative" system, placing a growing economy within a finite ecosystem, representing strong sustainable development. (Source: Author)

Figure 16: Rendering of integrated biodiversity of WOHA Architects' Park Royal Hotel in Singapore (Image) Available online at: https://inhabitat.com/park-royal-tower-wohas-stunning-vertical-urban-park-opens-in-singapore/parkroyal-singapore-woha-architects-9 (Accessed 22 October 2017)

Figure 17: Artist's impression of EDITT Tower by Ken Yeang (Image) Available online at: https://urban.melbourne/sustainability-environment/2013/08/05/top-5-ken-yeang-green-designs-wed-love-to-see-in-melbourne courtesy of inhabitat.com (Accessed 22 October 2017)

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Figure 20 & 21: The Sino-Italian Ecological and Energy Efficient Building (SIEEB) Source: Yang W (ed), 2012. Green Architecture. Liaoning Science & Technology Publishing House. Shenyang, Liaoning, China

Figure 22 & 23: SIEEB Locality plan (Source: Google Maps and Author)

Figure 24: Sketches of solar shading elements. Source: Yang W (ed), 2012. Green Architecture. Liaoning Science & Technology Publishing House. Shenyang, Liaoning, China

Figure 25 & 26: Detail sections of solar shading elements. Source: Yang W (ed), 2012. Green Architecture. Liaoning Science & Technology Publishing House. Shenyang, Liaoning, China

Figure 27: Foliage growing over solar screens. (Photograph) Source: Yang W (ed), 2012. Green Architecture. Liaoning Science & Technology Publishing House. Shenyang, Liaoning, China

Figure 28 & 29: Sketch sections. (Sketch) Source: Yang W (ed), 2012. Green Architecture. Liaoning Science & Technology Publishing House. Shenyang, Liaoning, China

Figure 30: Typical SIEEB floor plan. Source: Yang W (ed), 2012. Green Architecture. Liaoning Science & Technology Publishing House. Shenyang, Liaoning, China

Figure 31 & 32: Biodiversity integrated with architecture. (Photograph) Source: Yang W (ed), 2012. Green Architecture. Liaoning Science & Technology Publishing House. Shenyang, Liaoning, China

Figure 33: The Edith Green – Wendell Wyatt Building. (Photograph) Source: SERA Architects & Cutler Anderson Architects, Photograph by Nic Lehoux

Figure 34 & 35: Before and after photos of the west façade. (Photograph) Source: SERA Architects & Cutler Anderson Architects, Photograph by Nic Lehoux

Figure 36-38: Images of the internal and external views of planting. (Photograph) Source: SERA Architects & Cutler Anderson Architects, Photograph by Nic Lehoux