

A proposed Green Planning Development framework: Integration of spatial planning and green infrastructure planning approaches

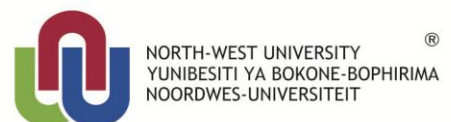
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It all starts here TM



PREFACE

Gratitude should be given to the persons who aided in the research conducted:

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ABSTRACT

Throughout human history, civilizations have impaired their own chances of survival by damaging their own environment as they did not follow sustainable practises (Diamond, 2005). For over 40 years humankind's demand on nature has exceeded what the earth can replenish (World Wildlife Fund *et al.*, 2014:10). Recent research suggests that humanity uses 40% more resources every year than what is placed back by nature, as trees are cut faster than they mature, more fish are harvested than what oceans replenish and more carbon is emitted into the atmosphere faster than forests and oceans can absorb (Lorek and Fuchs, 2011:2). The earth's finite resources, along with the provision of ecosystem services that are linked to the well-being of humanity and human settlements (Cilliers *et al.*, 2013: 1; TEEB, 2011:1) are now considered an integral part of spatial planning approaches.

The challenge, however, lies in successfully integrating and aligning green infrastructure planning as part of mainstream spatial planning approaches. This research presented a point of departure for such integration by creating and proposing a Green Planning Development Framework to guide the integration of spatial planning and green infrastructure planning. Such framework was based on (1) a literature study encompassing research on sustainability and sustainable development; green infrastructure planning; relevant international and national policies and legislation, and current frameworks and performance indices; (2) an empirical investigation and comparative analysis of international and local case studies based on identified best-practice approaches, along with (3) a local case study illustrating the proposed Green Planning Development Framework's application and added value.

Based on the theoretical grounding, empirical investigations and application of the proposed framework, specific conclusions and recommendations were made to guide future Green Planning Development from a spatial perspective.

Key terms:

Framework, Green Infrastructure Planning, Green Planning Development, Spatial Planning, Sustainable Development.

UITTREKSEL

Deur die eeue heen het beskawings hul eie kanse op oorlewing benadeel deur skade aan hul eie omgewing aan te rig, deur nie volhoubare benaderings te volg nie (Diamond, 2005). Vir meer as 40 jaar het mensdom se vraag op die natuur oortref wat die aarde kan vul (World Wildlife Fund *et al.*, 2014: 10). Onlangse navorsing dui daarop dat die mensdom 40% meer hulpbronne jaarliks gebruik as wat deur die natuur terug geplaas word, byvoorbeeld bome word vinniger gesny as wat dit kan terug groei, meer vis word geoes as wat oseane dit kan vul en meer koolstof word vinniger in die atmosfeer vrygestel as wat woude en oseane kan absorbeer (Lorek en Fuchs, 2011: 2). Die aarde se beperkte hulpbronne, saam met die verskaffing van ekosisteedienste wat gekoppel is aan die welstand van die mensdom en menslike nedersettings (Cilliers *et al.*, 2013: 1; TEEB, 2011:1), word nou beskou as 'n integrale deel van ruimtelike beplanningsbenaderings.

Die uitdaging lê egter in die suksesvolle integrasie en belyning van groen infrastruktuur beplanning as deel van hoofstroom ruimtelike beplanningsbenaderings. Hierdie navorsing bied 'n vertrekpunt vir sogenoemde integrasie, deur die skep en stel van 'n Groen Beplanning en Ontwikkelings raamwerk om die integrasie van ruimtelike beplanning en groen infrastruktuur beplanning te rig. Die voorgestelde raamwerk was gebaseer op (1) 'n literatuurstudie rakende volhoubaarheid en volhoubare ontwikkeling; groen infrastruktuurbeplanning; relevante internasionale en nasionale beleide en wetgewing, en huidige raamwerke en prestasie-indekse; (2) 'n empiriese ondersoek en vergelykende analise van internasionale en plaaslike gevallestudies, gebaseer op geïdentifiseerde beste praktyk benaderings, tesame met (3) 'n plaaslike gevallestudie wat die voorgestelde Groen Beplanning en Ontwikkelings raamwerk se toepassing en toegevoegde waarde illustreer.

Op grond van die teoretiese begronding, empiriese ondersoeke en toepassing van die voorgestelde raamwerk is spesifieke gevolgtrekkings en aanbevelings gemaak om toekomstige Groen Beplanning en Ontwikkeling vanuit 'n ruimtelike perspektief te rig.

Sleuteltermes:

Raamwerk, Groen Infrastruktuur Beplanning, Groen Beplanning en Ontwikkeling, Ruimtelike Beplanning, Volhoubare Ontwikkeling.

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CHAPTER 1: INTRODUCTION

1.1 Problem statement

Throughout human history, civilizations have impaired their own chances of survival by damaging their own environment as they did not follow sustainable practises (Diamond, 2005). For over 40 years humankind's demand on nature has exceeded what the Earth can replenish (World Wildlife Fund *et al.*, 2014:10) in time. According to Lorek and Fuchs (2011:2) humanity uses 40% more resources every year than what is placed back by nature, as trees are cut faster than they mature, more fish are harvested than what oceans replenish and more carbon is emitted into the atmosphere faster than forests and oceans can absorb. However using up earth's finite resources is not the only issue. It is vital to understand that the provision of ecosystem services is directly linked to the well-being of humanity and human settlements (Cilliers *et al.*, 2013: 1; TEEB, 2011:1). According to TEEB (2011:1) ecosystems are also the foundation of most economic activity as almost every resource which society utilizes daily relies directly and indirectly on nature. Furthermore the natural environment has reached a point where it is beginning to display negative "vital signs" caused by cities and developments built from a non- sustainable development approach (Brown *et al.*, 1995).

Therefore a successful integrated approach is required, which will not only safeguard the natural environment and its limited resources but will also make certain that sustainable and efficient developments are produced. Spatial planning plays a crucial role in cities and sustainability as city structures are already the products of interaction between the three principal domains of sustainability Hillier (2009:2). Urban planners have the knowledge and tools to design such an integrated approach and it will therefore become their responsibility to implement such an integrated approach to strive for a sustainable future.

1.2 Aim of the investigation

This research aims to:

- Define Green Planning Development (Based on an integrated multi-disciplinary approach).
- Determine which major categories will play significant roles in South Africa's Green Planning Development approach as derived from case studies, policies and legislation
- Determine the basic knowledge of a community in South Africa on Green Planning Development.
- Identify best-practices of international and local Green Planning Development approaches.
- Propose a framework to guide future Green Planning Development approaches.

1.3 Objectives

The primary objective of the study is to propose a framework that helps guide future urban and regional planners as well local authorities to incorporate sustainable development and green infrastructure planning as part of spatial planning in future urban developments. The primary goal of the framework is to ensure that developments realize in a sustainable manner by integrating spatial planning and green infrastructure. The framework will provide important categories that are important when considering Green Planning Development, along with indicators relevant to the South African context, which urban and regional planner's as well local authorities can use to assess their developmental plans, and identify gaps and opportunities to enhance Green Planning Development objectives.

1.4 Demarcation of the field of study

The main fields of study within this document are focused on sustainable development and green infrastructure as defined in the definitions of Chapter 2.3 and Chapter 3.2 respectively. All the information/sources/data have been interpreted from an Urban and Regional planning point of view.

The primary case study, Fleurhof, was selected as it is a modern development (built 2012 to 2016) aimed at attracting and providing residence to low - medium income class (majority of the general population). Therefore it can be considered as South Africa's latest neighbourhood design. Fleurhof is situated south west of Johannesburg CBD, South Africa. Figure 1.1 below displays the complete Fleurhof area which will be taken into account within this study. Fleurhof is currently one of the largest integrated housing developments in Gauteng (Calgro M3 Holdings, 2015a). Fleurhof comprises various types of residential units. The different types of units are fully subsidized RDP/BNG housing, Gap, Social rental, Open market rental and Entry level housing. Each type of unit is aimed at a different economic market (Calgro M3 Holdings, 2015a).

The green component of Fleurhof contains various green initiatives such energy saving technologies such as solar water heaters, heat pumps and improved insulation for the various types of housing units are currently being investigated. Residential recycling projects, urban greening initiatives (mostly active open space driven) and food gardening are also being considered. In addition, the benefit of these proposals will reduce electricity demand of the development and make the township more attractive from a social and visual perspective (Calgro M3 Holdings, 2015a).



Figure 1.1: Fleurhof
Source: Calgro M3 Holdings (2015b)

1.5 Methodology - methods and procedures regarding the investigation

Literature

The theoretical overview will start with a discussion of sustainability and sustainable development, focussing on defining these concepts and capturing their importance thereof within the current reality. A link between sustainable development and spatial planning will also be identified. The third chapter will proceed to discuss green infrastructure planning, what it entails and why it is important in the current spatial reality. The interconnection between sustainability and green infrastructure planning as well as the interconnection between spatial planning and green infrastructure will be identified; these links will be used as the foundations of the proposed concept of Green Planning Development and its proposed framework. The fourth chapter will provide an overview of policies and legislation guiding the environmental-dimension and sustainable development of planning in South Africa, in order to state the broad legislative environment in which the proposed Green Planning Development framework should manifest. In this sense, the chapter will discuss Habitat Agenda, Agenda 21, Sustainable Development Goals, RSA Constitution, Breaking New Ground, National Development Plan, National Environmental Management Act and the Integrated Development Plan of the City of Johannesburg. Chapter five will discuss current performance indices, tools and frameworks that will be used to guide the proposed Green Planning Development concept. The structure, major categories and indicators of the different indices, tools and frameworks will be analysed. The indices, tools and frameworks in question are the African Green City Index (AGCI), An Assessment Framework for Monitoring Cities' Sustainability (AAFMCs) and Global City Indicators Facility (GCIF). These tools assisted in the development of the proposed framework, based on structure, major categories and indicators identified within these. All the core principles from chapters two, three and four as well as the major categories and indicators identified in chapter five will be guiding the development of the proposed concept and its framework.

Empirical

The first empirical chapter, Chapter six, will consider case studies of international and local best practises of integrated approaches regarding sustainability, green infrastructure planning and spatial planning. Hammarby Sjöstad, Stockholm, Sweden was selected as the international case study and Durban, Kwazulu-Natal, South Africa as the local case study. Hammarby Sjöstad was chosen as it is one of the world's best examples of Sustainable City Development (Cilliers, 2014: 95) and Durban was chosen as it is a local South African city that was rated above average in the AGCI (Siemens AG, 2011:8). Chapter seven introduced the concept of Green Planning Development, provided a definition of the concept and identified which major categories and indicators are included in the proposed framework. Categories and indicators were selected based on relevance to analysed legislation (supportive law), indices, tools and frameworks (theory) and case studies (practise).

Further in Chapter eight a public participation approach followed by a quantitative and qualitative research approach was used to evaluate the main case study, Fleurhof, a modern low-income development located in Gauteng, South Africa. Information was gathered by means of a questionnaire in order to understand the area, understand the needs of the people who reside in the area and to collect the needed data that will be used to complete the proposed framework in chapter nine. All the data that was collected by the questionnaire has been discussed in this chapter, all information collected has been completed by a none-bias approach. Chapter nine will also follow a quantitative and qualitative research approach as it has been guided by the proposed framework that consists of indicators that are both quantitative and qualitative. The proposed framework will be applied to exhibit its functioning and potential. Structured interviews with Mr. C. Le Roux (divisional director at Calgro M3 Holdings Limited, Executive Head – Town planning) and Mr. C. De Jager (senior professional urban planner at Calgro M3 Holdings Limited) were completed as part of this chapter. The information and data collected through the structured interviews was used to further complete the proposed framework which has been fully applied in this chapter. Accordingly the results of Fleurhof, with regards to the proposed framework, were discussed to examine if the framework can identified any gaps in Fleurhof. Chapter ten discussed the conclusions of the study followed by Chapter eleven that provided recommendations incorporating green infrastructure planning as part of spatial planning approaches, emphasising the added value of the proposed Green Planning Development framework.

1.6 Limitations of the research

This study is focused on sustainable development and green infrastructure planning, linked to the realities of spatial planning from a local planning perspective. This research uses sustainable development as a point of departure, but focuses on the environmental considerations thereof, as a way to integrate green infrastructure (GI) planning and spatial planning. Therefore the economic and social aspects of sustainability were acknowledged, but not included comprehensively in this research. The different category goals of Hammarby Sjöstad are displayed in figures and not in text. This is done as the goals themselves are not the primary focus but are displayed for the purpose of supplementing a further understanding of Hammarby Sjöstad. The case studies of Hammarby Sjöstad and Durban are not completed under the same category format. This is due to the fact that each city has different priorities, different sustainable and environmental goals that wanted to be achieved and has different best practises. The empirical research was based on local scale realities (related to the Fleurhof area). The findings can be related to other scales (city or regional scale) but more research would be required to substantiate such. This study aims to collect and analyse new (possibly raw) data sets through the empirical research, as well as analyse already completed sets of

data. All calculations and mathematics done in the study are done by qualified personnel or by previous research done. The results of the questionnaires and opinions of residents will be discussed first in Chapter eight, followed by the detailed discussion of Fleurhof in Chapter nine. A bottom-up approach was followed first as to not enter the study area with a bias perspective. The recommendations given are based on the Fleurhof case study findings, whereby some generalisations could be drawn. Technology and the development thereof was not considered as part of recommendations, although this research acknowledge the rapid improvement of technology and great impact on development (example solar planes or heat pump systems) to make the development more sustainable. This research focused on the added-value of the proposed Green Planning Development Framework in terms of spatial planning approaches, acknowledging the location considerations and unique context of each area to be considered when implementing the proposed Green Planning Development framework.

1.7 Definitions of terms and abbreviation

1.7.1 Definitions

The definitions which were used in this research include the following:

Table 1.1: Glossary

Albedo	The ratio of the intensity of light reflected from an object, such as a planet, to that of the light it receives from the sun. (Collins English Dictionary, 2016a)
Agglomerate (Agglomeration)	To form or be formed into a mass or cluster Collins English Dictionary (2016c)
Archipelago	A collection of islands. (Collins English Dictionary, 2012a)
Biogas	The most eco-friendly form of fuel presently available. (Fränne, 2007:23)
Biofuel cars	Vehicles that use biofuel as a source of fuel, instead of petrol or diesel.
Bio-swales	Landscape elements consisting of a swaled drainage course with gently sloped sides and filled with vegetation-compost-and-or riprap; designed to remove silt and pollution from surface runoff water. (Collins English Dictionary, 2012b)
Calgro M3	The major developer of Fleurhof.
Carpool	An agreement among vehicle owners, where by each owner in sequence drives the others to and from their destination. (Collins English Dictionary, 2012b)
Ecobelts	Linear woody buffers that ease the tension between urban and rural land uses while providing ecological and social benefits for both populations (Benedict & McMahon, 2006:8)
Ecosystems	Ecosystems provide a range of goods and services vital for human well-being; the good and services collectively are called ecosystem services (Lafortezza <i>et al.</i> , 2013:2).
Green roofs	A vegetative layer grown on a rooftop. (EPA, 2013)
PM10	Particulate matter with an aerodynamic diameter of less than 10 µm. (Golder Associates Africa, 2014)
Resilience	The ability of a system to absorb changes and disturbances without losing its basic structure and function, otherwise it will change into another state (Cilliers, 2016:23)
Salinization	The excess accumulation of water-soluble salts in soil which hinder the growth of crops by limiting their ability to take up water. (Collins English Dictionary, 2016d)
Urban Heat Island	A phenomenon where the temperature is significantly higher above cities and metropolitan areas due to human activity and development. (Pickett <i>et al.</i> , 2011:334)

Urban Stream Syndrome	The observed ecological degradation of streams within urban areas.(Pickett <i>et al.</i> , 2011:335)
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Source: Benedict & McMahon (2006:8) ;Collins English Dictionary (2012a,b); Collins English Dictionary (2016a,b,c,d); Cilliers (2013); EPA (2013);Fränne (2007); Golder Associates Africa (2014); Laforteza *et al.* (2013:2); Pickett *et al.* (2011);

1.7.2 Abbreviations

The abbreviations which were used in this research.

Table 1.2: Abbreviations

AAFMCS	An Assessment Framework for Monitoring Cities' Sustainability (National University of Singapore, 2012.)
AGCI	African Green City Index Siemens (Own construction, 2015)
AQIA	Air Quality Impact Assessment (Golder Associates Africa ,2014)
BNG	Breaking New Ground (National Housing Development Agency, 2004)
BRT	Bus Rapid Transit (Siemens AG, 2011:62)
CoJ	City of Johannesburg (CoJ, 2016:1)
EIU	Economist Intelligence Unit (Siemens AG, 2011:1)
GCIF	Global City Indicators Facility (Global City Indicators Facility, 2013)
GI	Green Infrastructure
HS	Hammarby Sjöstad (Own construction, 2015)
IDP	Integrated Development Plan (Siemens AG, 2011:61)
IUCN	International Union for Conservation of Nature and Natural Resources
LED	Local Economic Development (Siemens AG, 2011:62)
LOD	Swedish acronym for "local storm water treatment" (Fränne, 2007:24)
MDGs	Millennium Development Goals (United Nations, 2015a)
NDP	National Development Plan (NPC, 2011)
NFSD	National Framework for Sustainable Development (South Africa, 2008)
NPC	National Planning Commission (NPC, 2011)
PM10	Particulate matter smaller than 10 µm (Golder Associates Africa ,2014)
RCR	Round collected refuse
RSA	Republic of South Africa
SA	*See <i>RSA</i>
SDP	Spatial Development Plan
SDF	Spatial Development Framework (Siemens AG, 2011:61)
SDGs	Sustainable Development Goals (United Nations, 2015b)
UHI	Urban Heat Island (Own construction, 2015)
UNDP	United Nations Development Programme (United Nations Development Programme, 2015)
UNEP	United Nations Environment Programme
USEPA	United States Environmental Protection Agency (USEPA, 2009)
USS	Urban Stream Syndrome (Own construction, 2015)
WWF	World Wide Fund for Nature

Source: CoJ (2016); Fränne (2007); Global City Indicators Facility (2013); Golder Associates Africa (2014); National Housing Development Agency (2004); NPC (2011);National University of Singapore (2012); Own construction (2015); Siemens AG (2011); South Africa (2008); United Nations (2015a); United Nations (2015b); United Nations Development Programme (2015); USEPA (2009);

CHAPTER 2: SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT

2.1 Points of departure

Chapter 2 will provide an overview of the concept of sustainable development as well as the importance thereof in terms of modern urban planning and spatial planning and development. This research uses sustainable development as a point of departure and as a way to integrate green infrastructure planning and spatial planning Figure 2.1 provides the organisation structure of Chapter 2.

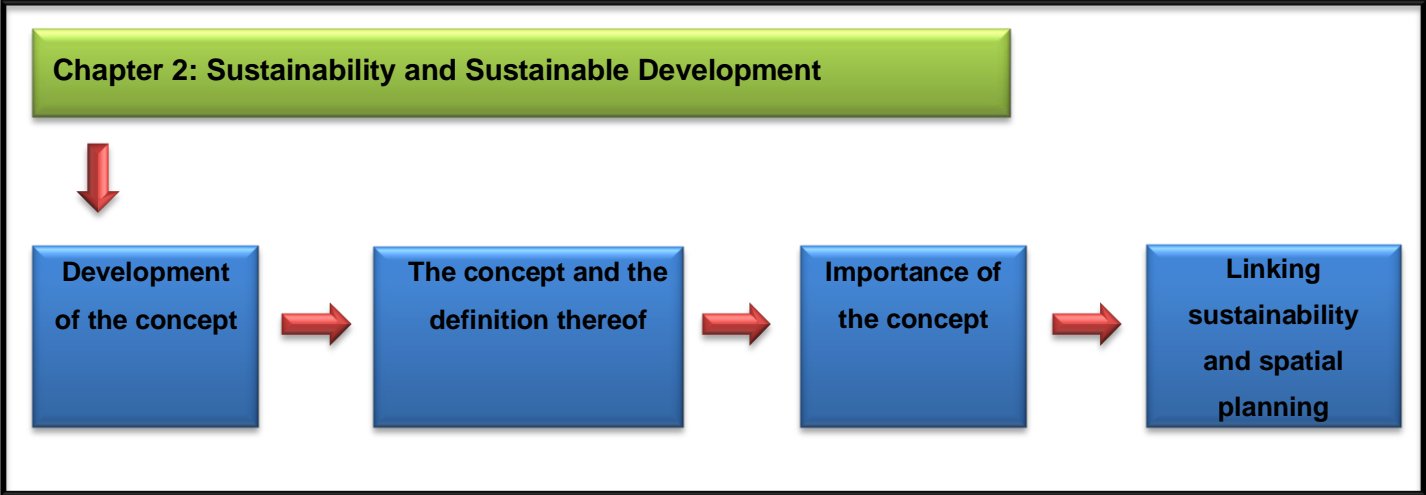


Figure 2.1: A graphical overview of the organisation and structure of Chapter 2
Source: Own construction (2016)

2.2 The development of the concept of sustainability

Humans have been a consumer rather than a creator of environmental resources since the Neolithic Agricultural Revolution (Mason, 2016). From nomadic society's such as the hunter-gatherers who moved into an area to use up its resources and moved on, only to return the following season to repeat the process (Mason, 2016). Permanent settlements were eventually established due to the development of a surplus economy, this led to natural wilderness being replaced with slash and burn farming replaced with uniform crop plantation (Beddoe *et al.*, 2009: 2483). Consequently camps became settlements, which became villages, then eventually towns and cities; however this placed pressure on the environment. Nonetheless a growing human population (which is one of the mentioned environmental pressures) forced people into moving on to somewhere new. The population had to find a place where the environment could better sustain them and their practices as well as be resilient to further changes which may take place within the environment (Mason, 2016).

Van Zon (2002:9-10) indicates that throughout human history the demand for raw materials and its impact on the environment have been a persistent concern. Environmental problems such as salinization, deforestation and loss of fertility of soil occurred as early as the ancient Egyptian, Mesopotamian, Greek and Roman civilizations. These environmental concerns are what the 21st century referred to as sustainability problems (Jacobus, 2006:85). Mason (2016) states even though there was no formal concept of sustainability, people of antiquity still understood that soil had a maximum fertility which could be exhausted, which would then be replenished with livestock.

Nonetheless environmental degradation resulting from human endeavours has been widely discussed since early centuries, by various authors such as Plato in the 5th century BC (Van Zon 2002: 27-29), Strabo and Columella in the 1st century BC (Columella 1948:3-5; Strabo, 1949:353) and Pliny the Elder in the 1st century AD (Pliny the Elder 1938: 293). Columella (1948:3, 19) further referred to methods and practises to maintain the “everlasting youth” of the earth, which can be linked to modern day equivalent of sustainable practices. Yet people did not heed the warnings or follow the recommendations due their own ignorance, consequently many civilizations buckled due to their incompetence to adapt to the conditions created by their own unsustainable practices (Diamond, 2005). Surprisingly cultural change often led to the survival of some civilizations, despite what might have been predictable under the circumstances (Beddoe *et al.*, 2009:2485).

Subsequently during the Renaissance and Enlightenment era (14th - 17th century AD) philosophers expressed their concern about over-population and resources, they discussed if whether these were sustainable in the long term (Jacobus, 2006:85). However these discussions were only seen as a hypothetical question and were not taken seriously at the time. An example of warnings and recommendations which were not taken seriously as described by Jacobus (2006:85) were the writings of Georg Agricola, a German mining engineer who described the negative impacts of mining and woodcutting on wildlife as early as the 16th century. Wood was used in almost all production processes; it was a fuel source and a construction material, this made it a crucial raw material up to 18th century. In 18th century Europe, the massive consumption of wood for mining, ship-building and various other purposes created a shortage of wood. This was the turning point as described by Van Zon (2002:19, 20, 55-56, 58-66). The fear of a shortage of wood which could threaten the foundation of people’s survival encouraged a new way of thinking. The paradigm shifted in favour of a more responsible use of natural resources which was in the interest of the current and future generations.

Hans Carl von Carlowitz was the first to use the term “sustainability” in 1713 (18th century). He suggested the phrase “*nachhaltende Nutzung*” (meaning sustainable use) of forest resources as he formed part of German forestry groups (Jacobus, 2006:85). Carlowitz wanted to maintain a

balance between harvesting trees and safeguarding trees so that there will be enough young trees to replace them. French words such as “durabilite” (meaning durable) and Dutch words like “duurzaamheid” and “duurzaam” (meaning durability and sustainable respectively) were also used as a terms for sustainability for centuries. However the Oxford English Dictionary only recognised the terms “sustainability” and “sustainable” for the first time during the second half of the 20th century (Van Zon 2002: 20 -22).

Consequently this meant that the modern world only started to understand the impact that modern society has on the environment by the 20th century, when negative impacts like destabilising soils by cutting down trees, environmental damage, fossil fuels (oil at the time and later coal), pollution, global temperature increase, urbanisation, and other environmental issues provoked concern about the environment and damaging the human ecosystem (Mason, 2016). During late 20th century (1980s) the difficulties of the greenhouse effect and the destruction of the ozone layer were discovered (World Wildlife Fund *et al.*, 2008); people, communities and countries alike were made aware that some resources were finite and that efforts should be made to find renewable methods of power. It was at this time that social, economic and scientific birth of the environmental movement was introduced (Mason, 2016).

2.3 Clarifying sustainability and sustainable development

According to Oxford Dictionaries (Oxford University Press, 2016a) the term sustainable can be defined as “*Able to be maintained at a certain rate or level*” and “*Conserving an ecological balance by avoiding depletion of natural resources*”. The second definition of the term sustainable is more applicable to this specific study. Oxford Dictionaries (Oxford University Press, 2016b) defines sustainability in a similar fashion to sustainable, stating it is “*Avoidance of the depletion of natural resources in order to maintain an ecological balance*”. It is noted through these definitions that sustainability therefore involves the conservation of earth’s natural resources. The EPA (2016) acknowledges that human development uses natural resources to sustain a modern way of life. Therefore the understanding and definition needs to be expanded to a concept which includes human society along with the aforementioned natural resources. This is where sustainable development comes in to play. According to Dunphy *et al.* (2000:21) there is a difference between sustainability and sustainable development. The term sustainable development gives priority to developments, within reason, where sustainability deals primarily with the environment. The sustainable development concept has been developed though a wide variety of definitions and interpretations. Unfortunately over time the concept has been twisted by people and institutions to meet their own needs at the time rather than compounding the fundamental nature of the concept (Mebratu, 1998:493).

Nevertheless a core definition of the concept that recognises and is comprised of both human and natural worlds, is the definition given by the Brundtland Report in 1987 at the World Commission on Environment and Development (WCED). This is possibly the best way to describe what the term “sustainable development” means in the modern world. The definition given states that sustainable development is “*Development that meets the needs of the present without compromising the ability of future generations to meet their needs*” (Brundtland, 1987:15). This definition implies that human advancement should continue but in a responsible manner, making sure that there will be enough resources for the future. Mahaffy (1999) proposes that this distinguished definition sets an ideal principle, but it does not explain specific environmental or human parameters for modelling and measuring sustainable developments. Nonetheless this definition formerly links human society and natural life in one concept.

However as each region, state or province may have different needs, a different solution to each problem created will be needed. In this sense, Van Schalkwyk (2012:19) stated that the perception of developing countries, in terms of sustainable development, may differ from that of developed countries (refer to Chapter 2.4). This due to varying problems related to developing countries, such as disease, poverty and overpopulation that it tries to address within the context of depleting resources and a polluted environment. Conversely developed countries struggle to sustain their high standards of living as well as the accompanying high resource usage, in the context of depleting international resources.

A joint publication by International Union for Conservation of Nature and Natural Resources (IUCN), United Nations Environment Programme (UNEP) and the World Wide Fund for Nature (WWF) gave a combined definition of sustainable development which is as follows: “*improving the quality of human life while living within the carrying capacity of supporting ecosystems.*”(IUCN/UNEP/WWF, 1991).

According to Azapagic *et al.* (2004:3) sustainable development “*is an approach to development which focuses on integrating economic activity with environmental protection and social concerns*”.

The definition of the concept stays similar on an international scale despite their needs being different. The United States Environmental Protection Agency (EPA, 2016) pronounces sustainable development to be based on a simple principle. The principle being that: “*Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. To pursue sustainability is to create and maintain the conditions under which humans and nature can exist in productive harmony to support present and future generations.*” (EPA, 2016).

In South African contexts sustainable development is defined in Section 24 (b) (ii) of the Constitution. Republic of South Africa (1996), states that everybody has the right to have *“the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.”*

According to South Africa’s National Environmental Management Act (NEMA), (Act No. 107 of 1998), *“Sustainable development means the integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations.”* (NEMA, 1998).

The CSIR’s Guidelines for Human Settlement Planning and Design (2005), aka the Redbook, considers sustainable development to have two main dimensions, including 1) the relationship between the built environment and the natural landscape, and 2) the degree to which the settlement reflects “timeless” qualities.

1. Urban environments exist as adaptations of natural landscapes and are dependent on resources drawn from in and around the area. Two central issues arise when trying to achieve environmental sustainability. 1) Rather than causing breakdowns in natural systems, urban environments need to work harmoniously with the natural landscape. 2) The need to recycle wastes to the greatest possible degree must be met.
2. Sustainable settlements accommodate growth and change well, and are in turn enriched by processes of change. They have three primary characteristics: They are scaled to the pedestrian; they reflect a structural order; and they have a strongly spatial feel with distinct created public spaces.

Van Schalkwyk (2012:12) stated that sustainability is a multifaceted notion and affects every level of administration. Mason (2016) and the World Bank (2012:2) relate the concept of sustainability to economic, social and environmental aspects of human society. Van Schalkwyk (2012:13) agrees that economic, social and environmental aspects form part of the concept however Van Schalkwyk also includes an extra dimension, spatial sustainability. Spatial sustainability is a key component within planning that relates to sustainable development, this is because as developments take place the spatial environment changes and this in turn affects how the unchanged environment around the development reacts. It may be a positive or negative impact, yet it is important that planners strive for a positive effect. Spatial sustainability will be discussed further in Chapter 2.5.

Within the Brundtland Commission’s report (Brundtland, 1994:15) three crucial elements of sustainable development were further identified, including:

- Meeting basic needs,
- Recognizing environmental limits, and
- The principles of intergenerational and intergenerational equity.

Monto *et al.* (2005:23) refined sustainable development and stated that that there are five broad requirements that sustainable development seeks to respond to, which are:

- The integration of conservation and development.
- The satisfaction of basic human needs.
- The achievement of social justice and equity.
- The provision of social self-determination and cultural diversity.
- To maintain ecological integrity.

These five broad requirements are ideal principles however it does not suggest that these are the only requirements that sustainable development seeks to respond to.

Due to the many diverse understandings and definitions it can be concluded that sustainability and sustainable development are approaches which guide society to advance in a sensible way, foreseeing for tomorrow, by means of integrating human existence with the natural world but doing so in the most efficient manner.

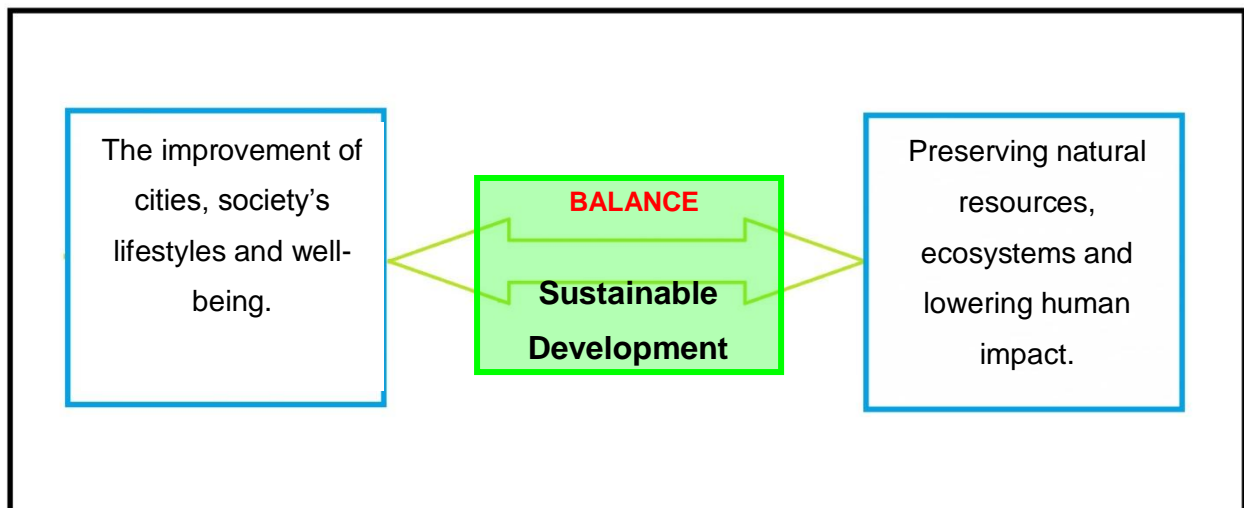


Figure 2.2: Sustainable development diagram

Source: Own construction (2016)

2.4 Importance of sustainability and sustainable development

There is an ancient Native American Proverb that states “*Treat the earth well. It was not given to you by your parents, it was loaned to you by your children. We do not inherit the Earth from our Ancestors, we borrow it from our Children*” (UNAH, 2015:1). The state in which the Earth is

passed down determines the future of the next generations. It is of great importance that the human race realizes that resources can be depleted to a point of no return.

Throughout human history, civilisations have damaged their own environment and impaired their own chances of survival (refer to Chapter 2.1) due to the fact that no sustainable practises were followed (Diamond, 2005). It has been recorded that since the 1950’s society has undergone extraordinary growth which includes urbanisation increases, a technological revolution, intensive farming and a massive increase in power needs (Robin, 2007:2), these changes in turn lead to an even greater pressure on the planet’s finite resources. For over 40 years humankind’s demand on nature has exceeded what the Earth can replenish (World Wildlife Fund *et al.*, 2014:10). The United Nations (2014:1) states that over 50% of the world’s population reside in cities. Cities grow by an estimated 67 million people per year, with Africa and Asia having the greatest forecast of growth for developing countries. Figure 2.3 provides a prediction of what percentage of the total urban population will be in 2050. It is noted that Africa will increase by 8%, almost doubling urban populations to a total of 19%.

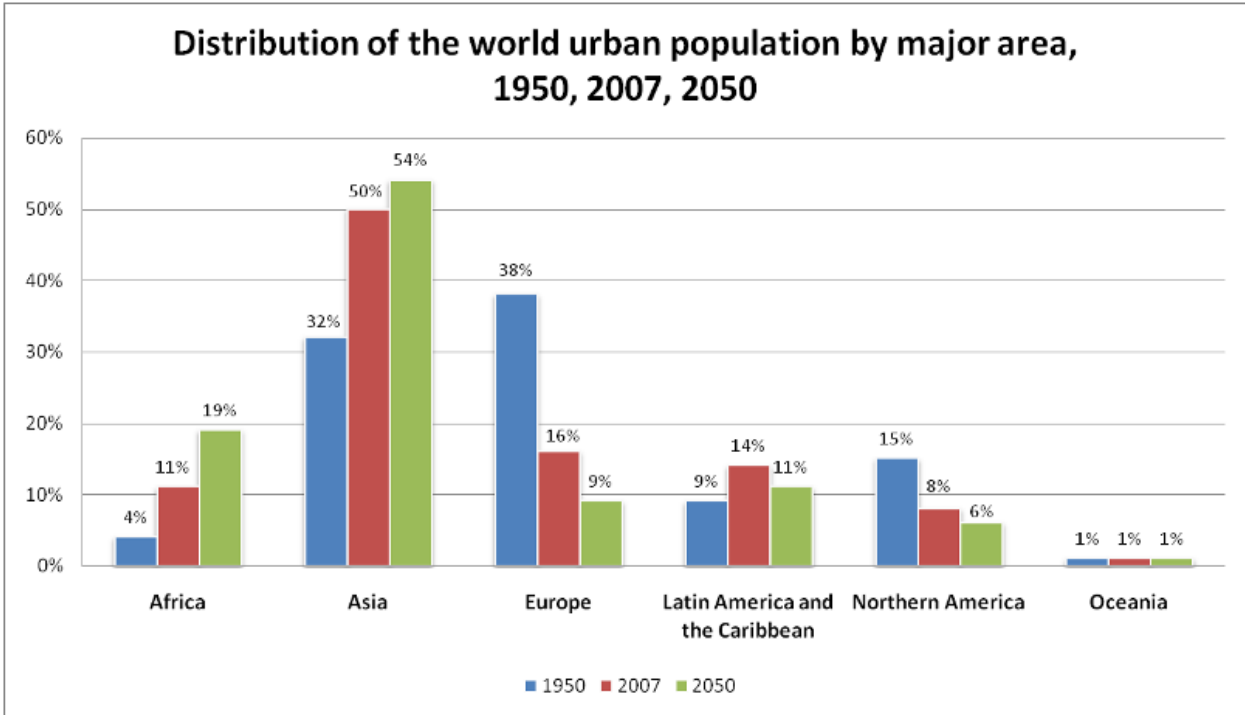


Figure 2.3: Distribution of world population by major area
 Source: United Nations (2008:7)

Skye (2013:1) states that as the population and urbanisation increases, cities will have to expand in order to accommodate the new residents. Skye (2013:1) continues to say that higher volumes of fuels and resources will be required as the cities becomes larger, and this will negatively impact on the environmental quality of cities. Research of Lorek and Fuchs (2011:2) also confirms such trends, stating that humanity uses 40% more resources every year than what is placed back by nature, as trees are cut faster than they mature, more fish are harvested

than what oceans replenish and more carbon is emitted into the atmosphere faster than forests and oceans can absorb. The modern world needs the regenerative capacity of 1.5 Earths to provide the ecological services that are currently being used (World Wildlife Fund *et al.*, 2014: 10). To make matters more complex, usage patterns on resources are dramatically different around the world (refer to Chapter 2.3). It is estimated that a European inhabitant consumes three times as many resources as an inhabitant in Asia does, and more than four times as much as an African inhabitant. Inhabitants of other rich countries consume up to 10 times more than people in developing countries (SERI, 2000). Therefore each city, province and country has to write unique sustainable policies to meet its own challenges (refer to Chapter 6)

Brown *et al.* (1995) believes that the natural environment has reached a point where it is beginning to display “vital signs” in terms of:

- Urban Biodiversity and ecosystem services
- Urban climate: Urban Heat Island (UHI)
- Urban hydrology: Urban Stream Syndrome (USS)
- Urban soil degradation

The importance of sustainability will accordingly be discussed in terms of these vital signs.

2.4.1 Urban Biodiversity and ecosystem services.

An ecosystem consists of living (biotic) organisms and their non-living (abiotic) environment which acts together as a functional unit (Miller & Spoolman, 2009: 57). Although ecosystems function as a unit, they are not isolated from other ecosystems and can therefore be connected in and around urban areas. Different ecosystems are connected and this feeds the need of transporting and receiving energy, matter and organisms from one ecosystem to another. The concept of ecosystem services is still new in terms of spatial planning, yet the concept has been included in various land use planning approaches, based on sustainable development objectives (Niemelä *et al.*, 2011). It is imperative to recognize that the provision of ecosystem services is directly linked to the well-being of humanity and human settlements (Cilliers *et al.*, 2013: 1; TEEB, 2011:1). According to TEEB (2011:1) ecosystems are also the foundation of most economic activity as almost every resource which society utilizes daily relies directly and indirectly on nature. The successful use of ecosystem services can save on municipal costs; boost local economies, enhancing quality of life and securing livelihoods (TEEB, 2011:1). The conservation of biodiversity is fundamental in sustainable development since the loss of biodiversity is irreversible. Figure 2.4 below displays the different types of ecosystem categories each ecosystem service will fall under.

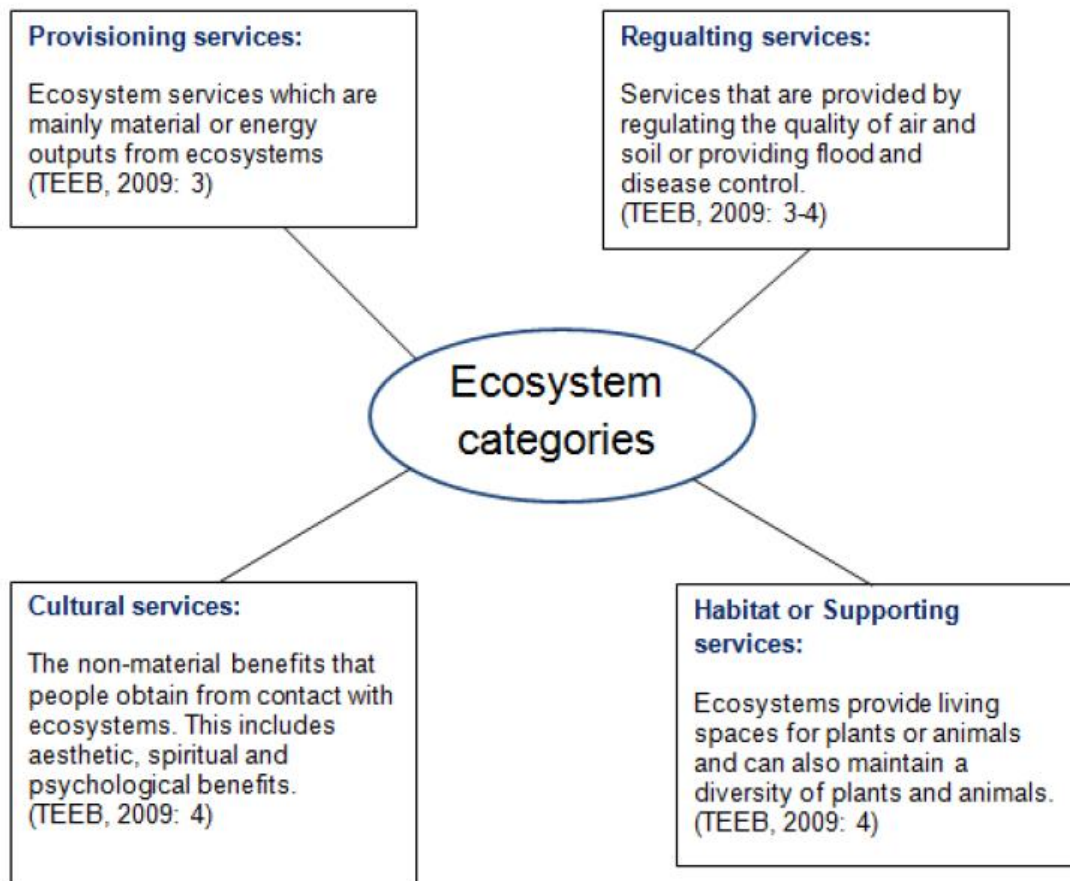


Figure 2.4: Ecosystem categories

Source: Cilliers (2014:19)

The importance of sustainability is therefore emphasised in terms of ecosystem services and urban biodiversity

2.4.2 Urban climate: Urban Heat Island (UHI)

Urban Heat Island (UHI) is a phenomenon where the average temperature is higher (even at night) above urban areas than above rural areas due to human activity and development (Pickett *et al.*, 2011:334). The main causes of UHI are lack of vegetation (which leads to a lack of evapotranspiration), high amounts of dark covered surfaces such as buildings, roads and paving which absorb heat (solar radiation), the population density of an urban area and the size of an urban area (Oke, 2011: 123-125), as illustrated in Figure 2.5, a visual representation of the UHI phenomenon.

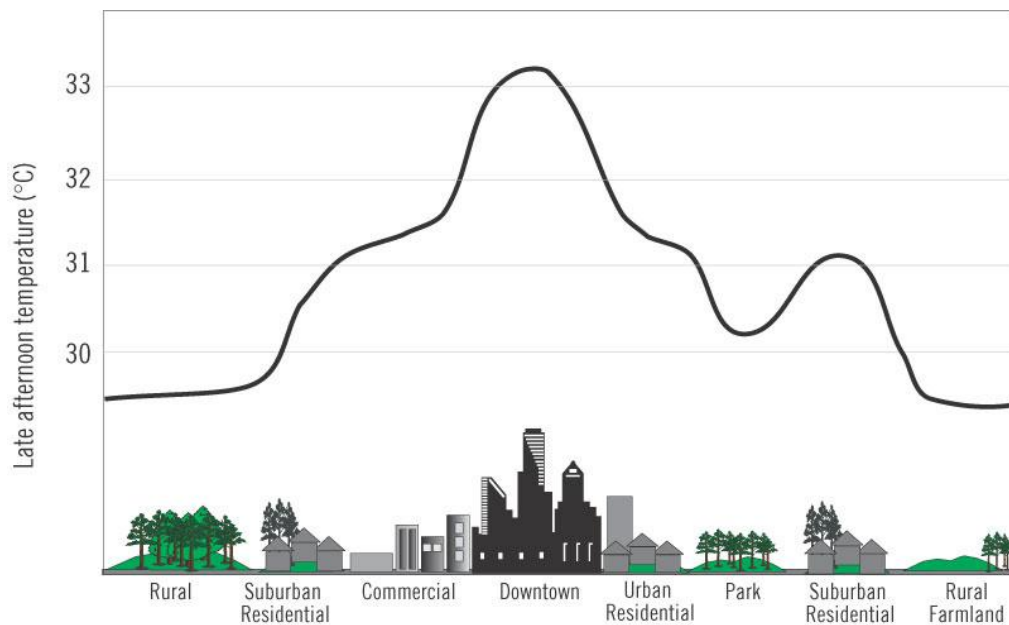


Figure 2.5: Urban Heat Island

Source: Arrau (2015).

Pickett *et al.* (2011:334) states that UHI has biological and human implications. Biologically in terms of flowering and leaf emergence times which are earlier in urban areas when compared to rural areas, as well as higher temperatures in urban areas leading to lower urban hydrological levels. Human implication in terms of the UHI which increases energy use (greater demand for air conditioning) and which leads to more pollution and increases the production of ground level ozone. These effects can be lowered by increasing vegetation and painting urban areas with brighter colours to increase their albedo (NC State University, 2013). The importance of sustainability is therefore emphasised in terms of urban climate.

2.4.3 Urban hydrology: Urban Stream Syndrome (USS)

Urban hydrology can be affected drastically by the urban areas which surround it. Hough (1995) compared urban to non-urban areas, and noted the following: surface runoff increases from 10% to 30%, evapotranspiration decreases from a 40% to 25% and ground water decreases from 50% to 32% in urban areas. These changes were mainly caused by the many impervious surfaces within the urban setting where the water is present. These changes also mean that there will be a decrease in interactions between ground water and biogeochemical activities (ecosystem services) in upper soil horizons, establishing a link between USS and ecosystem services.

USS is the observed ecological degradation of streams within urban areas (Pickett *et al.*, 2011:335). According to Walsh *et al.*, (2007) the negative impacts of USS include:

- Elevated nutrients (such as nitrogen and phosphorus);
- Decrease in biogeochemical functions;

- Increased organic and inorganic contaminants (metals);
- Increased water temperature;
- Increased hydrologic flashiness; and
- Reformed biotic communities.

With the decrease of biogeochemical functions and increase in water temperature, USS can contribute to issues of ecosystem services and UHI respectively. To reduce the negative effects of USS more porous ground cover should be included in the built environment, the storm water flow from parking areas should be lowered, bioswales and rain gardens should be built in catchment areas using indigenous plant species, developments shouldn't take place in the 1:50 year flood line and wetlands and rivers/streams should be conserved and restored. The importance of sustainability is, in this sense, emphasized in terms of urban hydrology.

2.4.4 Urban soil degradation

Urban soils are the foundation for many ecological procedures such as biogeochemical cycles, the location of human habitation and the spatial distribution of plant accumulations (Pouyat *et al.*, 2007). In the urban environment, soils serve as a growth medium and substrate for soil fauna and flora, they retain and supplying nutrients and also contribute to the hydrologic cycle through absorption, storage and water supply (Bullock & Gregory, 1991). According to Benedict and MacMahon (2002) soil plays a vital role as the "brown infrastructure" of urban ecological systems because of the services it provides. In the modern world, planners and engineers mainly focus on the mechanical aspects of soils for developments (urbanisation) and neglect the biological aspects; this leads degradation of urban soils.

According to Pickett *et al.* (2011:336) urban factors that increase degradation of soils are:

- Physical disturbances from development taking place;
- Introduction of exotic plant and animal species;
- Anthropogenic materials;
- Soils which are buried under or cover with impervious surfaces;
- Soil management practices such as fertilization and irrigation;
- Changes in biotic and abiotic environment; and
- Soil hydrophobicity.

With soils being buried, anthropogenic materials and lack of moisture in the soil due to hydrophobicity, soil degradation can contribute to UHI. The importance of sustainability it therefore emphasized in terms of urban soil degradation.

2.5 Ecological Footprint

Ecological Footprint consists of all the ecological services that societies demand that compete for space (World Wildlife Fund *et al.*, 2014: 10), as captured in the preceding Chapters 2.4.1 to 2.4.4.. It includes the biologically productive area needed for built-up areas, grazing land, fishing grounds, crops and forest products as well as the area of forest needed to absorb additional carbon dioxide emissions that cannot be absorbed by the oceans (World Wildlife Fund *et al.*, 2014: 10). Ecological Footprint is expressed in a common unit called a global hectare (gha). Figure 2.6 displays the average Ecological Footprint of the world with the different indicators.

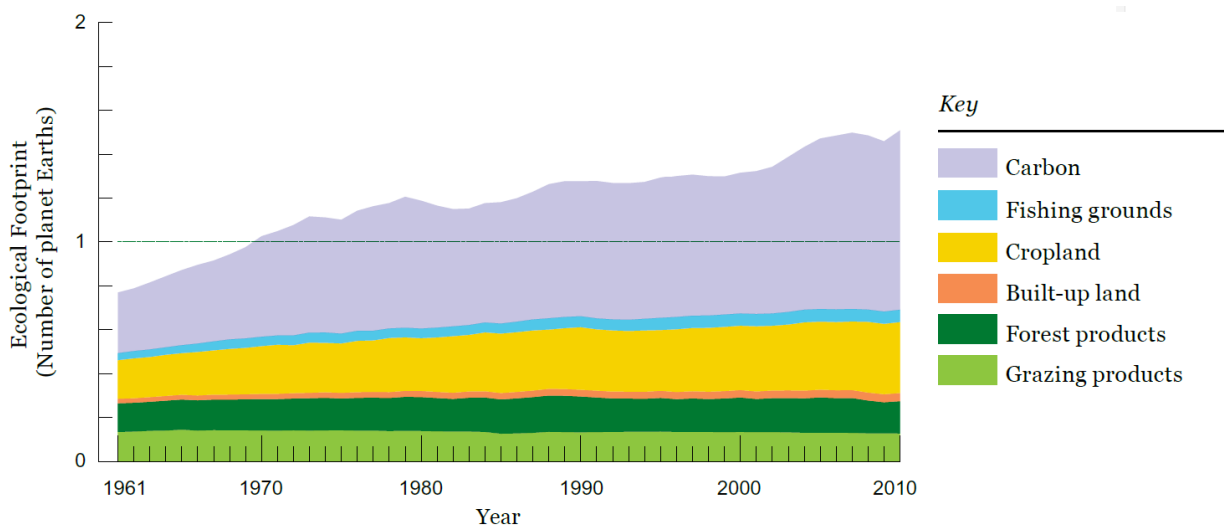


Figure 2.6: Ecological Footprint Indicators

Source: World Wildlife Fund *et al.* (2014: 10).

As populations increase so does the Ecological Footprint, however the average Ecological Footprint has increased faster than global bio-capacity (the land actually available to provide these services) (World Wildlife Fund *et al.*, 2014: 11). World Wildlife Fund *et al.* (2014: 16) has discovered that low-income countries have a smaller footprint, but suffer the greatest ecosystem losses. This relates to the high per capita Footprint that is greater than the amount of bio-capacity available. This trend has been consistent for over half a century, consequently high-income countries are largely dependent on the bio-capacity of other countries to support their lifestyles. Low- and middle- income countries have seen little increase in an already small per capita Ecological Footprint over the same period of time. Figure 2.7 displays the change in Ecological Footprints of the different income groups over a 40 year time span.

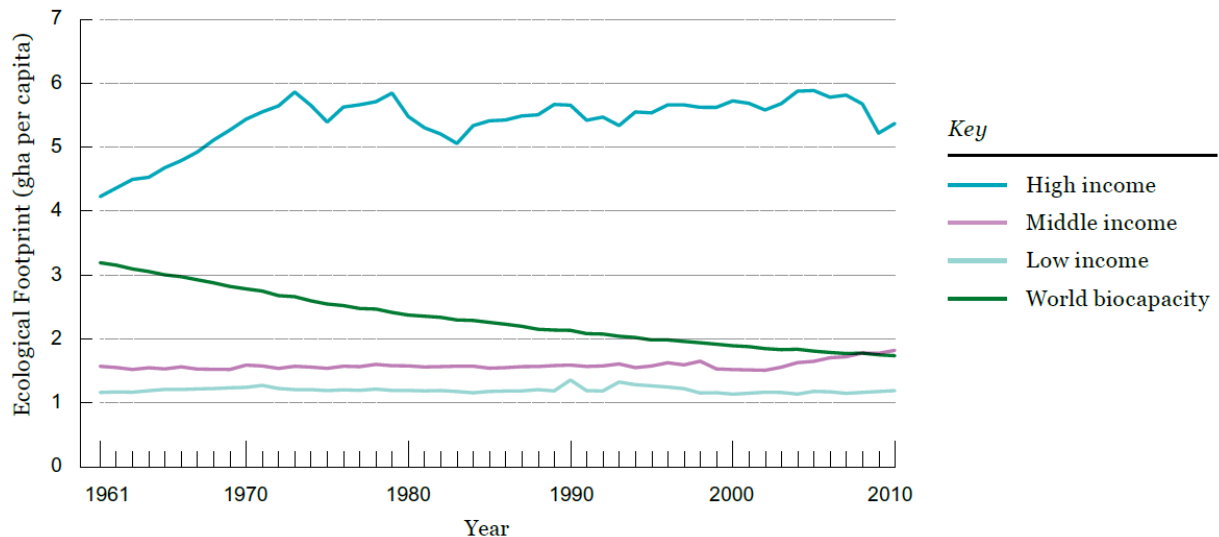


Figure 2.7: Ecological Footprint of different income groups

Source: World Wildlife Fund *et al.* (2014: 16).

The fact that high-income countries depend on low-income countries bio-capacity may limit the development and progression of the low-income country, however the outcome of this is questionable. The importance of sustainability is in this sense emphasized in terms of a country's Ecological Footprint.

2.6 Linking sustainability and spatial planning approaches

Hillier (2009:2) recognises the link between sustainability and spatial planning, and states that the concept of spatial sustainability is not new and has made its appearance in literature regarding ecological footprint of cities and regional studies. Ecological Footprint studies indicated the ecological demand that a city has on its surrounding spatial area (refer to Chapter 2.4) as cities and ecological services have to compete for space. Hillier (2009:2) acknowledges that a population living in city, with the same style and standard of living, under dispersed spatial conditions would have an even larger footprint than a population living under integrated spatial conditions. Therefore densities within cities are vital factor in spatial sustainability. The concept that some spatial forms are more sustainable than others has been the drive for much of the work for and against compactness and density in cities (Jencks, 1996; Rogers & Gumuchdjan, 1997).

Furthermore, spatial planning plays an essential role in promoting sustainability through regulating land use, protecting and enhancing environments and integrating sectorial policies. Hillier (2009:2) believes "*that some generic ways of arranging the primary spatial structure of the city, that is its street network, might be more sustainable than others*"; however a balance needs to be found between a sustainable spatial structure and the sustainable use of the environment of which the city occupies. Moreover he states that because structures are already

the products of interaction between the three principal domains of sustainability (environment, social and economic), the concepts of structure needs to be brought to tolerate sustainability.

2.7 Conclusion

Sustainability and sustainable development are extremely important in a modern world due to pressures of population growth and development impacting on urban biodiversity and ecosystem services, urban climate: urban heat island (UHI), urban hydrology, urban stream syndrome (USS) and urban soil degradation. Benedict & McMahon (2006) believe that as the sustainable development concept gained a greater acceptance and matured over time, it has had an increasingly and direct influence on development approaches. Over time as populations and cities grew, the demand for natural resources and natural services increased. These resources and services are not infinite and mankind consider the limited amount. Sustainable development is the product of a set of transformations and the fear that present and future generation might not be able to maintain their living standards.

As previously mentioned Africa is one of the most rapidly urbanising regions in the world (refer to chapter 2.4). According to Siemens AG (2011:20), Africa is undergoing radical transformations in terms of land usage, water and energy usage, food production, consumption and distribution. Siemens AG (2011:20) further states that the transformations taking place require an intensive set of social, economic and environmental policies which should become a priority. These policies will ultimately determine Africa's ability to provide a sustainably developed society (Siemens AG, 2011:20). In a South African context, the concept of sustainable development is gaining importance, although many other issues are often prioritized, such as the provision of basic services and houses.

In essence this Chapter stated the importance of sustainably and sustainable development and the relevance thereof in terms of spatial planning approaches. The world will continue to grow for centuries to come. As the growth takes places, cities expand; resource usage increases, environmental quality decreases and humans spend more money to continue this cycle. The vital signs discussed illustrate the different problems faced within the modern world. As such, Authorities, Planners and society needs to understand that sustainability is heavily reliable on interconnect ecosystems, and cities form part of this system. Therefore by being sustainable and incorporating sustainable development, humanity can oppose the negative influences that are within the system. The linkage between sustainability and spatial planning might pose solutions to create systems that are not only resource-aware, but also take the bio-capacity into consideration when planning future developments and land-uses. Green infrastructure planning (GI) will be explored in the next chapter as possible approach to bridge the spatial sustainability gap.

CHAPTER 3: GREEN INFRASTRUCTURE

3.1 Points of departure

Chapter 3 will discuss the concept of green infrastructure based on relevant theories and literature relating to various definitions thereof, the importance of green infrastructure and the interconnection between green infrastructure, sustainability and spatial planning. Figure 3.1 provides a structure of the organisation of Chapter 3.

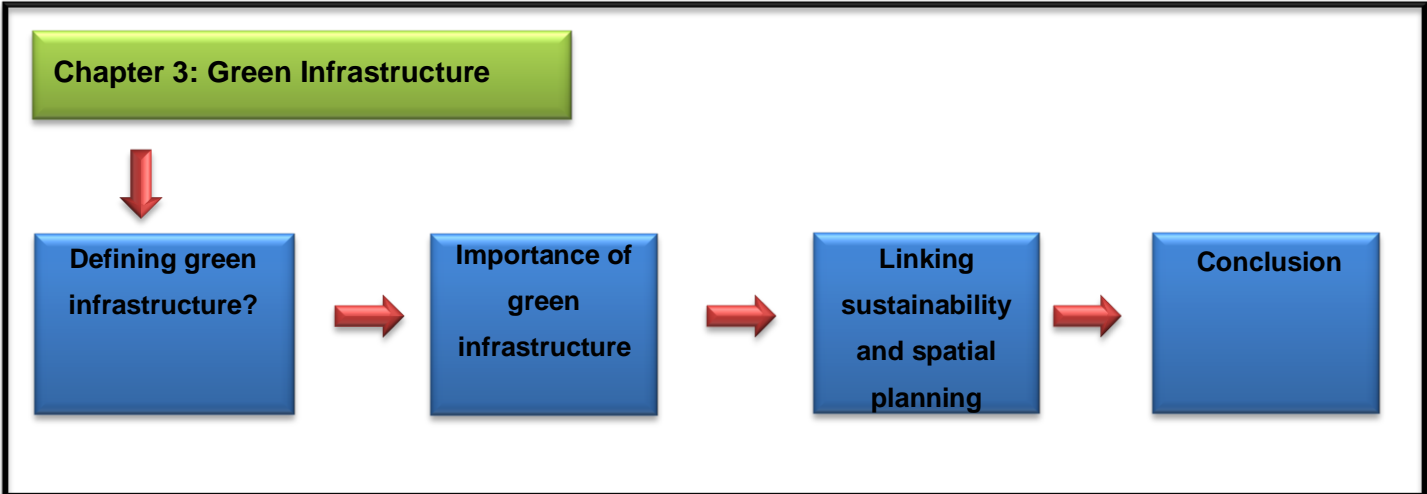


Figure 3.1: A graphical overview of the organisation and structure of Chapter 3
Source: Own construction (2016)

3.2 Defining green infrastructure (GI)

3.2.1 Concept

The term “green infrastructure” (GI) has a different meaning to different people, depending on the context in which the term is used. Firehock (2010) stated that there are several disciplines that have addressed GI, including disciplines of ecology and conservation biology, forestry, landscape architecture, transportation and urban planning. However Beauchamp *et al.* (2011:1) believes there is a lack of an integrated framework guiding different organizations (and disciplines) to plan and incorporate green infrastructure. According to Firehock (2010) the term was first formulated in Florida in 1994 in a report to the Governor on land conservation strategies. The term was proposed to reflect the notion that natural systems are equally and possibly more important components of a city’s grey infrastructure. Firehock (2010) states the fact that planning had to be done then for the “grey infrastructure” of cities has forced people to recognize GI planning and its importance to community planning to conserve or restore natural resources today. Example, previously green spaces were often valued for a single use, for their aesthetic appeal, sport or recreational use. However in modern times, GI is interpreted as green

spaces that can be valued for a number of functions which can often be achieved simultaneously, providing society with multiple benefits from a single site (The Royal Town Planning Institute, 2013:1).

According to Benedict & McMahon (2006:5), the definition of GI can be seen from two perspectives depending on the organization or discipline involved. 1 - Trees and natural areas in urban areas are seen as GI because of the “green” benefits they provide. 2 - GI refers to engineered structures (grey), such as water treatment facilities or green roofs that are designed to be environmentally friendly.

Murphy (2009) provides a typical European perspective that leans more to the first perspective described by Benedict & McMahon (2006:5) on GI, stating that GI includes the network of green routes and hubs that preserves animal and plant biodiversity. This perspective falls in contrast with the American perspective (such as the definition provided by USEPA) on GI which is in agreement with the second perspective described by Benedict & McMahon (2006:5). USEPA (2009) views GI as a network of structures that aids rural and urban development, along with the idea of protecting natural habitats and reducing the impact of development. This perspective of the concept aims to introduce green facilities such as gardens, parks, trees, and swales into a city’s infrastructure.

Various definitions of GI were formulated over the years, including amongst others:

- GI is a society’s natural life support system and the ecological framework needed for sustainability (American Planning Association. 2003: 1).
- *“Green infrastructure is the physical environment within and between our cities, towns and villages. It is a network of multi-functional open spaces, including formal parks, gardens, woodlands, green corridors, waterways, street trees and open countryside. It comprises all environmental resources, and thus a green infrastructure approach also contributes towards sustainable resource management.”* (Davies et al., 2006: 2).
- *“Green infrastructure is an emerging planning and design concept that is principally structured by a hybrid hydrological/drainage network, complementing and linking relict green areas with built infrastructure that provides ecological functions”* (Ahern. 2007:267).
- Green Infrastructure (in structural terms) is the components that function together to uphold a network of sites which support ecological and social processes. Depending upon the type of function or service being provided, the components range in size and shape (Ortega-Álvarez & MacGregor-Fors, 2009).

- “Green infrastructure is a phrase used to describe all green and blue spaces in and around our towns and cities. The term allows us to refer to – and consider the collective value of – all of these spaces at once” (The Royal Town Planning Institute, 2013:1).

The different definitions illustrate that GI is the combination of grey/green infrastructure which forms a network within cities. Davies *et al.* (2006:2) analysed the common ground between the many perspectives and definitions of GI and identified three primary occurring principles: 1 - GI involves natural and managed green areas in both urban and rural settings, 2 - GI is about the strategic connection of open green areas and 3 - GI should provide multiple benefits for people.

It is important to understand the difference between grey and green infrastructure. Green infrastructure refers to a network of trees and natural areas within urban areas that provide “green” benefits and grey infrastructure refers to engineered structures that are designed to be environmentally friendly, such as water treatment facilities or green roofs (Benedict & McMahon, 2006:5). According to Andoh (2011:1) grey and green infrastructure can reach a point where their functions overlap. Davies *et al.* (2006:3) proposed a grey-green continuum model which suggests a way of relating the grey and green infrastructure concepts. Figure 3.2 displays such grey-green continuum which illustrates that the term “green” can be used to denote the facility or function provided by an element, even if it is not strictly “green” in terms of land use. For example a bicycle lane can be seen as a complete grey infrastructure element as it an immovable cement structure, however it does contribute to green infrastructure and sustainability as it allows for pollutant and congestion free transportation, it can therefore be considered to be a grey-green infrastructure. Consequently grey infrastructure elements that contribute to the wider functioning of green infrastructure should be treated as part of the green infrastructure network. Furthermore Davies *et al.* (2006:3) stated that “grey” infrastructure should be integrated with green infrastructure networks rather than forcing green infrastructure networks to suit grey infrastructure integration.

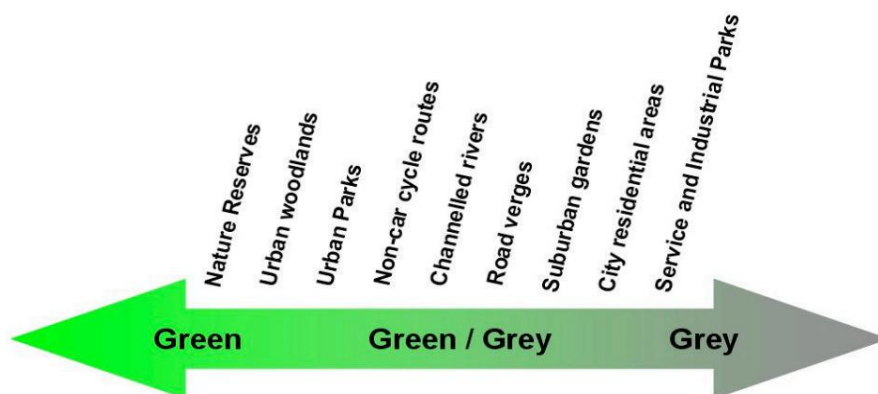


Figure 3.2: The Grey-Green continuum

Source: Davies *et al.* (2006:3)

3.2.2 Physical layout concept

Benedict & McMahon (2006:7) describe the basic physical layout of GI. They state that GI incorporates a range of natural and restored native landscape features and ecosystems that create a system of “hubs” and “links”. Figure 3.3 illustrates the concept of “hubs” and “links”.

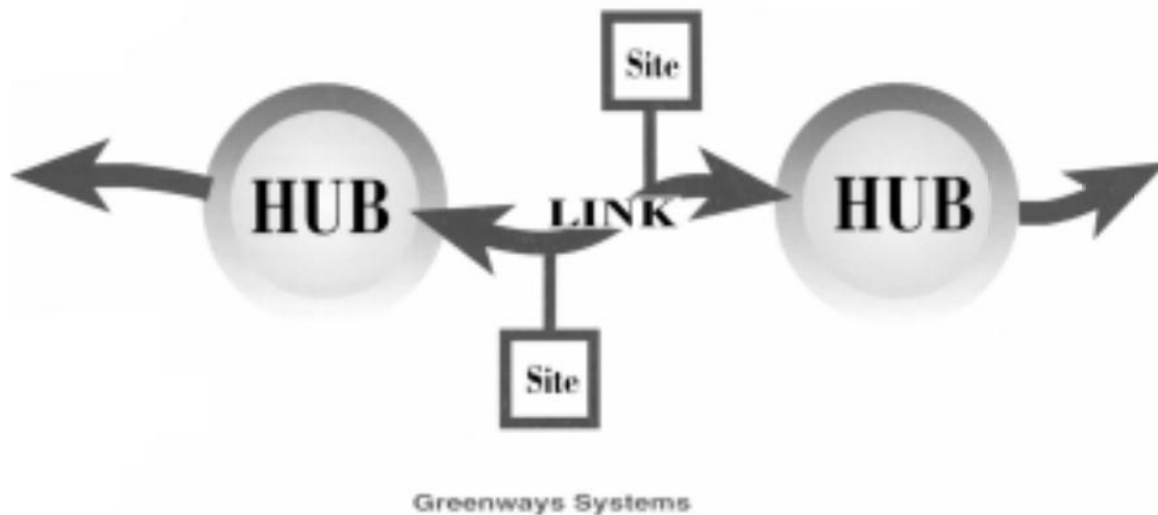


Figure 3.3: The physical layout of GI

Source: Benedict & McMahon (2006:7)

According to Benedict & McMahon (2006:7) “hubs” are an anchored GI network that provides an origin or destination for wildlife and ecological processes moving to or through it. Hubs may range in shapes and sizes and consist of reserves, large publicly owned lands, working lands such as farms, regional parks, community parks and natural areas. “Links” are described as connections (corridors) that interconnect the system (of hubs) and enable GI networks to function. Links may range in size, function and ownership and include large protected natural areas that connect existing parks, conservation corridors, greenways, greenbelts and eco-belts.

3.2.3 Examples of GI

There are many different types of GI found within the hubs and links. Examples of modern day GI include:

- **Bioswales** – Planted areas within urban locations that collect rainwater and stormwater runoff (NYC Environmental Protection, 2016:1).
- **Blue roofs** – Roofs that have weirs and roof drain inlets on top of them to service the primary purpose of detaining stormwater (NYC Environmental Protection, 2016:1).

- **Conservation corridors** – A natural green area that contains biodiversity (wildlife populations) that connects with other natural green areas separated by urban areas or structures (Benedict & McMahon, 2006:7).
- **Green roofs** – Roofs that contain a top vegetative layer that grows in engineered soil, which sits on top of a drainage layer. Collects water, improves air quality and reduces UHI; refer to Chapter 2.4, Figure 2.5 (NYC Environmental Protection, 2016:1).
- **Green streets** – Planted areas within streets designed to collect and manage stormwater runoff in streets and sidewalks (NYC Environmental Protection, 2016:1).
- **Hubs** – anchored GI network that provides an origin or destination for wildlife and ecological processes moving to or through it (Benedict & McMahon, 2006:7).
- **Links** – connections (corridors) that interconnect the system (of hubs) and enable GI networks to function (Benedict & McMahon, 2006:7).
- **Permeable paving/ Porous concrete** – Paving techniques and materials which allow water to seep in between the paving and be absorbed into the ground (NYC Environmental Protection, 2016:1).
- **Protected natural areas** – Natural land that is protected because their natural, ecological or cultural values have been recognized (Benedict & McMahon, 2006:7).
- **Rain gardens** – Vegetated or landscaped depressions designed with a soil layer that promotes infiltration of stormwater runoff into the underlying soil. This improves air quality and reduces UHI; refer to Chapter 2.4, Figure 2.5 (NYC Environmental Protection, 2016:1).
- **Rain harvesting** – Similar to Blue Roofs, however making use of watertight containers designed to catch and store stormwater off of roofs and other impervious surfaces for later use (NYC Environmental Protection, 2016:1).

3.2.4 Principles and objectives when planning GI

To understand GI further, one has to consider the principles and objectives of the concept. The American Planning Association (2007: 2-3) states that there are four key points which are essential for GI planning:

1. Parks and open space should form an interconnected system as these are more beneficial than parks in isolation,
2. Parks and open spaces should be used by settlements to help preserve essential ecological functions and to protect biodiversity,
3. Parks must be planned as part of a system of green infrastructure, as this can help shape urban form and buffer incompatible uses,

4. More parks should be utilised in urban settings as this will lower public costs for storm water management, improve flood control, improve transportation and other forms of negative built infrastructure can be reduced.

Pauleit *et al.* (2011: 273) proposes five principle categories each with sub-roles of planning for green infrastructure. These principles are similar to the American Planning Association's four key points. Cilliers (2014: 27-28) has discusses the five principles and Table 3.1 illustrates the discussion.

Table 3.1: Principles of green infrastructure planning

Principles:	Discussion:	Role of planning for green infrastructure in terms of this principle:
Multi-functionality	Multi-functional green infrastructure explicitly defines and combines different social, ecological and economic functions where possible.	<ul style="list-style-type: none"> • To consider different groups of ecosystem services (abiotic, biotic and cultural). • To combine different functions or uses whenever possible such as integrated interconnected green spaces. • Prioritizing between different functions and setting up goals for each. • Monitoring the different functions. • To improve the awareness of multi-functions through communication and education.
Connectivity	Connecting green spaces and creating green space corridors are important for the ventilation of the human settlement, access to green areas and recreational use of green areas. Connectivity also enhances species dispersal.	<ul style="list-style-type: none"> • To consider the different scales and perspectives of physical and functional connections between green spaces, such as recreation, biodiversity and storm water management. • To base the green infrastructure planning of the specific area on thorough analysis of the green space resource and its function in the area.
Integration	This concerns the links and interactions between the green infrastructure and other urban infrastructures in the human settlement.	<ul style="list-style-type: none"> • To consider integrating and coordinating green infrastructure with other urban infrastructure in terms of functional and physical relations. • To create beneficial relationships between different professions and other actors.
Communicative and social-inclusive process	Green infrastructure includes a variety of green spaces (such as public, institutional and private) and interacts with a lot of other urban structures, therefore	<ul style="list-style-type: none"> • Attempt to meet all the stakeholders' needs and interests. • To involve stakeholders in decision-making through cooperation and coordination between different professions and

	many stakeholders are involved.	levels. <ul style="list-style-type: none"> • To include public participation.
Long-term strategy	Green infrastructure planning should rather be based on a long-term vision instead of a static short-term plan. The long-term vision is aimed at achieving overall long-term goals while on-going learning is taking place between different actors in an adaptive planning mode.	<ul style="list-style-type: none"> • Adopting the sustainable concept of development which considers long-term benefits. • To consider interactive structures and multiple uses that will help to achieve a long-term goal. • To allow adaptation as on-going learning is taking place.

Source: Cilliers (2014: 27-28)

GI, from a spatial perspective, aims to create a network of multi-functional long term based green spaces that are interconnected and integrated with grey infrastructures as to provide similar services through a more sustainable approach.

3.2.5 GI's Linkage to sustainability

The primary goal of GI is to contribute to support the broad principles of sustainability (Ahern, 2007:269; Cilliers, 2014: 27-28; Pickett *et al.*, 2004). This includes, according to Chapter 2.4.1, ecosystems, which should be considered as part of a sustainable development approach. Ecosystems provide a range of goods and services that is vital for human well-being (Lafortezza *et al.*, 2013:2). However ecosystems also play a major role in GI; according to a report completed by Forest Research (2010), GI can be accredited to a few main ecosystem services and their associated components. The report further states that GI may impact the capacity of ecosystem to deliver services across an assortment of landscape scales (Feld *et al.*, 2009). Krause *et al.* (2011) connects GI and ecosystems services through the example that the risks from climate change can be mitigated by GI by protecting urban regions against floods or by increasing vegetation within urban settings. The concept of ecosystem services place a value on ecological functions (processes), these values are often directly beneficial to a society's physical health, economic or social status; therefore linking to the three spheres of sustainability (refer to Chapter 2). Pickett *et al.* (2004) describes ecological processes as mechanisms by which landscapes function over time and across space; and are therefore appropriate to use as goals and indicators of sustainability as the function (mechanisms) change in accordance to what is needed in the area, illustrating the primary needs as nature tries to be resilient to negative impacts. Furthermore a theoretical perspective as well as the analytical tools used to understand how complex and diverse landscapes are is provided through the landscape ecology profession, this includes urban environments function with respect to specific ecological processes.

Ahern (2007:268-269) completes this interconnection between GI and sustainability (ecosystem services) through the use of the Abiotic, Biotic and Cultural (ABC) resource model. This comprehensive and inclusive model is consistent with the landscape ecology perspective that clearly identifies the needs and joint impacts of society (humans) on biotic and abiotic systems and processes. The ABC resource model which is displayed in Table 3.2 is to articulate the key ecological functions of a green infrastructure.

Table 3.2: Key abiotic, biotic and cultural functions of a green urban infrastructure

Abiotic	Biotic	Cultural
Surface: groundwater interactions	Habitat for generalist species	Direct experience of natural ecosystems
Soil development process	Habitat for specialist species	Physical recreation
Maintenance of hydrological regime(s)	Species movement routes and corridors	Experience and interpretation of cultural history
Accommodation of disturbance regime(s)	Maintenance of disturbance and successional regimes	Provide a sense of solitude and inspiration
Buffering of nutrient cycling	Biomass production	Opportunities for healthy social interactions
Sequestration of carbon and (greenhouse gasses)	Provision of genetic reserves	Stimulus of artistic/abstract expression(s)
Modification and buffering of climatic extremes	Support of flora/fauna interactions	Environmental education

Source: Ahern (2007:269)

Table 3.2 emphasize the importance to consider GI as part of a sustainable development and spatial planning approach, in terms of ecological and cultural functions as the ABC resource model illustrates how each function links to GI. It must be noted how broad, multifunctional and multipurpose the ecological and cultural functions are and that the functions support the broad principles of sustainability. This falls in direct contrast with single-purpose policies or plans that address more focused goals as seen in local municipal strategies. This link goes to show that GI may just as important as sustainable development in the modern world.

3.3 Importance of green infrastructure

Chapter 2.4 previously discussed the importance of sustainability and sustainable development. History illustrated that civilizations have fallen due to non-sustainable practises. However in the Modern world cities are growing and populations are expanding rapidly (United Nations, 2014:1). If cities/developments are developed in a non-sustainable development method, they will become more costly to build and maintain (Skye, 2013:1). This due to the resources that are being used to develop and maintain the cities/developments are finite fossil fuels, which will become more expensive as they deplete. Furthermore the expanding cities are impacting the natural environment in a negative way (Brown *et al.*, 1995). It was also stated through the literature (Ahern, 2007:269; Cilliers, 2014: 27-28; Pickett *et al.*, 2004) that the primary goal of GI is to contribute to a sustainable existence and support the broad principles of sustainability. Consequently this means that four vital signs caused by a non- sustainable development approach (refer to Chapter 2.4) as discussed by Brown *et al.* (1995) could be conquered or at least be reduced through the implementation of GI, therefore lowering the human ecological footprint as a whole (refer to Table 3.3 below). The four vital signs are urban biodiversity and ecosystem services, urban climate: urban heat island, urban hydrology: urban stream syndrome and urban soil degradation.

Accordingly GI can be considered a vital part of broad sustainability thinking and sustainable development approaches. Table 3.3 below discusses the primary benefits (Brown *et al.*, 1995 and EPA, 2012) found through the implementation of GI in an urban area. The table then provides a low, medium and high rating of how each benefit positively influences each of the previously mentioned vital signs. If a benefit was directly addressing a vital sign, it would receive a high rating. The rating would decrease as the impact of the benefit shifted focus to other vital signs.

Table 3.3: Importance of GI

Benefit	Explanation	Positive effect on vital signs				Other positive effects	
		Biodiversity	UHI	USS	Soil degradation	LED	Local Social Impact
Direct UHI Mitigation	By increasing the amount of urban green space and vegetation, GI can help mitigate the effects of UHI's and reduce energy demands. Trees can provide shade and release water vapour as well as increase vegetation volume which all lower UHI affect.	MEDIUM	HIGH	MEDIUM	LOW	HIGH	LOW
Improved Recreational Space	By viewing green open space as a multifunctional area, more green open spaces will be considered and urban areas will be planned around green open spaces rather than green spaces being used to fill the gaps.	MEDIUM	HIGH	LOW	MEDIUM	LOW	HIGH
Improved Air Quality	GI contributes to improved air quality by facilitating the incorporation of trees and vegetation in urban landscapes. Trees and vegetation absorb certain pollutants from the air through leaf uptake and contact removal. If widely planted throughout a community, trees and plants can even cool the air and slow the temperature.	HIGH	HIGH	LOW	LOW	LOW	MEDIUM
Improved Human Health	Recent research has suggested that the presence of trees, plants and green space can reduce levels of internal city crime and violence, provide a stronger sense of community, improved academic performance and even reduce the symptoms associated with attention deficit and hyperactivity disorders.	MEDIUM	LOW	LOW	LOW	HIGH	HIGH
Increased Groundwater Infiltration	Groundwater provides about 40% of the water needed to maintain normal base flow rates in our rivers and streams. GI technologies can improve the rate at which groundwater aquifers are replenished. Improved groundwater recharge can also boost the supply of drinking water for private and public uses.	MEDIUM	MEDIUM	HIGH	HIGH	MEDIUM	LOW

Lower Energy Demands	Green roofs and other GI can also lower the demand for air conditioning energy, thereby decreasing the UHI affect through vegetation improve air quality.	MEDIUM	HIGH	LOW	LOW	HIGH	MEDIUM
Reduced Sewer Overflow	Through natural retention and infiltration proficiencies of plants and soils, GI limits the frequency of sewer overflow events by reducing runoff volumes and delaying stormwater discharges.	LOW	LOW	HIGH	HIGH	MEDIUM	LOW
Reduced Stormwater Runoff	By increasing the amount of pervious ground cover, GI increase stormwater infiltration rates. This leads to a reduction the volume of runoff entering our combined or separate sewer systems and ultimately our lakes, rivers, and streams. Bioswales or rain garden are more natural GI methods used to lower stormwater runoff.	MEDIUM	MEDIUM	HIGH	HIGH	LOW	LOW
Reduced Stormwater Pollutant	GI techniques infiltrate runoff close to its source, this helps to prevent pollutants from being transported to nearby surface waters. Once runoff is infiltrated into soils, plants and microbes can naturally filter and break down many common pollutants found in stormwater.	HIGH	LOW	HIGH	HIGH	LOW	LOW
Wildlife Habitat	Wetlands, parks (active or passive), greenways, urban forests and vegetated swales are all forms of GI that provide increased wildlife habitat. Biodiversity will thrive through GI by maintaining and connecting the habitats.	HIGH	MEDIUM	MEDIUM	MEDIUM	LOW	HIGH

Source: Own Construction (2016) adapted from Brown *et al.* (1995) and EPA (2012)

3.3.1 Benefits of GI

Benedict & McMahon (2006:3) believes that just as growing communities upgrade and enlarge their built infrastructures the need increases to upgrade and enlarge their GI. Benedict & McMahon (2006:3) also state that the GI network sustains clean air, water and natural resources and enriches society's quality of life which will to promoting development rather than opposing it due to the development being sustainable. This is due to the fact that people will have some assurance that areas with a high biodiversity value will be protected, which makes people more docile to accommodating new development. Other advantages or benefits of GI include:

- GI practices create desirable and aesthetically appealing urban environments, this encourages people to stay or move to the area (ABS Materials Inc, 2016).
- GI implemented in urban areas leads to increased land values as the land found within the GI area is more desirable and aesthetically appealing than land in areas with no GI (EPA, 2012).
- GI can lower the stress on the municipal water supply through the use of blue roofs that serve the primary purpose of detaining stormwater (NYC Environmental Protection, 2016:1).
- GI can deliver habitats for an extensive range of species thus increasing biodiversity at landscape and ecosystem levels (Martínez *et al.*, 2010). High levels of biodiversity can make ecosystems more resilient and likely to deliver long term services (Bunker *et al.*, 2005).

Consequently it can be concluded that GI is an important concept in the modern world. The GI concept contributes and supports a sustainable existence and therefore can be used as a tool to enhance sustainability and sustainable development in modern urban settings.

3.4 Linking green infrastructure and spatial planning

GI entails a network of green spaces in a spatial plan, including ecosystems and biodiversity considerations. As urbanisation increases it creates a patchwork of land uses and if the urbanisation is not planned correctly it results in isolated green open spaces. Consequently green open space (natural ecosystems) become scattered across the landscape and will be displaced by new land-use developments as the city grows (Geneletti, 2004; Laforteza *et al.*, 2008). Benedict & McMahon (2006:7) described the basic physical layout of GI and made the basic connection between GI and spatial planning clear (refer to Figure 3.3). Benedict & McMahon (2006:7) believe that GI incorporates a range of natural and restored native landscape features and ecosystems that create a system of "hubs" and "links". "Hubs" are fixed

GI network that consist of reserves, large publicly owned lands, working lands such as farms, regional parks, community parks and natural areas. “Links” are described as connections (corridors) that interconnect the system (of hubs) and consist of large protected natural areas that connect existing parks, conservation corridors, greenways, greenbelts and ecobelts. To solve the issue of isolation described by Geneletti (2004) and Laforteza *et al.* (2008) the linkages will between GI will have to be planned and implemented as part of the city’s spatial plan. By improving the functional and spatial connectivity of GI landscapes the city will have an increase in value of the goods and services that ecosystems provide (Grimm *et al.*, 2008; Hodgson *et al.*, 2009) thereby improving the urban sustainability of the area and city.

However GI considers ecological and social values in combination with other land use developments, therefore it differs from other approaches in spatial planning (Aegisdóttir *et al.*, 2009). As previously mentioned GI purposely supports the restoration of landscapes by connecting (refer to Figure 3.3) them to provide optimal habitats and channels for species to live and move through (Kindlmann & Burel 2008). Therefore spatial planning will have to be involved in the implementation of GI as there are many factors to consider; the spatial planning will also vary depending on different scales (local, regional or national). Laforteza *et al.* (2013:3) confirms the scale variation of spatial planning and states that the various policies, plans and related activities found in GI are completed on different spatial scales ranging from local neighbourhood to the trans-national scales. The EEA (2011) identifies three spatial groups:

1. Local, neighbourhood and village scale;
2. Town, city and district scale;
3. City-region, region and national scale.

The potential for a link exists between GI and spatial planning and there is opportunity for integration. To further establish a link an example can be considered where GI can address integration. As previously discussed, GI can be attributed to a few main ecosystem services (refer to Chapter 3.3). Escalating levels of transport infrastructure, new land-use developments and urbanization have created barriers that result in natural ecosystems that have become scattered across landscapes and displaced (Laforteza *et al.*, 2008). The increasing fragmentation of landscapes and ecosystems is one of the challenges faced by ecosystem functionality (Laforteza *et al.*, 2010). This issue can be solved through correct GI and spatial planning, refer to Figure 3.3. If implemented correctly GI can address some of the current urban problems such as the fragmented green networks and ecosystem services. Consequently enforcing the importance of GI and establishing the link between GI and spatial planning. Strategies that counteract spatial fragmentation on a local and regional scale take the form of green belts, greenways and green networks (Goddard *et al.*, 2010). By incorporating these strategies GI can support spatial planning by guiding planning approaches to be more

sustainable, and further enforcing the link between spatial planning and sustainable development.

3.5 Conclusion

It can be concluded that green spaces such as parks, are no longer seen as open spaces that exist around planning, but rather as green infrastructure that forms part of the whole infrastructure of a settlement which is intentionally planned for (Sandström, 2002: 375). GI entails more than green open space planning; it entails a function through which multi-dimensional benefits that can be achieved. Planners and authorities should realise the importance of GI and the functioning thereof when considering future development proposals. Through the different definitions and perspectives it can be concluded that GI can provide grey infrastructure functions with the benefit of being a more sustainable approach considering the green network in and around cities, and addressing urban and climatic challenges through the integration of nature in the planning process. In planning terms, it can be implied that the primary goal of GI is to secure as many benefits from green spaces as possible to support sustainability objectives. Therefore GI is an important concept as it contributes and supports objectives of sustainability and sustainable development.

GI also supports ecosystems significantly through its spatial layout and techniques such as green roofs, bioswales, etc. (refer to Chapter 3.2.3). The integration of spatial and GI planning approaches could enhance the functioning of GI. The concept of green infrastructure repositions open space planning as “community amenity” to a “community necessity”. This research supports the findings of Beauchamp *et al.* (2011:1) that there is a need for an integrated framework to guide green infrastructure planning, especially in South Africa where, according to Cilliers (2014:28) the concept is still very limited. As such, the following chapter will discuss supportive international, national and local legislation in support of such an integrative approach.

CHAPTER 4: INTERNATIONAL AND NATIONAL LEGISLATION

4.1 Points of departure

According to De Jager (2000:3) legislation is a vital instrument in a government that is used in organising society and protecting citizens, however discipline and enforcement of a law is crucial or else a law has little or no value. This is also true for the urban planning discipline. Policies, acts, strategies and action plans are set into motion to provide a standard level, assistance and guidance to urban and regional development. Policies and legislation underlies all planning approaches and therefore a crucial issue to include when considering the development of a new framework to guide planning.

South Africa (SA) has undergone extensive social, political and economic changes since 1994. The country has drastically changed its development approaches and development plans from an Apartheid approach to a modern integrative approach. SA has shown an escalating commitment to sustainable development by developing its own national framework for sustainable development which was co-developed with its involvement in international negotiations (Montmasson-Clair, 2012:5). SA further identifies sustainable development as a human right in the Bill of Rights of its 1996 Constitution (Republic of South Africa, 1996), stating *“the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.”* SA was devoted to realizing the Millennium Development Goals (MDGs) (United Nations, 2015a) and the recently developed Sustainable Development Goals (SDGs) set out by the United Nations (United Nations, 2015b). The country has also set out to create its own environmental conservation legislation called the National Environment Management Act (NEMA), which supports sustainable development (NEMA, 1998). This chapter therefore captures the relevant policy and legislative framework that will impact and guide the development of a new proposed framework for Green Planning Development. It considers international and local policies and legislation, including the new Sustainable Development Goals, Agenda 21, Habitat Agenda, 1996 Constitution of SA, National Development Plan (NDP), Breaking New Ground (BNG), National Environment Management Act (NEMA), Spatial Planning and Land Use and Management Act (SPLUMA) and the Integrated Development Plan (IDP) of Johannesburg which is directly applicable to the primary case study to be discussed in Chapter 8 and 9.

The selected policies and legislation were evaluated in terms of its support to sustainable development and Green Infrastructure (GI) urban planning. Within this chapter the goals, objectives, aims or principles of the different legislation will be mentioned and discussed. The

goals, objectives, aims or principles that are bold are seen the most important or most applicable to sustainable development and green infrastructure planning. The purpose of this chapter is to gain a viewpoint on the focus and support of guiding policies and legislation with reference to sustainable development and GI (from a spatial planning perspective). Figure 4.1 captures the structure of Chapter 4.

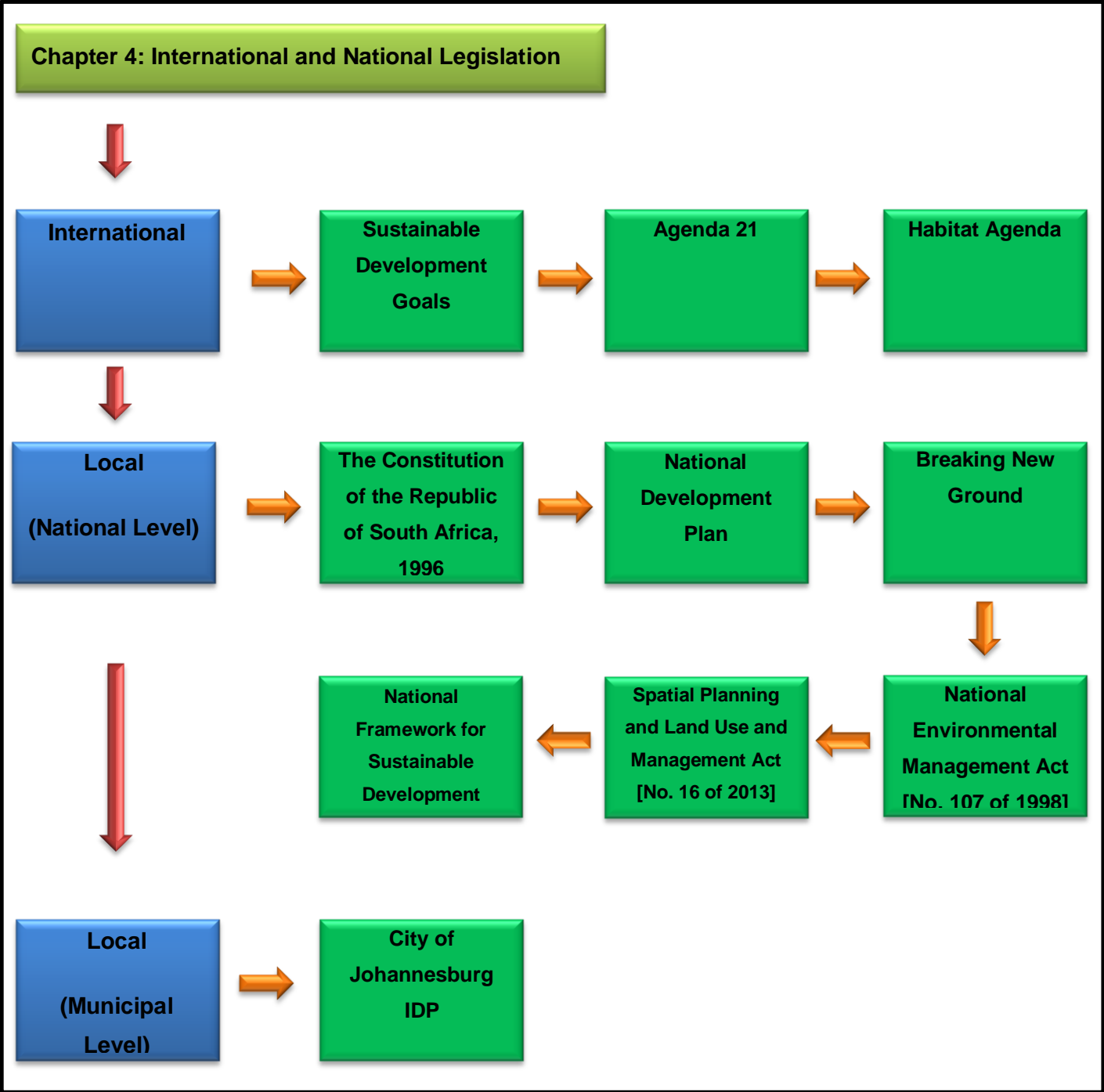


Figure 4.1: A graphical overview of the organisation and structure of Chapter 4
 Source: Own construction (2016)

4.2 International policies and legislation

International policies and legislation evaluated as part of this research included the 2016 Sustainable Development Goals, the 1992 Agenda 21 and the Habitat Agenda (Action Plan).

4.2.1 Sustainable Development Goals – SDG (Action Plan, 2016-2030)

As the MDGs have expired at the end of 2015, a new set of goals have been created, called Sustainable Development Goals (SDGs), which are built on the Millennium Development Goals (MDGs) (United Nations, 2015b). The goals are also known as Global Goals and there is a total of 17 goals. The SDGs will continue for the next 15 years until 2030. These goals have been adopted as of September 2015 by more than 150 world leaders of which South Africa is one (United Nations Development Programme, 2015). SDGs are as follows (United Nations, 2015b):

1. End poverty in all its forms everywhere
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3. Ensure healthy lives and promote well-being for all at all ages
4. Ensure inclusive and quality education for all and promote lifelong learning
5. Achieve gender equality and empower all women and girls
- 6. Ensure access to water and sanitation for all**
- 7. Ensure access to affordable, reliable, sustainable and modern energy for all**
8. Promote inclusive and sustainable economic growth, employment and decent work for all
- 9. Build resilient infrastructure, promote sustainable industrialization and foster innovation**
10. Reduce inequality within and among countries
- 11. Make cities inclusive, safe, resilient and sustainable**
- 12. Ensure sustainable consumption and production patterns**
- 13. Take urgent action to combat climate change and its impacts**
- 14. Conserve and sustainably use the oceans, seas and marine resources**
- 15. Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss**
16. Promote just, peaceful and inclusive societies
17. Revitalize the global partnership for sustainable development

The SDGs focus on themes and practical implementation, building upon the previous MDGs. The MDGs were formulated in 2000, eight international development goals that all 193 United Nations member countries (of which South Africa is one) and at least 23 international

organisations have agreed to achieve by the year 2015 (United Nations, 2015a). The eight MDGs are (United Nations, 2015a):

1. Eradicating extreme poverty
2. Achieving universal primary education
3. Promoting gender equality and empowering women
4. Reducing child mortality rates
5. Improving maternal health
6. Combating HIV/AIDS, malaria, and other diseases
- 7. Ensuring environmental sustainability**
8. Developing a global partnership for development

Goal number seven is the only goal applicable in supporting sustainability or green infrastructure planning. By considering the MDGs and comparing them to the new SDGs it is evident that the concept of sustainability gained importance since 2000. The MDGs only had one of eight goals focused on sustainable development whereas the SDGs have eight direct and three indirect of the 17 goals focused on sustainable development (and related green infrastructure planning). The SDGs also points out individual sustainability issues. The United Nations Development Programme (UNDP) stated that it will support governments around the world in undertaking the new agenda and taking it forward up to 2030 (United Nations Development Programme, 2015).

4.2.2 Agenda 21, 1992 (Action Plan)

The United Nations created the Agenda 21 in 1992 as a non-binding, voluntarily implemented action plan to enhance sustainable development. The Agenda 21 was set to overcome problems of ill health, poverty, illiteracy, hunger and the constant weakening of the ecosystems (United Nations, 1992:3). United Nations (1992:3) stated that “*Agenda 21 addresses the pressing problems of today and also aims at preparing the world for the challenges of the next century.*” The focus on sustainable development was captured in Section II of the Agenda 21 under “Conservation and Management of Resources for Development” and set out to (United Nations, 1992:76-269):

- **Protection of the atmosphere**
- **Integrated approach to the planning and management of land resources**
- **Combating deforestation**
- **Managing fragile ecosystems: combating desertification and drought**
- **Managing fragile ecosystems: sustainable mountain development**
- **Promoting sustainable agriculture and rural development**

- **Conservation of biological diversity**
- **Environmentally sound management of biotechnology**
- **Protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources**
- **Protection of the quality and supply of freshwater resources: application of integrated approaches to the development, management and use of water resources**
- **Environmentally sound management of toxic chemicals, including prevention of illegal international traffic in toxic and dangerous products**
- **Environmentally sound management of hazardous wastes, in hazardous wastes**
- **Environmentally sound management of solid wastes and sewage-related issues**
- **Safe and environmentally sound management of radioactive wastes**

Most objectives were focused on the natural environment and how to conserve it, and as a result not much focus was placed on the urban environment and how to integrate the urban and natural environments.

4.2.3 Habitat Agenda, 1996 (Action Plan)

The Habitat Agenda is also a non-binding, voluntarily implemented action plan of the United Nations, developed to guide sustainable development. UN-Habitat (2003) stated that *“We recognize the imperative need to improve the quality of human settlements, which profoundly affects the daily lives and well-being of our peoples. There is a sense of great opportunity and hope that a new world can be built, in which economic development, social development and **environmental protection** as interdependent and mutually **reinforcing components of sustainable development** can be realized through solidarity and cooperation within and between countries and through effective partnerships at all levels. International cooperation and universal solidarity, guided by the purposes and principles of the Charter of the United Nations, and in a spirit of partnership, are crucial to improving the quality of life of the peoples of the world.”*

The importance of sustainable development (and related green infrastructure planning) in the modern world is evident in the above statement. The Habitat Agenda recognised that developing countries lack the legal, human resources, institutional, financial and technological to respond adequately to rapid urbanization (UN-Habitat, 2003). It is the right and responsibility of the State to implement the Habitat Agenda in conformity with all human rights and fundamental freedoms. Habitat Agenda was thus set to be implemented on all levels of local,

regional and national governance, with the aim to provide adequate shelter for all, along with sustainable human settlements. As such, the objectives of Habitat Agenda were set to:

- **Create equitable human settlements**
- Eradicate poverty
- Promote human health and quality of life
- **Plan, develop and improve human settlements to be sustainable**
- Improve the quality of life of all people
- Strengthen the family as basic unit of society
- Generate a sense of citizenship and identity, cooperation and dialogue
- Create partnerships
- Create solidarity
- **Safeguard the interests of present and future generations in human settlements**

The Habitat Agenda included all spheres of sustainability (refer to Chapter 2.3) linked to human settlement development across a range of scales. Settlements include a range from villages to cities to metropolitan areas. The plan provided a basic concept and aims to achieve in order to reach an overall sustainable settlement.

4.3 Local policies and legislation: National level planning

National policies and legislation evaluated as part of this research included the 1996 Constitution of the Republic of South Africa, National Development Plan 2010, Breaking New Ground 2004, National Environmental Management Act [No. 107 of 1998] and Spatial Planning and Land Use and Management Act [No. 16 of 2013].

4.3.1 The Constitution of the Republic of South Africa, 1996 (Legislation)

The 1996 Constitution of South Africa identified sustainable development as a human right in the Bill of Rights, found in Section 24 of the Constitution, stating that (Republic of South Africa, 1996) *“Everyone has the right to an environment that is not harmful to their health or wellbeing; and to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures that prevent pollution and ecological degradation promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.”*

The fact that people have the right to sustainable environment in terms development, conservation, ecology and sociology proves the rising importance of sustainability in the modern era, especially since 1994 when Democracy came into play. Section 24 (b), specifically, linked

to the objectives of sustainable development as per definition given by the Brundtland Report in 1987 (WCED, 1987).

4.3.2 National Development Plan, 2010 – NDP (Strategy/Policy)

The National Development Plan (NDP) presented a long-term (more or less 20 years) plan, perspectives and goals for SA. It identified weak aspects of the country, along with goals and actions to address such and reach the set development goals. Therefore it defines a desired endpoint and identifies the role each different sector of society needs to play in order to reach that goal. According to the South African Government News Agency (2013.) the NDP serves four overall objectives, including:

1. Providing overarching goals for SA wants to achieve by 2030.
2. Creating consensus on the key complications that prevents achieving these goals and what needs to be done to overcome those complications.
3. Providing a joint long-term strategic framework, within more detailed planning can take place. This is done in order to advance the long-term goals set out in the NDP.
4. Creating a basis for making choices about how to make best use of limited resources.

Within these four broad objectives specific aims were identified in the NDP, such as addressing (South African Government News Agency, 2013.):

- Employment.
- Social protection.
- **Housing, water, electricity and sanitation.**
- Safety and security.
- Quality health care.
- Recreation and leisure.
- Quality education and skills development.
- **Clean environment.**
- Adequate nutrition.
- **Safe and reliable public transport.**

A focus on sustainable development and green infrastructure planning is found in Chapter 5: Environmental Sustainability and Resilience of the NDP. The NDP (NPC, 2011) states that *“Developing countries are at a specific risk due to a combination of geography, the inherent weakness of poor communities to environmental threats, and the pressures that economies based on resource extraction place on the environment”*. South Africa needs to strengthen the resilience of its society and economy to the negative effects which the country is subjected too

(NPC, 2011). Chapter 5: Environmental Sustainability and Resilience aims to combat these negative effects through meeting the following objectives (NPC, 2011):

- A set of indicators for natural resources, accompanied by publication of annual reports on the health of identified resources to inform policy.
- A target for the amount of land and oceans under protection (presently about 7.9 million hectares of land, 848kms of coastline and 4 172 square kilometres of ocean are protected).
- Achieve the peak, plateau and decline trajectory for greenhouse gas emissions, with the peak being reached around 2025.
- By 2030, an economy-wide carbon price should be entrenched.
- **Zero emission building standards by 2030.**
- **Absolute reductions in the total volume of waste disposed to landfill each year.**
- **At least 20 000 MW of renewable energy should be contracted by 2030.**
- Improved disaster preparedness for extreme climate events.
- **Increased investment in new agricultural technologies, research and the development of adaptation strategies for the protection of rural livelihoods and expansion of commercial agriculture.**

These objectives are heavily focused on the environment and how developments and technologies can reduce the negative effects created by them if planned correctly. Chapter 8 “Transforming Human Settlements” is specifically focused on the development and implementation urban environments, including objectives of (NPC, 2011):

- **Strong and efficient spatial planning system, well integrated across the spheres of government.**
- Upgrade all informal settlements on suitable, well located land by 2030.
- **More people living closer to their places of work.**
- Better quality public transport.
- **More jobs in or close to dense, urban townships.**

This chapter mainly considers spatial planning of cities and is therefore applicable to sustainable development and green infrastructure planning (refer to Chapters 2.5 and 3.4 for the established link between spatial planning and sustainable development - green infrastructure planning respectively). The NDP is concluded to be a national document which promotes the concept of sustainable development. The goals and objectives set up are in line with what sustainable development and green infrastructure planning aims to achieve.

4.3.3 Breaking New Ground, 2004 – BNG (Strategy/Policy)

The BNG strategy aims to promote an integrated society in SA, by developing sustainable human settlements and quality housing within a subsidy system for different income groups. However the link to sustainable development and green infrastructure planning within the BNG lies in “Part B: Comprehensive Plan, Chapter 3: From Housing to Sustainable Human Settlements”, including objectives such as (National Housing Development Agency, 2004):

- **Pursuing a more compact urban form**
- **Facilitating higher densities**
- **Mixed land use development**
- **Integrating land use and public transport planning**

The BNG is specifically focused on spatial planning and to ensure more diverse and responsive environments (similar to the NDP, refer to 4.3.2). Nevertheless the inequalities and inefficiencies of SA’s apartheid space economy inheritance are still noticeable despite all these well intended measures. The BNG identified that a spatial restructuring is needed and referred to “Sustainable human settlements” as (National Housing Development Agency, 2004), *“well-managed entities in which economic growth and social development are in balance with the carrying capacity of the natural systems on which they depend for their existence and result in sustainable development, wealth creation, poverty alleviation and equity”*. At the heart of this initiative is the move beyond the provision of basic shelter towards achieving the broader vision of sustainable human settlements and more efficient cities, towns and regions The National Housing Development Agency will enhance its contribution to spatial restructuring by (National Housing Development Agency, 2004):

- Progressive Informal Settlement Eradication
- Promoting Densification and Integration
- Enhancing Spatial Planning
- Enhancing the Location of New Housing Projects
- Supporting Urban Renewal and Inner City Regeneration
- Developing Social and Economic Infrastructure
- Enhancing the Housing Product

These goals are not focused directly on sustainable development and green infrastructure planning, however the problems identified which the above mentioned goals aim to correct will have to be conquered in order to achieve a good foundation. And only after this foundation has been established can the direct focus on sustainable development and green infrastructure planning advance in the country. Therefore making these contributions to spatial restructuring

identified by the BNG crucial to achieving sustainability. The BNG policy was discussed in this chapter due to the fact that the primary case study (Fleurhof) makes use of BNG housing typology.

4.3.4 National Environmental Management Act [No. 107 of 1998] – NEMA (Legislation/Act)

The National Environmental Management Act (NEMA) states that everyone has the right to an environment that is not harmful to their health or well-being (refer to Chapter 4.3.1). NEMA considers that inequality (wealth and resources) and poverty are among the leading causes of environmentally harmful practices. According to NEMA (1998:2), sustainability is *“the integration of social, economic and environmental factors in the\ planning, implementation and evaluation of decisions to ensure that development serves present and future generations.”*

NEMA sees the environment is a functional area of coexisting national and provincial legislative competence and believes that all spheres of government and state must co-operate, consult and support each other. NEMA aims to provide co-operative, environmental governance by (NEMA, 1998:2):

- Establishing principles for decision-making on matters affecting the environment,
- Establishing institutions that will promote co-operative governance,
- Establishing procedures for co-ordinating environmental functions exercised by organs of state.

The core principles by which NEMA is governed are applicable throughout SA, to the actions of all organs of state that may considerably affect the environment. These principles serve as a guideline and a general framework within implementation and environmental management plans must be formulated. The NEMA objectives include (NEMA, 1998:10-14):

- **Environmental management must place people and their needs at the forefront of its concern.**
- **Development must be socially, environmentally and economically sustainable.**
- **Sustainable development requires the consideration the following:**
 - That the disturbance of ecosystems and loss of biological diversity are avoided, minimised and remedied;
 - That pollution and degradation of the environment are avoided, minimised and remedied;
 - That the disturbance of landscapes and sites that establish the nation’s cultural heritage is avoided, minimised and remedied;

- That waste is avoided, minimised and re-used or recycled where possible and otherwise disposed of in a responsible manner;
 - That the use (and possible abuse) of non-renewable natural resources is responsible and reasonable, and that the concerns of depletion of the resource are taken into account;
 - That the development use (and possible misuse) of renewable resources and the ecosystems which they form part of do not exceed the level beyond which their integrity is threatened;
 - That negative impacts on the environment and on people's environmental rights be anticipated and prevented, minimised and remedied.
- **Environmental management must be integrated. Recognizing that all elements of the environment are linked and interrelated;**
 - **Responsibility for the environmental health and safety consequences of a policy;**
 - The participation of all interested and affected parties in environmental governance must be promoted and all people must have the opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation;
 - Community wellbeing and empowerment must be promoted through environmental education, raising of environmental awareness, sharing of knowledge and experience and other appropriate means;
 - The right of workers to refuse work that is harmful to human health or the environment, workers must be informed of dangers and must be respected and protected;
 - There must be intergovernmental co-ordination/ harmonisation of policies, legislation and actions relating to the environment;
 - Global and international responsibilities relating to the environment must be discharged in the national interest;
 - The environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage.

These principles are very focused on the sustainable use of the environment and green infrastructure planning. NEMA has taken all important factors into account, not only the physical impacts humans have on the environment but also how human interaction and laws can affect the environment. By proposing that environmental education is needed, rising of environmental awareness in communities, sharing of knowledge and experience of the environment means that NEMA suggests that people incorporate sustainable practises in their daily lives. NEMA applies to every level of governance (local, regional and provincial), and suggest an interconnected approach between the different spheres of government on both a physical and policy level.

4.3.5 Spatial Planning and Land Use and Management Act [No. 16 of 2013] – SPLUMA (Legislation/Act)

The Spatial Planning and Land Use and Management Act (SPLUMA) aims to provide South Africa with a framework for land use management and spatial planning, in hopes of stipulating a relationship between the land use management system and spatial planning (South Africa, 2013: 2). SPLUMA provides a framework through which the country can achieve efficient and equitable spatial planning as well as effective coordination among different spheres of government (South Africa, 2013: 2). Furthermore SPLUMA identified past regulatory and spatial imbalances that will be addressed by the Act. SPLUMA states that both forward planning and ongoing land use management need to incorporate the integration of social, economic and environmental to achieve a sustainable development of land. This will be done to ensure that development of land serves present and future generations (South Africa, 2013: 4). SPLUMA, like NEMA, applies to every level of governance (local, regional and provincial). SPLUMA provides the following development principles (South Africa, 2013: 18-20):

- The principle of spatial justice, whereby past spatial and other development imbalances must be redressed through improved access to and use of land.
- **The principle of spatial sustainability, whereby spatial planning and land use management systems must promote land development that is within the fiscal, institutional and administrative means of South Africa, protect prime and unique agricultural land, comply with environmental laws and limit urban sprawl.**
- **The principle of efficiency, whereby land development must optimise the use of existing resources and infrastructure and decision making procedures must be designed to minimise negative financial, social, economic or environmental impact.**
- **The principle of spatial resilience, whereby flexibility in spatial plans, policies and land use management systems are accommodated to ensure sustainable livelihoods in communities most likely to suffer the impacts of economic and environmental shocks.**
- The principle of good administration, whereby all spheres of government ensure an integrated approach to land use and land development, must provide their sector inputs and comply with any other prescribed requirements, transparent public participation takes place and policies, legislation and procedures must be clearly set.

Within the Development Principles SPLUMA provides aims towards sustainable development and green infrastructure planning by promoting the protection of prime and unique agricultural land and the compliance of environmental laws. Furthermore the principle of efficiency aims to

minimise negative impacts on all spheres of sustainability and the principle of spatial resilience guides support to communities most likely to suffer from the negative impacts. Therefore through the use of spatial planning and land use management systems (SPLUMA) these principles can be achieved by all spheres of government. The objectives of SPLUMA include (South Africa, 2013: 14):

- To provide for a uniform, effective and comprehensive system of spatial planning and land use management for the Republic;
- To ensure that the system of spatial planning and land use management promotes social and economic inclusion;
- To provide for development principles and norms and standards;
- **To provide for the sustainable and efficient use of land;**
- To provide for cooperative government and intergovernmental relations amongst the national, provincial and local spheres of government; and
- To redress the imbalances of the past and to ensure that there is equity in the application of spatial development planning and land use management systems.

SPLUMA doesn't directly address sustainable development (or green infrastructure planning) but does however focus on sustainable and efficient use of land. SPLUMA furthermore refers to sustainable development in its "Norms and standards" and states that "The norms and standards must promote social inclusion, spatial equity, desirable settlement patterns, rural revitalisation, urban regeneration and sustainable development;" (South Africa, 2013:20). Consequently solidifying the support provided to sustainable development and green infrastructure planning.

4.3.6 National Framework for Sustainable Development in South Africa, 2008. – NFSD (Framework)

The National Framework for Sustainable Development (NFSD) was created in July of 2008 (South Africa, 2008: 1). The NFSD aligned itself with the MDGs (refer to Chapter 4.2.1) and aims to become a coherent and overarching national strategy for sustainable development in South Africa by initiating a wide framework for sustainable development that can serve as a foundation for developing a national strategy and action plan (South Africa, 2008: 6). The NFSD states that sustainable development is (South Africa, 2008: 3) *"about enhancing human well-being and quality of life for all time, in particular those most affected by poverty and inequality. Resource use efficiency and intergenerational equity are the core principles."* The purpose of NFSD is to articulate South Africa's national vision for sustainable development and indicate strategic interventions to re-orientate South Africa's development so that it may become more sustainable (South Africa, 2008: 7). The NFSD states that its principles must guide all decisions

made and it divides the principles into three sections, namely the fundamental principles, substantive principles and process principles (South Africa, 2008: 8). The principles area as follow (South Africa, 2008: 8-9):

The fundamental principles relate to essential human rights that the Constitution guarantees:

- Human dignity and social equity,
- Justice and fairness,
- Democratic governance.

The substantive principles address the content and settings that have to be met in order to achieve a sustainable society. These principles are based on principles that are already enshrined in other legislation and policies:

- **Efficient and sustainable use of natural resources,**
- **Socio-economic systems are embedded within, and dependent upon, eco-systems,**
- Basic human needs must be met to ensure resources necessary for long-term survival are not destroyed for short term gain.

The process principles provide principles that specifically apply to the implementation of the NFSD:

- Integration and innovation,
- Consultation and participation,
- Implementation in a phased manner.

The substantive principles provide a direct focus on environmental sustainable development; the other two sections of principles are focused on broader perspective and include some social governing aspects. Furthermore the NFSD identifies five strategic priority areas that require action and intervention to reach the desired state of sustainable development; these include (South Africa, 2008:10):

- Enhancing systems for integrated planning and implementation,
- **Sustaining our ecosystems and using natural resources efficiently,**
- **Economic development via investing in sustainable infrastructure (refer to Chapter 4.4.1, Priority 3),**
- **Creating sustainable human settlements,**
- **Responding appropriately to emerging human development, economic and environmental challenges.**

The above identified five strategic priority areas address sustainable development in a practical manner and are aligned with principles of the NDP and NEMA. Four of the five strategic priority areas are directly addressing sustainability and only one of the five strategic priority areas indirectly address sustainability. The underlined principle can be perceived as promoting GI development as it is referring to an integrated plan and implementation (refer to Chapter 3); however this perception will depend on the discretion of the reader.

4.4 Local policies and legislation: Municipal level planning

4.4.1 City of Johannesburg Integrated Development Framework– CoJ IDP, 2016-2020 (Policy)

The primary case study, Fleurhof, is found within Region C of the City of Johannesburg (CoJ). Therefore the Integrated Development Plan (IDP) of Johannesburg is discussed as part of this research to understand the policy that guided the design and implementation of the case study..

The latest IDP for the CoJ was created in April of 2016 and is set to function until 2021, and places people at the centre development (CoJ, 2016:9). The IDP states that poverty, inequality and unemployment are major issues within SA and labels these issues as the “triple challenges” (CoJ, 2016:1). The CoJ’s IDP set a long term goal to create a city environment that is resilient, sustainable and liveable by 2040 (CoJ, 2016:1). The IDP has, in this sense, has been aligned with the objectives of the NDP (refer to Chapter 4.3.2) and the SDGs (refer to Chapter 4.2.1), (CoJ, 2016:1).

Furthermore the vision of the IDP is to create a world class African city and the mission set out is to collectively enable support that drives economic growth, optimal management of natural resources and the environment and to develop an inclusive society that contributes the development of a capable and developmental local government (CoJ, 2016:2). The IDP set four outcomes which it wants to achieve by 2021, including (CoJ, 2016:2, 9):

1. Improved quality of life and development-driven resilience for all.
2. **A sustainable city which protects its resources for future generations and a city that is built to last and offers a healthy, clean and safe environment.**
3. An inclusive, job-intensive, resilient and competitive economy that harnesses the potential of citizens’.
4. A high-performing metropolitan government that proactively contributes to and builds a sustainable, socially inclusive, locally integrated and globally competitive Gauteng City Region (GCR) good governance requires an efficient.

The IDP has translated these four outcomes into 11 strategic priority implementation plans that will assist in addressing the challenges and gaps it faces. The strategic priorities are as follow (CoJ, 2016:2, 9):

1. Economic growth, job creation, investment attraction and poverty reduction.
2. Informal economy and SMME support.
3. **Green and Blue economy.**
4. **Transforming sustainable human settlements.**
5. **Smart City and innovation.**
6. Financial Sustainability.
7. **Environmental sustainability and climate change.**
8. Building safer communities.
9. Social cohesion community building and engaged citizenry.
10. Repositioning Johannesburg in the global arena.
11. Good governance.

Priorities 4 and 7 will impact sustainable development and green infrastructure planning the most direct as they the most sustainable and environmentally focused. Priorities 4 and 7 are self-explanatory as these follow the general concepts about achieving a sustainable existence as mentioned before in previously discussed legislation and polices. However priorities 3 and 5 will be explained as their titles may sound irrelevant or misleading.

Priority 3: Green and Blue economy. The “green economy” priority focuses on a set of interlinked developmental outcomes for the city’s economy including (CoJ, 2016:2, 10):

- The growth of green economic activities that foster improved investment, jobs and competitiveness in the green economy sector; and
- The establishment of a shift in the economy as a whole towards a cleaner economy.
- **The City aims to support the growth of a greener city bolstered by the growth of a cleaner, inclusive economy – with programmes focusing on the reduction of carbon emissions, minimisation of waste impacts, protection of the natural environment and the sustainable use of resources in economic activities.**

The underlined points are attempting to improve the environment through an approach which has not been noted yet in the previously discussed legislation and polices. This approach aims to make use of the economy to support and improve what it titled the green economy sector, by increasing the economic activity in sections of the economy that affect the environment. This will therefore increase income and productivity in these economic sections and improve support and

guidance. The bolded point has the most direct impact on sustainable development and green infrastructure planning and it self-explanatory.

Priority 5: Smart City and innovation. The objective of this priority is to grow the CoJ's ability to provide services that are easy to access and use while being efficient and responsive (CoJ, 2016:2, 10). The outcomes of this priority are:

- Improved social development.
- Service delivery efficiency via smart-metering for water and electricity services, E-services, and widespread access to broadband.
- Better decision-making through the integration of city-wide data into a single view.
- An increase in economic activity.
- Active citizen participation and engagement through a user-friendly Johannesburg Application or App.
- **The creation of a sustainable and liveable environment via technological options that improve resource use and that allow for planning to be aligned to urban trends and pressures.**

The underlined point refers to a smart-metering for water and electricity services, these gadgets will assist in improving the overall usage (and wastage) of the services and consequently contributing to a more sustainable urban environment and lowering negative impacts on the environment. The bolded point refers to planning that should be aligned to urban trends and pressures, this may depend on the interpretation and what is considered to be a trend or pressure at the time. However it can lead to the support and implementation of sustainable development and green infrastructure planning as current trends and pressures are leaning towards a sustainable future.

The CoJ's IDP had one major aim; to create a world class African city. In this sense, the IDP offers support and guidance towards sustainable development and green infrastructure planning.

4.5 Conclusion

It can be concluded that supportive documentation (legislation, strategies, action plans, acts and policies) play a major role in sustainable development and green infrastructure planning on various government levels. The importance of the sustainable development and GI concepts can be noted on all levels of governance. It is important to consider policies and legislation in terms of local context, thus referring to international guidelines but adopting and implementing such to fit the local context.

As previously mentioned SA has many primary problems that should be addressed as part of broader sustainable development thinking. This includes a better coordination between spheres of government and addressing awareness and knowledge regarding sustainability and green infrastructure planning. Table 4.1 provide a comparative analysis of the included policies and legislation. Each policy and legislation was rated on a scale of 1-5 to illustrate its support to the specific concepts of 1) Sustainable Development, 2) Green Infrastructure, 3) Spatial Planning and 4) Environmental Focus. The evaluation rating given to each policy and legislative document is based on the support provided to each of the four concepts, with 1 being minimal and 5 begin maximal.

From the comparative analysis it is evident that both international and local policies and legislation are increasingly including objectives of sustainable development and green infrastructure planning. It is noted that legislation and policies are only in place to guide plans and propose goals. By analysing Table 4.1 and all the legislation and policies discussed within this chapter, it has been noted that the support for green infrastructure planning isn't direct. Support and guidance does exist however it is only to the discretion of the reader/interpreter. There have been no direct references to GI but principles and objectives want to achieve tasks that can be achieved through the implementation of GI. For example a principle brought forth by NEMA (refer to Chapter 4.3.4) was to realize that environmental management must be integrated and recognizing that all elements of the environment are linked and interrelated. This principle is essentially what GI stands for, integration of the environment and urban areas by connecting different environmental spaces within a city as they support and benefit each other. Consequently it is concluded that the support for GI in legislation and policies is at the discretion of the reader/interpreter. These policies and legislation provide adequate scope to include sustainable development and GI as part of the spatial planning processes, but implementation guidelines should be develop to direct future development in this direction. The following chapter aims to investigate such approaches by evaluating various indexes and frameworks to guide the development of a green planning framework.

Table 4.1 Policy and Legislation Evaluation

		International			National						Local
		Sustainable Development Goals	Agenda 21	Habitat Agenda	The Constitution of the Republic of South Africa	NDP	BNG	NEMA	SPLUMA	NFSD	JHB IDP
Supportive of specific concept	Sustainable Development	5	4	3	5	5	1	5	4	5	5
	Green Infrastructure	5	3	3	3	3	1	3	3	3	3
	Spatial Planning	1	1	1	1	5	5	1	5	1	3
	Environmental Focus	5	5	2	5	5	1	5	2	5	5
Total Rating (20)		16	13	9	14	18	8	14	14	14	16

Source: Own construction (2016)

Evaluation Rating	
1	No support
3	Support depends on interpreter
5	Full support

CHAPTER 5: CURRENT FRAMEWORKS AND PERFORMANCE INDICES

5.1 Points of departure

Chapter 5 aims to identify and discuss tools, in the form of frameworks and performance indices, used to evaluate the sustainability of cities in an attempt to guide the development of the proposed integrated framework for Green Planning Development (captured in Chapter 7). Therefore this chapter considered best practises and established frameworks and performance indices in order to develop the proposed Green Planning Development framework. Indicators of sustainability are a proven method for driving sustainable urban development, as they clearly indicate when there are problems or gaps which promotes the need to conquer the problems and fill out the gaps (Science for Environment Policy, 2015:23). Sustainability indicators, in this sense, deliver the simple, measurable evidence required to build and uphold cities to be environmentally-friendly, promote long-term economic productivity and stimulate health and well-being of its residents. Selecting suitable sustainability indicators can however be difficult as there are a variety of indicators that needs to be carefully selected to fit the local challenge and objectives.

As such Chapter 5 included the African Green City Index (AGCI), An Assessment Framework for Monitoring Cities' Sustainability (AAFMCs) and the Global City Indicator Facility (GCIF). These tools are the outcome of what a multi-disciplinary group have developed and have put in to practise. Figure 5.1 captures the structure of Chapter 5.

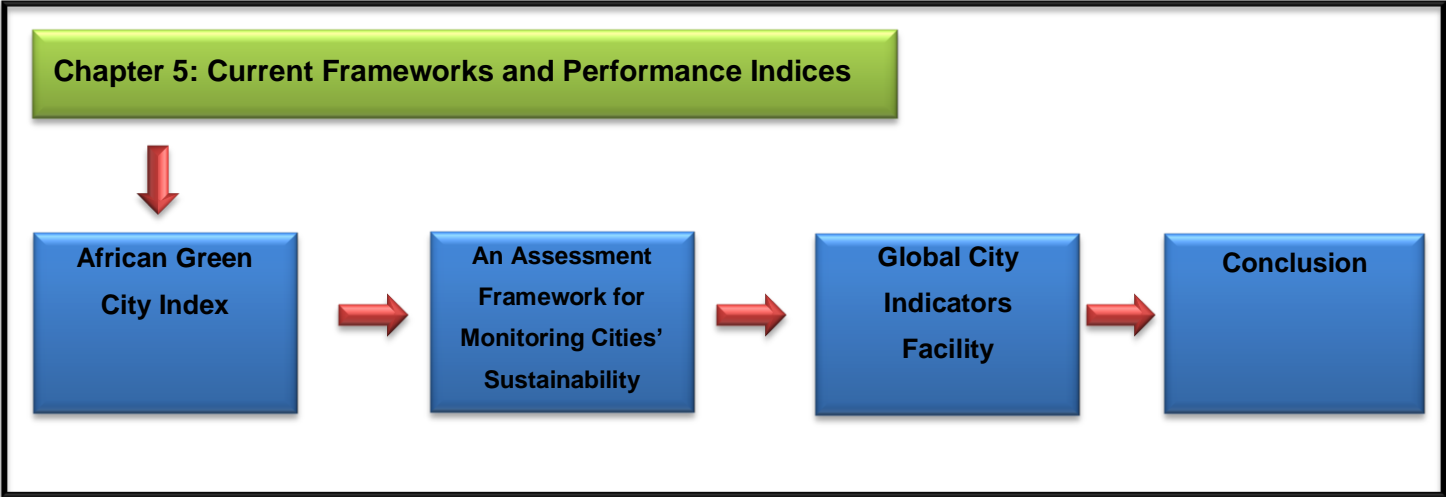


Figure 5.1: A graphical overview of the organisation and structure of Chapter 5
Source: Own construction (2016)

5.2 African Green City Index

The first performance index tool that was included as part of this research, is the African Green City Index (AGCI), a research project conducted by the Economist Intelligence Unit (EIU) and sponsored by Siemens. This performance index was selected as it is one of few that focus on an African context. The main objective of the document is "Assessing the environmental performance of Africa's major cities" (Siemens AG, 2011:1). The AGCI measured the environmental performance of 15 major African cities as well as their commitment to reducing the city's environmental impact. Representatives of major African countries, leading business capitals and capital cities were selected on the basis of data availability, size and geographical spread. A city was removed from the selection if there was a significant lack of data relating to the city. The methodology was developed by the EIU in co-operation with Siemens, and was based on the success of previous Green City Indexes Europe, Germany, Latin America, Asia, US and Canada (Siemens AG, 2011:1), and has adapted to accommodate variations in data quality, availability and environmental challenges applicable to Africa (Siemens AG, 2011:28). Vital insight and feedback is provided by an independent board of international experts in the field of urban sustainability. Figure 5.2 illustrates the different categories under which each city was analysed, which are important for this research, as it identifies broad categories that could be used to guide green planning. The final results of each city are not of importance in this case.

Category results

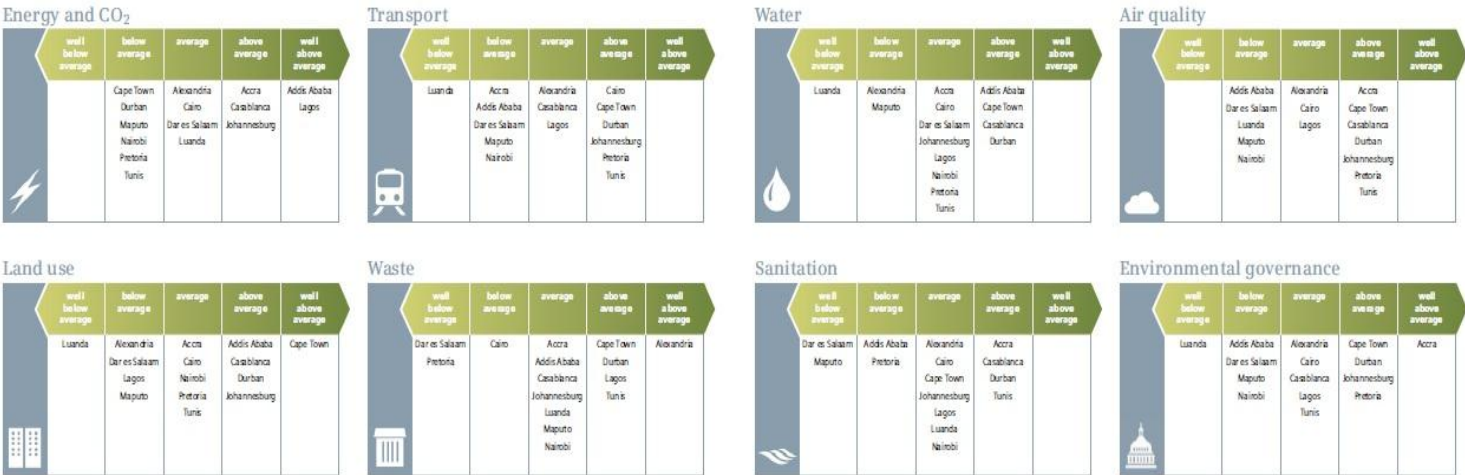


Figure 5.2: Category Results of the Index
Source: Siemens AG (2011:8-9)

The AGCI identified eight major categories through which the cities are assessed. Each one of the eight major categories had indicators that were used to complete a detailed evaluation to gather the needed data. The eight major categories include (Siemens AG, 2011:8-9):

1. Energy and CO₂
2. Transport
3. Water
4. Land Use
5. Waste
6. Air quality
7. Sanitation
8. Environmental Governance

The AGCI rated the cities through five levels, from well below average to well above average, however no numerical value was attached to the rating (Siemens AG, 2011:8-9). Each of the major categories was linked to indicators comprising of quantitative and qualitative data with a weight allocated to the specific indicator. The weight allocation is in place so that a score can be determined for each indicator, these weights then count as a percent score of each category to make one whole. The total score from the categories equates to 1/8 of the final city score. For example, under Energy and carbon dioxide (CO₂) (which is one of the eight major categories) there are four indicators with each counting 25% towards the major category (Siemens AG, 2011:31). And the major category, in this case is Energy and carbon dioxide (CO₂), counts 1/8 of the final score for that city.

Table 5.1 below provides all the major categories with their indicators as well as the descriptions of each indicator. The quantitative indicators were “normalised” on a scale of zero to ten (0-10); the best city scoring ten points and the worst scoring zero. The qualitative indicators were measured and scored by EIU experts in the city in question. This method was based on predetermined objective scoring criteria that consider the cities targets (goals), strategies and concrete actions. Furthermore the qualitative indicators were also scored on a scale of zero to ten (0-10), with full points allocated to cities that meet the criteria on the checklist. In the case of the “clean air policy” indicator, for example, legislation or policies were assessed to check if the city has plans to sustain or improve local air quality and also to evaluate the degree these legislation or policies are enforced (Siemens AG, 2011:30).

Table 5.1: African Green City Index Categories and Indicators

Categories	Indicator	Type	Weight	Description
Energy and CO ₂	Access to electricity	Quantitative	25%	Percentage of households with access to electricity.
	Electricity consumption per capita	Quantitative	25%	Total electricity consumption, in GJ per inhabitant (1 GJ = 277.8 kWh).
	CO ₂ emissions from electricity consumption per capita	Quantitative	25%	CO ₂ emissions, in kg per capita.
	Clean energy policy	Quantitative	25%	Measure of a city's efforts to reduce carbon emissions associated with energy consumption.
Transport	Public transport network	Quantitative	33%	Consists of two equally weighted sub-indicators: 1) Length of superior transport network, 2) Length of mass transport network. Measure of a city's efforts to create a viable mass transport system as an alternative to private vehicles.
	Urban mass transport policy	Qualitative	33%	
	Congestion reduction policy	Qualitative	33%	Measure of a city's efforts to reduce congestion.
Water	Access to potable water	Quantitative	20%	Proportion of population with access to potable water.
	Water consumption per capita	Quantitative	20%	Total water consumption, in litres per person per day.
	Water system leakages	Quantitative	20%	Share of water lost in transmission between supplier and end-user, excluding illegally sourced water or on-site leakages, expressed in terms of total water supplied.
	Water quality policy	Qualitative	20%	Measure of a city's policy towards improving the quality of surface water.
	Water sustainability policy	Qualitative	20%	Measure of a city's efforts to manage water sources efficiently.
Air quality	Clean air policy	Qualitative	100%	Measure of a city's efforts to reduce air pollution.
Land Use	Population density	Quantitative	25%	Population density, in persons per km ² .
	Population living in informal settlements	Quantitative	25%	Percentage of the population living in informal settlements.

	Green spaces per capita	Quantitative	25%	Sum of all public parks, recreation areas, greenways waterways, and other protected areas accessible to the public, in metres squared per inhabitant.
	Land use policy	Qualitative	25%	Measure of a city's efforts to minimise the environmental and ecological impact of urban development
Waste	Waste generated per capita	Quantitative	33%	Total annual volume of waste generated by the city, including waste not officially collected and disposed, in kg per capita per year.
	Waste collection and disposal policy	Qualitative	33%	Measure of a city's efforts to improve or sustain its waste collection and disposal system to minimise the environmental impact of waste.
	Waste recycling and re-use policy	Qualitative	33%	Measure of a city's efforts to reduce, recycle and re-use waste.
Sanitation	Population with access to improved sanitation	Quantitative	50%	Share of the total population either with direct connections to sewerage, or access to on-site sources.
	Sanitation policy	Qualitative	50%	Measure of a city's efforts to reduce pollution associated with inadequate sanitation.
Environmental Governance	Environmental management	Qualitative	33%	Measure of the extensiveness of environmental management undertaken by the city.
	Environmental monitoring	Qualitative	33%	Measure of the city's efforts to monitor its environmental performance.
	Public participation	Qualitative	33%	Measure of the city's efforts to involve the public in environmental decision-making.

Source: Adapted from Siemens AG (2011:31)

The methodology and categories (with indicators) used in the AGCI were used to guide the proposed Green Planning Development framework (details in Chapter 7). However the weighted and scoring methods of the AGCI are not applicable to the proposed framework as some of the data and categories are qualitative and require an independent board of experts to weigh and score. The proposed framework only seeks to guide development and identify gaps.

5.3 An Assessment Framework for Monitoring Cities' Sustainability

The second tool included as part of this research was “*An Assessment Framework for Monitoring Cities' Sustainability*” (National University of Singapore, 2012) or AAFMCS, which was created as part of a research project completed by the Centre for sustainable Asian cities of the National University of Singapore. This benchmark tool is focused on Asian cities, however it can be applicable to African cities as the level of development and rate of urbanisation is very similar between African and Asian cities (United Nations, 2014: 1), therefore this tool was selected.

The primary questions asked by the AAFMCS are (National University of Singapore, 2012: 2):

- How can cities continue to seek and enjoy economic development, while conserving their resource base, supporting urban life quality and protecting their environments?
- How do cities chart their progress toward sustainable growth?
- What assessment tools are available to support the process?

The AAFMCS aimed to address these questions by appointing a multi-disciplinary research team to develop a comprehensive framework to guide the assessment of sustainable development in cities; therefore the AAFMCS is regarded as a framework. The major categories and their indicators included in this framework were collected from various international databases such as United Nations, World Bank, Organization for Economic Co-operation and Development and World Resources Institute. Other categories and indicators originate from local city databases that have done extensive work in this field, for example the Boston Indicators (National University of Singapore, 2012: 2). As the list of sustainability categories/indicators available was very large, the process of creating a shortened list of sustainable categories/indicators was an important step in the research. This shortened list makes the assessment readily implementable. Over 100 experts and approximately 20 government agencies were involved in the consultation and validation processes and a shortened list of sustainable categories and indicators were created, namely (National University of Singapore, 2012: 2):

- | | |
|--------------------------|----------|
| 1. Governance | 3. Land |
| 2. Towards Green Economy | 4. Water |

- | | |
|-----------------|--------------------|
| 5. Energy | 10. Transport |
| 6. Food | 11. Culture |
| 7. Biodiversity | 12. People |
| 8. Air | 13. Climate Change |
| 9. Waste | |

Each of the major categories was linked to indicators which refined the different aspects considered in the AAFMCS (National University of Singapore, 2012: 5-18). The indicators comprised of a mixture of quantitative and qualitative data, but without a weight or score as allocated to the different indicators, as the AAFMCS claims that providing weights to indicator tends to obscure contextual information that is important for meaningful city evaluation (National University of Singapore, 2012: 3). Table 5.2 below displays all the categories with their indicators as well as the descriptions of each indicator. It is noted that the AAFMCS is somewhat different to the previously discussed AGCI in terms of evaluation; the AAFMCS has many more qualitative indicators when compared to the AGCI.

Table 5.2: AAFMCS Categories and Indicators

Categories	Indicator	Type	Description
Governance	Institutional capacity	Qualitative	Evidence of horizontal coordination in government, interaction with local level authority and strong commitment of high-level government leadership in formulating, implementing and supporting urban sustainability strategies
	Mutli-stakeholder partnership and engagement	Qualitative/Quantitative	Public participation in decision making and implementing on urban sustainability and representation of major groups in city council
	Integrating sustainability and policy	Qualitative	Evidence of strategies for sustainable development and programs for environmental statistics and environmental-economic accounting
	Legal and regulatory frameworks	Qualitative	Ratification of global agreements related to sustainable development
	Economic instruments	Qualitative/Quantitative	Environmental taxes and fees: Has the city implemented environmental taxes and fees as an economic disincentive in the following areas? Subsidies and other financial incentives that promote
	And financial commitments		
Economy	Macroeconomic performance	Quantitative	GDP vitals, inflation and labour productivity
	R&D expenditure	Quantitative	Total R&D expenditures
	Resource productivity	Qualitative/Quantitative	Energy, water and land productivity
Land	Land conservation	Quantitative	Legally protected area - area of legally protected land as a percentage of the total land area. Land consumption - area of new development on undeveloped land tracked from a specified base year (sq. Km, trend).
	Regeneration and redevelopment of land	Qualitative	Land degradation and redevelopment of land.
	Land compactness	Quantitative	Intensification of housing development - number of dwelling units per 1 sq. Km
	Land optimisation	Qualitative	Land efficiency and extent of mixed use
Water	Water use	Quantitative	Total water used (m ³ /capita per day, trend), internal renewable freshwater per capita and its use.
	Urban water system	Quantitative	Energy used for water treatment - energy used per cubic meter of water treated to drinking water quality (kwh/m ³).
	Sanitation, wastewater treatment and reuse	Qualitative/Quantitative	Access to improved sources of sanitation and wastewater treatment coverage.
	Surface water quality	Qualitative	Monitoring surface water quality
	Marine pollution	Qualitative	Discharge of pollutants into coastal waters

Energy	Energy use and intensity	Qualitative	Total primary energy supply (TPES) and use (kwh/capita).
	Energy mix and security	Qualitative/quantitative	Percentage of fuel types used in terms of tonnes of oil equivalent (e.g. Coal, oil, nuclear, renewable, natural gas).
	Energy pricing		Household expenditure on energy
	Alternative energy	Qualitative/Quantitative	Does the city have any support mechanism for the promotion of alternative energy, and effective are these mechanism? Are there alternative energy sources in electricity generation and generating electricity for the city?
	Energy efficiency	Qualitative	The efficient use of energy within the city.
Food	Food production	Qualitative	Farming land, space and productivity. Strategies for food security.
	Food availability	Qualitative	Food self-sufficiency and imported.
	Economic access to food	Quantitative	Household food expenditure - percentage of monthly household food expenditure in relation to total monthly household expenditure.
	Food utilization	Qualitative	Dietary diversity - per capita consumption of key food categories per year. Food safety policy and programs.
	Education and awareness related to food	Qualitative	Education and awareness related to food
Biodiversity	Nature conservation	Quantitative	Number of selected native species and their respective populations. Ecosystem coverage: amount (ha) of selected key ecosystem types. Percentage of total protected areas and respective ecosystem type.
	Park and natural area provision	Quantitative	Total area and percentage of greenery at ground level compared to the total area of the city and area of parks, including those with natural areas, provided per 1,000 people in the city.
	Ecosystem services	Qualitative	Ecosystem services for climate resilience - does the city actively recognise or engage ecosystem services contributed by biodiversity and urban greenery to climate resilience? Regulation of quantity of water through permeable surfaces - proportion of all permeable areas to total terrestrial area. Carbon storage and cooling effect of vegetation through tree canopy coverage
Air	Air quality	Quantitative	Pollution pm 2.5 concentrations ($\mu\text{gram}/\text{m}^3$).
	Emission intensities	Quantitative	Total sulphur and nitrogen oxide emissions.
Waste	Waste generation	Quantitative	Total waste per capita (kg/capita per day).
	Waste intensity	Quantitative	Total waste per GDP (kg/us\$1,000).
	Waste recovery	Quantitative	Amount of waste recycled as a percentage of total waste generated. Waste finally disposed of by incineration, landfills or other means

Transport	Modal split	Qualitative/quantitative	Ratio of private and public motorised transport. Share of each mode (passenger cars, buses and coaches, and trains) in total inland passenger land transport measured in passenger-km percentages.
	Vehicle use and ownership	Qualitative/Quantitative	<p>Vehicle ownership</p> <p>a. The number of vehicles registered per 1,000 population.</p> <p>b. Does the city apply policies to control vehicles and usage?</p>
	Land use and transport integration	Quantitative	<p>Proportion of the total population living within a 400 m radius of transit facilities. Proportion of population employed within the transit shed.</p> <p>Geographic coverage of a city's public transport system</p> <p>a. Length (km) of rail network per developed land area in a city.</p> <p>b. Length (km) of bus routes per developed land area in a city.</p>
	Road traffic management	Quantitative	Road vehicle density. Minutes taken for the trips from home to workplace and back.
	Environmental and social impacts	Qualitative	Road safety. Household expenditure on transport.
Culture	Cultural institutions and enactments	Qualitative/Quantitative	Number of arts and cultural establishments by non-profit and commercial establishment per thousand of population. Cultural events displayed in public. Does the city have institutional mechanisms to support culture?
	Cultural milieu	Qualitative	Attendance to arts and cultural events annually
	Culture and economy	Qualitative/Quantitative	Government funding for arts and cultural programs. Philanthropic donations to arts and cultural programs. Number of persons employed full time in the cultural sector. Value added by cultural industries.
	Education for culture	Qualitative/Quantitative	Integration of arts and cultural education into the baseline curriculum of schools. Students in degree-granting arts and cultural programs.
People	Population profile	Quantitative	The annual rate of change of population size (%). Number of population aged 0-19 and 65 and above as a ratio of the working age population 20-64.
	Healthy life and healthcare services	Qualitative/Quantitative	Life expectancy at birth. Public expenditure on health. Availability of healthcare services. Health conditions.
	Educational attainment and services	Quantitative	Percentage of adults aged 25-64 who have completed at least (upper) secondary education. Percentage of adults aged 25-64 who are undergoing job related training as part of the total population of the same group. Government expenditure on education as % of GDP.
	Housing provision	Quantitative	Availability of adequate housing. Housing expenditure monthly (%). Housing standard - Floor area per person (sq m/person).

	Urban life quality	Quantitative	<p>Work-life balance - Percentage of employees working more than 50 hours per week. Income gap - Average income of the top 10% over the average income of the bottom 10% of the population (90-10 ratio). Long-term unemployment rate - Percentage of total number of active persons in the labour market that have been unemployed for 12 months. Crime rate - Number of crimes per 100,000 population. Percentage of population participating in the following activities in the last 12 months:</p> <ul style="list-style-type: none"> • Volunteering • Community events <p>Sense of belonging</p>
	Social cohesion	Quantitative	
Climate Change	Greenhouse gas emissions	Quantitative	GHG Emissions per unit GDP and per capita. Carbon intensity of domestic consumption measured in tonnes per GDP. GHG emissions by sectoral distribution (%)
	Climate change impacts	Qualitative	Assessing future projections of climate change. Assessment of climate impacts and risks/ vulnerability.
	Climate change Governance	Qualitative	Climate change strategy. Political support and leadership. Institutional capacity – Is there a dedicated city department unit, council or equivalent body to manage and govern the climate change mitigation and adaptation processes? Multi-stakeholder partnership and engagement.
	Mitigation strategy	Qualitative	Does the city have recognized inherent limitations/constraints to known climate change mitigation measures? Emission reduction targets. Mitigation strategies developed. Has the city prioritized/ adopted an
	Adaptation strategy	Qualitative	Does the city have recognized inherent limitations/ constraints to frame effective actions towards climate change adaptation? Has the city identified and developed key adaptation strategies, based on the

Source: Adapted from National University of Singapore (2012: 5-18)

The methodology used by the AAFMCS is very applicable to this research as the AAFMCS is not intended to be a comparison index but a framework. The proposed Green Planning Development framework is also not considered a comparison index, but will rather focus on identifying gaps and guiding Green Planning Development in future urban developments. The AAFMCS as a whole is aimed at Asian cities; which should make it compatible, with minor changes, to an African context as the both continents experience similar level of development and high urbanisation rates (United Nations, 2014: 1).

5.4 Global City Indicators Facility

The third tool included as part of this research is the Global City Indicators Facility (GCIF) which has been developed and implemented based on a standardised set of global indicators that allowed for city evaluation on an international scale. The GCIF initiative was led by the World Bank’s Latin America and Caribbean Region (LCR) which in 2007 was the most urbanized region within the developing world, with 77% of the LCR’s population living in cities. For the purposes of this initiative the World Bank also partnered with nine cities from the American continent found in countries such as Brazil, Canada, Colombia and the United States. The World Bank also consulted with several international agencies (like the UN-Habitat) and city-focused organizations, like the United Cities and Local Governments – UCLG. (Global City Indicators Facility, 2007a: 1). The GCIF Indicator project built on substantial existing work, particularly on that of the UN-Habitat’s Urban Indicators Programme, the Global Urban Indicators Database and the Global Urban Observatories (Global City Indicators Facility, 2008: i). The GCIF currently hosts a network of 253 cities across 80 countries (Global City Indicators Facility, 2013: 1).

The GCIF identified a lack of standardisation with regards to performance indicators and states this lack limits the ability of cities to learn from each other and share best practices (Global City Indicators Facility, 2008: i). Therefore the primary objective of the GCIF was to identify indicators that would be sufficiently standardized to allow for cross-city comparisons and third-party verification in terms of city sustainability (Global City Indicators Facility, 2008: i). A notable strength of the GCIF system is that it is easy to implement and to participate in (Global City Indicators Facility, 2008: v). Fifteen (15) major categories were identified in the GCIF; including (Global City Indicators Facility. 2007b):

- | | |
|---------------------|-----------------------------|
| 1. Economy | 6. Governance |
| 2. Education | 7. Health |
| 3. Energy | 8. People |
| 4. Environment | 9. Safety |
| 5. Fire & Emergency | 10. Technology & Innovation |

11. Transportation

14. Wastewater

12. Urban Planning, Shelter

15. Water

13. Waste Management

Each major category was linked to indicators, leading to a total of 115 indicators (refer to Table 5.3). The indicator list provided by the GCIF is often reviewed adapted as needs change over time. These indicators were divided into core and supportive indicators (Global City Indicators Facility, 2008: viii-x). The GCIF did not provide a weight or a method to rate or score the categories or indicators, as the GCIF aimed to be a guiding framework and not a comparison index. The GCIF does however state, where possible, what the global standard is in regards to each indicator. Table 5.3 below displays all the categories with their indicators as well as the descriptions of each indicator. It has been noted that the GCIF is similar to the AGCI in terms of types of data. The GCIF has many quantitative indicators and only a few qualitative indicators, therefore making it easier to analyse the data once it has been collected.

Table 5.3: The Global City Indicators Facility Categories and Indicators

Categories	Indicator	Type	Description
Economy	Country's GDP [\$]	Quantitative	The country's annual GDP, expressed in US dollars.
	City Product per capita [\$]	Quantitative	The total product of the city as defined in national accounts procedures. It may be taken as the total income or value-added (wages plus business surplus plus taxes plus imports), or the total final demand (consumption plus investment plus exports). The City Product expressed in current US dollars (the numerator) divided by the city population (the denominator), expressed in US dollars.
	GDP per capita [\$]	Quantitative	The country's annual GDP (the numerator) divided by the city population (the denominator), expressed in US dollars.
	% of country's GDP	Quantitative	The percentage of the country's GDP which is produced by the city.
	% of country's population	Quantitative	The percentage of the country's population represented by the city.
	Average household income [\$]	Quantitative	The average income of households within the city.
	Annual inflation rate (avg. of last 5 years) [%]	Quantitative	The average annual inflation rate over the last 5 years expressed as a percentage.
	Cost of living [\$]	Quantitative	The basic issue is what to include and what not to include in the market basket. This measure is not an absolute measure of poverty, since it is explicitly intended to provide a "credible" standard of living and not just bare-bones survival and as such is really measuring inequality and not poverty. At the same time, it is designed to fall short of a basket sufficient for social inclusion so that this inequality can be kept visible and reported regularly
	Income distribution [GINI Coefficient]	Quantitative	The GINI Coefficient
	Total employment	Quantitative	The total amount of residents permanently employed.
	Annual avg. unemployment rate [%]	Quantitative	The average annual unemployment rate expressed as a percentage.
	Employment % change based on the last 5 years	Quantitative	The average annual employment change rate over the last 5 years expressed as a percentage.
	% of persons in full time employment	Quantitative	The number of persons resident in the city in full time employment (the numerator) divided by the city population (the denominator), expressed as a percentage.
	Commercial/Ind. assessment as % of total assets'	Quantitative	The total value of all current Commercial/Ind. assessment in the city (the numerator) divided by the total assessed value of the city for the purposes of real property taxation (the denominator), expressed as a percentage.
	Number of businesses per 1000 population	Quantitative	The Number of businesses per 1000 population.

	% of city population living in poverty	Quantitative	The number of persons in the city living below the poverty threshold (the numerator) is divided by the total current population of the city (the denominator) expressed as a percentage.
Education	Student/teacher ratio	Quantitative	The number of enrolled primary school students (the numerator) is divided by the number of full-time equivalent primary school classroom teachers (the denominator), expressed as a ratio
	% of children completing primary & secondary ed.	Quantitative	Percentage of a cohort of students enrolled in the first grade of primary education who reached the final grade of primary education.
	% of students completing primary education	Quantitative	The number of students that have completed primary education (the numerator) divided by the amount of students who enrolled for primary education (the denominator), expressed as a percentage.
	% of students completing secondary education	Quantitative	The number of students that have completed secondary education (the numerator) divided by the amount of students who enrolled for secondary education (the denominator), expressed as a percentage.
	% of school-aged children enrolled in schools	Quantitative	The number of school aged children enrolled at primary and secondary levels in public and private schools (the numerator) divided by the total number of the school aged population (the denominator).
	% of male children enrolled in schools	Quantitative	The number of male students who enrolled for school (the numerator) divided by the total amount of students who enrolled for school (the denominator), expressed as a percentage.
	% of female children enrolled in schools	Quantitative	The number of female students who enrolled for school (the numerator) divided by the total amount of students who enrolled for school (the denominator), expressed as an percentage.
Energy	% of pop. with authorized electrical service	Quantitative	The number of persons in the city with lawful connection to the electrical supply system (the numerator) divided the total population of the city (the denominator), expressed as a percentage.
	Total residential electrical use per capita [kW]	Quantitative	The total electrical usage of a city in kilowatts (the numerator) divided by the total official number of households (the denominator).
	Total electrical use per capita [kW]	Quantitative	The total electrical usage of a city in kilowatts (the numerator) divided by the total official population of that city (the denominator).
	Electrical interruptions per customer [avg. #/yr]	Quantitative	The System Average Interruption Frequency Index (SAIFI) is commonly used as a reliability indicator by electric power utilities to measure the average number of interruptions per customer. It is typically reported annually.
	Avg. length of electrical interruptions [hours]	Quantitative	The Customer Average Interruption Duration Index (CAIDI) is a reliability index commonly used by electric power utilities to measure the average length of interruption. It is typically measured in hour

Environment	Green area per 100,000 population [ha]	Quantitative	The total number of hectares of green/open space (the numerator) is divided by 100,000th of the city population (the denominator), expressed as a whole number in hectares.
	% of non-residential area	Quantitative	The total size of all non-residential area within the city (the numerator) divided by the total size of residential area within the city (the denominator), expressed as a percentage.
	Public indoor recreation space per capita [m ²]	Quantitative	Square meters of indoor public recreation space (the numerator) divided by the population of the city (the denominator), expressed as the number of square meters of recreation space per capita
	Public outdoor recreation space per capita [m ²]	Quantitative	Square meters of outdoor public recreation space (the numerator) divided by the population of the city (the denominator), expressed as the number of square meters of recreation space per capita
	Global region	Qualitative	The global region found within the city.
	Climate type	Qualitative	The climate type found within the city.
	Average annual temperature [Celsius]	Quantitative	The average annual temperature, expressed in degrees Celsius.
	Average annual rainfall [mm]	Quantitative	The average annual rainfall, expressed in millimetres.
	Average annual snowfall [cm]	Quantitative	The average annual snowfall, expressed in centimetres.
	PM10 concentration [μm^3]	Quantitative	Particulate matter is a mixture of microscopic solids and liquid droplets suspended in air. These particulates are made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, soil or dust particles, and allergens (such as fragments of pollen or mould spores). Coarse particles are greater than 2.5 microns and less or equal to 10 microns in diameter and are defined as “respirable particulate matter” or PM10. Sources of coarse particles include crushing or grinding operations, and dust from paved or unpaved roads.
GHG Emissions [tonnes per capita]	Quantitative	The total tonnage of greenhouse gases (equivalent carbon dioxide units) generated over the past year by all activities within the city (the numerator) is divided the current city population (the denominator) expressed as a per capita figure.	
Fire & Emergency	No. of firefighter per 100,000 population	Quantitative	A fire fighter means a full time operational staff member located in the fire suppression unit that regularly responds to daily calls. It is not intended to include, staff from fire prevention, safety, training, administration, senior management not directly involved in fire suppression, communication and dispatch.

	No. of fire related deaths per 100,000 population	Quantitative	The number of deaths annually directly attributed to a fire incident.
	Response time for fire department [minutes]	Quantitative	The annual number of minutes elapsing from all initial distress calls to the on-site arrival of the fire department personnel and equipment (the numerator) is divided by the number of fire department responses in the same year (the denominator), expressed in minutes and seconds
Governance	Gross Operating Budget [\$]	Quantitative	The Gross Operating Budget, expressed in US Dollars.
	Gross Operating Budget per capita [\$]	Quantitative	The Gross Operating Budget per capita, expressed in US Dollars.
	Gross Capital Budget [\$]	Quantitative	The Gross Capital Budget, expressed in US Dollars.
	Gross Capital Budget per capita [\$]	Quantitative	The Gross Capital Budget per capita, expressed in US Dollars.
	Debt service ratio [%]	Quantitative	Debt service ratio is the ratio of debt service expenditures as a percent of a municipality's own source revenue. A lower number can indicate either an increased ability to borrow or a decision by a municipality to limit its debt to enable funding of other service areas.
	Tax collected as a % of tax billed	Quantitative	Ratio of the actual tax collected to the mandated tax.
	Capital spending as % of total expenditures	Quantitative	Each year at an agreed date (after the receipt of the audited accounts for the preceding year) the total expenditure on fixed assets (capital spending) in that preceding year is determined and this figure is then divided by the total expenditure by the city in that same period
	Own-source revenue as % of total revenues	Quantitative	Percentage of local government revenues originating from fees, charges and taxes as permitted by law or legislation to all revenues including those provided by other levels of government. This only includes operating or re-occurring revenues as determined through methods such as: formula driven payments (such as repatriation of income tax), grant donations from higher government levels including national or state governments and other types of financial transfers that may be tied to the delivery of specific services.
	% of women employed in the city government	Quantitative	The percentage of the city government workforce that is women or minority (the numerator) divided by the total number of the city government workforce (the denominator).
	Voter participation in last municipal election [%]	Quantitative	The number of persons that voted in the last major city election (the numerator) is divided by the city population eligible to vote (the denominator), expressed as a percentage a. The number of public officials elected by citizens of the city (the numerator) divided by one 100,000th of the city's current population (the denominator), expressed as the number of elected officials per 100,000 of city population. b. The second component of this indicator is whether or not citizens have the right, guaranteed by law, to examine and then make submissions/objections to urban planning, development and infrastructure policies/plans/projects prior to their approval/construction.
	No. of local officials elected to office per 100,000	Quantitative	
Type of government (e.g. Local, Regional, County)	Qualitative	The type of government that operates within the city.	

Health	No. of in-patient hospital beds per 100,000 pop.	Quantitative	Number of in-patient public hospital beds (the numerator) divided by 100,000th of the city population (the denominator), expressed as the number of in-patient public hospital beds per 100,000 of the City population.
	No. of physicians per 100,000 pop.	Quantitative	The number of general or specialized practitioners whose work-place is in the city (the numerator) divided by 100,000th of the city population (the denominator), expressed as the number of physicians per 100,000 of the City population.
	No. of nursing/midwifery personnel per 100,000 pop.	Quantitative	The number of nursing/midwifery personnel whose work-place is in the city (the numerator) divided by 100,000th of the city population (the denominator), expressed as the number of nursing/midwifery personnel per 100,000 of the City population.
	Average life expectancy	Quantitative	The average life expectancy
	Under age five mortality per 1,000 live births	Quantitative	The probability of a child born in a specified year dying before reaching the age of five is expressed as a rate per 1,000 live births..
People	Total population	Quantitative	Total population
	% of population that are children	Quantitative	Percentage of population that are children within the city.
	% of population that are youth	Quantitative	Percentage of population that are youth within the city.
	% of population that are adults	Quantitative	Percentage of population that are adults within the city.
	% of population that are senior citizens	Quantitative	Percentage of population that are senior citizens within the city.
	Male -Female ratio (# of males per 100 females)	Quantitative	The number of males per 100 females within the city.
	Annual population change	Quantitative	Annual population change within the city.
	Population Dependency Ratio	Quantitative	The number for people/children who can't support themselves and depend on someone else, expressed as ratio.
	[%] of population that are new immigrants	Quantitative	Percentage of population that are new immigrants within the city.
% of pop. migrating from elsewhere in country	Quantitative	Percentage of population migrating from elsewhere in country, within the city.	
Safety	No. of police officers per 100,000 population	Quantitative	The number of permanent full-time (or full-time equivalent) sworn police officers (the numerator) divided by 100,000th of the city population (the denominator), expressed as the number of police officers per 100,000 of the City population.
	No. of homicides per 100,000 population	Quantitative	The annual number of reported homicides (the numerator) is divided by one 100,000th of the city population (the denominator), expressed as the number of homicides per 100,000 of City population.
	Violent crime rate per 100,000 population	Quantitative	The number of all violent crimes reported (the numerator) divided by 100,000th of the city population (the denominator), expressed as the number of violent crimes per 100,000 of the City population.

Technology & Innovation	No. of internet connections per 100,000 pop.	Quantitative	The number of internet connections in the city (the numerator) divided by one 100,000th of the city's current population (the denominator), expressed as the number of establishments per 100,000 of city population.
	No. of new patents per 100,000 per year	Quantitative	The number of patents issued to city residents in that year (the numerator) divided by one 100,000th of the city's current population (the denominator), expressed as the number of new patents per 100,000 of city population.
	% of jobs in the cultural sector	Quantitative	The number of careers within the cultural sector of the city, expressed as a percentage.
	No. of higher education degrees per 100,000 pop.	Quantitative	The number of higher education degrees (the numerator) divided by one 100,000th of the city's current population (the denominator), expressed as the higher education degrees per 100,000 of city population.
	No. of telephones (landlines & cell) per 100,000 pop.	Quantitative	The number of telephone connections in the city including land lines and cellar connections (the numerator) divided by one 100,000th of the city's current population (the denominator), expressed as the number of establishments per 100,000 of city population.
	No. of landline phone connections per 100,000 pop.	Quantitative	The number of landline phone connections in the city (the numerator) divided by one 100,000th of the city's current population (the denominator), expressed as the number of establishments per 100,000 of city population.
	No. of cell phone connections per 100,000 pop.	Quantitative	The number of cell phone connections in the city (the numerator) divided by one 100,000th of the city's current population (the denominator), expressed as the number of establishments per 100,000 of city population.
Transportation	Km of high capacity public transit per 100,000 pop.	Quantitative	The total lane-kilometres of public roads and dedicated bus way, and centreline kilometres of passenger rail, dedicated bicycle and pedestrian paths, and other specific transportation infrastructure within the city (the numerator), divided by 100,000th of city population, expressed as km of transportation system per 100,000 population. Separate calculations would be performed for each type of transportation infrastructure.
	Km of light passenger transit per 100,000 pop.	Quantitative	
	Number of personal automobiles per capita	Quantitative	The amount of private automobiles vehicles (the numerator) divided by the official total population of the city (the denominator).

	Annual number of public transit trips per capita	Quantitative	The average number of daily transit trips originating in the city (the numerator), divided by 100,000th of city population (the denominator), expressed as the number of trips per 100,000 population.
	Number of two-wheel motorized vehicles per capita	Quantitative	The amount of two-wheel motorized vehicle (the numerator) divided by the official total population of the city (the denominator).
	Number of non-stop commercial air destinations	Quantitative	The number of airports that can be accessed via nonstop commercial (i.e., scheduled) flights from airports serving the city (maximum of two hours land travel from the subject city).
	Transportation fatalities per 100,000 population	Quantitative	The annual number of fatalities related to transportation of any kind (the numerator), divided by 100,000th of city population (the denominator), expressed as number of transportation deaths per 100,000 population.
Urban Planning, Shelter	Land Area	Quantitative	The total land area of the city.
	Population Density [per km ²]	Quantitative	The population density per km ² .
	Jobs/housing ratio	Quantitative	Jobs include all types of employment opportunities including those provided in the retail, industrial, government and office sectors located within the city boundaries. . Housing means all dwelling units available for habitation.
	Total number of households	Quantitative	Total number of households within the city.
	Total # occupied dwelling units (owned & rented)	Quantitative	Total number of occupied dwelling units (owned & rented).
	Dwelling density [per km ²]	Quantitative	Dwelling density per km ² .
	Persons per unit	Quantitative	Persons per dwelling unit.
	Informal settlements as % of city area	Quantitative	The area of informal settlements in square kilometres (the numerator) divided by the city area in square kilometres, expressed as a percentage.
	% of city population living in slums	Quantitative	The number of people living in slums (the numerator) divided by the city population (the denominator), expressed as a percentage.
	No. of households without registered legal titles	Quantitative	Percentage of the households within the city that do not have a registered title.
No. of homeless people per 100,000 population	Quantitative	The number of homeless people in the city (the numerator) divided by one 100,000th of the city's current population (the denominator), expressed as the number of homeless people per 100,000 of city population.	
Waste Management	% of pop. with regular solid waste collection	Quantitative	The number of people within the city that are served by solid waste collection (the numerator) is divided by the city population (the denominator), expressed as a percentage.

	% of solid waste that is recycled	Quantitative	Solid waste: a) disposed to sanitary landfill; b) incinerated and burned openly; c) disposed to open dump; d) recycled; or e) other (the numerator) divided by the total amount of solid waste (the denominator).
	% of solid waste disposed of in an incinerator	Quantitative	
	% of solid waste burned openly	Quantitative	
	% of solid waste disposed of in an open dump	Quantitative	
	% of solid waste disposed of in a sanitary landfill	Quantitative	
	% of solid waste disposed of by other means	Quantitative	
Wastewater	% of population served by wastewater collection	Quantitative	The number of people within the city that are served by wastewater collection (the numerator) is divided by the city population (the denominator), expressed as a percentage.
	% of wastewater that has received no treatment	Quantitative	Amount of wastewater undergoing: a) no treatment; b) primary treatment; c) secondary treatment; and d) tertiary treatment (the numerator) divided by the total amount of wastewater collected.
	% of wastewater receiving primary treatment	Quantitative	
	% of wastewater receiving secondary treatment	Quantitative	
	% of wastewater receiving tertiary treatment	Quantitative	
Water	% of population with potable water supply service	Quantitative	The number of people within the city that are served by a potable water supply (the numerator) is divided by the city population (the denominator), expressed as a percentage.
	Domestic water consumption per capita [litres/day]	Quantitative	Consumption of water in liters per day (the numerator) divided by the total population (the denominator), for all domestic uses (excludes industrial and commercial).
	% of pop. with sustainable access to improved water source	Quantitative	The percentage of population with sustainable access to improved water source.
	Total water consumption per capita [litres/day]	Quantitative	Total water consumption per day (the numerator) divided by the official population of the city (the denominator), expressed as litres/day.
	% of water loss	Quantitative	Percentage of annual water loss.
	Water service interruption per household [avg. hrs/yr]	Quantitative	The average amount of time which a household experience an interruption of its water services, the total amount of time (hrs) water services were interrupted annually (the numerator) divide by the annual amount water services were interrupted (the denominator).

Source: Global City Indicators Facility, 2007a:11-111; Global City Indicators Facility (2007b:1-2)

GCIF is not solely focused on sustainability but rather focused on a city as whole and all of its functions which include factors of economic, social, educational, technological, safety, governance, etc. This furthers the GCIF indicators with its goals of creating a standardised set of global indicators that allows for city evaluation on an international scale. The methodology used by the GCIF to create the standardised set of global indicators is very applicable to this specific research, as the GCIF indicators are not intended to be a comparison index.

5.5 Conclusion

Based on a comparative analysis of the three tools included as part of this research the following conclusions were made. Cities vary greatly in terms of population size, available resources and urban metabolic processes, and therefore the selection process of suitable indicators should be prioritised and carefully considered.

The frequencies of usages were used to identify major categories to be considered in the proposed Green Planning Development Framework, thus referring to overlapping categories. Table 5.4, lists all the major categories identified by the frameworks and performance indexes discussed in Chapter 5. Each time a category was used by a framework or performance tool, its representative block was coloured coded green. If the category was not used, its representative block was coloured coded red. The following overlapping categories were identified from the three tools evaluated in this chapter:

Key	
Identified	Not Identified
✓	x

Table 5.4: Indicator Comparison

		Framework/ performance index			Total times identified
		African Green City Index	An Assessment Framework for Monitoring Cities' Sustainability	Global City Indicators Facility	
Major Categories	Air/ Air quality	✓	✓	x	2
	Climate Change	x	✓	x	1
	Culture	x	✓	x	1
	Economy/ Green Economy	x	✓	✓	2
	Education	x	x	✓	1
	Energy	✓	✓	✓	3
	Environment/ Environmental Governance/ Biodiversity	✓	✓	✓	3
	Fire & Emergency	x	x	✓	1
	Food	x	✓	x	1
	Governance	x	✓	✓	2
	Health	x	x	✓	1
	Land/ Land Use/ Urban Planning & Shelter	✓	✓	✓	3
	People (Social)	x	✓	x	1
	People (Demographics)	x	x	✓	1
	Safety	x	x	✓	1
	Sanitation/ Wastewater	✓	x	✓	2
	Technology & Innovation	x	x	✓	1
	Transportation	✓	✓	✓	3
	Waste/ Waste Management	✓	✓	✓	3
Water	✓	✓	✓	3	

Source: Own construction (2016)

It was noted that some of the major categories and their indicators are similar, and as such, these major (overlapping) categories were merged, as in the case with the “Water” category found in each of the tools discussed in the chapter. Some of the categories were thus re-coded to align (refer to air and air quality for example). If it was found that some of the indicators are similar in principle, but serve a more direct purpose, the categories were kept apart. This was the case for the merged “Air/ Air Quality” and the separate “Climate Change” (refer to Chapter 5.3 - AAFMCS) categories. Nevertheless all indicators will be considered and compared if they fall within the most used/identified major categories. The re-coded major categories identified as most important were:

1. Air/ Air quality
2. Economy/ Green Economy
3. Energy
4. Environment/ Environmental Governance/ Biodiversity

5. Governance
6. Land/ Land Use/ Urban Planning, Shelter
7. Sanitation/ Wastewater
8. Transportation
9. Waste/ Waste Management
10. Water

Each of the above listed categories was seen as a necessity in regards to this study, based on frequency of usage in the three tools discussed. The categories do not only cover sustainable or natural factors but also technology, social and economic aspects. Chapter 6 proceeded to discuss best practises which have been implemented, therefore building on these identified tools, but analysing such in terms of practical implementation with the aim to verify these categories and further identify more major categories. All further identified categories are to be considered in the proposed Green Planning Development Framework.

CHAPTER 6: INTERNATIONAL AND NATIONAL BEST PRACTISE (CASE STUDIES)

6.1 Points of departure

Chapter 6 aimed to investigate case studies of successful international and local best practise, with regards to sustainable development and green infrastructure strategies and similar initiatives. The findings of these case studies have contributed to the identification of major categories which are important to consider when dealing with sustainable development and green infrastructure planning, as perceived from a practical perspective. The case studies further contributed to the development of the proposed Green Planning Development Framework in this sense. The case studies included in this Chapter are:

- Hammarby Sjöstad, Stockholm, Sweden (international case study).
- Durban, Kwazulu-Natal, South Africa (local case study).

Hammarby Sjöstad, Stockholm, Sweden was chosen as it is one of the world's best examples of Sustainable City Development (Cilliers, 2014: 95). In 2010 Stockholm was selected and received the first ever European Green Capital Award (City of Stockholm Executive Office, 2011: 4). An urban area with such an ecological focus is important to this study and is reviewed in order to understand the model and planning approaches regardless of what type of area, rural or urban (detail discussion of model and approaches in Chapters 6.2.1 to 6.2.7). Durban, Kwazulu-Natal, South Africa was chosen as it is a local South African city that was rated above average in the AGCI (Siemens AG, 2011:8). The city has the longest public transport network in the AGCI and also boasts a great track record with distributing utilities, public services and policies as well as an abundant green space within the city (Siemens AG, 2011:60-63). In 2016 the Durban municipality (City of eThekwin) was awarded the greenest municipality in South Africa in the metro and local categories of the 5th Greenest Municipality Competition. The award is tied to implementation of waste, climate change and green economy (Petterson, 2016). These case studies contributed to the proposed Green Planning Development framework as core categories were identified that could be included in the framework, based on a practical implementation and best practices identified in each case. Figure 6.1 provides structure of the organisation of Chapter 6.

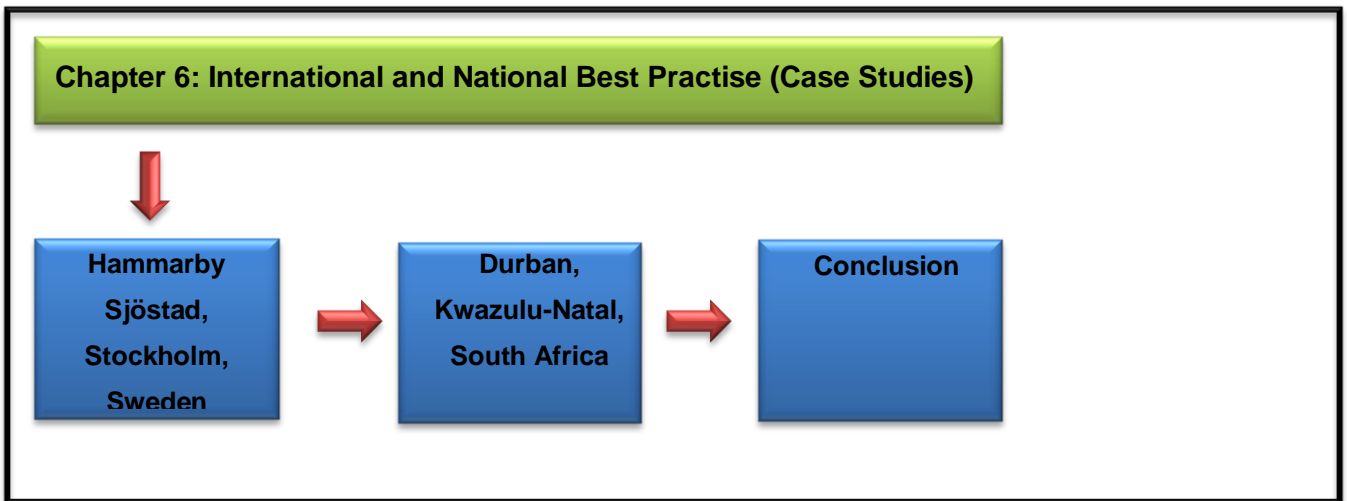


Figure 6.1: A graphical overview of the organisation and structure of Chapter 6
 Source: Own creation (2016)

6.2 Hammarby Sjöstad, Stockholm, Sweden.

Hammarby Sjöstad, which roughly translates in English to “Hammarby Sea city”, is an eco-city (Cilliers, 2014:94) in Stockholm, Sweden, located a few kilometres south of Stockholm’s city centre (refer to Figure 6.2). Hammarby Sjöstad was built according to a model which aimed to unify infrastructure of energy, water and waste, called the Hammarby model (detail discussion of model in Chapters 6.2.1 to 6.2.7) (Gaffney *et al.*, 2007: 4). Figure 6.12 provides a visual representation of the Hammarby Model. On completion Hammarby was set to have 11,000 residential units for slightly over 25,000 people and total of about 35,000 people who will be living and working in the area (Fränne, 2007:4).

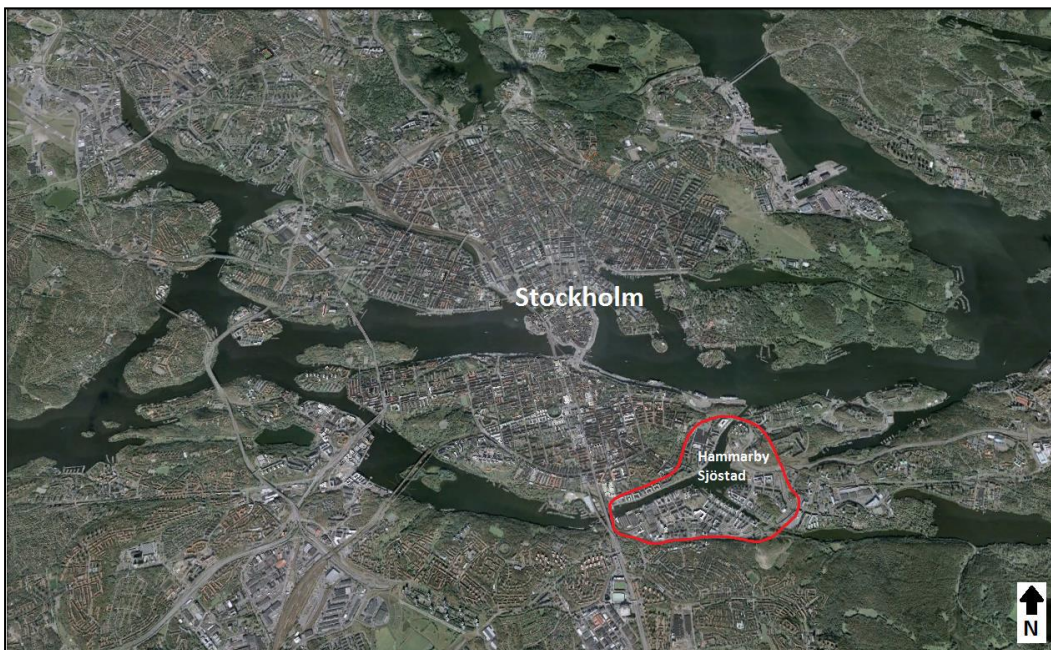


Figure 6.2: Location of Hammarby Sjöstad
 Source: Cilliers (2014:96)

The original plan of Hammarby Sjöstad was to develop the former industrial area to an ecological sports arena and athlete's village, to accommodate the Summer Olympics 2004. However as Stockholm was not selected to host the Summer Olympics 2004, the original plans were changed (Cilliers, 2014:95). Instead the Stockholm municipality in conjunction with 25 construction companies decided to make this the first eco-city district in Stockholm for the first millennium, with the latter contributing 80% of the total cost (Berg *et al.*, 2014 and Symbiocity, 2016). The rest of the funding came from two government agencies, the Swedish Rail Administration and the Swedish Road Administration (Symbiocity, 2016).

The City of Stockholm placed stern environmental requirements for buildings, technical installations and traffic infrastructure from the beginning. The primary aim was to halve the environmental impact of areas built in the early 1990's (Symbiocity, 2016). According Beatley (2004:251, 255) in addition to the Hammarby Model infrastructure (energy, water and waste), the urban-scaled density, access to multiple modes of transportation, preservation and restoration of existing natural systems, Hammarby Sjöstad is an "*effective demonstration that ecological and urban go together*" by means of comprehensive planning. The Hammarby model and its planning approaches will be discussed below in Chapters 6.2.1 to 6.2.7. Hammarby Sjöstad was built with a focus on integrating environmental goals. These environmental goals for Hammarby Sjöstad were divided into six categories; as developed by the City of Stockholm (Fränne, 2007: 8):

- **Building materials:** healthy, dry and environmentally sound.
- **Energy:** renewable fuels, biogas products and reuse of waste heat coupled with efficient energy consumption in buildings.
- **Land usage:** sanitary redevelopment, reuse and transformation of old brownfield sites into attractive residential areas with beautiful parks and green public spaces.
- **Transportation:** fast, attractive public transport combined with carpool and beautiful cycle paths, in order to reduce private car usage.
- **Waste:** thoroughly sorted in practical systems, with material and energy recycling maximised wherever possible.
- **Water & sewage:** as clean and efficient as possible – both input and output – with the aid of new technology for water saving and sewage treatment.

Through these goals set out it is noted that land use, transportation, water and sewage, building materials, energy and waste are important categories of sustainable development and green infrastructure planning (FieldIn, 2011: 32). These different categories and details thereof are discussed accordingly.

6.2.1 Building Materials

As part of a sustainable approach, only sustainable materials and eco-certified products were used. Avoiding the use of any hazardous substances was a priority, as hazardous substances can be found in construction materials or chemical products (Gaffney *et al.*, 2007: 57 and Symbiocity, 2016). As the Hammarby Sjö (Sea) is coupled with Hammarby Sjöstad, the rainwater that runs in to the sea was identified as a priority, in order to ensure that no contaminated water with oils or metals would enter. Consequently stainless steel has been used for the cycle bridge and eco-friendly oil has been used for the Sickla Canal footpaths. In addition facade or roofing materials that may release heavy metals or other hazardous substances have been avoided to lower rainwater contamination level (Fränne, 2007: 12). All left-over construction materials were sorted at source, as part of the waste management plan of Hammarby Sjöstad which is further discussed in 6.2.5. Figure 6.3 captures the objectives (and some regulations) that have determined the materials used in the construction process of Hammarby Sjöstad.

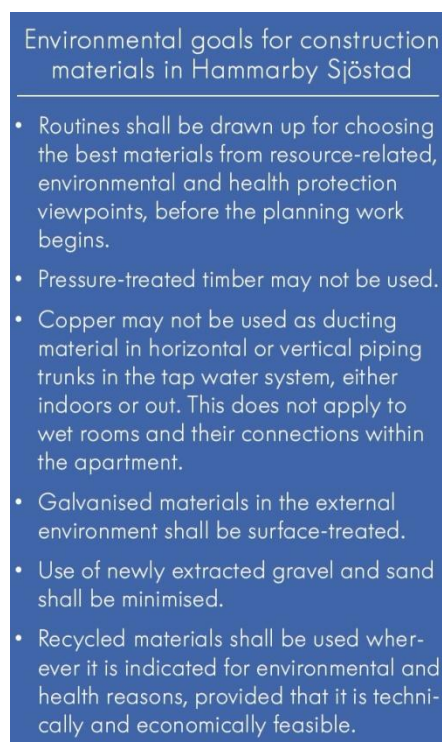


Figure 6.3: HS Construction Material Goals

Source: Fränne, 2007: 12

6.2.2 Energy

As part of the development plan, the residents of Hammarby Sjöstad were required to produce about 50% of all their energy needs themselves. This has been done by utilising the energy found in the combustible waste and the energy present in treated wastewater. Stockholm has been using sorted-at-source combustible waste as an energy source (fuel) to produce electricity and district heating (Fränne, 2007: 17-18; Symbiocity, 2016 and Gaffney *et al.*, 2007: 54).

Solar energy has been utilised through solar cells and panels on walls and roofs, and it is converted into electrical energy (Symbiocity, 2016) for water heating. Solar cells capture the sun's energy and convert it into electrical power. The energy from a 1m² solar cell module provides approximately a 100 kWh/year (Gaffney *et al.*, 2007: 54), in Hammarby 390m² of south-facing solar panels have been installed on the roofs of large buildings. These panels capture the sun's rays and use them to heat the water supply. The solar panels produced half of the energy required to meet the building's annual hot water requirement (Fränne, 2007: 19 and Hammarby Sjöstad Ekonomisk Förening, 2016a). In Figure 6.4 are the objectives (and some regulations) that have determined the energy used when within Hammarby Sjöstad.

The City of Stockholm's environmental goals for Energy in Hammarby Sjöstad		
<p>The goals relate to the sum of all the energy bought to heat the buildings and operate them each year. Household electricity is not included.</p>	<ul style="list-style-type: none"> • District heating connection with exhaust air systems: 100, of which 20 kWh electricity/m² UFA • District heating connection with heat extraction systems: 80, of which 25 kWh electricity/m² UFA 	<ul style="list-style-type: none"> • The entire heating supply shall be based on waste energy or renewable energy sources. • Electricity shall be "Good Environmental Choice"-labelled, or equivalent.

Figure 6.4: HS Energy Goals

Source: Fränne (2007: 17)

6.2.3 Land Use (Green Spaces)

Linking Hammarby Sjöstad's green public spaces and green corridors (refer to Figure 6.5) were methods used by City of Stockholm to achieve their objectives, this method links to the physical layout of GI, the concept of hubs and links discussed in Chapter 3. The southern parks of Hammarby Sjö (Sea) are all linked to Nacka nature reserve and Årsta forest green public spaces, this forms green wedges into the heart of Hammarby Sjöstad. The Nacka nature reserve is linked to the town area by means of eco-ducts (refer to Figure 6.6) over the Södra Länken highway (Cilliers, 2014:99-101). Northern Hammarby Sjöstad's new parks have been linked up with the Vitaberg Park and the Stora Blecktorn Park (Fränne, 2007: 10).



Figure 6.5: HS Green Space Corridors

Source: Gaffney *et al.* (2007: 53)



Figure 6.6: Eco-ducts

Source: Cilliers (2014:101)

Figure 6.7 below displays the land use scheme for Hammarby Sjöstad, the three best practice features on the map is the volume of green spaces (allocated by green colouring), the many footpaths, cycle paths and squares (allocated by yellow colouring) within the planning area and the high density land use (allocated by red colouring). Majority of Hammarby Sjöstad is high

density; the highest densities are concentrated along the primary corridor with buildings as tall as seven to eight stories (FieldIn, 2011: 35).

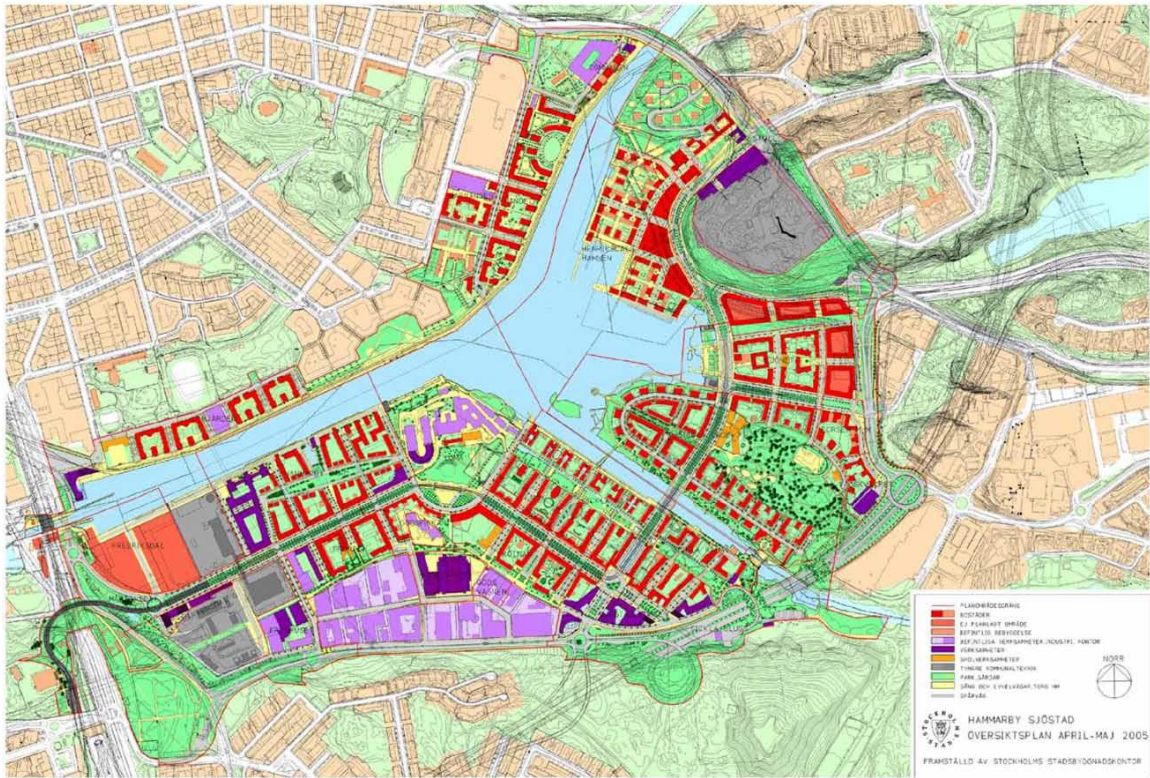


Figure 6.7: Land Use Map of Hammarby Sjöstad
Source: FieldIn (2011: 35)

Figure 6.8 displays the objectives (and some regulations) that have determined the land use of Hammarby Sjöstad. These goals are heavily focused on soft open space (active and passive green spaces).

Environmental goals for land usage in Hammarby Sjöstad

- Open space standard: There shall be at least 15m² of courtyard space and a total of 25–30m² of courtyard space and park area within 300m of every apartment (equiv. 100m² BTA).
- At least 15 % of the courtyard space shall be sunlit for at least 4–5 hours at the spring and autumn equinoxes.
- Development of undeveloped green public spaces shall be compensated for in the form of biotopes that benefit the biological diversity in the immediate area.
- Natural areas of particular value shall be protected from development.

Figure 6.8: Land Usage Goals
Source: Fränne (2007: 10)

6.2.4 Transportation

In an attempt to address sustainable development objectives and environmental concerns, Hammarby Sjöstad offered alternative transportation methods that brought along energy saving and attractive alternatives to private car usage in the form of buses, carpools, light rail links and ferry transportations (Fieldln, 2011: 33-34 and Gaffney *et al.*, 2007: 58).

- Bus

Hammarby has three new bus routes and one night bus that serves the area. The bus service is highly efficient as buses are driven by biogas. Stopping points for the buses are now computerized and inform the users with an electronic time table (Gaffney *et al.*, 2007: 58).

- Carpool

The carpool scheme is available to both residence and people working in the Sjöstad area. The carpool scheme has a total of 46 cars at its disposal and there are currently about 910 people making use of carpooling. Provision has been made for electric cars, these can be recharged outside the GlashusEtt information centre building in the city (Hammarby Sjöstad Ekonomisk Förening, 2016b). Around 75% of the carpool vehicles are biofuel-cars which is an added bonus (Fränne, 2007: 11 and Gaffney *et al.*, 2007: 58).

- Ferry

As the Hammarby Sjö (Sea) divides Hammarby Sjöstad, the city has ferry links which traffics Hammarby Sjö (Sea) between the southern and northern sides of the city. The ferry service is free to use and is run by the City of Stockholm. The ferry runs 365 days of the year, every 10-15 minutes, from early in the morning until midnight. (Fränne, 2007: 11; Gaffney *et al.*, 2007: 58 and Hammarby Sjöstad Ekonomisk Förening, 2016b).

- Light rail link

Hammarby Sjöstad's "Tvärbanan" or new light rail link is a central route which runs through the city and connects directly to the underground network of Stockholm. The Tvärbanan has four stops along the primary corridor that connects one side of the city district to the other (Fränne, 2007: 11; Gaffney *et al.*, 2007: 58 and Hammarby Sjöstad Ekonomisk Förening, 2016b), this is the focus of city's public transportation.

In addition, Hammarby Sjöstad was found to be pedestrian friendly as noted in Chapter 6.2.3, with many footpaths, cycle paths and squares (allocated by yellow colouring in Figure 6.7), making it more appealing to walk a short distance or cycle a medium distance, and consequently the reducing traffic on city roads (Fieldln, 2011: 34). The city is also served with numerous boat services in addition to the ferry service, which launch right from the city centre. A

service called “Sjöbussen” (The Sea Bus) and is aimed to run small biogas driven boats to and from Nybroviken, Stockholm’s city centre (Gaffney *et al.*, 2007: 58). However if cars are to be used, the Södra Länken highway has been designed in accordance with the city’s environmental requirements. The Södra Länken highway is lowered (sunken into the ground) and bridged by two Eco-ducts (refer to Figure 6.6 and Chapter 6.2.3) to connect the city to Hammarbybacken and the large Nacka nature reserve (Gaffney *et al.*, 2007: 59 and Hammarby Sjöstad Ekonomisk Förening, 2016b). Figure 6.9 displays the objectives (and some regulations) that have determined transportation in the city.



Figure 6.9: HS Transportation Goals

Source: Fränne (2007: 11)

6.2.5 Waste

Fränne (2007: 27) states that “*These days waste is no longer just waste. It is a resource that is being utilised more and more. New things are being produced from recycled materials, allowing us to be more economical with nature’s resources.*” Recycling, in this sense, is a very useful tool in the sustainability and green infrastructure arsenal, relying on the sorting process that turns waste into a resource that can be used for recycling and energy recovery (combustible waste, refer to 6.2.2) (Gaffney *et al.*, 2007: 54). By having residents sort the waste the amount of domestic waste is reduced and this improves the refuse collection personnel’s working environment (Fränne, 2007: 27). Figure 6.10 below displays the objectives (and some regulations) that have determined the waste management of the city.

The City of Stockholm's environmental goals for waste in Hammarby Sjöstad

<p>Energy shall be extracted from 99 % by weight of all domestic waste from which energy can be recovered by 2010. Reuse or recycling shall, however, be prioritised.</p> <p>The amount of domestic waste generated shall be reduced by at least 15 % by weight between 2005 and 2010.</p> <p>The amount of domestic bulky waste disposed of in landfill sites shall be reduced by 10 % by weight between 2005 and 2010.</p> <p>The amount of hazardous waste generated shall be reduced by 50 % by weight</p>	<p>between 2005 and 2010.</p> <ul style="list-style-type: none"> • Residents shall be given the opportunity to separate their waste at source into the following fractions: <ul style="list-style-type: none"> - Materials with a producer responsibility, within the building - Separated food waste and "refuse bags", within the building - Bulky waste, within the building - Hazardous waste, in the local area • By 2010, 80 % of food waste by weight shall be handed in for biological treatment which 	<p>utilises its component nutrients for plant cultivation and also utilises its energy content.</p> <ul style="list-style-type: none"> • A maximum of 60 % (vehicle km) of waste transports and transportation of recycled materials within the area shall involve the use of heavy vehicles, in comparison with the amount transported using conventional waste management transportation. • A maximum of 10 % by weight of the total waste generated during the construction phase shall comprise waste that is disposed of in landfill sites.
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Figure 6.10: HS Waste Goals

Source: Fränne (2007: 27)

Hammarby Sjöstad has three **levels of waste management** (Fränne, 2007: 28 and Gaffney *et al.*, 2007: 55-56):

1. Building-based separating at source

The largest waste is separated into fractions and deposited in different refuse chutes (a vacuum system). The chutes are in or adjacent to the buildings.

- **Combustible waste.** Waste made of plastic, paper and other forms of non-packaging are placed in regular plastic bags.
- **Food waste.** Food waste is placed in bags created of corn starch which is biodegradable.
- **Newspapers, catalogues, paper, etc.** Not packed. Not for the mobile automated waste disposal system.

2. Block-based recycling rooms

The types of waste that do not belong in the building-based refuse chutes (discussed above) are left in these block-based recycling rooms:

- Some of the recycling rooms also have containers for textiles.
- Glass, paper, plastic and metal packaging.
- Bulky waste (example old furniture).
- Electrical and electronic waste, like low-energy light bulbs, regular light bulbs and fluorescent tubes.

3. Area-based hazardous waste collection point

Hazardous waste includes waste such as nail polish, paint, glue residues, solvents, varnish, cleaning agents, batteries and chemicals. This is waste that poses a danger to people and the

environment. This type of waste must never be poured down the drain or placed in along with domestic waste. It must be separated out and handed in at the hazardous waste collection point in Glashus Ett, the city's environmental information centre.

Hammarby Sjöstad has two types of **waste disposal systems**, namely the (1) mobile automated waste disposal system and (2) stationary automated waste disposal system (Fränne, 2007: 29 and Gaffney *et al.*, 2007: 56). Both systems are key players in the successful waste management of the city.

- Mobile automated waste disposal system

The waste collected in this system builds up in underground tanks; these tanks are emptied by a refuse collection vehicle equipped with a vacuum suction system. Combustible domestic waste and food waste are placed in separate tanks. The refuse collection vehicle stops at docking points where several buildings waste tanks are emptied simultaneously. However the refuse collection vehicle can only empty one type of waste every round of collection (Fränne, 2007: 29 and Gaffney *et al.*, 2007: 56).

- Stationary automated waste disposal system

Refuse chutes are powered by vacuum suction and are connected by underground pipes which lead to a central collection station. The various fractions collected are sent to the right container via the collection station advanced control system. There is a large container for each fraction: combustible domestic waste, food waste and newspapers. This system reduces traffic in the local area, which in turn means the air is kept cleaner compared to traditional refuse collection techniques. In addition heavy lifting is avoided; this improves the work environment for the refuse collection workers (Fränne, 2007: 29).

6.2.6 Water and Sewage

- Water

One of Hammarby Sjöstad's main objectives was to reduce water consumption by 50%, from 200 litres/person/day to 100 litres/person/day, utilising energy class A/eco-friendly installations, such as washing machines, dishwashers, low flush toilets and air mixer taps; which have a low energy consumption and are affordable (Fränne, 2007: 21). Storm water, rainwater and snowmelt was treated locally in different manners, referred to the LOD system ("local storm water treatment"). Storm water from urban areas penetrates into the ground or is drained into the Sickla Canal, Hammarby Canal or Danvik Canal; an additional storm water canal that runs through the city park is also utilized (Hammarby Sjöstad Ekonomisk Förening, 2016c). Green roofs on top of some Hammarby Sjöstad's buildings were identified as another component of the local storm water treatment plan. The green roofs were set to collect the rainwater, delay it

and allow for evaporation; therefore giving the rainwater back to the environment (Fränne, 2007: 24; Gaffney *et al.*, 2007: 57 and Hammarby Sjöstad Ekonomisk Förening, 2016c). Simultaneously green roofs enhanced vegetation in the city centre and addressed some of issues related to heat insulation and UHI. (Hammarby Sjöstad Ekonomisk Förening, 2016c). The most common way used to treat rainwater and snowmelt was by draining the water into special basins known as an equalizer, of which Sjöstad has two closed settling tanks. The water remains in these tanks for some hours; this is to allow the contaminants to sink and is then drained out into the previously mentioned canals (Fränne, 2007: 25 and Gaffney *et al.*, 2007: 57).

- Sewage

A wastewater treatment plant has been built to evaluate new technology in the field of wastewater treatment for Sjöstad, named Sjostadsverket (Gaffney *et al.*, 2007: 56 and Hammarby Sjöstad Ekonomisk Förening, 2016c). The aim was to reduce the amount of heavy metals and non-biodegradable chemicals present in wastewater, as the metals and chemicals will decrease the contaminants being distributed into the Stockholm archipelago via Sjöstad's treated wastewater. An additional benefit was evident in terms of residual sludge, which was reused on agricultural land while methane recovered from this sludge was used as biogas to fuel homes, cars and buses (Gaffney *et al.*, 2007: 56). Hammarby Sjöstad created a strategy, the Upstream approach, to work with customers and community (a form of public participation) to reduce the amount of chemicals flushed into the wastewater (Fränne, 2007: 21).

The wastewater treatment process has four lines that contain chemical, physical and biological processes, which are run as efficiently as possible. The objective is to treat the wastewater and to recycle resources from the wastewater, with as little input of external resources as possible (Fränne, 2007: 22 and Hammarby Sjöstad Ekonomisk Förening, 2016c). Storm water and industries wastewater is not included in the wastewater treatment process (Fränne, 2007: 22 and Hammarby Sjöstad Ekonomisk Förening, 2016c). Organic material is removed from the wastewater in the form of sludge at the wastewater treatment plant. The sludge is then moved and digested in large digestion tanks to create biogas and bio solids. The biogas is mainly used as vehicle fuel and supplied to approximately 1,000 gas stoves in Hammarby Sjöstad (Fränne, 2007: 23 and Hammarby Sjöstad Ekonomisk Förening, 2016c). The sludge or bio solids can be used as fertiliser, and is currently being used as fertiliser in the forestry industry and aims to be used on agricultural land in the future (Hammarby Sjöstad Ekonomisk Förening, 2016c). Stockholm Water also sends these bio solids to northern Sweden; there they use the bio solids as filling material in closed down mines (Fränne, 2007: 23). Figure 6.11 below displays the objectives (and some regulations) that have determined the waste management of the city.

The City of Stockholm's environmental goals for water and sewage in Hammarby Sjöstad		
Water consumption shall be reduced to 100 litres per person per day.	<ul style="list-style-type: none"> • Lifecycle analyses (LCA) shall be carried out to determine the suitability, from an energy and emissions viewpoint, of returning nitrogen to agricultural land and of utilising the chemical energy present in the wastewater. • Drainage water shall be connected to the storm water network and not to the wastewater network. 	<ul style="list-style-type: none"> • Storm water shall primarily be treated locally. • The nitrogen content of the purified wastewater shall not exceed 6 mg/litre and the phosphorus content shall not exceed 0.15 mg/litre. • Storm water from streets with more than 8,000 vehicles per day shall be treated.
95% of the phosphorus in wastewater shall be reusable on agricultural land.		
The quantity of heavy metals and other environmentally harmful substances shall be 50 % lower in the wastewater from the area than in the wastewater from the rest of Stockholm.		

Figure 6.11: HS Water and Sewage Goals

Source: Fränne (2007: 21)

6.2.7 Hammarby Sjöstad Conclusion

According to Beatley (2000), Hammarby Sjöstad is noted as one of the best examples of implemented sustainable urbanism in the world today. The city has become a multifunctional organism as it provides many services to its residents, feeds off itself in many aspects and has a positive effect on the near environment. The city has achieved great feats of sustainability; however the following best practise aspects was emphasised:

- Combustible waste is recycled and food waste is composted into soil.
- Energy is produced in a renewable fuel-fired district heating plant in the city.
- Surface water is treated locally to avoid overloading the sewage works.
- The heat recovered for heating houses and the silt is converted to biogas.
- Wastewater is treated in the local sewage plant.

The success of the city (related to sustainability) could most possibly be a result of the integrative planning approach enforced by the Hammarby Model (refer to Chapters 6.2.1 to 6.2.6 and Figure 6.12) which was designed to integrate energy, water and waste. Integration in this sense is significant because of the “green agglomeration advantage” achieved. Fränne (2007:i) stated that, *“Planning work was integrated with environmental goals from the very start of the planning process, and this is, we believe, the main reason why it has been so successful. This approach has been followed ever since by consultations between the City of Stockholm’s administrative departments and the companies responsible for waste management, energy, water & sewage, aimed at developing the solutions needed to enable the environmental goals to be met.”*

Many other aspects are interconnected as well in Hammarby, such as: (1) Waste is sorted on site, which is part of the standard waste management plan, the combustible waste is sent to create energy. Due to the in-situ waste management, waste is recycled and energy is created in one go, achieving two objectives simultaneously making the process multi-functional. (2) The

automated waste disposal system that improves both work environment and air quality, which can be seen as a social improvement and environmental improvement respectively. (3) As mentioned in 6.2.1, the choice of construction and building materials has been planned well and buildings built with great care. By avoiding the use of certain metals and plastics in the buildings, by ensuring that rainwater and snowmelt are treated and drained separately and by providing residents with information, it has ensured that households wastewater is relatively clean. (4) Green roofs on top of some Hammarby Sjöstad's buildings form a component of the local storm water treatment (LOD), increase green space and improve the aesthetic appeal of the city. (5) Heavy lifting is avoided in the waste management sector which improves the work environment for the refuse collection workers. Consequently it is noted that integration plays an extremely important role.

Hammarby Sjöstad has created its own urban ecosystem (Symbiocity, 2016) through the integration created by the Hammarby Model. The urban ecosystem was achieved by placing waste management, energy and water & sewage together, allowing the system to feed off itself. Figure 6.12 provides a visual representation of the Hammarby Model and its urban ecosystem created by Sjöstad. Transportation, land use and building materials are an extra addition to the green elements of the system. The city makes use of many green infrastructure methods especially with regards to stormwater management. From a spatial planning point of view, according to Cilliers (2014:106) "*Hammarby Sjöstad was able to find solutions in providing parks and green spaces which are integrated with the urban area*", consequently making Hammarby Sjöstad successful in green infrastructure planning and spatial planning (refer to Chapter 3)..

Another key factor of the city's success is the coordination across and between authorities (at all levels of government) and public/private cooperation. Hammarby Sjöstad would not have come as far as it did without municipal control as they had to enforce integration of infrastructure as envisioned by the Hammarby Model. Furthermore it had to be ensured that the developer teams retained their commitment to the environmental program throughout projects design and construction. Through this case study of Hammarby Sjöstad, it is noted that land use (green open space), transportation, water and sewage, building materials, energy and waste are all major categories linked to the sustainability of the city. Consequently these categories will be considered in the proposed Green Planning Development framework. Table 6.1 below provides a brief summary of the best practises within Hammarby Sjöstad.

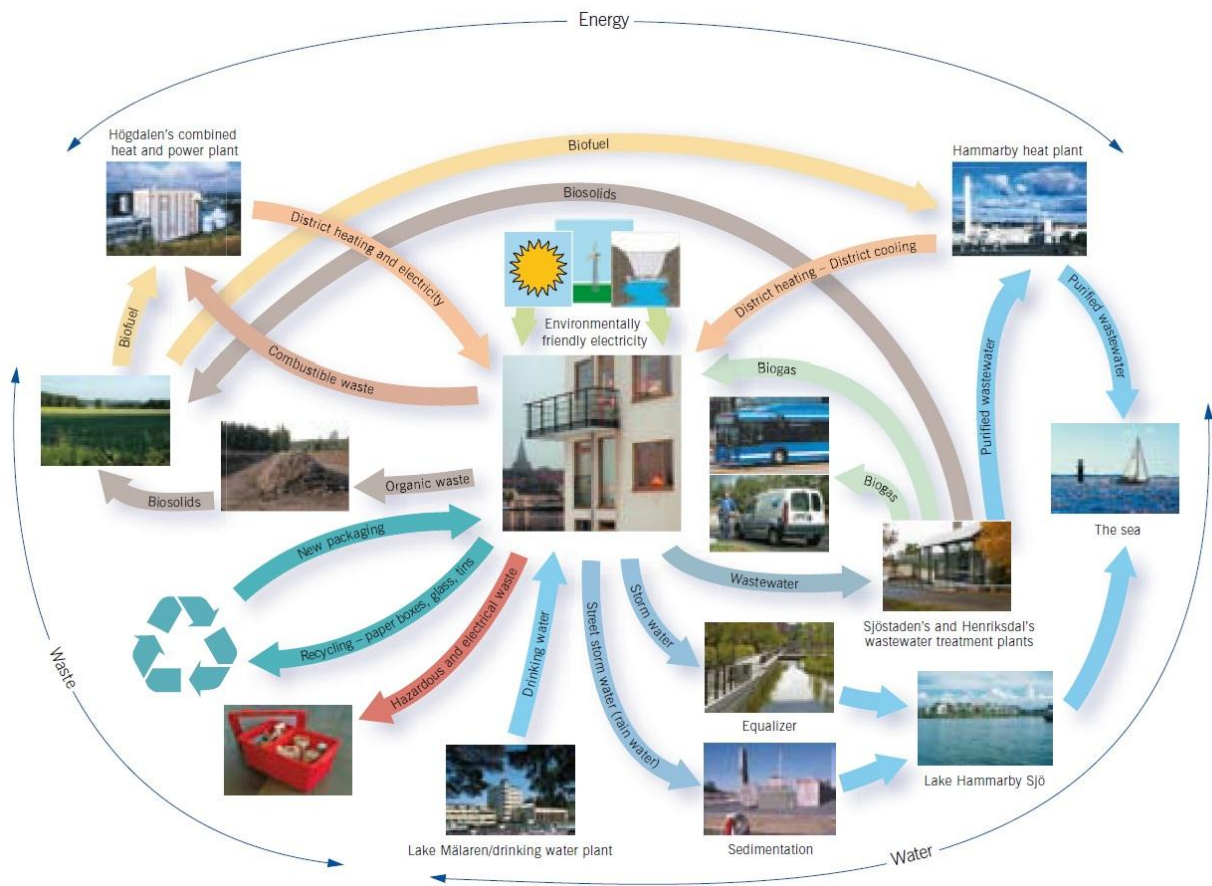


Figure 6.12: Illustration of the Hammarby Model (Eco-cycle)

Source: Fränne (2007: 31 A)

Table 6.1: Best Practise Summary of Hammarby Sjöstad

Building Materials	Energy	Land Use	Transportation	Water and Sewage	Waste
Building material is only sustainable materials and eco-certified products. Avoiding the use of any chemical products or construction materials that contain hazardous substances.	Combustible waste is converted into heating and electricity.	Linking Hammarby Sjöstad's new green public spaces.	Bus, carpool, light rail link and ferry transportations are the alternative modes of transport.	Water consumption is reduced through the use of eco-friendly installations	Combustible waste is converted into district heating and electricity
Eco-friendly oil has been used for the footpaths along the Sickla Canal and stainless steel has been used for the cycle bridge.	Biofuel from nature is converted into heating and electricity.	Forming green corridors within the city.	Some 75% of vehicles run on biofuel. The city is pedestrian friendly with many footpaths, cycle paths and squares.	Digestion is used to extract biogas from the sewage sludge. The digested bio solids can be used for fertilisation.	Hazardous waste is incinerated or recycled
Facade or roofing materials that may release heavy metals or other hazardous substances have been avoided.	Heat from treated wastewater is converted into district heating and cooling	The southern parks are all linked to Nacka nature reserve and Årsta forest green public spaces, this forms green wedges into the heart of Hammarby Sjöstad.	All heavy vehicles are forced to meet environmental needs.	A wastewater treatment plant has been built specifically for the area in order to evaluate new sewage treatment techniques.	Organic waste is converted/digested into bio solids and used as fertiliser.
All left-over construction materials are sorted at	Solar cells change solar energy into electricity	The Nacka nature reserve is linked to the town area by means of		Rainwater is drained into Hammarby Sjö, rather than into the wastewater treatment	All recyclable material is sent for

source.	eco-ducts (refer to Figure 10) over the Södra Länken highway.	plant.	recycling.
Solar panels use solar energy to heat water.	Northern Hammarby Sjöstad's new parks have been linked up with the Vitaberg Park and the Stora Blecktorn Park.	Rainwater from streets is treated locally using settling basins and then drained into Hammarby Sjö, rather than being drained into the wastewater treatment plant.	An automated waste disposal system with various deposit chutes, a block based system and an area-based environmental station system help the residents sort their waste.

Source: Adapted from Cilliers (2014); FieldIn (2011); Fränne (2007); Gaffney et al. (2007); Hammarby Sjöstad Ekonomisk Förening (2016a); Hammarby Sjöstad Ekonomisk Förening (2016b); Hammarby Sjöstad Ekonomisk Förening (2016c); Symbiocity (2016)

6.3 Durban, Kwazulu-Natal, South Africa.

Durban, Kwazulu-Natal, South Africa is located on the Indian Ocean. It is South Africa’s second most populous municipal area (eThekweni), with an approximate 3.5 million residents, a density of 1502.36 people per km² and is 2291.31 km² large (Statistics South Africa, 2012). Durban itself has a population of 595 061, a density of 2634.02 people per km² and is 225.91 km² in size (Statistics South Africa, 2012). Durban’s port is considered to be East Africa’s largest container port and the most active general cargo port consequently making it the busiest port in the country (Writer, 2015). Durban, like other South African cities, used the 2010 FIFA World Cup as a catalyst to improve and implement a range of environmental initiatives (Siemens AG, 2011:60). Durban ranks above average overall in the African Green City Index (AGCI). The city has the longest public transport network in the AGCI and also boasts a great track record with distributing utilities, public services and policies as well as an abundant green space within the city. Consequently Durban ranks above average in the AGCI in categories such as land use, transport, waste, water, sanitation, air quality and environmental governance. Durban however ranks below average in the category of energy and CO₂ (Siemens AG, 2011:60). Figure 6.13 above displays the performance level Durban achieved within the AGCI based on the categories the AGCI identified as important and relevant to their study.

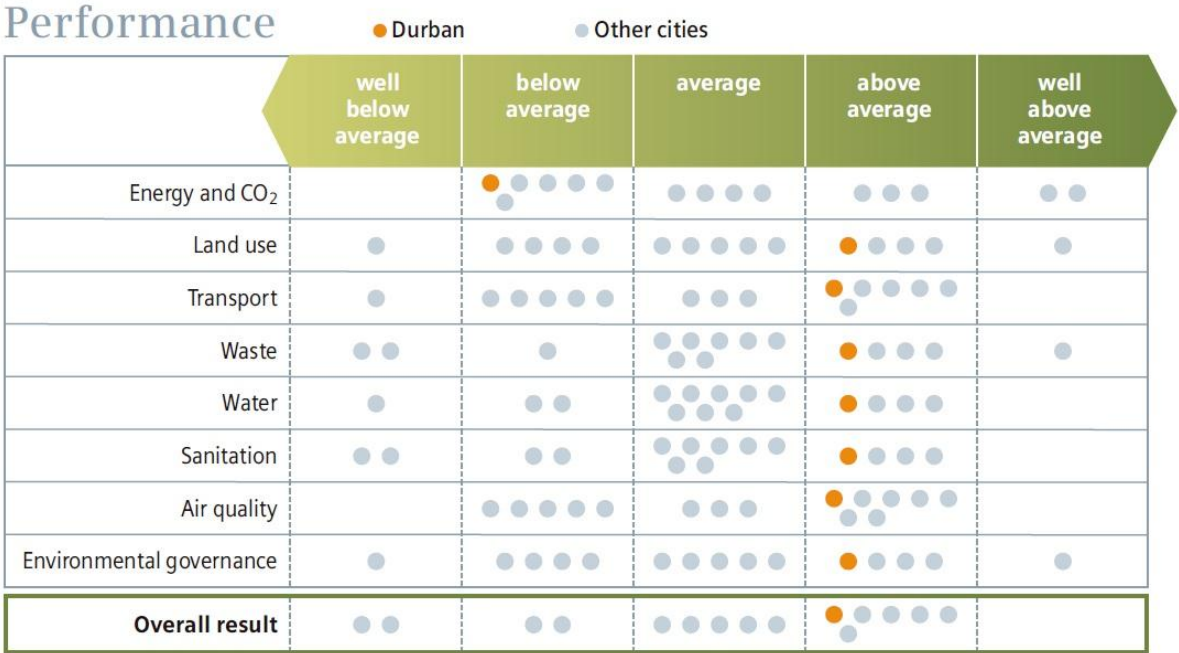


Figure 6.13: Durban's Performance Rating
Source: Siemens AG (2011:61)

Durban’s scores are the illustrated by the orange dots; all other grey dots are the scores of the other 15 African cities which took part in the AGCI. Durban’s final results placed it under the top

six (6) cities with a final result of above average. Unlike Hammarby Sjöstad which was built in modern times with the purpose of being an eco-city, Durban is a city that has been established since 1835 (South African History Online, 2011) and has grown and developed as required over time. Durban was originally developed as a port city (South African History Online, 2011). Durban's modern municipality, eThekweni, addresses environmental and sustainable issues through various plans such as the Imagine Durban Project, the Durban Metropolitan Open Space System (D'MOSS) and the IDP of the eThekweni area (eThekweni Municipality, 2010 and Crouch, 2002). The Imagine Durban Project is city-council-led green project on integrated and long-term planning (eThekweni Municipality, 2010). Nonetheless Durban has never had a strict list of objectives and goals, such as Hammarby Sjöstad, that has guided development, and as a result, there were no main categories of sustainable development and green infrastructure planning identified for this city. The AGCI was therefore used to assist in this regard, as the AGCI analysed Durban through eight major categories (refer to Chapter 5.2) when the index was developed. Consequently the Durban case study was evaluated in terms of the eight major categories used in the AGCI (Siemens AG, 2011:1) including: 1) Air quality, 2) Energy and CO₂, 3) Environmental Governance, 4) Land Use, 5) Sanitation, 6) Transport, 7) Waste and 8) Water, as explained accordingly.

6.3.1 Air quality

Durban's air policies are one of the best in the AGCI comparison. In 2000 the Durban Metropolitan Council purchased the first air quality monitoring laboratory, by 2004 air quality has been monitored at various sites by officials around the city (eThekweni Municipality, 2011a and Siemens AG, 2011:63). The systems used measure nitrogen dioxide, sulphur dioxide, particulate matter (PM₁₀) and carbon monoxide (eThekweni Municipality, 2011a and Siemens AG, 2011:63). Durban has set a target to make certain that within 10 years (by 2020) air is not harmful to human health within the city, this target was captured in the project titled "Imagine Durban" (eThekweni Municipality, 2010: 24), the target was linked to the following objectives (eThekweni Municipality, 2010: 26 and Siemens AG, 2011:63):

- Reduce commercial pollution by establishing and implementing by-laws that create penalties for pollution
- Promote low-emission industries.
- Vehicles are to meet low-emissions standards
- Workers share vehicles (carpooling) or there is more provided communal transport.

6.3.2 Energy and CO₂

It has been determined that 88% of Durban's homes have access to electricity, which is above the 84% average of the AGCI (Siemens AG, 2011:60-61). Consequently electricity consumption is also higher than the 6.4 gigajoules AGCI average with Durban consuming 11.3 gigajoules per capita (eThekweni Municipality, 2011b and Siemens AG, 2011:60-61). Durban's electricity is mainly generated through coal; however some renewable methods are also being utilised, mostly solar and hydro (eThekweni Municipality, 2010: 24-25, 27). The renewable methods comprised of just less than 2% of the total electricity production. Furthermore the city has also begun generating energy from local waste by-products, similar to Hammarby Sjöstad mentioned in Chapter 6.2.5 but this is only on a limited basis. As Durban's heavy reliance on coal for electricity, the city emits an approximate 3,503 kg per person of CO₂ due to the high levels of electricity consumption. This approximate 3,503 kg per person of CO₂ is also well above the AGCI average of 984 kg. However, the policies in this area are promising and will hopefully spur on reductions in consumption of electricity as well as provide improvements in efficiency (Siemens AG, 2011:60-61).

6.3.3 Environmental management

Durban was South Africa's first city to adopt the UN's Local Agenda 21 in 1994 (United Nations, 1997). The Local Agenda 21 committed Durban to implement sustainability measures, of which incorporated creating a small environmental management department; the department has expanded since then. The local government continually monitors its environmental performance and frequently publishes information on progress (Siemens AG, 2011:63). Furthermore Durban's "Imagine Durban Project" focused on what citizens would like the future city to be in the future, and then sets out short- medium- and long-term targets to meet these goals (eThekweni Municipality, 2010). Other than the city council, the project is implemented along with other partners such as Sustainable Cities, a Canadian non-governmental organisation and PLUS Network, a network of 35 cities sharing experiences in sustainability planning (eThekweni Municipality, 2010:1). Other efforts to create a greener city include the "Sustainable Living Exhibition" which is held in Durban each year. This exhibition is aimed to display pioneering ideas for more environmentally friendly lifestyles. It also includes showcasing technologies like ozone-friendly appliances, devices to save water and energy, tools for organic gardening/recycling and solar-power equipment (eThekweni Municipality, 2011c and Siemens AG, 2011:63).

Furthermore the Durban Metropolitan Open Space System (D'MOSS) was implemented in 1982 (Crouch, 2002). It is a system of open spaces (active and passive) which is approximately 2 000

ha of dams, 2 400 ha of estuarine environment, 11 000 ha of forests including (dune, coastal and scarp forests), 7 500 ha of wetlands, 6 700 ha of grassland, 15 500 ha of dry valley thicket and 17 700 ha of woodland (eThekweni Municipality, 2011d). This stretch of land is considered to be of high biodiversity value. The D'MOSS has identified and categorised endangered and sensitive areas to protect them from development, this is also done to raise awareness about the city's biodiversity (eThekweni Municipality, 2011d and Siemens AG, 2011:61). According to the AGCI (Siemens AG, 2011:63) Durban has a number of the strongest policies on environmental management and monitoring in the AGCI, such as the UN's Local Agenda 21 (Siemens AG, 2011:63), D'MOSS and the Imagine Durban Project (eThekweni Municipality, 2010).

6.3.4 Land use

Durban has densely populated urban core, but the density decreases outside the core due to the surrounding suburbs. The rural areas are fairly densely populated in the outskirts (Siemens AG, 2011:61). However Durban is one of the least dense cities in the AGCI due to its wide sprawl and large administrative area. Durban's land use stats (Siemens AG, 2011:61 and Statistics South Africa, 2012):

- 2634.02 people per square kilometre.
- 884.34 households per square kilometre
- 22% of the population live in informal settlements.
- 187 square metres of green space per person.

According to the AGCI Durban had the third highest amount of green space per person in SA, behind Cape Town and Johannesburg (Siemens AG, 2011:61), totalling to 187 square meters of green spaces per person. Durban's Spatial Development Framework (SDF) plan aimed to combat urban sprawl. Initiatives within Durban aimed to improve the city's ecosystems within the urban areas, these initiatives are in conjunction with Durban Metropolitan Open Space System (D'MOSS) project, as discussed in 6.3.3 (eThekweni Municipality, 2011d). Furthermore a Greening Durban project in 2010 initiated that 104 000 trees were planted on 100 hectares in Durban (eThekweni Municipality, 2011e). With this Greening Durban project, the city mainly targeted the city's biggest landfill site, Buffelsdraai, which achieved its target of 82 000 newly planted trees (eThekweni Municipality, 2011f). It was targeted for reasons of low-income residents living nearby, to encouraged new wildlife to flourish, and to absorbing some of the smells from the landfill (Siemens AG, 2011:61).

6.3.5 Sanitation

In Durban, 90% of the population had access to sanitation according to the AGCI report, which was above average in comparison to the other cities (Siemens AG, 2011:62-63). The city's wastewater was found to be treated before discharged into near rivers and the ocean. However Durban did face challenges of providing sanitary conditions to the low-income/informal settlements, however this problem has been taken care of through municipal projects (eThekweni Municipality, 2011g). The poorly maintained and often vandalised sewerage network in Durban was prone to blockages throughout periods of high demand. Nevertheless Durban has made efforts to promote public awareness about correct sanitation use to reduce damage and lower blockages (eThekweni Municipality, 2011k). In 2000 the city's water service launched a sewage education programme. The city's water service designed educational resources and toolkits for use in schools and at informal education settings such as clinics. This campaign seemed to have had a helpful impact by lowering blockages within the sewage network considerably (Siemens AG, 2011:62-63).

6.3.6 Transport

The Durban city council used the hosting of the 2010 FIFA World Cup as an opportunity to invest in public transportation. Durban has the longest public transport system in the AGCI (Siemens AG, 2011:62). With 1,400 bus routes and 200 operators, in total it measures 9.2 km per square kilometre. Its public transport system includes superior forms of public transport such as metro, Bus Rapid Transit (BRT) and tram lines (eThekweni Municipality, 2011i and Siemens AG, 2011:62). Other initiatives included a new passenger bus called the People Mover, which created new routes in areas not served by existing transport providers (eThekweni Municipality, 2011h). A new online travel information system was also created, aimed at integrating details of buses, taxis and minibuses on touch screens at various sites around the city.

6.3.7 Waste

Durban has a typical domestic collection programme that ensures the adequate disposal of cardboard, paper, tin and glass. The refuse collection programme covers most of the city's formal housing areas and includes (eThekweni Municipality, 2011j):

- 23 Operational Centres,
- 6 Transfer Stations;
- 3 Active Landfill Sites,
- 23 Recycling Plants,
- 3 Landfill Gas Projects,

- 2 Leachate Plants.

The city was found to generate 0,5 tons/ person/ annum (eThekweni Municipality, 2008: 42). Durban also introduced public clean-up campaigns to deal with the problem of illegal dumping. The city initiated a forceful set of waste policies aimed at enforcing environmental standards on landfill sites (Siemens AG, 2011:62). In attempt to increase recycling and Local Economic Development (LED), informal waste-pickers were allowed to access the Bisasar Road landfill site for items they may find valuable. These items were then sold at various buy-back centres around the city which were organised and maintained by private recycling companies and the city. It is estimated that around 300-400 waste collectors (200 families) make an income from this scheme (Siemens AG, 2011:62).

6.3.8 Water

According to Siemens AG (2011:62) Durban implemented strict policies on improving/ monitoring surface water and enforcing water pollution standards on local industry, consequently Durban has the strongest policies on water sustainability in the AGCI, along with Cape Town, on water quality policy. As a result of the water policies, the quality of Durban's drinking water was concluded to be clean. In 2011 Durban had a consumption of 253 litres per person per day, and 98% of its population had access to water (Siemens AG, 2011:62). Another initiative that Durban promoted was water conservation in homes, whereby free water-flow limiters are given out and people are encouraged to use water meters (eThekweni Municipality, 2011k and eThekweni Municipality, 2011l). Furthermore, treated wastewater was supplied to irrigate farmland and community gardens by the Water and Sanitation Department of the city (Siemens AG, 2011:62).

6.3.9 Durban's Conclusion

Based on the case study, the following was concluded as Durban's best practises in terms of Green Planning Development approaches:

- Policies that were implement and maintain services supplied (sanitation and water), land use and environmental management.
- Encouraging and teaching people about improved sanitation and water conservation.
- Supply of basic services to over 90% of the population.
- The action plans implemented to address current problems, such as supply of water and sanitation services.
- The amount of green open space per person totalling to 187 square metres per person.
- The large area covered by the public transport system.

Like Hammarby Sjöstad, Durban illustrated some integrated sustainable aspects, especially in terms of water and sewage. Durban has very little built/ structure implementation, for example there are little to no new radical facilities that treat water, recycle, move people around or create electricity sustainably as seen in Hammarby Sjöstad. The only built/ structure implementation is the air quality monitoring laboratories which function in the city.

Durban makes use of policies and projects to conquer sustainable issues that are currently seen as the priority, such as the lack of services. There are no fixed set of goals that dictate the scrutiny of development taking place, however the local municipality sets targets and goals that have a time frame within their policies, plans and projects as seen in the “Imagine Durban project” (eThekweni Municipality, 2010). It must be noted that Durban’s perception of a sustainable development achievement is far different compared to Hammarby Sjöstad’s perception of a sustainable development achievement, due to the location differences and unique considerations linked to developed versus developing countries. However Durban addressed sustainability issues such air quality and ecosystem services, along with specific developing countries issues related to lack of services and knowledge. Nonetheless the issues of lack of services and knowledge are extremely important to conquer as this sets a foundation on which sustainable development can advance in the future. It has been noted that Durban doesn’t make mention of any green infrastructure initiatives. Based on the best practices captured in this chapter, Chapter 7 will proceed to introduce the proposed Green Planning Development concept and its framework, applicable to the local South African environment and context.

CHAPTER 7: THE PROPOSED GREEN PLANNING DEVELOPMENT CONCEPT AND FRAMEWORK

7.1 Points of departure

This chapter aims to introduce the proposed concept of Green Planning Development as well as the proposed Green Planning Development framework. Figure 7.1 captures the structure of the organisation of Chapter 7.

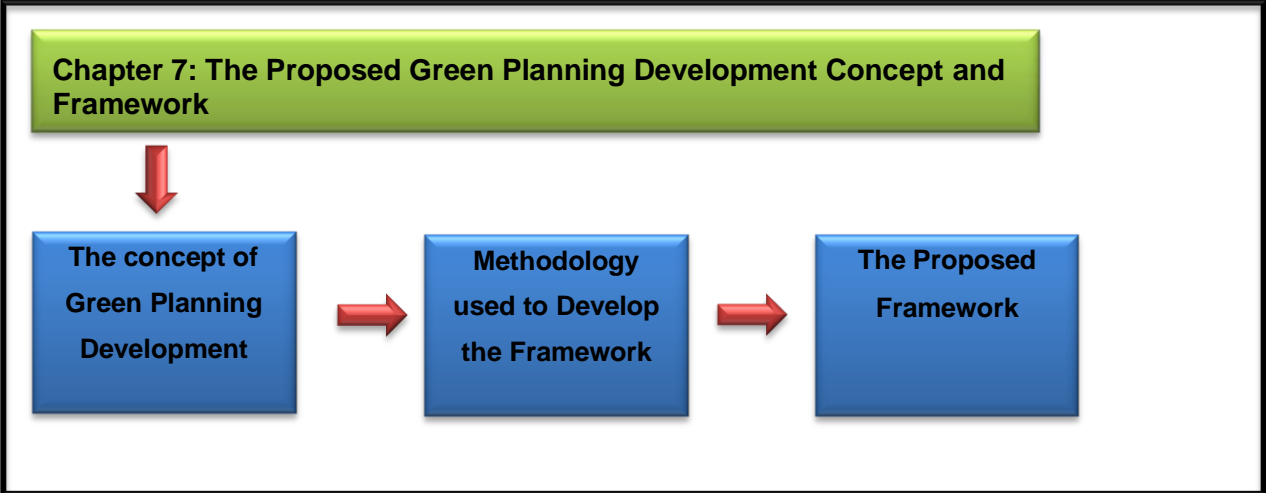


Figure 7.1: A graphical overview of the organisation and structure of Chapter 7
Source: Own construction (2016)

7.2 The concept of Green Planning Development

The importance of sustainability and sustainable development was emphasized throughout this research, as well as the increasing importance thereof (refer to Chapter 2.2-2.4). The research also emphasized the importance of green infrastructure planning and the relation between such and objectives of sustainable development (refer to Chapter 3.2-.3.3). Accordingly the link between spatial planning and green infrastructure planning was identified in Chapter 3.4, consequently linking the three concepts of sustainable development, spatial planning and green infrastructure planning. This research states that the concept of Green Planning Development is based on the notion of this integration between the objectives of sustainable development, spatial planning and green infrastructure. The primary principle behind the Green Planning Development concept is to allow for integration of the urban and natural environment, to enhance sustainable thinking that will allow for planning of lower impact developments, and to promote the awareness and inclusion of environmental planning as part of mainstream urban planning.

Based on research conducted and captured in the previous chapter, this research stated the definition of Green Planning Development as follows:

Green Planning Development is considered the integration of spatial planning and green infrastructure planning and approaches, which forms under the planning discipline jurisdiction and is realised in terms of spatial implementation and strategic planning.

This concept is supported and promoted by several of the current international and national policies and legislation (captured under “sustainability” and “environmental management”), as stated in Chapter 4.

7.3 Methodology used to develop the Green Planning Development Framework

This research further intended to create a Green Planning Development Framework, to enhance Green Planning Development as part of mainstream urban planning approaches and guide the planning of future projects to include a Green Planning Development approach. A framework was selected over a benchmark or performance index as benchmark and performance indices frequently lack the ability to identify place-based development opportunities or constraints. An indicator framework can be used in relation with a detailed city plan and therefore will be specific to an area (Weber, 2015:2). Frameworks can provide many advantages that support planners in designing and developing more sustainable urban areas, Weber (2015:2) identified eight benefits for the use of frameworks, they include:

- Add accountability to sustainability plans and actions, providing constructive feed-back that can provide insight on what functions and what doesn't.
- Frameworks can be used as leverage against individuals or groups who would undermine sustainability efforts, by identifying problems and showing where there is the greatest need for improvement.
- Provide structure to policy monitoring, evaluation and revision, allowing future plans and targets to be defined.
- Guide decisions by providing an evidence base, supplying a useful view of issues on the ground and how they change over time.
- Assist planners to define smart, measurable goals in regional development strategies and plans.
- Identify impacts and challenges associated with policy-making, allowing policy-makers to understand what the toughest issues are to conquer.
- Improve performance comparability, allowing regions or cities with similar issues to compare their progress and share solutions.

- Involve stakeholders by providing tangible material to comment on and allowing stakeholders to see where progress is being made.

Therefore frameworks can be powerful monitoring and communication tools and also provide structure and validity to sustainability efforts. Weber (2015:2) states that frameworks offer a platform that combines various façades of sustainability and organises them directly in line with comprehensive plans.

The theoretical grounding of Chapters 2, 3 and 4 guided the initial development of the Green Planning Development framework. Core issues as derived from various international and local policies and legislations were also considered when major categories of the framework were identified. Chapter 5 analysed three different Green Planning Development benchmarking tools and indices used to identify the level of sustainability of a city or region, including the AGCI (refer to Chapter 5.2), AAFMCS (refer to Chapter 5.3) and the GCIF (refer to Chapter 5.4). These three tools further contributed to the development of the proposed framework, in terms of identification of major categories to be included in the new proposed framework (refer to Table 5.4). Chapter 6 evaluated the practicalities of Green Planning Development by considering the international award winning eco-city Hammarby Sjöstad (refer to Chapter 6.2) and the local city Durban (refer to Chapter 6.3) to identify best practices and major categories to be considered as part of a Green Planning Development approach.

The proposed Green Planning Development Framework was thus comprised from a variety of theoretical and empirical issues identified in this research. These issues were ranged in terms of broad themes, and major categories were identified based on frequency of usage within the research literature, policies and legislations, benchmarking tools and case studies. This proposed framework was tested on a local case study (refer to Chapters 8 and 9), to illustrate the added-value thereof in terms of sustainable development and green infrastructure planning. The Green Planning Development Framework is discussed accordingly.

7.4 The proposed Green Planning Development Framework

The proposed Green Planning Development framework aims to enhance the integration of the urban and natural environments, to allow for lower impact developments, and to promote the awareness and inclusion of green infrastructure planning as part of urban and spatial planning approaches. Table 7.1 below displays the proposed framework, including indicators within each major category, and cross-references to previous chapters where this Green Planning Development focus has been captured. The framework aims to guide future urban developments to be more sustainable and to integrate green infrastructure and spatial planning approaches. The categories is thus not a comprehensive representation of all sustainability or

green infrastructure categories, but a selection of specific planning-related categories, which can be incorporated in the urban planning process, and layout and design of a new development, or urban areas.

Table 7.1: The Proposed Framework

Major Category	Indicator	Type	Description	Collection Method	Literature Link
Energy	Access to electricity (%)	Quantitative	The percentage of residents that have access to electricity.	Developer/ Local authority/ Public participation.	IDP (4.4.1); AGCI (5.2); GCIF (5.4); Durban (6.3);
	Electricity demand per unit (kVA)	Quantitative	The total electrical usage per unit (kVA).	Developer/ Local authority.	NFSD (4.3.6); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Durban (6.3);
	Clean energy policy (Alternative energy)	Qualitative	Measure of the study areas policy and efforts to make use of clean/ alternative energy.	Developer/ Local authority	IDP (4.4.1); NEMA (4.3.4); AGCI (5.2); AAFMCS (5.3); Hammarby Sjöstad (6.2); Durban (6.3);
Environmental governance	Air quality (PM10)	Quantitative	Particulate matter is a mixture of microscopic solids and liquid droplets suspended in air. These particulates are made up of a number of components, including acids, organic chemicals, metals, soil or dust particles, and allergens. Coarse particles are greater than 2.5 microns and less or equal to 10 microns in diameter and are defined as “respirable particulate matter” or PM10.	Developer/ Local authority	Agenda 21 (4.2.2); IDP (4.4.1); RSA Constitution (4.3.1); SDG (4.2.1); AGCI (5.2); GCIF (5.4); Durban (6.3);
	Ecology and ecosystem services	Qualitative	Assessment of the fauna and flora found within the study area in terms of ecological sensitivity, ecosystem services and conservation.	Developer/ Local authority/ Site visit.	Sustainability and ecological integrity (Chapter 2); Agenda 21 (4.2.2); IDP (4.4.1); NEMA (4.3.4); RSA Constitution (4.3.1); SDG (4.2.1); SPLUMA (4.3.5); NFSD (4.3.6); AGCI (5.2); AAFMCS (5.3); Hammarby Sjöstad (6.2); Durban (6.3);
	Stormwater management	Qualitative	Measure of the study areas policy and efforts to control and manage stormwater/ run off water.	Developer/ Local authority/ Site visit.	Sustainability and ecological integrity (Chapter 2); IDP (4.4.1); NEMA (4.3.4); NFSD (4.3.6); SDG (4.2.1); Hammarby Sjöstad (6.2);
	Green space per capita (m ² /person)	Quantitative	The total number of square metres of green/ open space divided by the total number of residents.	Developer/ Local authority.	Green Infrastructure (Chapter 3); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Durban (6.3);

	Green space linkages	Qualitative	Measure of connectivity of the green open spaces within the study area (that allow for positive ecological impacts).	Developer/ Local authority/ Site visit.	Sustainability and ecological integrity (Chapter 2); Green Infrastructure (Chapter 3); SDG (4.2.1); NFSD (4.3.6); Hammarby Sjöstad (6.2);
	Green infrastructure	Qualitative	Measure of the study areas efforts and implementation of green infrastructure techniques.	Developer/ Local authority/ Public participation/ Site visit.	Sustainability and ecological integrity (Chapter 2); Green Infrastructure (Chapter 3); IDP (4.4.1); SDG (4.2.1); Hammarby Sjöstad (6.2);
Knowledge	Knowledge of concept (%)	Qualitative	The percentage of residents that have an understanding of sustainable development or green infrastructure.	Public participation/ Site visit.	NEMA (4.3.4); Durban (6.3);
	Understanding importance of concept (%)	Qualitative	The percentage of residents that understand and agree on the importance of sustainable development or green infrastructure.	Public participation/ Site visit.	NEMA (4.3.4); Durban (6.3);
	Willingness to participate (%)	Qualitative	The percentage of residents that is willing to participate in sustainable development or green infrastructure methods on a consumer level, such as making use of solar panels or having gardens instead of paving.	Public participation/ Site visit.	NEMA (4.3.4); AGCI (5.2); Durban (6.3);
Land use	Population density (person/km ²)	Quantitative	The population density per km ² .	Developer/ Local authority.	BNG (4.3.3); NDP (4.3.2); AGCI (5.2); GCIF (5.4); Durban (6.3);
	Land compactness (Total building coverage)	Quantitative	The total number of hectares that have been developed (built on).	Developer/ Local authority/ Site visit.	Agenda 21 (4.2.2); BNG (4.3.3); Habitat Agenda (4.2.3); NDP (4.3.2); SPLUMA (4.3.5); AAFMCS (5.3);
	Land optimisation (%)	Quantitative	Measure of land efficiency and extent of mixed use.	Developer/ Local authority/ Site visit.	Agenda 21 (4.2.2); BNG (4.3.3); Habitat Agenda (4.2.3); IDP (4.4.1); SPLUMA (4.3.5); NFSD (4.3.6); AAFMCS (5.3); Hammarby Sjöstad (6.2);
	Total open space coverage (active and non-active)	Quantitative	The total number of hectares of green/open space (active and passive).	Developer/ Local authority/ Site visit.	AAFMCS (5.3); GCIF (5.4); Hammarby Sjöstad (6.2);
	Units per hectare	Quantitative	The total number of units (per typology) divided by the total number of hectares.	Developer/ Local authority/ Site visit.	Agenda 21 (4.2.2); BNG (4.3.3); Habitat Agenda (4.2.3); SPLUMA (4.3.5);

Sanitation & Water	Access to sanitation (%)	Quantitative	The percentage of residents that have access to sanitation.	Developer/ Local authority/ Public participation.	NDP (4.3.2); SDG (4.2.1); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Durban (6.3);
	Waste Water Treatment policy	Qualitative	Measure of the study areas policy towards providing sanitation and reducing pollution associated with inadequate sanitation.	Developer/ Local authority.	Agenda 21 (4.2.2); AGCI (5.2); Hammarby Sjöstad (6.2); Durban (6.3);
	Access to water (%)	Quantitative	The percentage of residents that have access to clean water.	Developer/ Local authority/ Public participation.	NDP (4.3.2); SDG (4.2.1); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Durban (6.3);
	Water consumption (L/person/day)	Quantitative	Consumption of water measured in litres per day.	Developer/ Local authority.	NFSD (4.3.6); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Hammarby Sjöstad (6.2); Durban (6.3);
	Water Treatment policy	Qualitative	Measure of the study areas policy towards providing clean water.	Developer/ Local authority.	GCIF (5.4); Hammarby Sjöstad (6.2);
	Water use sustainability policy	Qualitative	Measure of the study areas efforts to manage water sources efficiently.	Developer/ Local authority.	Agenda 21 (4.2.2); NFSD (4.3.6); IDP (4.4.1); NEMA (4.3.4); AGCI (5.2); Hammarby Sjöstad (6.2); Durban (6.3);
	Waste water (recycling):				
	Grey water	Qualitative		Developer/ Local authority.	GCIF (5.4); Hammarby Sjöstad (6.2);
Black water	Qualitative	Measure of the study areas policy towards recycling grey and black water.	Developer/ Local authority.	GCIF (5.4); Hammarby Sjöstad (6.2);	
Structures	People per unit	Quantitative	Persons per dwelling unit.	Developer/ Public participation.	GCIF (5.4);
	Construction materials	Qualitative	The types of material used to construct the dwellings units. Measured for lower energy demand purposes.	Developer/ Local authority.	BNG (4.3.3); Habitat Agenda (4.2.3); IDP (4.4.1); NDP (4.3.2); NFSD (4.3.6); Hammarby Sjöstad (6.2);
	Insulation	Qualitative	The types of insulation used within the dwellings units. Measured for lower energy demand purposes.	Developer/ Local authority.	BNG (4.3.3); Habitat Agenda (4.2.3); IDP (4.4.1); NDP (4.3.2);
	Natural lighting (windows)	Qualitative	Measure of natural lighting within dwelling units. Measured for lower energy demand purposes.	Developer/ Local authority/ Site visit.	BNG (4.3.3); Habitat Agenda (4.2.3); IDP (4.4.1); NDP (4.3.2);

	Orientation	Qualitative	The orientation of dwelling units. Measured for lower energy demand purposes.	Developer/ Local authority/ Site visit.	BNG (4.3.3); Habitat Agenda (4.2.3); IDP (4.4.1); NDP (4.3.2);
Transportation	Amount of vehicles per unit (Each typology)	Quantitative	The amount of private automobiles vehicles (two and four wheeled) divided by the amount of units per typology.	Public participation/ Site visit.	AAFMCs (5.3); GCIF (5.4); Hammarby Sjöstad (6.2);
	Distance from work (km)	Quantitative	The distance residents travel to get to work each day (km).	Public participation.	NDP (4.3.2); Hammarby Sjöstad (6.2);
	Main methods of transportation used	Quantitative	Ratio of private and public transportation. Share of each mode of private car, taxi, bus, train, bicycle, and walking.	Public participation.	Agenda 21 (4.2.2); BNG (4.3.3); IDP (4.4.1); NDP (4.3.2); SPLUMA (4.3.5); AGCI (5.2); AAFMCs (5.3); GCIF (5.4); Hammarby Sjöstad (6.2); Durban (6.3);
	Parking allocation per unit (Ratio)	Quantitative	The ratio of parking spaces per single unit.	Developer/ Local authority/ Site visit.	Green Infrastructure (Chapter 3); IDP (4.4.1); SDG (4.2.1); AAFMCs (5.3);
Waste management	Access to waste management service (%)	Quantitative	The percentage of residents that have access to waste management services.	Developer/ Local authority/ Public participation.	GCIF (5.4); Hammarby Sjöstad (6.2);
	Waste generated (m ³ /week)	Quantitative	Total weekly volume of waste generated by residents.	Developer/ Local authority/ Public participation.	AGCI (5.2); NFSD (4.3.6); AAFMCs (5.3); Durban (6.3);
	Waste management policy	Qualitative	Measure of the study areas policy to dispose of solid waste.	Developer/ Local authority.	Agenda 21 (4.2.2); IDP (4.4.1); NEMA (4.3.4); AGCI (5.2); Hammarby Sjöstad (6.2); Durban (6.3);
	Recycling or reusing policy	Qualitative	Measure of the study areas policy and efforts to recycle and reuse waste.	Developer/ Local authority.	NEMA (4.3.4); NFSD (4.3.6); AGCI (5.2); AAFMCs (5.3); GCIF (5.4); Hammarby Sjöstad (6.2); Durban (6.3);
	Hazardous waste policy	Qualitative	Measure of the study areas policy to dispose of hazardous waste.	Developer/ Local authority.	Agenda 21 (4.2.2); NFSD (4.3.6); Hammarby Sjöstad (6.2);

Source: Own construction (2016)

CHAPTER 8: APPLICATION OF THE PROPOSED GREEN PLANNING DEVELOPMENT FRAMEWORK (COMMUNITY-INPUT)

8.1 Points of departure

Chapter 8 aimed to illustrate the application of the proposed Green Planning Development framework and the community input that is needed in order to present a comprehensive framework for further analysis. As such the local community perspective was captured by means of questionnaires completed by the residents of the Fleurhof area. The community input surveys ensures that the important issues perceived by communities are also considered as part of the framework analysis, and therefore an important part of the proposed Green Planning Development framework. The questions included in the survey were linked to the identified categories as included in the proposed framework. A bottom up approach was followed in this chapter which has fully utilised the aspects of public participation, this approach method was also followed to avoid any bias impacts or perceptions on how the survey was constructed or delivered to the residents. Therefore this chapter has been discussed before the current state of affairs, Chapter 9, to follow the methodology of bottom up approach and avoid any bias impacts. Figure 8.1 below provides the structure of Chapter 8.

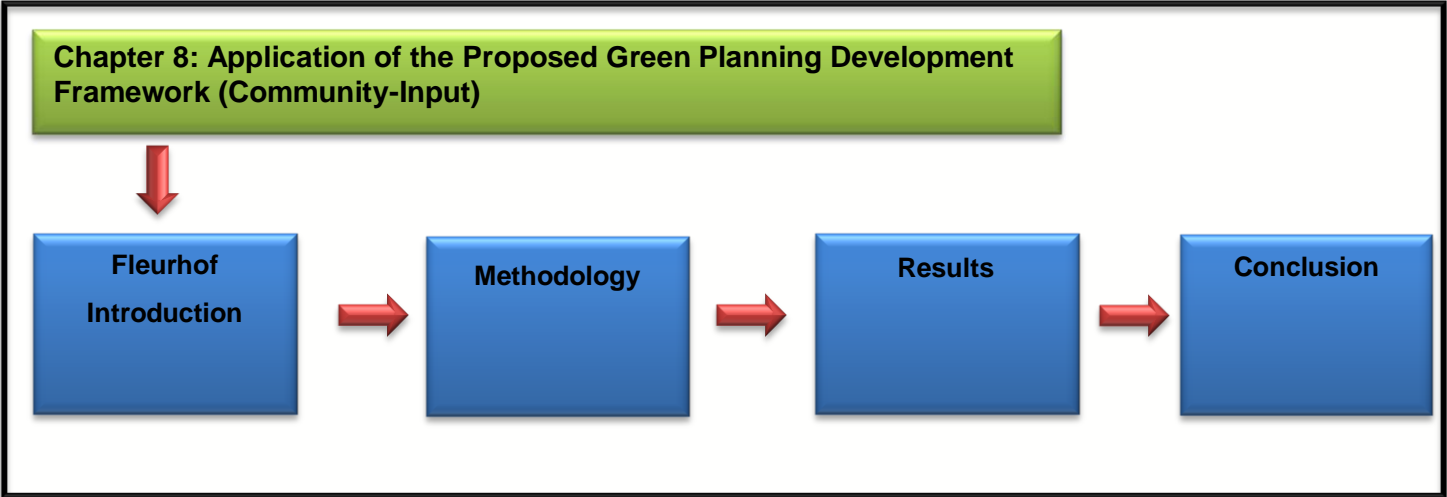


Figure 8.1: A graphical overview of the organisation and structure of Chapter 8
Source: Own construction (2016)

8.2 Introduction to the Fleurhof case study

The selected case study, Fleurhof, is situated south west of Johannesburg CBD, South Africa (refer to Figure 1.1). Fleurhof is currently one of the largest modern integrated housing developments in Gauteng, and was therefore selected as case study for this research. It comprises various types of residential units, including fully subsidized RDP/BNG housing, Gap

housing, Social rental housing, Open market rental and Entry level housing. Each type of unit is aimed at a different economic market (Calgro M3 Holdings, 2015a).

The green component of Fleurhof – Various green initiatives are found in Fleurhof such as: energy saving technologies such as solar water heaters, heat pumps and improved insulation for the various types of housing units are currently being investigated. Residential recycling projects, urban greening initiatives and food gardening are also being considered. Apart from the economic and environmental benefits brought along by these initiatives, it will also enhance social and visual perspectives (Calgro M3 Holdings, 2015a).

The Fleurhof area was considered in terms of all the categories included in the proposed Green Planning Development framework, aiming capture the status quo and to guide future urban developments to be more sustainable and to integrate green infrastructure and spatial planning approaches. This chapter focus on the community input included as such.

8.3 Methodology

In order to consider the community input as part of the proposed Green Planning Development framework, questionnaires were provided to residents of the Fleurhof area. A total number of 322 questionnaires were completed by the residents of Fleurhof, equating to a 3.19% sample size group, reflecting the views of the 322 households. The target group included a representation of each of Fleurhof's housing typologies, including RDP/BNG housing, apartments (Gap and Social rental), free standing and semi-detached homes (Open market rental and Entry level housing). An example of the questionnaire given out to the residents of Fleurhof can be found in Annexure A. The questions were structured to relate to the identified major categories in the proposed Green Planning Development framework (refer to Chapter 7), the categories include: Knowledge, energy, environmental governance, land use, sanitation, water, structures, transportation and waste management. As there was a high percentage of illiterate respondents, and due to the fact that the concept of Green Planning Development is a newly proposed concept, the terms “environmental planning/friendly” were used instead of “Green Planning Development”.

The results of the questionnaires and opinions of residents has been discussed first (Chapter 8), followed by the detailed discussion of Fleurhof in Chapter 9. This method was followed due to the fact that this was the order in which the study was completed. A bottom-up approach was followed first as to not enter the study area with a bias perspective. The effectiveness of this method is illustrated in the following example: In Chapter 9.3 it was calculated that there is 293.54m² of green open space per person, however it was identified through the questionnaires

in Chapter 8.4.3 (refer to Figure 8.16 and Question 4.9 in Annexure A) that the residents feel there is not enough green open space. If only the information in Chapter 9 was considered, it would show that there is more than enough green open space. However due to the none-bias bottom up approach used a different result was identified as majority of the green open space is passive and not active, therefore identifying a gap and demonstrating the importance of public participation.

The North-West University's Statistical consultancy services aided in the statistical analyses and interpretation of the captured data for this research. As a convenience and not a random sample was used, p-values is reported for completeness sake but is not interpreted as part of this research. Crosstabs were completed on all questions based on Question 2.3 (refer to Annexure D). Crosstabs summarize the relationship between two categorical variables, where in this case Question 2.3 was a fixed variable (Question 2.3 asked residents if they think that environmental planning is important, and considered the core issue related to Green Planning Development from a community perspective). Only the relationships between variables that had a statistical significance have been mentioned even though crosstabs have been completed on all the questions.

Chi-Square Tests and Symmetric Measures were initially completed to see if there is a statistical significant association between the questions, if $p < 0.005$, then there is a statistical significant association. The values under the columns "Asymptotic Significance (2-sided)" and "Approx. Sig." displayed in Annexure D are the p values that should be below 0.005. If the p value was below 0.005 then the effect sizes were considered. Effect sizes were indicated in the Symmetric Measures table under the "Value" column. Effect sizes are identified as follow:

- ~0.1 practical non-significant association or small effect
- ~0.3 practical visible significant association or medium effect
- ~0.5 practical significant association or large effect

Only if the effect size was 0.2 or higher was the crosstab table further analysed to illustrate possible relationships to Question 2.3. Annexure C displays the frequency tables of the data captured in Annexure D as some of the data categories were grouped together (recoded) in order to achieve a large enough frequency that may have an impact on the crosstabs.

8.4 Results of the community-input survey

The discussion below makes use of graphs to visually illustrate the results collected through the Fleurhof community-input survey. The results were categorised in terms of the major categories of the proposed Green Planning Development framework (refer to Table 7.1). Only questions

informing the proposed Green Planning Development framework were reported on, and thus included in this section.

8.4.1 Knowledge

Fleurhof residents had to make an educated choice between which of the three images in Question 2.1 they regard as the most green or environmentally friendly. Figure 8.2 displays the images which were provided to the respondents. Figure 8.3 displays the results of Question 2.1. 81% of people selected what was regarded to be the right the answer, answer C. Question 2.2 asked the residents to state which of the images they would regard as their current home and environment. However it was noted that most of the residents selected the image they were most fond of (answer C) and did not always choose the best representation which was B. Nevertheless 55% of residents stated that B best represented their home as seen in Figure 8.4.

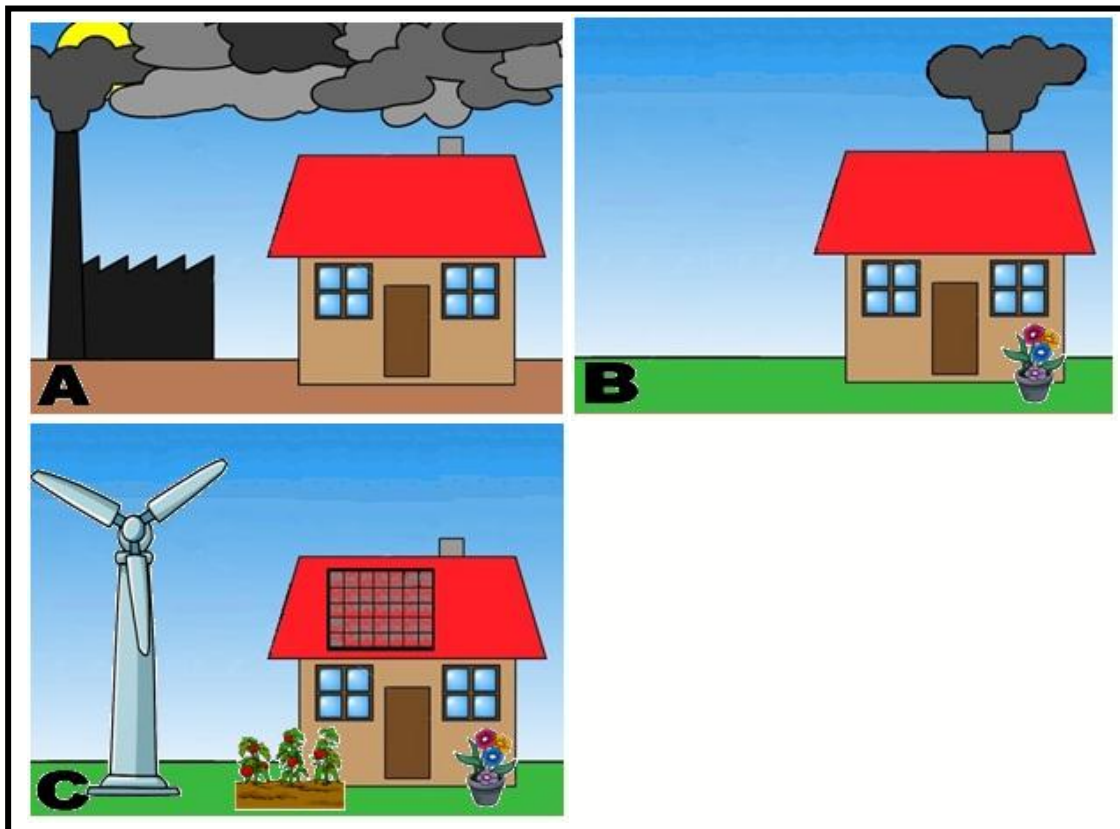


Figure 8.2: Visual Answers

Source: Own creation (2015)

What do you regard as environmentally friendly/sustainable planning?

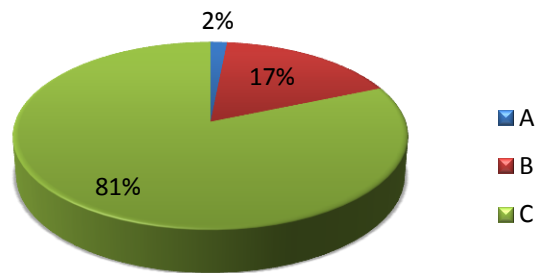


Figure 8.3: Question 2.1

Source: Adapted from Database Fleurhof Master (2015)

Which of the images would you regard as your current home and environment?

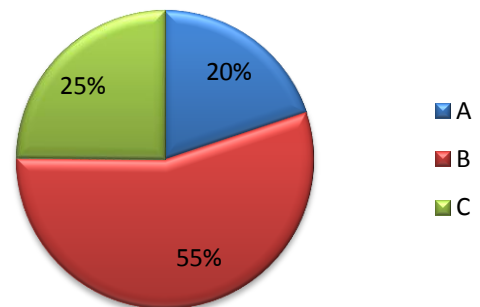


Figure 8.4: Question 2.2

Source: Adapted from Database Fleurhof Master (2015)

Questions 2.3, 2.4 and 2.6 aimed to further capture the community’s perspective regarding Green Planning Development. The sole purpose of these questions was to see if respondents truly understand the concept of sustainable development and green infrastructure. If respondents mentioned anything linked to renewable resources (solar, hydro, wind etc.), sustainable living, improving the natural environment, prevent harmful developments to nature, integrating humans and nature, looking after the natural environment, prevent pollution, or even “fighting greenhouse gasses” (global warming) it was interpreted that the respondent understood the (basic) objectives of Green Planning Development. Any other statements like “I like green grass”, “It is good for me”, “It makes me happy” (without elaborating on how it connects to human wellbeing or an improved lifestyle) or “Because it is important” were regarded as “not understanding the concept” and respondents were marked with a cross (X) by questions 2.4 and 2.6. However regarding Question 2.3, 93% agreed that environmental planning is important as seen in Figure 8.5.

Figure 8.6 displays a low 39% of all residents had a true understanding of what sustainable development and green infrastructure is. Therefore it can be noted that the people in the area could be taught on how to be more sustainable and live a more “greener” life style within their means in the Fleurhof area.

Do you think environmental planning is important?

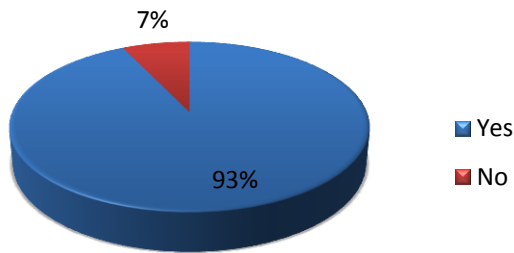


Figure 8.5: Question 2.3

Source: Adapted from Database Fleurhof Master (2015)

Do they understand the concept of Green Planning Development?

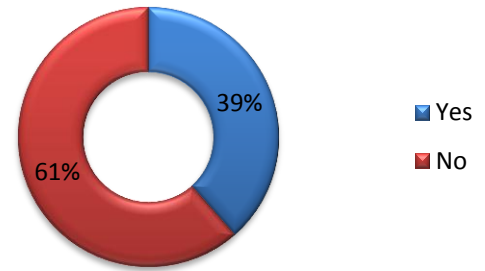


Figure 8.6: Questions 2.4 and 2.6

Source: Adapted from Database Fleurhof Master (2015)

A total of 89% of residents agreed that Green Planning Development should form part of their home and community despite them understanding Green Planning Development or not. As seen above in Figure 8.6, only 39% of the respondents understood the concept of Green Planning Development. And it would be suggested that the people might learn more about the Green Planning Development concept and living greener. Therefore Question 2.7 was asked to determine if the residents would like to learn about the Green Planning Development concept. As displayed in Figure 8.7, only 13% of all respondents stated that they do not want to learn more about Green Planning Development.

Would you like to learn about environmental planning?

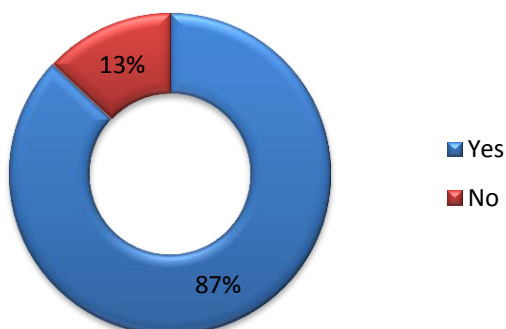


Figure 8.7: Question 2.7

Source: Adapted from Database Fleurhof Master (2015)

Questions 2.8, 2.9 and 2.10 were asked to determine whether the resident of Fleurhof would take part and make use of Green Planning Development tools and technology if it was provided to them. Questions 2.9 and 2.10 focused on finance and whether or not the respondents would be willing to pay a small sum extra every month to have access to Green Planning Development tools and technology.

Figure 8.8 displays that 89% of respondents would make use and practise Green Planning Development if they had access to Green Planning Development tools and technology (referred to as elements in the Figures). And 62% of those that would use and practise Green Planning Development are willing to pay an extra cost every month (if need be) to have access to Green Planning Development tools and technology (referred to as elements in the Figures) (Refer to Figure 8.9).

Would you take part or make use of these green elements?

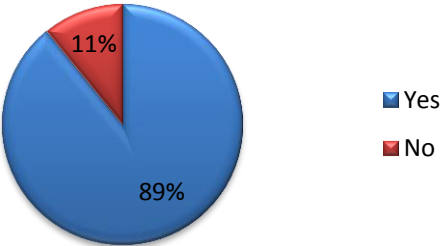


Figure 8.8: Question 2.8
Source: Adapted from Database Fleurhof Master (2015)

Would you be willing to pay slightly more for your home to have access to the green elements?

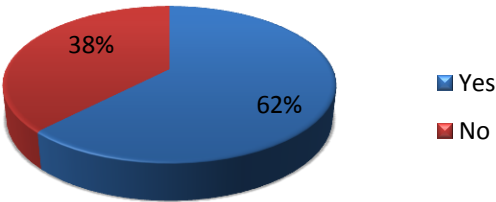


Figure 8.9: Question 2.9
Source: Adapted from Database Fleurhof Master (2015)

Based on the results of Question 2.9, residents were asked how much they were willing to pay for access to Green Planning Development tools and technology. Figure 8.10 displays the amount of people who are willing to pay more to have access to Green Planning Development tools and technology as well the amount of money (ZAR) they would pay extra every month. The results are as follow:

- 38% agreed to pay less than R100
- 48% agreed to pay R100-150
- 11% agreed to pay R150-R300
- 3% agreed to pay R300+

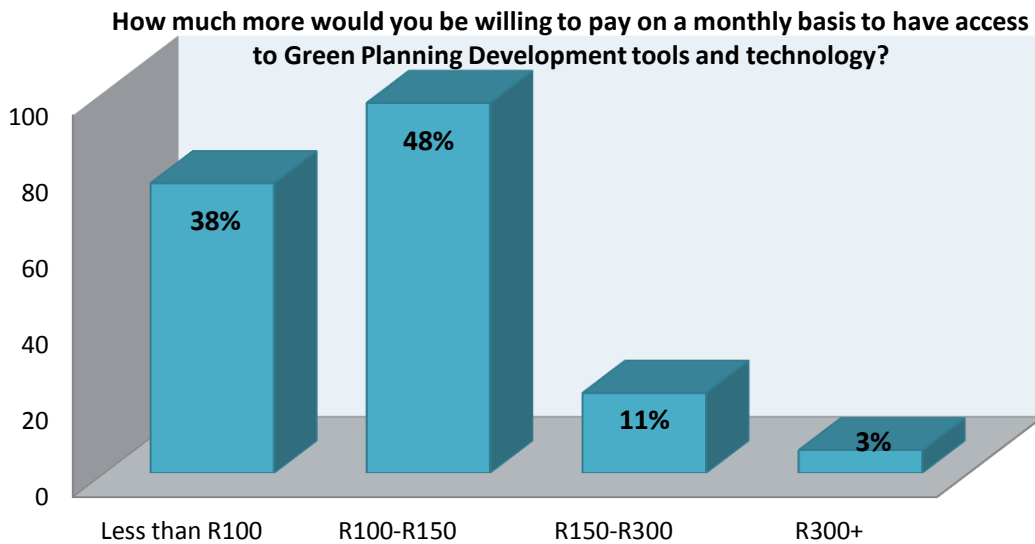


Figure 8.10: Question 2.10

Source: Adapted from Database Fleurhof Master (2015)

In summary, only 39% of the respondents understood the (basic) concept of Green Planning Development (refer to Figure 8.6). However 87% of respondents stated that they do not want to learn more about Green Planning Development (refer to Figure 8.7) and a high 89% of respondents stated they would make use and practise Green Planning Development daily if they had access to Green Planning Development tools and technology (refer to Figure 8.8).

8.4.2 Energy

From a community perspective, the only question posed to residents with regards to energy provision, was whether they had access to electricity. The residents of Fleurhof **all** have access to electricity that is supplied by the local electrical network. Table 8.1 displays the results for Question 3.1.

Table 8.1: Question 3.1

Do you have access to electricity?	
Yes	322
No	0
	322

Source: Adapted from Database Fleurhof Master (2015)

8.4.3 Environmental Governance

The residents of Fleurhof were asked if they had access to open public space in Question 4.1, 85% of respondents stated that had access (refer to Figure 8.11). Question 4.2 tried to identify the type of open space people had access to. 43% of people said they had access to soft open space and 39% stated they access to both soft and hard open space, refer to Figure 8.12.

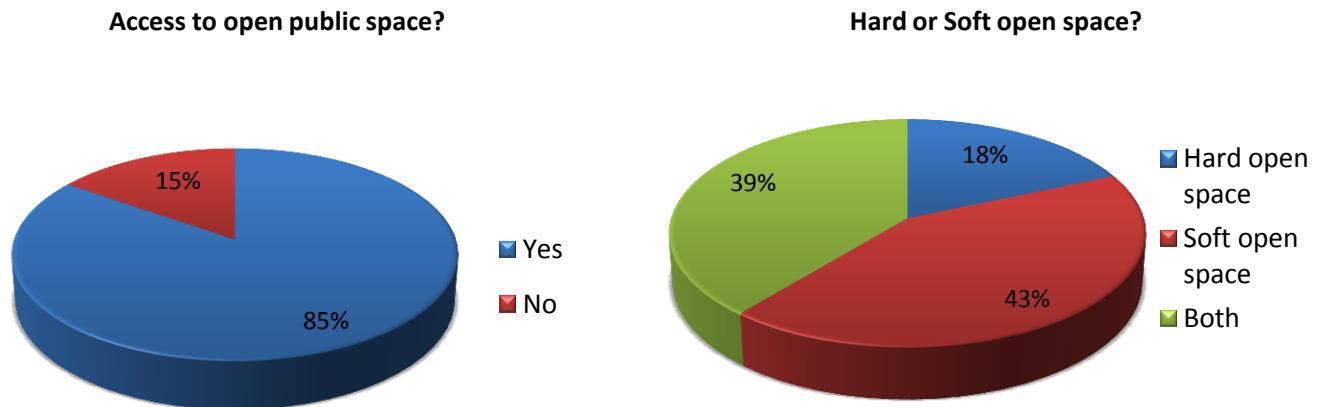


Figure 8.11: Question 4.1

Source: Adapted from Database Fleurhof Master (2015)

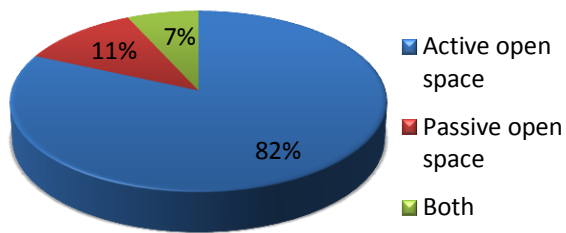
Figure 8.12: Question 4.2

Source: Adapted from Database Fleurhof Master (2015)

Figure 8.13 displays the results of Question 4.3 was asked to determine the type of open green space that as available to the people. 82% of people access to active open spaces, 11% of people access to passive open space and 7% of people access to both types. Figure 8.14 displays the results of Question 4.5. It was important to determine the frequencies open spaces were used as this can determine what type of open spaces will be needed to be developed in the future. 31% of respondents stated that they visit open spaces at least once a week, 26% of respondents stated that they visit open spaces once a month and 25% gave varied amounts of visits and times. Only 8% of people said they visit an open space every day, majority of these people had small children.

Figure 8.15 displays how people travel to the open spaces majority of the time. A large 90% of people travel by foot, meaning that the open spaces are within walking distance. A further 4% use privately owned vehicles and 3% go by taxi (public transport).

Type of open space?



How often do you visit the open space?

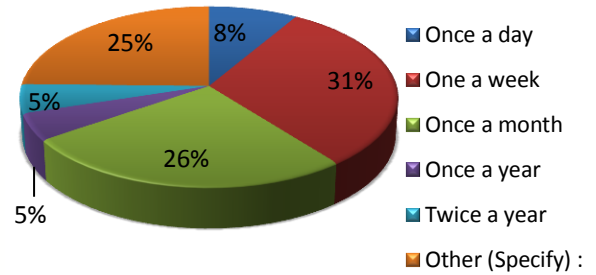


Figure 8.13: Question 4.3

Source: Adapted from Database Fleurhof Master (2015)

Figure 8.14: Question 4.5

Source: Adapted from Database Fleurhof Master (2015)

How do you usually travel to open space

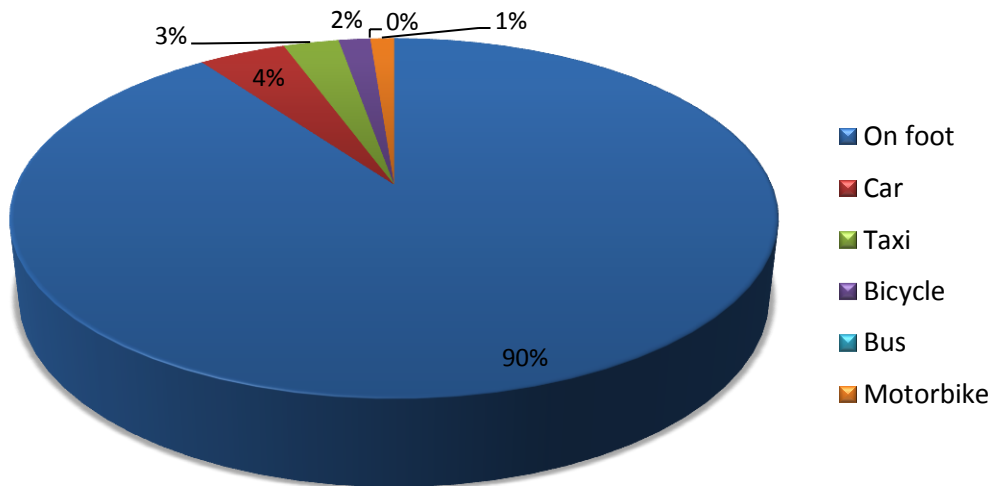


Figure 8.15: Question 4.6

Source: Adapted from Database Fleurhof Master (2015)

Question 4.9 gave the respondents the chance to state if whether they feel there is enough public open space for them to visit in the near area. A large 81% of locals said that there is not enough public open space, whether it is active or passive, hard or soft spaces. Figure 8.16 below displays the results.

Enough public spaces?

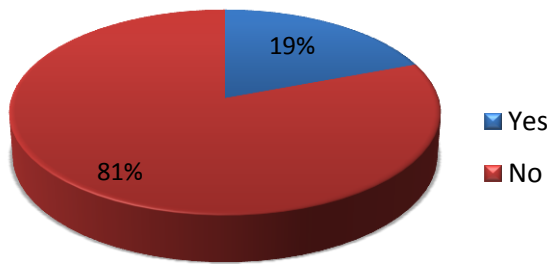


Figure 8.16: Question 4.9

Source: Adapted from Database Fleurhof Master (2015)

The final question of this section, Question 4.10, asked respondents what is their need in a public open space. 39% of people stated their need is recreational, 22% stated their need is business orientated, 18% stated their need is for markets (another form of business) and a low 10% stated their need is for children's jungle gyms and play areas (refer to Figure 8.17).

Residents need in a public space?

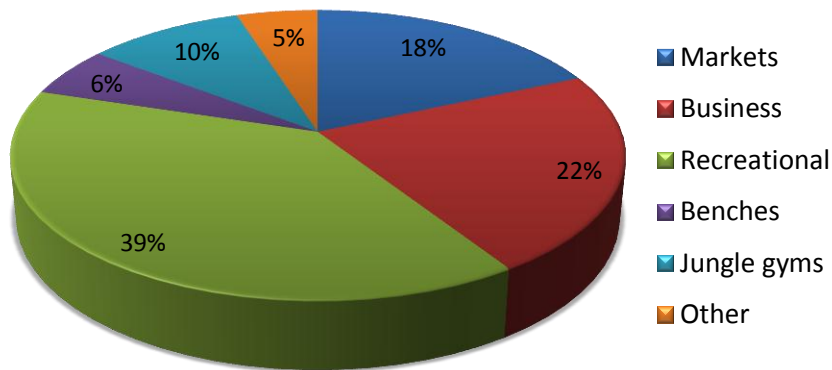


Figure 8.17: Question 4.10

Source: Adapted from Database Fleurhof Master (2015)

In summary, the important findings were that 85% of respondents stated that had access to green open space (refer to Figure 8.11), of which 82% had access to active open spaces, 11% had access to passive open space and 7% had access to both types (refer to Figure 8.13). Despite the large percentage of access people who had access to green open space, 81% of locals said that there is not enough public open space, whether it is active or passive, hard or soft spaces (refer to Figure 8.16).

8.4.4 Land Use

The questions asked in this section were focused on what types of economic amenities are in around the area to further understand the different land use in Fleurhof. Question 5.1 was asked to provide evidence of the different typologies found within Fleurhof. Figure 8.18 displays the results, 63% of people live in an apartment building and 37% of people live in a single storey free standing home.

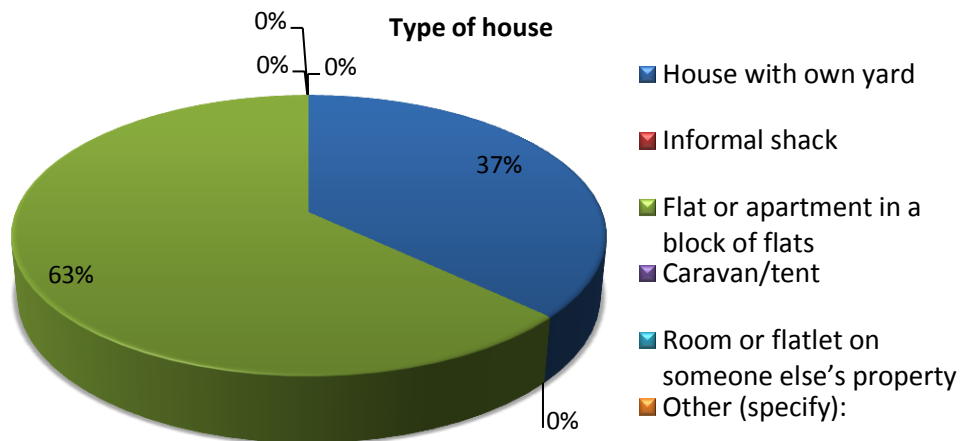


Figure 8.18: Question 5.1

Source: Adapted from Database Fleurhof Master (2015)

Figure 8.19 displays the results of Question 5.2, how far must residents travel to reach retail services (other than a spaza shop)? A total of 57% stated that they have to travel very far, meaning not within walking distance, 29% said they travel a far distance and only 14% stated that they travel a short distance. This was dependent on how deep in Fleurhof each respondent stayed. The closer to the main entrance the closer they were to major retail outlets.

Distance to travel to reach retail uses?

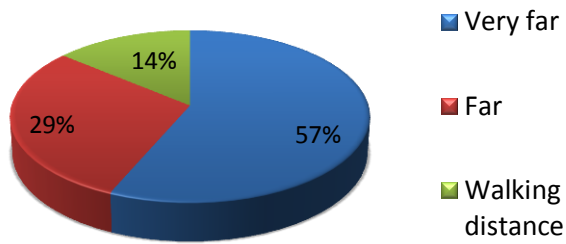


Figure 8.19: Question 5.2

Source: Adapted from Database Fleurhof Master (2015)

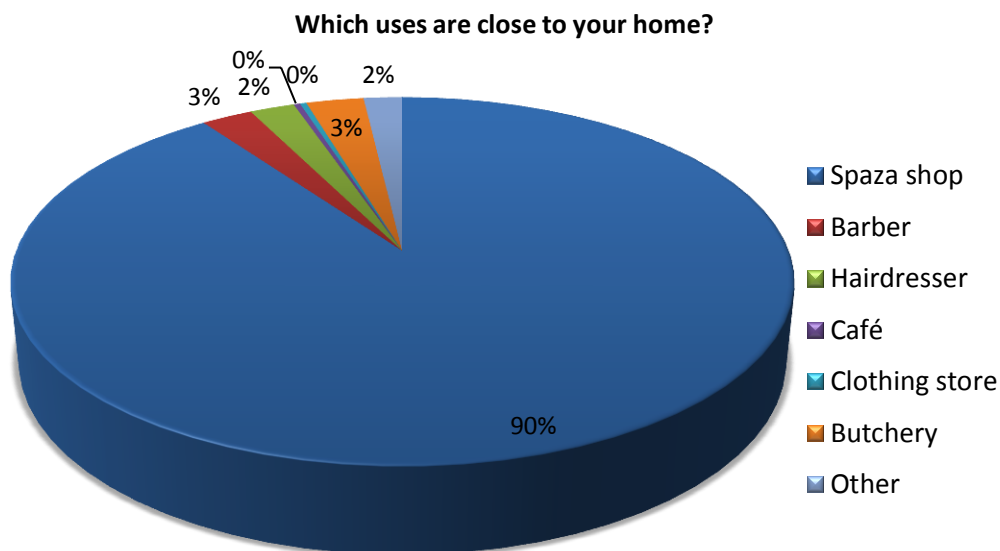


Figure 8.20: Question 5.3

Source: Adapted from Database Fleurhof Master (2015)

Question 5.3 identified which type of retail and service store is closest to respondents' home. Spaza shops were rated the closest to most people's homes with a high 90% of people stating that a spaza shop was near their home. The remainder was divided between 3% stating a barber, 3% stating a butchery, 2% stating a hairdresser and the final 2% stating other types of retail and service were the closest.

In summary, 63% of people live in an apartment building and 37% of people live in a single storey free standing home (refer to Figure 8.18) and 57% of respondents stated that they had to travel very far, meaning not within walking distance, to reach the closest retail store (refer to Figure 8.19).

8.4.5 Sanitation and Water

From a community perspective, the only question posed to residents with regards to sanitation, was whether they had access to sanitation. The residents of Fleurhof **all** have access to sanitation. Table 8.2 displays the results gathered by the questionnaire.

Table 8.2: Question 6.3

Do you have access to sanitation?	
Yes	322
No	0
	322

Source: Adapted from Database Fleurhof Master (2015)

From a community perspective, the only question posed to residents with regards to water, was whether they had access to water. The residents of Fleurhof **all** have access to clean water that is supplied by the local water system. Table 8.3 displays the results gathered by the questionnaire for Question 6.1 and Table 8.4 displays the results for Question 6.2.

Table 8.3: Question 6.1

Do you have access to clean water?	
Yes	322
No	0
	322

Source: Adapted from Database Fleurhof Master (2015)

Table 8.4: Question 6.2

Where do you get your water from	
Communal Tap	0
In-house (Local water scheme)	322
Rain Water Tank	0
Water Tank(Local jo-jo tank)	0
Wetlands/River/ Stream	0
Other (Specify):	0
	322

Source: Adapted from Database Fleurhof Master (2015)

In summary, all the residents of Fleurhof have access to sanitation and clean water (refer to Tables 8.2 and 8.3).

8.4.6 Structures

The questions asked in this section aimed to gather an understanding of the resident's opinion about the buildings in which they live. Question 7.1 asked respondents if they were satisfied with their home when they had moved in, 61% said they were satisfied, 22% was extremely satisfied and a low 17% were unsatisfied (refer to Figure 8.21). Question 7.2 asked respondents to rate Fleurhof in terms of scale (Question 7.2.1), design (Question 7.2.2) and relation (Question 7.2.3). Question 7.2.1 is represented by Figure 8.22, where 43% of respondents stated that the scale of buildings is good. Question 7.2.2 is represented by Figure 8.23, where 28% of respondents stated that the quality is good, 27% stated that the quality is fair and 25% stated that the quality is bad. This provides food for thought. Question 7.2.3 is represented by Figure 8.24, where 44% of respondents stated that the relation of the buildings is good and 30% stated that the relation is fair.

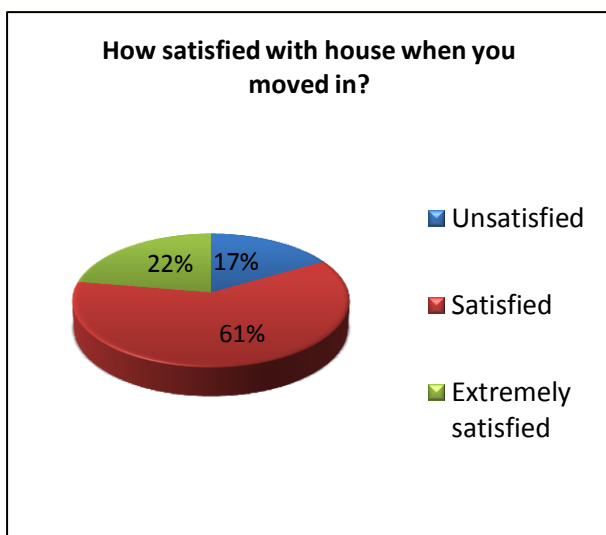


Figure 8.21: Question 7.1

Source: Adapted from Database Fleurhof Master (2015)

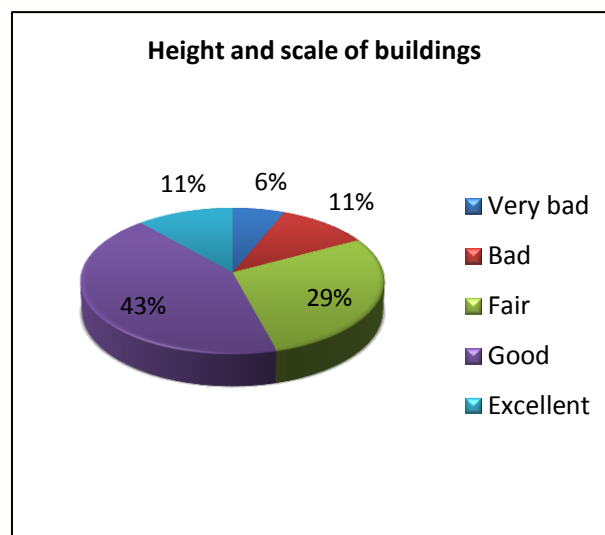


Figure 8.22: Question 7.2.1

Source: Adapted from Database Fleurhof Master (2015)

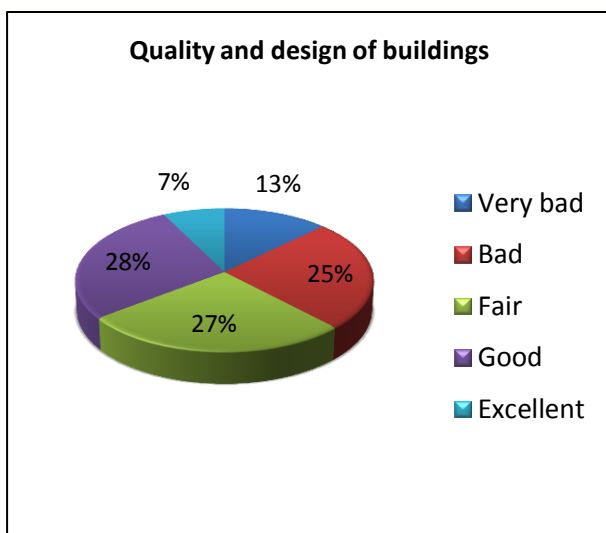


Figure 8.23: Question 7.2.2

Source: Adapted from Database Fleurhof Master (2015)

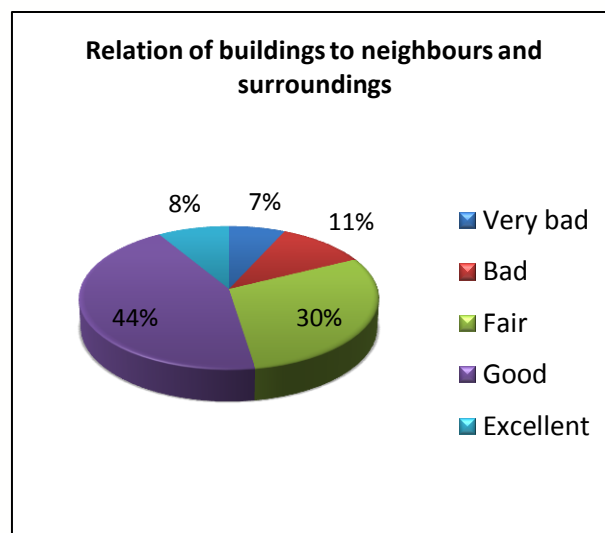


Figure 8.24: Question 7.2.3

Source: Adapted from Database Fleurhof Master (2015)

In Summary, 61% of respondents stated they were satisfied with their house (structure thereof), 22% was extremely satisfied with their house and a low 17% were unsatisfied with their house (refer to Figure 8.21).

8.4.7 Transportation

Do you own a car?

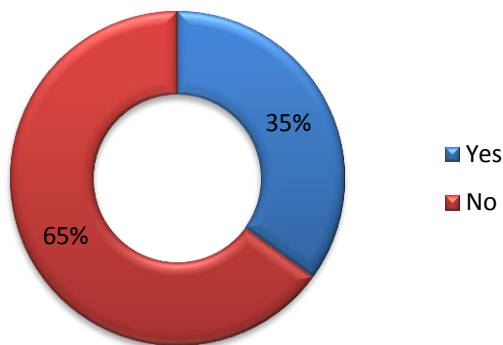


Figure 8.25: Question 8.1.1

Source: Adapted from Database Fleurhof Master (2015)

Distance travelled to work

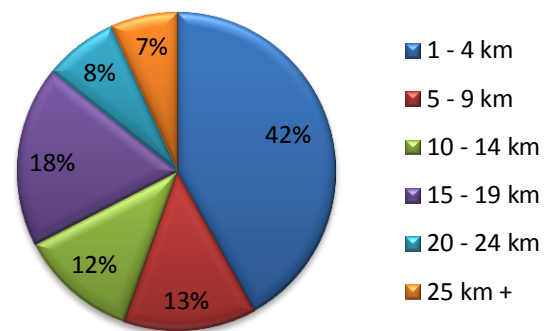


Figure 8.26: Question 8.2

Source: Adapted from Database Fleurhof Master (2015)

Only 35% of residents own a private car, refer to Figure 8.25. Figure 8.26 displays that 42% of residents live within a 1-4km radius of their work, and next biggest percentage being 18% of residents live within a 15-19km radius. 50% of residents use a taxi (public transport) most of the time, 26% of respondents use their own vehicle (refer to Figure 8.27).

Main mode of transport

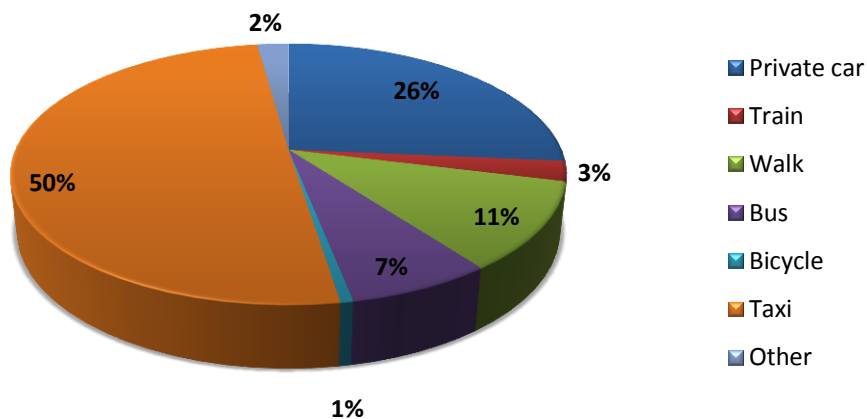


Figure 8.27: Question 8.3

Source: Adapted from Database Fleurhof Master (2015)

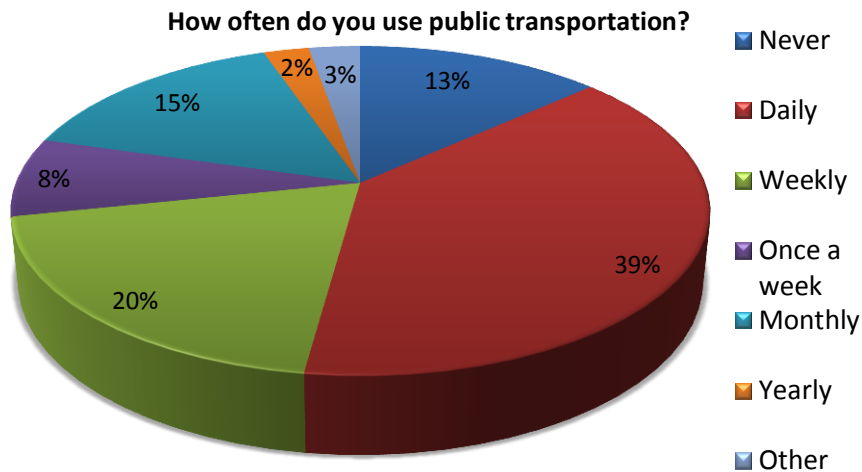


Figure 8.28: Question 8.4

Source: Adapted from Database Fleurhof Master (2015)

A large 39% of residents make use of public transport each day, with 20% using public transport on weekly basis. However 13% of people never use public transport, refer to Figure 8.28.

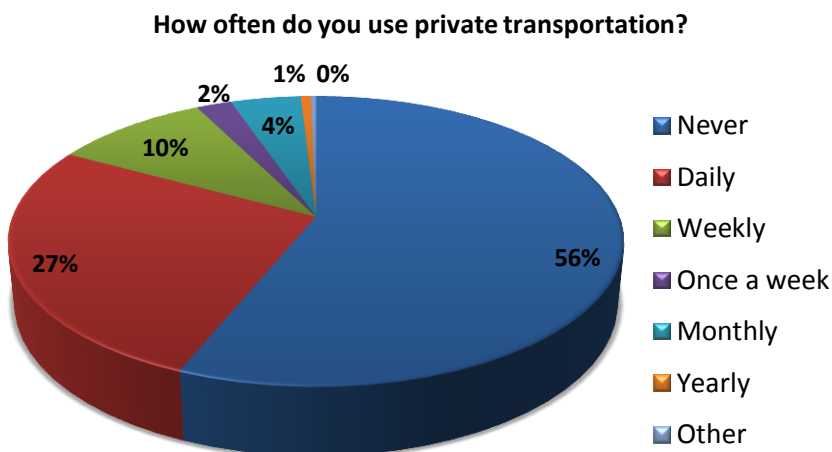


Figure 8.29: Question 8.5

Source: Adapted from Database Fleurhof Master (2015)

A high 56% of respondents never use private transportation, including lift clubs or car-pooling to their destination. 27% of respondents use private transportation on daily basis and only 10% of respondents use private transportation weekly (normally on weekends only), refer to Figure 8.29.

In summary, a total of 35% of residents own a private car (refer to Figure 8.25), however only 26% of respondents use their own vehicle as their main mode of transport the majority (60% of

residents) make use of public transport (refer to Figure 8.27). A large 39% of residents make use of public transport each day, with 20% using public transport on weekly basis (refer to Figure 8.28).

8.4.8 Waste Management

From a community perspective, the only question posed to residents with regards to waste management, was how their waste was disposed of. The residents of Fleurhof **all** have access to municipal waste management services. All waste is collected by the local authority. Residents have to dispose of their waste in the temporary storage refuse areas found outside their home, the local authority (City of Johannesburg) comes and collects it every week. Table 8.5 displays the results for Question 9.1.

Table 8.5: Question 9.1

How do you dispose of your solid waste (refuse)?	
Communal Refuse Dump	0
No Rubbish Disposal	0
Own Refuse Dump	0
Recycling Bin	0
Removal By Local Authority	322
Other (Specify):	0
	322

Source: Adapted from Database Fleurhof Master (2015)

8.5 Crosstab results and correlations

Crosstabs were completed on all questions based on Question 2.3 (refer to Annexure D). Crosstabs summarize the relationship between two categorical variables, where in this case Question 2.3 was a fixed variable (Question 2.3 asked residents if they think that environmental planning is important, and considered the core issue related to Green Planning Development from a community perspective). Only the relationships between variables that had a statistical significance have been mentioned even though crosstabs have been completed on all the questions.

The following questions had an effect size of 0.2 or higher (refer to Chapter 8.3), which means that there was a practical significant association or an effect as to how they answered Question 2.3 (refer to Annexure D):

- Question 1.1 (referring to the age of respondents)
- Question 2.1 (referring to what respondents regard as the concept of environmentally friendly/sustainable planning)
- Question 2.5 (referring to whether respondents think that environmental planning should form part of their home and community)
- Question 2.7 (referring to if respondents would like to learn about environmental planning)
- Question 2.8 (referring to daily use of Green Planning Development tools and technology)
- Question 4.10 (referring to respondents need in a public space)

Based on the crosstab results and correlations, the following conclusions were drawn with regard to the study area:

8.5.1 Younger generations more informed about the concept of Green Planning Development

Question 1.1 was recoded and asked respondents “What is your age?” where they had the options of <29, 30-39, 40-49, 50-59 and 60+. The p value was recorded as being between 0.000 minimum and 0.002 maximum therefore $p < 0.005$. The effect size of this specific relationship was 0.248, meaning that the relationship has a closer to practical visible significant association than not.

This relationship indicates that there is a higher count percentage among the younger ages therefore the younger the respondents were the more likely to agree and state that yes, environmental planning is important (Question 2.3). As the respondents got older they became less likely to agree that environmental planning is important. This implies that the younger generations are more informed about the concepts of sustainability, sustainable development, environmental planning and green infrastructure.

8.5.2 Identification of knowledgeable group of participants

Question 2.1 was recoded as part of the study and asked respondents “What do you regard as environmentally friendly/sustainable planning?” which they had to answer by selecting one of three provided visual answers (refer to Figure 8.2). The p value was recorded as being 0.000, therefore $p < 0.005$. The effect size of this specific relationship was 0.235 (-0.235), meaning that the relationship has a closer to practical visible significant association than not.

This relationship indicates is a higher count percentage among respondents who answered that C (option 3) was the correct answer. Therefore people that that stated C as the correct answer

were more likely to agree that environmental planning is important. This indicates that this group of respondents were more knowledgeable about the concepts of sustainability, sustainable development, environmental planning and green infrastructure.

8.5.3 Environmental planning to be considered as part of individual property

Question 2.5 asked respondents “Do you think that environmental planning should form part of your home and community?” The p value was recorded as being 0.000, therefore $p < 0.005$. The effect size of this specific relationship was a high 0.552, meaning that a practical significant association or large effect was present.

This relationship indicates is a higher count percentage among respondents who answered yes (option 1) to Question 2.5. Therefore people that that stated “yes” as their answer in Question 2.5 were more likely to agree that environmental planning is important. This again as in Question 2.1 indicates that this group of respondents were more knowledgeable about the concepts of sustainability, sustainable development, environmental planning and green infrastructure.

8.5.4 A need to train and educate communities with regard to environmental planning

Question 2.7 asked respondents “Would you like to learn about environmental planning?”. The p value was recorded as being 0.000, therefore $p < 0.005$. The effect size of this specific relationship was a high 0.501, meaning that a practical significant association or large effect was present.

This relationship indicates is a higher count percentage among respondents who answered yes (option 1) to Question 2.7. Therefore people that that stated “yes” as their answer in Question 2.7 were more likely to agree that environmental planning is important. This indicates that respondents who want to understand more about the concepts of sustainability, sustainable development, environmental planning and green infrastructure also understood the importance of the concepts in the modern world.

8.5.5 Personal preference towards Green Planning Development elements

Question 2.8 asked respondents “If green elements such as solar panels, energy efficient globes, local veggie gardens, recycle programmes, etc. are introduced to your community, would you take part or make use of these elements?” The p value was recorded as being 0.000, therefore $p < 0.005$. The effect size of this specific relationship was 0.484, meaning there is a practical visible significant to practical significant association.

This relationship indicates is a higher count percentage among respondents who answered yes (option 1) to Question 2.8. Therefore people that that stated “yes” as their answer in Question 2.8 were more likely to agree that environmental planning is important, consequently indicating that respondents who are willing to practise sustainability were more likely to understand the importance of the sustainability in the modern world.

8.5.6 Needs related to public spaces

Question 4.10 was recoded and asked respondents “What is your need in a public space?” where respondents had the options of Markets; Business; Recreational; Benches, Jungle gyms and Other (specify). The p value was recorded as being between 0.001 and 0.002, therefore $p < 0.005$. The effect size of this specific relationship was the lowest of those that qualified with a size of 0.212, meaning that the relationship has a slightly closer to practical visible significant association than not.

This relationship indicates is a higher count percentage among respondents who answered “*recreational*” (option 3) as their primary need in a public space. Therefore people that that stated “*recreational*” as their answer in Question 4.10 were more likely to agree that environmental planning is important, consequently indicating those respondents who want to spend leisure time in a public space might have understood the concepts of sustainability, sustainable development, environmental planning and green infrastructure more than the rest. However statistical significance was only slightly visible.

8.6 Conclusion with regard to the community-input survey

8.6.1 Knowledge

Based on the community surveys conducted, it was evident that there is a gap with regard to the understanding of the concept of environmental planning as only 39% of all residents had a basic understanding of what Green Planning Development (sustainable development, spatial planning and green infrastructure) is (refer to Figure 8.6); However 87% of residents stated that they want to learn more about Green Planning Development (refer to Figure 8.7)) and 89% of respondents said they would make use and practise Green Planning Development if they had access to Green Planning Development tools and technology (refer to Figure 8.9). 62% of those that would use and practise sustainability are willing to pay an extra cost every month (if need be) to have access to the tools and technology (Refer to Figure 8.10). Even though most respondents do not have a basic understanding of the concept, they are willing to learn even it may become an extra monthly expense to them. If this willingness to learn is utilized it may lead to many benefits for the people and Fleurhof.

In the crosstabs completed (refer to Annexure D) it was noted that the younger the respondents were the more likely they were to agree and state that yes, environmental planning is important (Question 2.3). This shows that the younger generations are more informed about the concepts of sustainability, sustainable development, environmental planning and green infrastructure. Furthermore in questions 2.5 and 27 people that that stated “yes, environmental planning should form part of your home and community” and “yes they would like to learn about environmental planning” as their answer in Question 2.5 and 2.7 respectively were more likely to agree that environmental planning is important.

8.6.2 Energy, Sanitation, Water and Waste Management (All services)

It can be safely concluded that Fleurhof does extremely well by providing services with a 100% record to all residents, which includes fresh water, sanitation, refuse disposal and electricity (refer to Tables 8.1-8.5). In the modern world these services are expected to be provided to everyone, but in Africa as a whole it is considered an accomplishment and it may be necessary to be monitored.

8.6.3 Environmental Governance

85% of respondents stated that they had access to open public space (refer to Figure 8.11). However a large 81% of locals said that there is **not** enough public open space, whether it is active or passive, hard or soft spaces (refer to Figure 8.16), consequently identifying another gap, a lack of open space. The primary need of public open space was thought to be recreational, 39% of people agreed to this statement, 22% stated their need is business orientated, 18% stated their need is for markets (another form of business) and a low 10% stated their need is for children’s jungle gyms and play areas (refer to Figure 8.17).

8.6.4 Land Use

Spaza shops was said to be the closest to most people’s homes with 90% of people stated that a spaza shop was near their home (refer to Figure 8.19). Retails stores were identified as being far from respondents homes, a total of 57% stated that they have to travel very far, 29% said they travel a far distance and only 14% stated that they travel a short distance (walking distance) to the nearest retail outlet (refer to Figure 8.19). This was dependent on how deep in Fleurhof each respondent stayed. The closer to the main entrance the closer they were to major retail outlets.

The long travel distances identifies a gap, as majority of these people form part of the lower income bracket and cannot afford to drive or take the available public transport each time they need to shop. Closer stores would be beneficial and may be lucrative.

8.6.5 Structures

61% of respondents said they were satisfied with their building structures, 22% was extremely satisfied and only 17% were unsatisfied (refer to Figure 8.21). Furthermore the scale and relation of buildings was rated highly overall with 43% of respondents stated that the scale of buildings is good (refer to Figure 8.22) and 44% of respondents stated that the relation of the buildings is good (refer to Figure 8.24). However the quality of buildings had a medium rating where 28% of respondents stated that the quality is good, 27% stated that the quality is fair and 25% stated that the quality is bad (refer to Figure 8.23). Nevertheless this was only the opinion of the residents and not a professional analysis from site visits and conducting the surveys with the residents it was noted that the structures did improve in quality the newer they

8.6.6 Transportation

42% of residents live within a 1-4km radius of their work (refer to Figure 8.26), which is considered to be an advantage and also adheres to a guiding principle of the NDP (refer to Chapter 4.3.2). 50% of residents use a taxi (public transport) most of the time, and only 26% use their own vehicle (refer to Figure 8.27). This factor alone keeps pollution and traffic congestion lower in the area which is one step closer to a successful green planned environment. Through conducting the surveys it was noted that the respondents make use of public transportation as it the only form of transportation available to them due to financial constraints, and not because they understand the environmental implications of using private vehicles.

More data/information about Fleurhof was collected directly from the developer, Calgro M3 Holdings, as the community-input survey was not able to provide all data for the required categories of the proposed framework. The following Chapter will further discuss the application of the proposed framework along with the developer's input.

CHAPTER 9: APPLICATION OF THE PROPOSED GREEN PLANNING DEVELOPMENT FRAMEWORK (EXPERT- INPUT)

9.1 Points of departure

Chapter 9 aimed to illustrate the application of the proposed Green Planning Development framework and the top-down approach (expert input and policy input) that is needed in order to present a comprehensive framework for further analysis. As such the quantitative data was obtained from interviews conducted with the developers of Fleurhof and guiding policies and legislation applicable to the Fleurhof case study area. This data was related to the major categories of the proposed Green Planning Development framework (refer to Table 7.1) including; Energy, environmental governance, knowledge, land use, sanitation and water, structures, transportation and waste management. Calgro M3 Holdings (selected experts and professional teams) was the main participant in this research, as planner and developer of the Fleurhof area. The results of all data collected in terms of the expert-input are discussed below. An example of a blank questionnaire given out to the personnel working at Calgro M3 Holdings can be found in Annexure B. All questions asked to Calgro M3 Holdings were based off the required data from the proposed framework displayed in Table 7.1. Figure 9.1 illustrates the structure of Chapter 9.

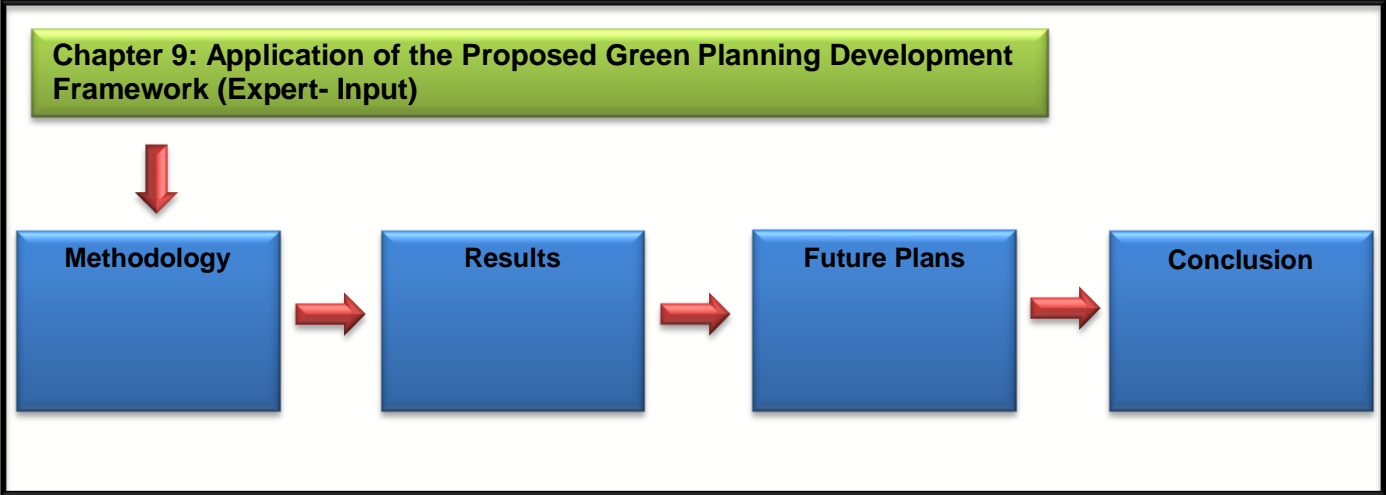


Figure 9.1: A graphical overview of the organisation and structure of Chapter 9
Source: Own construction (2016)

9.2 Methodology

In order to consider the status quo of Fleurhof as part of the proposed Green Planning Development framework, surveys were provided to selected experts and professional teams

that were part of developing team of Fleurhof. An example of a blank survey can be found in Annexure B. The questions within this survey targeted each of Fleurhof's housing typologies, including: RDP/BNG housing, apartments (Gap and Social rental), free standing and semi-detached homes (Open market rental and Entry level housing).

As part of the development process, the developer (Calgro M3 Holdings) had to have assessments done on the Fleurhof area such as EIA's and geotechnical surveys. Some of these assessments were outsourced to companies or specialists who specialise in the needed criteria of the assessment task. Their data and information collected through their research has been used in this chapter as the studies could present the required data. Recognition has been given to the related companies and specialists. Future plans and initiatives were also considered.

9.3 Results of the Expert-Input survey

9.3.1 Energy

Based on the expert-survey the following information was captured with regards to energy:

- Access to electricity (%)

All residents (100%) of Fleurhof have access to electricity as previously discussed, refer to Table 8.1.

- Electricity demand per unit

The electrical demand per unit is determined by City Power and is 5kVA. This number can be reduced with energy saving implements such as heat pumps and solar energy (refer to clean energy policy below) to 3.5kVa. However 5kVA is the standard supply in electricity capacity per unit.

- Clean energy policy

Fleurhof makes use of a central heat pump system which is found only in the multi storey buildings, furthermore there aren't other clean energy policies currently implemented. However the questionnaire asked to Calgro M3 Holdings personnel indicated that there was a drive towards solar energy geysers. Unfortunately some residents did not want their neighbours to see that they received a house as part of a government grant, therefore a negative connotation formed by residents towards these solar geysers. Calgro M3 Holdings believe that this is a concept that first needs to be applied successfully in the high end market before it can be introduced it into the lower end of the market.

9.3.2 Environmental Governance

Based on the expert-survey the following information was captured with regards to environmental governance:

- Air quality (PM10)

An Air Quality Impact Assessment (AQIA) was done by Golder Associates Africa (2014) for Calgro M3 Holdings. Fleurhof was monitored from 10 August 2009 to 31 October 2010. The assessment revealed that the PM10 of Fleurhof did not exceed the PM10 daily National Standard of 120ug/m³. The maximum PM10 concentration recorded during this assessment was **58 µg/m³** in June of 2010. Golder Associates Africa (2014) also stated that the PM10 concentrations were relatively low throughout the monitoring period. However the assessment did reveal that during 04:00am to 08:00am in the morning and between 19:00pm to 21:00pm in the evenings the PM10 concentrations were elevated. This is said to be due to emissions from domestic fuel burning (Increased traffic volumes). PM10 concentrations were noted to be commonly originating from the north-east, east-north-east and east. This was due to the dominance of the north easterly winds.

Golder Associates Africa (2014) discovered that the primary sources of air pollution in the locality included: Cement production, domestic fuel burning; domestic fuel burning for cooking and space heating in informal settlements linked to artisanal mining operations; emissions associated with construction sites; explosives manufacturing; tailings dams; unpaved roads and exposed area; vehicle emissions, and waste disposal and incineration

- Ecology and ecosystem services

Fleurhof's ecological state was analysed by Strategic Environmental Focus (Pty) Ltd (2008). The purpose of this study was to assess the ecological sensitivity of the new proposed Fleurhof Ext 2. Fleurhof falls within the Grassland Biome, specifically the Soweto Highveld Grassland vegetation community. The Soweto Highveld Grassland is classified as endangered vegetation. This grassland vegetation community is under pressure from urban development, it is suggested that remaining portions should thus be conserved (Strategic Environmental Focus, 2008a: ii).

Strategic Environmental Focus (2008) used satellite images and topographical maps to demarcate relatively homogeneous vegetation units within Fleurhof Ext 2. Based on species similarities, vegetation was grouped into the following communities (refer to Figure 9.2):

- Riparian Vegetation community
- Hydrophilic Grassland community

- Disturbed Grassland community
- Rocky Grassland vegetation
- Exotic Bush Clumps (which was not sampled)

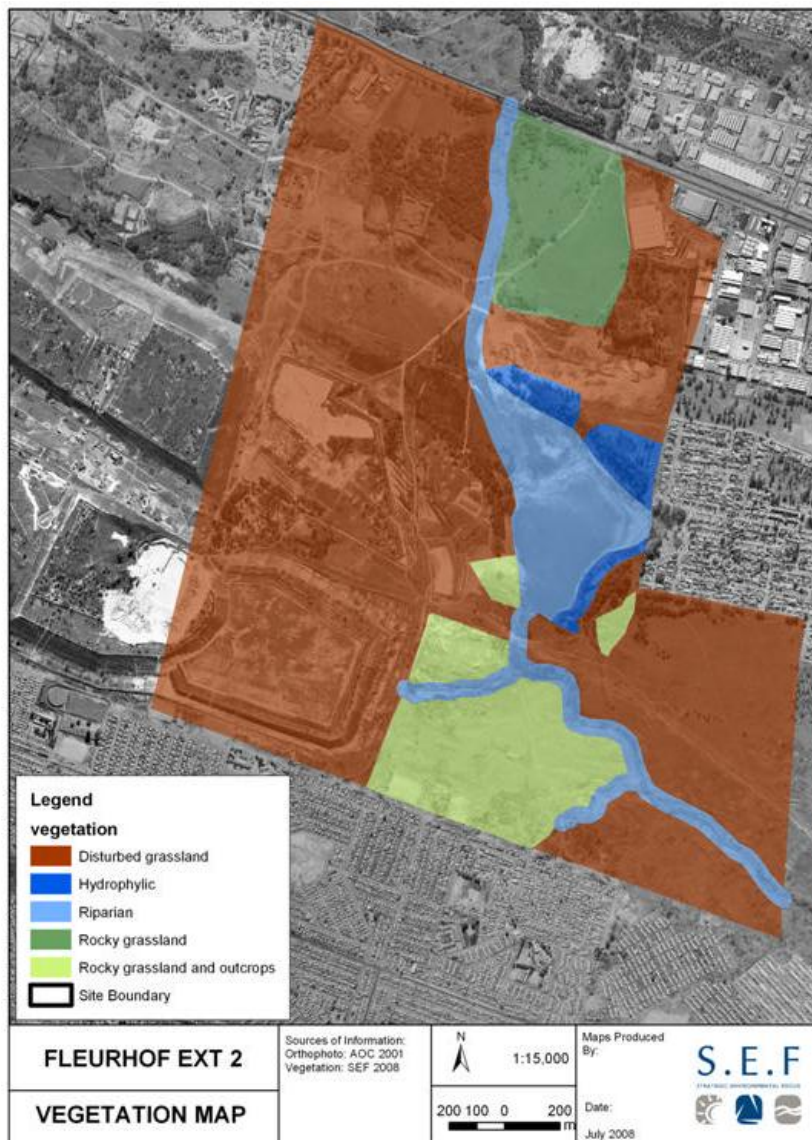


Figure 9.2: Fleurhof Vegetation

Source: Strategic Environmental Focus (2008a: 13)

Most of the vegetation was found to be greatly disturbed; despite a number of sensitive vegetation communities present. Areas demarcated as high sensitivity were: (1) riparian areas, the dam and associated hydrophilic vegetation as well as (2) the rocky outcrop west of the Fleurhof Dam (Refer to Figure 9.3).



Figure 9.3: Sensitivity Map

Source: Strategic Environmental Focus (2008a: 29)

The rocky grassland was considered to be of medium sensitivity due to its potential to support numerous faunal species. Many of the medium sensitivity areas can be linked to the high sensitivity areas to form ecological corridors. The rest of Fleurhof included disturbed grassland and exotic bush clumps. Development in the mentioned areas is possible from an ecological viewpoint according to Strategic Environmental Focus (2008a: 40).

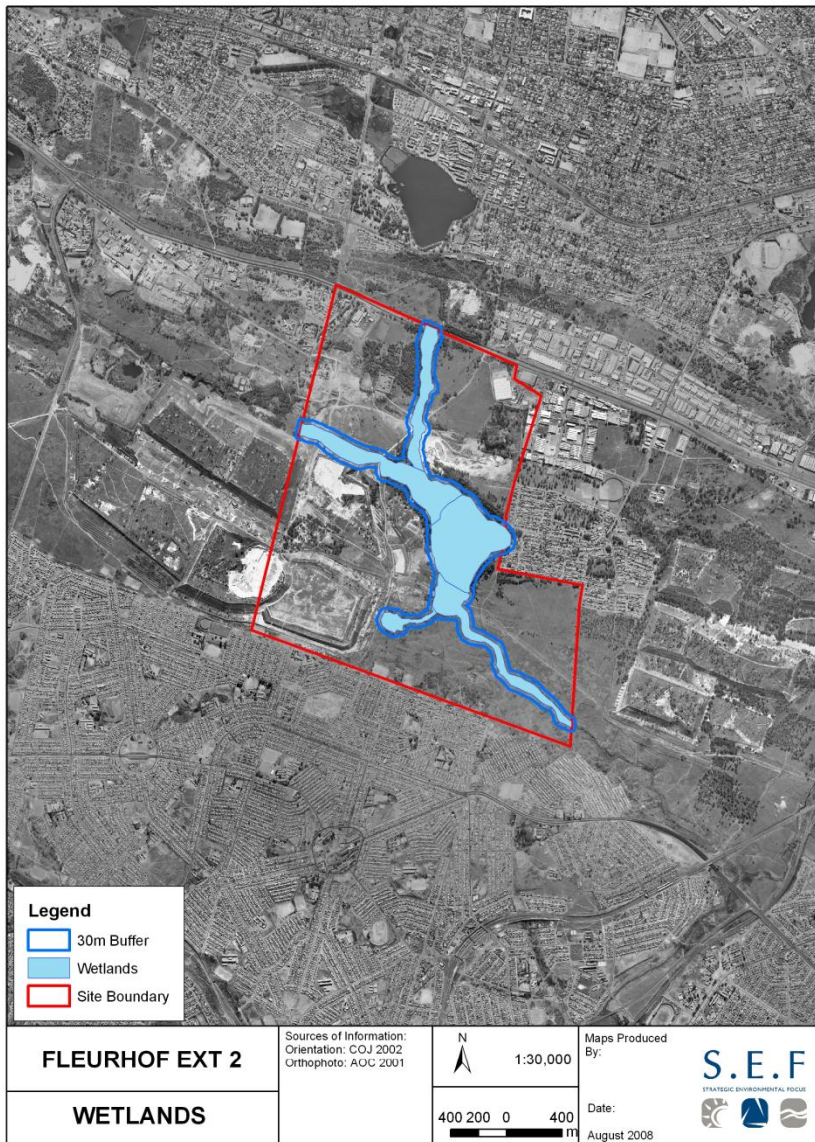


Figure 9.4: Wetlands Map

Source: Strategic Environmental Focus (2008b: 18)

The high sensitivity areas are mostly formed by the Hydrophilic Grassland community or the wetland areas (refer to Figure 9.4). Wetland areas are a great source of natural biodiversity and ecosystem services. Fleurhof has a large dam right in the centre of the development, with branched off streams leading north, south east, south west and west. The wetlands provide direct and indirect ecosystem services in the area (Kotze *et al.*, 2005). Therefore SSI Environmental (2012) completed a study on the ecosystem services provided to understand which services are predominant in Fleurhof's wetland. The assessment done included a scoring system, as described in Kotze *et al.* (2005), whereby values are subjectively awarded to characteristics of wetland systems in order to present the ecosystem services they provide in a graphic manner (refer to Figure 9.5).

Table 9.1: Ecosystem Scores

Goods and services	Fleurhof Dam
Flood attenuation	2.5
Stream flow regulation	2
Sediment trapping	3
Phosphate trapping	4
Nitrate removal	4
Toxicant removal	3
Erosion control	1.5
Carbon storage	3
Maintenance of biodiversity	3.5
Water supply for human use	2.5
Natural resources	3
Cultivated foods	4
Cultural significance	3
Tourism and recreation	3
Education and research	4

Source: SSI Environmental (2012: 34)

Table 9.1 displays the scores of each ecosystem service Kotze *et al.* (2005) identified as important. All services score above the intermediate level (Score system is found in Figure 9.5) besides erosion control. The services provided here are of great importance and should be protected. It can be noted that the wetlands provide a very high score for human interaction such as cultivated foods, education and research. Other services which maintain the environment also scoring high include sediment and phosphate trapping, nitrate and toxicant removal and carbon storage. Figure 9.4 displays a 30 meter buffer around the wetland which is ideal for protection.

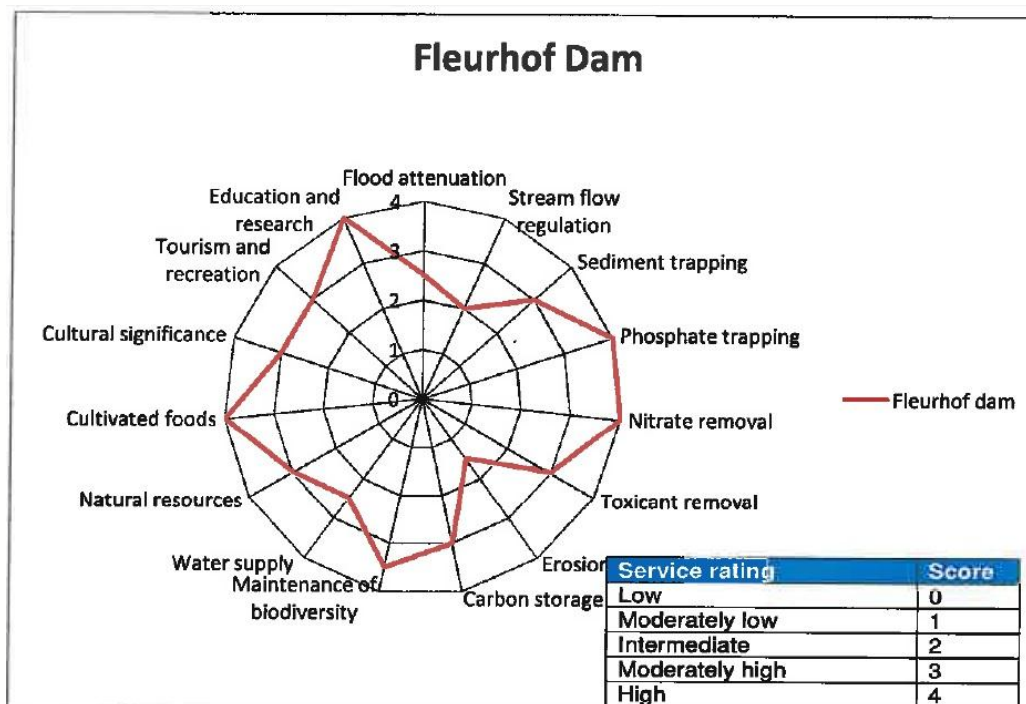


Figure 9.5: Radar Graph of Scores

Source: SSI Environmental (2012: 35)

The Fleurhof dam and wetland areas are found to be in moderately modified state, this is due to land use intensity and the artificial nature of the dam discovered by SSI Environmental (2012: 35). Consequently the natural ecological features are responsive and not indicative of the natural wetlands found in Fleurhof. Therefore the ecological features are present and act as a response to the development taking place; they are not present exclusively due to the wetlands. This result is also supported by the ecosystem services as they are more human based rather than ecological and system integrity based according to SSI Environmental (2012: 35). However the ecosystem services cannot be ignored and still exist despite the origin of existence, consequently they will have to be considered and taken into account before, during and after the development construction. It will be ideal to integrate the services and not just block them off for conservation.

- Stormwater management

As seen in Figure 9.4, the wetland areas are located in the centre of the Fleurhof development. The layouts of the roads have been designed to use the location of the wetlands as an advantage (refer to Figure 9.6). The run-off water from the development is guided by the roads (by gravitational force) into the wetland area. Calgro M3 Holdings personnel state that this method is now a requirement set by the Department of Environmental Management for other developments of this nature.

- Green space per person (m²/person)

The total amount of green space in Fleurhof is 114.45ha (1144500m²). Fleurhof currently has a total population of 3899 people. Therefore to calculate the m²/person of green space would be as follow:

Equation 1: Green space per person (m²/person)

<p><i>Total green space in m² / total population</i></p> <p><i>1144500 / 3899 =293.5368043m²/person</i></p>

Rounded off the answer equates to 293.54m²/person.

- Green space linkages

Figure 9.6 displays the land use map of the Fleurhof. When focusing on the green/yellow spaces identified as parks in the legend, one can see how the green open spaces are all connected (active and passive) with limited exceptions. In Chapter 3 Benedict & McMahon (2006:7) describes the basic physical layout of GI as range of natural and restored native landscape features and ecosystems that create a system of “hubs” and “links (refer to Figure 3.3). The wetlands running from north to south are the primary links and Fleurhof Dam is the hub within the study area. The links are further spread linking to areas that are outside of the study in the north-west, east and south-east directions.

However not all green open spaces are connected. The passive spaces are all protected or untouched and therefore have natural linkage, but the active spaces have been placed within the higher density urban areas to provide green open space for the residents. These green open spaces have been marked with a red dot on Figure 9.6. Nevertheless the linkages that exist provide a massive positive impact on the ecosystems and biodiversity within Fleurhof. The fact the majority of the linkages are naturally occurring means that the area will continue to function as normal with low negative impacts.

- Green infrastructure

There is no evidence of any green infrastructure planning by the developers. However the residents of Fleurhof do grow gardens where possible. Yet some of the units are surrounded by paving and there is no space to grow gardens, nonetheless the locals find solutions by taking bathtubs outside, filling them with soil and proceed to plants flowers and vegetable gardens in there. All paved surfaces are impermeable and there is parking bays around all multi storey buildings further reducing open land mass. There are no roof gardens, rain gardens or

bioswales in the area. The stormwater is managed by letting it runoff move back into the wetlands; however this can lead to hydrological flashiness and further the process of urban stream syndrome.

9.3.3 Knowledge

Based on the expert-survey the following information was captured with regards to knowledge:

- Knowledge of concept (%)

A low 39% of the residents understood the concept of sustainable development and green infrastructure (refer to Figure 8.6).

- Understanding importance of concept (%)

A total 93% of residents agreed that sustainable development and green infrastructure is important despite them understanding or not understanding the concept (refer to Figure 8.5).

- Willingness to participate (%)

87% of residents stated that they want to learn more about sustainable development, green infrastructure and how to live a greener lifestyle (refer to Figure 8.7). A total of 89% of residents said they would make use and practise sustainability if they had access to the tools and technology (refer to Figure 8.8). And 62% of those that would use and practise sustainability are willing to pay an extra cost every month (if need be) to have access to Green Planning Development tools and technology (refer to Figure 8.9).

9.3.4 Land Use

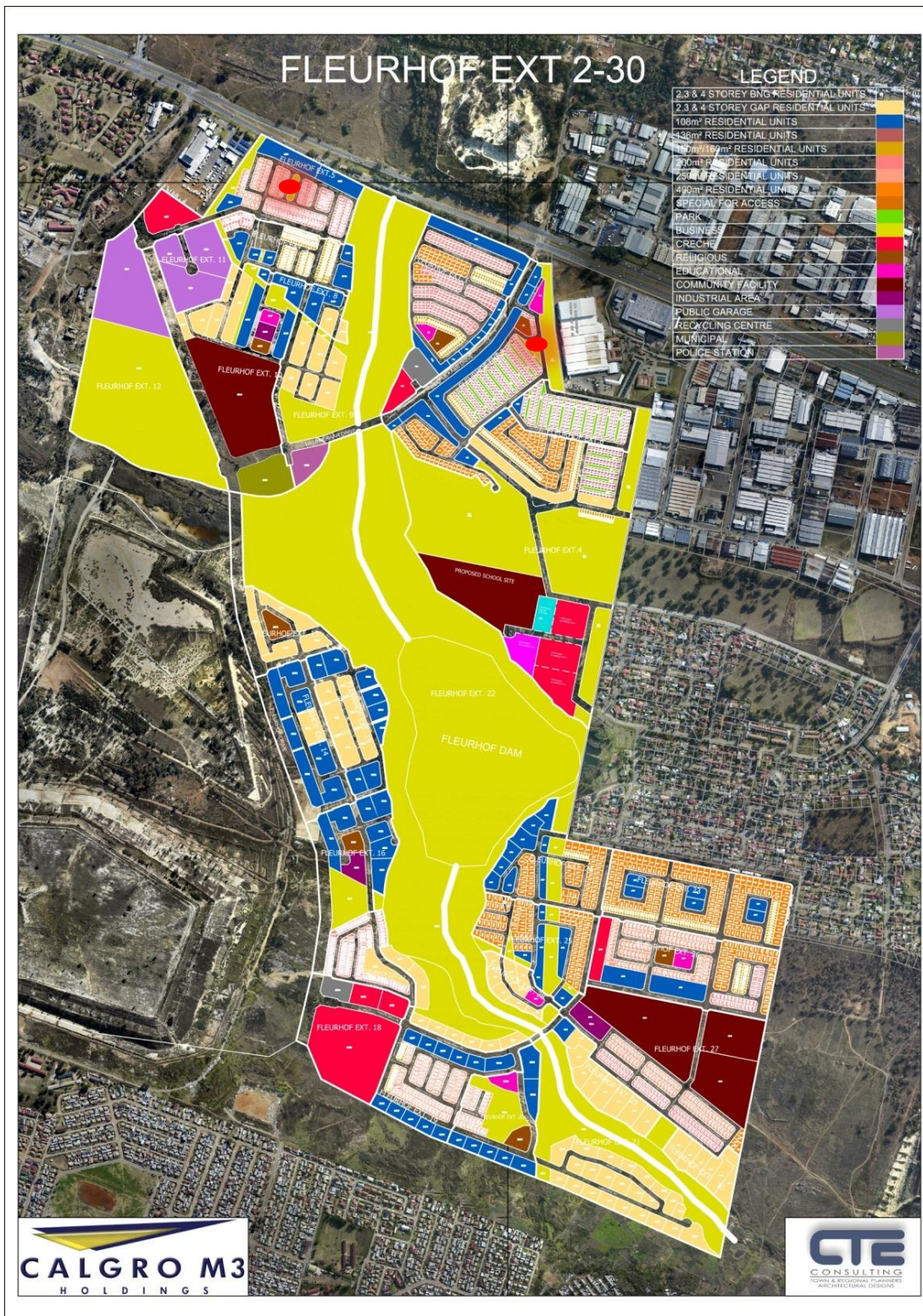


Figure 9.6: Fleurhof Land Use

Source: Calgro M3 Holdings (2015b)

Fleurhof has a wide variety of land use. One may not notice it straight way on surface level, but looking at Figure 9.6 it noticeable just how vast Fleurhof is. With land uses not only residential 1

and 3 but also public open space, roads, special for recycling, municipal, industrial, institutional and educational. Based on the expert-survey the following information was captured with regards to land use:

- Population density (person/km²)

According to 2014 studies conducted, currently there are 3899 people living in the area. Estimated Population is based on the average household size (3 people per household) in terms of 2012/2016 IDP for the City of Johannesburg. It has been determined through the Database Fleurhof (Master) (2015) that the average household size is indeed 3 (3.24 to be exact). The entire Fleurhof Development is 447.25ha in extent (refer to Table 9.2). Currently this will amount to a density of 10.26 people per km². Once Fleurhof is completed it is estimated that the density will increase to 20 people per km².

- Total building coverage and total mixed land use (%)

Fleurhof is a total size of 894.5ha or 8.945km². However the area comprises of a mine dump site which is 156.37ha large. This leaves a total usable size 290.88ha (refer to Table 9.2). Figure 9.7 illustrates the percentage values of the un/available and land in Fleurhof.

Table 9.2: Available Land

Type	Area (hectare)
Gross Property	447.25
Mine Dump	156.37
Total Usable	290.88
Total	894.5

Source: Calgro M3 Holdings (2015c)

Unavailable and available Land

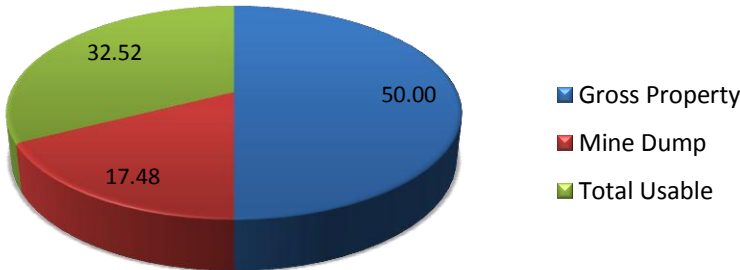


Figure 9.7: Percentage of unavailable and available land in Fleurhof

Source: Adapted from Calgro M3 Holdings (2015c)

All sizes covered and percentages given are based on the total usable space from here on down. As mentioned before, Fleurhof contains residential 1 and 3, public open space, roads, special for recycling, municipal, industrial, institutional and educational. Table 9.3 below displays all the sizes (in hectare) as well as the percentage of the total usable space (290.88ha) each land takes up.

Table 9.3: Land Use Cover

Type	Size (hectare)	Percent (%)
Res 1	40.09	13.78
Res 3	46.02	15.82
Educational	15.04	5.17
Institutional	2.76	0.95
Business	16.88	5.80
Industrial	6.81	2.34
Municipal	0.72	0.25
Special for Recycling	0.13	0.04
Public Open Space	114.45	39.35
Roads	47.98	16.49
Total	290.88	100

Source: Adapted from Calgro M3 Holdings (2015c)

Table 9.4 below provides a summary of Table 9.3 by placing all residential in one category and all other uses besides roads in their own category. Therefore it can be concluded that of the total usable space 29.60% is residential (res 1 and 3), 14.56% is all other land use (see table 9.3, types which are bolded), 39.35% is public open space (active and none active) and 16.49% is used for roads (refer to Figure 9.8).

Table 9.4: Land Use

Type	Size (hectare)
Residential	86.11
All Other land use	42.34
Public Open Space	114.45
Roads	47.98
Total	290.88

Source: Adapted from Calgro M3 Holdings (2015c)

Land Use

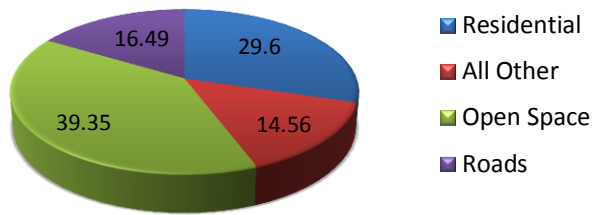


Figure 9.8: Percentage of land occupied by the different land uses

Source: Adapted from Calgro M3 Holdings (2015c)

Furthermore 60.65% (176.43ha) of the land is covered, 39.35% (114.45ha) is open space (refer to Total open space coverage: Active and none active below).

Table 9.5 below displays the amount of units which will have been constructed when Fleurhof is complete under each Non-Residential land use. Refer to Table 9.3 to see the total sizes of each land use and the **percentage** each land use will cover of the total usable land. There are a total of 73 units which are non-residential.

Table 9.5: None Residential Cover

Non-Residential Units	
Business	14
Industrial	4
Parks	29
Municipal	1
Recycling	1
Public garage	1
Educational	13
Institutional	10
Total	73

Source: Adapted from Calgro M3 Holdings (2015c)

- Total open space coverage (active and non-active)

Public Open Space is 114.45ha which equal to 39.35% of the total usable land area, refer to Table 9.2.

- Units per hectare

Units per hectare are worked out per typology. The approved development controls allow for 240 units/ha however this can't be achieved as space for parking has to be taken in to account for the residents. Therefore the average units per hectare are:

- Social and GAP multi storey units equate to 170 units/ha and
- BNG/RDP units equate to 190/ha
- Affordable/Entry level home units equate to 55 units/ha

9.3.5 Sanitation & Water

Based on the expert-survey the following information was captured with regards to sanitation and water:

- Access to sanitation (%)

All residents (100%) of Fleurhof have access to sanitation as previously discussed, refer to Table 8.2.

- Waste Water Treatment policy

Currently Fleurhof makes use of the of the municipal city sewer work system (CoJ Scheme).

- Access to water (%)

All residents (100%) of Fleurhof have access to water as previously discussed, refer to Table 8.3.

- Water consumption (L/person/day)

The water consumption is determined by the South African National Standards (SANS). Fleurhof's consumption equate to 98 litres of hot water per day per household of five (5) people. However this does not include cold water, which Calgro M3 Holdings estimates is double (196 litres) that of the hot water. Furthermore it must be noted that the BNG / RDP units don't have geysers installed, so their hot water consumption cannot be monitored. As a result Fleurhof uses 196 to 294 litres of water per household of five people. This means that 39.2 to 58.8 litres of water is used per person per day.

- Water Treatment policy

Fleurhof does not currently have a water treatment policy of its own, but makes use of the CoJ system.

- Water use sustainability policy

Currently there is no enforced water use sustainability policies found in Fleurhof.

- Waste water (recycling) – Grey water and Black water

Fleurhof does not currently have a waste water treatment policy for grey or black water, but makes use of the CoJ system.

9.3.6 Structures

Based on the expert-survey the following information was captured with regards to structures:

- People per unit

The average household size is 3 people per household in terms of 2012/2016 IDP for the City of Johannesburg. It has been determined through the Database Fleurhof (Master) (2015) that the average household size is 3.24.

- Construction materials

The building material is mainly the traditional concept of brick and mortar, tiles are used for the v-shape roofing, concrete slabs where needs and bricks (paving) is used to create the parking areas. A new construction policy is implemented on some sites, where some of the structures (example the stairs) are precast and simply fit together during in-situ construction. This saves on costs as well as time spent in construction. It is also noted that Fleurhof only uses water based paints that are not considered hazardous to paint their structures.

- Insulation

Only the ceilings of the structures have insulation, Rockwool insulation is used. Some homes will receive double glassing glass if the orientation of the home is not to standard (north is standard, refer to Orientation discussion below.).

- Orientation

Fleurhof applies the general rule of north facing structures in the Southern hemisphere. This rule is applied as far as possible, if this rule cannot be applied on a site, the SANS regulations become applicable. For example structures will then be fitted with double glassing glass. However this increases the cost of the structures.

- Natural lighting

The homes receive adequate natural light as the orientation of the homes are set to the general rule of north facing structures in the Southern hemisphere

9.3.7 Transportation

Based on the expert-survey the following information was captured with regards to transportation:

- Amount of vehicles per person or per unit (Each typology)
 - BNG/RDP: 0.12 cars per one person
 - Social or GAP: 0.32 cars per one person
 - Freestanding: 0.59 cars per one person
 - Semi-detached: 0.56 cars per one person
 - **Average of the whole Fleurhof:** 0.35 cars per one person or one (1) car for every three (3) people.

- Distance from work

Figure 8.26 displays that 42% of residents live within a 1-4km radius of their work, the next biggest percentage being 18% of residents live within a 15-19km radius. Considering that 1-4km is close range, 5-19km is a medium (average) range and 20km+ is far range; it can be concluded that 42% of residents live close to work, 43% live a medium (average) from work and only 15% live far from work.

- Main methods of transportation used

Only 35% of residents own a private car, refer to Figure 8.25. 50% of residents use a taxi (public transport) most of the time, 26% use their own vehicle (refer to Figure 8.27). A total of 60% of residents use public transport. And a further 12% travel mainly by foot or bicycle. Therefore a total of 72% of Fleurhof residents use transportation methods which produce a lowered negative impact.

- Parking allocation per unit

The parking allocation is 0.75 parking bays per residential 3 (multi storey unit) and 1 parking bay for freestanding/semidetached (Residential 1) units. However the parking ratio for multi storey units may be increased to 1 parking bay if the client requires it.

9.3.8 Waste Management

Based on the expert-survey the following information was captured with regards to waste management:

- Access to waste management service

All residents (100%) of Fleurhof have access to refuse disposal services (refer to Table 8.5).

- Waste management policy

Fleurhof is compliant with the City of Johannesburg's by-laws and policies as well as national requirements regarding waste management. Each block of flats and neighbourhood area has a temporary storage of refuse which is compliant with the specification of the City of

Johannesburg. These temporary storage refuse areas enable the storage of all refuse in a sanitary manner. This method prevents odours, flies and rodents. Waste is collected by a “Round collected refuse” (RCR) scheme once a week. However this scheme only collects domestic and non-hazardous waste. Currently the service is provided in all formal residential areas by means of 240-litre wheeled bins. The refuse area is designed by the following specifications:

- Must be walled in by a 1.8m high wall
 - Must have a 1.2m wide door
 - The door must be solid so that the refuse is not visible
 - Must have a tap and floor level gully (wash-down gully)
 - The gully must drain to the sewer and not to the storm-water system or to the road
 - Stormwater from outside the refuse area must not enter the gully
- Waste generated (m³/100m²/week)

The waste generated in Fleurhof is measured in m³/100m²/week, it is calculated by means of the City of Johannesburg formula, the calculation is as follow:

$$f(g) \times FA / 100 = \text{volume (m}^3\text{)/week}$$

f(g) = generation factor

FA = floor area

Table 9.6: Generation Factor

Generation factor: Type of building	f(g) Generation factor (m ³ /100m ² /week)
Factory	0.472707
Warehouse	0.379058
Flats	0.1425
Offices	0.2258
Shops	0.92353

Source: Calgro M3 Holdings (2015d)

The f(g) values in Table 9.6 are provide by the City of Johannesburg. The FA per unit ranges from 40m² to 80m² as these are the smallest and largest size of residential units available in Fleurhof (Calgro M3 Holdings, 2015c).

Equation 2: Minimum waste generated in Fleurhof

$$f(g) \times FA / 100 = \text{volume (m}^3\text{)/week}$$

$$0.1425 \times 40/100 = 0.057$$

Equation 3: Maximum waste generated in Fleurhof

$$f(g) \times FA / 100 = \text{volume (m}^3\text{)/week}$$

$$0.1425 \times 80/100 = 0.114$$

Therefore the waste generated by the residents of Fleurhof range between 0.057m³ of waste/week and 0.114m³ of waste/week. This calculation is also used to determine the size of the refuse area (refer to waste management policy). It takes approximately four 240 litre bins to store 1m³ of un-compacted refuse and about one square metre (1m²) of floor area to store a 240 litre bin.

- Hazardous waste

Hazardous waste policies are in place, however currently Fleurhof is only dealing with general waste. The hazardous waste policy includes storing the waste at specific storage locations and is removed to municipal hazardous waste sites, the policies are in place if such an occasion will transpire where this will be required. The existing hazardous waste mainly includes asbestos.

- Recycling or reusing policy

Fleurhof initially had a recycling policy in place; however the policy was cancelled by the contractor due to large amount of vandalism to the recycle bins throughout the development. The vandalism was caused by people wanting the material inside to recycle. This policy will be considered at on a later stage of the development once construction is completed

9.4 Future plans

Energy- Calgro M3 Holdings personnel indicated that there was a drive towards solar energy geysers. However some residents did not want their neighbours to see that they received a house as part of a government grant, therefore a negative connotation formed by residents towards these solar geysers. Calgro M3 Holdings believe that this is a concept that first needs to be applied successfully in the high end market before it can be introduced into the lower end of the market.

Recycling- Fleurhof initially had a recycling policy in place; however it was cancelled by the contractor due to a large amount of vandalism to the recycle bins throughout Fleurhof. Calgro states that this type of vandalism can be found throughout the city of Johannesburg. Nevertheless the recycling policy will be considered again on a later stage of the development, once construction is complete and when the income generated can be used to upgrade and maintaining the recreational areas within the development.

Water sustainability- Calgro M3 Holdings states that they have implemented a few rain water collection tanks that can be used for irrigation purposes. However these tanks are still within a testing phase and Calgro is waiting to see how the market reacts. If the testing results are positive, the rain water will defiantly be implemented on a larger scale through other developments such as Fleurhof.

Movement networks- There is a proposed plan to create a non-motorised transport route that will run through the centre of Fleurhof. This will create a direct link between different nodes within Fleurhof. People can then walk or cycle to their destinations via this route and reach their destinations sooner. Calgro also plans on using solar power to supplying the lighting and other electrical needs of this route.

Open space- Other than creating more active public space for the local people, the largest active open space initiative is the "Freedom Walk" initiative. This initiative is aimed to cover the areas along the pristine natural wetlands of Fleurhof and Fleurhof Dam. The Initiative was put forth by the Mayor of Johannesburg. However not in construction just yet, the idea is to link the Fleurhof dam and Florida Lake with pathways and bridges. This route will be 18 kilometres long and is estimated to cost a R100 million. Furthermore other open space initiatives are being considered which will link from the "Freedom Walk" to other areas within Fleurhof such as non-active open space, educational and recreational sites. Figure 9.9 displays the latest layout of the "Freedom Walk" initiative.



Figure 9.9: Freedom Walk Initiative

Source: Adapted from Calgro M3 Holdings (2015f)

9.5 Fleurhof case study conclusion

The purpose of this chapter was to illustrate the implementation of the proposed framework in a practical case study to demonstrate the added-value of the framework in terms of sustainable development, green infrastructure planning and spatial planning, as well as to identify opportunities for improvement thereof. The assessment criteria's and framework (Table 7.1) used for the evaluation of the Fleurhof case study was based on the findings of the previous chapters (Chapters 2-6).

Based on the community input survey, Chapter 8, and the current state of affairs (expert input), Chapter 9, the Green Planning Development framework could be completed for the Fleurhof Case study. All the results of the framework analysis are displayed in tabular form in Table 9.7 below. It is evident that Fleurhof has many aspects that contribute to a Green Planning Development but also has many opportunities for improvement.

Table 9.7: Fleurhof Results

Major Category	Indicator	Fleurhof's Results
Energy	Access to electricity (%)	100% of residents have access.
	Electricity demand per unit	The standard electrical demand per unit is 5kVA. This number can be reduced with energy saving implements to 3.5kVA.
	Clean energy policy (Alternative energy)	Fleurhof makes use of a central heat pump system which is found only in the multi storey buildings.
Environmental governance	Air quality (PM10)	Maximum PM10 was 58 µg/m ³ . Under National Standard of 120ug/m ³ .
	Ecology and ecosystem services	Vegetation's have been identified, wetland is protected but not fully utilised. Ecological corridors are clearly displayed, however not always taken into account. Ecosystem services are mainly found in wetland, which is projected.
	Stormwater management	The layout of the roads has been designed to use the location of the wetlands as an advantage (refer to Figure 7.6). The run-off water from the development is guided by the roads (by gravitational force) into the wetland area.
	Green space per person (m ² /person)	293.54m ² /person.
	Green space linkages	Green open spaces are linked very well (with limited exceptions) and support the local ecosystems and biodiversity within Fleurhof.
	Green infrastructure	None
Knowledge	Knowledge of concept (%)	39% of the residents understood the concept
	Understanding importance of concept (%)	93% of residents agreed that sustainable development and green infrastructure is important despite them understanding or not understanding the concept

	Willingness to participate (%)	A total of 89% of residents said they would make use and practise sustainability if they had access to the tools and technology (refer to Figure 8.8). And 62% of those that would use and practise sustainability are willing to pay an extra cost every month (if need be) to have access to Green Planning Development tools and technology (refer to Figure 8.9)
Land use	Population density (person/km ²)	10.26 people/km ² .
	Total building coverage	60.65% (176.43ha) is covered, 39.35% (114.45ha) is open space.
	Total mixed land use (%)	Residential covers 86.11ha (29.60%), open space covers 114.45ha (39.35%), roads cover 47.98ha (16.49%) and all other usage covers 42.34ha 14.56%.
	Total open space coverage (active and non-active)	Public Open Space is 114.45ha which equal to 39.35% of the total usable land area.
	Units per hectare	Social and GAP 170 units/ha, BNG/RDP 190units /ha, Affordable/Entry level 55 units/ha.
Sanitation & Water	Access to sanitation (%)	100% of residents have access.
	Waste Water Treatment policy	Municipal city sewer work system (CoJ Scheme)
	Access to water (%)	100% of residents have access (CoJ Scheme).
	Water consumption (L/person/day)	39.2 to 58.8 litres/person/day.
	Water Treatment policy	Local municipal policy (CoJ Scheme)
	Water use sustainability policy	None
	Waste water (recycling): Grey water Black water	None None
Structures	People per unit	3.24 people per unit
	Construction materials	Brick and mortar, tiles for roofing, concrete slabs where needs and paving for parking. Some stairs are precast. Fleurhof only uses water based paints that are not considered hazardous.
	Insulation	Rockwool insulation in the ceilings. Double glassing glass.
	Orientation	Fleurhof applies the general rule of north facing structures in the Southern hemisphere.
	Natural lighting (Windows)	Enough natural light, the orientation assists with this.

Transportation	Amount of vehicles per unit (Each typology)	BNG: 0.12 cars per one person, GAP: 0.32 cars per one person, Freestanding: 0.59 cars per one person, Semi-detached: 0.56 cars per one person. Total: 0.35 cars per one person (1 In 3 own a car).
	Distance from work (km)	42% of residents live 1-4km from work, 43% live 5-19km from work and 15% live 20km+ from work.
	Main methods of transportation used	60% of residents use public transport.
	Parking allocation per unit (Ratio)	0.75 parking bays per residential 3 and 1.0 parking bay for freestanding units.
Waste management	Access to waste management service	100% of residents have access (CoJ Scheme).
	Waste generated (m ³ /week)	Fleurhof range between 0.057m ³ of waste/ week and 0.114m ³ of waste/week. Dependent of size of home.
	Waste management policy	Local municipal policy (CoJ Scheme)
	Recycling or reusing policy	None. Fleurhof initially had a recycling policy in place; however the policy was cancelled by the contractor due to large amount of vandalism to the recycle bins.
	Hazardous waste policy	Hazardous waste policies are in place, however currently Fleurhof is only dealing with general waste. The hazardous waste policy includes storing the waste at specific storage locations and be removed to municipal hazardous waste sites.

Source: Own construction (2016)

9.5.1 Added value brought along by proposed Green Planning Development framework (Conclusions)

The future development of Fleurhof may have a larger contribution to sustainability, referring to elements such as sustainable energy (solar energy geysers), reintroducing the recycling scheme, water sustainability (rain water collection tanks that can be used for irrigation purposes), movement networks (non-motorised transport route that will run through the centre of Fleurhof) and the open space "Freedom Walk" park. Fleurhof has many aspects that contribute to a Green Planning Development but also has many opportunities for improvement, as explained accordingly.

9.5.1.1 Indicators with positive impacts

The implementation of the proposed framework identified that the Fleurhof case study does include, and refer to (some) Green Planning Development aspects, and that most of the development initiatives does contribute to the broader sustainable development objectives, with specific reference to all services (energy, sanitation, water and waste Management), environmental governance, land use, structures and transportation.

Air quality according to required standards (PM10) – The air quality of Fleurhof is excellent with a maximum PM10 of 58 $\mu\text{g}/\text{m}^3$ (well below the National Standard of 120 $\mu\text{g}/\text{m}^3$), and the study was completed during construction. Therefore it can be assumed that the air quality will improve once the development is complete (refer to Chapter 9.3.2 and Table 9.7).

Close proximity between homes and work areas (km) – A total 42% of residents live 1-4km from their work place and 43% live 5-19km from their work place (refer to Figure 8.26, Chapter 9.3.7 and Table 9.7).

Excellent use of public transport – A massive 60% of residents use public transport (refer to Figure 8.27 and Chapter 9.3.7). Integrative approaches considering transportation and land-use is an important part of Green Planning Development approaches.

Green space linkages provided by strategically place green open spaces – Green open spaces are linked well and support the local ecosystems and biodiversity within Fleurhof (refer to Chapter 9.3.2 and Table 9.7).

Identification and protection of ecosystem services and wetlands as part of the development plan – The wetland and dam area was identified as the most sensitive and is

protected. Ecological corridors and ecosystem services are mainly found in the wetland and dam area (refer to Chapter 9.3.2 and Table 9.7).

Low use of energy throughout the area – The standard electrical demand per unit is 5kVA. This number can be reduced with energy saving implements to 3.5kVA. This equates to a low energy demand in the area (refer to Chapter 9.3.1 and Table 9.7).

Low water consumption – The water use equates to 39.2 to 58.8 litres per person per day (refer to Chapter 9.3.5), which is far below the average identified by the AGCI for Durban which was 252.9 litres per person per day (Siemens AG, 2011:63).

Mixed land use and the functional advantages that come with – Fleurhof has a wide range of mixed land use, utilizing the space on which the neighbourhood is built on and bring amenities closer to the residents (refer to Chapter 9.3.4 and Table 9.3).

Schemes in place to supply sustainable energy through heat pumps – Fleurhof makes use of a central heat pump system which is found only in the multi storey buildings (refer to Chapter 9.3.1 Table 9.7).

Supply of services (electricity, sanitation, water, waste management) to all residents within the Fleurhof area – Fleurhof supplies electrical, sewage, waste management, water and sanitation need to all of its residents (refer to Tables 8.1-8.5 and Table 9.7). This 100% achievement may be taken for granted, yet some parts in Africa are likely to disagree and acknowledge the feat achieved.

Well-insulated structures, natural light as well as orientation were considered as part of the development plan – Fleurhof uses Rockwool insulation in the ceilings and double glassing glass and also applies the general rule of north facing structures in the Southern hemisphere with enough natural light (refer to Chapter 9.3.6 and Table 9.7).

9.5.1.2 Indicators with gaps

The implementation of the proposed framework did however also identify gaps and opportunities in the current Fleurhof case study that could be used to enhance Green Planning Development in Fleurhof.

Lack of knowledge regarding the concept of Green Planning Development and overall sustainability – A low 39% of the residents understood the concept of sustainable

development and green infrastructure (refer to Figure 8.6, Chapter 9.3.3 and Table 9.7). An improvement of knowledge may allow for more and better opportunities within the study area.

The large amount of parking provision (Green infrastructure) – There is a parking policy of 0.75 parking spaces for every one dwelling unit, and there are many dwelling units within Fleurhof (refer to Chapter 9.8 and Table 9.7). The standard dimensions of a parking bay are normally 2.1 m to 2.5 m wide and 6 m long (CSIR, 2000: 21). Therefore the average size of a single parking bay would be between 12.6 m² and 15 m². The multi storey buildings on average contain seven (7) dwelling units per storey and are three (3) storeys high. This means that there are, on average, 21 units per building. This means that there will be an average of 15.75 parking bays (policy ratio of 0.75:1) per multi storey building. 15.75 parking bays equates to an area between **198.45 m²** and **236.25 m²** per building that is only used for parking. Five multi storey buildings will have a total area between 993.25 m² and 1181.25 m² solely allocated for parking. The amount of impervious surface area needed for required parking spaces do not correlate with the community need, referring to predominant use of public transport (refer to Figure 8.27) and only one in three people owning a private vehicle (refer to Chapter 9.3.7).

A low population density – Fleurhof has a very low population density with 10.26 people per km² (refer to Chapter 9.3.4 and Table 9.7). Once Fleurhof is completed it is estimated that the density will increase to 20 people per km² which is still extremely low. This explains why residents stated they have to walk far to retail outlets as retail stores require a specific threshold in terms of population, the lower the density the bigger the threshold area becomes. A total of 57% stated that they have to travel very far, 29% said they travel a far distance and only 14% stated that they travel a short distance (walking distance) to the nearest retail outlet (refer to Figure 8.19). A higher density will increase the threshold value of the area. This will in turn make it more profitable for business as there are more people to provide goods or services too. Amenities will then be used to a fuller capacity and may have to increase in size or amounts; this is dependent on how large the increase in density is.

Opportunities to include a recycling or reusing policy – Fleurhof initially had a recycling policy in place; however the policy was cancelled by the contractor due to large amount of vandalism to the recycle bins (refer to Chapter 9.4). This gap goes hand in hand with the *willingness to participate* gap and the *knowledge* gap identified. If people understand the importance of the concept and they are willing to live a greener lifestyle, the vandalism will stop and recycling can continue, consequently leading to a healthier Fleurhof environment.

Opportunities to enhance stormwater management in the Fleurhof area – As previously mentioned the layouts of the roads have been designed to use the location of the wetlands as an advantage (refer to Chapter 9.3.2 and Figure 9.6). The run-off water from the development is guided by the roads (by gravitational force) into the wetland area. This method is now a requirement set by the Department of Environmental Management for other developments of this nature. However this method may have a negative impact as there are many other variables to consider. The speed at which the water flows to the wetlands, the types of pollution the water picks up as it flows and if the water really reaches the wetlands. If the water flows too slow or too fast some biogeochemical process will not take place. If the water picks up too much pollution on the way to the wetlands, this can impact the ecosystems and biodiversity found within the wetland areas which will in turn affect the dam and all the connected green open space.

The need to include water use sustainability policy – There is no sustainable water use policy in place, however the need of water consumption is not high (refer to Chapter 9.3.5 and Table 9.7). Given the current reality in South Africa and decreasing water availability, a policy should be in place in case the water consumption does increase.

Opportunities to improve the willingness to participate in daily Green Planning Development practises – A high 87% of residents stated that they want to learn more about sustainable development, green infrastructure and how to live a greener lifestyle (refer to Figure 8.7, Chapter 9.3.3 and Table 9.7). A total of 89% of residents said they would make use and practise sustainability if they had access to the tools and technology (refer to Figure 8.8). And 62% of those that would use and practise sustainability are willing to pay an extra cost every month (if need be) to have access to Green Planning Development tools and technology (refer to Figure 8.9).

However in the questionnaires completed by the Calgro personnel (refer to Annexure B and refer to attached CD with details of professional input received), it was identified that there was an issue regarding the local's willingness to participate. Previously there was a drive towards solar energy geysers (as seen in many low cost developments across the country) the residents shied away from the idea and this halted the scheme. It was stated that there was a negative connotation formed by residents towards these geysers on their roofs as they did not want their neighbours to see that they received a house with a solar energy geyser as part of a government grant. Based on this research it was evident that participation of residents and experts, as well as awareness of the importance of green planning development approaches, should be enhanced. The following chapter aims to draw conclusions based on the theoretical and empirical investigations included in this research.

CHAPTER 10: CONCLUSION

10.1 Points of departure

Chapter 10 aims to discuss the conclusions drawn in relation to the set research objectives (refer to Chapter 1), informed by the theoretical investigation, policy and legislation considerations, empirical investigations of best practices, as well as the assessment of the Fleurhof case study in terms of the proposed Green Planning Development framework. Figure 10.1 below provides the structure of the layout of Chapter 10.

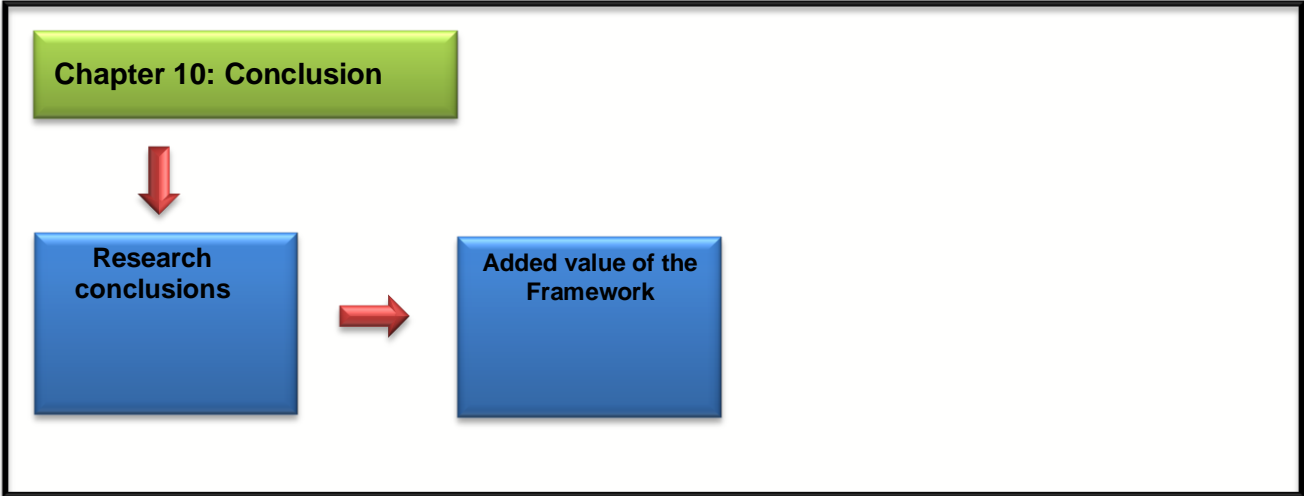


Figure 10.1: A graphical overview of the organisation and structure of Chapter 10

Source: Own construction (2016)

10.2 Research conclusions

This research aimed to reach specific objectives, the list below restates the objectives asked as well as the results that were achieved through the research.

10.2.1 Define Green Planning Development (Based on an integrated multi-disciplinary approach).

Based on research conducted and captured in the previous chapter, this research stated the definition of Green Planning Development as follows:

Green Planning Development is considered the integration of spatial planning and green infrastructure planning and approaches, which forms under the planning discipline jurisdiction and is realised in terms of spatial implementation and strategic planning (refer to Chapter 7.2).

The primary principle behind the concept is to enhance the integration of spatial and environmental planning as part of the mainstream planning purposes. This research illustrated the need to consider Green Planning Development from an integrative and multi-disciplinary research approach, including disciplines of spatial planning, environmental management, engineering, governance and education (refer to Table 7.1).

However, based on further findings included in this research, it was evident that the concept of Green Planning Development should be better supported in terms of policies and legislation, and in terms of micro scale measurement indices and tools, in order to enhance the success thereof.

- Lack of policies and legislation guiding Green Planning Development: Chapter 4 discussed legislation, policies and actions plans on international, national and local levels for the purpose of determining how much support there is for sustainable development, spatial planning and green infrastructure planning. It was concluded that there exists various policies and legislation in support of sustainability, sustainable development and spatial planning, however there is lack of direct support towards green infrastructure planning.
- Lack of micro scale performance tools and indices: Chapter 5 dealt with established performance tools and indices. Research was conducted on the three most relevant tools and indices applicable to Green Planning Development (refer to Chapters 5.2, 5.3 and 5.4) including the African Green City Index (AGCI), An Assessment Framework for Monitoring Cities' Sustainability (AAFMCS) and the Global City Indicator Facility (GCIF) respectively. Based on the findings of this research it is evident that measurement tools or indices primarily exist on national and regional (macro) scales, but is limited on a local or neighbourhood (micro) scale.

10.2.2 Determine which major categories will play significant roles in South Africa's Green Planning Development approach as derived from case studies, policies and legislation

The research identified major categories to be included in South Africa's Green Planning Development approach, as derived from case studies, policies and applicable legislations.

These categories were identified through Chapter 4's legislation, policies and actions plans; Chapter 5's AGCI (Chapter 5.2), AAFMCS (Chapter 5.3) and GCIF (Chapter 5.4) and Chapter 6's Hammarby Sjöstad (Chapter 6.2) and Durban (Chapter 6.3). Refer to Table 5.4 in Chapter 5 for a comparison of all major categories identified by the performance tools and indices discussed in Chapter 5. These categories cover all aspects of the Green Planning Development

concept. Figure 10.2 below displays the categories that were identified as being important in a South African context when considering a Green Planning Development framework.

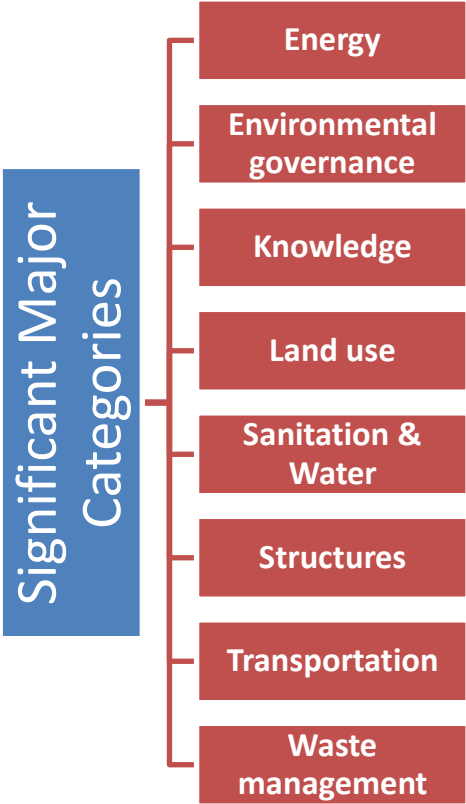


Figure 10.2: The most significant major categories
Source: Own construction (2016)

10.2.3 Determine the basic knowledge of local a community in South Africa on Green Planning Development.

This research investigated amongst others, the basic knowledge of local communities in South Africa, with reference to Green Planning Development and related concepts.

The assessment formed part of the community survey (refer to Chapter 8.4.1) that was completed by the residents of Fleurhof (refer to Annexure A questions 2.1 to 2.10). Based on the findings of this survey it was concluded that only 39% of the respondents understood the (basic) concept of Green Planning Development (refer to Figure 8.6). However 87% of respondents stated that they do not want to learn more about Green Planning Development (refer to Figure 8.7). The importance of knowledge regarding Green Planning Development was enhanced throughout this research as knowledge played a greater role than expected, and was supported as being a major category in the proposed framework by NEMA (refer to Chapter 4.3.4), AGCI (refer to Chapter 5.2) and Durban (refer to Chapter 6.3). The lack of knowledge

that was identified in Chapter 8 (refer to Figure 8.6) illustrated that many people are not aware of the modern urban problems and how to address such. If people could be more aware, it may possibly lead to them living a more sustainable lifestyle which will have a positive impact on the area in terms of Green Planning Development. Chapter 8 further identified (refer to Chapter 8.4.9) a strong correlation between the age of the respondents and their basic knowledge of Green Planning Development. Younger respondents were more knowledgeable and more in favour of approaches towards sustainable development and considered environmental planning more important than older generations, suggesting that that the younger generations are more informed about the concepts of sustainability, sustainable development, environmental planning and green infrastructure, and related benefits thereof. This survey sample is not sufficient to draw conclusions regarding the knowledge of local communities in South Africa in general, but does offer a point of departure to understand the scope of communities' knowledge with regard to Green Planning Development.

10.2.4 Identified best-practices of international and local Green Planning Development approaches.

In an attempt to identify best-practices of Green Planning Development approaches. The following could be concluded:

10.2.4.1 Hammarby Sjöstad, Stockholm, Sweden (international case study)

According to Beatley (2000), Hammarby Sjöstad (refer to Chapter 6.2) is noted as one of the best examples of implemented sustainable urbanism (sustainable development and GI) in the world today. The city has achieved great feats of sustainability; however the following best practise aspects stand out among the rest:

- Combustible waste is recycled and food waste is composted into soil.
- Energy is produced in a renewable fuel-fired district heating plant in the city.
- Surface water is treated locally to avoid overloading the sewage works.
- The heat recovered for heating houses and the silt is converted to biogas.
- Wastewater is treated in the local sewage plant.

Hammarby is objective focused, as the city is planned according to eco-city best practises. The best practises are interconnected and the city present successful integrated, sustainable planning approaches. This example of best practise stretches past the initial planning and illustrates that city planning doesn't end once construction is complete, city planning can continue to the processes of maintaining and controlling the operational aspects of the city; to

ensure that the initial goals are met. All of the above outstanding best practise aspects is the result of city planning and city operation control.

10.2.4.2 Durban, Kwazulu-Natal, South Africa (local case study)

In 2016 the Durban (refer to Chapter 6.3) municipality (City of eThekweni) was awarded the greenest municipality in South Africa in the metro and local categories of the 5th Greenest Municipality Competition. The award is tied to implementation of waste, climate change and green economy (Petterson, 2016). The following lists Durban's best practise aspects that stood out among the rest:

- Policies that implement and maintain services supplied, land use and environmental management.
- Supply of basic services to over 90% of the population.
- The action plans implemented to address current problems, such as supply of water and sanitation services.
- The amount of green open space per person, 187 square metres per person.
- The large scale of the public transport system.

Durban's best practises are focused on providing basic services of water, sanitation and transport. These best practises are set in place to address current issues and seem to have become a necessity for the city. Only one of Durban's best practise is aimed the natural environment and it is the only best practise doesn't aim to provide a basic service such as water or sanitation.

10.2.5 Proposed framework to guide future Green Planning Development approaches

Table 10.1 displays a summary of the proposed framework (refer to Chapter 7, Table 7.1 for details of such). A cross reference to the literature from which each indicator was identified has been provided in the 'literature link' column in Table 10.1. The purpose of this is to give validity and substantiate the selection of each indicator as part of the proposed framework (refer to Chapter 7). Furthermore refer to Chapter 7.2 for the methodology on how the framework was developed.

Table 10.1: Summary of proposed framework

Major Category	Indicator	Type	Literature Link
Energy	Access to electricity (%)	Quantitative	IDP (4.4.1); AGCI (5.2); GCIF (5.4); Durban (6.3);
	Electricity demand per unit (kVA)	Quantitative	NFSD (4.3.6); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Durban (6.3);
	Clean energy policy (Alternative energy)	Qualitative	IDP (4.4.1); NEMA (4.3.4); AGCI (5.2); AAFMCS (5.3); Hammarby Sjöstad (6.2); Durban (6.3);
Environmental governance	Air quality (PM10)	Quantitative	Agenda 21 (4.2.2); IDP (4.4.1); RSA Constitution (4.3.1); SDG (4.2.1); AGCI (5.2); GCIF (5.4); Durban (6.3);
	Ecology and ecosystem services	Qualitative	Sustainability (Chapter 2); Agenda 21 (4.2.2); IDP (4.4.1); NEMA (4.3.4); RSA Constitution (4.3.1); SDG (4.2.1); SPLUMA (4.3.5); NFSD (4.3.6); AGCI (5.2); AAFMCS (5.3); Hammarby Sjöstad (6.2); Durban (6.3);
	Stormwater management	Qualitative	Sustainability (Chapter 2); IDP (4.4.1); NEMA (4.3.4); NFSD (4.3.6); SDG (4.2.1); Hammarby Sjöstad (6.2);
	Green space per capita (m ² /person)	Quantitative	Green Infrastructure (Chapter 3); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Durban (6.3);
	Green space linkages	Qualitative	Green Infrastructure (Chapter 3); SDG (4.2.1); NFSD (4.3.6); Hammarby Sjöstad (6.2);
	Green infrastructure	Qualitative	IDP (4.4.1); SDG (4.2.1); Hammarby Sjöstad (6.2);
Knowledge	Knowledge of concept (%)	Qualitative	NEMA (4.3.4); Durban (6.3);
	Understanding importance of concept (%)	Qualitative	NEMA (4.3.4); Durban (6.3);

	Willingness to participate (%)	Qualitative	NEMA (4.3.4); AGCI (5.2); Durban (6.3);
Land use	Population density (person/km ²)	Quantitative	BNG (4.3.3); NDP (4.3.2); AGCI (5.2); GCIF (5.4); Durban (6.3);
	Land compactness (Total building coverage)	Quantitative	Agenda 21 (4.2.2); BNG (4.3.3); Habitat Agenda (4.2.3); NDP (4.3.2); SPLUMA (4.3.5); AAFMCS (5.3);
	Land optimisation (%)	Quantitative	Agenda 21 (4.2.2); BNG (4.3.3); Habitat Agenda (4.2.3); IDP (4.4.1); SPLUMA (4.3.5); NFSD (4.3.6); AAFMCS (5.3); Hammarby Sjöstad (6.2);
	Total open space coverage (active and non-active)	Quantitative	AAFMCS (5.3); GCIF (5.4); Hammarby Sjöstad (6.2);
	Units per hectare	Quantitative	Agenda 21 (4.2.2); BNG (4.3.3); Habitat Agenda (4.2.3); SPLUMA (4.3.5);
Sanitation & Water	Access to sanitation (%)	Quantitative	NDP (4.3.2); SDG (4.2.1); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Durban (6.3);
	Waste Water Treatment policy	Qualitative	Agenda 21 (4.2.2); AGCI (5.2); Hammarby Sjöstad (6.2); Durban (6.3);
	Access to water (%)	Quantitative	NDP (4.3.2); SDG (4.2.1); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Durban (6.3);
	Water consumption (L/person/day)	Quantitative	NFSD (4.3.6); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Hammarby Sjöstad (6.2); Durban (6.3);
	Water Treatment policy	Qualitative	GCIF (5.4); Hammarby Sjöstad (6.2);
	Water use sustainability policy	Qualitative	Agenda 21 (4.2.2); NFSD (4.3.6); IDP (4.4.1); NEMA (4.3.4); AGCI (5.2); Hammarby Sjöstad (6.2); Durban (6.3);
	Waste water (recycling):		
	Grey water	Qualitative	GCIF (5.4); Hammarby Sjöstad (6.2);
	Black water	Qualitative	GCIF (5.4); Hammarby Sjöstad (6.2);
Structures	People per unit	Quantitative	GCIF (5.4);

	Construction materials	Qualitative	BNG (4.3.3); Habitat Agenda (4.2.3); IDP (4.4.1); NDP (4.3.2); NFSD (4.3.6); Hammarby Sjöstad (6.2);
	Insulation	Qualitative	BNG (4.3.3); Habitat Agenda (4.2.3); IDP (4.4.1); NDP (4.3.2);
	Natural lighting (windows)	Qualitative	BNG (4.3.3); Habitat Agenda (4.2.3); IDP (4.4.1); NDP (4.3.2);
	Orientation	Qualitative	BNG (4.3.3); Habitat Agenda (4.2.3); IDP (4.4.1); NDP (4.3.2);
Transportation	Amount of vehicles per unit (Each typology)	Quantitative	AAFMCS (5.3); GCIF (5.4); Hammarby Sjöstad (6.2);
	Distance from work (km)	Quantitative	NDP (4.3.2); Hammarby Sjöstad (6.2);
	Main methods of transportation used	Quantitative	Agenda 21 (4.2.2); BNG (4.3.3); IDP (4.4.1); NDP (4.3.2); SPLUMA (4.3.5); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Hammarby Sjöstad (6.2); Durban (6.3);
	Parking allocation per unit (Ratio)	Quantitative	Green Infrastructure (Chapter 3); IDP (4.4.1); SDG (4.2.1); AAFMCS (5.3);
Waste management	Access to waste management service (%)	Quantitative	GCIF (5.4); Hammarby Sjöstad (6.2);
	Waste generated (m ³ /week)	Quantitative	AGCI (5.2); NFSD (4.3.6); AAFMCS (5.3); Durban (6.3);
	Waste management policy	Qualitative	Agenda 21 (4.2.2); IDP (4.4.1); NEMA (4.3.4); AGCI (5.2); Hammarby Sjöstad (6.2); Durban (6.3);
	Recycling or reusing policy	Qualitative	NEMA (4.3.4); NFSD (4.3.6); AGCI (5.2); AAFMCS (5.3); GCIF (5.4); Hammarby Sjöstad (6.2); Durban (6.3);
	Hazardous waste policy	Qualitative	Agenda 21 (4.2.2); NFSD (4.3.6); Hammarby Sjöstad (6.2);

Source: Own construction (2016)

10.3 Added value brought along by the proposed Green Planning Development Framework

The added value of the proposed Green Planning Development Framework can be related to strengths-analysis (identifying current Green Planning Development initiatives to further elaborate on within the specific area) and gap-analysis (identifying Green Planning Development gaps to be addressed as future opportunities). To further illustrate the value of the proposed Green Planning Development framework, Table 10.2 displays a summary of the initiatives that contribute to Green Planning Development, as applied to the Fleurhof case study, linked to the major categories identified in the framework. Refer to Chapter 9.5.1.1 for detailed discussion.

Table 10.2: Green Planning Development Contributing Initiatives.

Major Categories						
	All services	Environmental Governance	Land Use	Structures	Transportation	Water
Contributing Initiatives	Schemes in place to supply sustainable energy through heat pumps,	Air quality according to required standards,	Mixed land use and the functional advantages that come with,	Well-insulated structures, natural light as well as orientation were considered as part of the development plan.	Excellent use of public transport,	Low water consumption
	Supply of services (electricity, sanitation, water, waste management) to all residents within the Fleurhof area,	Green space linkages provided by strategically place green open spaces,	Large amounts of public open space (passive) provided.		Close proximity between homes and work areas.	
	Low use of energy throughout the area.	Identification and protection of ecosystem services and wetlands as part of the development plan.				

Source: Own construction (2016)

The identification of current initiatives within broad categories is an outcome of the proposed Green Planning Development framework, and could be applied in similar areas or cases. Table 10.2 illustrates the collective result when the framework was applied in the Fleurhof case study.

To further illustrate the value of the proposed Green Planning Development framework, Table 10.3 displays a summary of the identified gaps/ opportunities within their major categories, as applied to the Fleurhof case study. Refer to Chapter 9.5.1.2 for detailed discussion.

Table 10.3: Identified gaps/ opportunities

Major Categories						
Identified Opportunities	Environmental Governance	Knowledge	Land Use	Sanitation and water	Transportation	Waste Management
	Opportunities to enhance stormwater management in the Fleurhof area.	Lack of knowledge regarding the concept of Green Planning Development and overall sustainability.	A low population density.	The need to include water use sustainability policy.	The large amount of parking provision.	Opportunities to include a recycling or reusing policy.
		Opportunities to improve the willingness to participate in daily Green Planning Development practises.			Opportunities to expand public transport to neighbouring areas.	

Source: Own construction (2016)

The identification of gaps within broad categories is an outcome of the proposed Green Planning Development framework, and could be applied in similar areas or cases. Table 10.3 illustrates the collective result when the framework was applied in the Fleurhof case study.

The application of the proposed Green Planning Development framework consequently serves as a development checklist to identify current initiatives and gaps, in line with Green Planning objectives. Chapter 11 will provide recommendations to include the findings of Chapter 10 as part of mainstream spatial planning approaches.

CHAPTER 11: RECOMMENDATIONS

11.1 Points of departure

This chapter will conclude the research with proposals for spatial planning and development initiatives relating to green infrastructure planning. Figure 11.1 provides the organisation structure of Chapter 11.

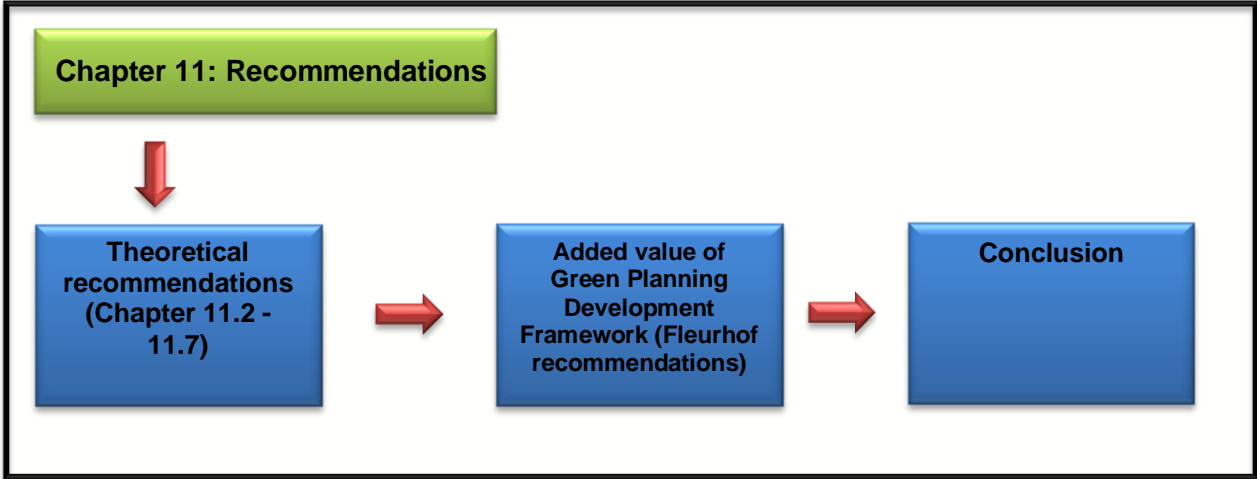


Figure 11.1: A graphical overview of the organisation and structure of Chapter 11
Source: Own construction (2016)

11.2 Need to define Green Planning Development in context of spatial and green infrastructure planning approaches

This research created a definition for Green Planning Development but further recommends contextualising such as part of spatial and GI planning approaches, acknowledging the multi-disciplinary nature thereof (refer to Chapter 7.2 for proposed definition). Relevant policies and legislation should incorporate such a definition in order to ensure the successful implementation thereof.

The research further proposes the framework (inclusive of major categories and indicators) that could be used to guide and assist future and current developments in terms of the concept of Green Planning Development (follow the example provided as seen in Table 7.1.)

11.3 Addition of Green Planning Development and principles in local municipal legislation

It is recommended that the concept of Green Planning Development be implemented in the local Integrated Development Plan (IDP), where the IDP could identify various projects in which the community can get involved with, to practise Green Planning Development as well as improve LED. The principles within an IDP may also be improved with the addition of some of the fore mentioned proposals. Examples of the proposed principles to be added to the IDP are:

- Always consider ecological corridors before commencing with a development, for the corridors may serve as movement of natural species.
- Always consider ecosystem services before commencing with a development, for the services may serve human needs as well as provide, support and regulate the natural environment.
- Ensure that there are local municipal officials who are informed and educated in Green Planning Development involved in the project at hand.
- Ensure that local and provincial spheres of government follow similar Green Planning Development applications and implementation so that their co-ordination will be seamless in the project at hand.
- Promote the awareness and reduction of the urban heat island (UHI) affect.
- Promote the awareness and reduction of urban stream syndrome (USS).
- Promote the awareness of biodiversity's in the area.

As the spatial development framework (SDF) forms part of the IDP, it too can benefit from the proposed principles. The SDF is an illustration (map) of the spatial planning policy within a city or area in question. A SDF also displays development proposals and applications, as well as provide a citywide perspective of spatial challenges and interventions within a city. Therefore it is proposed that SDF's should indicate highly sensitive vegetation, ecological corridors and areas where important ecosystem services exist. This will assist future developments to select feasible areas to develop in and develop in a manner that will support and not harm the natural environment.

11.4 Enhance the basic community understanding of Green Planning Development

The Fleurhof case study identified a low 39% of the residents who understood the concept of sustainable development and green infrastructure (refer to Figure 8.6, Chapter 9.3.3 and Table 9.7. This survey sample is not sufficient to make generalisations regarding the knowledge of local communities in South Africa in general, but does offer a point of departure to understand

the scope of communities' knowledge with regard to Green Planning Development. An improvement of knowledge may allow for more and better opportunities within urban areas. Therefore it is recommended that people be taught about sustainable living and Green Planning Development and also that people are made aware of how their actions impact the environment and what they could do to avoid or completely prevent negative impact towards the environment in their daily lives. This increased knowledge should also improve the quality of urban areas which will in turn improve the value of the area.

A further consideration in this regard, is the inclusion of the younger generation as part of the planning process. On completion of the cross tabs (refer to Chapter 8.4.9) a strong relationship was identified between the age of the respondents and their basic knowledge of Green Planning Development. This indicated that the younger the respondents were the more likely they were to agree and state that yes, environmental planning is important (refer to Annexure A, Question 2.3). As the respondents got older they became less likely to agree that environmental planning is important. This implies that the younger generations are more informed about the concepts of sustainability, sustainable development, environmental planning and green infrastructure. This survey sample is not sufficient to make generalisations, but does, again, offer a point of departure to understand the scope of the involvement of younger generations as part of the Green Planning Development approach.

11.5 Need to address policies and legislation in terms of Green Planning Development

The purpose of Chapter 4 was to identify how much support there is for sustainable development, spatial planning and green infrastructure planning on international, national and municipal levels. It was identified support may exist for GI, but this will be at the discretion of the reader as the concept was never referred to directly or by name. There is no direct support for GI. It is recommended that future legislation, policies and actions plans consider GI and the many benefits it provides (refer to Chapter 3.3) and include direct support for the concept at the very least. Schemes of implementation of GI can also be included but this may have to start in the wealthier regions or urban areas and work its way down to rural areas.

11.6 Need to address the scale of framework and performance tools and indices

Chapter 5 discussed established performance tools and indices and it was concluded that these types of tools or indices primarily exist on national and regional (Macro) scales, but don't exist on a local or neighbourhood (Micro) scale. The lack of micro scale tools and indices should be addressed, and consider initiatives such as LED approaches, eco-planning approaches linked to natural biodiversity's, UHI and USS. Each tool and index should be tailor made to capture the

unique challenges and opportunities of the specific area, to enable the successful realization of Green Planning Development.

11.7 Added value brought along by proposed Green Planning Development framework (Recommendations)

The proposed Green Planning Development framework could offer added value in terms of spatial planning and green infrastructure planning approaches, linked to the different categories included in the framework. The proposals within this section of Chapter 11 are aimed at illustrating the added value of the proposed Green Planning Development framework by providing recommendations for the Fleurhof case study, based on the application, results and conclusions deduced from implementing the proposed framework (refer to Table 9.7). The recommendations are practical solutions to guide an integrated approach towards Green Planning Development, using the Fleurhof case study to illustrate such. The recommendations have been numbered, discussed and displayed on a map (refer to Figure 11.2).

1. Through the questionnaire completed by the residents of Fleurhof, it was recorded that only 39% of all residents had a true understanding of what Green Planning Development is (refer to Figure 8.6 and Chapter 8.4.1). Therefore it is clear that there is a great lack of knowledge regarding green planning among the residents, this goes hand in hand with the fact that 87% of residents stated that they want to learn more about Green Planning Development (refer to Figure 8.7) as they don't know what the concept is. This increased knowledge should also improve the quality of the Fleurhof area which will in turn improve the value of the area.

Methods used to promote Green Planning Development and teach the residents about Green Planning Development could include meetings every month with the local leaders or influential people within the community or information sessions for the public. Other means of teaching could be completed by handing out pamphlets or having information boards around the community that explains to residents how they can make small differences and various concepts of Green Planning Development. Educational and awareness approaches should consider the language and literacy levels of the specific community, in order to adhere to their specific needs and requirements. Furthermore the officials on a local municipal level could also be informed and educated on Green Planning Development as it may fall on them in the future to successfully assess Green Planning Development applications and its implementation on a local municipal level.

2. 89% of residents agreed that they would favour Green Planning Development if they had access to Green Planning Development tools and technology (refer to Figure 8.8). Residents

who practise Green Planning Development can facilitate Green Planning Development in and around the urban areas, making others more aware of Green Planning Development and assisting people who are new to the concept and practise. This related to residents who stated they do not understand the concept of Green Planning Development but would like to learn more about it (refer to Figure 8.7). Residents practising Green Planning Development may also improve the quality and value of the land and area as the local people make an effort towards Green Planning Development and sustainability. To take it one step further, local unemployed people can be trained in the usage and implementation of Green Planning Development. After which the trained locals can be employed to teach and assist the other locals in their Green Planning Development needs, which will in turn be an attempt to reduce poverty in the area.

3. Furthermore 62% of those that would use and practise Green Planning Development are willing to pay an extra cost every month (if need be) to have access to Green Planning Development tools and technology (refer to Figure 8.9). This is a good indication of how many people are serious about Green Planning Development, and it may be a method of generating income or it may motivate developers to include equipment that may improve the Green Planning Development of the urban area (such as solar geysers, gas geysers or heat pumps for apartment buildings). It may also be a good incentive for investors (or the government) to develop Green Planning Development as people are willing to pay for the technology attached to the concept. Incentives for home owners or renters to practise Green Planning Development at home could also be introduced. Such willingness-to-pay emphasise the community need and possibilities to explore subsidy-policies linked to green planning initiatives, for example, a reduced bond (or rent) for a subsidised home depending on how well the residents implement and practise Green Planning Development in their homes and communities.

4. Other Green Planning Development recommendations include ideas of home grown vegetable gardens; this will save the local people money and create a local trade between neighbours. The people can trade extra vegetables of one kind for other kinds of vegetables which they do not have but need (want). This could turn into a lucrative scheme which will improve income for the local people, a form of local economic development (LED). Having gardens instead of cement or barren land will assist in lowering runoff water and mitigate the effects of UHI. The water can then enter the ground at the gardens, this will lower the negative effects on the urban hydrology as the water will feed the local area and will allow biogeochemical activities in upper soil horizons to take place. The water will also collect fewer pollutants as it travels a shorter distance before being absorbed. Therefore the Urban Stream Syndrome (USS) will be lowered as well as improve the Urban Heat Island (discussed below) of the area.

5. For areas where gardens are not an option, a porous or permeable surface is proposed instead of solid cement. This type of cover will allow water to penetrate the ground below. Another method proposed (5.1) would be to create bio-swales (or rain gardens) at water catchment points; these points will not only contribute to improving the USS and UHI as the permeable surface cover does but will improve the aesthetics of the area. Although these options might be costly for a rural development area, the positive impact provided by them cannot be measure by a monetary value.

6. Given that the water bodies of Fleurhof were (and still are) exposed to pollutants, a clean-up of the Klipspruit Rivers could be an important step and should part of the environmental management plan for Fleurhof (refer to Figure 9.4).

7. A “trash for food” scheme could also be put in place. This is considered form of recycling that works well in rural communities where the local people take their solid waste and trade it for fresh fruit or vegetables. The vegetables could be grown locally or provided by interested party (Government) who takes the waste to be recycled. Therefore this initiative will have a few advantages:

- The area is kept cleaner as the waste is used as currency (motivation),
- The local people save money and eat healthy (LED),
- Waste is still recycled (possibly more waste).

8. The green space linkage has been measure by the proposed framework (refer to Table 9.7) and it was considered to be one of the highlights of Fleurhof. However there is a lack of green space linkage in between the urban areas. Given that majority of the Fleurhof site consists of disturbed grassland and exotic bush clumps (refer to Figure 9.2), the large scale development does not negatively affect the ecological elements of Fleurhof. This is due to the fact that these areas are of low sensitivity and conservation value (refer to Figure 9.3). Nevertheless these areas could serve as ecological corridors for the movement of species and it is proposed that this idea be considered in future plans. This will assist and improve the urban biodiversity of the Fleurhof. It goes without saying that construction should be carried out with consideration to the natural life that inhabits Fleurhof and make every effort to not obliterate the natural vegetation and life.

9. Furthermore as the development grows, there will be less and less open space. An area with lower vegetation cover will contribute to the Urban Heat Island (UHI) affect, this is where the average temperature of an area is higher than its surrounding natural areas due to it being urbanised (refer to Chapter 2.4). However the Fleurhof model is very focused on maximizing the

land use through its multi-story designs, but the increase in population density increases the UHI. A proposal to improve on the UHI of the area could be to keep the colours of the buildings a very light (bright or reflective) colour as this will improve the albedo of the building. This idea could be promoted to the home owners who have free standing or semi-detached homes through the training the 87% have asked for (refer to Figure 8.7). Another previously discussed method to reduce UHI is the vegetable gardens as this will increase the amount of vegetation cover (refer to proposal 4).

10. In Chapter 10.3.2 it was identified that due to the parking policy of 0.75 parking spaces for every one dwelling unit, there are 15.75 parking bays per multi storey building. 15.75 Parking bays equates to an area between **198.45 m²** and **236.25 m²** per building only for parking. That becomes a large amount of impervious surface area throughout Fleurhof that could at the least be reduced as there are 60% of people who don't even need parking spaces as they make use of public transport (refer to Figure 8.27) and only one in three people own a private vehicle (refer to Chapter 9.8). It is proposed that the parking policy ratio be reduced or that parking's are constructed with permeable materials to allow for water penetration. This allow for the water to enter the ground, mitigating the effects of USS as the water will feed the local area and will allow biogeochemical activities in upper soil horizons to take place. The water will also collect fewer pollutants as it travels a shorter distance before being absorbed. Therefore the USS will be lowered as well as improve the impacts of the UHI of the area (refer to Chapter 2.4).

11. The survey identified that respondents felt there is a lack of green open space, 81% of locals said that there is not enough green public open space (refer to Figure 8.16). However the framework did result in a massive ratio of 293.54m² of green open space per person, active or passive (refer to Table 9.7). The respondents may have been referring to active open space as the lack in the area. Consequently it is proposed that more active open spaces be considered and constructed in the areas that have not been built yet. Solving this solution may lead to better green infrastructure use as more green open space can lead to better linkages (creating improved ecological corridors, refer to proposal 8) which will create a healthier biodiversity and ecological state. USS and UHI negative impacts will also be mitigated and LED will be improved as people will be needed to keep the active spaces clean.

Based on the conclusions and recommendations included in this research, specific planning and layout considerations were proposed for the Fleurhof area. Figure 11.2 below displays the proposed locations of information billboards, where the "trash for food" scheme could take place, areas where ecological corridors already exist, places where informative Green Planning Development meetings could take place and areas where construction should be done with

great consideration to the natural environment. The billboards proposed are to be placed along the primary roads in Fleurhof. These are marked with red, primary intersections may be ideal locations for the billboards as well. The intersections have been marked by the X symbol. The areas marked with the orange shade are all vacant stands and therefore would be an ideal location for the “trash to food” proposal. These locations have been strategically placed so that there is one within each major section of Fleurhof. The ecological corridors have been marked off as a green shade. Only the areas that fall within the high sensitivity vegetation have been demarcated as ecological corridors as these sections contain the most ecosystem services which complement the ecological corridors and form part of Fleurhof’s hydrology and are already protected. All other unshaded areas are where there is structures and a lack of green space linkages. Nevertheless the entire Fleurhof area could be considered as an ecological corridor, however a balance needs to be found. Lastly the proposed stands distinguished by Calgro M3 to be a future school would be an ideal location for the proposed informative meetings (shaded light blue on the map), since all the required furniture and equipment will already be present and majority of the residents will feel safe within the grounds (neutral area).

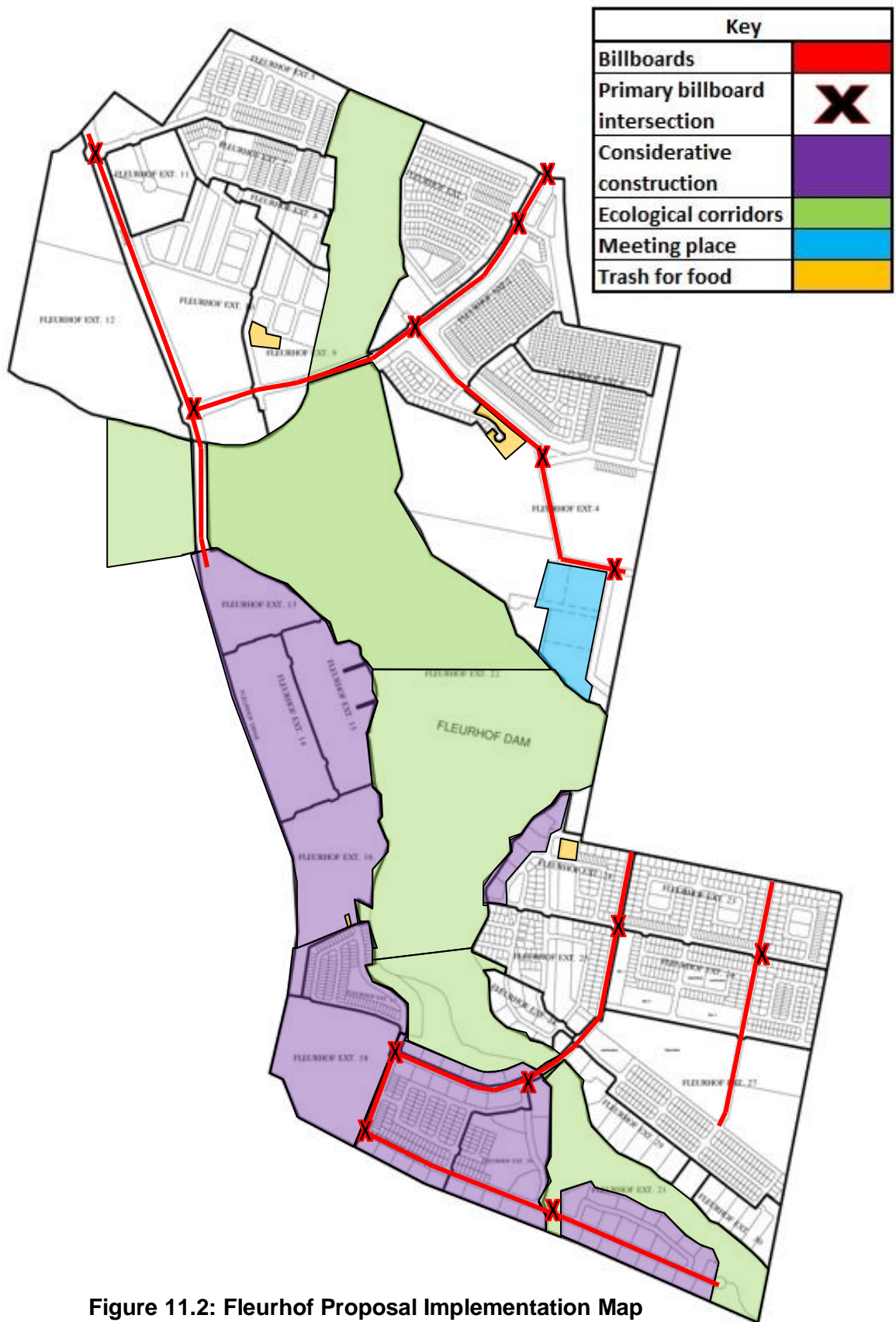


Figure 11.2: Fleurhof Proposal Implementation Map
 Source: Adapted from Calgro M3 Holdings, 2015e

Table 11.1 displays a collective overview of all the proposals and linked benefits, ranked according to a colour coding, illustrating the primary benefit (green), the secondary benefit (blue) and no benefit (grey).

Table 11.1: Proposals and Benefits

Key	
	Primary benefit
	Secondary benefit
	No benefit

Proposals and Benefits		Benefits					
		Aesthetics	LED	Recycling	UHI	Urban Biodiversity	USS
Proposals	1-2. Improved knowledge and implementation						
	3. Incentives						
	4. Vegetables Gardens						
	5. Permeable surfaces						
	5.1 Bio-swales						
	6. Cleaning rivers						
	7. Trash for fruits or vegetables						
	8. Considering ecological corridors						
	9. Bright coloured homes						
	10. Permeable parking						
	11. More active green open space						

Source: Own Creation (2016)

The primary and secondary benefits provided by the proposals can apply to any area or urban setting, therefore the proposals can serve a broader purpose are not only Fleurhof focused.

11.8 Conclusion

This research aimed to create a Green Planning Development Framework to guide the integration of spatial planning and green infrastructure planning approaches. The application of the proposed framework was illustrated in the Fleurhof case study. This framework can be applied and adopted to similar cases, developments or future initiatives, providing that sufficient legislation support such approaches and that communities, experts and authorities understand, and embrace the value of Green Planning Development. This is not simply green or eco-friendly retro fitting; this is detailed planning from the genesis to find a balance between nature and all

the significant major categories (refer to Figure 10.2) identified in the study. *“The best way to predict your future is to create it”* (Abraham Lincoln), therefore a green planned and sustainable future can exist; it only needs to be created.

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ANNEXURE A

Questionnaire number: _____

Questionnaire

The purpose of this study is to gather information on different aspects: Knowledge, energy, environmental governance, land use, sanitation, water, structures, transportation and waste management in Fleurhof integrated housing development in Gauteng.

Dissertation submitted in fulfilment of the requirements for the degree M. Art et Scien in Urban and Regional Planning the Potchefstroom Campus of the North-West University

Supervisor: Prof. E.J. Cilliers

June 2016

RESEARCH ETHICS PROJECT INFORMATION SHEET
UNIT FOR ENVIRONMENTAL SCIENCES AND MANAGEMENT, SUBPROGRAM 7:

Informed consent for participation in the research *A proposed Green Planning Development framework: Integration of spatial planning and green infrastructure planning approaches* by Reinaldo Silverio Veiga (23529652) as part of post-graduate research for the degree M. Art et Scien (Planning) at the North-West University

<p>Purpose of the research: <i>To gather information on different aspects: Knowledge, energy, environmental governance, land use, sanitation, water, structures, transportation and waste management in Fleurhof integrated housing development in Gauteng.</i></p>	<p>Orientation of research topic: <i>Sustainable development</i></p> <p>Relevance and value: <i>Fulfilment of the requirements for the degree M. Art et Scien in Urban and Regional Planning the Potchefstroom Campus of the North-West University</i></p>
<p>Research competence and expertise:</p>	<p>Post-graduate student introduction: <i>RS Veiga.</i></p> <p>Study leader introduction: <i>Prof. EJ Cilliers.</i></p> <p>Introduction of entity: <i>Urban and Regional Planning, Unit for Environmental Sciences and Management, North-West University.</i></p>
<p>Research sponsor:</p>	<p><i>None.</i></p>
<p>Requirements of participation: <i>Resident of Fleurhof</i></p>	<p>State favourable risk-benefit ratio: <i>None.</i></p>
<p>Statements of voluntary participation:</p>	<p><i>Your participation in this study is voluntary. If you do not want to participate, please return the questionnaire to the researcher. You also do not have to answer any question that makes you uncomfortable</i></p>
<p>Privacy statements:</p>	<p>Participant's responses are confidential.</p> <p>Anonymity statement: <i>Do NOT write your name on this questionnaire, so your responses will never be linked to you personally</i></p> <p>Confidentiality statement: <i>Only the researchers involved in this study will see your responses</i></p>
<p>Submission information:</p>	<p><i>RS Veiga collects on completion.</i></p>
<p>Note of thanks:</p>	<p><i>Thank you.</i></p>



**RESEARCH ETHICS CONSENT FORM
 UNIT FOR ENVIRONMENTAL SCIENCES AND MANAGEMENT, SUBPROGRAM 7:**

Full title of Project: *A proposed Green Planning Development framework: Integration of spatial planning and green infrastructure planning approaches.*

Name, position and contact address of Researcher:
RS Veiga, M student, PO Box 40 2520 Potchefstroom South Africa

Please Initial Box

- 1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.
- 2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.
- 3. I agree to take part in the above study.

Note for researchers: Include the following statements if appropriate, or delete from your consent form:

- 4. I agree to the interview / focus group / consultation being audio recorded
- 5. I agree to the interview / focus group / consultation being video recorded
- 6. I agree to the use of anonymised quotes in publications'
- 7. I agree that my data gathered in this study may be stored (after it has been anonymised) in a specialist data centre and may be used for future research.

Name of Participant	Date	Signature
---------------------	------	-----------

Name of Researcher	Date	Signature
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Demographics

1.1 What is your age? (Choose relevant category)							
16 or younger	1	20 - 29	2	40 - 49	3	60 - 74	4
17 - 19	5	30 - 39	6	50 - 59	7	75 +	8
1.2 What is your gender? (Choose relevant category)							
Male			1	Female			2
1.3 What is your home language? (Choose relevant category)							
Zulu	1	Tswana	2	Shona	3	English	4
Xhosa	5	Tsonga	6	Phedi	7	Afrikaans	8
Venda	9	Sotho	10	Ndebele	11	Other (specify)	12
1.4 What is your occupation?							

Knowledge

2.1 What do you regard as environmentally friendly/sustainable planning? (Visual answers) (Please select one only) See three houses Annexure A							
A	1	B	2	C	3		
2.2 Which of the images would you regard as your current home and environment? (Please select one only)							
A	1	B	2	C	3		
2.3 Do you think environmental planning is important? (Please select one only)							
Yes			1	No			2
2.4 If you answered 'Yes', please describe below							
2.5 Do you think that environmental planning should form part of your home and community? (Please select one only)							
Yes			1	No			2
2.6 What suggestions would you have to improve environmental planning in your home and local community?							
2.7 Would you like to learn about environmental planning? (Please select one only)							
Yes			1	No			2
2.8 If green elements such as solar panels, energy efficient globes, local veggie gardens, recycle programmes, etc. are introduced to your community, would you take part or make use of these elements? (Please select one only)							
Yes			1	No			2
2.9 If these mentioned green elements should increase the cost of your home, would you be willing to pay slightly more for your home to have access to the green elements? (Please select one only)							
Yes			1	No			2
2.10 How much more would you be willing to pay on a monthly basis to have access to the green elements? (Please select one only)							
Less than R100	1	R100-R150	2	R150-R300	3	R300+	4

Energy

3.1 Do you have access to electricity? (Please select one only)							
Yes			1	No			2

Environmental governance

4.1 Do you currently have access to public open space? (Please tick one only)							
Yes			1	No			2
4.2 Is it a hard or soft open space? (Please tick one only)							
Hard open space			1	Soft open space			2
4.3 What type of open space is it? (Please tick one only)							
Active open space (Formal park)			1	Passive open space (Close to the dam)			2
4.4 Can you access the park with ease? (Please tick one only)							
Yes			1	No			2
4.5 How often do you visit the park or open space in general? (Please tick one only)							
Once a day	1	One a week	2	Once a month	3		
Once a year	4	Twice a year	5	Other (Specify) :	6		

4.6 When you visit the park or open space, How do you usually travel? (Please tick one only)					
On foot	1	Car	2	Taxi	3
Bicycle	4	Bus	5	Motorbike	6
4.7 What is your overall impression of the park or open space? (Please tick one only)					
Very satisfied	1	Dissatisfied	2		
Satisfied	3	Very dissatisfied	4		
4.8 Please rate the following places from 1 to 5 for where you feel the safest. (1 being unsafe to 5 being extremely safe).					
	Not safe	Reasonably safe	Fair	Safe	Extremely safe
Public spaces	1	2	3	4	5
4.9 Do you think there are enough public spaces? (Choose one)					
Yes	1	No	2		
4.10 What is your need in a public space? (Choose one)					
Markets	1	Benches	4		
Business	2	Jungle gyms	5		
Recreational	3	Other (specify):	6		
Land use					
5.1 Which type of house do you currently live in? (Choose one)					
House with own yard	1	Informal shack	2		
Flat or apartment in a block of flats	3	Caravan/tent	4		
Room or flatlet on someone else's property	5	Other (specify):	6		
5.2 How far do you travel to reach any retail uses such as shops (hairdresser, barber, clothing, butchery)? (Choose one)					
Very far	1	Far	2	Within walking distance	3
5.3 Which of the following uses are in close proximity to your home? (Choose one)					
Spaza shop	1	Barber	2	Hairdresser	3
Café	4	Clothing store	5	Butchery	6
Other (specify):					7
Sanitation & water					
6.1 Do you have access to clean water? (Please select one only)					
Yes	1	No	2		
6.2 If "Yes" in 6.1), where do you get your water from (Please select one only)					
Communal Tap	1	In-house (Local water scheme)	2	Rain Water Tank	3
Water Tank(Local jo-jo tank)	4	Wetlands/River/ Stream	5	Other (Specify):	6
6.3 Do you have access to sanitation? (Toilets, showers/ baths) (Please select one only)					
Yes	1	No	2		
Structures					
7.1 How satisfied were you with the appearance of your house when you moved in? (Choose one)					
Unsatisfied	1	Satisfied	2	Extremely satisfied	3
7.2 Please rate the following aspects of Fleurhof from 1 to 5 (1 being not good to 5 being excellent)					
	Very bad	Bad	Fair	Good	Excellent
7.2.1 Height and scale of buildings	1	2	3	4	5
7.2.2 Quality and design of buildings	1	2	3	4	5

7.2.3 Relation of buildings to your neighbours and surroundings		1	2	3	4	5
Transportation						
8.1.1 Do you own a car/cars?		Yes	No	8.1.2 How many?		
8.2 Where do you work?						
1 – 4 km	1	5 – 9 km	2	10 – 14 km	3	15 – 19 km
4		20 – 24 km	5	25 km +	6	
8.3 What is your main mode of transport? (Choose one)						
Private car	1	Train	2	Walk	3	
Bus	4	Bicycle	5	Taxi	6	
Other (specify):					7	
8.4 How often do you use public transportation (taxi, bus, train)? (Choose one)						
Never	1	Daily	2	Weekly	3	
Once a week	4	Monthly	5	Yearly	6	
Other (specify):					7	
8.5 How often do you use private transportation? (Choose one)						
Never	1	Daily	2	Weekly	3	
Once a week	4	Monthly	5	Yearly	6	
Other (specify):					7	
Waste management						
9.1 How do you dispose of your solid waste (refuse)? (Please select one only)						
Communal Refuse Dump	1	No Rubbish Disposal	2	Own Refuse Dump	3	
Recycling Bin	4	Removal By Local Authority	5	Other (Specify):	6	

Thank you for your time and Participation

Annexure A (Questionnaire)



ANNEXURE B

Questionnaire number: _____

Questionnaire

The purpose of this study is to gather information on Green Planning Development in Fleurhof integrated housing development in Gauteng.

Dissertation submitted in partial fulfilment of the requirements for the degree B.Art et Scien in Urban and Regional Planning the Potchefstroom Campus of the North-West University

Supervisor: Prof. E.J. Cilliers

September 2016

**RESEARCH ETHICS PROJECT INFORMATION SHEET
UNIT FOR ENVIRONMENTAL SCIENCES AND MANAGEMENT, SUBPROGRAM 7:**

Informed consent for participation in the research *A proposed Green Planning Development framework: Integration of spatial planning and green infrastructure planning approaches* by Reinaldo Silverio Veiga (23529652) as part of post-graduate research for the degree M. Art et Scien (Planning) at the North-West University

<p>Purpose of the research: <i>To gather information on different aspects: Knowledge, energy, environmental governance, land use, sanitation, water, structures, transportation and waste management in Fleurhof integrated housing development in Gauteng.</i></p>	<p>Orientation of research topic: <i>Sustainable development</i></p> <p>Relevance and value: <i>Fulfilment of the requirements for the degree M. Art et Scien in Urban and Regional Planning the Potchefstroom Campus of the North-West University</i></p>
<p>Research competence and expertise:</p>	<p>Post-graduate student introduction: <i>RS Veiga.</i> Study leader introduction: <i>Prof. EJ Cilliers.</i> Introduction of entity: <i>Urban and Regional Planning, Unit for Environmental Sciences and Management, North-West University.</i></p>
<p>Requirements of participation: <i>Professional Urban and Regional Planners or field related professionals</i></p>	<p>State favourable risk-benefit ratio: <i>None.</i></p>
<p>Statements of voluntary participation:</p>	<p><i>Your participation in this study is voluntary. If you do not want to participate, please return the questionnaire to the researcher. You also do not have to answer any question that makes you uncomfortable</i></p>
<p>Privacy statements:</p>	<p>Participant's responses are not confidential.</p> <p>Anonymity statement: <i>Write your name on this questionnaire, your responses will be linked to you personally as your name will provide the required validity to your responses</i></p>
<p>Submission information:</p>	<p><i>RS Veiga collects on completion.</i></p>
<p>Note of thanks:</p>	<p><i>Thank you for your contribution and valuable input, it will be used in post-graduate research.</i></p>

**RESEARCH ETHICS CONSENT FORM
UNIT FOR ENVIRONMENTAL SCIENCES AND MANAGEMENT, SUBPROGRAM 7:**

Full title of Project: *A proposed Green Planning Development framework: Integration of spatial planning and green infrastructure planning approaches.*

Name, position and contact address of Researcher:

RS Veiga, M student, PO Box 40 2520 Potchefstroom South Africa

Please Initial Box

- | | | |
|----|--|--------------------------|
| 2. | I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | <input type="checkbox"/> |
| 3. | I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. | <input type="checkbox"/> |
| 3. | I agree to take part in the above study. | <input type="checkbox"/> |

Note for researchers: Include the following statements if appropriate, or delete from your consent form:

- | | | |
|-----|---|--------------------------|
| 4. | I agree to the interview / focus group / consultation being audio recorded | <input type="checkbox"/> |
| 8. | I agree to the interview / focus group / consultation being video recorded | <input type="checkbox"/> |
| 9. | I agree to the use of anonymised quotes in publications' | <input type="checkbox"/> |
| 10. | I agree that my data gathered in this study may be stored (after it has been anonymised) in a specialist data centre and may be used for future research. | <input type="checkbox"/> |

Name of Participant	Date	Signature

Name of Researcher	Date	Signature

Name	
Qualification	
Company	
Position	

The questions within the survey are based on the concepts of sustainable development, green infrastructure planning and spatial planning. The study proposes an integration of the three mentioned concepts and titles the integrated concept “*Green Planning Development*”. The primary objective of the Green Planning Development concept is to enhance the integration of spatial and environmental planning as part of the mainstream planning purposes. This survey has been divided into Sections A, B, C and D. Section A everyone must answer, the remaining three Sections are divided into the different qualification groups. Please answer only the Section which is applicable to you. All questions in Sections B-D are based on the Fleurhof Development.

**Section A
Everyone**

Please answer the following questions to the best of your ability.

1. What do you think Green Planning Development is? Please provide an example to motivate your answer.

The theoretical study preceding this questionnaire defined Green Planning Development *Green* as being “*considered the integration of spatial planning and green infrastructure planning and approaches, which forms under the planning discipline jurisdiction and is realised in terms of spatial implementation and strategic planning*”.

2. Does this definition change your idea of Green Planning Development?

3. Considering the Fleurhof development, do you think that there is currently Green Planning Development? (Please motivate)

4. What other suggestions would you make to improve Green Planning Development within Fleurhof?

5. Are there any future Green Planning Development initiatives or scheme which will be implemented in Fleurhof?

Section B
Architects

1. What construction materials were used to build the structures (Homes)?

2. What type of insulation do the structures have?

3. What is the orientation of the structures?

4. What is the parking allocation per unit for each typology?

5. What is the total building coverage per typology?

6. What is the waste generated ($\text{m}^3/100\text{m}^2/\text{week}$) per typology?

**Section C
Engineers**

1. What is the Electricity demand pre typology?

2. What is the electricity consumption per capita?

3. Are there any clean energy policies implemented?

4. What is the water consumption ($\text{L}/\text{unit}/\text{year}$) per typology?

5. How does waste water get recycled?

- Grey water

- Black water

6. Are there any water sustainability policies implemented?

7. What is the current Waste Water Treatment policy?

Section D
Town Planners

1. What is the current population of Fleurhof?

2. What is the population density per km²?

3. How many green spaces (Active only) are there per capita?

4. Is there a public transport network within Fleurhof? Please describe it if there is.

5. Does Fleurhof have a waste recycling or re-use policy? How does it function?

6. What are the environmental management schemes within Fleurhof?

7. How is stormwater managed?

8. What is the total mixed land use (%)?

9. What is the Total open space coverage (active and non-active)?

10. How many units are there per hectare?

11. Are there any Eco-system services in Fleurhof which you know about?

- Cultural services
- Habitat services

- Provisioning services
- Regulating services

A large, empty rectangular box with a thin black border, positioned below the list of services.

12. What is the current Hazardous waste policy?

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ANNEXURE C

Frequency Tables

Q1.1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	5	1.6	1.6	1.6
	2	85	26.4	26.4	28.0
	3	57	17.7	17.7	45.7
	4	27	8.4	8.4	54.0
	5	14	4.3	4.3	58.4
	6	98	30.4	30.4	88.8
	7	26	8.1	8.1	96.9
	8	10	3.1	3.1	100.0
	Total	322	100.0	100.0	

Q1.1_recoded

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	29 or younger	104	32.3	32.3	32.3
	30 - 39	98	30.4	30.4	62.7
	40 - 49	57	17.7	17.7	80.4
	50 - 59	26	8.1	8.1	88.5
	60+	37	11.5	11.5	100.0
	Total	322	100.0	100.0	

Q2.1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	5	1.6	1.6	1.6
	2	55	17.1	17.1	18.6
	3	262	81.4	81.4	100.0
	Total	322	100.0	100.0	

Q2.1_recoded

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	55	17.1	17.4	17.4
	3	262	81.4	82.6	100.0
	Total	317	98.4	100.0	
Missing	System	5	1.6		

Total		322	100.0		
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Q2.5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	286	88.8	88.8	88.8
	2	36	11.2	11.2	100.0
	Total	322	100.0	100.0	

Q2.7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	280	87.0	87.0	87.0
	2	42	13.0	13.0	100.0
	Total	322	100.0	100.0	

Q2.8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	287	89.1	89.1	89.1
	2	35	10.9	10.9	100.0
	Total	322	100.0	100.0	

Q4.10

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	59	18.3	18.3	18.3
	2	72	22.4	22.4	40.7
	3	125	38.8	38.8	79.5
	4	18	5.6	5.6	85.1
	5	31	9.6	9.6	94.7
	6	17	5.3	5.3	100.0
	Total	322	100.0	100.0	

Q4.10_recode

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	59	18.3	18.3	18.3
	2	72	22.4	22.4	40.7
	3	125	38.8	38.8	79.5
	6	66	20.5	20.5	100.0
	Total	322	100.0	100.0	

ANNEXURE D

Crosstabs

Q1.1_recoded * Q2.3

Crosstab

			Q2.3		Total
			1	2	
Q1.1_recoded	29 or younger	Count	102	2	104
		% within Q1.1_recoded	98.1%	1.9%	100.0%
	30 - 39	Count	91	7	98
		% within Q1.1_recoded	92.9%	7.1%	100.0%
	40 - 49	Count	55	2	57
		% within Q1.1_recoded	96.5%	3.5%	100.0%
	50 - 59	Count	22	4	26
		% within Q1.1_recoded	84.6%	15.4%	100.0%
	60+	Count	29	8	37
		% within Q1.1_recoded	78.4%	21.6%	100.0%
Total		Count	299	23	322
		% within Q1.1_recoded	92.9%	7.1%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	19.764 ^a	4	.001
Likelihood Ratio	17.225	4	.002
Linear-by-Linear Association	12.959	1	.000
N of Valid Cases	322		

a. 3 cells (30.0%) have expected count less than 5. The minimum expected count is 1.86.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.248	.001
	Cramer's V	.248	.001
N of Valid Cases		322	

Q2.1_recoded * Q2.3

Crosstab

			Q2.3		Total
			1	2	
Q2.1_recoded	2	Count	44	11	55
		% within Q2.1_recoded	80.0%	20.0%	100.0%
	3	Count	251	11	262
		% within Q2.1_recoded	95.8%	4.2%	100.0%
Total		Count	295	22	317
		% within Q2.1_recoded	93.1%	6.9%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	17.574 ^a	1	.000		
Continuity Correction ^b	15.213	1	.000		
Likelihood Ratio	13.497	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	17.519	1	.000		
N of Valid Cases	317				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3.82.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	-.235	.000
	Cramer's V	.235	.000
N of Valid Cases		317	

Q2.5 * Q2.3

Crosstab

			Q2.3		Total
			1	2	
Q2.5	1	Count	280	6	286
		% within Q2.5	97.9%	2.1%	100.0%
	2	Count	19	17	36
		% within Q2.5	52.8%	47.2%	100.0%
Total		Count	299	23	322

% within Q2.5	92.9%	7.1%	100.0%
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Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	98.163 ^a	1	.000		
Continuity Correction ^b	91.477	1	.000		
Likelihood Ratio	57.674	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	97.858	1	.000		
N of Valid Cases	322				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.57.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.552	.000
	Cramer's V	.552	.000
N of Valid Cases		322	

Q2.7 * Q2.3

Crosstab

			Q2.3		Total
			1	2	
Q2.7	1	Count	274	6	280
		% within Q2.7	97.9%	2.1%	100.0%
	2	Count	25	17	42
		% within Q2.7	59.5%	40.5%	100.0%
Total	Count	299	23	322	
	% within Q2.7	92.9%	7.1%	100.0%	

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	80.913 ^a	1	.000		
Continuity Correction ^b	75.237	1	.000		

Likelihood Ratio	51.035	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	80.662	1	.000		
N of Valid Cases	322				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3.00.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.501	.000
	Cramer's V	.501	.000
N of Valid Cases		322	

Q2.8 * Q2.3

Crosstab

			Q2.3		Total
			1	2	
Q2.8	1	Count	279	8	287
		% within Q2.8	97.2%	2.8%	100.0%
	2	Count	20	15	35
		% within Q2.8	57.1%	42.9%	100.0%
Total	Count		299	23	322
	% within Q2.8		92.9%	7.1%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	75.516 ^a	1	.000		
Continuity Correction ^b	69.595	1	.000		
Likelihood Ratio	44.854	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	75.281	1	.000		
N of Valid Cases	322				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.50.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.484	.000
	Cramer's V	.484	.000
N of Valid Cases		322	

Q4.10_recode * Q2.3

Crosstab

			Q2.3		Total
			1	2	
Q4.10_recode	1	Count	52	7	59
		% within Q4.10_recode	88.1%	11.9%	100.0%
	2	Count	62	10	72
		% within Q4.10_recode	86.1%	13.9%	100.0%
	3	Count	124	1	125
		% within Q4.10_recode	99.2%	.8%	100.0%
	6	Count	61	5	66
		% within Q4.10_recode	92.4%	7.6%	100.0%
Total		Count	299	23	322
		% within Q4.10_recode	92.9%	7.1%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	14.524 ^a	3	.002
Likelihood Ratio	17.650	3	.001
Linear-by-Linear Association	1.527	1	.217
N of Valid Cases	322		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 4.21.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.212	.002
	Cramer's V	.212	.002
N of Valid Cases		322	

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