FRAMEWORK TOWARDS WATER-SENSITIVE SPATIAL PLANNING AND LAND USE MANAGEMENT

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Report to the

Water Research Commission

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The publication of this report emanates from a project entitled “Securing water sustainability through innovative spatial planning and land use management tools: Case study of two local municipalities in South Africa” (WRC Project No. K5/2587).

This report forms part of a series of two reports. The other report is titled “*Guidelines for compiling water-sensitive spatial plans* (**WRC Report no. TT 809/2/19**).

EXECUTIVE SUMMARY

BACKGROUND

Continents, countries, cities, towns and settlements, together the people living in them, experience different climates daily, relative to their location from the equator (Das & Abhyankar, 1953, p. 497). Societies have become accustomed to their unique climates and have structured their day-to-day lives around historical and current climatic conditions (Geng & Sugi, 2003, p. 2262). Observational climate records indicate that extreme climatic events have become a frequent reality on many parts of the globe (IPPC, 2014, p. 7). In addition to climate-related stresses, the United Nations' Department of Economic and Social Affairs (UN DESA, 2015, p. 2) predicts that global population figure will reach 9.7 billion by 2050, with most of the growth deemed to take place in Africa. Of the 9.7 billion people, over 70% (or 6.4 billion people) are predicted to reside in urban areas. The predicted increase in population will increase total water demand for adequate municipal, industrial and agricultural supply (Bradley et al., 2002). It is also anticipated that, for urban areas to accommodate this growth, urban space, which currently occupies 3% of global land cover, will need to double in developed countries and expand by 326% in developing countries (Angel et al., 2011).

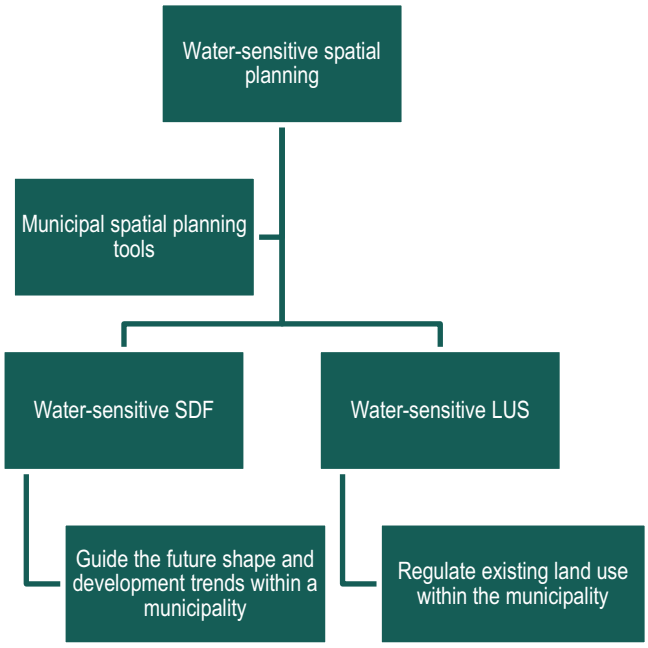
Everything society does, from its economy to its culture, depends – in part – on safe, stable access to water resources. Water sensitivity has gained global awareness as the risks associated with climate change, increasing resource demands due to population growth, and environmental degradation due to rapid urbanisation continue to escalate at an alarming rate. The Cooperative Research Centre for Water-sensitive Cities (CRCWSC) defines a water-sensitive city as a city that interacts with the urban hydrological cycle in ways that provide for water security, which is essential for economic prosperity, by efficiently using the diversity of water resources that are available, by enhancing and protecting the health of watercourses and wetlands, mitigating drought and flood risk, and creating public spaces that harvest, clean and recycle water. It is widely accepted that, in becoming a water-sensitive city, the process will involve a transition, driven by radical shifts in the structure, culture and practices that are currently locked into unsustainable development paths. In 2011, South Africa's Water Research Commission commenced with water sensitive-related research activities by soliciting research proposals aimed at guiding urban water management decision makers on the use of water-sensitive urban design (WSUD) within the South African context, specifically leading to the publication of "Water-sensitive urban design for South Africa: framework and guidelines" (Armitage et al., 2014). The framework states that water-sensitive settlements comprise three components: water-sensitive urban design, water-sensitive urban planning and water-sensitive urban management.

In 2016, the WRC embarked on a new research project to bring WSUD, as defined and envisioned by the framework and guideline document (Armitage et al., 2014), into an even larger municipal planning environment. This project (WRC Project No. K5/2587) is titled "Securing water sustainability through innovative spatial planning and land use management tools – case study of two local municipalities". This document is one component of the project.

OBJECTIVES

In June 2015, Parliament enacted a new planning legislation, the Spatial Planning and Land Use Management Act, Act No. 16 of 2013 (SPLUMA) (DRDLR, 2013). Today, this Act is South Africa's only framework act to regulate and guide spatial planning and land use management for the entire country. The Act mandates all local municipalities to develop and adopt a municipal Spatial Development Framework (SDF) and a municipal Land Use Scheme (LUS) for their entire municipal areas within five years of the enactment of SPLUMA. The municipal SDF and LUS are planning tools that are designed to guide the future shape of a municipality and to lawfully administer and regulate land use – both of which carry water-related implications.

To give effect to SPLUMA, and to achieve water sensitivity within the broader municipal planning environment, this project adopted new-term water-sensitive spatial planning (WSSP), which replaces water-sensitive urban planning (WSUP) as it relates to the entire municipal area (built up and natural environments), instead of just the urban environment. Water-sensitive spatial planning will therefore be achieved through two planning tools, which include the development and implementation of a water-sensitive SDF and a water-sensitive LUS.



The project aims to do the following:

- Establish a framework for WSSP in South Africa
- Carry out a hydro-socio and hydro-political literature review to understand the impact and relationship between national political development objectives and their impact on spatial planning and water resources planning and management
- Carry out a legislative and policy analysis to identify which strategic planning instruments can and must inform WSSP, down to municipal level
- Identify appropriate spatial data, resources and additional tools to assist spatial planners in developing water-sensitive SDFs and LUSs
- Conduct a case study analysis of two local municipalities to identify gaps and opportunities for WSSP in a typical South African local municipality
- Produce a guideline on how to develop and implement a municipal water-sensitive SDF and a municipal water-sensitive LUS within the legal framework of SPLUMA

The target audience intended for the use of this document includes the following:

- Municipal officials and/or consultants responsible for developing a municipal SDF and a municipal LUS as mandated by SPLUMA
- Municipal officials or authorities concerned with general spatial planning, water resources planning, environmental management and those responsible for developing SDFs, integrated development plans (IDPs), catchment management strategies (CMSs), water services development plans, environmental management plans (EMPs), bioregional plans, municipal asset management plans and other sector plans related to land and water resources planning, either in-house or outsourced to a service provider

- Property owners, community and business stakeholders within the selected study areas who have an interest in or are affected by an SDF or a municipal LUS
- Traditional leaders and community members who had previously been excluded from spatial planning and land use management

APPROACH

- The first section of this document includes a literature review that is aimed at illustrating and explaining South Africa's hydro-socio contract. The notion of a hydro-socio contract was first introduced by Turton and Ohlsson (1999) at the 9th Stockholm Water Symposium. Throughout our history (and at an ever-increasing tempo), the country has been relatively good at establishing policies and plans and creating various pieces of legislation aimed at addressing issues of national importance. More recently, access to an adequate supply of water has placed the national focus on water consumption and – more importantly – ways to curb consumption. Water is consumed by individuals and users of land (such as agriculture and industry). The provision of water, as well as the management of infrastructure, is most often the responsibility of local government, which is the same institution that is tasked with the management and approval of land uses. It is clear that, while many of the policies and legislation have been drafted at national level, it is most often local government that will have to implement these policies to ensure their eventual success.

- The second section investigates the relationship between development, water and the environment. People, land, water and the broader environment are all interdependent. Despite this close relationship, urban and regional (people and land) and environmental resource management (water and the broader environment) are typically governed by different sector departments, often to the detriment of sustainable development. Water is a renewable natural resource as it operates within a closed loop system called the hydrological cycle. In engineered environments like towns and cities, people have a significant influence on the local hydrological cycle by introducing artificial surfaces and man-made, engineered infrastructure that has had both a quantitative and a qualitative impact on water resources and the ecosystems that depend on them. Land-based activities are much to blame for the loss of the country's ecological infrastructure and the state of water resources. The physical development of land is inevitable, yet the degree of impact can be managed to some extent. Low density and sprawling development footprints are widely criticised for their environmental impact as they take up far more surface area than is actually needed and contribute to the fragmentation of landscapes. However, according to the South African National Biodiversity Assessment of 2011, the country's most important ecological infrastructure is often located within the broader rural areas where the allocation of land and the management of land use has been and still is "governed" by tribal chiefs, traditional authority or councils. The concerning status of freshwater ecosystems is not caused by land cover change alone, as the construction of hydrological control sources such as dams, weirs and large-scale water transfer schemes contributes to severe flow alterations in the form of over-abstraction, inter-basin transfers, and high return flows from urban areas. In South Africa, the major agricultural water uses include the irrigation of crops and water for the water-intensive grazing of livestock. Compared to other countries, the agricultural demand for water is generally higher in South Africa, due to the country's climate and soil characteristics, which are extremely vulnerable to degradation and have a low recovery potential. Thus, even the smallest mistakes in land management can be devastating, with little chance of recovery (Galdblatt, 2014, p. 7).

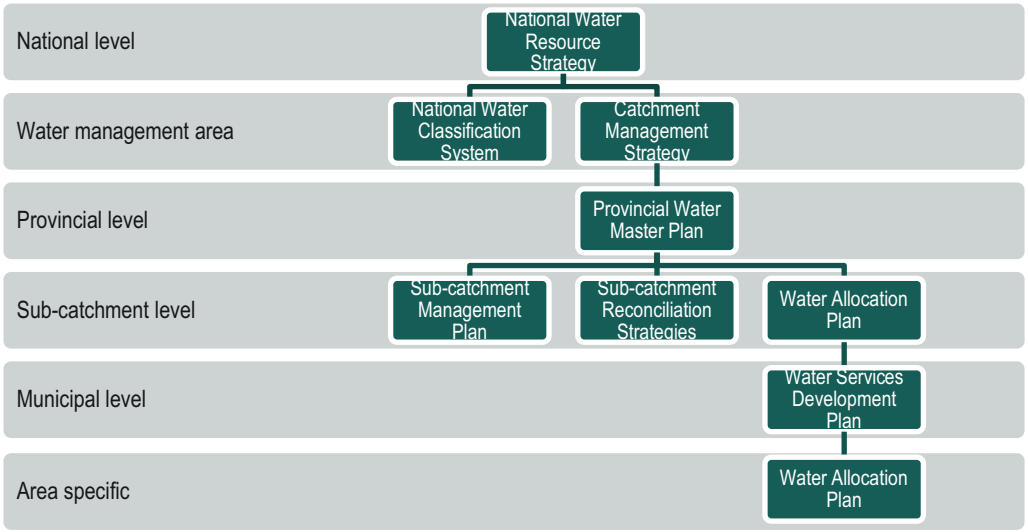
- The third section investigates the concept of water sensitivity, with specific reference to South Africa. The 21st century marks the first point in recorded history that the proportion of the world's population living in urban environments has surpassed those residing in the rural environment, making cities a critical focal point for realising sustainable practices (Brown et al., 2008, p. 1).

According to Cilliers and Cilliers (2016, p. 15), the close relationship between human and natural systems implies that cities and settlements cannot be sustainable or resilient until their dependence on ecosystem services has been recognised. The following “pillars of practice” for water-sensitive cities were identified from literature:

- **Cities as catchments:** By utilising water from various portfolios within the city, the city becomes the catchment, and less strain is placed on centralised water and wastewater treatment works, which also reduces energy demand.
- **Cities providing ecosystem services:** The value of urban open spaces and landscapes must be evaluated in terms of its “ecological functions”, which captures the essence of sustainable water management, microclimate influences, the facilitation of carbon sinks and water use for food production.
- **Cities as water-sensitive communities.** New technologies must be socially embedded into the local institutional context, otherwise their development in isolation will be insufficient to ensure their successful implementation in practice.

- “Water-sensitive urban design for South Africa: framework and guidelines” sets the foundation for future research that revolves around urban water management and policy development in the integration of water cycle management into planning and design for the growth and development of water-sensitive settlements in South Africa (Armitage et al., 2014, p. 1). According to Armitage et al. (2014, p. viii), “there is untapped potential for more extensive coordination which could be facilitated by the urban and strategic planning fora.” Information is still limited as to exactly how design and planning should engage with the concept of water-sensitive settlements, specifically within the South African context. Environmental management and improved land management practices are cross-cutting themes that also support the provision of green, resilient infrastructure and adaptation to climate change. Households, industries and other land use activities consume water. Any new development must be planned (according to exact standards) and approved by the applicable municipality. This approval takes both the location and the extent of the development into consideration.

- The fourth section provides more insight into strategic planning for land, water and environmental resources. This section identifies all legislative elements at various levels (national, provincial, municipal, catchment, etc.) that aim to protect or influence water and environmental resource planning. A summary of this legal framework pertaining to water resources is given below:



This section goes on to investigate the legal case for spatial planning in South Africa, which comprises the following interrelated processes:

- **Spatial planning,** which is the compilation of an initial plan or framework for future development. Known in South Africa as an SDF, this type of planning is more concerned with the future shape of cities and towns. “Forward planning is a future-oriented exercise. It is concerned with the long-term future of a large area and identifying opportunities for growth and development so that land can be managed in the best interests of the public” (Fiji Department of Town and Country Planning, 2015).
- **Land use management**, which is the administration and regulation of changes to the use of land as determined in the original plan. This type of planning seeks to manage the legality of existing land uses and buildings through tools such as zoning codes (also referred to as town planning schemes, zoning schemes and land use schemes in other parts of the world). This type of planning came about in the early part of the 1900s to separate living areas and neighbourhoods from the negative effects of residing close to job opportunities such as industries (Elliot, 2008).
- **Land development management,** which is the control of development that occurs after land use has been determined (Ahmad & Bajwa, 2005, p. 2).

The fifth section of this document applies the theory and research to two case studies: the Mogalakwena Local Municipality and the Lephalale Local Municipality. The aim of this section is to investigate the extent to which the municipalities’ existing spatial planning documents are “water sensitive”. The results of the empirical investigation will be discussed later in this executive summary.

The document concludes with a framework for water-sensitive spatial planning and land use management, which will be discussed in the policy actions section of this executive summary.

KEY FINDINGS

- Both case study areas typify those areas addressed within the current WSUD framework for South Africa, where the country’s urban water resources are managed through the integration of the various disciplines of engineering, social and environmental sciences, while acknowledging that South Africa is a water-scarce country; access to adequate potable water is a basic human right; the management of water should be based on a participatory approach; water should be recognised as an economic good; and water is a finite and vulnerable resource, which is essential to sustaining all life and supporting development and the environment at large. Both study areas are considered “arid”, and characterised by low rainfall, high temperatures and low surface water run-off. The populations of both study areas are generally poor and cannot afford to pay for basic services. Water use in these areas seems to be very high (especially in Lephalale). Water is also relatively cheap and does not appear to reflect the value of the resource. Even though the majority of households have access to water services infrastructure, this may not always be a reliable service.
- Both planning instruments (the SDF and the LUS) are required by law. Both these instruments are key policy instruments, which inform current and future development. The SDF provides an indication of what type of future development could occur in areas of the municipality, and is used in the adjudication of development applications. However, the LUS is the only planning tool that has the force of law and can therefore be used to declare development illegal or can be used to enforce certain conditions or requirements on the development before it takes place.
- In both cases, the SDF indicates in some measure where sensitive environmental areas are located. It is clear that the identification of these areas was more a factor of available data (at the time) than conscious thought as to the protection of all natural resources. In fact, more attention is given to the occurrence of mineral resources (coal in the case of Lephalale and gold in the case of Mogalakwena) than the occurrence and protection of water resources.

- While the SDFs quantify the extent of future development, they fall drastically short in considering the implications of future development on the availability and quality of water. It would seem as if there is a basic assumption that, no matter what type of development will occur in future, water will always be available to support this type of development.

- There is no alignment between the municipality's SDF and its Water Services Development Plan (WSDP). In fact, in both cases, there is no mention of the WSDP whatsoever. Furthermore, there is no mention of the SDF in either of the two municipalities' WSDPs. These documents must be aligned to ensure the adequate provision and protection of water resources and the sustainable delivery of water services.

- While both SDFs contain the words "sustainability" and "resilience" in their vision statements, only one of the documents provides any indication of how to achieve this. The Lephalale SDF Implementation Plan contains several actions for future consideration. Examples include the following:

    - Reduce loss of biodiversity and protect ecological areas as part of the municipal LUS
    - Develop a municipal Invasive Alien Plant Control Management Plan, which monitors the performance and change actions as necessary
    - Appoint a service provider to develop a Lephalale Urban Design Plan, which focuses on the integration of urban blue-green corridors, WSUD and city beautification
    - Regulate and promote efficient building design and construction

- There is no alignment between the national SDF and the municipal SDFs. This is obvious since the National Spatial Development Framework (NSDF) was completed after the municipal SDFs. Future iterations of the municipal SDFs must take their cue from the NSDF and incorporate sections on climate change and water dependence.

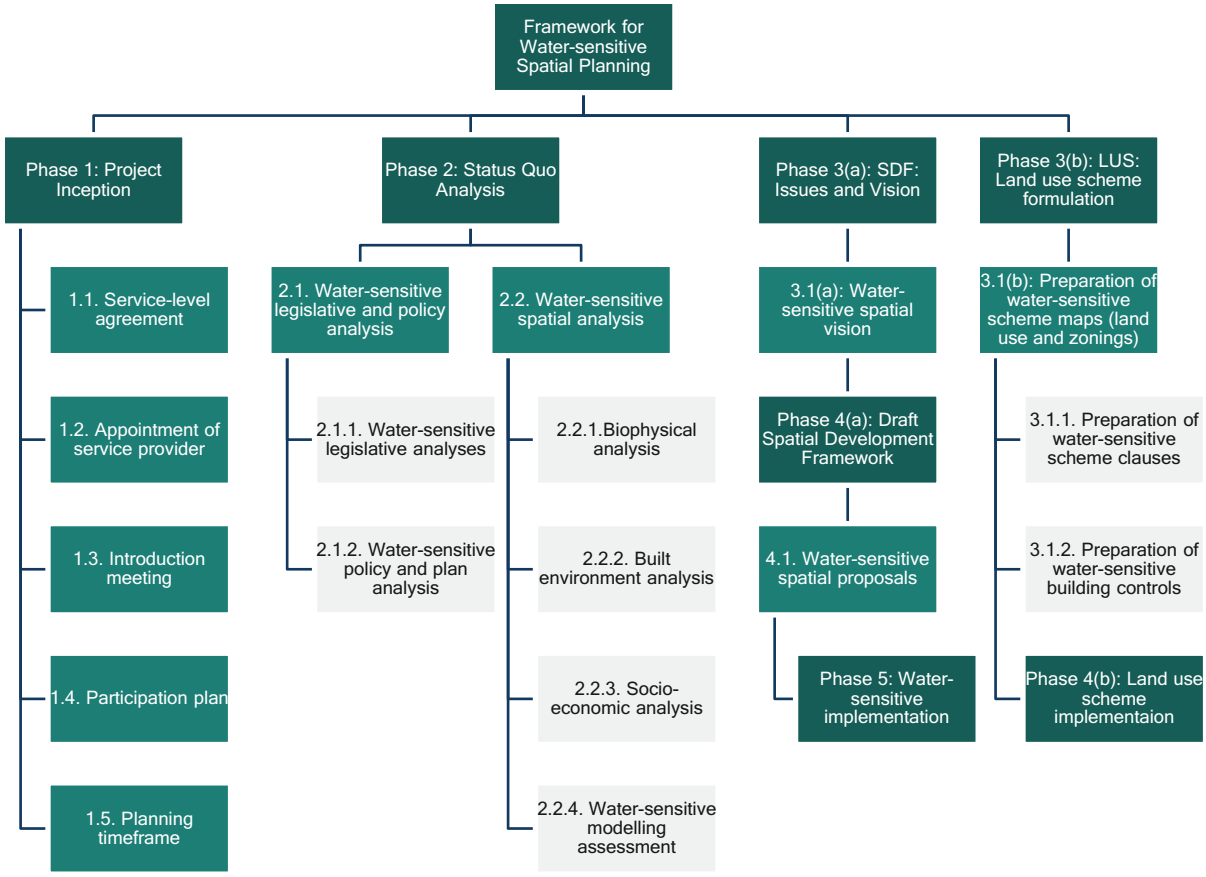
- Both LUSs are completely ignorant of water sensitivity. Water-sensitive areas such as freshwater ecosystem priority areas (FEPAs) and groundwater recharge zones often occur in the rural hinterland of the municipality. Most often these areas are zoned as "agriculture" without even considering whether they should be used for agricultural activities, or what the impact of these activities would be.

- It is clear that town and regional planners (as the authors of the SDF and LUS) do not have the skills set to deal with issues related to water sensitivity. This is often seen as either an "environmental" subject or an "engineering" one. Skills development in this area is a necessity if water sensitivity is to be considered in these planning instruments.

POLICY ACTIONS

The purpose of this document is to provide a broad framework that can be used to include and address water sensitivity in municipal planning documents. The framework relies on the typical approach taken by town planners (as well as the framework and guidelines prescribed by the Department of Rural Development and Land Reform) and adds additional objectives, actions and outcomes that will ensure that water sensitivity is addressed in the spatial planning documents of a municipality.

A diagram of the framework is shown below:


Framework for Water-sensitive Spatial Planning
Phase 1: Project Inception
1.1. Service-level agreement
1.2. Appointment of service provider
1.3. Introduction meeting
1.4. Participation plan
1.5. Planning timeframe
Phase 2: Status Quo Analysis
2.1. Water-sensitive legislative and policy analysis
2.1.1. Water-sensitive legislative analyses
2.1.2. Water-sensitive policy and plan analysis
2.2. Water-sensitive spatial analysis
2.2.1.Biophysical analysis
2.2.2. Built environment analysis
2.2.3. Socio-economic analysis
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Phase 3(a): SDF: Issues and Vision
3.1(a): Water-sensitive spatial vision
Phase 4(a): Draft Spatial Development Framework
4.1. Water-sensitive spatial proposals
Phase 5: Water-sensitive implementation
Phase 3(b): LUS: Land use scheme formulation
3.1(b): Preparation of water-sensitive scheme maps (land use and zonings)
3.1.1. Preparation of water-sensitive scheme clauses
3.1.2. Preparation of water-sensitive building controls
Phase 4(b): Land use scheme implementaion

More detail on the framework is contained in the following table:

Phase	Water-sensitive objectives	Water-sensitive outcome
Phase 1: Project Inception		
1.1. Service-level agreement 1.2. Appointment of service provider	Most municipalities appoint private sector service providers to compile the spatial planning documents required by law using an open tender process. Most often the professional team requirements for a service provider are only a registered professional town and regional planner. Water-sensitive planning requires additional input, e.g. a certified water efficiency professional or a civil engineer who specialises in water and sanitation. A major skills requirement is also a Geographic Information Systems (GIS) specialist to assist in the modelling of spatial data.	A professional service provider with the necessary skills and competencies to ensure that planning documents adhere to water-sensitive guidelines.
1.3. Introduction meeting	The introduction meeting is set to be the first engagement between the municipality's project coordinator and the service provider. This meeting also presents an opportunity for the service provider, together with the municipal or district project coordinator, to discuss possible stakeholders to be invited to the inception meeting. During this meeting, the water-sensitive spatial planning framework must be introduced to the service provider to ensure that the framework is used during the process of compiling an SDF and LUS that address water sensitivity. This meeting should also be used as an opportunity for the project coordinator to share existing documents and data applicable to the project.	A professional service provider and project owner who are aware of the objectives of water-sensitive SDFs and LUSs, capacitated with a framework and guideline to influence normal planning methodology.
1.4. Participation plan	Different forms of participation occur during the planning process. Firstly, a steering committee must also include representatives of water services authorities, as well as the Department of Water and Sanitation (DWS). Secondly, the plan should make provision for consultation with water sector professionals to ensure that other sectors are presented with the proposals and have time to provide input into the process. Lastly, even though it is the responsibility of the Municipal Council to approve and adopt the LUS and SDF, it would be good practice to also have the water services authority (if not the municipality), as well as the DWS, sign off on the final plan.	A plan that will also ensure the water sector ample opportunity to do the following: • Provide input into the process • Share documents, policies and plans • Have the opportunity to approve the plan and ensure alignment with other water sector policies and plans
Phase 2: Status Quo Analysis		
2.1.1. Water-sensitive legislative analyses	The aim of this phase is to establish a baseline legal and institutional framework for the planning and management of land, water and environmental resources.	Identified legislation (inclusive of water and environmental legislation) that will ensure alignment (and therefore compliance) of the municipality's spatial planning documents with the legislation.
2.1.2. Water-sensitive policy and plan analysis	The objectives of a water-sensitive policy analysis are to do the following: • Identify development principles and strategies, regulations, norms and standards, visions and goals, and, if available, development targets and other collaborative development initiatives by outlining the key spatial informants or directives. • Strengthen the inter-governmental alignment of development priorities and ensure that the plans and programmes are coordinated, consistent and in harmony with each other. • Act as a platform for stakeholder identification.	Identified policies that can be included or will impact on the compilation of a water-sensitive SDF and LUS. Furthermore, a gap analysis on where policies may differ, and a plan on how to ensure alignment.

Phase	Water-sensitive objectives	Water-sensitive outcome
2.2.1. Biophysical analysis	The objective of a water-sensitive biophysical analysis is to limit the expansion of the built footprint onto areas of ecological importance, and to protect and expand ecological infrastructure and restore ecological functionality, specifically in FEPAs. The aims of a water-sensitive biophysical analysis are to do the following: • Determine the climate, hydrological and geological characteristics of the municipality. • Determine areas of ecological significance. • Determine spatial areas with groundwater resources of a high value.	Spatially identified areas of ecological importance, as well as areas that require protection in order to ensure the security and quality of water over time. This analysis should result in GIS layers that can be used to inform the later stages of the SDF and the LUS.
2.2.2. Built environment analysis	Land use has both a water resource quality and quantity impact and should be planned for. Like the critical biodiversity areas (CBAs) and ecological support areas (ESAs), natural and near-natural landscapes provide ecosystem services that are vital to the local hydrological cycle as it regulates the flow, encourages infiltration and purifies water. The objective of the built environment analysis is to determine which areas within the municipality are still in a natural or near-natural condition and how much of the municipality's surface areas have been transformed to accommodate desired anthropogenic land uses.	A GIS dataset identifying, among others, areas in a natural or near-natural state, which provide ecosystem services, which should be protected in the SDF and LUS.
2.2.3. Socio-economic analysis	The socio-economic analysis strongly relates to the ability of the biophysical and built environment to provide services to the municipalities' residents and economic sectors. The socio-economic analysis makes use of statistical information to count the number of households, as well as businesses, industries and institutions.	A base profile of the number of consumers (of water) in the municipality, together with attributes describing their characteristics, which can be used to express current water consumption, as well as predicted future water demand.
2.2.4. Water-sensitive modelling assessment	Water-sensitive modelling uses all information collected above in order to do the following: • Determine areas of environmental conflict. • Determine potential areas that can be used to expand protected areas. • Determine surface water protection and conservation zones. • Determine groundwater protection and conservation zones. • Delineate blue-green corridors. • Determine current and future water demand patterns and potential for rainwater harvesting.	• A detailed analysis and key datasets that must be used to inform the SDF (and form part of the final SDF). • Detailed GIS datasets that will provide the basis of an overlay zone that will be used in the LUS in order to protect sensitive areas and keep development away from areas under pressure (or limit it).
Phase 3(a): SDF: Issues and Vision		
3.1(a): Water-sensitive spatial vision	The key objective (with regard to water sensitivity) as far as the spatial vision of the SDF is concerned, is to ensure that water sensitivity is, in some way or form, entrenched in the spatial vision of the SDF. Most often, it is not. At best, some aspects related to "sustainability" can be found in the vision statements.	A spatial vision statement that incorporates water sensitivity that will guide the development of the SDF.
Phase 4(a): Draft Spatial Development Framework		
4.1. Water-sensitive spatial proposals	The objectives of water-sensitive spatial proposals are to do the following: • Improve water quality: reduce sprawl and rapid land cover change, which in turn reduces the rate and volume of stormwater runoff. This reduces stormwater pollution and increased groundwater recharge.	Water-sensitive input into spatial proposals, which will form the municipality's adopted SDF.

Phase	Water-sensitive objectives	Water-sensitive outcome
	Water quality, as well as surrounding ecosystems, is likely to improve as more water is available to infiltrate into surrounding areas, instead of feeding built infrastructure. • Mitigate water scarcity by limiting the extent or directing it where development can take place. A compact settlement form can be achieved through spatial growth management tools.	
Phase 5: Water-sensitive SDF implementation		
Phase 5: Water-sensitive implementation and monitoring	The municipality's SDF must be reviewed at least every five years. It should also contain an implementation plan that includes projects and research (inclusive of budgets and responsibilities). A water-sensitive SDF should identify projects, research and responsible sectors to ensure that the SDF is implemented, and improved on every five-year cycle.	• A water-sensitive implementation plan that identifies water-sensitive projects and plans. • Gaps or future research required to improve on the SDF in the next five-year cycle.
Phase 3(b): LUS: Land use scheme formulation		
3.1.1. Preparation of water-sensitive scheme clauses	From a water-sensitivity perspective, additional areas may require some form of protection, more than most land use schemes currently offer. These areas may not necessarily be declared "protected areas" and, as such, may in fact be included under the agricultural zoning with no regard to water sensitivity. Water-sensitive scheme clauses aim to do the following: • Establish overlay zones that identify areas that require immediate intervention in order to protect them from harmful development activities. • Establish overlay zones that identify areas of future concern where development should be prohibited or limited. • Establish water-sensitive development controls that promote rainwater harvesting and prevent stormwater runoff that could be used at the source to limit excessive water consumption (e.g. permeability).	Water-sensitive scheme clauses (including overlay zones and development controls) that can be legally enforced to ensure the protection of water resources and limit the water consumption footprint of future development.
3.1.2. Preparation of water-sensitive building controls	At the time of writing, no national standard for water efficiency in buildings could be found. The LUS could be used to bridge this gap until such time as water efficiency is similarly dealt with. This would imply that a specific chapter (or clause) be added to the LUS specifically dealing with water efficiency in buildings.	• Water-sensitive building controls that can be legally enforced to limit the water consumption footprint of future development.

CONCLUSION

South Africans only recently woke up to the fact that we all stay in a relatively dry country. All indicators point to the fact that we can expect temperatures to rise because of global warming. At the same time, the population and corresponding water demand grow every day. Linked to rapid urbanisation, we can expect populated areas and cities to increasingly experience pressure to ensure reliable and safe water for its citizens and consumers. Planning for water and spatial planning have existed side by side for many years. To date, these two disciplines (although water is a key requirement of all development) fail to inform each other on a municipal scale. This framework attempts to link planning for water and spatial planning in a way that can inform the legal and policy documents of municipalities that must be compiled, implemented and monitored. If successfully implemented, this framework could be the start to ensure water sustainability in future.

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The research group responsible for the project consisted of the following persons:

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DEFINITIONS

Agricultural land, as defined in the Draft Policy on the Preservation and Development of Agricultural Land (DAFF, 2016), means any land that is or may be used to produce biomass that provides food, fodder, fibre, fuel, timber and other biotic material for human use, either directly or through animal husbandry, including aquaculture and inland and coastal fisheries, or for any other agricultural purpose, excluding land which the Minister, after consultation with other relevant ministers and Members of the Executive Committee (MECs) concerned, excludes by means of a notice in the Government Gazette.

Aquifer, as defined in the National Water Act, Act No. 36 of 1998 (Republic of South Africa, 1998a), means a geographical formation that has structures or textures that hold water or permit appreciable water movement through them.

Biodiversity/biological diversity, as defined in the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a), means variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part, and includes diversity within species, between species and of ecosystems.

Biodiversity management plan means a biodiversity management plan as required in terms of the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a).

Bioregion means a geographic region that has been determined a bioregion in terms of Section 40(1) of the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a).

Bioregional plan means a bioregional plan as required in terms of the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a).

Buffer means a strip of land surrounding a wetland or riparian area in which activities are controlled or restricted to reduce the impact of adjacent land uses on the wetland or riparian area as defined in the publication of the Department of Water Affairs and Forestry (DWAF), “A practical field procedure for identification and delineation of wetland and riparian areas” (DWAF, n.d.).

Catchment management strategy means a catchment management strategy as mentioned in the National Water Act, Act No. 36 of 1998 (Republic of South Africa, 1998a).

Catchment means the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse through surface flow to a common point or common points as defined in the National Water Act, Act No. 36 of 1998 (Republic of South Africa, 1998a).

Catchment management agency means a water management institution that is a statutory body governed by a board representing the interests of users, local and provincial government, and environmental interest groups. It manages all water resources within a defined water management area as described in the WRC’s “Implementation Manual for Freshwater Ecosystem Priority Areas” (WRC, 2011).

Channel means an excavated hollow bed for running water or an artificial underwater depression to make a water body navigable in a natural watercourse, river or the sea, as defined in the National Environmental Management Act, Act No. 107 of 1998 (Republic of South Africa, 1998b).

Communal land means land that is or is to be occupied or used by members of a community subject to the rules or custom of that community as defined in Section 4 of the Communal Land Rights Act, Act No. 11 of 2004 (Republic of South Africa, 2004b).

Community means a group of persons whose rights to land are derived from shared rules determining access to land held in common by such group as defined in the Communal Land Rights Act, Act No. 11 of 2004 (Republic of South Africa, 2004b).

Corridors are links between nodes, along which an increased intensity of development may be encouraged. Corridors provide efficient access to a higher level of economic opportunities than would generally be the case in a less structured space. They typically include public transport routes as defined in the "Guidelines for the Development of Municipal Spatial Development Frameworks" of the Department of Rural Development and Land Reform (DRDLR) (2011).

Critical biodiversity areas are areas that are required to meet quantitative targets for biodiversity, as determined by an integrated terrestrial and aquatic systematic biodiversity plan, and defined in the WRC's "Atlas of Freshwater Ecosystem Priority Areas in South Africa" (Nel et al., 2011). These areas are critical for conserving biodiversity and maintaining ecosystem functioning in the long term. These areas differ from FEPAs in that they are usually determined at a finer, subnational scale and integrate terrestrial and aquatic priority areas.

Critical endangered ecosystems are ecosystems that have undergone severe degradation of ecological structure, function or composition as a result of human intervention and are subject to an extremely high risk of irreversible transformation in terms of Section 52(2) of the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a).

Critical endangered species are any indigenous species that faces a high risk of extinction in the wild in the near future, although they are not a critically endangered species as per Section 56(b) of the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a).

Dam means any barrier dam or any other form of impoundment used for the storage of water as defined in the National Environmental Management Act, Act No. No. 107 of 1998 (Republic of South Africa, 1998b) and the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a).

Densification means the increased use of space both horizontally and vertically within existing areas, properties and new developments, accompanied by an increased number of units and/or population threshold, as defined in the Western Cape Provincial Spatial Development Framework (Western Cape Government, 2014).

Density is defined as the number of units (e.g. people, dwelling units or floor area) per unit of land area, e.g. dwelling units per hectare.

Ecological infrastructure refers to naturally functioning ecosystems that deliver valuable services to people, such as healthy mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitats, which together form a network of interconnected structural elements in the landscape. Ecological infrastructure is therefore the asset, or stock, from which a range of valuable services flow, as defined in the publication of the South African National Biodiversity Institute (SANBI), "A framework for investing in ecological infrastructure in South Africa" (SANBI, 2014a).

Ecological support areas are areas that play a significant role in supporting the ecological functioning of critical biodiversity areas and/or delivering ecosystem services as determined in a systematic biodiversity plan, as defined in the WRC's "Atlas of Freshwater Ecosystem Priority Areas in South Africa" (Nel et al., 2011).

Ecosystem, as defined in the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a), means a dynamic system of plant, animal and micro-organism communities and their non-living environment, which interact as a functional unit.

Ecosystem services are the benefits that people obtain from ecosystems, including provisioning services (such as food, water and reeds), regulating services (such as flood control), cultural services (such as recreational fishing) and supporting services (such as nutrient cycling and carbon storage) that maintain the conditions for life on earth, as defined in the WRC's "Atlas of Freshwater Ecosystem Priority Areas in South Africa" (Nel et al., 2011).

Environmental impact assessment (EIA) is a project-specific process that looks at how a proposed development might impact on the environment, and how those impacts might be mitigated. The EIA is an extremely important and useful tool in South Africa, and is the primary legislative check on most forms of development: a check that allows for the shaping of the development to be more environmentally acceptable. The completion of an EIA is a legal requirement for many types of development projects, including all forms of land transformation, such as the conversion of natural veld to agriculture or forestry. The Department of Environment Affairs (DEA) has the statutory authority to apply EIAs to all development, through the National Environmental Management Act (NEMA), as defined in DWAF's "Guidelines for Catchment Management Strategies" (DWAF, 2007a).

Environmental management framework is the study of the biophysical and socio-cultural systems of a geographically defined area to reveal where specific land uses may best be practiced and to offer performance standards for maintaining appropriate use of such land, as defined in DEA's "Environmental Management Framework Regulations: Integrated Environmental Management Guideline Series" (DEA, 2010).

Environmental management plan is an implementation plan, as referred to in Section 11 of the National Environmental Management Act, Act No. 107 of 1998 (Republic of South Africa, 1998b).

Environmental sustainability means meeting the needs of the present without compromising the ability of future generations to meet their needs, as defined in DWAF's "Guidelines for Catchment Management Strategies" (DWAF, 2007a).

Floodplain, as defined in DWAF's publication, "A practical field procedure for identification and delineation of wetlands and riparian areas" (DWAF, n.d.), means a relatively level alluvial (sand or gravel) area lying adjacent to the river channel, which has been constructed by the present river in its existing regime.

Freshwater ecosystems, as defined in the WRC's "Atlas of Freshwater Ecosystem Priority Areas in South Africa" (Nel et al., 2011), are all inland water bodies, whether fresh or saline, including rivers, lakes, wetlands, subsurface waters and estuaries. The incorporation of groundwater considerations into the FEPA maps was rudimentary, and future refinement of FEPAs should seek to include groundwater more explicitly.

Groundwater means subsurface water in the saturated zone below the water table, as defined in DWAF's publication, "A practical field procedure for identification and delineation of wetlands and riparian areas" (DWAF, n.d.).

Hydrology means the study of the occurrence, distribution and movement of water over, on and under the land surface, as defined in DWAF's publication, "A practical field procedure for identification and delineation of wetlands and riparian areas" (DWAF, n.d.).

Infill development means development on vacant or under-utilised land within existing settlements to optimise the use of infrastructure, increase urban densities and promote integration, as defined in DRDLR's "Guidelines for the development of Municipal Spatial Development Frameworks" (DRDLR, 2011).

Integrated development plan means a plan as envisaged by Section 25 of the Municipal Systems Act, Act No. 32 of 2000 (Republic of South Africa, 2000).

Integrated water resource management recognises the linkages between water and land, between upstream and downstream areas of a catchment, and between socio-economic, political and environmental factors, as defined in DWAF's publication, "Guidelines for Catchment Management Strategies" (DWAF, 2007a).

Integrated water resources management plan is a proposed plan for local government aimed at dealing with the socio-economic, technical, financial, institutional, political and environmental issues as they pertain to management of the water resource. The plan also serves as a framework to ensure the efficient, appropriate, affordable, economical and sustainable use and development of water resources, and includes the management of waste that has the potential to impact on the water resource, as defined in DWAF's publication, "Guidelines for Catchment Management Strategies" (DWAF, 2007a).

Invasive species is any species that is established and spreads outside its natural distribution range.

Land development means the erection of buildings or structures on land or the change of use of land, including township establishment, the subdivision or consolidation of land or any deviation from the land use or uses permitted in terms of an applicable land use scheme as defined in the Spatial Planning and Land Use Management Act, Act No. 16 of 2013 (DRDLR, 2013).

Land means any erf, agricultural holding or farm portion, and includes any improvement or building on the land and any real right in the land as referred to in the Spatial Planning and Land Use Management Act, Act No. 16 of 2013 (DRDLR, 2013).

Land use management means establishing or implementing any measure to regulate the use or a change in the form or function of land, and includes land development as defined by the Land Use Management Bill, 2008 (Republic of South Africa, 2008).

Land use management system means the system of regulating and managing land use and conferring land use rights using schemes and land development procedures as defined in the Spatial Planning and Land Use Management Act, Act No. 16 of 2013 (DRDLR, 2013).

Land use means the purpose for which land is or may be used lawfully in terms of a land use scheme, existing scheme or in terms of any other authorisation, permit or consent issued by a competent authority, and includes any conditions related to such land use purposes as defined in the Spatial Planning and Land Use Management Act, Act No. 16 of 2013 (DRDLR, 2013).

Land use scheme means the documents referred to in Section 24 of the Spatial Planning and Land Use Management Act, Act No. 16 of 2013 (DRDLR, 2013) for the regulation of land use.

Management zones refer to a specific demarcated geographical area, represented spatially on a map illustrating a specific sensitive feature that needs to be managed in a proactive and dedicated way as defined in the DEA's "Environmental Management Framework Regulations: Integrated Environmental Management Guideline Series" (DEA, 2010).

Mining operation means any operation relating to the act of mining and matters directly incidental to it, as defined in the Mineral and Petroleum Resources Development Act, Act No. 28 of 2002 (Republic of South Africa, 2002a).

Mining permit means a permit issued in terms of Section 27(6) of the Mineral and Petroleum Resources Development Act, Act No. 28 of 2002 (Republic of South Africa, 2002a).

Mining right means a right to mine granted in terms of Section 23(1) of the Mineral and Petroleum Resources Development Act, Act No. 28 of 2002 (Republic of South Africa, 2002a).

Municipal council means a municipal council as referred to in Section 157(1) of the Constitution of the Republic of South Africa, Act No. 108 of 1996 (Republic of South Africa, 1996).

Municipality means a municipality as described in Section 2 of the Municipal Systems Act, Act No. 32 of 2000 (Republic of South Africa, 2000).

National biodiversity framework is a requirement in terms of the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a).

National development plan is a proposed multidimensional framework to bring about a virtuous cycle of development with progress in one area supporting advances in others, as defined in the National Development Plan 2030 (National Planning Commission, 2011).

Node means areas where a higher density of land uses and activities are supported and promoted. Typically, any given municipal area would accommodate a hierarchy of nodes that indicate the relative intensity of development anticipated for the various nodes, their varying sizes, and their dominant nature, as defined in the DRDLR's "Guidelines for the development of Municipal Spatial Development Frameworks" (DRDLR, 2011).

Protected ecosystem means any ecosystem listed as a protected ecosystem in terms of Section 52(2) of the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a).

Reserve refers to water quality and quantity for two components: water for basic human needs, known as the basic human needs reserve, and water to maintain aquatic ecosystems, known as the ecological reserve. The basic human needs reserve provides for the essential needs of individuals served by the water resource in question and includes water for drinking, for food preparation and for personal hygiene. The ecological reserve is captured through reserve determinations. The reserve refers to both the quantity and quality of the water in the resource and will vary depending on the class of the resource. The reserve, as defined in the WRC's "Implementation Manual for Freshwater Ecosystem Priority Areas" (WRC, 2011), is the only right to water use in the National Water Act, and water must be assigned to meet the requirements of the reserve before it can be allocated to other uses. As such, a reserve must be determined before any water use can be authorised. A preliminary reserve can be determined before a comprehensive reserve determination.

Resource quality, as defined in DWAF's "Guidelines for Catchment Management Strategies" (DWAF, 2007a), refers to all aspects of the water resource, including the water quantity, water quality, character and condition of in-stream and riparian habitats and characteristics, as well as the condition and distribution of the aquatic biota.

Rural areas, as defined in the DRDLR's "Guidelines for the development of Municipal Spatial Development Frameworks" (DRDLR, 2011), are areas outside urban settlements where population densities are less than 150 people per km^2 and dwelling densities are less than one dwelling unit per hectare.

Rural development, as defined in the DRDLR's "Guidelines for the development of Municipal Spatial Development Frameworks" (DRDLR, 2011), generally includes primary economic activities, agriculture, agro-processing, mining, tourism, resource extraction, water and energy.

Sector plans, as defined in the DRDLR's "Guidelines for the development of Municipal Spatial Development Frameworks" (DRDLR, 2011), means municipal plans for different functions, such as biodiversity conservation, housing, transport, local economic development and disaster management. They may also be geographically based, for example a subregion, settlement within a local municipality or a component of a settlement.

Spatial development framework is a framework for spatial development as defined in Section 12 of the Spatial Planning and Land Use Management Act, Act No. 16 of 2013 (DRDLR, 2013).

Spatial planning is a planning process that is inherently integrative and strategic, considers a wide range of factors and concerns, and addresses how those aspects should be arranged on the land, as defined in the White Paper on Spatial Planning and Land Use Management (Republic of South Africa, 2001).

Strategic conservation planning, as defined in DWAF's "Guidelines for Catchment Management Strategies" (DWAF, 2007a), deals with the prioritisation of freshwater resources, its status and threats. It is already being used by various provinces on a sub-catchment basis (5,000 ha or less).

Strategic environmental management planning (SEMP), as defined in DWAF's "Guidelines for Catchment Management Strategies" (DWAF, 2007a), is a strategic plan, generally undertaken at the scale of the province. The SEMP is also an important tool in providing the overarching environmental management system for development clusters or nodes. For example, an SEMP would provide the environmental limits and guidelines for the establishment of an industrial park in which various different companies may be involved.

Sustainable development, as defined in the WRC's "Atlas of Freshwater Ecosystem Priority Areas in South Africa" (Nel et al., 2011), is development that serves the needs of both present and future generations equitably. It involves the integration of social, economic and ecological factors into planning, implementation and decision making.

Township, as defined in the Spatial Planning and Land Use Management Act, Act No. 16 of 2013 (DRDLR, 2013), means an area of land divided into erven, and may include public places and roads indicated as such on a general plan.

Traditional council means a traditional council established in terms of Section 3 of the Traditional Leadership and Governance Act, Act No. 41 of 2003 (Republic of South Africa, 2003).

Traditional leadership means the customary institutions or structures, or customary systems or procedures of governance, recognised, utilised or practised by traditional communities, as defined in the Traditional Leadership and Governance Act, Act No. 41 of 2003 (Republic of South Africa, 2003).

Urban area means areas situated within the urban edge (as defined or adopted by the competent authority), or in instances where no urban edge or boundary has been defined or adopted, areas situated within the edge of built-up areas, as defined in the National Environmental Management Act, Act No. 107 of 1998 (Republic of South Africa, 1998b).

Urban edge management zone means a zone or buffer area on either side of the urban edge, where land uses are to be managed to protect the integrity of the urban edge line, as defined in the Western Cape Provincial Spatial Development Framework (Western Cape Government, 2014).

Urban sprawl means the expansion of urban areas across the landscape and the conversion of forested, wetland and agricultural areas to urban areas. Urban sprawl includes the expansion of major roadways, not only housing and commercial areas. It is usually associated with increased automobile usage, water and air pollution, under-utilisation of infrastructure and land use segregation, as defined

in the DRDLR's "Guidelines for the development of Municipal Spatial Development Frameworks" (DRDLR, 2011).

Vulnerable ecosystem means any ecosystem listed as a vulnerable ecosystem in terms of Section 52(2) of the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a).

Vulnerable species means any indigenous species listed as a vulnerable species in terms of Section 56 of the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (Republic of South Africa, 2004a).

Water conservation and water demand management, as defined in DWAF's "Guidelines for Catchment Management Strategies (DWAF, 2007a), is an approach in water resource management that seeks to improve water use efficiency by using available water more wisely and seeking appropriate and cost-effective technologies that reduce wasteful use. Water demand management encourages efficient use by encouraging users to reduce their demands on the resource.

Water management area, as defined in the National Water Act, Act No. 36 of 1998 (Republic of South Africa, 1998a), is an area established as a management unit in the National Water Resource Strategy within which a catchment management agency will conduct the protection, use, development, conservation, management and control of water resources.

Water quality, as defined in DWAF's "Guidelines for Catchment Management Strategies" (DWAF, 2007a), is the physical, chemical, toxicological, biological (including microbiological) and aesthetic properties of water that determine sustained healthy functioning of aquatic ecosystems and fitness for use (e.g. domestic, recreational, agricultural and industrial use). Water quality is therefore reflected in concentrations or loads of substances (either dissolved or suspended) or micro-organisms, physico-chemical attributes (e.g. temperature) and certain biological responses to those concentrations, loads or physico-chemical attributes.

Water security is defined by Grey and Sadoff (2007) as the reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risk.

Water services means water supply services and sanitation services, as defined in the National Water Services Act, Act No. 108 of 1997 (Republic of South Africa, 1997).

Water services authority means any municipality, including a district or rural council, as defined in the Local Government Transition Act, Act No. 209 of 1993 (Republic of South Africa, 1993a), responsible for ensuring access to water services, as defined in the National Water Services Act, Act No. 108 of 1997 (Republic of South Africa, 1997).

Water services provider means any person who provides water services to consumers or to another water services institution, but does not include a water services intermediary as defined in the National Water Services Act, Act No. 108 of 1997 (Republic of South Africa, 1997).

Wetland, as defined in the National Water Act, Act No. 36 of 1998 (Republic of South Africa, 1998a), means land that is transitional between terrestrial and aquatic systems where the water table is usually on the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

Zone means a defined category of land use that is shown on the zoning map of a land use scheme as defined in the Spatial Planning and Land Use Management Act, Act No. 16 of 2013 (DRDLR, 2013).

ABBREVIATIONS

ANC	African National Congress
ARC	Agricultural Research Council
AsgiSA	Accelerated and Shared Growth Initiative for South Africa
ATS	All Towns Study
BMP	Biodiversity Management Plan
BNG	Breaking New Ground
CBA	Critical Biodiversity Areas
CEIMP	Consolidated Environmental Implementation and Management Plan
CMA	Catchment Management Agency
CMIP	Consolidated Municipal Infrastructure Programme
CMS	Catchment Management Strategy
CoGTA	Co-operative Governance and Traditional Affairs
CRCWSC	Cooperative Research Centre for Water-sensitive Cities
CRDP	Comprehensive Rural Development Programme
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEAT	Department of Environmental Affairs and Tourism
DFA	Development Facilitation Act
DHS	Department of Human Settlements
DoH	Department of Housing
DPLG	Department of Provincial and Local Government
DPME	Department of Planning, Monitoring and Evaluation
DRDLR	Department of Rural Development and Land Reform
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
EIP	Environmental Implementation Plan

EMF	Environmental Management Framework
EMP	Environmental Management Plan
ESA	Ecological Support Area
ESER	Ecological Socio-economic Relationship
FBS	Free Basic Service
FEPA	Freshwater Ecosystem Priority Area
GEAR	Growth, Employment and Redistribution
GHG	Greenhouse Gas
GIS	Geographic Information System
GWP	Global Water Partnership
IDP	Integrated Development Plan
IPCC	Intergovernmental Panel on Climate Change
ISRDP	Integrated Sustainable Rural Development Plan
ISRDS	Integrated Sustainable Rural Development Strategy
IWRM	Integrated Water Resource Management
LTAS	Long-term Adaption Scenarios
LUS	Land Use Scheme
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MDG	Millennium Development Goal
MEC	Member of the Executive Committee
MTSF	Medium-term Strategic Framework
NBF	National Biodiversity Framework
NBSAP	National Biodiversity Strategy and Action Plan
NCCRS	National Climate Change Response Strategy
NDP	National Development Plan
NEMA	National Environmental Management Act
NEMBA	National Environmental Management: Biodiversity Act
NEMPAA	National Environmental Management: Protected Areas Act

NFEPA	National Freshwater Ecosystem Priority Area
NFSD	National Framework for Sustainable Development
NGP	New Growth Path
NIP	National Infrastructure Plan
NIPP	National Industrial Participation Programme
NPAES	National Protected Areas Expansion Strategy
NRW	Non-Revenue Water
NSBA	National Spatial Biodiversity Assessment
NSDF	National Spatial Development Framework
NSDP	National Spatial Development Perspective
NSSD	National Strategy for Sustainable Development
NWRS	National Water Resource Strategy
PICC	Presidential Infrastructure Coordinating Commission
RDP	Reconstruction and Development Programme
RDM	Resource-directed Measure
RIDS	Regional Industrial Development Strategy
RSA	Republic of South Africa
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SANS	South African National Standard
SBP	Spatial Biodiversity Plan
SDC	Source-directed Control
SDF	Spatial Development Framework
SEA	Strategic Environmental Assessment
SEMP	Strategic Environmental Management Planning
SIP	Strategic Infrastructure Project
SPLUMA	Spatial Planning and Land Use Management Act
SUDS	Sustainable Urban Drainage System
SWSA	Strategic Water Source Area

UARL	Unavoidable Annual Real Loss
UN	United Nations
UNCED	United Nations Conference on Environment and Development
URP	Urban Renewal Programme
URS	Urban Renewal Strategy
VIP	Ventilated Improved Pit Latrine
WCDM	Water Catchment Development Management
WHO	World Health Organisation
WMA	Water Management Area
WRC	Water Research Commission
WRCS	Water Resource Classification System
WSA	Water Services Authority
WSDP	Water Services Development Plan
WSP	Water Services Provider
WSSP	Water-sensitive Spatial Planning
WSUD	Water-sensitive Urban Design
WSUM	Water-sensitive Urban Management
WSUP	Water-sensitive Urban Planning
WWTW	Wastewater Treatment Works
WTW	Water Treatment Works

UNITS OF MEASURE

cm	Centimetre
ha	Hectare
km	Kilometre
km²	Square kilometre
m³	Cubic metre
m³/a	Cubic metre per annum
m³/d	Cubic metre per day
m³/ km²/a	Cubic metre per square kilometre per annum
m	Metre
mm	Millimetre
mm/yr	Millimetre per year
MW	Megawatt
R	Rand

CHAPTER 1: DEVELOPING A FRAMEWORK FOR WATER-SENSITIVE SPATIAL PLANNING AND LAND USE MANAGEMENT

1.1. INTRODUCTION

Continents, countries, cities, towns and settlement, together and the people living in them, experience different climates daily, relative to their location from the equator (Das & Abhyankar, 1953, p. 497). Societies have become accustomed to their unique climates and have structured their day-to-day lives around historical and current climatic conditions (Geng & Sugi, 2003, p. 2262). The disadvantage of this is that cities and settlements, and their accompanying communities, economies, infrastructure and natural resource, have become habituated to a normal range of conditions and may be sensitive to extremes that fall outside this range (Mastaler, 2011, p. 66; Berkhout et al., 2006, p. 135). Observational climate records indicate that extreme climatic events have become a frequent reality on many parts of the globe (IPPC, 2014, p. 7). The period between 1983 and 2012 has most likely been the warmest 30-year period in the last 1,400 years. This has caused the earth's dryland surface areas to double since the 1970s (Bates, 2008, p. 38; Zhang & Yan, 2014, p. 595). Research suggests that this climatic phenomenon is triggered by an increase in greenhouse gas (GHG) emissions, largely driven by human activities embedded in economic and social needs (IPCC, 2014, p. 4). Observational records and climate projections provide evidence that, globally, freshwater resources are most vulnerable to climate change, which will most likely have wide-ranging consequences for human societies and ecosystems, such a food insecurity, and exacerbate health problems. On a localised level, the southern African region is particularly vulnerable, as existing arid regions will most likely become hyper-arid, adding additional strain to the already limited resource base (Bates, 2008).

In addition to climate-related stresses, the United Nations' Department of Economic and Social Affairs (UN DESA) (2015, p. 2) predicts that the global population figure will reach 9.7 billion by 2050, with most of the growth deemed to take place in Africa due to the continent's annual average growth rate of 2.55%, contributing over 1.3 billion people (UN DESA, 2015, p. 3). Of the 9.7 billion people, over 70% (or 6.4 billion people) are predicted to reside in urban areas. The predicted increase in populaiton will increase total water demand for adequate municipal, industrial and agricultural supply (Bradley et al., 2002; Falkenmark & Lindh, 1974; Falkenmark & Widstrand, 1992; McDonald et al., 2011; Postel et al., 1996). Alexandratos and Bruinsma (2012) add that, by 2050, agriculture will need to produce 60% more food globally, and 100% more in developing countries. In addition, the urbanisation trends will most likely create rising income levels, which will change food habits towards richer and more varied diets, which requires far more water resources to produce (IWMI, 2007, p. 8).

It is also anticipated that, for urban areas to accommodate this growth, urban space, which currently occupies 3% of global land cover, will need to double in developed countries and expand by 326% in developing countries (Angel et al., 2011). Intermediate cities, those with populations between 20,000 and 20,000,000, will have to make room for a population growth of up to 5% annually (Angel et al., 2011). This growth in population and the need for space will trigger rapid land cover change, widely recognised as the major driver of habitat and biodiversity loss. This change will mostly likely result in increased levels of water quality deterioration, causing high risks to human health, economic development and ecosystems (WWAP, 2017, p. 20).

Due to the combined effects of population growth, with direct implications for water, food and energy demand, and increased urbanisation rates causing rapid and uncontrollable land cover change, greenhouse gas emissions are most likely to increase, hence the predicted change in global temperature and precipitation patterns (Vitousek, 1994; Millennium Ecosystem Assessment, 2005; Jetz et al., 2007; Showalter et al., 2000).

In urban areas, climate change is predicted to increase risk for people, assets, economies and ecosystems. These risks include heat stress, storms and extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, water scarcity, a rise in sea level and storm surges (IPCC, 2014, p. 16). According to Satterthwaite (2007, p. 4), the scale of the risk posed by climate change is influenced by, among others, the quality of housing and infrastructure in a city and the extent to which urban planning and land use management have successfully ensured risk reduction within urban construction and expansion. As such, the impact of climate change will be felt most intensely by the urban poor, living in informal settlements that are often located outside the land use management plan, bordering floodplains or other areas at high risk of flooding or unstable slopes (Hardoy et al., 2001, p. 448). Furthermore, the 2014 report of the Intergovernmental Panel on Climate Change (IPCC) emphasised that poor communities residing in southern Africa, who are dependent on natural resources both in terms of direct use and exploration for economic growth will be worst affected by climate change. This is due to the fact that climate change will cause even lower precipitation rates, higher temperatures and higher evaporation rates (OECD, 2012, p. 6). When these cities and settlements fail to protect the ecological infrastructure, fail to reduce their consumption demand and fail to spend on the upgrading and maintenance of existing infrastructure, they will most likely (if not already) face economic water scarcity.

1.2. BACKGROUND

All aspects of society, from its economy to its culture, depend, in part, on safe, stable access to water resources. Water sensitivity has gained global awareness as the risks associated with climate change, increasing resource demands due to population growth, and environmental degradation as a result of rapid urbanisation continue to escalate at an alarming rate. The conventional urban water management approach is highly unsuited to addressing current and future sustainability issues due to the physical and institutional compartmentalisation of municipal systems (Wong & Brown, 2008, p. 2). Sustainable development is no longer a minor developmental issue, but a transdisciplinary challenge that must be placed at the forefront of the development agenda. As a response to the above, the aspirational concept of the water-sensitive city emerged in scientific policy and practice as an alternative and sustainable approach to water resource planning and management.

The CRCWSC defines a water-sensitive city as a city that interacts with the urban hydrological cycle in ways that provide for water security, which is essential for economic prosperity, by efficiently using a diversity of water resources that are available, by enhancing and protecting the health of watercourses and wetlands, mitigating drought and flood risk, and creating public spaces that harvest, clean and recycle water. It is widely accepted that, in becoming a water-sensitive city, the process will involve a transition, driven by radical shifts in the structure, culture and practices that are currently locked into unsustainable development paths.

In 2011, South Africa's Water Research Commission commenced with water sensitive-related research activities by soliciting research proposals aimed at guiding urban water management decision makers on the use of WSUD, specifically within the South African context. This soon led to the publication of "The South African guidelines for sustainable drainage systems" (referred to as the Sustainable Urban Drainage Systems (SUDS) Guidelines), which emanated from a project entitled "Alternative technologies for stormwater management" (WRC Project No. K5/1826) in 2013. The guideline document primarily focused on stormwater management in South Africa's urban areas to mitigate the effect of urbanisation on both stormwater quality and quantity. The guideline document provides detailed information on calculations and technical illustrations for alternative approaches to stormwater management, including bio-retention areas, filter strips, green roofs, infiltration trenches, multi-purpose detention ponds, permeable paving, rainwater harvesting, wetlands and soakaways. Collectively, these systems are referred to as SUDS or green infrastructure.

Following the 2013 publication of the SUDS Guidelines, the WRC published "Water-sensitive urban design for South Africa: framework and guidelines" (referred to as the WSUD Framework (Part 1) or WSUD Guidelines (Part 2)) in 2014 (keeping in mind that these form one document).

This publication emanated from a project entitled “Water-sensitive urban design for improving water resource protection/conservation and re-use in urban landscapes” (WRC Project No. K5/2071), which aimed to link the SUDS, as per the SUDS Guidelines, to the larger issue of water management in urban areas (Armitage et al., 2014, p. 3). The WSUD Framework introduces the philosophy of WSUD in South Africa, and defined water sensitivity as “… the management of the country’s urban water resources through the integration of the various disciplines of engineering, social and environmental sciences, while acknowledging that South Africa is a water scarce country; access to adequate potable water is a basic human right; the management of water should be based on the participatory approach; water should be recognised as an economic good; and water is a finite and vulnerable resource, essential to sustaining all life and supporting development and the environment at large” (Armitage et al., 2014).

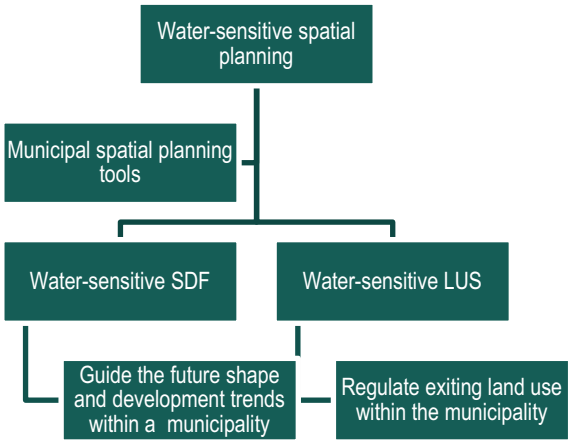
The framework highlights three physical areas of intervention, which include formal areas, greenfield developments and informal areas where high population densities and limited infrastructure are common (Armitage et al., 2014, p. 26). For this reason, the framework adopted the term water-sensitive settlements instead of the water-sensitive city, to include the non-urban, but densely populated rural settlement areas. The framework also introduced a roadmap towards creating water-sensitive settlements, suggesting that formal areas will have to retrofit existing infrastructure and focus on integrated urban water cycle management, point source management, water demand management and water conservation, while the roadmap recommends a leapfrog development approach to service delivery in poorly serviced or unserviced informal settlements (Armitage et al., 2014, p. 25).

The framework states that the water-sensitive settlement comprises three components: WSUD, WSUP and water-sensitive urban management (WSUM). The WSUD Guidelines illustrate that WSUD brings together a range of activities related to urban water infrastructure, and design and planning under one umbrella (Armitage et al., 2014, p. 46). However, the guideline only offered detailed information, technical illustrations and approaches on urban water infrastructure, focusing mainly on alternative infrastructures or green infrastructure technologies and solutions for stormwater management, sanitation and wastewater minimisation, groundwater management and water supply options. The guidelines did not address the design and planning component of WSUD, nor did the framework provide comprehensive information on WSUP or WSUM, as it was beyond the scope of their work.

As a result, the WRC embarked on a new research project to bring WSUD – as defined and envisioned by the WSUD framework and guideline document – into an even larger municipal planning environment. This project, entitled “Securing water sustainability through innovative spatial planning and land use management tools – case study of two local municipalities” (WRC Project No. K5/2587), aims to address the WSUP component of water-sensitive settlements.

However, the following should be noted: Since the beginning of the research, the term WSUP seemed limiting within the broader environment of municipal spatial planning and land use management. In June 2015, Parliament enacted new planning legislation (the Spatial Planning and Land Use Management Act, Act No. 16 of 2013). Today, this Act is South Africa’s only Framework Act that regulates and guides spatial planning and land use management for the entire country. The Act mandates all local municipalities to develop and adopt a municipal SDF and LUS for their entire municipal area within five years of the enactment of SPLUMA.

The municipal SDF and the municipal LUS are planning tools that are designed to guide the future shape of a municipality and to lawfully administer and regulate land use, both of which carry water-related implications. The research team therefore raised the issue that WSUP was not inclusive of the broader rural environment found in municipal boundaries, even though the Framework for WSUD in South Africa redefined water-sensitive cities to water-sensitive settlements. To give effect to SPLUMA, and to achieve water sensitivity within the broader municipal planning environment, this project adopted a new term: water-sensitive spatial planning, which replaced WSUP as it relates to the entire municipal area (built-up and natural environments), instead of just the urban environment. The WSSP will therefore be achieved through two planning tools, which include the development and implementation of a water-sensitive SDF and LUS.



The project's aims were as follows:

- Establish a framework for WSSP in South Africa
- Carry out a hydro-socio and hydro-political literature review to understand the impact and relationship between national political development objectives and their impact on spatial planning and water resources planning and management
- Carry out a legislative and policy analysis to identify which strategic planning instruments can and must inform WSSP, down to municipal level
- Identify appropriate spatial data, resources and additional tools to assist spatial planners in developing water-sensitive SDFs and LUSs
- Conduct a case study analysis of two local municipalities to identify gaps and opportunities for WSSP in a typical South African local municipality
- Produce a guideline on how to develop and implement a municipal water-sensitive SDF and a municipal water-sensitive LUS within the legal framework of SPLUMA

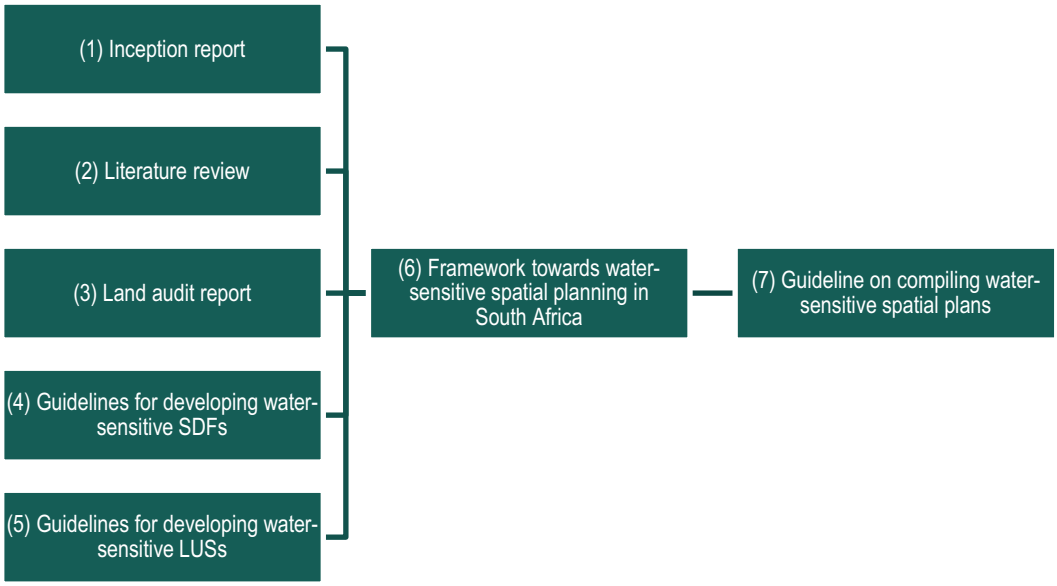
1.2.1. Target audience

The target audience intended for the use of this document includes the following:

- Municipal officials and/or consultants responsible for developing a municipal SDF and municipal LUS, as mandated by SPLUMA
- Municipal officials or authorities concerned with general spatial planning, water resources planning, environmental management and those responsible for developing SDFs, IDPs, CMSs, water services development plans, EMPs, bioregional plans, municipal asset management plans and other sector plans related to land and water resources planning, either in-house or outsourced to a service provider
- Property owners, community and business stakeholders within the selected study areas who have an interest in or are affected by an SDF or a municipal LUS
- Traditional leaders and community members who had previously been excluded from spatial planning and land use management

1.2.2. Deliverables to date

Five research documents have been produced to date. This document will represent the sixth document, "Framework towards water-sensitive spatial planning", which should be read together with the seventh document, "Guideline on compiling water-sensitive spatial plans".


(1) Inception report
(2) Literature review
(3) Land audit report
(4) Guidelines for developing water-sensitive SDFs
(5) Guidelines for developing water-sensitive LUSs
(6) Framework towards water-sensitive spatial planning in South Africa
(7) Guideline on compiling water-sensitive spatial plans

CHAPTER 2: SOUTH AFRICA'S HYDRO-SOCIO CONTRACT

2.1 INTRODUCTION

The notion of a hydro-socio contract was first introduced by Turton and Ohlsson (1999) at the 9th Stockholm Water Symposium. It has subsequently been referred to by Warner (2000a; 2000b) in a manner that shows conceptual development. The importance of the concept is that it encapsulates the normative values present within the hydro-socio environment. As such, it forms the basis on which institutional arrangements are subsequently built. By understanding this concept in a more profound manner, it is anticipated that both spatial planners and water resource managers will be better equipped to deal with issues that are emerging from rapidly changing environments.

The hydro-socio history of South Africa's water resources is closely connected to human settlements and is best understood in the context of the settlement of the land, for various reasons. The purpose of this chapter is to explain South Africa's spatial development trends and water resources management history in a concise manner. The reader will miss many facts in this rendition of South Africa's history, but there is no room or time for detail. The purpose is to illustrate the meaning of certain developments and related events in relation to the hydro-socio, and later to the hydro-political history of South Africa. This chapter is arranged chronologically. Its basis is the origin and interaction of South Africa's different population groups over time.

The chapter is divided into several parts. The first part provides an overview of South Africa's physiography, before anthropogenic interferences. The second part discusses the colonial frontier, followed by a discussion of the establishment of the Boer Republics and the discovery of minerals in South Africa. The third part considers the rise of Afrikaner nationalism, followed by a discussion of the establishment of the Union of South Africa and the history of South Africa from this time up to the 1950s. The fourth section of the chapter looks at South Africa's apartheid policy and development within the water sector up to 1990. In the fifth part of the chapter, the period 1990 to the present is discussed. In this period, South Africa witnessed radical political reforms. The section deals with the history of legal and institutional developments regarding the management of South Africa's land, water and environmental resources. Lastly, a conclusion is drawn.

2.2 SOUTH AFRICA'S PHYSIOGRAPHY

Situated between 22°S and 35°S latitude and stretching over 17°E to 33°E longitude, lies 1,219,090 km^2 of land, known as the Republic of South Africa (RSA) (Statistics South Africa, 2011, p. 6). The northeastern corner of the country lies within the tropics, astride the Tropic of Capricorn, and borders Zimbabwe and Mozambique. The remaining northern border shares an international boundary with both Botswana and Namibia. The rest of the country's eastern, southern and western boundaries are defined by an extensive coastline of approximately 3,200 km. Due to South Africa's relative location to the equator, large parts of the country's interior, mostly towards the west, experience hot or cold arid desert climates, typically associated with Koppens Climate Zone B. The country's eastern interior is slightly less arid, with dry winters and hot summers, and humidity levels increasing towards the eastern coastline.

As for South Africa's topography, an invariant feature of physical landscape explains much of the country's climatic features and hydrological responses (Schulze, 2011, p. 8). South Africa generally has low altitudes ranging between 0 and 400 m along the coastline with generally cooler maximum summer temperatures ranging from <24 ˚C to 26 ˚C.

As the altitude increases along the east and south coast towards the Great Escarpment, maximum annual summer temperatures decrease to below 24 ˚C. This is where peak altitudes, ranging between 2,000 and 2,500 m are found in KwaZulu-Natal and Lesotho, forming part of the Drakensberg mountain range. The vast interior plateau inland of the Great Escarpment drops gently from the east at around 1,500 m to around 1,000 m in the west (Schulze, 2011, p. 9). In areas with declining altitudes, maximum annual summer temperatures increase from 27 ˚C in the east to extreme highs of over 31 ˚C to the west. According to the maximum summer temperature database of the Agricultural Research Council (ARC), 27% of the Northern Cape experiences maximum annual summer temperatures of over 31 ˚C. The ARC's spatial data also reveals that 22% of the country experiences an average maximum summer temperature between 29 and 31 ˚C, followed by 18% of the country with a slightly higher average maximum summer temperature between 31 and 33 ˚C.

Due to the gradual north to south, yet slightly rapid east to west altitude and temperature change, spatial and temporal variations in mean annual precipitation (MAP) can be observed. South Africa has an average MAP of less than 500 mm yr-1 (Nel & Driver, 2015, p. 1; Colvin & Muruven, 2017, p. 8), which is less than half of the global average. Between the eastern coastline and the great escarpment, irregularities in altitude causes severe fluctuation in MAP ranging from 600 mm yr^{-1} to 1,000 mm yr^{-1}, decreasing to a low of 200 mm yr^{-1} towards the south of the coastline. South Africa's highest MAP, ranging between 800 mm yr^{-1} and >1, 000 mm yr^{-1}, is found along the high-altitude areas of Amatole, the Boland Mountains, the Eastern Cape Drakensberg, the Groot Winterhoek, Kougaberg, Langeberg, Maloti Drakensberg, Mbabane Hills, Mfolozi Headwaters, Mpumalanga Drakensberg, Northern Drakensberg, Outeniqua, Phongola Drakensberg, Pondoland Coast, Southern Drakensberg, Soutpansberg, Swartberg, Table Mountain, Tsitsikamma, Wolkberg and the Zululand Coast. According to Schulze (2011, p. 9), the overall feature of the distribution of MAP over South Africa is that it decreases uniformly westwards from the escarpment across the interior plateau from approximately 1,000 mm yr^{-1} to less than 200 mm yr^{-1}. King et al. (2011, p. 2) noted that 21% of the country receives less than 200 mm yr^{-1}. Most of the 21% is found within the warm interior plateau towards the west in the Northern Cape.

The combination of low altitudes and high temperatures causes South Africa to experience high evaporation rates averaging 1,800 mm yr^{-1} (Colvin & Muruven, 2017, p. 7). According to the ARC's mean annual evaporation database, the lowest evaporation occurs along the east to south coastline, remaining relatively low towards the Great Escarpment. Like the temperature observations, evaporation increases uniformly westwards from the escarpment across the interior plateau from approximately 1,601 mm yr^{-1} to 2,400 mm yr^{-1}, increasing rapidly towards the Northern Cape to >2,401mm yr^{-1}.

In most regions across South Africa, the evaporation rate is three times the precipitation rate, resulting in a very low MAP:MAR ratio (the rate at which precipitation is converted into runoff) of 8.6% (Davies et al., 2006, p. 550). According to the DWS's spatial data, 75% of the country's catchments have a mean annual runoff (MAR) potential of less than 100 mm yr^{-1}, found mostly northwest of the Great Escarpment across the country's vast interior. Only 25% of catchments have relatively high volumes of runoff, ranging between 100 mm yr^{-1} and >500 mm yr^{-1}. These areas are limited to Swaziland, Lesotho and most of the Eastern Cape, decreasing southwards over KwaZulu-Natal and the Western Cape with some catchments producing less than 20 mm yr^{-1}.

Disproportionately high volumes of runoff, at least three times more than that of the primary catchment, is produced by several catchments across the country and are referred to as South Africa's strategic water source areas (SWSAs). The DWS (2013, p. 42) describes SWSAs as "…foundational infrastructure on which a great deal of built infrastructure for water services depend," which should be treated as "strategic national assets that are vital for water security and need to be acknowledged as such at the highest level across all sectors" (DWS, 2013, p. 42). SWSAs are found within the high-altitude areas of Amatole, the Boland Mountains, the Eastern Cape Drakensberg, Groot Winterhoek, Kougaberg, Langeberg, the Maloti Drakensberg, the Mbabane Hills, the Mfolozi Headwaters, the Mpumalanga Drakensberg, the Northern Drakensberg, Outeniqua, Phongola Drakensberg, Pondoland Coast, Southern Drakensberg, Soutpansberg, Swartberg, Table Mountain, Tsitsikamma, Wolkberg and the Zululand Coast.

SWSAs take up less than 8% of the geographic entity and produce over 50% of the country's surface water. Some 80% of surface water is generated by the 3.9% of land found in South Africa alone (Nel et al., 2013b, p. 21; Driver et al., 2012, p. 157). Unfortunately, only 18% of the country's SWSAs are formally protected (Driver et al., 2012, p. 71).

Runoff recharges groundwater aquifers, and like SWSAs, South Africa's aquifer recharge potential does not occur uniformly across the country, as it is mainly dependent on rainfall and geological permeability. Much of the country's high recharge potential is found in Gauteng, Mpumalanga, the Free State and scattered zones across the Western Cape. Although preferential recharge areas exist, the mapping of these areas is still underway (Nel et al., 2011, p. 45). Base flow calculations determine the dry weather flow in streams and rivers, which result largely from groundwater seeping into rivers. South Africa's groundwater base flow is generally high in KwaZulu-Natal, Mpumalanga and Gauteng, ranging between 6,001 $m^3/km^2/a$ and 65,576 $m^3/km^2/a$, decreasing rapidly towards the north of Limpopo. Base flow in Limpopo is highly irregular as some catchments have a high baseflow between 15,001 $m^3/km^2/a$ and 65,576 $m^3/km^2/a$, while the rest has a base flow of 0 $m^3/km^2/a$. Along the international border and down to the western interior of the country, base flow is 0 $m^3/km^2/a$. The countrywide low base flow is typical of a semi-arid to arid climate situation as groundwater tables are too deep to contribute to river base flow. Under natural undeveloped conditions, South Africa's average total mean runoff is estimated at just over 49,000 million m^3/a (WRC, 2016, p. 8). According to Colvin and Muruven (2017, p. 7) an estimated low 9% (or 4,410 million m^3/a) of the runoff ends up in rivers, causing a high variability of water flow and very low to zero levels of river flow, while 4% (or 1,960 million m^3/a) recharges groundwater aquifers.

Yet, South Africa is no longer naturally undeveloped. Due to colonisation, population growth and the continual need to grow the economy, land cover and land use change has had a significant part to play in the availability and quality of natural water resources.

2.3 COLONISATION OF SOUTH AFRICA

According to Oliver and Oliver (2017, pp. 2-5) South Africa, as it stands today, experienced two phases of colonisation: "unofficial colonisation" and "official colonisation". Unofficial colonisation dates back approximately 2,000 years to when farmers and metal workers moved southwards form North Africa (Meyer, 2012, p. 32; Giliomee & Mbenga, 2007, p. 22). Most of these travellers never claimed land as they were nomads roaming the territory. The discovery of artefacts, tools and weapons does, however, indicate that certain areas of land, specifically land close to water, was occupied by groups of people on a more permanent basis. Yet, no political structures or demarcation of land was involved (Oliver & Oliver, 2017, p. 3). Official colonisation started somewhere between 1650 and 1700 when the initial halfway station, established by the *Vereenigde Oostindische Compagnie* (VOC), became a colony (Pearson, 2012, pp. 99-138; Cameron & Spies, 1986, p. 53; Ross, 1999, p. 21).

According to Giliomee and Mbenga (2007, p. 42), the colonisers brought with them the Western culture and Western "intellectual baggage", like the Roman-Dutch law, the reformed religion and capitalism (Ross, 1999, p. 21). During the 1700s, farmers started to migrate inland in search of land (Boucher, 1986, p. 66; Wilcox, 1986, p. 100). Migration took place towards the Orange River Basin and north of it (Ross, 1999, pp. 25-26). According to Boucher (1986, p. 66), the population density of the area where the Dutch resided was around two persons per 10 km^2. In the interior of the country, where the farmers started to reside, the population density was around one person per km^2. In the arid regions, it was about one person per 20 km^2.

In 1806, the British took control of the Cape to protect the sea route to the Asian empire. Not long afterwards, the Colony of Britain was formally established and the freehold tenure of land introduced. According to Rowlston (2011, p. 21), this had a profound effect on the state's control of water resources as all natural rights that were attached to land, including water, belonged to the land owner.

The riparian principle of English-American law was established under the Colony's water law, meaning that owners of land alongside rivers had common rights to the exclusive and in-perpetuity use of the water in the rivers (Rowlston, 2011, p. 21). However, disputes over water rights became prominent, and a Special Water Court was established to determine new water allocation. The Water Court also assigned the responsibility of providing water supply and sanitation services to local councils for their respective towns and villages.

2.3.1 South Africa's early era of industrialisation and urbanisation

With the discovery of diamonds and, more importantly, gold during the late 1800s in the country's interior, the "Mineral Revolution" stimulated rapid industrialisation and urbanisation, particularly in the Witwatersrand area (Oosthuizen, 2000). After the discovery of diamonds and gold, in 1867 and 1886 respectively, the expansion of settlements by whites accelerated, leading to more land coming under white control. The Mineral or Mining Revolution brought along with it European technicians, capital and a railroad system deep into the interior (Thompson & Lamar, 1981, p. 23). According to Turton et al. (2004, p. 39), "this technical skill, capital and infrastructure were much-needed prerequisites for the development of irrigated agriculture later in the 19th century, at least in the Orange River basin in the Cape Colony".

Mining companies and colonial government invested in various schemes to attract workers for longer periods (Turok, 2012, p. 4). Some schemes provided accommodation in the form of large-scale residential compounds or hostels, close to the mines. However, these compounds were notorious for diseases, malnutrition and cramped, squalid conditions. By 1900, more than 100,000 black workers resided in these mining settlements (Yudelman, 1984). As for the rest of the country, cattle farming and/or cash crops, such as sugar, coffee, wine and other agrarian activities, dominated (Turok, 2012, pp. 4-5).

At the time, the county was divided among the British Empire, states formed by Afrikaner settlers, and various native African states. Britain's desire to control the entire region soon led to the Second Anglo-Boer War, lasting from 1899 to 1902 (Turok, 2012, p. 6; Pakenham, 1986, p. 200; Van Zyl, 1987, p. 333; Davenport & Saunders, 2000, p. 223). According to Ross (1999, p. 72), the war had a devastating impact on the population as 30,000 of the 300,000 members of the Boer Republic had died, while an estimated 150,000 were imprisoned in British concentration camps (Ross, 1999, p. 72). After the war, an estimated 30,000 farmsteads were destroyed, together with 22 villages (Pakenham, 1986, p. 494; Davenport & Saunders, 2000, p. 226).

2.4 POST-WAR SOUTH AFRICA

The official end of the Second Anglo-Boer war on 31 May 1902 led to the signing of the Treaty of Vereeniging (Turton et al., 2004, p. 54). The British authorities ensured that landowners would regain power over their farms. However, the Afrikaners were left impoverished and thousands left their farms to settle in the cities. During the post-war era, emphasis was placed on economic reconstruction, which led to a gradual rise in intensive commercial farming. Mining activities recovered to their pre-war status, yet land became scarcer.

2.4.1 Urban reconstruction

In 1910, the Act of Union was signed, and the country gained independence. During this period, authorities wanted to recast urban society through social and civil engineering, which required new government structures (Giliomee & Mbenga, 2007, p. 49). In an attempt to reconstruct urban areas, municipalities were established in terms of the Transvaal Ordinance Establishing Municipalities, No. 58 of 1903, which granted powers to municipalities in terms of clause 30 to regulate "the closing of buildings… unfit for human habitation" and clause 32, which required "giving of notice and deposit of plans by persons wishing to lay out building lots or new townships".

However, local councils failed to implement the chief instrument of urban reconstruction and “forced colonial government to take more powers itself in an attempt to impose its view of urban order on the ground” (Giliomee & Mbenga, 2007, p. 50). As a response, government introduced a new system whereby township establishment would be regulated allowing government much greater control over urban growth. Other urban problems, including sanitation, water supply and other services, required regulation at regional and municipal level.

The first nationally applicable water law, the Irrigation and Conservation of Waters Act, Act No. 8 of 1912, was passed into law in 1912 and superseded all previous colonial laws. According to Thompson et al. (2001, p. 12), the Act of 1912 aimed to deal with the problem of endemic dry and low rainfall conditions. However, the riparian principle remained a central feature of the new water law (Uys, 2008, p. v), perpetuating the discriminatory practice of unequal allocation of water resources. Ever too often, overallocation of water for irrigation purposes was made to the detriment of the environment (Mackenzie, 2009, p. 443).

One year later, the first key piece of apartheid legislation, the Native Land Act of 1913, was passed by the Union (Magubane, 1996, p. 148). Act 27 of 1913 had a major impact on the way in which urban and rural areas are structured today, as it set aside approximately 7.3% of the country’s land area as reserves to accommodate the “native” population. The remaining lands became known as “white land”. According to Turok (2012, p. 7), “the reserves themselves were in areas with very limited agricultural and mining potential, mostly arid and distant from the main economic centres.” The Act created a system of land tenure, meaning that land under "communal" tenure was vested in African chiefs. It also prohibited the native people from owning land outside the reserves. According to Rowlston (2011, p. 25), the combined effects of the riparian system, by which access to water resources was tied to land ownership, and the severe restriction on land ownership by the majority black population ensured that access to water was in favour of the minority white population.

2.4.2 The First World War, 1914

In 1914, the South African government was asked to invade German South West Africa (Namibia) during the First World War. According to Turton et al. (2004, p. 47), this war had a major impact on the operations of the Department of Irrigation as building and construction material was placed at the disposal of the Department of Defence. Shortly after the war, the Department adopted a policy of active development, which led to the construction of several major dams with crest heights in excess of 20 m above the functional level: Hartebeespoort Dam (59 m), Lake Mentz (34 m), Tygerpoort Dam (20 m), Kammanassie Dam (41 m), Gariep Dam (24 m) and Lake Arthur (38 m) (DWA, 1988, p. 2).

2.4.3 Radical new departures in planning, 1913-1930

Act No. 27 of 1913 was followed by the passing of the 1918 Natives in Urban Areas Bill, which forced blacks into outlying townships or locations, and the Native Urban Areas Act, Act No. 21 of 1923, which gave local authorities the power to demarcate and establish African locations on the outskirts of white urban and industrial areas (Turok, 2012, p. 7). Parnell and Mabin (1995, p. 45) noted that these laws were also shaped by wider global concerns related to unprecedented industrialisation. Government had to intervene and, at the time, the Native Urban Areas Act and other public health legislations were developed as mechanisms that could be used to improve public health, provide a clean water supply, reduce fire risks, redevelop overcrowded slums, modernise the physical layout of urban areas and generally manage settlement growth.

Radical new departures in planning, such as the rise of modernism driven by the ideals of Le Corbusier and the Congress International du Architecture Moderne was brought to South Africa between 1920 and 2030. According to Parnell and Mabin (1995, p. 55), it was a coincidence that town planning in South Africa emerged at a time when the modern movement in architecture and planning was at its peak. The modernistic movement, which was based on the theory of comprehensive segregation of land use, clearly lent itself to apartheid spatial planning in South African cities.

2.4.3.1 Droughts and urbanisation

During the Great Depression in 1930, even though the riparian principle was still in force and favourable for agricultural uses, a significant number of Afrikaner farmers moved to towns as several regions faced serious drought conditions (Davenport, 1989). Nearly six million sheep had died while other agricultural production levels also decreased (Turton et al., 2004, p. 50). The migration of a vast number of people called for a formal institutional framework for settlement building. The idea of "reconstruction" for the post-war period saw the increasingly enthusiastic acceptance of the modernist movement, such as the separation of land uses, the concept of the inwardly oriented neighbourhood units, and the dominance of the private motor car (National Development and Planning Commission, 1999, p. 4). South Africa followed the movement of the British Town Planning Institute, which called for a structured approach by introducing land use regulations as a national socio-economic planning tool (Herbert, 1983). In the early 1930s, the first Provincial Town Planning and Settlement Establishment Ordinance was passed which required municipalities to exercise greater control over town planning. This included land use, building size and housing density.

The modernist architects of the time noted that unplanned city planning and development, and the uncontrolled utilisation of natural resources, had to be replaced with rational spatial development, based on science and ingenuity (Martienessen, 1941; Muller, 1996). The Department of Physical and Regional Planning was established to conduct national and regional planning and zoning to ensure the enforcement of a strict set of spatial planning rules and regulations (Union of South Africa, 1944). It was clear that the agencies who administered town planning had "racial zoning" on their agenda.

2.4.3.2 Tightened influx control

In 1936, the Native Trust and Land Act, Act No. 18 of 1936, increased the "native reserve" land area from 7.3% to almost 13% of the total land area of the Union. More specifically, the Act prohibited any ownership and/or purchase of land by natives outside the stipulated reserves, thereby formalising the separation of urban white and rural black areas. The Native Urban Areas Act of 1923 was amended several times (in 1930, 1937 and 1944) until the Native Urban Areas Consolidation Act of 1945 was passed giving "tightened influx control" for government over the natives in urban areas.[1] The Group Areas Act, Act No. 41 of 1950, was yet another Act invested in segregated apartheid spatial planning. According to Mabin (1992, p. 429), cited by (O'Malley, 2016),[2] "the practice of implementing the Act depends on the existence and growth of planning bureaucracies whose origins were wider than those of the Act itself ".

2.5 INDUSTRIALISATION AND POPULATION GROWTH, 1950 ONWARDS

Industrial development in the post-war era, combined with population growth and improving living standards, specificity of the white Afrikaner, placed increasing demands on the country's limited water resources.

2.5.1 Increased water demands and disputes

According to Uys (2008, p. iii) "…the majority of water court cases were decided before 1956, when water users relied heavily on the courts to establish and declare their water rights, mainly because the Water Law was a statutory system and not an administrative system." Between 1912 and 1956, 272 Water Court cases had to be dealt with (Uys, 2008, pp. xiii-xx).

[1] Also see the Native Laws Amendment Act of 1945, the Asiatic Land Tenure and [Indian] Representation Act, Act No. 28 of 1946 and the 1946 Ghetto Act, the 1951 Bantu Authorities Act, Act No 68 of 1951, the Prevention of Illegal Squatting Act of 1951, the Native Urban Areas Amendment Act of 1952, the Native Urban Areas Consolidation Act of 1954, the Natives Resettlement Act of 1954, the Group Areas Development Act of 1955, the Native Urban Areas Amendment Act of 1955, the Native Administration Amendment Act, Act No 42 of 1956, and the Native Urban Areas Amendment Act of 1956.
[2] Also see the Bantu Authorities Act, Act No 27 of 1951, the Prevention of Illegal Squatting Act, Act No 1951, the Native Urban Amendment Act of 1952, the Native Law Amendment Act, Act No. 45 of 1952, the Native Resettlement Act of 1954, the Group Areas Development Act of 1955 and the Native Urban Areas Amendment Act.

As such, the 1912 Irrigation and Conservation of Water Act was reviewed several times until the Water Court introduced two innovative administrative devices: “normal” and “surplus” flow. This allowed the Water Court to authorise the use of “surplus” flow on non-riparian land for urban or industrial use.

Nevertheless, in 1956 a new Water Law was enacted, replacing the 1912 Irrigation and Conservation of Water Act. The riparian principle remained. However, the Act of 1956 permitted the state to declare “control areas”, where the control of water was deemed by the Minister to be desirable in public or national interests (Hall & Burger, 1974, p. 23). In these “control areas”, water rights were administratively allocated by the state, which had a major impact on the role of the Water Court to determine water rights (Tewari, 2005, p. 107). The state’s role in water resource planning and management became prominent as the Department’s name changed from the Irrigation Department to the Department of Water Affairs in 1956 (Van Vuuren, 2009).

However, the growing demand for water resources remained unsatisfied, which called for urgent and innovative planning to provide water where it was needed. It became evident that the solution was to build more dams and develop inter-basin transfer. These transfers would convey water from catchments with excess supplies to catchments with a shortage of supply (DWA, 1987, p. 2). Water transfers were a financially acceptable approach to water resource management. However, little consideration was given to the long-term environmental consequences of dam construction and water transfers (Showers, 1996, p. 1). King et al. (2011, p. 12) explain that, at the time, the impact of dam construction and water transfers on donor aquatic ecosystems was not understood by management and not voiced effectively by the scientific community, and so it was not factored into water resource planning in any structured way, if at all.

2.5.1.1 First phase of systematic resource analysis

With regard to the country’s water resource management, an inter-departmental committee of the Soil Conservation Board was assigned to investigate geographic areas known for their high water supply. By the end of the investigation, the inter-departmental committee identified, hand-mapped and categorised 109 mountain catchments areas, see Figure 2.1 (Department of Agricultural Technical Services, 1961; Nel et al., 2013).

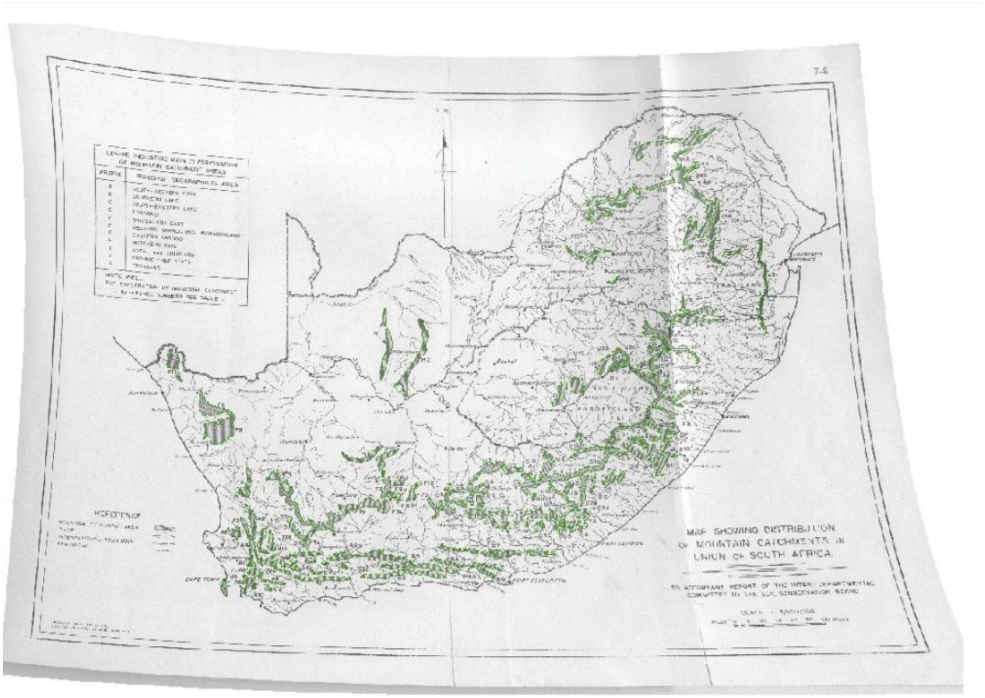


Figure 2.1: A total of 109 hand-mapped mountain catchment areas

During the same period, a Commission of Inquiry into Water Matters was appointed to investigate and make recommendations on all aspects of water provision and utilisation within the Republic. The Commission gave special attention, among other things, to determine the volume of surface and groundwater resource availability and future potential, to compile a long-term national master plan for coordinated development, conservation and control of water resources, to make recommendations for the systematic development of potential water sources, and to identify methods that can be applied immediately to effect the increased saving and re-use of water (Republic of South Africa, 1970, pp. xii-xiii).

The Commission published its findings and recommendations in 1970, which uttered that "…unless essential steps are taken to plan the exploitation and augmentation of our water resources, to conserve and re-use our available supplies, and to manage and control our resources in the most efficient manner, serious shortages will be suffered somewhere before the close of the century" (Republic of South Africa, 1970, p. 3). The Commission recommended that water saving in urban areas could be achieved through improved water use methods, the elimination of leakage, pressure regulation at distribution points, the instalment of individual metering, and the reduction in the size of urban plots (Republic of South Africa, 1970, p. 6). These recommendations became known as water demand management (Turton et al., 2004, p. 68).

2.5.2 Grand apartheid, 1950-1980

Between 1950 and 1980, the so-called "grand apartheid" took place. This phase of development in South Africa saw intense spatial and racial segregation as an additional 22 apartheid laws were passed.[3] One of these, the 1950 Population Restriction Act, formalised racial classification. Another, the Group Areas Act of 1950, prescribed the racial composition of every residential area. Combined, they facilitated the forcible removal of people who lived in the "wrong" areas (Turok, 2012, p. 8). The nationalist government aimed to establish 10 homelands for most black people, ultimately intended to be self-governing states, independent in all respects from "white" South Africa. According to Oranje and Merrifield (2010, p. 33), government introduced a development instrument to bring some form of economic rationale to the ideology of apartheid. This included the development of "border industries" close to the black reserves, which enabled black communities to work close to their territories, but the tax income would still come to South Africa. Several regulations (R293/1962 and R188/1969) were passed in terms of the Native Administration Act of 1927, which provided for the national control of land uses in these areas.

In 1967, the Physical Planning Act and Utilisation of Resources Act, Act No 88 of 1967, further controlled African urbanisation by placing limitations on the extent of new industrial land that could be proclaimed in the main urban areas (O'Malley, 2016). One of the instruments that the Physical Planning Act of 1967 provided for was guide plans. These were traditional spatial plans that were key spatial planning instruments during this era that embodied a wider concept of planning and elements of forward planning (Van Wyk, 2012, p. 41). However, these plans were only to cover urban areas, excluding the rural homelands and black settlements from spatial planning. By 1972, eight homelands, including Transkei, Ciskei, KwaZulu, Lebowa, Venda, Gazankulu, Bophuthatswana and QwaQwa, were self-governing homelands (Geldenhuys, 1984, p. 35).

[3] Also see the Bantu Authorities Act, Act No. 68 of 1951, the Prevention of Illegal Squatting Act of 1952, the Native Urban Areas Amendment Act, the Native Urban Areas Consolidation Act of 1954, the Natives Resettlement Act of 1954, the Group Areas Development Act of 1955, the Native Urban Areas Amendment Act of 1955, the Native Administration Amendment Act, Act No. 42 of 1956, the Native Urban Areas Amendment Act of 1956, the Native Urban Areas Amendment Act, Act No. 77 of 1957, the Reservation of Separate Amenities Amendment Act, Act No. 10 of 1960, the Urban Bantu Councils Act, Act No. 79 of 1961, the Transkei Constitution Act, Act No. 48 of 1963, the Bantu Urban Areas Amendment Act of 1964, the Bantu Homelands Development Corporations Act of 1965, the Bantu Laws Amendment Act of 1965, the Community Development Act of 1966, the Group Areas Amendment Act, Act No. 36 of 1966, the Physical Planning and Utilisation of Resources Act, Act No. 88 of 1967, the Promotion of Economic Development of the Homelands Act of 1968, the Public Service Amendment Act of 1969 and the Bantu Homelands Citizen Act, Act No. 26 of 1970.

2.5.2.1 The apartheid city model

The apartheid city was deliberately designed to separate races and classes into distinct segments of the city. Figure 2.2 illustrates the design of a typical apartheid city model that informed many urban master plans at the time.

Poor residents, and especially poor black residents, were pushed to the margins of the city. With rigorously enforced apartheid laws on residential location and movement, they were given no option but to live in sprawling, squalid dormitory townships comprising undifferentiated “matchbox” houses.

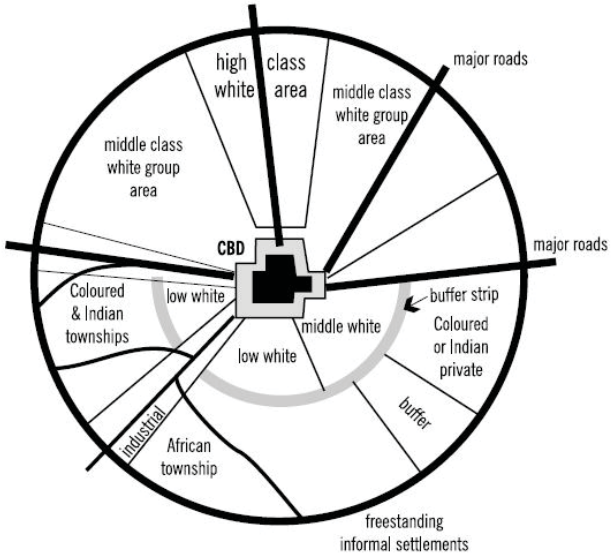


Figure 2.2: The apartheid city model

These areas were poorly serviced with infrastructure and urban amenities and were virtually devoid of work opportunities or shopping and entertainment facilities. A large part of the city was set aside for white residents. The size of this slice was generally far out of proportion to the white population. White residential areas were generally well laid-out and well-serviced, tree-lined suburbs, conveniently located close to employment and major urban facilities.

2.5.3 Environmental concerns, domestic turmoil and racial unrest

By the mid-1980s, the country experienced one of the worst droughts ever. Many experts argue that the effect of the drought was aggravated by the water resource management philosophy of increasing supply to meet demand. The Department of Water Affairs was under tremendous pressure to deal with the water crisis. While the global trend towards the recognition and incorporation of environmental concerns into water resource management added pressure for change, the Department embarked on developing numerous policies that were aimed at bringing about change and stability within the sector. The Department identified the following issues to be addresses, among others:

- various principles of the existing water law derived from European countries, where climates, cultures and hydrology were very different to that of South Africa;
- the relatedness between water resources quality and quantity management was not fully addressed;
- while the Minister had the power to restrict water usage during drought, he was unable to provide measures to regulate and ensure water conservation and demand management at all times;
- there was a need for a well-structured water tariff policy or pricing structure to give effect to the economic value of water; and
- there was an urgent need to regard rivers as integrated systems and to control then in a catchment-orientated way.

To the Department's disappointment, the ruling party rejected the above policy proposals. To aggravate the effects of the extreme drought, which lasted until 1987, South Africa also experienced the worst domestic turmoil and racial unrest the country had ever experienced. According to Turton et al. (2004, pp. 77-78), the unrest grew out of the context of economic hardship due to the recession, international sanction and drought. Many townships became militant and ungovernable, and residents boycotted paying their rent and service charges, which created a financial crisis for many municipalities (Barber & Barratt, 1990, p. 304; Geldenhuys, 1990, p. 333). Infrastructure began to collapse, and physical and social conditions deteriorated (Turok, 2012, p. 11). This era of development facilitated a deep class-based segregation, which still characterises South African cities and towns (CoGTA, 2016, p. 22).

2.6 ROAD TOWARDS DEMOCRACY

A series of national and international events finally led to the unbanning of the African National Congress (ANC), the release of Nelson Mandela and the repeal of several apartheid legislations, in particular the Group Areas and Native Land Act (Turok, 2012, p. 11). According to Turton (2004, p. 82), the repeal led to a ballooning of the urban population, as blacks from the rural areas came to the towns and cities in search of a better life. They swelled the number of informal settlements and backyard shacks. It also led to increasing competition for the scarce jobs in the urban areas (Barber & Barratt, 1990, p. 336; Ross, 1999, p. 185). Nonetheless, the South African government succeeded in dramatically changing global perceptions towards the country and international sanctions were lifted.

2.6.1 International interest, local effects

In 1992, members of the ANC attended the United Nations Conference on Environment and Development (UNCED) as observers and representatives of the national liberation movement. Emanating from this conference was a comprehensive action plan informed by principles that promoted social, economic and environmentally sustainable development, called Agenda 21 (United Nations, 1997). The United Nations (UN) requested members of states to put in place adequate legislative instruments to address their own social, political and environmental issues (Dodds et al., 2012, p. 2). One such programme, drafted by the ANC shortly after UNCED, was the Reconstruction and Development Programme (RDP) (Rowlston & Schreiner, 2011, p. 50).

During this phase of transformation, South Africa was characterised by "deep glaring differences in quality of life, large variations in economic activities in different parts of the country, considerable differences in access to services and quality of life and a huge public debt" (Oranje & Merrifield, 2010, p. 35). The RDP therefore set out a number of development targets, which included, among others, the redistribution of land to landless people, building over one million houses, providing all households with a clean, safe supply of 20 to 30 litres of water per capita per day within 200 m of their homes and an adequate or a safe sanitation facility per site (Republic of South Africa, 1994).

2.6.2 South Africa's new constitution

While the ruling party made all the right noises about abandoning the apartheid regime, a series of events, including the Boipatong and Bisho massacres, took place in the early 1990s. This proved a different reality. Both the National Party and the ANC realise that common ground had to be found. This led to the drafting of the Interim Constitution, Act No. 200 of 1993 (Republic of South Africa, 1993b). The Interim Constitution contained 34 constitutional principles applicable to all citizens; it provided for a new government structure to be adopted after the first democratic election; and it redefined the country's four provinces and ten "independent" and "self-governing" bantustans into nine provinces (Republic of South Africa, 1993b). South Africa's first general elections took place on 27 April 1994, from which the ANC emerged as victors. In 1997, the Interim Constitution was replaced by a new supreme law, the Constitution of the Republic of South Africa, Act No. 108 of 1996 (Republic of South Africa, 1996).

For the first time in the history of South Africa, each citizen had a constitution inclusive and applicable to all. The Constitution stated that everyone had the right to an environment protected for the benefit of present and future generations (section 24(b)); the right to have access to adequate housing (section 26(1)); and the right to have access to water (section 27(1)(b)). Through the Constitution, new government structures were adopted, described as three spheres, rather than tiers, of government. These were national, provincial, and municipal government (see Table 2.1).

Table 2.1: Spheres of government

Sphere	Legislature	Executive	Administration	Chapter
National	Parliament	President and Cabinet	Directors-General and departments	Chapter 5
Provincial	Legislature	Premier and Executive Council	Heads of Department and staff	Chapter 6
Local	Council	Mayor and Mayoral Committee	Municipal Manager, Heads of Department and staff	Chapter 7

The Constitution grants national and provincial government the power to implement reasonable laws and other measures within its available resources to achieve land, water and related reform as contemplated by the Bill of Rights (section 25(8); section 27(2)), while local government is recognised as the sphere of government that is mandated to ensure the provision of services to communities in a sustainable and efficient manner, according to section 152 of the Constitution (Republic of South Africa, 1996). Therefore, laws and other measures adopted by national or provincial government should not make it difficult for local government to give effect to its own constitutional mandate.

Furthermore, the Constitution recognised that not all municipalities are equal in terms of capacity. The Constitution therefore requires local government to be categorised according to its own competency, whereby it will be granted the right to administer and develop by-laws for matters that it has the right to administer, according to section 155 of the Constitution (Republic of South Africa, 1996). Table 2.2 provides a summary of municipal categories, their authority and some of the matters that local government has the constitutional mandate to administer.

Table 2.2: Local government structure and mandate

Local government category	Description of authority	Matters to administer
Category A: Metropolitan municipality	Exclusive municipal executive and legislative authority in its area	• Building regulations • Firefighting • Municipal planning • Stormwater management systems in built-up areas • Water and sanitation services (limited to potable water supply systems) • Cemeteries • Local sports facilities, as well as parks and recreation facilities • Municipal and public roads
Category B: Local municipality	Shares municipal executive and legislative authority in its area with a district municipality (Category C)	
Category C: District Municipality	Executive and legislative authority in an area that includes more than one local municipality (Category B)	

Source: Republic of South Africa 1996

Of utmost importance to the study is the fact that the Constitution assigns matters of municipal planning, and water and sanitation services to local government. However, at the time, the new government had to build on the foundations of the old, which presented internal structural limitations and physical challenges, most of which was found in rural municipalities. Therefore a local government re-demarcation process was initiated between 1998 and November 2000. The boundary demarcation process merged previously separated councils, creating new wall-to-wall municipal boundaries. The new boundaries were designed to include both urban and rural settlement patterns that would strengthen rural local government.

2.7 RDP IMPLEMENTATION PHASE

Between 1995 and 2000, South Africa's newly elected government was intent on demonstrating its commitment to addressing the past service imbalances as promised by its RDP policy framework (Rowlston & Schreiner, 2011, p. 50). In 1995, the RDP was adopted as the White Paper on the Reconstruction and Development Programme (1995) and was government's primary socio-economic programme. The redistribution of land, providing housing and access to sufficient water and basic sanitation services for all became a central theme for government. National government worked endlessly on drafting new policies and legislation to facilitate the much-needed reform.

2.7.1 Finding space for reconciliation

South Africa reached an estimated household figure of 9 million in 1994. Of the estimated 9 million households, 60% resided in urban areas and 40% in rural areas. In the urban areas, the majority (65%) of urban households lived in a formal house or brick structure, while 29% lived in informal dwellings or shack in backyards or elsewhere. In rural areas, 45% of households lived in some type of formal house or brick structure, followed by 42% residing in traditional dwellings and 9% residing in informal dwellings or shacks in backyards or elsewhere. At the time, many homelands were overpopulated, which led to soil compaction, desertification and the pollution of land. The deterioration of agricultural land became evident and threatened food security at large. Living conditions did not reflect the vision of democracy, and government was under pressure to provide land for residential purposes in urban areas. According to Oosthuizen (2000, p. 103), this could only be achieved by either filling up open space in large cities or by expanding the cities' borders into adjacent rural areas. The latter was found to be favourable due to the vast areas of land required to accommodate the large-scale, single detached dwelling units as defined by low-income housing schemes (Republic of South Africa, 1995). Parliament promulgated two new Acts in support of government's aim to redistribute land and provide housing for all: the Development Facilitation Act, Act No. 67 of 1995 (the DFA), and the National Housing Act, Act No. 107 of 1997. Both Acts provided administrative preference for RDP housing projects on land outside proclaimed urban areas.

The DFA was adopted as an interim measure to bridge the gap between the old apartheid era planning laws and a new planning system that reflected the needs and priorities of the new democratic South Africa. Prior to the promulgation of the DFA, development applications were subject to long approval processes and a high degree of legal and procedural complexity. However, the DFA did not wipe the slate clean, with the result that national and provincial laws relating to land use planning promulgated before 1994 were still in existence. The National Housing Act, on the other hand, replaced all previous housing legislation with the aim of facilitating national sustainable housing development processes.

Even though the DFA and the National Housing Act echoed Agenda 21's principles of integrated planning, optimal use of existing resources and the promotion of sustainable development (Republic of South Africa, 1995), the ambitious programme to eradicate backlogs on the urban periphery gave little consideration to the fact that single-use, low-density development patterns tended to consume significant amounts of land per capita and generated larger per capita infrastructure installation and maintenance costs (UN-Habitat, 2013).

As for the economy, government announced its preference for a new liberal economic policy in 1996, shifting away from a basic needs RDP-orientated economy (Davenport & Saunders, 2000, p. 570; Peet, 2002, p. 54). As such, the Growth, Employment and Redistribution (GEAR) policy was adopted. GEAR aimed to rebuild the economy and attain a growth rate of 6% per annum through orthodox budgeting, tight control on inflation, and the creation of 400,000 new jobs by 2000 (Department of Finance, 1996, p. 1). GEAR noted that the implementation of housing and infrastructure programmes was slow until 1995, but acceleration in housing delivery became evident thereafter. GEAR highlighted the importance of agricultural development and associated land reform programmes for improving long-term prospects for employment and income generation in the rural economy.

It also recognised water and sanitation projects as priority projects in rural communities as they would contribute to major poverty relief (Department of Finance, 1996, p. 16). However, the country was in desperate need of generating new financial resources for the construction of infrastructure and service delivery.

2.7.2 Some, for all, forever

Regarding water services, an estimated 14 million people across the country lacked access to adequate water supply services, while some 21 million (half the country's population) were without adequate sanitation. Some 65% of urban households had access to piped water inside their dwellings, which was significantly higher than in rural areas, where only 11% of households had access to piped water inside their dwellings. Up to 30% of rural households only had access to untreated water, which they had to utilise directly from the source (dam, river, stream or spring). Evidently, this could be linked to the location of informal settlements, which was within the 100-year floodline, to be close to water resources. Statistics on access to sanitation services differed vastly between urban and rural areas. In rural areas, only an estimated 9% of households had access to a flush or chemical toilet, whereas the majority (64%) of households depended on pit latrines. Some 25% of households had no access to sanitation services and were subject to open defecation.

Backlog in access to services was most prominent in black rural areas, which could – in part – have been caused by the previous system, which did not provide for one dedicated department taking responsibility for water supply and sanitation services (DWAF, 2004a, p. 4). It was left to the fragmented homeland government and local municipalities to decide whose responsibility it would be (DWAF, 2004a). Nevertheless, government adopted a White Paper on Water and Sanitation in 1994, which extended the mandate of existing water boards to assist DWAF with its large development projects. Generally, these projects involved the extension or rehabilitation of existing rural supply networks, also known as DWAF's Presidential Lead Projects (DWAF, 2004a, p. 5). Water boards across South Africa played an important role in the first phase of reconstruction and development as five of the 12 Presidential Lead Projects were completed in three years, while a further four had already begun (DWAF, 2004a, p. 6).

Water Services Act, Act No. 108 of 1997

In December 1997, the Water Services Act, Act No. 108 of 1997, commenced, providing a new institutional framework for the delivery of water supply and sanitation services. The Water Services Act confirmed the Constitution's long-term goal that local government would take responsibility for providing and sustaining water and sanitation services within its area of jurisdiction (Republic of South Africa, 1997). The Act defines local government as a water services authority (WSA), which would take the lead in water services decision-making and planning processes by preparing a five-year WSDP (Republic of South Africa, 1997). The WSDP had to integrate technical, social, institutional, financial and environmental planning, and would ultimately form part of the municipal IDP process. The Act also stated that a WSA had the responsibility of securing water use licences from DWS or, in some cases, from catchment management agencies (CMAs) to abstract and discharge water.

As for national government, the Water Services Act required the Minister to set national norms and standards for basic water services (relating to the amount, quality, distance from point of use, etc.) (section 9(1)) and standards for water services tariffs (fees or pricing) (section 10(1)). The DWAF published regulations pertaining to section 9(1) in June 2001, which introduced a water service concept, as a national standard of free basic service (FBS), which was the prescribed minimum standard of service necessary for the reliable supply of water of a sufficient quantity and quality to households, including informal households, in order to support life and personal hygiene, free of charge. Regulation 509 of 2009 defined the minimum standard for basic sanitation as "a toilet which is safe, reliable, environmentally sound…" and the minimum standard for basic water supply "as a minimum quantity of potable water of 25 ℓ per person per day or 6 kℓ per household per month at a minimum flow rate of not less than 10 ℓ per minute within 200 m of a household.

The minimum volume of water was protected by the Act, which also stated that all other uses would be allocated through water use licences. Subregulation 5(3) of Regulation 509 of 2009 also regulated potable water quality and stated that water quality must comply with the standard SABS 241: Specifications for drinking water, or the South African Water Quality Guidelines published by DWAF. It is important to note that the South African Water Quality Guidelines do not require all water use to be of potable water quality.

2.7.2.1 Water and sanitation service provision

Most of the water facilities constructed and services provided during the RDP implementation phase were achieved through joint efforts of DWAF, the Department of Provincial and Local Government (DPLG) and the Department of Housing (DoH). These departments came to an agreement through the Consolidated Municipal Infrastructure Programme (CMIP) that DWAF would continue with its capital programmes in rural areas. The arrangement was that DPLG would provide municipal infrastructure development support in urban and peri-urban areas, and would take responsibility for the development and rehabilitation of bulk and connector infrastructure, while DoH would contribute to the development of internal infrastructure required to connect newly constructed houses to water and sanitation networks by utilising a proportion of the housing subsidy (DWAF, 2004a, p. 11). One of the main reasons why local government was unable to fulfil its mandate and function as a WSA during the RDP implementation phase was due to a lack of financial resources. The Department of Finance therefore developed a formula and distribution mechanism to provide an equitable share of nationally raised revenue. The equitable share structure was an unconditional transfer to all local councils based on the cost of providing a basket of basic services and the number of indigent households in the municipality. The financial assistance provided by equitable shares helped local municipalities to fully assume their water services delivery responsibility.

DWAF recognised that the provision of water supply and sanitation services was an activity separate from the overall management of water resources. However, water services must be undertaken in a manner consistent with the broader goals of water resource management as contained in the National Water Act, Act No. 36 of 1998.

National Water Act, Act No. 36 of 1998

While the National Water Act only commenced in December 1999, the Act shifted emphasis from supply management to demand management as an approach to water resource management. The Act sought to conserve the nation's water resources through an integrated water resource management (IWRM) approach, a philosophy and concepts that were, at the time, distilled through an array of key international engagements, declarations and documents. The Act declared national government the public trustee of the nation's water resources. It also repealed all previous riparian laws. The Act mandates the Minister to develop and adopt a National Water Resource Strategy (NWRS) to ensure the sustainable and equitable use, management and conservation of water resources (Republic of South Africa, 1998). As part of the strategy, the Minister must declare water management areas (WMAs). DWAF announced its intention to establish 19 WMAs based on hydrological rather than political boundaries in 1999. Once WMAs have been declared, the Act requires CMAs to be established in each WMA, which will inherit a wide range of water resource management functions. The functions of the CMA may include developing strategies for IWRM, also referred to as a catchment management strategy, regulate water use through authorisation and water use charges, implement physical interventions such as water catchment development management (WCDM), and, possibly, infrastructure development and/or operations. The Act also requires a water allocation plan to be included in the CMS to further inform all municipal WSDPs, as contemplated in the Water Services Act. Chapter 3 of the National Water Act further mandates national government to implement resource-directed measures, which consider the quality and quantity of water, the animals that live in the water and the vegetation (plants) around the water resource, also referred to as aquatic ecosystems.

According to Rowlston (2011, p. 28), protecting ecosystems is necessary to sustain the quantity and quality of water resources to fulfil basic human needs. Water resource management can therefore not be divorced from its broader environment (Rowlston & Schreiner, 2011, p. 74).

Environmental Management Act, Act No. 107 of 1998

A few months prior to the commencement of the National Water Act, government also adopted the National Environmental Management Act, Act No. 107 of 1998 (NEMA). The core environmental principle of NEMA is to promote ecologically sustainable development through the conservation and sustainable utilisation of natural resources. Like the water acts, NEMA declares national government, acting through the Minister, to be the national custodian of biodiversity and grants the right to national government to publish regulations to give effect to environmental resource planning and management. NEMA requires certain departments to develop EMPs (mostly national departments), environmental implementation plans (EIPs) (mostly provincial departments) and environmental management frameworks (EMFs) (mostly local government departments) (section 24(3)). Key to the EMF is identifying environmentally sensitive areas and areas where certain land uses are most compatible or incompatible with environmental opportunities (Driver et al., 2011, p. 48). On a local level, NEMA requires the impact of development on the environment to be regulated through EIAs, which were at the time an existing legal tool as it became mandatory in 1989 after the Environmental Conservation Act, Act No. 73 of 1989, was enacted.

Between the Constitution, the Water Services Act, the National Water Act and NEMA, an entirely new institutional and spatial planning framework for land, water and environmental resources had to be adapted by national, provincial and local spheres of government. Adhering to the various mandates, such as developing national strategies and plans, and publishing regulations, mostly only took place several years into the new millennium.

2.8 DEVELOPMENT POST-2000

By 2000, local government was still unable to give effect to its constitutional mandate of municipal planning as the abolition of the fragmented South African state and the demarcation of municipal boundaries created confusion regarding the powers and authority of municipalities. In some areas, many municipalities had never practised proper planning functions and had never had any proper planning instruments (Department of Agriculture and Land Affairs, 2001). Literature points to the fact that, during the transition period from apartheid to democracy, and in the restructuring of local government, limited integrated development planning took place (Dewar, 1998; Asmal, 2000; Donaldson & Marais, 2002) as policies were formulated “within discrete national line function departments, with little reference to the activities in other departments.” This approach contributed to a fragmented and distorted urban and rural development phase.

2.8.1 Integrated municipal planning

As noted in section 2.6.2, the Constitution bestows the responsibility of municipal planning on local government, which includes the responsibility of structuring and managing its administration and preparing the budget and planning processes to give priority to the basic needs of the community, and to promote the social and economic development of the community (section 153(a) of the Constitution). Entering a new millennium, national government remained adamant that local government would take over municipal planning. Thus, Parliament promulgated the Municipal Systems Act, Act No. 32 of 2000, which reintroduced the concept of IDP to help municipalities identify strengths and weaknesses, constraints and opportunities to prioritise effective and efficient service delivery to stakeholders. As part of the IDP process, the Act required local government to adopt a single, inclusive and strategic plan, referred to as an IDP), as its principal planning instrument to guide and inform all planning and decision-making processes with regard to development in the municipality (sections 23 and 24) (Republic of South Africa, 2000b).

Regarding water services, sections 12(1)(a) and 15(5) of the Water Services Act requires a WSDP to be prepared as part of the IDP, whereas, the IDP must reflect the development strategies and align with any national or provincial sectoral plans and planning requirements binding on the municipality in terms of legislation (e.g. the NWRS, CMS and WSDP). Regarding spatial planning and land use management, section 26(e) of the Municipal Systems Act set out the core components of the IDP, which included an SDF with basic guidelines for a land use management system for the municipality.

The content of an SDF was generally unclear to planners, and so the Minister for Provincial and Local Government gazetted regulations which fleshed out the minimum requirements of a municipal SDF (Regulation 786 of the Local Government: Municipal Planning and Performance Management Regulations). Subregulation 2(4) of Regulation 796 requires municipal SDFs to indicate desired patterns of land use, address spatial reconstruction, provide strategic guidance in respect of the location and nature of development within the municipality, set out basic guidelines for a land use management system, include a capital investment framework, contain a strategic assessment of the environmental impact of the SDF, and provide for a visual representation of the desired spatial form, which includes (among others) an indication of where public and private land development and infrastructure investment should take place, and an urban edge.

While the regulations provided new guidance towards strategic municipal spatial planning, land use planning was still confined to a highly complex and confusing legal environment due to the legacy of apartheid legislation. As the Minister of Land Affairs claimed, “the area of governance responsible for land inherited an extraordinary legislative mess from apartheid” (Department of Agriculture and Land Affairs, 2001). Various town planning ordinances, including Ordinance 15 of 1985, applicable to the Eastern Cape, Northern Cape and Western Cape, Ordinance 15 of 1986 (or the Transvaal Ordinance), applicable to Gauteng, Mpumalanga, North West and Limpopo, Ordinance 27 of 1949, applicable to KwaZulu-Natal, and Ordinance 9 of 1969, remained in existence after 1994. For this reason, land use planning and the authorisation of development applications continued to be managed and regulated within the traditional “town planning schemes” approach, which focused only on urban areas, while a single zoning labelled “agriculture” was assigned to rural areas, even though agricultural practices had very little to do with the actual land use. The agricultural zoning was merely a status given to any land outside the urban area. For this reason, the Minister of Land Affairs proposed introducing new legislation to Parliament, providing a uniform, effective and efficient framework for spatial planning and land use management in both urban and rural contexts (Department of Agriculture and Land Affairs, 2001). This led to the signing of the White Paper on Spatial Planning and Land Use Management in 2001. The White Paper was strongly influenced by Chapter 10 of Agenda 21 and called for an improved approach to integrated planning for the sustainable management of land resources (Republic of South Africa, 2001). However, the White Paper remained “just” a White Paper for many years to follow.

2.8.2 Key socio-economic development strategies between 2000 and 2004

The review of key national socio-economic policies and strategies adopted after 2000 indicates that government remained focused on stimulating economic growth as targeted in GEAR, and on land and water reform. While economic growth averaged around 3%, which was considerably higher than previous years, rural areas remained characterised by high levels of poverty, unemployment and a lack of access to basic services (The Presidency, 2005, p. 2).

In a response to the rural challenges, government adopted a new Integrated Sustainable Rural Development Strategy (ISRDS) in November 2000. The strategic objective of the ISRDS was to ensure that, by 2010, the rural areas would attain the internal capacity for integrated development (The Presidency, 2000, p. 1). Key to the strategy was to get community members involved in the IDP process to identify priority areas where “baskets of services” were required (Republic of South Africa, 2000a, p. 14). Once communities have expressed their needs, the needs assessment will translate into municipal programmes (Republic of South Africa, 2000a, p. 27). It was anticipated that the bottom-up approach would lead to quicker implementation and service delivery (Republic of South Africa, 2000a, p. 24).

However, the initial response of the post-1996 policies was to continue to promote growth in the areas that had existing advantages of economic agglomerations in the hope that this would trickle down to rural areas. Unfortunately, this hegemonic economic planning paradigm further promoted the development of strategic urban areas, while rural areas remained underdeveloped (DRDLR, 2014, pp. 2-5).

To address the challenge, the President announced two new programmes in 2001, which derived from the ISRDS: the Integrated Sustainable Rural Development Programme (ISRDP) and the Urban Renewal Programme (URP). Both programmes were defined as area-based approaches to development, as capital spending was a priority in 14 rural and 8 urban nodes (Everatt & Smith, 2008, p. 7). The aim of the area-based approach was to "crowd-in" opportunities, mobilise local partnerships, strengthen public participation and create a hot-house for broad-scale development (Forster et al., 2006). However, neither the ISRDP nor the URP adequately lived up to their promises (Public Service Commission, 2010, p. 79). One of the reasons for this was that decision makers had no spatial criteria to guide the choices they made. Instead, most choices were made in terms of those communities that attracted the most attention (The Presidency, 2003, p. 6).

In 2003, government aimed to address the issue of "lack of spatial guidance", as identified in the ISRDS, ISRDP and URP by adopting a National Spatial Development Perspective (NSDP) in 2003 (The Presidency, 2003, p. 6). The NSDP was an indicative framework to inform decisions on infrastructure investment and development spending as it gave clear direction to where urban and rural investment should take place (The Presidency, 2003, pp. 16-18). The 2003 NSDP also noted that several development programmes, including housing programmes, did not address the distortions of the inherited apartheid space economy. Part of the problem lay within the development-driven model where developers had been taking advantage of available land at a lower cost on the periphery, rather than to spend money on well-located land within major urban centres. This disconnected development trend not only created unsustainable urban forms, but also encroached on high-value agriculture land and scenic locations with tourism potential (The Presidency, 2003, p. 30).

In a response to address the concerns raised by the "development-driven model" of a low-income housing scheme, the DoH develop a Comprehensive Plan for the Development of Sustainable Human Settlements, also referred to as the Breaking New Ground (BNG) document, in 2004. The plan emphasised the need to move away from a housing-only approach to a more holistic development of human settlements, including the provision of social and economic infrastructure (Department of Housing, 2004). The BNG promoted human settlements that are compact, have mixed land uses and have life-enhancing environments with maximum possibilities for pedestrian movement and transit (Department of Housing, 2004, p. 11). The BNG also encouraged social housing to be of medium density that provided infrastructure services through alternative technology and design. The BNG strategy did not specify which technologies it was referring to, but it noted that the "Department will investigate measures and incentives to enhance housing design and promote alternative technologies…" (Department of Housing, 2004, p. 16).

2.8.2.1 First edition of the NWRS 2004

A strategy that was to address and promote the use of alternative technologies with regard to water services was the NWRS, as the country's national strategic framework, which provides for the "protection, use, development, conservation, management and control of water resources for the country as a whole" (DWAF, 2004b). However, the NWRS only mentions rainwater harvesting once: "Rainwater harvesting from roofs or other hardened surfaces, using tanks, small check dams or catch pits can supplement more conventional sources of supply…" (DWAF, 2004b, p. 66), whereas the concept of water reuse was broadly used as a substitute for return flow to centralised water treatment works. However, the NWRS provided other options for reconciliation interventions, which included water demand management, improved resource management and conservation, the management of invasive alien vegetation, the reallocation of water, the development of surface water resources and the inter-catchment transfer of water, and the increased use of groundwater (DWAF, 2004b, pp. 78-90).

The latter became a focus point for DWAF as the increased use of groundwater played a pivotal role in rural water supply (DWAF, 2004b, p. 15). These interventions were designed to address the water deficits in WMAs, which were projected to increase, while surpluses were expected to diminish by 2025 (DWAF, 2004b, p. 38). This was determined by measuring growth in socio-economic standards as the primary determinant for future water requirements (DWAF, 2004b, p. 33).

The NWRS reflected on development in general and noted that the occurrence of mineral riches and/or the political dispensation of apartheid had led to the development of major urban, industrial and dense rural settlements in remote areas, far from large watercourses. As a result, the natural availability of water in river basins was severely hindered by large-scale water transfers across catchments.

In terms of water quality, the NWRS identified agricultural drainage and wash-off, urban drainage and effluent return flows, industry wash-off and return flows, mining activities and areas with insufficient sanitation services as the country's major sources of surface water pollution, whereas groundwater is mainly polluted from mining activities, leachate from landfills, human settlements and the intrusion of sea water (DWAF, 2004b, pp. 23-24). Of utmost importance to the study is the fact that the 2004 NWRS recognises the potential influence of land use practices, e.g. impervious surfaces in urban areas, on the proportion of runoff that reaches streams or penetrates the surface, and its water quality impact. However, in-depth reporting on these factors was deemed beyond the scope of the 2004 NWRS (DWAF, 2004b, p. 38) and referred to land use and climate change as "other factors influencing water availability and water requirements" (DWAF, 2004b, p. 38). As for climate change, the NWRS stated that "whilst this phenomenon has been observed internationally, and points to the likelihood of changing climatic patterns, there is as yet little conclusive evidence of any accelerated, large-scale and persistent long-term climatic shifts in South Africa" (DWAF, 2004b, p. 38).

Yet another strategy, the South African National Climate Change Response Strategy (NCCRS), also published in September 2004, begged to differ. The NCCRS noted that climate change will most likely change precipitation patterns, and cause densification, storms and flood events. These changes will have a severe impact on the availability and quality of freshwater resources (DEAT, 2004, p. 5).

Nevertheless, the NWRS (2004b, p. 148) contributed to the aims and programmes of the ISRDP and the Urban Renewal Strategy (URS) by prioritising water resources management programmes in areas identified in the ISRDP. As for urban areas, the interventions of the NWRS (2004b, p. 148) would include the planning and development of urban river floodplains to ensure public and infrastructure safety during flood events, ensuring compliance with licence conditions, emphasising the value of urban rivers as social amenities, and assisting with clean-up campaigns.

2.8.2.2 Systematic biodiversity planning

As noted in the previous section, environmental discourse and concerns were raised by several national strategies such as the NSDP, NWRS and the NCCRS. In 2004, Parliament promulgated two new Acts, the National Environmental Management: Protected Areas Act, Act No. 57 of 2003 (NEMPAA), in February 2004, and the National Environmental Management: Biodiversity Act, Act No. 10 of 2004 (NEMBA), in June 2004 (Republic of South Africa, 2015). Together with NEMA, the trio of Acts facilitates the legal protection, conservation, planning and management of the county's biodiversity.

National Environmental Management: Protected Areas Act, Act No. 57 of 2003

The National Environmental Management: Protected Areas Act grants national government, acting through the Minister and, in some instances, the MEC, the authority to declare areas as special nature reserves, nature reserves or protected environments. The objective of declaring areas as such is to protect an ecologically sensitive area's viability and integrity. Declared areas provide for the sustainable use of natural and biological resources. Protected areas also establish an interrelationship between natural environmental biodiversity, human settlements and economic development (section 17(a-j) of the Act).

National Environmental Management: Biodiversity Act, Act No. 10 of 2004

The National Environmental Management: Biodiversity Act mandates the Minister to prepare and adopt a National Biodiversity Framework (NBF) (section 38(a) of the Act) that provides for an integrated, coordinated and uniform approach to biodiversity management (section 39(1)(a) of the Act) (Republic of South Africa, 2004a). Key to the NBF is the identification of areas for conservation action and the establishment of protected areas (section 39(1)(c) of the Act), providing a direct link to NEMPAA. NEMBA also makes provision for the Minister or the MEC for Environmental Affairs in a province to delineate bioregions and to develop a bioregional plan for the protection and management of biodiversity in the bioregion (sections 40 and 41 of the Act). However, this is not compulsory, but rather at the discretion of the Minister. Section 43(1) of NEMBA also allows for any person, organisation or organ of state with the desire to contribute to biodiversity management the right to submit to the Minister a draft biodiversity management plan for any ecosystem listed in terms of section 52 of the Act, or not listed, but that warrants special conservation attention. The Act provides for ecosystems to be listed as critically endangered, endangered, vulnerable or as a protected ecosystem (sections 52 to 55 of the Act).

In support of the Minister's mandate to develop and adopt an NBF, the Department of Environmental Affairs and Tourism (DEAT) commissioned the country's first-ever comprehensive spatial biodiversity assessment. The findings of the assessment were published in 2004 as part of the National Spatial Biodiversity Assessment (NSBA) report. The 2004 NSBA indicated that 31% of terrestrial ecosystems were threatened, 5% were critically endangered, 13% were endangered, and 16% were vulnerable. The assessment of the mainstream rivers revealed that 26% of quaternary catchments were intact (category A or B), whereas 48% were moderately modified (category C), and 26% were transformed (categories D-F). The assessment of the rivers also revealed that out of 120 signature rivers, 82% were threatened, and of these, 44% were critically endangered, 27% were endangered, 11% were vulnerable and 18% were least threatened. At the time, no wetland ecosystems were assessed due to a lack of appropriate national data on wetlands. Yet, the assessment made it clear that the multiple demands from urban settlements, agriculture and industry had a major impact on the country's already scarce water resources, while rapid and uncontrolled land cover change was identified as the single biggest cause of loss of biodiversity in the country (Driver et al., 2004, pp. 6-33). The NSBA also raised concerns about the country's existing national protected area system, which did not adequately conserve a representative sample of the country's biodiversity, nor did it adequately maintain key ecological processes across the landscape and seascape (Republic of South Africa, 2010, p. 16; SANBI, 2014b, p. 73).

The spatial component of the NSBA later informed the 2005 National Biodiversity Strategy and Action Plan (NBSAP), which defined the long-term strategy for the conservation and sustainable use of South Africa's biodiversity (SANBI, 2016a). The goal of the NBSAP was to conserve and manage terrestrial and aquatic biodiversity to ensure sustainable and equitable benefits to the people of South Africa, now and in the future (DEAT, 2005, p. 27). The NBSAP listed several strategic objectives to be reached within the next 15 years. Among these objectives, the NBSAP identified the need to integrate terrestrial and aquatic management, create an enabling policy and legislative framework that integrates biodiversity management objectives into the broader economy, develop a network of conservation areas and maintain key ecological processes across landscapes (DEAT, 2005, pp. 28-30). Ultimately, the key findings from the 2004 NSBA and the strategic objectives of the 2005 NBSAP led to the development of the 2008 NBF.

2.9 SOUTH AFRICA'S SECOND DECADE OF DEMOCRACY

Within the passing of the first decade post-apartheid, most of the country's socio-economic strategies were criticised for lacking some or other component, some being spatial and environmental, while others may have been economic or financial. Nevertheless, economic growth reached an all-time high of 5% in 2004.

This was considerably higher than previous years, which averaged 1% per annum (The Presidency, 2005, p. 2). Between 1994 and 2004, an estimated R8 billion in capital grants was towards municipal infrastructure programmes. More than 50% of the capital (R4.9 billion) was invested in urban and peri-urban water and sanitation services infrastructure schemes (DWAF, 2004a, p. 11), while expectations for future economic growth was high, and an estimated 27.7 million people already benefitted directly from the Free Basic Water Policy (DWAF, 2004a, p. 15). However, concerns about unemployment did not fade. Since the 2000 UN Millennium Summit, government's target was to halve poverty by 2015. This target was adopted as part of national government's pledge towards the Millennium Development Goals (MDGs). However, research indicates that the real income of the poorest 20% of South Africans rose by 30% in real terms between 1994 and 2004, while unemployment remained above 26% in 2005 (The Presidency, 2005, p. 2).

Government's response to the socio-economic shortfalls was to replace the 1996 GEAR strategy with a new macro-economic strategy called the Accelerated and Shared Growth Initiative for South Africa (AsgiSA) in 2005. The strategy set lofty goals for socio-economic development, i.e. to reduce poverty by 2010, and halve unemployment by 2014. AsgiSA identified investment in public infrastructure as a response to achieving the set targets. It identified several large provincial projects that would contribute to job creation. However, it was not concerned with where local government infrastructure investment should take place, as this was to be addressed in the revised NSDP.

2.9.1 National Spatial Development Perspective, 2006

The revised NSDP, adopted in 2006, aimed to facilitate optimum alignment between infrastructure investment and development programmes within localities (The Presidency, 2006, p. i). The difference between the 2003 and the 2006 NSDP was that the latter did not predetermine what should happen where, when and how. Instead, it provided for norms and principles designed to guide the investment and development spending of all spheres of government (The Presidency, 2006, p. i). The NSDP argued that government's social objectives will be best achieved through infrastructure investment in economically sustainable areas with proven development potential. As such, areas displaying little or no possibility of growth should only be provided within the constitutionally mandated minimum levels of services. In these areas, government spending should rather be on the people, i.e. social development spending (The Presidency, 2006). Furthermore, the 2006 NSDP encouraged compact, nodal urban development and discouraged investment in fixed infrastructure in marginal areas of limited economic potential. However, the 2006 NSDP was perceived to support an unbalanced national spatial development profile. Thus, to give effect to the shortcoming of the 2006 NSDP, government adopted the Regional Industrial Development Strategy (RIDS) in 2007, which entailed state support for economic development in non-metropolitan regions and small towns with limited asset bases (Oranje, 2010, pp. 61-62).

2.9.2 South Africa's framework for sustainable development

In 2008, a new wave of thinking emerged, one which was based on a systematic approach to sustainability "where the economic system, the socio-political system and ecosystem services are embedded within each other, and integrated through the governance systems that hold all the other systems together in a legitimate regulatory framework" (DEAT, 2008, p. 14) (see Figure 2.3).

2.9.2.1 National Framework for Sustainable Development, 2008

The National Framework for Sustainable Development (NFSD) was government's first national applicable framework to spell out South Africa's vision for a sustainable society. The vision states that "South Africa aspires to be a sustainable, economically prosperous and self-reliant nation that safeguards its democracy by meeting the fundamental human needs of its people, by managing its limited ecological resources responsibly for current and future generations, and by advancing efficient and effective integrated planning and governance through national, regional and global collaboration" (DEAT, 2008, p. 19).

Figure 2.3: The 2008 NFSD system's approach to sustainability

The NFSD assessed natural, social, economic, governance and critical cross-cutting global trends, and derived priority areas or "pathways" to achieving sustainable development. In terms of governance and integrated planning, the NFSD emphasised the need to integrate environmental considerations with government policies, laws and strategies, and more specifically, an SDF. The NFSD also emphasised the need for soil rehabilitation and investment in alternative and sustainable infrastructure, broadly referring to green infrastructure investment. Most importantly, the NSDF called for sustainable human settlement strategies that promote densification and reduce urban sprawl (DEAT, 2008, pp. 32-40).

2.9.2.2 National Biodiversity Framework, 2008

During the same year, the Minister of Environmental Affairs and Tourism published DEAT's first NBF in terms of section 38 of NEMBA, which also emphasised the need for ecological sustainable development. The NBF shifts attention from "conserve or develop" to "how and where to conserve and develop" (DEAT, 2009 , p. 39). The framework reflected on other national economic and environmental strategies, including AsgiSA 2005, the NSDF 2006 and the 2008 NFSD.

In terms of AsgiSA 2005, the NBF noted that the targeted 6% growth rate would have major implications on the use of natural resources, especially water. Yet, the NBF claimed that it is possible to overcome the challenge if care is taken over the location, type and consumption pattern of proposed developments (DEAT, 2009, p. 25). As for the 2006 NSDP, the NBF noted that it is "consistent with biodiversity conservation objectives, especially to the extent that it encourages compact, nodal urban development and discourages investment in fixed infrastructure in marginal areas of limited economic potential" (DEAT, 2009, p. 32).

In terms of the 2008 NFSD, which identified the need for greater integration between environmental considerations and other strategic plans, such as SDFs, the NBF proposed that the "how and where" of development should be addressed by provincial spatial biodiversity plans (SBPs). The NBF explained that provincial SBPs are to be informed by a variety of systematic biodiversity assessment processes, ultimately to identify CBAs and ESAs and to provide guidelines for land use planning and decision making in these areas. On a more localised spatial scale, provincial SBPs should form the basis of bioregional plans published in terms of NEMBA and should also be used to inform environmental assessment, the EMF, and local and district SDFs. The NBF also proposed that provincial SBPs should inform authorities responsible for environmental conservation on "where" possible expansion of protected areas can take place, as it was already a known fact that the country's existing protected area system was insufficient (see section 0). Guidance on "how" to expand protected areas was later addressed in a new strategy published by the DEA in 2009, the National Protected Areas Expansion Strategy (NPAES) (Republic of South Africa, 2010, p. v).

2.9.2.3 National Protected Areas Expansion Strategy

The NPAES targets the expansion of land-based protected areas with 2.7 million hectares, inshore marina with 88 km^2 and offshore marine areas with 52 km^2 (Republic of South Africa, 2010, p. 17). The NPAES highlighted the importance of freshwater ecosystems in land-based protected areas as they are vital for maintaining resilience to climate change (Republic of South Africa, 2010, p. 11). Yet, the NPAES did not set any expansion targets for freshwater ecosystems as another project, the National Freshwater Ecosystem Priority Area (NFEPA) project, was underway. The goal of the NPAES was to achieve the cost-effective expansion of protected areas. Therefore, the strategy introduced four mechanisms: the acquisition of land, contract agreements, the declaration of public land and biodiversity management agreements (Republic of South Africa, 2010, p. 32). The expansion strategy emphasised the fact that protected areas also "support land reform, rural livelihoods, ecosystem services and socio-economic development" (Republic of South Africa, 2010, p. 9).

2.9.2.4 Medium-term Strategic Framework, 2009-2014

In April 2009, South Africa's fourth democratic elections took place, where the ANC emerged as victors once again. The Medium-term Strategic Framework (MTSF) for 2009-2014 captured government's strategic objectives and targets for the new election term, which included, among others, halving poverty and unemployment by 2014, ensuring a more equitable distribution of the benefits of economic growth, and reducing inequality (The Presidency, 2009, p. 2). To give effect to the objectives, the MTSF developed 10 strategic priorities, four of which affected land and water resources directly (The Presidency, 2009, p. 10-44).

Firstly, the MTSF aimed to speed up economic growth and transform the economy by creating jobs through infrastructure projects and upgrading informal settlements, while at the same time, government should work to improve expenditure and urban management, especially in respect of infrastructure projects and economic services (The Presidency, 2009, p. 12-15).

Secondly, the MSTF aimed to build economic and social infrastructure, while also considering environmental sustainability and pursuing maximum employment (The Presidency, 2009, p. 16). As for water infrastructure, the MSTF required government to continue to build and maintain water infrastructure, improve reticulation, prevent wastage and ensure reliable and safe supply for human consumption, industrial activity and agriculture (The Presidency, 2009, p. 18). As for human settlements, the MSTF stated that the finalisation of the Land Use Management Bill was critical for facilitating the development of sustainable human settlements (The Presidency, 2009, p. 18).

Thirdly, the MTSF called for the development of a Comprehensive Rural Development Programme (CRDP) to facilitate the aggressive implementation of land reform policies where water allocation is tied into the land release process (The Presidency, 2009, p. 19). The MTSF emphasised that increased investment in service delivery, guided by spatially targeted strategies and using alternative technologies, where appropriate, to overcome physical and other impediments, should be a main priority in rural areas (The Presidency, 2009, p. 20). Finally, the MTSF promoted sustainable resource management and use by focusing on various interventions, such as developing a national framework response on climate change mitigation, a strategy for the payment of ecosystems services, exploring the concept of green jobs and the implementation of the 2008 NFSD (The Presidency, 2009, p. 38-39).

As called for by the MTSF, the DRDLR published a CRDP in July 2009 (DRDLR, 2009), which took a proactive, participatory community-based planning approach, rather than an interventionist approach to rural development. The CRDP aimed to provide an alternative to urban centres by creating economic opportunities in both agricultural and non-agricultural sectors, thus contributing to the reduction of rural-urban migration. The CRDP proposed that this could be achieved through three strategic thrusts: agrarian transformation, rural infrastructure development and land reform. Linking to the second thrust, the supply of clean, safe drinking water was an important part of the programme, and the development of groundwater resources in rural areas was considered integral to achieving the goals of the CRDP (DWAF, 2010, p. 9). This was further explored in the 2010 National Groundwater Strategy.

2.9.2.5 National Groundwater Strategy, 2010

The 2010 National Groundwater Strategy, published by DWAF, emanated from DWAF's internal directive to better understand the underutilised and misunderstood resource. The strategy noted that groundwater resources did not receive the same level of attention as surface water. The opinions of skilled water managers were that it might relate to the system of water management introduced in the early 19th century (the riparian principle discussed in section 2.3). The strategy reports that decision makers in the fields of climate change preparedness, rural poverty alleviation and related fields did not always have adequate information about the way in which groundwater can assist them. As a result, spatial planning documents rarely consider groundwater, even where groundwater is a potential major factor in continued economic development (DWAF, 2010, p. 11). Furthermore, the lack of understanding of the spatial elements of groundwater also led to widespread deteriorations in groundwater quality. The strategy blamed land use linked to various sectors such as mining, industrial activities, effluent from municipal wastewater treatment works (WWTW), stormwater runoff from urban and especially informal settlements (where adequate sanitation facilities are often lacking), return flows from irrigated areas, effluent discharge from industries, etc." (DWAF, 2010, p. 24). These land use activities contributed to high levels of electricity conductivity in several regions, making groundwater brackish or even saline (DWAF, 2010, p. 18). However, the strategy noted that South Africa's groundwater is generally safe to drink without treatment, and that groundwater resources will be "less directly and more slowly impacted by climate change compared to, e.g. rivers (surface water) as the volumes are stored underground and do not evaporate as quickly as surface water resources" (DWAF, 2010, p. 9). Therefore, the development of groundwater extraction infrastructure will be fundamental for sustainable rural development, as called for in the CRDP. It was said that this strategy will form part of the second edition of the NWRS, as it is designed to ensure that groundwater is recognised, utilised and protected as an integral part of South Africa's water resource (DWAF, 2010, p. 2).

2.10 GOVERNMENT'S NEW DEVELOPMENT PATH

In December 2010, government announced the adoption of a new economic strategy, the New Growth Path (NGP), which recognised that, despite of all other national strategies, inequalities were deeper than ever before (Ministry of Economic Development, 2010, p. 10). The NGP set a new goal, which was to create five million new jobs through five job leavers, two of whom were of specific importance to the study. According to the NGP (Ministry of Economic Development, 2010, pp. 27-28), investment in infrastructure development (the first job driver) could create 250,000 jobs a year through construction, operation, expanded maintenance and the manufacture of components, while spatial development (the fifth job driver), more specifically rural development, had the possibility of improving the livelihoods of 500,000 households, as well as stimulating employment in other sectors (Ministry of Economic Development, 2010, pp. 35-36). Furthermore, the NGP stressed the importance of a green economy as one of South Africa's future key job drivers by "greening" economic progresses (Ministry of Economic Development, 2010, p. 45; NPC, 2012, p. 55).

During the same year, the Presidential Infrastructure Coordinating Commission (PICC) was established to assess South Africa's shortcomings and achievements since 1994. The diagnostic report, published in 2011, highlighted major developmental challenges in terms of inadequate infrastructure, poor quality of public services, high levels of unemployment, high levels of corruption, and a resource-intensive economy (Armitage et al., 2014, p. 30). The diagnostic report led to the approval of a new national plan, the National Infrastructure Plan (NIP), providing national direction on where strategic infrastructure projects (SIP) must take place. The PICC introduced 18 SIPs, several of which have spatial and water-related implications.

Regarding spatial planning, the NIP aims to develop the country's first major post-apartheid "green" urban centre (SIP 1), and coordinate the planning and implementation of sustainable urban settlements connected by densified transport corridors (SIP 7).

Regarding infrastructure investment, the NIP aims to develop national capacity to address the maintenance and upgrading of existing bulk water and sanitation infrastructure (SIP 6), improve investment in irrigation schemes in poor areas to facilitate agricultural and rural development (SIP 11), build new WWTW, provide water services to 1.4 million households and basic sanitation to 2.1 million households, and implement water leak management and water demand awareness programmes (SIP 18).

2.10.1 South Africa's National Development Plan

The 2011 diagnostic report also noted that, in future, the country should approach development needs differently, shifting from a paradigm of entitlement to a paradigm that promotes the development of capacities, the creation of opportunities and the participation of all citizens. To give effect to the future development of South Africa, government announced the adoption of a National Development Plan (NDP), which would lay down the long-term socio-economic development roadmap for the next 20 to 30 years (National Planning Commission, 2012).

2.10.1.1 The NDP's take on water resources

Regarding water resources, the NDP acknowledges that South Africa is a water-scarce country and emphasises that greater attention will need to be placed on the management and use of this resource (National Planning Commission, 2012, p. 177). This is to be addressed by an existing statutory public process, the NWRS, which, by law, must be reviewed every five years (National Planning Commission, 2012, p. 179). However, almost 10 years have passed since the release of the first edition of the NWRS. As for the NDP's vison for water and water services, it states that "before 2030, all South African will have affordable access to sufficient, safe and hygienic sanitation to live healthy and dignified lives… the country's economic and social development will reflect an understanding of and an alignment with available water resources… All main urban centres will have a reliable supply of water to meet their needs… The natural water environment will be protected to prevent excessive abstraction and pollution" (National Planning Commission, 2012, pp. 177-187). The NDP's target for water services is to reduce water demand in urban areas to 15% below the business-as-usual scenario by 2030 (National Planning Commission, 2012, p. 179).

2.10.1.2 The NDP's take on the environment

Regarding environmental sustainability, the NDP recognises that South Africa has a rich endowment of natural resources and mineral deposits, which can fund the transition of a low-carbon future and a more diverse and inclusive economy, if used responsibly (National Planning Commission, 2012, p. 197). The NDP's vision in respect of environmental sustainability and a low carbon economy states that "by 2030, planning and investment in infrastructure and services will take into account climate change and other environmental pressures… invest in sustainable technologies and programmes to conserve and rehabilitate ecosystems and biodiversity areas… and have a land use policy and regulatory framework in place to determine the environmental and social cost of new developments" (National Planning Commission, 2012, p. 199). The NDP supports the NPAES by promoting the biodiversity stewardship programme and building conservation partnerships around privately owned land, while National Treasury introduces incentives to protect and rehabilitate ecosystems, such as tax rebates (National Planning Commission, 2012, p. 202).

2.10.1.3 The NDP's take on human settlements

Regarding sustainable human settlements, the NDP acknowledged that a great deal of progress has been achieved since 1994, but South Africa was still far from "breaking down apartheid geography" as many people still live in poverty traps (National Planning Commission, 2012, pp. 260-261). Despite reforms to the planning system, colonial and apartheid legacies still structure space across different scales (National Planning Commission, 2012, p. 260). This legacy has caused extreme differentiation within rural and urban areas.

The NDP further explains that while most rural settlement are located in remote areas, characterised by low densities and marginal economies, other rural settlement are fast approaching urban densities and have established a potential economic base as they are well located in terms of urban markets and transportation corridors (National Planning Commission, 2012, pp. 263-265).

As for urban areas, huge differentiation in terms of spatial form, economic base and institutional strengths are observed (National Planning Commission, 2012, p. 266). Other sources characterise the typical South African towns and cities as resource intensive, suffering from inefficiencies across sectors (energy, food, water, waste and transport) (Turok & Borel-Saladin, 2014). While some decoupling has been observed in the energy sector, generally, the development trajectory is unsustainable (SACN, 2016). Cities and towns also have unique peri-urban environments that are defined by variations in affluent residential areas (high-end residential development that often consumes resources unsustainably – planned); low cost and social housing estates (RDP housing on degraded land with a low market value, often referred to as poorly planned settlements); and informal settlements (located on vacant and unsuitable land for human settlements due to local topological features such as unsuitable soils, wetlands and flood risks – unplanned and in many cases illegal) (DEA, 2014). Combined features of urban and rural settlements are also found in areas that form part of traditional land, under the authority of traditional councils (DEA, 2014). In these areas, land use decisions are made on behalf of the community by the tribal chief. These decisions are often uninformed due to a lack of adequate planning of land use management systems. The fact that urban and rural settlements suffer from inefficiencies is no secret. These inefficiencies, as identified by the NDP, are summarised below:

Table 2.3: NDP: inefficiencies across urban and rural settlements

Rural inefficiencies	Urban inefficiencies
High cost of providing services and infrastructure in rural areas, especially in places that are remote and have low population densities.	As urbanisation continues, a large proportion of the urban residents will be poor, reflecting a phenomenon referred to as the urbanisation of poverty.
Many rural settlements have population densities approaching those of urban areas, but lack a mix of land uses, urban economies and infrastructure.	South African towns and cities are highly fragmented, imposing high costs on households and the economy. Overall, little progress has been made in revising apartheid geography.
The current framework that governs land in traditional areas is not working, nor is it integrated with overall municipal spatial planning.	The relationship between where people live and how they survive is often overlooked.
Large areas of high-potential agricultural land are grossly underutilised, particularly in traditional areas.	Although cities are generally more resource efficient than scattered settlements, their concentration requires the development of large sources of energy and water, placing strain on the surrounding environments.
Rural areas have weak mechanisms to resolve spatial conflicts involving tourism, agriculture, mining rights and the protection of the environment, which are becoming increasingly acute as natural resources are depleted.	Continuous urbanisation will result in increased water resource consumption and wastewater production as higher levels of services are provided in urban areas.

Source: National Planning Commission, 2012, pp. 265-267

Within the context of differentiation and inefficiencies in existing urban and rural settlements, the NDP provides a vision for each. The NDP's vision for rural settlements states that "by 2030, South Africa will have developed vibrant, productive rural communities that create and keep wealth in their areas and also provide benefits for the nation" (National Planning Commission, 2012, p. 283).

In achieving this vision, it is necessary to understand the rationale for investment in various types or levels of services, e.g. innovative forms of service and infrastructure provision where conventional, fixed infrastructure may be unavoidable (National Planning Commission, 2012, p. 283).

The NDP's vision for urban futures is less direct and states that, among other things, "… urban sprawl should be contained and possibly revised as denser forms of development become more efficient in terms of land use, infrastructure cost and environmental protection… towns must be designed for long-term resilience and flexibility… and more attention should be given to the design and quality of urban public space" (National Planning Commission, 2012, pp. 285-286). However, solutions and strategies must be tailored to their unique circumstances.

2.10.1.4 The NDP's criticism of spatial planning and land use management

The NDP criticised the existing spatial planning systems and called for an urgent and comprehensive review. According to the NDP, due to the complex division of powers and functions between local, provincial and national government, there is uncertainty about who is responsible for spatial planning. Furthermore, legislation that regulates land use management is largely unreformed and dates back to apartheid, while provincial land use management functions, such as agriculture, tourism and environmental management, overlap with those of municipalities, creating confusion and conflict (National Planning Commission, 2012, pp. 274-275). The NDP also called for a national spatial vision to be informed by overarching spatial principles, including spatial justice, spatial sustainability, spatial resilience, spatial quality and spatial efficiency. However, it did not take long for Parliament to react to the criticism raised by the NDP in terms of the spatial planning system as new planning legislation was soon to be enacted.

2.10.2 A unified system for spatial reform

The post-apartheid era saw little reform in planning legislation. Various Acts and ordinances governed spatial planning (as apparent in the following list):

- Constitution of the Republic of South Africa, Act No. 108 of 1996
- Municipal Systems Act, Act No. 32 of 2000
- Development Facilitation Act, Act No. 67 of 1995
- Less Formal Township Establishment Act, Act No. 113 of 1991
- Planning Acts and Ordinances in the provinces
- Free State – Townships Ordinance No. 9 of 1969
- Eastern Cape – Cape Land Use Planning Ordinance No. 15 of 1985
- North West – Cape Land Use Planning Ordinance No. 15 of 1985
- Western Cape – Cape Land Use Planning Ordinance No. 15 of 1985
- Gauteng – Transvaal Town Planning and Townships Ordinance No. 15 of 1986
- Limpopo – Transvaal Town Planning and Townships Ordinance No. 15 of 1986
- Mpumalanga – Transvaal Town Planning and Townships Ordinance No. 15 of 1986
- Northern Cape – Northern Cape Planning and Development Act No. 7 of 1998.
- KwaZulu-Natal - KwaZulu-Natal Planning and Development Act No. 6 of 2008 (and vestiges of the Natal Town Planning Ordinance No. 27 of 1949 for special consent)

On 18 June 2010, the Constitutional Court delivered judgment in the application by the City of Johannesburg Metropolitan Municipality for the confirmation of an order made by the Supreme Court of Appeal, declaring Chapters V and VI of the Development Facilitation Act unconstitutional and thus invalid. In view of this evidence, the court then suspended the order of invalidity for 24 months to allow Parliament to rectify the defects in the Act or to pass new legislation. This "rectification" process led to the eventual enactment of the Spatial Planning and Land Use Management Act in 2013.

Spatial Planning and Land Use Management Act, Act No. 16 of 2013

In August 2013, the spatial planning system of South Africa underwent a dramatic reform as the long-awaited Spatial Planning and Land Use Management Bill was enacted in terms of section 155(7) and section 44(2) of the Constitution, and became the Spatial Planning and Land Use Management Act, Act No. 16 of 2013.

Although SPLUMA was only set for implementation on 1 July 2015, it was the first legislative measure to provide a unified spatial planning and land use management system for the whole of South Africa and all levels of government (Nel, 2016, p. 80). SPLUMA addressed the concerns raised by the NDP, as it clarified the roles and responsibilities of each sphere of government where spatial planning is concerned. Among others, section 5 of SPLUMA assigns the following planning responsibilities:

- National government is responsible for "the compilation, approval and review of spatial development plans and policies, including a national spatial development framework… execution of legislative and executive powers related to land… the making and review of policies and laws necessary to implement national planning."
- Provincial governments are responsible for "the compilation, approval and review of a provincial spatial development framework… monitor, approve and review municipal land use schemes… execution of its legislative and executive powers related to land… the making and review of policies and laws necessary to implement provincial planning."
- Local government (municipalities) is responsible for "the compilation, approval and review of integrated development plans, spatial development frameworks and a land use scheme… and the control and regulation of the use of land within the municipal area where the nature, scale and intensity of the land use do not affect the provincial planning mandate of provincial government or the national interest."

SPLUMA creates a spatial planning system that integrates policy, spatial planning and land use management, especially at local government level, to address the inclusion of people and spaces that were previously excluded from the development framework (Strauss & Liebenberg, 2014, p. 434). It defines the spatial planning system in South Africa as consisting of SDFs to be prepared and adopted by national, provincial and municipal spheres of government, and the management and facilitation of land use management through the mechanism of a municipal LUS.

The Act also mandates that all plans should give effect to spatial principles, including spatial justice, spatial sustainability, spatial resilience, spatial quality and spatial efficiency, as called for in the NDP. SPLUMA mandates that spatial planning and land use management practices adhere to all other legal requirements as they reflect the spirit of relevant legislation, such as the Constitution and the Municipal Systems Act, which sets out the principles of cooperative governance and the duties and objectives of local government, including the alignment of all plans. Moreover, spatial planning and land use management must adhere to environmental legislation, including NEMA, NEMBA and NEMPAA. The National Water Act and the Water Services Act also fall within the description of the relevant legislation. However, SDFs and LUSs hardly ever mention these Acts – hence the unsustainable trajectory of land and water resource planning and management.

2.10.2.1 Spatial Development Framework

An SDF is best described as a long-term (10- to 20-year) development framework with a vison, goals and objectives expressed spatially through strategies designed to address physical, social and economic defects. The SDF is therefore concerned with the future and development trends within the municipality and more specifically within urban and rural settlements. A municipal SDF exists within a multidisciplinary environment. It is therefore not confined to IDP-related projects and programmes, but integrates and coordinates the development proposals, strategies, plans and projects of sectors within the various spheres of government and adjacent municipalities (see discussion in section 0).

2.10.2.2 Land use scheme

The requirements for developing and implementing a municipal LUS has changed radically since the commencement of SPLUMA. Section 4 of SPLUMA specifies that a municipality should adopt and approve a single LUS for its entire municipal area within five years of the commencement of the Act.

Prior to the implementation of SPLUMA, LUSs (or zoning schemes) mostly covered only urban or developed town areas, excluding the broader and much larger rural areas characterised by informal settlements, former homelands, and areas of widespread poverty and deprivation from the benefits of land use management (Strauss & Liebenberg, 2014, p. 343; Charlton, 2008, p. 18; Parnell & Pieterse, 2010, p. 153).

SPLUMA acknowledges the challenges of introducing land use management within these areas, which will most likely include limited data or the absence of surveyed sites, lack of information on the boundary verification of individual properties and a lack of ownership information on these locations (Nel, 2016, p. 81). Parnell and Pieterse (2010, p. 157) also state that the inclusion of these areas have been ignored by municipal officials as they are concerned with their own safety to enforce land use regulations in many townships and informal settlements. Furthermore, the right to allocate land for occupation is viewed as one of the core roles of traditional authorities. Implicit in the allocation of land is the determination of land use, such as shops or businesses, residential use and the delineation of fields for crops and rangelands for grazing. To date, traditional authority areas have received very little planning attention, and have been left to manage land according to their own customs and practices. Unfortunately, very few traditional chiefs have the necessary skills, tools and exposure to adequately give effect to the principles of sustainable development. Furthermore, many traditional leaders see the imposition of land use management schemes and land use decisions by the municipality, as mandated by SPLUMA, as intruding on their traditional authority (Nel, 2016, p. 81). In acknowledging the above concerns, SPLUMA provides for the “incremental introduction”, as defined in section 24(2)(c), of land use management in areas previously not subject to an LUS. Land use management through a municipal LUS should not be seen as a threat to those unfamiliar with it. In fact, an LUS should be regarded as the implementation mechanism for spatial plans and policy and the realisation of the principles in practice.

2.11 SECOND-GENERATION STRATEGIES

Between 2010 and 2018, many existing national assessments, reports and strategic plans were either reviewed or replaced, hence the heading “second-generation strategies". To start with, the 2004 NSBA was reviewed and published as the National Biodiversity Assessment in 2011. The NBF addresses the gaps in the first assessment, specifically relating to freshwater resources, revealing that 48% of wetland ecosystem types are critically endangered, yet they only take up 2.4% of the country’s surface area. The NBF also revealed that high water yield areas of strategic importance take up less than 4% of the country’s area, but only 18% of them have any form of formal protection.

During the same year, a new strategy, designed to give effect to the 2008 NFSD, was adopted in 2011: the National Strategy for Sustainable Development and Action Plan 2011-2014 (NSSD 1). As mentioned in section 2.9.2.4, this was one of the strategic actions of the 2009-2014 MTSF to be fulfilled. The NSSD reformulated the strategic objectives of the 2008 NFSD into five new strategic objectives, which included “enhancing systems for integrated planning and implementation… sustaining our ecosystems and using natural resources efficiently… towards a green economy… sustainable communities, and… responding effectively to climate change”. Within these objectives, the NSSD 1 established 20 headline indicators and 113 interventions that could be monitored for implementation.

Furthermore, the NBSAP of 2005 was reviewed, updated and published as the NBSAP 2015-2025. The NBSAP 2015-2025 provided for a conceptual framework embedded in the notion that “biodiversity assets and ecological infrastructure directly underpin development and human wellbeing and offer immense potential support to the country’s development path, including enhancing resilience to global change” (Republic of South Africa, 2015, p. 22). The plan set out a vision for South Africa’s biodiversity, which was to “conserve, manage and sustainably use biodiversity to ensure equitable benefits to the people of South Africa, now and in future” (Republic of South Africa, 2015). The NBSAP 2015-2025 developed six strategic objectives, which included “managing biodiversity assets and its contributions to socio-economic development… investment in ecological infrastructure to enhance resilience… mainstreaming biodiversity considerations into other sector policies, strategies and practices… mobilise people to adopt practices that sustain the long-term benefits of biodiversity… build effective knowledge foundations for the sustainable management, conservation and use of biodiversity”.

Last but not least, the DWS reviewed both the 2004 NWRS and the 2010 National Groundwater Strategy, publishing the second edition of the NWRS in 2013, and the second edition of the National Groundwater Strategy in 2016. These two strategies will be discussed in more detail as they provide important information on the current and future state of water resources in South Africa.

2.11.1 National Water Resource Strategy, 2013

In September 2013, the second edition NWRS (NWRS-2) was published, and like the first one, provided an overview of the state of South Africa's water resources, and the challenges and opportunities facing the water sector, and set out the strategic direction for water resource management in the country over the next 20 years. The NWRS-2 acknowledged that much has changed since 1994, among other things, the adoption of new legislation and policies providing a progressive water management framework and providing access to water and sanitation services for millions of South Africans. However, the NWRS-2 states that "although the regulatory framework and institutional arrangements have changed since the advent of democracy, one aspect remains constant: water scarcity – whether quantitative or qualitative or both – which originates as much from inefficient use and poor management as from real physical limits and the potential impact of climate change". Furthermore, the NWRS-2 raised concerns that socio-economic growth will potentially be restricted if water security, water quality and associated water management issues are not resolved.

The NWRS-2 reflected on the findings of several water reconciliation studies conducted in major urban areas. These studies provide insights into future water demand and supply to be addressed by reconciliation strategies. The assessment used two system modelling approaches, including a water resource yield model and a water resource planning model to determine future demand (DEA, 2013, p. 55). These models are designed to inform long-term development planning decisions (for a target time horizon of, say, 10 to 20 years) under conditions of growing demand (e.g. domestic, industrial, agricultural and power generation) as expressed in provincial growth and development strategies, IDPs and other sector plans. Of the 10 reconsolidation strategies, four indicated a water resource shortfall of less than 100 million m³/a, three indicated a shortfall exceeding 200 million m³/a, while the remaining three will exceed a demand of 300 million m³/a by 2030. In all study areas, urbanisation (migration or population growth) was identified as a major contributor to the growing demand. In some cases, this is due to higher levels of services to be provided or simply improved standards of living. Only five studies specified economic growth related to either mining or industry development as major drivers of water demand.

As for the measures to secure future water demand, most reconciliation strategies defaulted to high-level, traditional approaches, such as developing surface water resources through conventional fixed infrastructure, with desalination implied as the next option to supply bulk water. Only four strategies identified groundwater, while two strategies identified the removal of alien invasive plants as possible measures. The above proposed interventions are, in fact, contradictory to the NWRS-2's statement that there is a need to include alternative water sources in its bulk water calculations.

In addition to the reconciliation studies, the NWRS-2 also reported on an All Towns Study (ATS), which assessed the water resource situation in specific cities and towns. The ATS revealed that 30% of towns were currently in deficit, and that this deficit was not the result of water resource shortages, but rather poor water supply management (DWA, 2013a, p. 23). This defect can generally be traced back to large wastages of water and very high per capita usage. This reality was also revealed in a study on the state of non-revenue water (NRW) in South Africa. NRW is in the order of 37% (volume of around 1,580 million m³/a, which has an estimated financial value of R7.2 billion per annum). In some areas, free water is being provided far above the indigent level obligations, resulting in poor cost recovery. In addition, most WSAs suffer from limited metering information, lack of proper maintenance and skilled operators, and low technical competency.

The key strategic messages flowing from both studies were that water conservation and water demand management are extremely important in all areas, and that there is huge potential in increasing the re-use of water. The cost of water should also be reassessed as water is undervalued.

Groundwater is important. However, it is currently under-valued and under-used. Catchment rehabilitation, the clearing of invasive alien plants and rainwater harvesting are growing in importance. The desalination of mine and seawater potential should be explored to add to the water mix (DWA, 2013a, p. 20).

On a national level, the NWRS responds to South Africa's water resource situation through five management approaches: responding to specific socio-economic drivers, the implementation of a resource mix, ensuring access to water through the effective implementation of agreements, sustainable service delivery through effective business management, sustainable resource management through effective protection and conservation, and proficient governance.

2.11.2 Groundwater Resource Strategy, 2016

The role of groundwater in South Africa has undergone major changes during the water sector transformation since 1994, from an undervalued resource with a "private water legal status to a source of domestic water and general livelihood to more than 60% of communities in thousands of villages and small towns countrywide as part of the national drive to meet the basic water needs". The first initiative to develop a National Groundwater Strategy was undertaken during the early 2000s, and in 2007, DWAF published a Framework for National Groundwater Strategy, which laid the foundation for the first National Groundwater Strategy 2010. This also led to the 2011 Artificial Recharge Strategy for South Africa. Artificial recharge, the process whereby surplus surface water is transferred underground to be stored in an aquifer for later abstraction and use, is growing in importance in South Africa and internationally. The most common recharge methods used involve injecting water into boreholes and transferring water into spreading basins where it infiltrates the soil subsurface and percolates into the groundwater. Underground storage is efficient in that the reserves are not vulnerable to evaporation losses and are relatively safe from contamination (DWA, 2010).

The NWRS-2 states that groundwater's role will be increasing as surface water resources are already limited in many catchments. NWRS-2 also noted that groundwater is often not recognised as a valuable resource by land use planners and municipalities, resulting in poor coordination between groundwater development and the use of land for human settlements and other purposes, groundwater pollution from source, such as acid mine drainage and poor sanitation not being addressed effectively, and the backlog in license applications for the use of groundwater, resulting in water use without proper regulation and monitoring (DWA, 2013a, p. 25). As such, the National Groundwater Strategy 2016 identified 12 strategic themes, including, among others, stakeholder-driven development and implementation, a responsive groundwater regulatory framework, groundwater resource protection, the utilisation of sustainable groundwater resources, and groundwater resources planning and development.

2.12 INTERNATIONAL OBLIGATIONS

Like many other countries, South Africa is committed to sustainable development, as is evident in the Rio Declaration on Environment and Development, the World Summit on Sustainable Development, the World Summit for Social Development, the Programme of Action of the International Conference on Population and Development, the Beijing Platform for Action, the United Nations Conference on Sustainable Development, and the most recent 2030 Agenda for Sustainable Development. The latter, which came into effect on 1 January 2016, stipulates 17 SDGs with 169 targets to address specific issues (UN, 2015, p. 10). The 2030 SDGs calls attention to sustainable development, which recognises that eradicating poverty in all its forms and dimensions, combating inequality within and among countries, preserving the planet, creating sustained, inclusive and sustainable economic growth and fostering social inclusion are linked to each other and are interdependent (United Nations, 2015, p. 5). Two goals are directly related to strategic water-resource planning and management, and human settlements (see Table 2.4).

Table 2.4: SDG goals

	Goal 6: Clean water and sanitation	Goal 11: Sustainable cities and communities
Aim	Availability and sustainable management of water and sanitation. Refers to: 6.1: Safe and affordable drinking water 6.2: Adequate and equitable sanitation 6.3: Safe water reuse 6.4: Water scarcity and water use efficiency 6.5 Integrated water-resource management	Make cities and human settlements inclusive, safe, resilient and sustainable. Refers to: 11.1: Basic services 11.3: Integrated and sustainable human settlement planning 11.5: Water-related disasters 11.6: Per capita environmental impact of cities 11.7: Green public spaces
Focus	• By 2030, expand international cooperation and capacity to developing countries in water-related activities and programmes. • Support and strengthen the participation of local communities in improving water and sanitation management.	• Support positive economic, social and environmental links. • By 2020, substantially increase inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters. • Support least-developed countries in building sustainable and resilient buildings

Several of the above goals (and others not mentioned here) can be achieved when focusing on the way in which settlements are planned and shaped though spatial planning and land use management. However, spatial planning and land use management can also have an opposite impact when planned without taking other sectors into consideration. Globally, the human consumption of land is greater than ever, and the mismanagement of land uses can have serious environmental consequences (Sustainable Cities Institute, 2012). Nonetheless, since the beginning of the 21st century, several countries and private developers directed funding towards research and development to achieve more sustainable cities. This could be linked to the initial mainstreaming of sustainable development principles within planning and development processes, as promoted by the United Nations' Agenda 21. However, it was not until recently that attention shifted towards water. Today, water sensitivity, as a broader theory in spatial planning and land use management, is gaining global awareness as the risks associated with climate change and increasing resource demands due to population growth and urbanisation continue to escalate at an alarming rate. In response to the SDGs and to combat water-related challenges, the aspirational concept of the water-sensitive city emerged in scientific, policy, as well as in the spatial planning domains, as an alternative approach to water resource management and service delivery.

2.13 CONCLUSION

South Africa is a dry country with a growing population that is increasingly moving to cities and towns in search of employment and access to services. Throughout our history (and at an ever-increasing tempo), the country has been relatively good at establishing policies and plans, and creating various pieces of legislation aimed at addressing issues of national importance. More recently, access to an adequate supply of water has placed the national focus on water consumption and, more importantly, on ways to curb consumption. Water is consumed by individuals and land uses (such as agriculture and industry). The provision of water, as well as the management of infrastructure, is most often the responsibility of local government, which is the same institution that is tasked with the management and approval of land uses. It is quite clear that, while many of the policies and pieces of legislation have been drafted at national level, it is most often local government that will have to implement these policies to ensure their eventual success.

CHAPTER 3: DEVELOPMENT, WATER AND THE ENVIRONMENT

3.1 INTRODUCTION

South Africa's NFSD indicated that people, land, water and the broader environmental are all interdependent. Despite this close relationship, urban and regional (people and land) and environmental resource management (water and the broader environment) are typically governed by different sector departments, often to the detriment of sustainable development. The close relationship between people and natural systems implies that settlements cannot be sustainable or resilient until their interdependence on ecosystem services has been recognised and the value of ecological sustainable development acknowledged (Armitage et al., 2014, p. 46; Cilliers & Cilliers, 2016, p. 15).

Throughout the previous section, several policies and strategies emphasised the need for ecological sustainable development, making urban and rural settlement more sustainable in terms of form and function, and managing and protecting water resources in a sustainable manner, while also providing access to basic water services for all. Above all, South Africa must grow the economy in order to alleviate poverty and improve human wellbeing. This chapter therefore investigates the linkage between development, water and the environment.

3.2 THE IMPACT OF DEVELOPMENT ON WATER RESOURCES

Water is a renewable natural resource as it operates within a closed loop system called the hydrological cycle (Camp & Heath-Camp, 2015, p. 515; Watson, 1993, p. 24; Sarni, 2011, p. 31). Figure **Error! Reference source not found.**illustrates the natural hydrological cycle, placing emphasis on the sub-surface component, which is often neglected as it is somewhat invisible to the human eye (Davis & De Wiest, 1966, p. 460). The diagram shows a closed loop system. As temperatures rise, heat results in evaporation from land and water resources. As the water vapour rises, it cools and condenses to form clouds. When conditions are appropriate, water in clouds is released as precipitation (rain, hail, snow or sleet) and falls to the earth's surface (Camp & Heath-Camp, 2015, p. 515; Watson, 1993, p. 24; Sarni, 2011, p. 31.

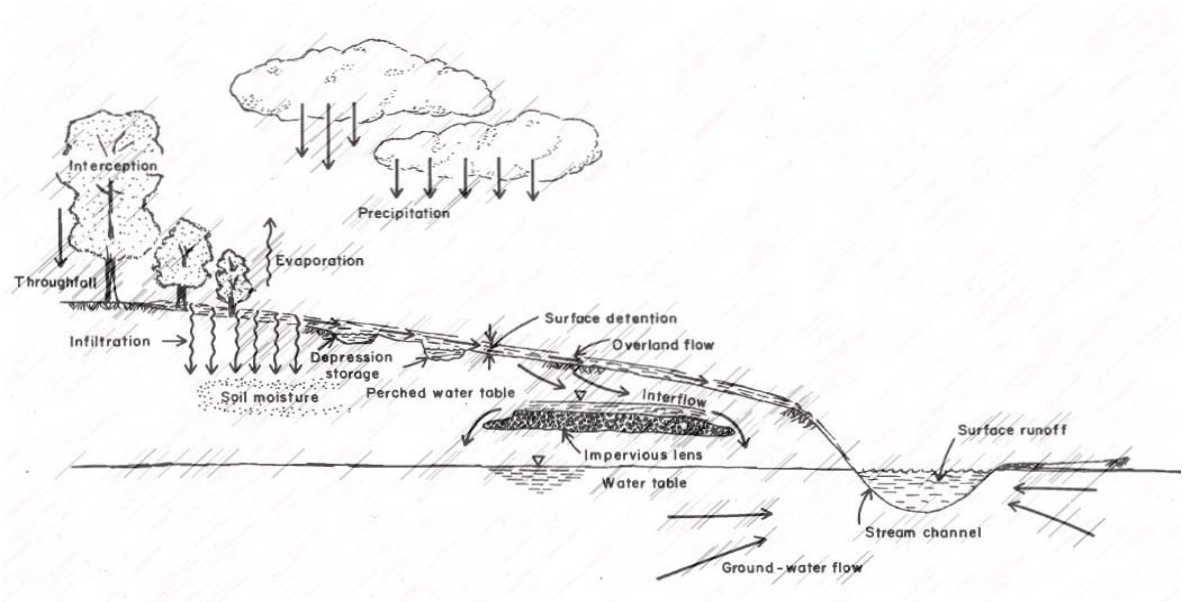


Figure 3.1: Diagrammatic representation of the natural hydrological cycle

Source: Davis & De Wiest, 1966, p. 460

According to Edwards et al. (1983, p. 22) the intercepted moisture, stored in the canopy of a tree, is the first component of the hydrological cycle to be lost directly back into the atmosphere. The interception of raindrops by canopies or trees reduces soil erosion, which protects surface soils and maintains infiltration, which is the second step of the hydrological cycle (Edwards et al., 1983, p. 22). When precipitation falls through the canopy, throughfall infiltrates the soil to become soil moisture or groundwater. However, this process depends on the infiltration capacity of the soil. Horton (1933), Philip (1969), Hillel (1971) and Morel-Seytoux and Khanji (1974) define the infiltration capacity of soils as the rate at which water can enter the ground. When soil infiltration capacity is low, precipitation will result in surface runoff, which will seep into streams, rivers, wetlands, estuaries and oceans. If the soil infiltration capacity is high, due to good surface cover, infiltration will lead to aquifer recharge, which takes place in the saturated zone of the subsurface, reaching the water table and becoming groundwater (Wilhelmson & Ramamurthy, 2010).

Groundwater can remain underground for hundreds or thousands of years or be discharged as springs, rivers, lakes or to the ocean to continue the cycle (Nel, 2017, p. 9). As water travels through the natural hydrological cycle, it interacts with ecological infrastructure such as the soil, wetlands and rivers, and undergoes a series of physical, chemical and biological reactions, which purifies water (Hairston & Stribling, 2001, p. 2; Cape Nature, 2014). This purification process is an essential factor to the renewability of water resources. Metaphorically, the hydrological cycle can be described as earth "metabolism", which, by definition, is the set of chemical reactions that occurs in living organisms to maintain life (Smith & Morowitz, 2004).

In engineered environments like towns and cities, humans have a significant influence on the local hydrological cycle, by introducing artificial surfaces and man-made engineered infrastructure that have had both a quantitative and a qualitative impact on water resources and the ecosystems that depend on then. According to Marsalek et al. (2006, p. 3), this artificial hydrological cycle has altered the rate and functionality of this well-known natural cycle of replenishment and the hydrological responses of watersheds, making the renewability of water resources increasingly questionable.

3.2.1 The impact of artificial surfaces on South Africa's local hydrological cycle

Until recent years, little information has been available on the importance of ecological infrastructure. SANBI (2014a, p. 3) defines the ecological infrastructure as "the nature-based equivalent of engineered infrastructure and is important for providing for services and underpinning socio-economic development. It provides these services either directly to society (such as a coastal dune protecting a road from sea surge), or as part of a broader infrastructure system that includes engineered infrastructure (such as a natural catchment area function with a dam and pipes to provide water to nearby settlements)." Ecological infrastructure is a useful concept in planning as it can be spatially delimitated and therefore included in local government's spatial planning processes. It is important to be aware of ecological infrastructure as it provides a wealth of useful, interconnected services. These natural areas can be "working landscapes", conserving biodiversity, while providing associated benefits to society through strategic spatial and careful land use planning.

3.2.1.1 The quantitative impact of land cover on water

Land-based activities are much to blame for the loss of the country's ecological infrastructure and the state of its water resources. As natural land cover undergoes change to accommodate artificial surfaces and man-made infrastructure, the ecological infrastructure is often destroyed. The destruction can be either knowingly, when there is no other area of land available to accommodate development, or unintentionally as the ecological infrastructure and the services they provide are not always visible to the naked eye. Since the ecological infrastructure is largely free, its value is seldom captured in market transactions and its importance is often undervalued.

The physical development of land is inevitable, yet the degree of impact can be managed to some extent. Low density and sprawling development footprints are widely criticised for their environmental impact as they take up far more surface area than actually needed and contribute to the fragmentation of landscapes (Vitousek, 1994; Millenium Ecosystem Assessment, 2005; Jetz et al., 2007). The loss and fragmentation of landscapes leads to changes in biogeochemical cycles, climate, ecosystem processes and ecosystem resilience, thereby changing the nature of ecosystem services provision and human dependencies (Verburg et al., 2011; Chapin et al., 2000; Lambin et al., 2001). The previous chapter provided an overview of South Africa's physical development trends, which are driven largely by political agendas. It also highlighted that most of South Africa's cities and towns are characterised by low densities and sprawling new developments. In some instances, higher densities can be found on the outskirts of cities. These peri-urban settlements exhibit characteristics such as affluent residential areas (high-end residential development that often consumes resources unsustainably), low-cost and social housing estates (RDP housing on degraded land with a low market value and often poorly planned) and high-density, unplanned, informal and illegal settlements (DEA, 2014). As this unlimited outwards expansion of urban areas continues, ecological infrastructure will continue to be destroyed at a rapid pace.

However, according the 2011 NBF, the country's most important ecological infrastructure is often located within the broader rural areas, where the allocation of land and management of land use has been, and still is "governed" by tribal chiefs, traditional authorities or councils. These allocations and land use decisions are often uninformed due to a lack of adequate spatial information and land use management knowledge (DEA, 2014). This unplanned and unregulated development of land in rural areas has led to the development of even lower density and severely sprawling rural settlement patterns. There is no exact figure to indicate how much of South Africa's ecological infrastructure has already been destroyed by development. However, land cover data (sourced from the DRDLR) indicates that, between 2000 and 2014, more than 2% of the country's previously natural landscape is now developed. This also means that artificial surfaces or man-made surfaces increased with 2% in only 10 years (see Table 3.1).

Table 3.1: South Africa's land cover change from 2000 to 2014

Land cover	2000	2014	Percentage change
Natural	115,469,705	105,834,517	-2%
Non-natural	17,758,472	19,095,303	2%

Typically, artificial land cover (such as buildings and tarred streets) are impervious or impermeable, therefore increasing stormwater runoff and decreasing aquifer recharge. The previous chapter highlighted that 8% of the land that forms part of South Africa's SWSAs produces over 50% of surface water resources. Unfortunately, only 18% of the country's SWSAs is formally protected (Driver et al., 2012, p. 71). The lack of legal protection continues into South Africa's rivers, wetlands and estuaries as only 14% of the country's 223 river ecosystem (Driver et al., 2012, p. 67) is well protected and one third is poorly protected, leaving more than half of all river ecosystems entirely unprotected (Driver et al., 2012, p. 68). As for South Africa's 791 wetland ecosystem types, which only take up an estimated 2.4% of land, 11% is well protected, while 71% is not protected at all (Driver et al., 2012, p. 80). Only 33% of estuary ecosystem types is well protected, while 59% has no protection at all (Driver et al., 2012, p. 8). The lack of legal protection, coupled with rising pressure to fulfil socio-economic needs, has resulted in a looming water supply crisis, fed by the widespread destruction and pollution of freshwater ecosystems.

3.2.1.2 The qualitative impact of land cover on water

Artificial services, whether permeable or non-permeable, also have a quality impact on water resources. The description of the natural hydrological cycle indicated that, when soil infiltration capacity is low, precipitation will result in surface runoff, which will seep into streams, rivers, wetlands, estuaries and oceans.

However, in built-up areas, the soil infiltration potential decreases significantly as vegetated and previous open areas are replaced with impervious surfaces such as buildings, roofs and driveways, causing increased runoff volumes (also referred to as stormwater runoff) and less groundwater recharge (Korgaonkar et al., 2014, p. 3; Makepeace et al., 1995; Leopold, 1968; Rose & Peters, 2001).

At first glance, built-up areas and stormwater are mutually non-compatible as the space required for natural drainage systems, such as rivers, streams, wetlands and ponds, restricts physical development. Furthermore, increased stormwater volumes can cause damage to buildings and other man-made infrastructure. On the other hand, stormwater is highly susceptible to non-point source pollution when it travels over the impervious surfaces and interacts with land-based activities. In South Africa, the major sources of non-point source contamination are agricultural drainage and wash-off (irrigation return flows, fertilizers, pesticides and runoff from feedlots), urban wash-off and effluent flows (bacterial contamination, salts and nutrients), industries (chemical substances), mining (acids and salts) and areas with insufficient sanitation services (microbial contamination) (WRC, 2016, p. 8; Nel et al., 2011, p. 5; DWS, 2013, pp. 39-41). These contaminants cause severely high levels of sediment and nutrient pollution in receiving water bodies.

- **Sediment pollution** is caused by accelerated erosion due to human activities such as deforestation, poor agricultural practices, road construction and landscaping. It causes high levels of turbidity, which limits the penetration of sunlight into the water column, thereby limiting or prohibiting the growth of algae and rooted aquatic plants. Elevated levels of sedimentation in rivers lead to the physical disruption of the hydraulic characteristics of the channel. This can have serious impacts on navigation through a reduction in the depth of the channel and may result in increased flooding because of reductions in the capacity of the river channel to efficiently route water through the drainage basin.

- **Nutrient pollution** is caused by fertilizers, animal waste, organic matter and septic tanks, which produce excess nitrogen, nitrates, ammonia and phosphorus in the air and water. Agriculture is considered to be the largest source of nitrogen and phosphorus pollution, followed by urban stormwater, which carries pollutants into local waterways. Wastewater treatment works that do not operate properly or remove enough nitrogen and phosphorus before discharging the water into waterways also cause nutrient pollution in water sources, whereas electric power generation, industry, transportation and agriculture have increased the amount of nitrogen in the air through the use of fossil fuels. Fertilizers, yard and pet waste, and certain soaps and detergents used in and around the house, contain nitrogen and phosphorus and can contribute to nutrient pollution if not properly used or disposed of. Too much nitrogen and phosphorus in the water causes algae to grow faster than ecosystems can handle it. Significant increases in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other aquatic life need to survive. Large growths of algae are called algal blooms, and can severely reduce or eliminate oxygen in the water, leading to illnesses in fish and the death of a vast number of fish. Other pollutants commonly found in stormwater include organic matter, pathogens, hydrocarbons, metals, toxic chemicals and solids such as debris and rubbish.

3.2.1.3 Conventional stormwater management

Since the early urban era, the focus of stormwater management has been to direct large volumes of water, which are unable to infiltrate into the soil from the urban environment as fast as possible (EPA, 2005, p. 15). This has been and is still achieved through concrete drainage and discharge channels, collectively termed conventional stormwater infrastructure. There are predominantly two methods of dealing with stormwater in built-up areas: either through a combined or through a separated system. The combined system conveys runoff into the sewerage network where it is treated before being released into the natural environment. This system is mostly used in developed countries, whereas the separate system is commonly found in developing counties. Stormwater that is managed within a separate system is distributed back to receiving water bodies with little or no treatment.

In South Africa, stormwater is managed within a separate system, and in most municipalities, the responsibility is assigned to the Roads Department, which treats it as “hazardous water” that needs to be disposed of as quickly as possible. According to Armitage et al. (2014, p. 37), “this paradigm fails to recognise a broad range of regulations and has resulted in the fragmented ‘silo management’ of the different aspects of the urban water cycle”. As a result, most of the receiving water bodies have become polluted, so must be managed if there is any hope of rehabilitation.

According to the 2011 NBF, 57% of the country’s river ecosystems has become threatened, 26% is critically endangered, 19% is endangered and 13% is vulnerable (Driver et al., 2012, p. 67). Furthermore, 48% of wetlands is critically endangered, 12% is endangered, 5% is vulnerable and 35% is least threatened (Driver et al., 2012, p. 77).

3.2.2 The impact of sophisticated water engineering systems on water resources

The concerning status of freshwater ecosystems is not caused by land cover change alone, as the construction of hydrological control sources such as dams, weirs and large-scale water transfers contributes to severe flow alterations in the form of over-abstraction, inter-basin transfers and high return flows from urban areas. These alterations (e.g. timing, frequency, speed or volume of flow) are known to change the channel and its habitat characteristic, which affect the quality of water and the integrity of the aquatic life in rivers and wetlands (Nel et al., 2011, p. 5; DWA, 2011, p. 2). Yet, hydrological control sources, coupled with other conventional water infrastructure systems, have been the sought-after solution for distributing water and wastewater over thousands of kilometres to where it is required at selected volumes as determined by consumer demand.

Like most other countries, South Africa built a modern water distribution network, designed to operate within a centralised closed-piped system where water, wastewater and stormwater are separated into isolated sectors of management. Figure 3.2 gives a simplified schematic of a typical sophisticated water engineering system, which starts by extracting raw water from dams, rivers and groundwater resources. Raw water is then pumped through a conveyance network to a centralised water purification or treatment plant. Once purified, treated water is distributed to reservoirs through distribution pipelines (Van Zyl, 2014, p. 11). Inspired by the rationale behind the Roman aqueduct, if topography permits, reservoirs would usually be located on higher ground as the system relies on pressure fed by kinetic energy. If the topography does not allow this, additional energy is used to distribute water through internal pipe networks to customers (Van Zyl, 2014, p. 11). Once consumed, grey water and sewerage are collected and passed through a network of sewer drains to pump stations, which pump the raw sewerage to a centralised wastewater treatment plant at the lowest elevation where wastewater is purified. Treated effluent is then discharged back into natural water bodies where it once again forms part of the natural hydrological cycle (DWS, 2015, p. 14; Tchobanoglous et al., 2014).

South Africa has constructed thousands of small dams and 320 major dams, each with a full supply capacity of more than 1 million m^3 and a total capacity of 32,400 m^3. Part of the water engineering system is a 29 inter-basin and inter-river system transfer scheme with a total capability of 7,000 million m^3/a. South Africa also has an estimated 1,300 water treatment works (WTWs) and boots with 1,363 registered WWTWs (DWS, 2016a, pp. 41-43). This sophisticated water distribution system allows South Africa to harvest, store and distribute 30% (or an estimated 15,000 million m^3/a) of the county’s average annual runoff at 98% assurance. Of the estimated 15,000 million m^3/a, 68% (or an estimated 10,200 million m^3/a) consists of surface water, 13% (or an estimated 1,950 million m^3/a) consists of groundwater, 13% (or an estimated 1,950 million m^3/a) consists of return flow and 6% (or an estimated 900 million m^3/a) is from other sources such as desalination.

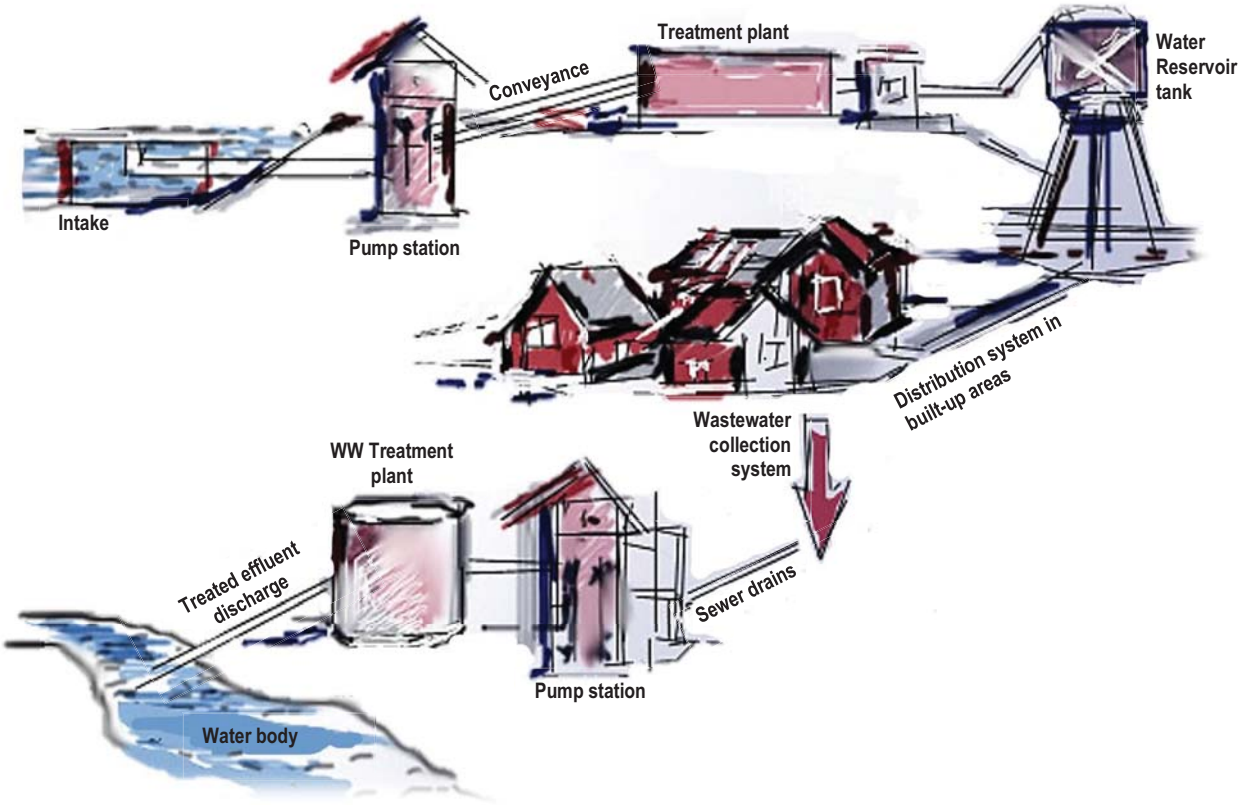


Figure 3.2: Schematic of a typical water and wastewater treatment and disposal system

Source: Wordpress, 2018

In some way, it could be argued that this network of modern infrastructure facilitated the rapid transformation and occupation of land outside settlements historically preferred for their relative location to natural water resources. Through South Africa's sophisticated water engineering system, more than 9,450 million m^3/a of water is distributed to the agricultural sector (63%), 1,650 million m^3/a to the industrial sector (11%) and 3,900 million m^3/a to local municipalities (11%).

3.2.2.1 Agricultural water demand

In South Africa, the major agricultural water uses include the irrigation of crops and the water-intensive grazing of livestock. Compared to other countries, the agricultural demand for water is generally higher, due to the country's climate and soil characteristics, which are extremely vulnerable to degradation and have a low recovery potential. Thus, even the smallest mistakes in land management can be devastating, with little chance of recovery (Galdblatt, 2014, p. 7). According to Goga and Pegram (2014, p. 10), only an estimated 12% (or 146,291 km^2) of the country is suitable for growing rain-fed crops, while only about 3% (36,573 km^2) is considered truly fertile. Even though irrigated agriculture is by far the largest water consumer, only 1.5% of agricultural land is under irrigation, producing 30% of the country's crops (GCIS, 2009, cited by Goga & Pegram, 2014), while 67% is used for grazing and livestock farming (DWS, 2015, p. 10). According to Nel et al. (2011), many of South Africa's rivers are over-abstracted by agricultural practices, and several naturally perennial rivers are now seasonal.

3.2.2.2 Industrial water demand

Industrial water demand is roughly split between 53% manufacturing, 27% mining and 2% power generation. The high demand for water by manufacturing companies is mainly for processing minerals and crops, textiles and chemical refinement, and, in some instances, a component of automobile manufacturing.

However, the required volume and impact of manufacturing on water depends largely on the type of manufacturing industry. One of the major concerns of industrial water use is the high level of contaminated water generated by most industries. Gold, coal, platinum and diamond mining are four of the major mining sectors in South Africa. Water demand for mining is mainly for extraction purposes, often resulting in acid mine drainage. South Africa's energy supply is mainly generated in water-intensive coal-fired power stations. These stations require water mostly for cooling purposes.

3.2.2.3 Municipal water demand

The major municipal water uses include water for gardening, toilet flushing and personal hygiene in homes, schools, hospitals, commercial centres and business. According to Colvin and Muruven (2017, p. 9), domestic water use is split between 35% (or 3,307 million m^3/a) for garden use, 29% (or 2,740 million m^3/a) for toilet flushing, 20% (or 1,890 million m^3/a) for personal hygiene, 13% (or 1,128 million m^3/a) for laundry and 3% (or 283 million m^3/a) for other uses such as cooking. According to the 2016 household statistics (Stats SA, 2016), 90% of all households in South Africa have access to piped water, while the remaining 10% uses water from other sources. South Africa is faced with a unique situation with regard to government's Free Basic Services Policy. Government allocates 6,000 ℓ of "free" water per month to every household. With an average household consisting of 3.3 people (Stats SA, 2016), this means that each person has an allocated 60 ℓ of free basic water per day. This is known as government's promise to provide free basic water for all. However, according to DWS, South Africa's gross average water consumption is estimated at 229 ℓ per person per day (or 0.229 m^3 per day). Using the 2016 statistics, which indicated that the average household size consists of 3.3 people, to determine the volume of gross average household water consumption would equate to 22,671 ℓ of water per month per household, which is 3.7 times the volume of government's free basic water supply. According to UN-Habitat (2013, p. 70), Johannesburg consumes ten times the daily recommendation of the World Health Organisation (WHO).

3.2.3 Infrastructure challenges

Although South Africa's sophisticated water engineering system has sustained the country's socio-economic development, conventional infrastructure is often criticised as being fragmented, lacking flexibility, being energy intensive and often implementing measures that are not cost effective or sustainable in the long term.

3.2.3.1 State of WTW and WWTW

In South Africa, this criticism is often found to be true, as the performance of 43% of all WTWs seems to be average, followed by 24% being poor, and 17% being in critical state. As for WWTW, 30% are in a critical condition, 20% are poor, 34% are average, and only 16% are performing well to excellent. In addition, South Africa's total WWTW operational flow is calculated at 5,128.8 Mℓ daily. Yet, the systems' collective hydraulic design capacity is 6,509.7 Mℓ/day. This means that 78.8% of the existing design capacity is accounted for by the current operational flows, leaving a theoretical surplus of 22.2% as available capacity for future demand (although many individual plants have no surplus and run at full capacity).

In several catchments, the discharging of partially treated or untreated effluent back into the natural hydrological system is a major concern. These unlawful actions can be traced back to the 50% of WTWs that are already in a poor or critical state and operating at full design capacity. Treating effluent to an appropriate quality will become increasingly more difficult as water demand continues to grow.

3.2.3.2 Non-revenue water

According to DWS, municipalities currently use 4,500 million m^3/annum. Category B and C municipalities only demand approximately 17% of the total municipal system input, whereas metropolitan municipalities use over 50% of the total national volume.

According to DWS, approximately 36% of all municipal water is being lost as South Africa has an Infrastructure Leakage Index[4] of 5.3 on average. Of the 4,500 million m³/a, approximately 39% is NRW. The term NRW is used by the International Water Association to represent the volume of water used by a municipality for which no income is received. In South Africa, the term NRW includes "apparent losses, real losses, unbilled unmetered and unbilled metered" (DWS, 2015, p. 44). The volume of unbilled and unmetered water is estimated at 90 million m³/a or a small 2% of the total NRW. According to DWS, only by halving water losses will an annual water saving of R2 billion per annum be achieved (DWS, 2015).

The volume of apparent and real losses is estimated at 1,665 million m³/a or 37% of the total NRW. Apparent losses are calculated as the volume of water used illegally or in an unauthorised manner, or miscalculated due to technical and administrative inaccuracies. Real losses, on the other hand, are calculated as the volume of water that leaks from the system pipes, connections or overflows from the reservoir. However, all systems will lose water, even under the most efficient operating conditions. This is called unavoidable annual real losses (UARL), which represents the minimum level of real losses for a specific system that can occur in transmission and distribution mains, service connections, mains to the street or property boundary or in private underground pipes between the street property and the consumer meter. Based on methodology developed by the WRC, and sophisticated spatial analysis, a direct relationship was established between UARL and settlement densities, which revealed that the lower the density, the higher the volume of UARL (see Table 3.2 and Figure 3.3).

Table 3.2: UARL by settlement density

Density	UARL (litres per day)	Number of customers serviced	Litres per customer per day
High	104,405	23,918	4 ℓ
Medium	88,486	13,471	7 ℓ
Low	332,200	26,634	12 ℓ

Table 3.2 and Figure 3.3 prove that, in high-density developments, the amount of water lost per day equates to 4 ℓ per person per day. In areas where the development density is low, the average amount of water calculated as UARL is three times more, at 12 ℓ per person per day.

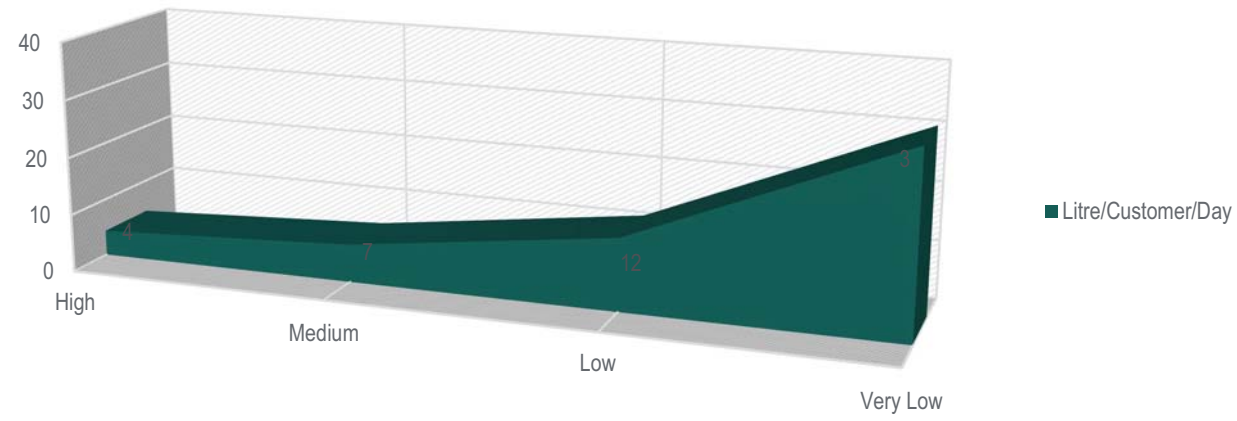


Figure 3.3: UARL by settlement density

[4] The Infrastructure Leakage Index compares leakages to a benchmark likely to be a minimum value of "1: good practice" and "10: bad practice".

From the above analysis, a strong argument can be made for higher density development as the volume of UARL is almost three times less per person in higher density development areas than in sprawling low-density settlements. The latter is a common characteristic of most settlements in South Africa.

3.2.3.3 Other water-related challenges

The DWS is facing a number of other challenges as well. Most of these challenges have a spatial component (DWS, 2015; Nel et al., 2011).

Biophysical environment	South Africa is a semi-arid country with an average rainfall of 450 mm, far below the world average of 860 mm per annum. Less than 9% of annual rainfall ends up in rivers, and only about 5% recharges groundwater in aquifers.
	South Africa has no surplus water available, and rainfall and river flow are unpredictable in time and unevenly distributed in space.
	High water yield areas or strategic water source areas are our water factories, supporting growth and development needs that are often a long distance away. Strategic water source areas consist of only 8% land area that provides 50% of South Africa's surface water. Only 16% of the national SWSA in South Africa enjoys legal protection. Land uses that reduce stream flow or affect water quality (e.g. mining, plantations, overgrazing) should be avoided in these areas. Wetlands should be kept in a good condition or rehabilitated, and invasive alien plants should be cleared. The dominant land cover is natural vegetation cover (63%), often because slope and altitude have prevented more intense development. Some 15% of the area is cultivated, 13% is under plantation, and 3% is degraded land, mainly in the Eastern Cape. Less than 1% of water source areas are currently mined. However, 70% of the areas in Mpumalanga are under either a prospecting or a mining license. This is cause for particular concern.
	The NFEPAs indicate that 60% of South Africa's river ecosystems are threatened, and 23% are critically endangered. The situation with wetlands is even worse: 65% of South Africa's wetland types are threatened, and 48% are critically endangered (Nel et al., 2013b).
	Climate change predictions: Under a wetter future climate scenario, significant increases in runoff would result in increased flooding, human health risks, ecosystem disturbance and aesthetic impacts. Drier future climate scenarios would result in reduced surface water availability, but would not exclude the risk of extreme flooding events. In both wetter and drier futures, a higher frequency of flooding and drought extremes is expected with cross-sectoral effects on human settlements, disaster risk management and food security.
	Water pollution threatens freshwater ecosystems and the available water resources, posing a health risk to South African society. Pollution sources include industrial and mining effluent, agricultural pesticides and fertilizers, and domestic effluent, including sewage. Acid mine drainage adds to the pollution problem.
	The destruction of riverbanks and wetlands, for example by ploughing or building infrastructure, results in often irreversible damage to freshwater ecosystems and their ability to provide ecosystem services.
	It is believed that diarrhoea in nature (water resources) is the leading cause of death in children under the age of five years. It is particularly prevalent in informal settlements and rural areas. Diarrhoea is a symptom of an illness that indicates the presence of high levels of e-coli in drinking water.
Built environment	In 2014, 14.1% of households had basic water supply below RDP standards. The biggest basic water supply backlog still lies with 27 district municipalities, largely rural in nature and chiefly within "old homelands" areas (tribal land). These areas are generally in remote areas that are difficult to service, with high associated costs.
	In 2011, 31.3% of households had basic sanitation below RDP standards. Political pressure to provide full waterborne sanitation as a basic level of sanitation is severely impacting on the cost of service provision and operation in certain parts of the country and the overall municipal viability. It is also slowing down delivery. There is an increased demand for waterborne sanitation versus dry sanitation.
	The WWTWs are generally in a poor condition, and many are over capacity. Due to the scarcity of water, pollutants will need to be treated to ever higher standards before being discharged. According to the 2011 Green Drop Assessment, 317 (38.6%) of all WWTWs were in a critical state. Wastewater treatment poses one of the biggest threats to the water services sector.
	South Africa is experiencing a fragmented service delivery approach, where responsibilities for water services have been delegated to a number of government departments, such as DWS, CoGTA, the Department of Human Settlements (DHS) and the WSAs.

	In 2013, all WSAs were assessed, and 46% were classified with a very high vulnerability, 32.9% with a high vulnerability, 17.8% with a moderate vulnerability and only 3.3% with a low vulnerability. The areas with the highest vulnerability in 2013 included those with a lack of technical staff capacity (numbers), lack of operations and maintenance of assets (lack of infrastructure asset management with the result that infrastructure fails, and service delivery suffers), low staff skills levels, wastewater and environmental safety, and Green Drop status and revenue collection. Many municipalities are unable to provide sustainable services or to run a successful water services business because of a lack of capacity and skills.
	South Africa's Infrastructure Leakage Index is about 5.3 (1 = best practice; 10 = losses).
	Infrastructure-focused targets have neglected longer-term sustainability requirements, and inappropriate, unsustainably higher levels of service are often provided for short-term political gain.
Socio-economic	High unemployment with a low economic growth rate indicates an increased potential for social unrest, which could affect service delivery and increase the incidence of protests.
	Lack of appreciation of the value of water is partially due to low tariffs, which are not cost reflective. This, together with poor operations and maintenance, and lack of metering, contributes to wastage, high consumption, high NRW and financial loss. If not addressed, this will continue to threaten municipal viability.
	South Africa's gross average consumption of 229 ℓ (per person per day) is too high for a water-scarce country. South Africa also has poor water use efficiency and little implementation of water conservation and water demand management.
	In the longer term, it is government's intention to ensure that all households receive 50 to 60 ℓ (per person per day) via an individual connection, either in the house or in the yard. The introduction of higher levels of service in urban and rural areas is not in accordance with the basic services policy.
	According to the non-financial census, in 2013, 5.27 million households received free basic water, and 3.10 million households received free basic sanitation. Many municipalities are just not able to run a successful water services business. Their water tariffs are often not cost reflective, and the service runs at a loss.
	The highest NRW and water losses are found in the smaller, more rural municipalities. Municipalities currently use about 4,500 million m^3/a, of which 39% is NRW (the volume of water used by a municipality for which no income is received) and 36% is water losses.
	Significant household growth due to smaller household size, migration and an influx of illegal immigrants into metropolitan areas and informal settlements adds to the service backlog.
	Achieving the basic water supply and sanitation targets is problematic due to limited funds that are available for bulk water infrastructure requirements. Municipalities consistently underspend government grants. The biggest and most persistent under-expenditure is to be found in the rural municipality, especially within the 27 district municipalities where the biggest service backlogs exist.
	Statistics South Africa reports that there has been an increase in the number of households with access to water, but a decline in the number of households that pays for water. Statistics indicated a decline from 66,9% in 2004 to only 44.5% in 2013. This negatively impacts on the financial viability of municipalities.

3.3 URBANISATION AND FUTURE WATER DEMAND IN SOUTH AFRICA (FUTURE DEMAND)

With more people flocking to cities and towns, ensuring that everybody will have a place to stay with enough resources is becoming the top priority for planners worldwide. South Africa's growth and development largely depends on the availability of water, as well as the quality of water resources, which is affected by competing demands between people, industries, food security, the environment and development (GreenCape, 2016). The demand for water is expected to increase with economic growth, population growth, increased urbanisation and a higher standard of living (2030 Water Resource Group, 2009). The fact that water is a scarce natural resource in South Africa is highlighted in many strategic planning documents as it is key to most socio-economic development initiatives. Yet, the current use and management of water resources are unsustainable, and it is expected that the country will face a water demand-supply gap of almost 17% by 2030 (2030 Water Resource Group, 2009). Increases in water supply cannot match the expected increase in demand without additional and far-reaching interventions. The water crisis cannot be solved through engineering alone. Demand management in terms of both efficiency and allocation will have to play a large part in the efforts to close the water demand-supply gap in South Africa.

3.4 WATER SENSITIVITY

A global response to the water crisis has led to the development of an alternative approach to conventional water resource management. This section looks at the recently framed concept of water-sensitive cities and provides a brief overview of South Africa's achievements to date.

3.4.3 Integrated water resource management

The concept of IWRM is defined as "the process that promotes the coordination, development and management of water, land and related resources, to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2000, p. 22). The definition of IWRM explicitly refers to the integrated management of land and water. The Global Water Partnership (GWP) report (GWP, 2000, p. 24) describes this relationship as follows: "Land use developments and vegetation cover influence the physical distribution and quality of water and must be considered in the overall planning and management of water resources. Another aspect is the fact that water is a key determinant of the character and health of all ecosystems (terrestrial and aquatic), and their water quantity and quality requirements, therefore, have to be considered in the overall allocation of available water resources." South Africa is no stranger to this concept. In fact, IWRM was adopted in early 1990 in new water policies and legislation drafted after the fall of the apartheid regime.

Even though the concept of IWRM was included in water policies, it was primarily focused on infrastructure provision, water pricing and governance as South Africa embarked on an ambitious programme to eradicate water backlogs as envisioned by the RDP. Though well intentioned, literature points out that, during the transition period from apartheid to democracy, and in the restructuring of local government, limited integrated development planning took place (Asmal, 2000; Dewar, 1998; Donaldson & Marais, 2002). During this transition period, according to Dewar (1998, p. 369), policies were formulated "within discrete national line function departments, with little reference to the activities in other departments." He claims that this approach contributed to a fragmented and distorted urban planning and development phase. Unfortunately, planning for land and planning for water still lack critical integration in South Africa. As stated by Woltjer and Als (2007), "the majority of decisions around water management are made without reference to spatial planning issues related to urbanisation and population growth, and conversely development and land use decisions are made with little consideration of their effects on water systems." According to Thomson-Smeddle and Roux (2016), this is primarily due to the continued predominance of old approaches to township planning, infrastructure and housing design and a lack of cross-sector integration and collaboration.

The acknowledgement of major global issues of environmental degradation and resource depletion, as well as the deterioration of living standards, has contributed to the collective agreement that sustainability is no longer a minor developmental issue, but a transdisciplinary challenge that must be placed at the forefront of the development agenda. The delivery of more sustainable development requires a shift in thinking for all sectors, which cuts across traditional disciplinary, professional and administrative boundaries. Spatial planning comes to the fore as a tool that can, and must, be used in South Africa when planning for the security of water and land resources.

3.4.4 Water-sensitive cities

The 21st century marks the first point in recorded history when the proportion of the world's population living in urban environments surpassed those residing in the rural environment, making cities a critical focal point for realising sustainable practices (Brown et al., 2008, p. 1). The majority of South Africa's population resides in urban areas, which, according to the NDP, has created a reasonably balanced spatial structure, consisting of a network of metros, cities, large towns and service centres, all linked by an established network of connecting infrastructure (National Planning Commission, 2011, p. 235).

However, the sustainability and resilience of these urban areas have been in question for several years as city centres deteriorate and new developments have become favourable on the urban periphery. The result of this is low-density developments, which are energy intensive and cause severe depletion in soil quality and loss of biodiversity. The sustainability debate continues into the rural environment as a substantial number of people still reside within landscapes where settlement patterns are dysfunctional and inequitable due to the sheer scale of unregulated development (National Planning Commission, 2011, p. 235).

Investing in conventional infrastructure in these settlement areas is challenging as the cost associated with construction, operations and maintenance is financially unsustainable for most municipalities. In addition to the infrastructure-related implications, it is essential to recognise that the impact of development spreads far beyond the actual extent of developed areas, specifically, via the requirement for large (upstream) land areas to supply, capture and store water for urban and rural use, and the discharge of a cocktail of wastewater and stormwater to receiving waters downstream. This has caused a significant modification of the natural hydrological regimes and associated ecological processes in waterways upstream, within and downstream of the urban and rural settlement areas. According to DWS, the country's future challenge will be to ensure that there is fair and equitable redistribution of water resources across the various sectors, considering the country's socio-political and economic transformation agenda (DWS, 2016c, p. 26).

To address this, cities, towns and settlements should be designed and developed within the broader sustainability and resilience framework. According to Cilliers and Cilliers (2016, p. 15), the close relationship between human and natural systems implies that cities and settlements cannot be sustainable or resilient until their dependence on ecosystem services has been recognised. This is a well-recognised theory known as the ecological socio-economic relationship (ESER) framework, which indicates the dependency of economic efficiency on human capital and social justice, which, in turn, are both dependent on ecological integrity. In addressing the above, pioneered by Brown et al. (2008, p. 2), the aspirational concept of a water-sensitive city was introduced at the 11th International Conference on Drainage in 2008. Although there is no universally accepted definition of a water-sensitive city, the CRCWSC defines it as "a city that interacts with the urban hydrological cycle in ways that provide the water security essential for economic prosperity by efficiently using a diversity of water resources available; enhances and protects the health of watercourses and wetlands; mitigates flood risk and damage; and creates public spaces that harvest, clean and recycle water." A transitioning framework, which emanated from a six-year social research programme, was developed by Brown et al. (2008, p. 5). This framework clarifies the hydro-social contracts currently operating across cities, and sets a roadmap towards transitioning into a water-sensitive city.

The roadmap depicts a typology of six city states: the water supply city, the sewered city, the drained city, the waterway city, the water cycle city and the water-sensitive city. The transitioning framework takes into consideration the "temporal, ideological and technological context that cities transition through when moving between different management paradigms and is sensitive to other influencing conceptual variables, such as city-specific history, ecologies, geographies and socio-political dynamics" (Brown et al., 2008, p. 2).

According to Brown et al. (2008, p. 5), not one city can be directly compared to another, as each city is in its own transitioning stage due to differing socio-political and biophysical conditions. It is widely acknowledged that the process of becoming a water-sensitive city will involve a transition, driven by radical shifts in the structures, cultures and practices, underpinned by urban planning and water resource management. It calls for integrated development planning between all spheres of government and many diverse stakeholders to enable change that would result in a more sustainable system, notably by overcoming resistant cultures, structures and practices that are "locked in" to a current unsustainable path. Facilitating transitions is not easy. It requires dedicated attention to disrupt the dominant paradigm (in this case, urban planning practices) so that the emerging alternative of a water-sensitive city can become influential. Wong and Brown (2008, p. 4) refer to the three "pillars of practice" of a water-sensitive city, which must be seamlessly integrated into the built environment.

3.4.4.3 Pillars of practice: water-sensitive cities

The “pillars of practice” for water-sensitive cities include cities as catchments, cities providing ecosystem services and cities as water-sensitive communities.

Cities as catchments

Most cities are almost exclusively dependent on water supply from a single source, where water is extracted either from rivers or dams, treated and distributed from a centralised water treatment plant to the city. This treated water is used for almost all purposes, including drinking, cooking, cleaning, toilet flushing and gardening, even though not all uses require water of potable quality. As a response, cities must break their dependency on a single water source and access a diversity of water sources, underpinned by centralised and decentralised infrastructure. A diversity of water sources for cities could potentially include the utilisation of groundwater, stormwater and rainwater harvesting, recycled wastewater (grey water and black water) and desalinated water. These water sources can be harvested and treated through green infrastructure technologies or natural systems and reused on-site or pumped to the centralised wastewater treatment plant and redistributed.

By utilising water from various portfolios within the city, the city becomes the catchment, and less strain is placed on centralised water and WWTW, which also reduces energy demand.

Initiatives for creating cities as catchments include the following:

- Rainwater and stormwater harvesting for non-potable use
- City-scale, indirect potable reuse schemes and the pipeline grid, which links regional reservoirs
- Large-scale centralised desalination plants and indirect potable substitution schemes (treated recycled water returned to the water supply scheme)
- Secondary supply pipeline for non-potable water (third-pipeline system or dual pipeline)
- Non-potable water from a variety of local sources (e.g. stormwater, groundwater and recycled wastewater) can replace potable water for uses such as toilet flushing, laundry, garden watering and open space irrigation

Cities providing ecosystem services

The value of urban open spaces and landscapes must be evaluated in terms of their “ecological functions”, which captures the essence of sustainable water management, microclimate influences, the facilitation of carbon sinks and use for food production.

Protecting the environment from polluted stormwater is one of the primary objectives of sustainable water resource management, which can be achieved through land use management and by implementing SUDS such as constructed wetlands and bio-retention systems on a range of spatial scales. It calls for new principles in spatial planning in developed areas through higher density development, less built coverage and a greater utilisation of public open spaces for multiple functions.

Initiatives for creating cities that provide ecosystem services include the following:

- Protecting FEPAs through buffer zone waterway health management initiatives
- The ecological infrastructure should be enhanced and better utilised through the urban landscape design of large open spaces and connected blue-green corridors with both an aesthetic and a functional role
- Limiting the expansion of built footprints through development boundaries and by promoting higher densities and less floor coverage

Cities as water-sensitive communities

New technologies must be socially embedded in the local institutional context, otherwise their development in isolation will be insufficient to ensure their successful implementation in practice. New governance approaches towards policy, legislative and regulatory frameworks that guide the activities, roles and responsibilities of local governments, water utilities and government agencies, households and communities must be informed by the principles of water sensitivity.

Initiatives for creating water-sensitive communities include the following:

- Water sensitivity should feature in government and municipal policies
- Planning provisions should address water sensitivity, e.g. set specific water quality targets
- Water conservation and demand management strategies can be implemented through adjusted tariff structures (although this is not entirely related to spatial planning)
- Stormwater quality objectives can be regulated through municipal by-laws
- Tools and guidelines can be developed for water-sensitive planning

3.5 WATER SENSITIVITY IN SOUTH AFRICA

The WRC undertakes water-related research activities and plays a fundamental role in securing future water resources for economic, environmental and social development. In 2011, the WRC solicited a research proposal aimed at guiding urban water management decision makers on the use of water-sensitive urban design in a South African context.

3.5.3 The South African Guidelines for Sustainable Urban Drainage Systems

In 2013, the WRC published the South African Guidelines for Sustainable Drainage Systems, which emanated from a project entitled “Alternative technologies for stormwater management” (WRC Project No. K5/1826). The guidelines primarily focus on stormwater management in South Africa’s urban areas and the effect of urbanisation on both the quality and quantity of stormwater. The guideline document provides detailed information on calculations and technical illustrations for alternative approaches, including bioretention areas, detention ponds, filter strips, green roofs, infiltration trenches, multi-purpose detention ponds, permeable paving, rainwater harvesting, retention ponds, wetlands and soakaways (see Figure 3.6). Collectively, these systems are referred to as SUDS. Introducing SUDS into the urban environment will reduce the quantity, flow rate and volume of stormwater, improve the quality of stormwater, enhance the amenity and maintain biodiversity.

Key points from the guideline document applicable to spatial planning and land use management

The following should be considered in order to maintain pre-development conditions:

- Stormwater should be controlled and treated as close to its source as possible. The collection, storage, use, infiltration and evapotranspiration processes inherent in many source SUDS controls (green roofs, rainwater harvesting, soakaways, permeable pavements) are particularly useful in mimicking natural drainage characteristics.
- If stormwater cannot be handled on site, the next link in the management train is local SUDS controls, which attempt to manage all the stormwater generated in a local area. Where stormwater is to be conveyed from one place to another, more “natural” channels, such as filter strips, swales, infiltration trenches, bioretention areas and sand filters, should be used instead of pipes and concrete-lined canals, which speed up the flow and provide little water quality benefits.
- Regional SUDS controls (detention ponds, retention ponds, constructed wetlands) represent the last line of defence for the management of stormwater before it is discharged into the receiving waters.

A comprehensive review of the SUDS Guidelines provided new insights as to how spatial planning and land use management can give effect to SUDS on municipal level.

In order to achieve pre-development conditions (source control), the following should be considered:

- Building controls and development incentives should promote rainwater and stormwater harvesting:
    - The material used, and the angle of the roof can increase or decrease the harvesting potential of a building. However, this is subject to rainfall patterns, as well as the availability of space for storage tanks.
    - In large-scale developments such as shopping centres, businesses and industrial precincts or apartment blocks, storage solutions can be accommodated underground of building and parking areas. This too should be enforced by development controls.
- Reduce coverage (density and floor area ratio):
    - Increase development densities and building heights (go “up” instead of “wide”). Increasing densities within the existing development footprint will reduce the need to expand the development edge, protecting natural vegetation from land cover change. By increasing building heights, the impact of development on the surface can be reduced.
    - The floor area ratio refers to the percentage of land that may be developed. This excludes driveways, parking areas and verandas. These surfaces are mostly impervious and affect stormwater quality and quality. Floor area ratio should be recalculated to include these surfaces so that a recommended permeability percentage can be prescribed to a site.

When transporting stormwater (local control), the following should be considered:

- Road design:
    - Contour planning is an age-old method used mainly in agricultural practices (contour ploughing) to reduce runoff volumes that may cause erosion. Contour road design means that the road should follow the natural contour of the area.

When attempting to preserve the natural environment (regional control), the following should be considered:

- Master planning for ecological infrastructure:
    - Land use schemes and layout plans should protect ecological infrastructure and plan for connected corridors and open spaces.
- Protective zonings for ecological infrastructure:
    - The municipal LUS can legally protect the ecological infrastructure with a protective zoning or development overlay.

3.5.4 Water-sensitive urban design for South Africa: framework and guidelines

Following the 2013 publication of the South African Guidelines for Sustainable Drainage Systems, the WRC published the Water-sensitive Urban Design for South Africa: Framework and Guidelines. This publication emanated from a project entitled “Water-sensitive urban design for improving water resource protection or conservation and re-use in urban landscapes” (WRC Project No. K5/2071). It consists of two parts: the Framework (Part 1) and the Guidelines (Part 2).

The framework highlights several key issues and challenges, including, among others; that: “RSA is severely constrained by low rainfall, limited underground aquifers, and reliance on significant water transfers from neighbouring countries… wastewater is being generated at an alarming rate and often

water treatment is compromised, leading to increased pollution of surface and ground water... the deteriorating quantity and quality of RSA's water resources is particularly problematic as these systems support the environmental ecosystem and affect reliable production of food and energy, all of which are critically important for the country's social and economic development… people have a general disregard for the value of water – both economic and socio-cultural… fragmented "silo-management" of different aspects of the urban water cycle occurs, in part, because of the allocation of different responsibilities to different municipal departments… it will be difficult for the government to implement "green" projects when basic services do not exist, unless these are accomplished simultaneously."

Due to South Africa's unique settlement structure, the authors identified the need to change the internationally accepted term water-sensitive city to water-sensitive settlements, which expands the term "city" to "settlements", which, in South Africa, is broadly understood as comprising a concentration of people within a specific area, serviced by some public infrastructure. The framework suggests that a water-sensitive settlement is one where the management of the water cycle is undertaken in a water-sensitive manner with the overall objective of ecologically sustainable development. The framework also highlights that water-sensitive settlements consist of three components: water-sensitive urban design, water-sensitive urban planning and water-sensitive urban management, but they should be considered in an integrated manner.

The Framework (Part 1) introduces the philosophy of WSUD in South Africa and defines what "water sensitivity" means within the South African context. The framework defines "water sensitivity" in South Africa as "… the management of the country's urban water resources though the integration of the various disciplines of engineering, social and environmental sciences, while acknowledging that South Africa is a water-scarce country; access to adequate potable water is a basic human right; the management of water should be based on the participatory approach; water should be recognised as an economic good; and water is a finite and vulnerable resource, essential to sustaining all life and supporting development and the environment at large" (Armitage et al., 2014).

The framework highlights three areas of intervention. These include formal areas, greenfield developments and informal areas, where high densities and limited infrastructure are common (Armitage et al., 2014, p. 26). For this reason, the framework adopted the term water-sensitive settlements instead of water-sensitive cities to include the non-urban, but densely populated rural settlement areas. Figure 3.4 captures the essence of South Africa's framework towards water-sensitive settlements. Considering South Africa's history, the framework shows "where we are now" and labels formal areas as drained settlements, and informal areas as poorly serviced or unserviced high-density settlements. Figure 3.4 also illustrates the roadmap towards the "goal" of creating water-sensitive settlements. In reaching this goal, the framework suggests that formal areas will have to retrofit existing infrastructure and focus on integrated urban water cycle management, point source management, water demand management and water conservation.

The framework also suggests a leapfrog approach to development in the poorly serviced or unserviced informal settlement areas by developing water-sensitive services. The framework highlights the various components required for managing the transition towards water-sensitive settlements, which includes policy development, institutional structures, community participation, as well as the construction, operation and maintenance of centralised and decentralised wastewater treatment systems and green infrastructure.

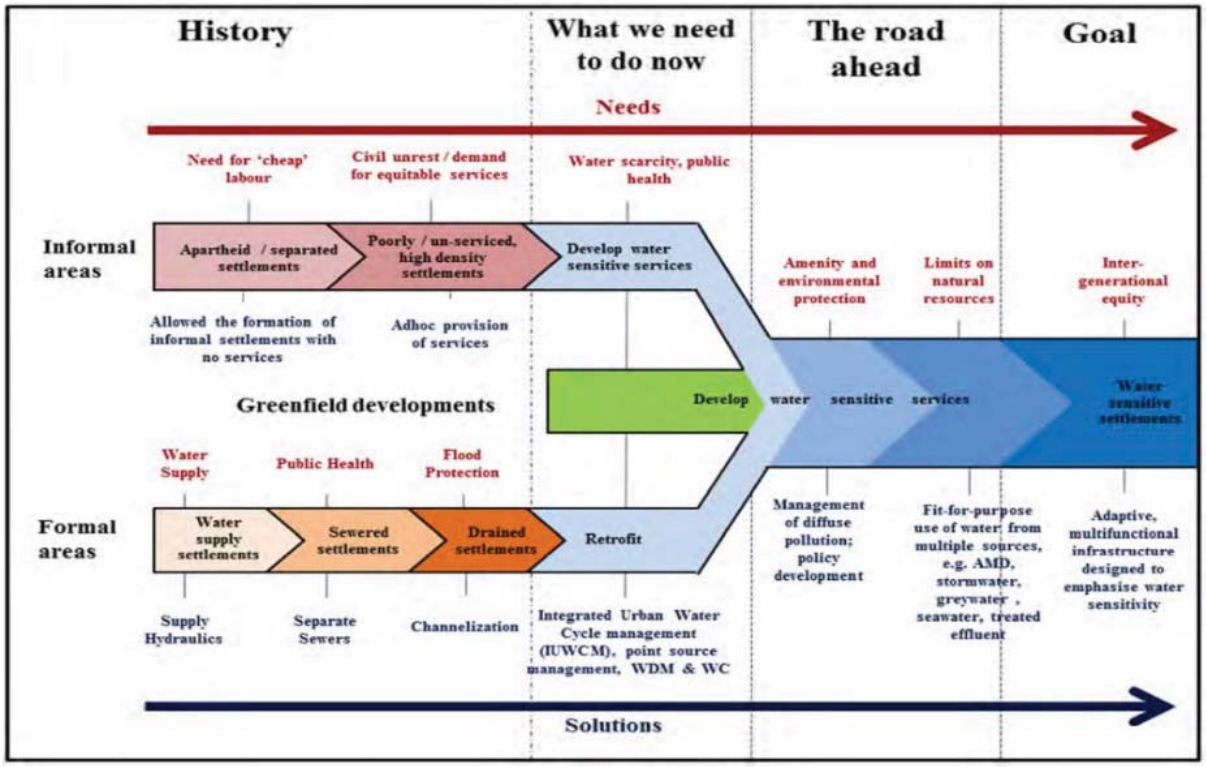


Figure 3.4: The WSUD framework for South Africa

Source: Armitage et al., 2014, p. 25

The Guidelines (Part 2) illustrate that WSUD brings together a range of activities under one umbrella. However, the two main components of WSUD refer to urban water infrastructure, and design and planning (Armitage et al., 2014, p. 46). The guidelines provide detailed information on technical illustrations and approaches to the urban water infrastructure component. However, research on the design and planning component was beyond the scope of work at the time.

The guidelines focused on the following:

- Stormwater management: taking a SUDS approach, which incorporates elements such as the enhancement of amenities and biodiversity, and flood mitigation, as well as SUDS selection applicable to South Africa
- Bioretention areas, detention ponds, filter strips, green roofs, infiltration trenches, multi-purpose detention ponds, permeable paving, rainwater harvesting, retention ponds, wetlands and soakaways
- Sanitation or wastewater minimisation, including the improvement of effluent quality and the use of treated wastewater or recycled water
- Groundwater management: artificial recharge and the use of groundwater
- Sustainable water supply options, including water conservation, water demand management, a reduction of NRW and alternative water sources, e.g. rainwater or stormwater harvesting

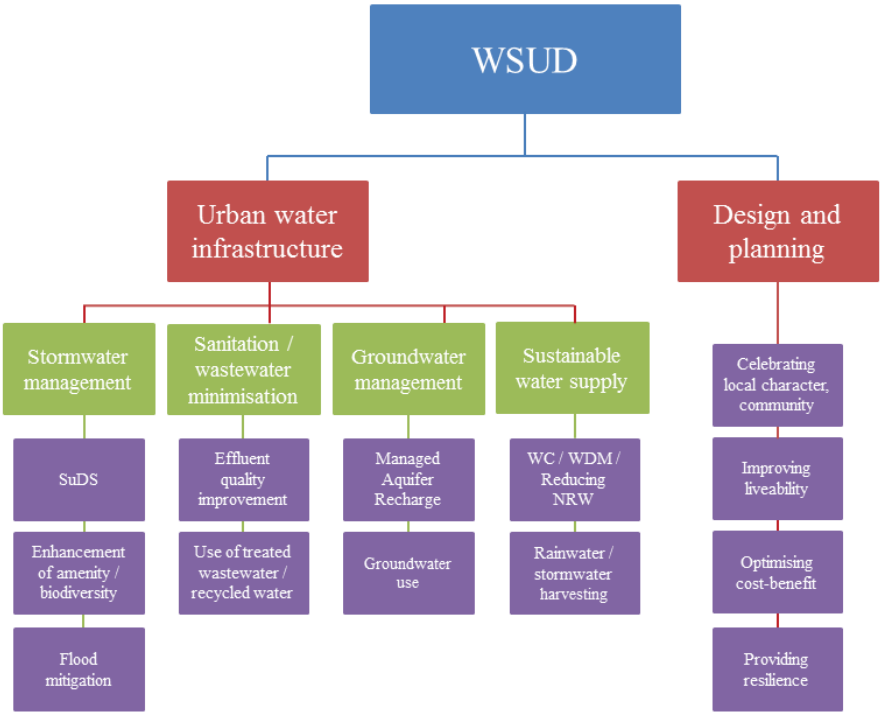


Figure 3.5: WSUD activities

The Water-sensitive Urban Design for South Africa: Framework and Guidelines sets the foundation for future research that revolves around the topic of urban water management and policy development in the integration of water cycle management into planning and design for the growth and development of water-sensitive settlements in South Africa (Armitage et al., 2014, p. 1). According to Armitage et al. (2014, p. viii), "there is untapped potential for more extensive coordination, which could be facilitated by the urban and strategic planning fora". Information is still limited as to exactly how design and planning should engage with the concept of water-sensitive settlements, specifically in the South African context.

However, spatial planning and land use can give effect to WSUD and water-sensitive settlements as presented in the framework and guideline document through several initiatives, including the following:

Stormwater management

- Refer to the previous section.

Sanitation or wastewater minimisation

- Level of wastewater services:
  - Providing a sustainable level of services is the municipality's mandate. However, not all settlements or households can have the same level of services due to the natural availability of the resource, the affordability of the resource and the spatial location of the settlement. Dry sanitation solutions should not be of a lower level of service, but a sustainable level of service.
- Location of (wet and dry) sanitation solutions:
  - Groundwater is a highly vulnerable resource as it is often unseen. Special planning and implementation requirements should be enforced when the location of wet and dry sanitation systems are selected.

- Access to sanitation systems:
    - One of the major concerns with alternative sanitation solutions is maintenance. Maintenance is often jeopardised by a lack of access to these systems due to the unplanned nature of informal settlements.
- Grey water reuse:
    - Dual-piped systems in household and building

Groundwater management and surface water resources

- Protection of high groundwater recharge areas:
    - With 98% of its surface water already developed, the demand for surface water outstrips supply in most catchments.
- Reduce coverage
- Buffer zone on boreholes
- Managed aquifer recharge

Sustainable water supply

- Level of services of potable water: Providing a sustainable level of services is the municipality's mandate. However, not all settlements or households can have the same level of service due to the natural availability of the resource, the affordability of the resource and the spatial location of the settlement.

Water conservation and demand management

- Review tariff structure
- Make use of water-efficient fixtures
- Make use of water reuse technologies. Water harvesting may not be as feasible as water reuse options as the previous section explained that rainfall is distributed unevenly and temporally throughout the country. Alternatively, water reuse is supported by an improved efficiency of treatment processes, reduced cost, and within close proximity of the point of application.
- Rainwater and stormwater harvesting: Unconventional sources of water could include water recycling or reuse and rainwater harvesting, which has become an attractive option for water resource managers and planners.

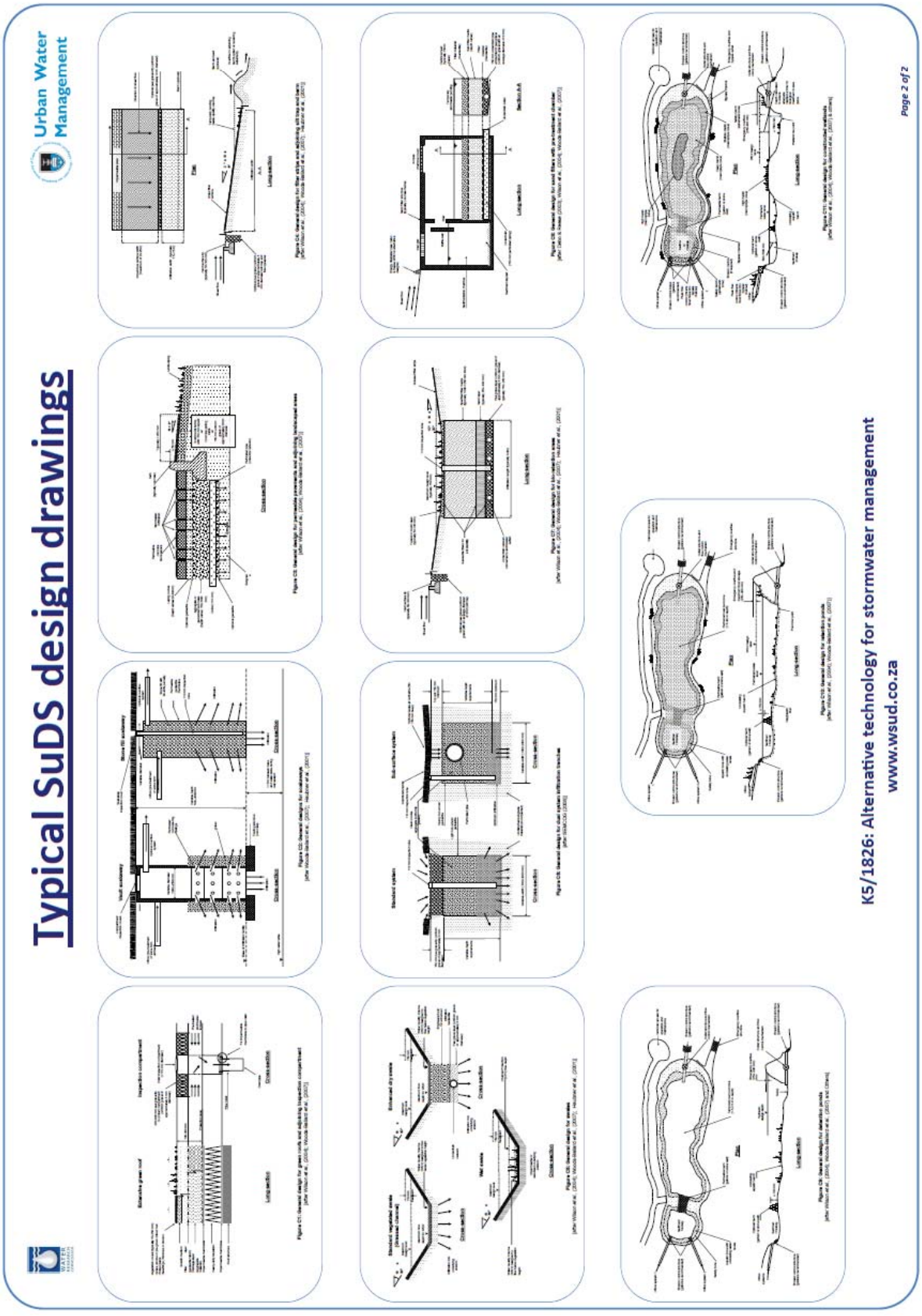


Figure 3.6: Typical SUDS design drawings

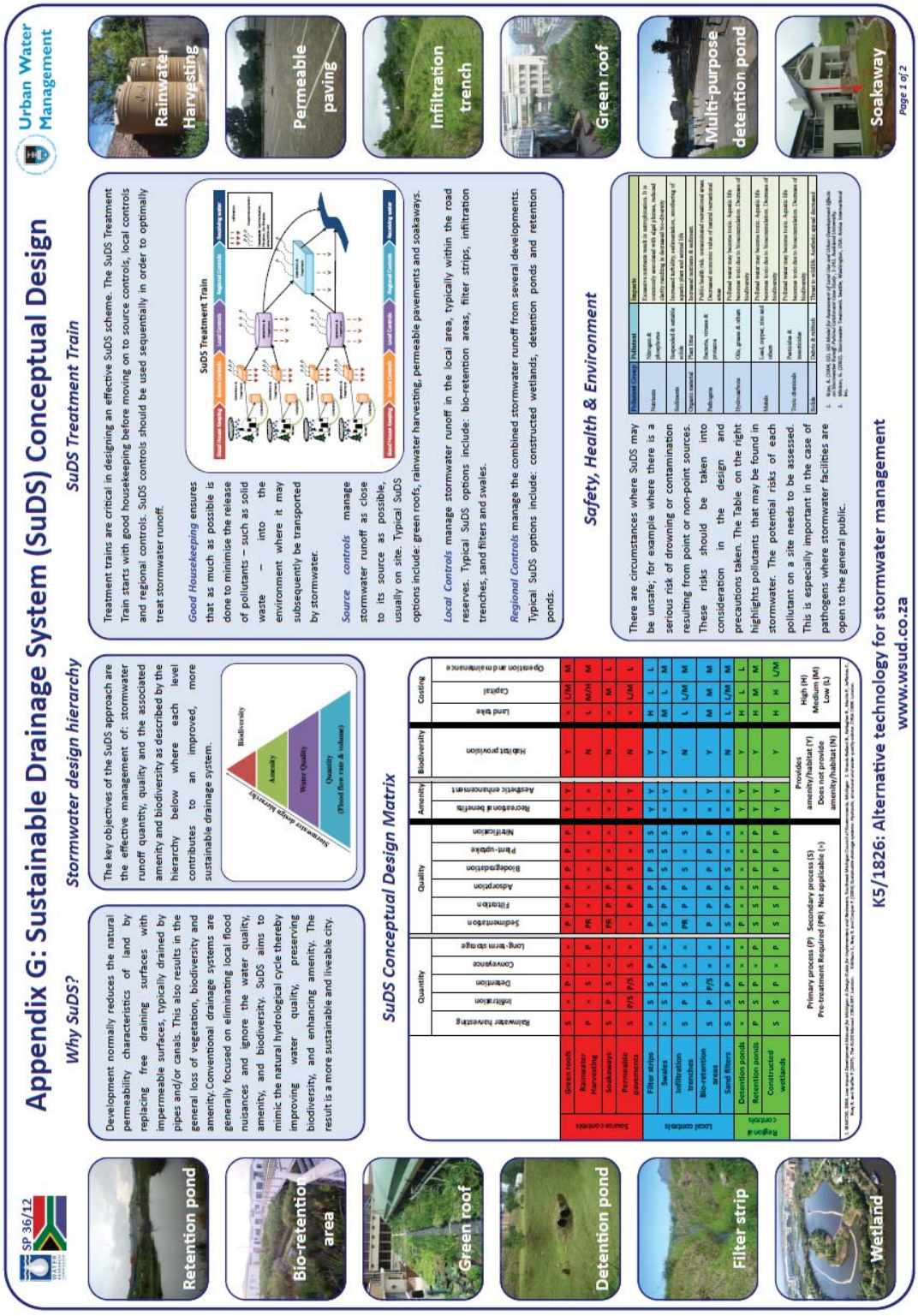


Figure 3.7: SUDS conceptual design

In addition to the recommendations, the framework identifies several other areas in need of change and intervention, including "…there is a need to change the linear urban metabolism pattern (where resources such as water, food, energy, materials and chemicals are delivered, metabolised and changed to waste outputs) to a cyclical one of reuse... there is a need to recognise the importance of the total water cycle and its impacts on other sectors... RSA must move towards water use efficiency, demand management, improved water governance, optimisation of existing water resources including

groundwater, seawater, rainwater harvesting, reuse of water, and resource protection and groundwater recharge... municipal authorities need to go beyond the delivery of basic services to ensure urban resilience by, inter alia, reconfiguring cities by way of strategic planning and investment to address future uncertainties like resource shortages, flood risks and climate change impacts... municipalities with limited funding and capacity must "do what you can with what you have", i.e. begin by strengthening local legislation and regulations to encourage this transition… policy development and institutional restructuring, community participation, construction of infrastructure and operations and maintenance... it is evident that alternative, integrated systems-based approaches to conventional water management of water supply and modes of ensuring water quality are required. An integrated systems-based approach has the potential to facilitate a change from "water wasteful" to "water sensitive" in both urban and rural areas. The ultimate goal is the holistic management of the country's water cycle to simultaneously achieve the desired economic, environmental and social sustainability and the benefits thereof".

3.6 CONCLUSION

The Water-sensitive Urban Design for South Africa: Framework and Guidelines sets the foundation for future research that revolves around the topic of urban water management and policy development in the integration of water cycle management into planning and design for the growth and development of water-sensitive settlements in South Africa (Armitage et al., 2014, p. 1). According to Armitage et al. (2014, p. viii), "there is untapped potential for more extensive coordination, which could be facilitated by the urban and strategic planning fora". Information is still limited as to exactly how design and planning should engage with the concept of water-sensitive settlements, specifically within the South African context. Environmental management and improved land management practices are cross-cutting themes that also support the provision of green, resilient infrastructure and adaptation to climate change.

Households, industries and other land use activities consume water. Any new development must be planned (according to exact standards) and approved by the applicable municipality. This approval takes into consideration both the location of the development and the extent of the development. While this chapter established the linkage between development and water consumption, the next chapter investigates planning instruments in more detail, specifically to investigate ways in which these planning instruments can be leveraged to achieve water sustainability.

CHAPTER 4: STRATEGIC PLANNING FOR LAND, WATER AND ENVIRONMENTAL RESOURCES

4.1 INTRODUCTION

Chapter 2 provided an overview of various legislations, polices and plans adopted by national government since 1994 to give effect to land, water and environmental reform. Today, South Africa has an extensive suite of legislation that mandates various spheres of government to prepare and implement strategic plans to guide development within its respective sector. This chapter provides a synopsis of the various plans to be prepared as mandated by national legislation, as well as frameworks, guidelines and decision support tools that should be used by a planner or any other national, provincial or local government official entrusted with powers and duties aimed at achieving a sustainable and productive environment.

The chapter is structured into three main parts. The first establishes the legal case for water resource planning and management from a national to a municipal scale. The second addresses environmental resource planning and management, and highlights the importance of systematic biodiversity planning. Finally, the chapter establishes a legal case for spatial planning and land use management, and identifies several aspects regarding how spatial planning and land use management can and should give effect to water sensitivity within the existing framework of developing water-sensitive settlements. The chapter focuses on sector alignment and aims to break the linear and silo management approach towards spatial planning, and land use, water and environmental resources planning and management.

4.2 THE LEGAL CASE FOR WATER RESOURCES PLANNING AND MANAGEMENT

The national Department of Water and Sanitation, acting through the Minister, is the custodian for all inland water resources, whether fresh or saline, including rivers, lakes, wetlands, groundwater and estuaries (Nel et al., 2011). South Africa's main legislative framework that provides for the protection, planning, development and management of water resources includes the National Water Act, Act No. 36 of 1998, and the Water Services Act, Act No. 108 of 1997. While the National Water Act is concerned with the protection, use, development, conservation, management and control of water resources, the Water Services Act provides the mechanisms for ensuring that all South Africans have access to a basic supply of water and sanitation. Both Acts legislate the development of strategic planning documents to guide the planning and management of water resources from national to municipal level. Different levels of strategic planning for water resources and water-related infrastructure services exist.

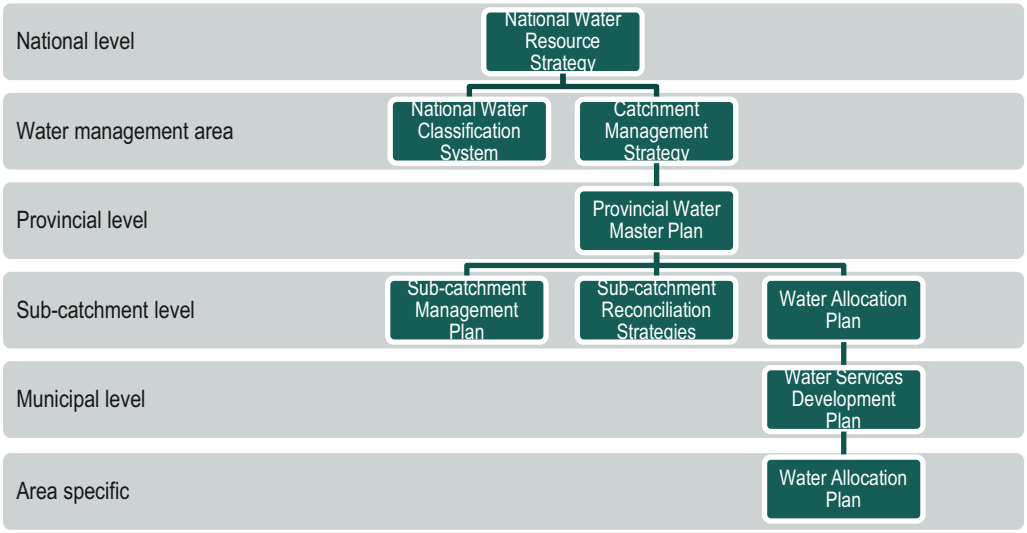


Figure 4.1: Legislative framework for strategic water resource planning and management

Since 1994, DWS has published numerous policies, regulations and guidelines in the pursuit of achieving constitutional water reform. Those applicable to the study include the following:

Table 4.1: Regulations published in terms of South Africa's Water Acts

Date	Regulation, policies and guidelines
1999	Regulations on use of water for mining and related activities aimed at the protection of water resources
1999	Water use registration regulations
2001	Regulations relating to compulsory national standards and measures to conserve water
2001	Norms and standards in respect of tariffs for water services in terms of section 10(1)
2002	Guidelines for the compulsory national standards in terms of section 9 of the Act and the norms and standards for water services tariffs in terms of section 10 of the Act
2007	Pricing strategy for water use charges
2009	General authorisation for the rehabilitation of wetlands
2010	Regulations for the establishment of the classification system
2013	Revision of general authorisations
2013	Regulations relating to compulsory national standards for process controllers and water services works
2015	Draft revision of norms and standards for setting water services tariffs
2016	General authorisation for water uses defined in section 21(c) and 21(i)
2017	Regulations requiring the taking of water for irrigation purposes to be measured, recorded and reported
2017	Regulations regarding the procedural requirements for water use licence applications and appeals
2017	General authorisation for taking and storing a water resource (as contemplated in section 21(a) and (b))
2017	Draft national norms and standards for domestic water and sanitation services

4.2.1 Strategic planning for water resources on national level

Part 1 of the National Water Act of 1998 makes provision for the progressive development, by the Minister, after consultation with civil society at large, of a National Water Resource Strategy. The NWRS must be formally reviewed from time to time and is legally binding on all authorities and institutions exercising powers or performing duties under the National Water Act.

4.2.1.1 National Water Resource Strategy

The first edition of the NWRS was published in 2004. It has since been reviewed and published in 2013 as NWRS-2. The NWRS provides the framework for the protection, use, development, conservation, management and control of water resources for the country as a whole. It also provides the framework within which water will be managed at a catchment level in defined water management areas. The central objective of managing water resources is to ensure that water is used to support equitable and sustainable social and economic transformation and development.

Chapter 2, Section 6 of the National Water Act provides an outline of what the NWRS should contain:

Table 4.2: Contents of the NWRS

S.6(1)	The NWRS must:
(a)	…set out the strategies, objectives, plans, guidelines and procedures of the Minister and institutional arrangements relating to the protection, use, development, conservation, management and control of water resources within the framework of existing relevant government policy in order to achieve: (i) the purpose of this Act; and (ii) any compulsory national standards prescribed under section 9(1) of the Water Services Act, Act No. 108 of 1997;
(b)	…provide for at least: (i) the requirements of the **reserve** and identify, where appropriate, water resources from which particular requirements must be met (National Water Classification System); (ii) international rights and obligations; (iii) actions to be taken to meet **projected future water needs** (interventions); and (iv) water use of strategic importance;
(c)	…establish **water management areas** and determine their boundaries (read together with section 6(2) (declarations of WMAs);
(d)	… contain estimates of present and **future water requirements** (reconciliation strategies);
(e)	…state the total quantity of water available within each WMA (reconciliation strategies);
(f)	…state WMA surpluses or deficits (reconciliation strategies);
(g)	…provide for inter-catchment water transfers between surplus WMAs and deficit WMAs (reconciliation strategies);
(h)	…set out principles relating to water conservation and water demand management (interventions);
(i)	…state the objectives in respect of water quality to be achieved through the classification system for water resources provided for in this Act (National Water Classification System);
(j)	…contain objectives for the establishment of institutions to undertake water resource management (objectives for catchment management agencies);
(k)	…determine the inter-relationship between institutions involved in water resource management; and
(l)	…promote the management of catchments within a WMA in a holistic and integrated manner (catchment management strategies).

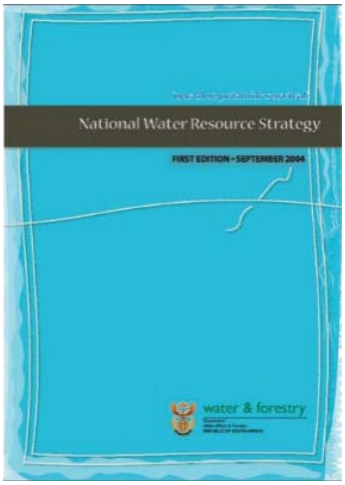
Source: Republic of South Africa, 1998

4.2.1.2 Water management area

In terms of section 6(1)(c) of the National Water Act, the Minster declared the boundaries of nine new WMAs in 2016, including Limpopo-North West, Olifants, Inkomati-Usuthu, Pongola-Mtamvuna, Vaal, Orange, Mzimvubu-Tsitikamma, Breede-Gouritz and Berg-Olifants. Between 2014 and 2016, seven CMAs have been established in terms of section 78(3) of the National Water Act, two of which are currently operational (see Table 4.3).

Table 4.3: Water management areas and catchment management agencies

	WMA boundaries	**CMA established**	**CMA operational**
1.	Limpopo-North West	4 May 2014	No
2.	Olifants	27 February 2015	No
3.	Inkomati-Usuthu	2 May 2014	Yes
4.	Pongola-Mtamvuna	23 May 2014	No
5.	Vaal	29 January 2016	No
6.	Orange		No
7.	Mzimvubu-Tsitikamma		No
8.	Breede-Gouritz	23 May 2014	Yes
9.	Berg-Olifants		No



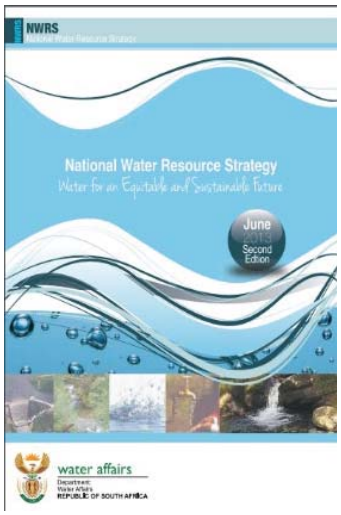


Figure 4.2: NWRS-1 and NWRS- 2

As noted in section 4.2.1.1, each WMA must have an established CMA. CMAs serve as the first port of call for all water resource management issues and must therefore develop strategies for IWRM within the WMA, regulate water use through authorisation and licencing, assign water quality monitoring, and implement physical interventions such as water conservation and demand management (DWS, 2013, p. 11). The National Water Act therefore requires CMAs, in terms of section 78(3), to develop a catchment management strategy for the protection, use, development, conservation, management and control of water resources within its WMA (DWA, 2013a, p. 64).

4.2.1.3 Catchment management strategies

Essentially, the NWRS-2 provides the basis for the CMS and is thus a key source document for the CMAs. Catchment management strategies should, however, contain more detailed and updated information in order to inform strategic planning for water resources on a catchment or regional scale (Republic of South Africa , 1998). Section 9 of the National Water Act provides an outline of what the CMS should contain (see Table 4.4):

Table 4.4: Contents of a catchment management strategy

S(9)	A catchment management strategy must:
(a)	…take into account the class of water resources and resource quality objectives contemplated in Chapter 3, the requirements of the reserve and, where applicable, international obligations (National Water Classification System);
(b)	…not be in conflict with the national water resource strategy;
(c)	…set out the strategies, objectives, plans, guidelines and procedures of the CMA for the protection, use, development, conservation, management and control of water resources within its WMA;
(d)	…take into account the geology, demography, land use, climate, vegetation and waterworks within its WMA (land use planning);
(e)	…contain water allocation plans which are subject to **section 23,** and which must set out principles for allocating water, taking into account the factors mentioned in **section 27(1)** (highlights the importance of class and the resource quality objectives – Chapter 3);
(f)	…take account of any relevant national or regional plans prepared in terms of any other law, including any development plan adopted in terms of the Water Services Act, Act No. 108 of 1997 (SDFs; LUSs);
(g)	…enable the public to participate in managing the water resources within its water management area;
(h)	…take into account the needs and expectations of existing and potential users; and
(i)	… set out the institutions to be established.

In 2007, the Minister published guidelines for the preparation of a CMS in terms of section 10(1) of the National Water Act. The guidelines noted that different scales of planning may be needed for different circumstances. In the case where catchments within a WMA vary markedly, it will be essential to draft sub-catchment management plans that will address issues relevant to a specific catchment or sub-catchment. The catchment management plans are then consolidated into a CMS for the WMA (Republic of South Africa, 1998, p. 16).

The process of developing CMSs is described in detail in the guideline document. The guideline document conceptualises IWRM as comprising four clusters: Part A (important foundational information), Part B (water resource management sub-strategies), Part C (facilitating sub-strategies) and Part D (integration strategy), which collectively inform the CMS.

Much of the information applicable to Part A should be retrieved from the SDF and land use information as represented in the municipal LUS. The statement is based on the fact that the guideline document for developing CMSs requires a holistic status quo assessment, informed by key biophysical, social, economic and political features or characteristics found within the WMA (land use data). The status quo assessment should also provide information of likely future scenarios related to water resources. In this regard, land use information and spatial planning documents should be included. Based on an understanding of the current situation and potential future directions (with and without management interventions), a WMA vision is to be defined.

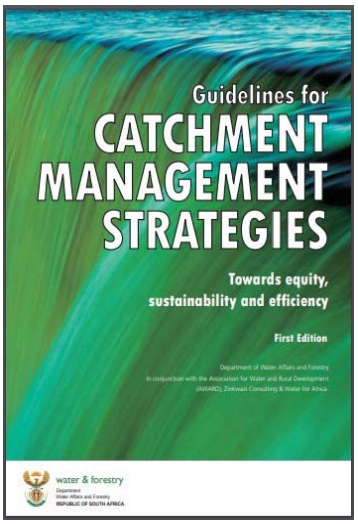


Figure 4.3: Guidelines for catchment management strategies

Part B calls the development of water resource management sub-strategies to inform the process of achieving the vision as defined in Part A. For the CMS to develop realistic resource management sub-strategies, the management class of the catchment(s) should first be determined using the Water Resource Classification Systems (WRCS). The classification of water resources aims to ensure a balance between the need to protect and sustain water resources and the need to develop and use water resources (DWA, 2013b). In 2007, the Minister published guidelines for WRCS, which define the procedure for determining the management class (DWS, 2016b). Similar to Part A, several of the procedures can and should be informed by spatial planning and land use information and vice versa. The regulations for the establishment of the WRCS define three management classes, reflecting a gradual shift from resources that are to be minimally used to resources that are heavily used by taking the social and economic needs of all who rely on the water resource into consideration.

In term of section 6(1)(i) of the National Water Act, the Minster also gazetted regulations for the establishment of the WRCS in 2010. The national water classification systems, together with the declared WMA, provide for the second tier of strategic planning for water resources. The purpose of the management class is to establish clear goals relating to the quantity and quality (quantitative targets) of the relevant water resource (resource quality objectives), and conversely, the degree to which the reserve can be utilised by considering the economic, social and ecological goals from an IWRM perspective (DWA, 2013b). The determination of the reserve for aquatic ecosystems entails investigating the relationship of major interactive components of the hydrologic cycle, namely groundwater and surface water bodies, including rivers, lakes and estuaries, as well as the current stress caused by land uses on the resource in question. Detailed land use information as contained in the municipal LUS should therefore be a key informant in the process.

Ultimately, the management class informs resource-directed measures (RDMs) and source-directed controls (SDCs) to be implemented as catchment management strategies in order to achieve the vision. The RDMs are directed at protecting the water resources base, while the SDCs are controls for water use. The SDCs cannot be undertaken without RDMs and vice versa. The management classes should also inform part of the conditions related to water use authorisation (the water licence), making water users responsible for managing the impact of their water use by complying with water use authorisation conditions.

Figure 4.4: The water resource classification system

4.2.1.4 Water Allocation Plan

The responsibility for the allocation of the total available resource within a WMA is shared between the Minister and the CMA of a particular WMA. First, the Minister will determine the allocation for the reserve, international agreements, strategic purposes and water for future needs. Thereafter, the allocation for other uses is the responsibility of the CMA. Generally, the allocation of available water by the CMA is sector based. When CMAs develop their water allocation plans, as per section 9(e) of the National Water Act, the plan is subject to section 23 and section 27(1). Section 23 of the Act states that the Minister may limit the amount of water that a responsible authority may allocate; hence, the Minister makes the first allocations, while section 27(1) states that when the responsible authority considers issuing a general authorisation or licence, the authority must consider, among other things, all existing lawful water uses, the need to redress the results of past racial and gender discrimination and the socio-economic and environmental impact of the water use on the water resources, as well as the impact on other water users. Linking to Chapter 3, Protection of water resources, before issuing a general authorisation or a water use license, the responsible authority must consider the class and resource quality objectives of the water resource, as well as the quality of water in the water resource, which may be required for the reserve and for meeting international obligations.

4.2.2 Strategic planning for water resources on provincial level

4.2.2.1 Provincial Water and Sanitation Master Plan

Water is not a direct provincial function, yet DWS has provincial offices in each province. Provinces may be required to intervene in municipal water affairs if a municipality is not performing well enough. Provinces are also required to participate in water sector planning in conjunction with national and local government. Several of South Africa's provinces have a Water and Sanitation Master Plan in place to guide and ally various infrastructure projects from national to local municipal level.

4.2.3 Strategic planning for water resources on sub-catchment or regional level

4.2.3.1 Sub-catchment management plans

As mentioned in section 0, in the case where catchments within a WMA vary markedly, it will be essential to draft sub-catchment management plans that will address issues relevant to a specific catchment or sub-catchment. The content of these plans should be similar to those of the larger catchment, but the level of detail should improve at this planning scale.

4.2.4 Strategic planning for water resources on municipal level

According to the Water Services Act of 1997, municipalities that have been awarded the responsibility of ensuring access to water services are termed water services authorities, and have the constitutional responsibility for planning, ensuring access to and regulating the provision of water services (including water supply and sanitation) within their area of jurisdiction. Water services authorities are also responsible for securing licences from the DWS or CMAs to abstract and discharge water. A WSA may provide services themselves or contract a water services provider (WSP) to provide the services. The primary municipal water service planning instrument is the Water Services Development Plan.

4.2.4.1 Water Services Development Plan

The Water Services Act mandates that all WSAs develop a five-year WSDP, which integrates technical, social, institutional, financial and environmental planning, ultimately forming part of the IDP process. Section 13 of the Water Services Act provides an outline of what a WDSP should contain (see Table 4.5).

Table 4.5: Contents of a Water Services Development Plan

S(13)	Every draft WSDP must contain detail:
(a)	…of the physical attributes of the area to which it applies (biophysical analysis);
(b)	…of the size and distribution of the population within that area (socio-economic analyses);
(c)	…of a timeframe for the plan, including the implementation programme for the following five years (spatial growth as per the SDF);
(d)	…of existing water services (infrastructure map or levels of services);
(e)	…of existing industrial water use within the area of jurisdiction of the relevant WSA (industrial land use information);
(f)	…of existing industrial effluent disposed of within the area of jurisdiction of the relevant water services authority;
(g)	…of the number and location of persons within the area who are not being provided with a basic water supply and basic sanitation (levels of service assessment – SDF);
(h)	…regarding the future provision of water services and water for industrial use and the future disposal of industrial effluent, including: (i) the WSPs that will provide those water services; (ii) the contracts and proposed contracts with those WSPs; (iii) the proposed infrastructure necessary (future growth scenario – SDF); (iv) the water sources to be used and the quantity of water to be obtained from and discharged into each source (CMS water allocation plans – mix of water resources – redefine levels of service); (v) the estimated capital and operating costs of those water services and the financial arrangements for funding those water services, including the tariff structures (cost of water); (vi) any water services institution that will assist the WSA; and (vii) the operation, maintenance, repair and replacement of existing and future infrastructure (Infrastructure Asset Management Plan);
(i)	…of the number and location of persons to whom water services cannot be provided within the next five terms, setting out: (i) the reasons therefor; and (ii) the time frame within which it may reasonably be expected that a basic water supply and basic sanitation will be provided to those persons (why are people located there?); and
(j)	…of existing and proposed water conservation, recycling and environmental protection measures.

Tariff structure

Chapter 2, sections 9 and 10, Standards and tariffs, states that the Minister may, from time to time prescribe compulsory national standards relating to the provision of water services, and with the concurrence of the Minister of Finance, prescribe norms and standards in respect of tariffs for water services.

Norms and standards for basic water services

The Strategic Framework for Water Services, 2003 (currently under review), sets out a comprehensive approach with respect to the provision of water services. National standards prescribed under section 9(1) of the Water Services Act, Act No. 108 of 1997, prescribes the following levels of services:

Levels of services: water supply	Description
Basic level of domestic water supply	• A basic (or RDP) household water supply is defined by the Strategic Framework for Water Services of 2003 as either 25 ℓ per person per day, or 6,000 ℓ per household per month, supplied according to the following criteria: - Minimum flow rate of not less than 10 ℓ per minute - Within 200 m of a household; however, according to DWS (2015), Cabinet approved that a basic water supply be amended from within 200 m to within the yard, although this has yet to be promulgated - Interruption of **less** than 48 hours at any one time and a cumulative interruption of less than 15 days per year; and at a potable standard (SANS 241 or according to the South African Water Quality Guidelines published in 1998)
Interim water supply solution	• DWS prioritises all communities living in settlements that are greater than 50 households within these areas, who will receive at least a minimum interim water supply by 30 June 2015. The minimum standard of interim or intermediate water supply is as follows: - 10 ℓ per person per day within 500 m of a household and fit for human consumption (SANS 241). - No consumer is without a water supply for more than seven full days in any year and no more than three consecutive days.
Longer-term domestic water supply	• Medium and higher levels of domestic water are aimed at ensuring that all households receive 50 to 60 ℓ per person per day via an individual connection, either in the house or in the yard.

A basic toilet facility is regarded as a toilet that is safe, reliable, environmentally sound and easy to keep clean, provides privacy and protection against the weather, is well ventilated, keeps smells to a minimum and prevents the entry and exit of flies and other disease-carrying pests.

Levels of services: sanitation	Description
Basic level of domestic sanitation	• A ventilated improved pit latrine (VIP), which is a dry toilet facility • The preferred temporary sanitation solution is a chemical toilet • A bucket toilet is unacceptable
Higher level of domestic sanitation	• Any of the following: full waterborne sanitation, septic tank, soakaways and urine diversion toilets

4.2.5 Additional water-related tools and strategies

4.2.5.1 National Freshwater Ecosystem Priority Areas

In 2008, the NFEPA project was launched. The results were published in 2011. The project aimed to identify a national network of freshwater conservation areas through systematic biodiversity planning, as explained in the technical report of the NFEPA project. Freshwater ecosystems refer to “all inland water bodies, whether fresh or saline, including rivers, lakes, wetlands, subsurface water (groundwater) and estuaries” (Nel et al., 2011). The Atlas of Freshwater Ecosystem Priority Areas in South Africa presents all maps of NFEPAs developed during the project and provides guidance on how many and which rivers, wetlands and estuaries should remain in a natural or near natural condition to support the water resource protection goals of the National Water Act and to protect water from human use (Nel et al., 2011, p. 12).

According to Driver et al. (2011, p. 2) the spatial data and NFEPA maps should be used to inform planning and decision-making processes, which affect freshwater ecosystems, such as CMSs, the classification of water resources, reserve determination, and the setting and monitoring of quality objectives for resources, listing threatened freshwater ecosystems and the expansion of the protected areas network. They should also be used to inform other policies and legislation that affect the management and conservation of freshwater ecosystems at municipal level. Table 4.6 lists the spatial data and maps produced by the NFEPA mapping project.

Table 4.6: NFEPA maps and description

National map products	Description	Implications
Density of FEPAs per WMA	The density of the FEPA is a calculated percentage of the total area of a WMA that has been identified as a FEPA or associated sub-quaternary catchment.	Only FEPAs in good condition were used for the calculations. However, this does not mean that areas with low-density FEPAs are less important. In fact, where the FEPA density per WMA is low due to poor conditions, rivers and wetlands should be regarded with higher importance and concern.
Density of FEPAs per sub-WMA	The density of the FEPA is a calculated percentage of the total area of a sub-WMA that has been identified as a FEPA or associated sub-quaternary catchment.	
Free-flowing rivers	Free-flowing rivers refer to rivers without dams that flow undisturbed from their source to the confluence with a larger river or the sea.	South Africa has 62 free-flowing rivers, of which 19 have been identified as flagship free-flowing rivers. The upper Groot Marico River in North West is the only free-flowing river representing the northwestern region of the country. The Eastern Cape and KwaZulu-Natal have the highest number of free-flowing rivers, several of which are short coastal rivers.
High water yield areas	These are sub-quaternary catchments where mean annual runoff is at least three time more than the average for the related primary catchment.	High water yield areas or water factories support growth and development needs that are often long distances away. These areas make up 8% of the land area across South Africa, Lesotho and Swaziland, but provide 50% of the water in these countries. However, only 16% of the water source areas are formally protected (Colvin et al., 2013, p. 14). Land uses that reduce stream flow or affect water quality (e.g. mining, plantations, overgrazing) should be avoided in these areas. Wetlands should be kept in a good condition or rehabilitated, and invasive alien plants should be cleared.
High groundwater recharge areas	These are sub-quaternary catchments where groundwater recharge is at least three times more than the average for the related primary catchment.	High groundwater recharge areas are crucial for sustaining groundwater resources, which may be far away from the recharge area. Groundwater abstraction and loss of natural vegetation should be avoided in these areas, and invasive alien plants should be cleared.
River conditions	River conditions describe the extent to which the river has been modified by human activity.	The data provides information on the condition of the rivers.
Rivers FEPAs	The data shows river conditions that should not be degraded any further, as they may in future be considered for rehabilitation once FEPAs are considered to be fully rehabilitated and well managed.	The data represents areas that are essential for achieving targets for river ecosystems and threatened or near threatened fish species in a natural or near natural condition.
Wetlands and estuaries FEPAs	Data indicates where wetlands and estuaries are located.	The data represents wetlands and estuaries where ecological processes should be maintained

National map products	Description	Implications
Wetlands clusters	Wetland clusters represents a group of wetlands embedded in a relatively natural landscape. These are clusters for important ecological processes.	Areas defined as wetland clusters are critical for supporting ecosystems. These areas should be kept in a good ecological condition, where possible.
Fish sanctuaries	These are developed for threatened and/or near threatened fish species indigenous to South Africa	At least one third of South African indigenous freshwater fish species are threatened. Healthy river and sub-quaternary catchment conditions are essential to protect these fish species.

Together with the maps and spatial data generated from the NFEPA project, an implementation manual was published that should be used to guide planning and land use in and around these ecosystems. Chapter 6 of the "Implementation Manual for Freshwater Ecosystem Priority Areas" gives clear management guidelines for wetlands, rivers, sub-quaternary catchments associated with rivers and upstream management areas (Driver et al., 2011, pp. 69-90) and FEPAs for land use practices or activities. Cited from Driver et al. (2011), "the land use practices and activities highlighted in the guidelines are known to influence the drivers of ecosystem condition (hydrology, geomorphology, water quality), which, in turn, determine habitat attributes (e.g. habitat availability and condition), which, in turn, determine biological responses (Kleinhans & Louw, 2007)."

The implementation manual refers to three management approaches to IWRM:

- Reactive decision making, such as the EIA, agricultural land use decisions, water use licensing and other development control decisions, e.g. through provincial land use legislation
- Proactive forward planning, such as informing the NWRS, National Planning Commission processes, IDPs, SDFs and zoning schemes
- Proactive conservation and rehabilitation, such as biodiversity stewardship, land acquisition for protected areas, the clearing of invasive alien plants, and rehabilitating wetlands (Driver et al., 2011)

Increased human pressure from the settlement can be avoided if land use management takes ecological infrastructure into account. Freshwater ecosystems provide a valuable natural resource, with economic, aesthetic, spiritual, cultural and recreational value. Yet, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely because of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

4.2.5.2 National Integrated Water Information System

The DWS also established a website where information on the following can be accessed: the assessment of water, infrastructure delivered, water supply reliability, dam safety, eutrophication levels, groundwater reserves, groundwater status, NRW, resource water quality objective, surface water storage, water tariffs – municipalities and raw water tariffs, and drought status and management.

This information can be accessed through the following link:
http://niwis.dws.gov.za/niwis2/DocumentManagement

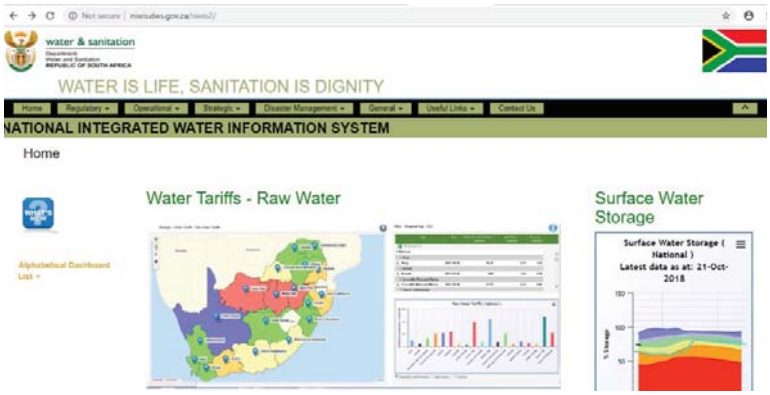


Figure 4.5: National Integrated Water Information System

4.2.5.3 Water resources of South Africa

Another website with valuable spatial data on water resources in South Africa (WR2012) is the website waterresourceswrc2012.co.za. This website describes the water resources of South Africa, Lesotho and Swaziland. It is the culmination of a number of water resource appraisals that have been carried out over the past four decades. Its predecessor was WR2005. The intention of this website is to provide all the data, information, GIS maps, water resource models, spreadsheets and tools to allow water resource practitioners to investigate, analyse and plan their water resource studies.

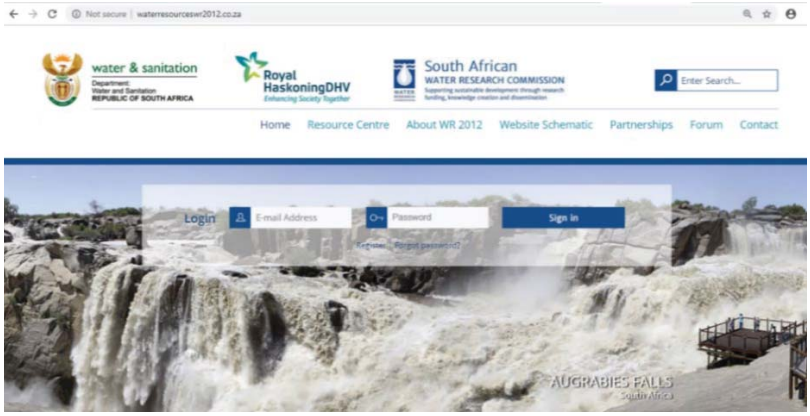


Figure 4.6: The website for WR2012

4.3 LEGAL CASE FOR ENVIRONMENTAL RESOURCES PLANNING AND MANAGEMENT

The national Department of Environmental Affairs, acting through the Minister, is the custodian of South Africa's biodiversity. South Africa has an extensive policy and legislative framework concerning the environment, from the Constitution to the listing of invasive alien species. The National Environmental Management Act, Act No. 107 of 1998 is the overarching framework Act, which covers the broad principles of environmental management. It is regarded as the most important piece of general legislation. Under the auspice of this Act, South Africa also has the National Environmental Management: National Protected Areas Act, Act No. 57 of 2003, and the National Environmental Management: Biodiversity Act, Act No. 10 of 2004.

South Africa has a long history of almost three decades of systematic biodiversity planning,[5] which is firmly imbedded in both policy and practice (Nel et al., 2011, p. 7). Systematic biodiversity informs different levels of strategic planning for environmental resources, as indicated in Figure 4.7:

[5] Systematic biodiversity planning is a strategic and scientific approach to identifying those areas that are the most important for biodiversity conservation (Nel et al., 2011, p. 7).

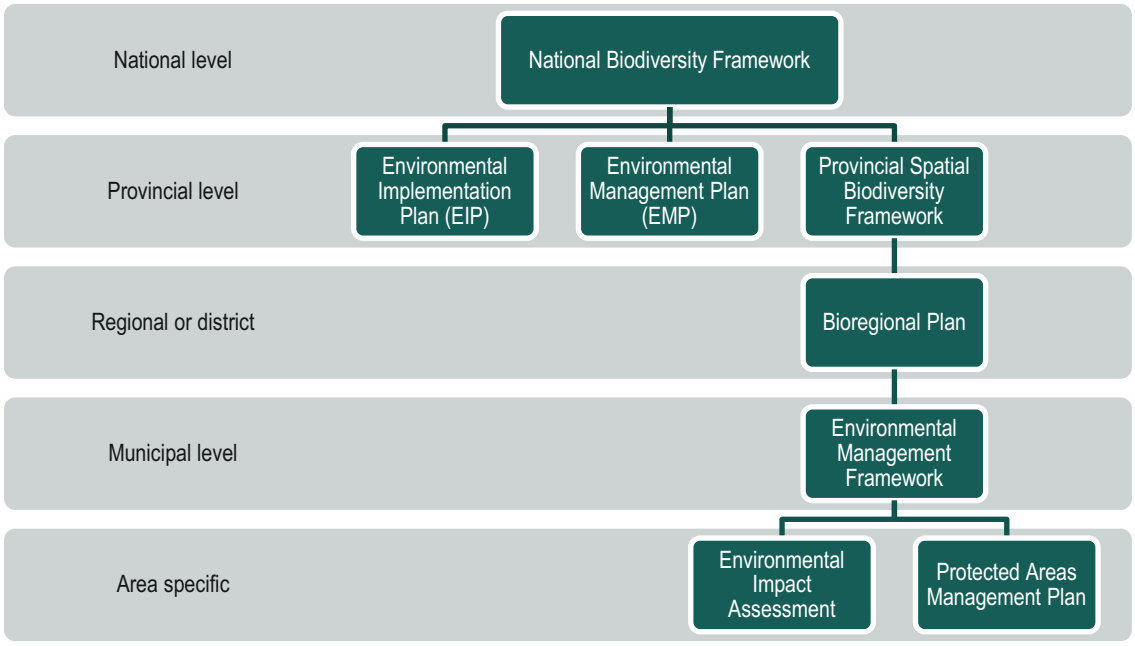


Figure 4.7: Legislative framework for strategic environmental resource planning and management

4.3.1 Strategic planning for environmental resources on national level

The planning and management of environmental resources on national level is set out in NEMA, NEMBA and NEMPAA. Together, these Acts call for a harmonised and integrated approach towards environmental resource planning: the EIP and the EMP.

On national level, NEMA requires certain national departments and all provinces to develop an EIP (Schedule 1), an EMP (Schedule 2) or a Consolidated Environmental Implementation and Management Plan (CEIMP) (if listed in Schedule 1 and Schedule 2). In 2014, the Minister gazetted amendments to Schedule 1 and Schedule 2. Ironically, DWS, DEA and DRDLR are the only national departments that are listed in both Schedule 1 and Schedule 2 and may therefore prepare a CEIMP. Chapter 3, sections 13 and 14 of NEMA, provides an outline of what EIPs and EMPs should contain (see tables 4.7 and 4.8).

Table 4.7: Contents of an Environmental Implementation Plan

S(13)(1)	Every EIP must contain a description of:
(a)	…policies, plans and programmes that significantly affect the environment;
(b)	…the manner in which this will comply with section 2 of NEMA's principles and national norms and standards;
(c)	…the manner to ensure that the functions are exercised as in (b); and
(d)	… recommendations for the promotion (objectives and plans) for the implementation of NEMA's procedures and regulations as contained in Chapter 5

Table 4.8: Contents of an Environmental Management Plan

S14(1)	Every EMP must contain a description of:
(a)	… functions in respect of the environment;
(b)	… environmental norms and standards;
(c)	… policies, plans and programmes designed to ensure compliance with its policies by other organs of state or persons;
(d)	…priorities regarding compliance by other organs of state and persons;
(e)	…the extent of compliance with departmental policies by other organs of state or persons;
(f)	…environmental management arrangements for cooperation with other national departments and spheres of government; and
(g)	…proposals for the promotion of objectives and plans for the implementation of Chapter 5.

The functions of EIPs and EMPs are to coordinate and harmonise the environmental policies, plans, programmes and decisions of the various national, provincial and local departments that exercise functions that may affect the environment or are entrusted with powers and duties aimed at the achievement, promotion and protection of a sustainable environment.

4.3.1.1 National Biodiversity Framework

The Minister is required to publish a National Biodiversity Framework in terms of Chapter 3, Section 28(2) of NEMBA (Republic of South Africa, 2009). The NBF aims to coordinate and align the efforts of organisations and individuals involved in conserving and managing South Africa's biodiversity outside protected areas. Chapter 3, Section 39(1) of NEMBA provides an outline of what the NBF should contain (see Table 4.9).

Table 4.9: Contents of the National Biodiversity Framework

S(39)(1)	The NBF must:
(a)	…provide for an integrated, coordinated and uniform approach to biodiversity management by organs of state in all spheres of government, non-governmental organisations, the private sector, local communities, other stakeholders and the public;
(b)	…be consistent with: (i) this Act; and (ii) any relevant international agreements binding on the Republic;
(c)	…identify priority areas for conservation action and the establishment of protected areas; and
(d)	…reflect regional cooperation on issues concerning biodiversity management in Southern Africa.
(2)	The NBF may determine norms and standards for provincial and municipal environmental conservation plans.

The NBF rests on two preceding documents, the NSBA, which provides for spatial information on the state of South Africa's biodiversity and the NBSAP, which sets strategic objectives to inform the NBF (DEAT, 2009 , p. 26). See section 0, section 2.9.2.2 and section 2.11.

Figure 4.8: Systematic biodiversity planning document 2004-2025

Key to the NBF is to identify threatened ecosystems and priority areas for management, to restore ecosystems and to highlight areas where more detailed assessment and planning is required.

This information should be used to strengthen national development planning and other strategic planning processes, assist in the streamlining of environmental decision making and strengthen land use planning on municipal level (SANBI, 2016). The NBF provides for 33 priority actions to guide the work of the biodiversity sector for the next five years (Republic of South Africa, 2009; DEAT, 2009). Priority actions 16 and 17 refer to the development of provincial spatial biodiversity plans and bioregional plans to assist in facilitating strategic biodiversity planning on a more detailed spatial scale.

4.3.2 Strategic planning for environmental resources on provincial level

4.3.2.1 Provincial spatial biodiversity plans

As mentioned in section 0, priority action 16 of the NBF requires provinces to develop provincial spatial biodiversity plans, which are a systematic biodiversity plan that identifies CBAs and ESAs. A provincial spatial biodiversity plan is a supporting tool for land use planning and integrates biodiversity decision making as it identifies areas that represent samples of biodiversity, which are crucial for maintaining ecosystem functioning. The provincial spatial biodiversity plan also needs to guide conservation agencies in terms of protected area expansion by identifying priority areas for protected area expansion and consolidation, which includes priority areas for stewardship contracts with private and communal landowners. The responsibility of leading the development of a provincial biodiversity plan lies with the provincial conservation authority. Unfortunately, no provincial guidelines or regulations for the proposed contents of a provincial spatial biodiversity plan have been published to date.

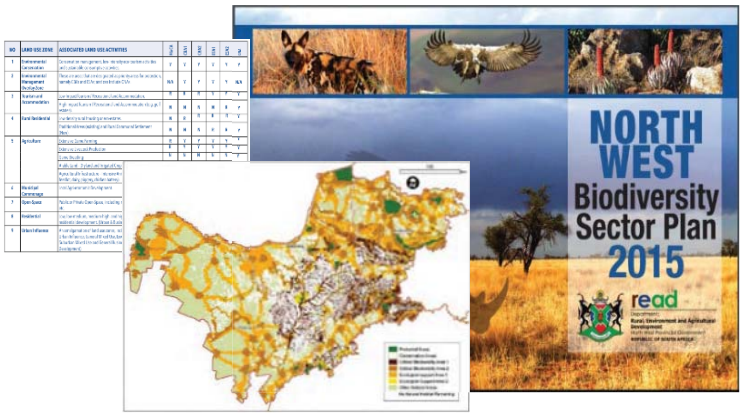


Figure 4.9: Northwest Biodiversity Sector Plan

The CBAs and ESAs identified in the provincial spatial biodiversity plans call for a finer-scale biodiversity plan, which is the bioregional plan.

4.3.3 Strategic planning for environmental resources on regional level

4.3.3.1 Bioregional plans and bioregional management plans

NEMBA, as well as priority action 17 of the NBF, promotes the development of bioregional plans. Section 40 of NEMBA states that bioregions are designated, and similarly bioregional plans are published by the Minister. The Minister may initiate a designation of a bioregional plan at his or her own discretion. However, the Act also allows for provinces or municipalities to make requests for such a plan. In 2008, a guideline document regarding the determination of bioregions and the preparation of and publication of bioregional plans was published by the Minister of Environmental Affairs and Tourism[6]. Broadly speaking, the boundary of a bioregion would typically include a “whole or nested ecosystems” and “characterised by its landforms, vegetation cover, human culture and history”.

[6] National Environmental Management: Biodiversity Act, Act 10 of 2004. Guidelines regarding the determination of bioregions and the preparations of and publications of bioregional plans (Republic of South Africa, 2004a).

However, it is recommended that bioregions align with administrative boundaries, such as provincial, district, metropolitan or local municipal boundaries[7]. Detail on the determination of a bioregion can be found in Chapter 1 of the guideline document. As for the content of a bioregional plan, Chapter 6 of the guideline document provides a comprehensive list of what a bioregional plan should contain (see Table 4.10).

Table 4.10: Content of a bioregional plan

Part A:	Introduction and objectives, including details of the bioregional boundary: …explain the purpose and objective of the plan; and …state the areas of the bioregional plan which it covers.
Part B:	Biodiversity profile and description of the region: …highlighting its biodiversity significance; and …descriptions of the biodiversity features shown on the map.
Part C:	Map of CBAs, based on a systematic biodiversity plan, including: i) protected areas; ii) irreplaceable sites, important sites, terrestrial ecological corridors, aquatic ecological corridors, special habitats, critical wetlands, critical estuaries, critical sub-catchments wetlands, critically endangered ecosystems and endangered species; and iii) areas of critical ecological support, including… primary water protection zones, groundwater recharge areas, all wetlands, all estuaries and all riparian zones.
Part D:	Guidelines for land use planning and decision making, linked to the CBAs on the map: i) categorise CBAs; ii) specify the land management objective; and iii) provide information on which land uses are likely to be compatible with the specified land management objective.
Part E:	Other measures for the effective management of biodiversity in the area, where necessary.
Part F:	Instructions on how the plan must be monitored, reviewed and updated, and how its implementation must be assessed.
Part G:	GIS files for the mapping of CBAs and any other maps included in the bioregional plan.

The purpose of a bioregional plan is to inform land use planning, environmental authorisation and natural resource management and decision making for a range of sectors whose policies and decisions impact on biodiversity outside protected areas. Mandatory users of bioregional plans therefore include local and district municipalities, which must align their CBAs and the contents of their bioregional plans generally into their IDPs and SDFs, as well as organs of state that must prepare an EIP or EMP in terms of Chapter 3 of NEMA, and environmental decision makers who are required by section 2(1)(6) of NEMA to apply the principles of NEMA Section 2 in their decision making. The bioregional plan is thus considered to be a multi-sectoral planning tool, providing detailed spatial information on CBAs and ESAs with accompanying land use management guidelines, which should inform SDFs, EMFs, strategic environmental assessments (SEAs) and EIAs.

Although this is regarded as standard practice, very few, if any SDFs give effect to these plans. The geographic data would usually be included in a map in the status quo report, but when the final product is presented, information on biodiversity regions is lost.

In addition to bioregional plans, NEMBA provides for the development of biodiversity management plans (BMPs) for indigenous or migratory species. The BMP aims to provide for the long-term survival of a species in the wild and to provide a platform for an implementing organisation or responsible entity, as appointed by the Minister, to monitor and report on progress regarding the implementation of the BMP.

[7] National Environmental Management: Biodiversity Act, Act 10 of 2004. Guidelines regarding the determination of bioregions and the preparations of and publications of bioregional plans, sections 2.2 to 2.3 (Republic of South Africa, 2004a).

4.3.4 Strategic planning for environmental resources on municipal and site-specific level

4.3.4.1 Environmental management frameworks

The DEA is driving a shift towards the greater use of strategic tools for environmental impact management, such as the SEA and EMF[8]. These tools have evolved, complementary to the EIA, and allow decision makers to proactively determine the most suitable development type for a particular area before development proposals are formulated. It is intended that these strategic tools will reduce the need for EIAs in non-sensitive areas, thus protecting the environment and facilitating appropriate development. Section 24(3) of NEMA provides the basis for the EMF, which is an environmental planning tool that highlights environmentally sensitive areas, and specifies areas where certain land uses are most compatible or incompatible with environmental opportunities and constraints in the landscape (Driver et al., 2011, p. 48). The proposed content of an EMP is set out in section 4 of the Environmental Management Framework Regulations No. R547 (see Table 4.11).

Table 4.11: Content of environmental management frameworks

4.	A draft EMF must:
(a)	…identify, by way of a map or otherwise, the geographical area to which it applies;
(b)	…specify the attributes of the environment in the area, including the sensitivity, extent, interrelationship and significance of those attributes;
(c)	…identify any parts in the area to which those attributes relate;
(d)	…state the conservation status of the area in those parts;
(e)	…state the environmental management priorities of the area;
(f)	… indicate the kind of developments or land uses that would have a significant impact on those attributes and those that would not;
(g)	…indicate the kind of developments or land uses that would be undesirable in the area or in specific parts of the area; and
(h)	…indicate the parts of the area with specific sociocultural values and the nature of those values.

The EMF is spatial in nature and is legally binding in terms of Regulation 72 of the EIA Regulations.

4.3.4.2 Environmental impact assessment

The EIA assesses the environmental implications of proposed development and informs decisions relating to their authorisation (Republic of South Africa, 2015, p. 45). The DEA published the first set of EIA Regulations in 1997[9], which were amended in 2002[10] and replaced in 2006 with the EIA Regulations[11] promulgated in terms of NEMA. The 2006 Regulations were replaced in 2010 with R543, R544, R545 and R546[12], and one again in 2014. The 2014, current EIA Regulations[13] R982, R983, R984 and R985 list 121 activities that are subject to an EIA. The regulations also set out the general procedures to be followed in order to obtain a permit or authorisation for a specific development. Depending on the type, extent and location of the development or activity, an application is either subject to a basic assessment, or a full scoping and EIA process.

The competent authority may grant exemption of the process if the rights and/or interest of other parties are not likely to be adversely affected by the exemption. According to SANBI (2014b, pp. 49-50), the "EIA process is based on a "mitigation hierarchy", in that the process should first strive to prevent the loss or damage of biodiversity though the consideration of alternative sites, layout technologies and designs.

[8] National Environmental Management Act, 1998, Act No. 107 of 1998. Environmental Management Framework Regulations No. R547, 18 June 2010.
[9] EIA Regulations promulgated in terms of the Environment Conservation Act, Act No 73 of 1989, Government Notice R1182 and R1183, 5 September 1997.
[10] Government Notice R670 and R672, 10 May 2002.
[11] EIA Regulations promulgated in terms of the National Environmental Management Act, 1998, Act No 107 of 1998 Government Notice R385, R386 and R387, 21 April 2006.
[12] Government Notice R543, R544, R545 and R546, 18 June 2010.
[13] The 2014 Regulations promulgated in terms of the National Environmental Management Act, 1998, Act No 107 of 1998.

After these have been considered, damage and loss of biodiversity should be minimised, again by considering alternative sites, designs and technologies, where unavoidable damage has occurred over and above efforts to avoid and minimise biodiversity loss. Finally, any significant residual negative effects on biodiversity should be offset through the restoration and/or protection of an area of equal biodiversity value" (see Figure 4.10).

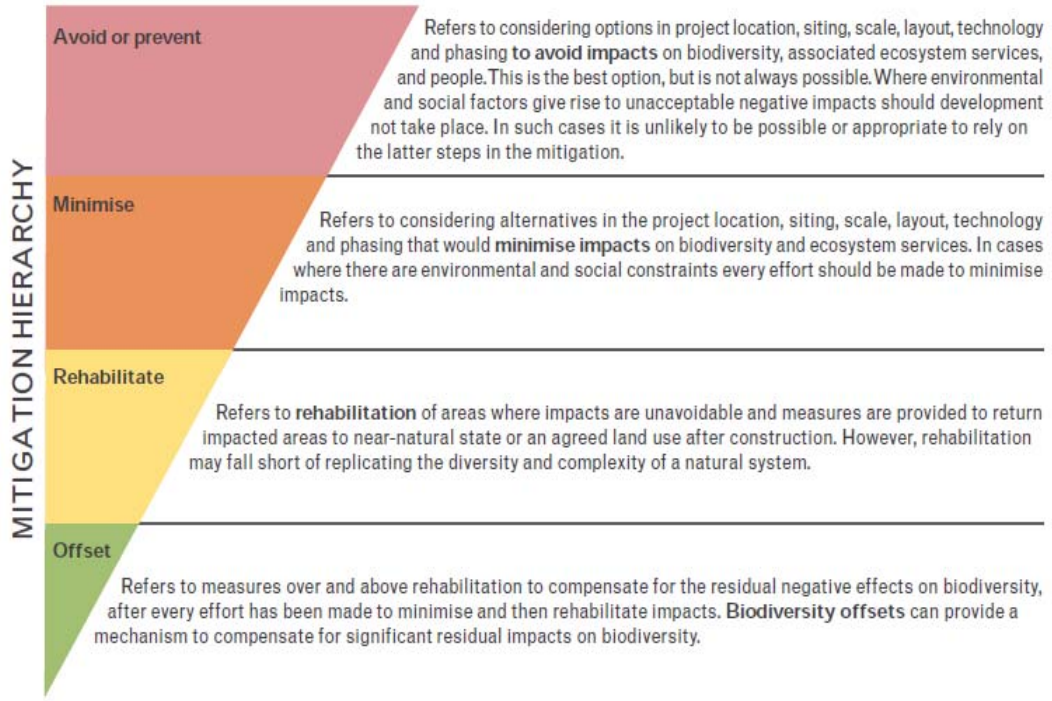


Figure 4.10: EIA mitigation hierarchy

According to Middleton et al (2011, p. 19) the EIA process, which is generally conducted on a case-by-case basis, has been severely criticised in the past for the levels of backlogs in assessing applications and long time frames for approval, as well as difficulties in addressing cumulative impacts.

4.3.4.3 Protected areas management plan

The highest degree or level of protection that may be granted to a piece of land is to declare the area protected in terms of NEMPAA. This Act grants national government, acting through the Minister and, in some instances, the MEC, the authority to declare areas as special nature reserves, nature reserves or protected environments. Once the area has been declared a protected area, the Minister must assign its management to a suitable person, organisation or organ of state (section 38(1)(a)). In terms of section 30 of NEMPAA, the management authority must submit a management plan to the Minister or the MEC for approval. The object of a management plan is to ensure the protection, conservation and management of the protected area concerned in a manner that is consistent with the objectives of this Act and for the purpose for which it was declared (section 41(1)). Section 41 of NEMPAA provides an outline of what a protected area management plan should contain (see Table 4.12).

Table 4.12: Contents of a protected area management plan

41(2)	A management plan must contain at least:
(a)	…the terms and conditions of any applicable biodiversity management plan;
(b)	… a coordinated policy framework;
(c)	… such planning measures, controls and performance criteria as may be prescribed;
(d)	… a programme for the implementation of the plan and its costing;
(e)	… procedures for public participation, including participation by the owner (if applicable), any local community or other interested party;
(f)	… where appropriate, the implementation of community-based natural resource management; and

(g)	… a zoning of the area indicating what activities may take place in different sections of the area, and the conservation objectives of those sections, provided that, in a marine protected area, the zoning must not conflict with a zoning in terms of section 48A(2)(a).

Protected areas are a powerful tool for conserving biodiversity and adapting to climate change, but they are not the only tool.

4.3.5 Additional environmental management strategies

4.3.5.1 Framework for investing in ecological infrastructure in South Africa

The National Biodiversity Strategy and Action (Strategic objective 2: Investment in ecological infrastructure enhances resilience and ensures benefits to society) has been an emerging area of interest and work within South Africa over the last years. In 2014, a framework for investing in ecological infrastructure in South Africa was published. Investing in ecological infrastructure involves maintaining functioning ecological infrastructure, as well as restoring degraded ecological infrastructure. The framework highlights that this can be done by integrating ecological infrastructure into land use planning and decision-making processes (SANBI, 2014a, p. 4). The benefits of investing in ecological infrastructure includes, among others, a lengthened lifespan of built water infrastructure, reduces maintenance cost, soil erosion and soil degradation, supports food security, protects buffer settlements from storms and surge events, and assists ecosystems in adapting to climate change (SANBI, 2014a, pp. 5-7).

However, ecological infrastructure is often located in the rural areas of municipalities, which may be on private or communal land where the landowners themselves are often not receiving the full benefit of the services and will, therefore, tend to under-invest. Another issue, which is dominant considering the nature of a developing country, is the fact that many of these landowners are unable to afford the necessary investment (cash) that is required for the large-scale and often relatively complex interventions that may be needed in the landscape.

For this reason and others, the state should be central to optimal investment in ecological infrastructure (SANBI, 2014a, p. 7). The state can provide subsidies and incentives or create new regulations, which directly ensure private sector investment in ecological infrastructure. The biodiversity stewardship approach is one approach that allows for a range of agreements to be put in place between the state and the landowner, with the intention of managing and/or protecting the natural environment. Biodiversity stewardship can be used as a mechanism to work with landowners who have important ecological infrastructure on their land, creating working partnerships between the state and the private sector, and, where appropriate, incentivise private landowner investment in the ecological infrastructure (SANBI, 2014a, p. 12).

Another emerging theme within the biodiversity management sector is ecosystem-based adaption. The Secretariat of the Convention on Biological Diversity defines ecosystem-based adaption as an approach that uses biodiversity and ecosystem services in an overall adaption strategy and includes the sustainable management, conservation and restoration of ecosystems to maintain and increase the resilience, and reduce the vulnerability of ecosystems and people in the face of adverse effects of climate change (CBD, 2009). Ecosystem-based adaption strategies for South Africa are well documented in SANBI's publication of the long-term adaption scenarios (LTAS) flagship research programme for South Africa (SANBI, 2013).

4.3.5.2 National Strategy for the Expansion of Protected Areas

In 2008, the DEA, with technical support from SANBI and South African National Parks (SANParks), commissioned a National Protected Areas Expansion Strategy (Republic of South Africa, 2010). The goal of the NPAES was to achieve cost-effective protected area expansion for ecological sustainability and increased resilience to climate change. The NPAES calls for the development and use of fiscal incentives for the consecration of biodiversity on private and communal land. The strategy refers to four main mechanisms in Chapter 5 for expanding the land-based protected area network. These include the acquisition of land, contractual agreements, the declaration of public land and biodiversity management agreements (Republic of South Africa, 2010, p. 32).

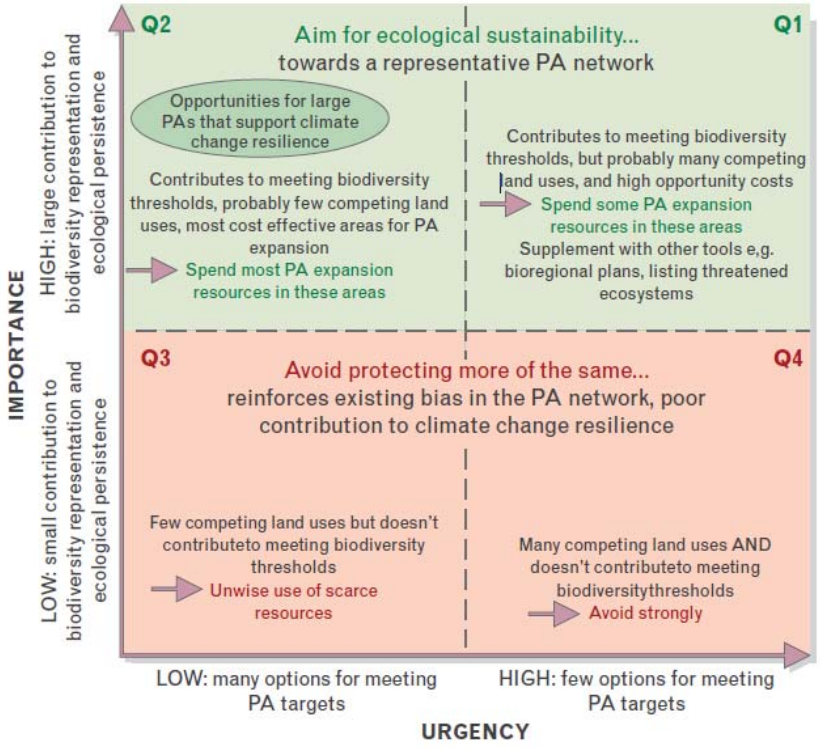


Figure 4.11: Biodiversity fiscal incentives

Source: Matcalfe et al., 2016

- Land acquisition is the acquisition of land in the traditional way of establishing and expanding protected areas. It involves large upfront costs and is usually used most appropriately in Quadrant 2 expansion.
- Contractual agreements, in which landowners maintain ownership of their land, but enter into a contract with a protected area agency in return for formal protected area status, are facilitated by provisions in NEMPAA. They are appropriate for Quadrant 1 or Quadrant 2 expansion and are being increasingly used as part of biodiversity stewardship programmes. Contractual agreements are attractive because they tend to cost protected area agencies less than acquisition, and because by far the largest proportion of land in the focus areas for protected area expansion is in private hands. Biodiversity stewardship programmes should be strengthened so that more use can be made of contractual agreements in the expansion of the protected area network. There are significant potential synergies between stewardship programmes, land reform and rural development.
- The declaration of public or state land involves reassigning land to a protected area agency from another organ of state. It is appropriate for Quadrant 1 or Quadrant 2 expansion, but has limited applicability because only a small proportion of land in the focus areas for protected area expansion is public land.
- Biodiversity management agreements are agreements entered into by the Minister and the responsible person, organisation or organ of state with regard to the sound management of land. Biodiversity management agreements can be grouped with the protected area categories in NEMPAA to form the statutory conservation categories. These statutory conservation categories are being implemented through biodiversity stewardship programmes.

There are several tools available that assist in protecting and conserving the many biodiversity priority areas. This wide range of biodiversity management tools complements the expansion and effective management of the protected areas network in pursuit of the overall goals of biodiversity conservation and sustainable development.

These are included in NEMBA, the NBF 2008, the National Biodiversity Assessment 2011, the National Strategic Biodiversity Action Plan 2015-2025, the Provincial Spatial Biodiversity Plan, bioregional plans and biodiversity management plans. Although not discussed in the previous sections, other legal tools mentioned in NEMBA include the listing of threatened or protected ecosystems, the listing of threatened or protected species, and regulations on alien and invasive species. However, SANBI recognises the Provincial Spatial Biodiversity Plan as the key instrument to provide the basis for the development of provincial protected area expansion strategies. These provincial spatial biodiversity plans are also crucial for provinces wanting to develop stewardship programmes as they guide the identification of stewardship sites (SANBI, 2016a).

4.4 LEGAL CASE FOR SPATIAL PLANNING AND LAND USE MANAGEMENT

Planning is concerned with where to go (Ahmad & Bajwa, 2005). Originally, planning focused more on urban design and the actual layout of streets (for example, Paris in 1852 and Central Park, New York, in 1856). From these beginnings, planning evolved into a science that aimed to solve various problems found in cities and towns, for example solving the problems created by the industrial city (separating noxious land uses), or in reaction to pestilence and plague (for example the yellow fever outbreak in Memphis in 1879) (Elliot, 2007). From there, planning started to focus on social issues such as the plight of people living in poverty and slums (Elliot, 2007).

Planning became professional (and legally enforceable) in the early 1900s through various laws and zoning codes (the very first land use schemes) (Elliot, 2007). As more and more people flocked to the cities, urban problems (and therefore the scope of planning) became more intricate. The concept of planning shifted from addressing only a specific sector to comprehensive planning (Ahmad & Bajwa, 2005). In South Africa, the profession of planning is defined as “areas of expertise which involve the initiation and management of change in the built and natural environment across a spectrum of areas, ranging from urban to rural and delineated at different geographic scales (regional, subregional, city, town, village, neighbourhood) in order to further human development and environmental sustainability” (Republic of South Africa, 2002b).

With the urban environment under considerably more pressure due to increasing urbanisation, there was a call for planning to become more proactive, focusing on sustainability “and making the connections between people, economic opportunity and the environment” (Farmer et al., 2006).

Planning comprises the following distinct, yet interrelated processes (Van Wyk, 2012):

- **Spatial planning:** This is the compilation of an initial plan or framework for future development. Known in South Africa as SDFs, this type of planning is more concerned with the future shape of cities and towns. “Forward planning is a future-oriented exercise. It is concerned with the long-term future of a large area and identifying opportunities for growth and development so that land can be managed in the best interests of the public” (Fiji Department of Town and Country Planning, 2015).

- **Land use management:** This is the administration and regulation of changes to the use of land as determined in the original plan. This type of planning seeks to manage the legality of existing land uses and buildings through tools such as zoning codes (also referred to as town planning schemes, zoning schemes and land use schemes in other parts of the world). This type of planning came about in the early 1900s to separate living areas and neighbourhoods from the negative effects of residing close to job opportunities such as industries (Elliot, 2008).

- **Land development management:** This is the control of development that occurs after the land use has been determined (Ahmad & Bajwa, 2005).

In South Africa, spatial planning is done at various levels:

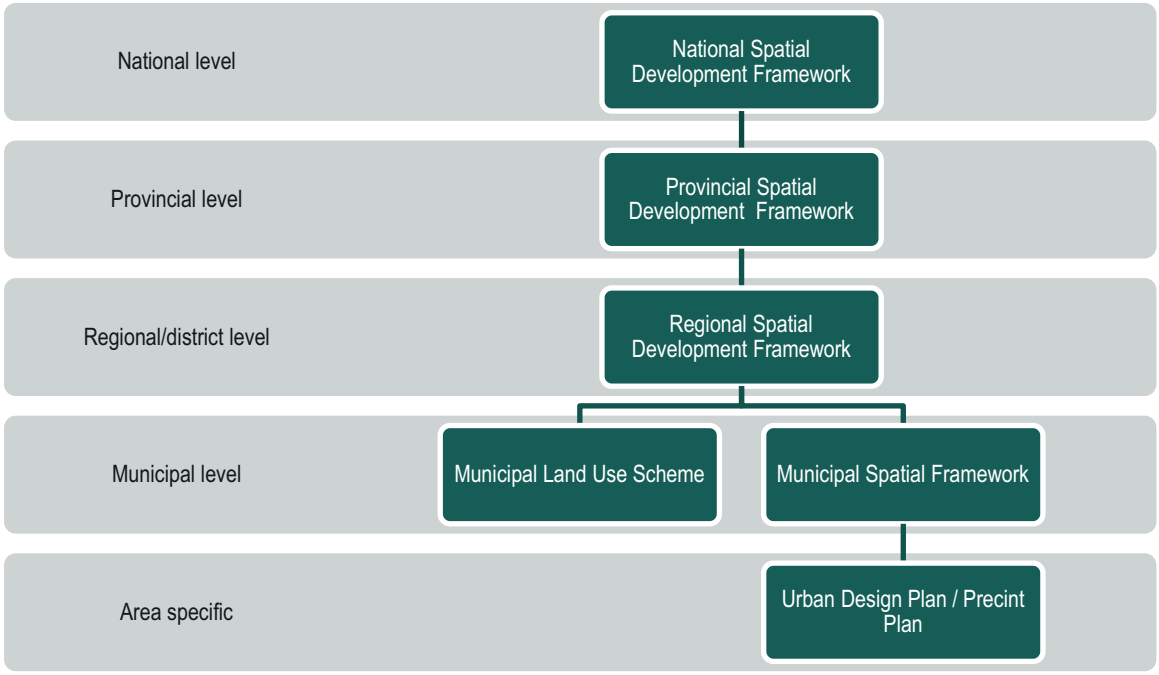


Figure 4.12: Planning at various geographic levels

4.4.1 Strategic spatial planning on national level

4.4.1.1 National Spatial Development Framework

Section 13 of SPLUMA requires the Minister to compile a national SDF, which considers policies, plans and programmes of public and private bodies that impact on spatial planning, land development and land use management. Such plans would typically include the NDP, the National Industrial Participation Programme (NIPP), the NSDP and the MTSF. Section 14 of SPLUMA provides an outline of what a national SDF should contain (see Table 4.13).

Table 4.13: Content of a national Spatial Development Framework

(S)14	The national SDF must:
(a)	…give effect to the development principles and norms and standards set out in Chapter 2;
(b)	…give effect to relevant national policies, priorities, plans and legislation;
(c)	…coordinate and integrate provincial and municipal SDFs;
(d)	…enhance spatial coordination of land development and land use management activities at national level;
(e)	…indicate desired patterns of land use in the Republic; and
(f)	…take cognisance of any environmental management instrument adopted by the relevant environmental management authority (NBF, NWRS and National Growth Strategy).

The DRDLR and the Department of Planning, Monitoring and Evaluation (DPME) compiled the first national SDF in June 2018. It highlights (among other things) the following two important considerations that directly impact on water availability and sustainability:

Climate change. The northern and the western parts of South Africa can expect significantly hotter average temperatures and more very hot days per year by 2050. By the end of the century, temperature increases of between 4 and 7 °C can be expected over the interior of the country.

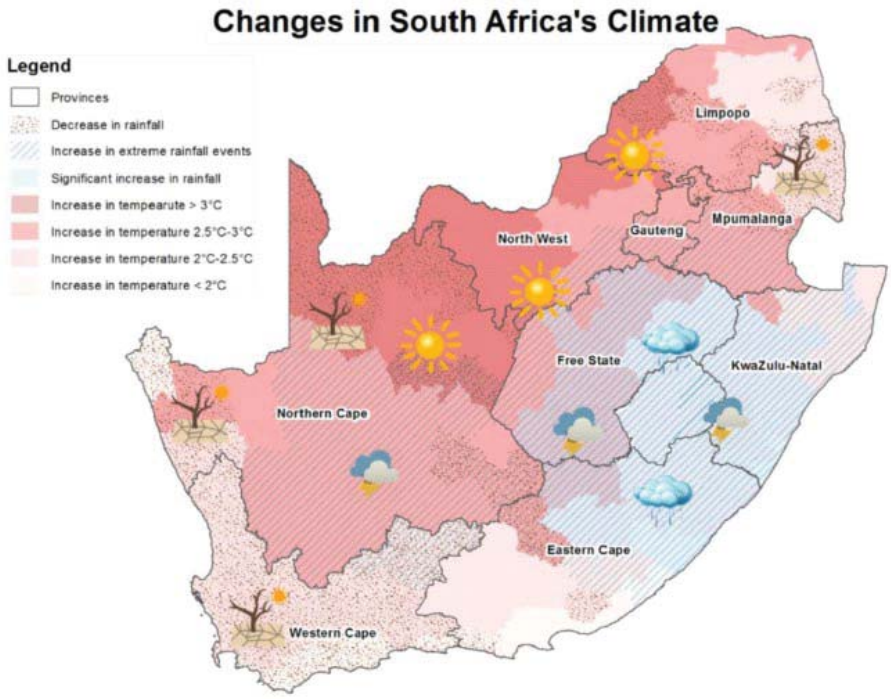


Figure 4.13: NSDF implications of climate change

Supportive infrastructure: ecology: In terms of water resources, cities and towns that support the national economy and large population concentrations are already relying on water transfers from stressed catchment areas. Based on projections, the national water deficit, or difference between water requirements and water availability, could be between 2.7 and 3.8 billion m³/a by 2030, a gap of about 17% of available surface and ground water if the interventions proposed in the Draft National Water Plan are not implemented (DWS, 2017).

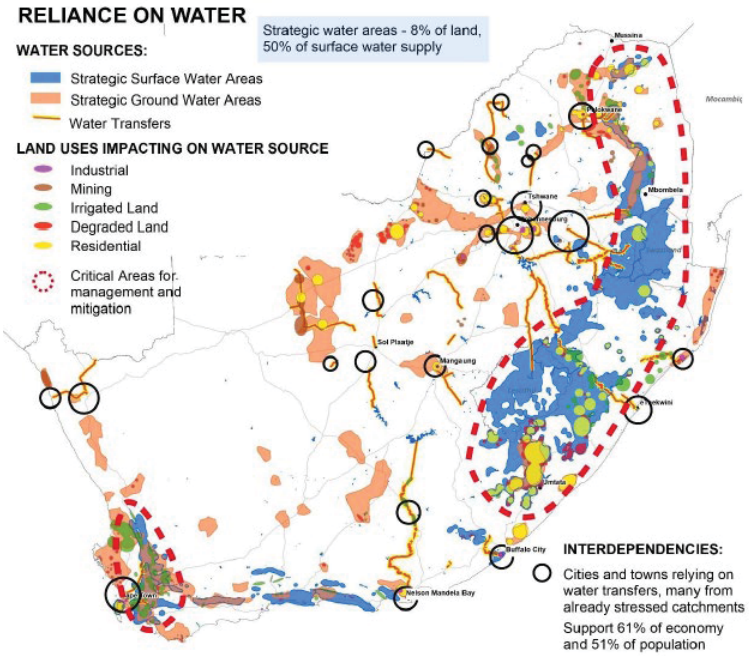


Figure 4.14: NSDF: reliance on water

The spatial proposals contained in the national SDF focus on five specific frames:

Frame 1: Critical role and strategic focus areas: urban regions, clusters and development corridors as engines of national transformation

- Develop urban core regions as sustainable centres of wellbeing, international gateways and engines of national transformation: Do better.
- Consolidate growth and prioritise development within priority development and transport corridors: Do more of and do new things.
- Consolidate urban growth, and grow the rural-urban anchor network in growth regions and corridors: Do new things.

Frame 2: Productive rural regions and regional development anchors as a foundation of national transformation

- Protect high-value national food baskets: Do better.
- Agri-enterprise regions: Do better and do new things.
- Agri-innovation, urban-rural interface, ocean economy and resource protection regions: Do more of and do new things.
- Network of rural-urban anchors: Do new things.
- Rural-rural connections and supportive infrastructure: Do better and do more of and do new things.

Frame 3: National ecological infrastructure system as enabling infrastructure for a shared and sustainable resource foundation

- National protected areas: Keep on protecting and do more of by adding water-sensitive settlement areas to protected areas.
- Priority national ecological infrastructure areas: Stop doing and do more of by adding water-sensitive settlement management guidelines, rehabilitation and address water conflict areas.
- International and national resource conservation areas: Do more of by adding CBAs as conservation areas and do better in terms of ecology-related enterprise development and rehabilitation.

Frame 4: National connectivity and economic infrastructure networks as enabling infrastructure for a shared, sustainable and inclusive economy

- Maintain, expand and manage the impact of spatial infrastructure to support a sustainable mining economy.
- Undertake collaborative long-term planning and innovative interventions to support regional economic diversification and transition in the core innovation and mining belt as a strategic national focus area.
- Collaborative long-term planning in new exploration, renewable energy production and regional development focus areas.
- Rehabilitation focus areas (scattered).

Frame 5: National social service and settlement infrastructure system in support of national wellbeing

- Network of rural-urban anchors: Do new things.
- Rural-rural connections and supportive infrastructure: Do better and do more of.
- Prioritised small rural service centres: Do less of and do better.
- Resilient rural hinterlands and livelihoods: Do new things.

4.4.2 Strategic spatial planning on provincial level

4.4.2.1 Provincial Spatial Development Framework

Section 15 of SPLUMA requires the Premier of each province to compile, determine and publish a provincial SDF, which is consistent with the national SDF and coordinates, integrates and aligns provincial plans and development strategies with the policies of national government, the provincial departments and municipalities. However, the provincial SDF cannot grant the right to use or develop a piece of land to any person. Section 14 of SPLUMA provides an outline of what a provincial SDF should contain (see Table 4.14).

Table 4.14: Content of a provincial Spatial Development Framework

S.16	Content of a provincial SDF:
(a)	…provide a spatial representation of the land development policies, strategies and objectives of the province, which must include the province's growth and development strategy where applicable;
(b)	…indicate the desired and intended pattern of land use development in the province, including the delineation of areas in which development in general or development of a particular type would not be appropriate;
(c)	…coordinate and integrate the spatial expression of the sectoral plans of provincial departments;
(d)	…provide a framework for coordinating municipal SDFs with each other where they are contiguous;
(e)	…coordinate municipal SDFs with the provincial SDF and any regional SDFs as they apply in the relevant province; and
(f)	…incorporate any spatial aspects of relevant national development strategies and programmes as they apply in the relevant province.

In theory, the provincial SDF should take guidance from the national SDF and focus on issues of provincial importance. In reality, the national SDF was only completed recently, while many provincial SDFs were completed much earlier. As the national SDF takes climate change and water dependence on a national level into consideration, the provincial SDFs should take this into account and incorporate these issues into its planning framework.

4.4.3 Strategic spatial planning on regional level

4.4.3.1 Regional Spatial Development Frameworks

SPLUMA also allows for the development of regional SDFs to guide spatial planning, land development and land use management in any region of the Republic (section 18(1)). Regional SDFs are thus only prepared for a specific purpose and in response to a unique circumstance that manifests across administrative boundaries (section 18(3)). Section 14 of SPLUMA provides an outline of what a regional SDF should contain (see Table 4.15).

Table 4.15: Contents of a regional Spatial Development Framework

S(19)	A regional spatial development framework must:
(a)	…give effect to the development principles and applicable norms and standards set out in Chapter 2;
(b)	…give effect to national and provincial policies, priorities, plans and planning legislation;
(c)	…reflect the current state of affairs in that area from a spatial and land use perspective of the region;
(d)	…indicate desired patterns of land use in that area;
(e)	…provide basic guidelines for spatial planning, land development and land use management in that area;
(f)	…propose how the framework is to be implemented and funded.

4.4.4 Strategic spatial planning on municipal level

4.4.4.1 Municipal Spatial Development Framework

An SDF is the principal strategic planning instrument that guides and informs all planning and development, and all decisions concerning planning, management and development within the municipality. The aim of the SDF is to provide an overview of the future spatial form of the municipality. It is the primary tool that is used to decide if a change in land use rights (through the amendment of the LUS) should be allowed.

SPLUMA calls for spatial proposals that align with capital budgets, and identify priority intervention areas and associated land development programmes. While an SDF provides an indication of acceptable land uses or the intensity of land uses in some geographical regions, land use rights are managed through an LUS. Section 21 of SPLUMA provides an outline of what a municipal SDF should contain.

Table 4.16: Legislated content of a municipal SDF

S(21)	A municipal SDF must:
(a)	…give effect to the development principles and applicable norms and standards set out in Chapter 2;
(b)	…include a written and spatial representation of a five-year spatial development plan for the spatial form of the municipality;
(c)	…include a longer-term spatial development vision statement for the municipality;
(d)	…identify current and future significant structuring and restructuring elements of the spatial form of the municipality, including development corridors, activity spines and economic nodes where public and private investment will be prioritised and facilitated;
(e)	…include population growth estimates for the next five years;
(f)	…include estimates of the demand for housing units across different socio-economic categories and the planned location and density of future housing developments;
(g)	…include estimates of economic activity and employment trends and locations in the municipal area for the next five years;
(h)	…identify, quantify and provide location requirements of engineering infrastructure and services provision for existing and future development needs for the next five years;
(i)	…identify the designated areas where a national or provincial inclusionary housing policy may be applicable;
(j)	…include a strategic assessment of the environmental pressures and opportunities within the municipal area, including the spatial location of environmental sensitivities, high potential agricultural land and coastal access strips, where applicable;
(k)	…identify the designation of areas in the municipality where incremental upgrading approaches to development and regulation will be applicable;
(l)	…identify the designation of areas in which i. more detailed local plans must be developed; and ii. shortened land use development procedures may be applicable and LUSs may be so amended;
(m)	…provide the spatial expression of the coordination, alignment and integration of the sectoral policies of all municipal departments;
(n)	…determine a capital expenditure framework for the municipality's development programmes, depicted spatially;
(o)	…determine the purpose, desired impact and structure of the land use management scheme to apply in that municipal area; and
(p)	… include an implementation plan comprising: i. sectoral requirements, including budgets and resources for implementation; ii. necessary amendments to a land use scheme; iii. specifications of institutional arrangements necessary for implementation; iv. specifications of implementation targets, including dates and monitoring indicators; and v. specifications, where necessary, of any arrangements for partnerships in the implementation process.

The following diagram summarises the content of Municipal SDFs:

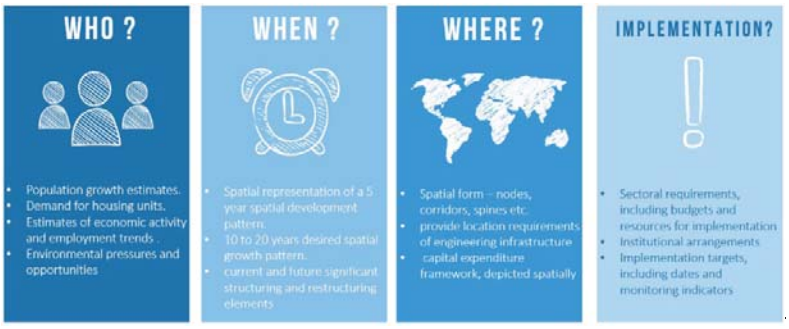


Figure 4.15: Contents of spatial development frameworks

4.4.4.2 Municipal land use scheme

Section 25 of SPLUMA mandates all local municipalities to develop and adopt a single land use scheme that gives effect to the municipal SDF and promotes economic growth, social inclusion, efficient land development and minimal impact on public health, the environment and natural resources. A land use scheme adopted in terms of SPLUMA must consist of regulations setting out the procedures and conditions relating to the use and development of land in any zone, a zoning map, and a register of all amendments to such a land use scheme. Section 24(2) of SPLUMA provides an outline of what a municipal LUS should contain.

Table 4.17: Content of a municipal LUS

S(24)(2)	An LUS adopted in terms of subsection (1) must:
(a)	…include appropriate categories of land use zoning and regulations for the entire municipal area, including areas not previously subject to an LUS;
(b)	…take cognisance of any environmental management instrument adopted by the relevant environmental management authority, and comply with environmental legislation;
(c)	…include provisions that permit the incremental introduction of land use management and regulation in areas under traditional leadership, rural areas, informal settlements, slums and areas not previously subject to an LUS;
(d)	…include provisions to promote the inclusion of affordable housing in residential land development;
(e)	…include land use and development incentives to promote the effective implementation of the SDF and other development policies;
(f)	…include land use and development provisions specifically to promote the effective implementation of national and provincial policies; and
(g)	…give effect to municipal SDFs and integrated development plans.

Unlike other plans, the LUS is a legal instrument that grants developmental rights on each registered land parcel or erf. It gives effect to an SDF by granting development controls associated with the SDF initiatives. An LUS records permissible use zones and provides other standards and procedures that can be employed in case a land use under a permissible use zone is to be amended. Thus, any amendment to the use of a property or an erf must be consistent with an SDF and a land development application must be submitted to a municipality for approval so that land use changes and developmental rights granted are registered for accountability and to assess the performance and effectiveness of proposed SDF strategies.

4.4.5 Site specific

4.4.5.1 Urban design plan or precinct plans

While not specifically legislated, urban design plans or precinct plans can be found in many cities and towns across South Africa. This type of plan delves into even more detail than the SDF and provides land use recommendations at a street block or even individual stand level.

4.5 CONCLUSION

In reading the above chapter, it is quite clear that we have to (by law) plan for water, the environment and future development. It is furthermore quite clear that these plans (required by law) are in place in most provinces, catchments and municipalities. With most of these plans requiring cross-sector alignment, one can almost assume that all issues are aligned and addressed in these documents. The next section will investigate two case studies to identify if this is happening.

CHAPTER 5: EMPIRICAL INVESTIGATION

5.1 INTRODUCTION

One of the aims of this research project is to change the business-as-usual approach to spatial planning, land use management and water resources planning and management on municipal level. It therefore seemed fitting to use a case study approach to evaluate exiting planning practices within two local municipalities: the Lephalale and Mogalakwena local municipalities. The aim of the case study approach was to identify the extent to which exiting spatial planning and land use management "tools" give effect to water sensitivity. The case study analysis is structured in two parts. The first part focused on conducting a gap analysis, while the second provided for new tactics on how local municipalities, through their SDFs and LUSs, can give effect to water-sensitive spatial planning. This project will act as a case study from which spatial planners, municipal officials, and community members will learn in the sense that a municipality's entire development perspective will be aligned with the notion of water sensitivity. This chapter will provide an overview of the case study areas and the reasons for selecting these areas for research purposes.

5.2 CASE STUDY

Two adjacent study areas, the Lephalale and Mogalakwena local municipalities, both located in Limpopo, were selected for research purposes.

5.2.1 Locational analysis

Both municipalities form part of the Waterberg District's administrative boundary and cover almost 2,000,000 ha of land. The Lephalale Local Municipality stretches over 1,378,400 ha, while the Mogalakwena Local Municipality extends over 616,600 ha (see Table 5.1). The study area falls within the Limpopo WMA, Primary Catchment A, with A4, A5 and A6 as secondary catchments.

Table 5.1: Locational analysis publication

Statistics South Africa	**Lephalale Local Municipality**	**Mogalakwena Local Municipality**
Province	Limpopo	Limpopo
District	DC36: Waterberg District C1	DC36: Waterberg District C1
Municipal code	LIM362	
Municipal subcategory	B3	B2
Geographic area	1,378,400 ha	616,600 ha
Water Management Area	**Limpopo**	**Limpopo**
Primary catchment	A	A
Secondary catchments	A4	A5
	A5	A6
Tertiary catchments	A41	A61
	A42	A50
	A50	A62
	A62	
	A63	
Quaternary catchments	A41A	A50B
	A41B	A50C
	A41C	A50D
	A41D	A50E
	A41E	A50F
	A42D	A50G
	A42E	A61E
	A42F	A61F
	A42G	A61G
	A42H	A61J
	A42J	A62A
	A50C	A62B

Statistics South Africa	Lephalale Local Municipality	Mogalakwena Local Municipality
	A50D	A62C
	A50E	A62D
	A50F	A62E
	A50G	A62F
	A50H	A62G
	A50J	A62H
	A62J	A62J

Source: Statistics South Africa, 2016

The Limpopo, Mokolo, Lephalale and Mogalakwena rivers are the major rivers or primary river networks within the study area as they feed several secondary river networks (see Figure 5.1). The availability of water resources is impacted on by several factors, such as rainfall, temperature, evaporation rate and runoff. The southern part of the study areas, closest to the Waterberg Mountains, receives close to 700 mm mean annual precipitation, whereas the majority of the study area receives, on average, between 400 and 600 mm MAP, with most of the rainfall occurring mainly during mid-summer (see Figure 5.2). In summer months, the study areas experience extremely high temperatures, averaging from 27 ºC to more than 31 ºC. These high temperatures cause high evaporation rates within the study area, which ultimately decreases runoff. According to the s-pan calculations (see Figure 5.3), the study areas' mean annual evaporation ranges between 1,700 and 2,000 mm and from 2,000 mm to more than 2,600 mm according to the A-pan calculations (see Figure 5.4).

The low to medium rainfall, high temperatures and severely high mean annual evaporation rates have resulted in low to medium runoff rates within the study area (see Figure 5.5). The quaternary catchments, A50J and A50H, which border Botswana in the north, have by far the lowest MAR, which ranges between 2.5 and 5 mm. This impacts on the quantity of the water resources needed to support the Lephalale River and the ecological functioning of the catchment. Fortunately, the MAR increased to between 5 and 10 mm in A50G and between 20 and 50 mm in A50F, A50E and A50D as the Lephalale River crossed the Mogalakwena municipal boundary, entering the southern interior of the study area. The Mokolo River also flows through low runoff areas (5 to 10 mm), which increases to 20 to 50 mm towards the southern interior of the study area, feeding into several secondary river networks over A42H, A42G and A42F. The Mogalakwena river network crosses several low MAR catchments (5 to 10 mm) before entering the municipal boundary somewhere along the A62J catchment, reaching A62G, A62D and A62C, which have a MAR of 10 to 20 mm. Generally, the MAR within the Mogalakwena Local Municipality ranges between 20 and 50 mm over A62B, A62A, A61J and A61F, which feeds several secondary river networks. Compared to the rest of South Africa, and specifically other municipalities also located within the 27 °E and 29 °E coordinates, the study area is considered semi-arid as it is located within the semi-arid zone.

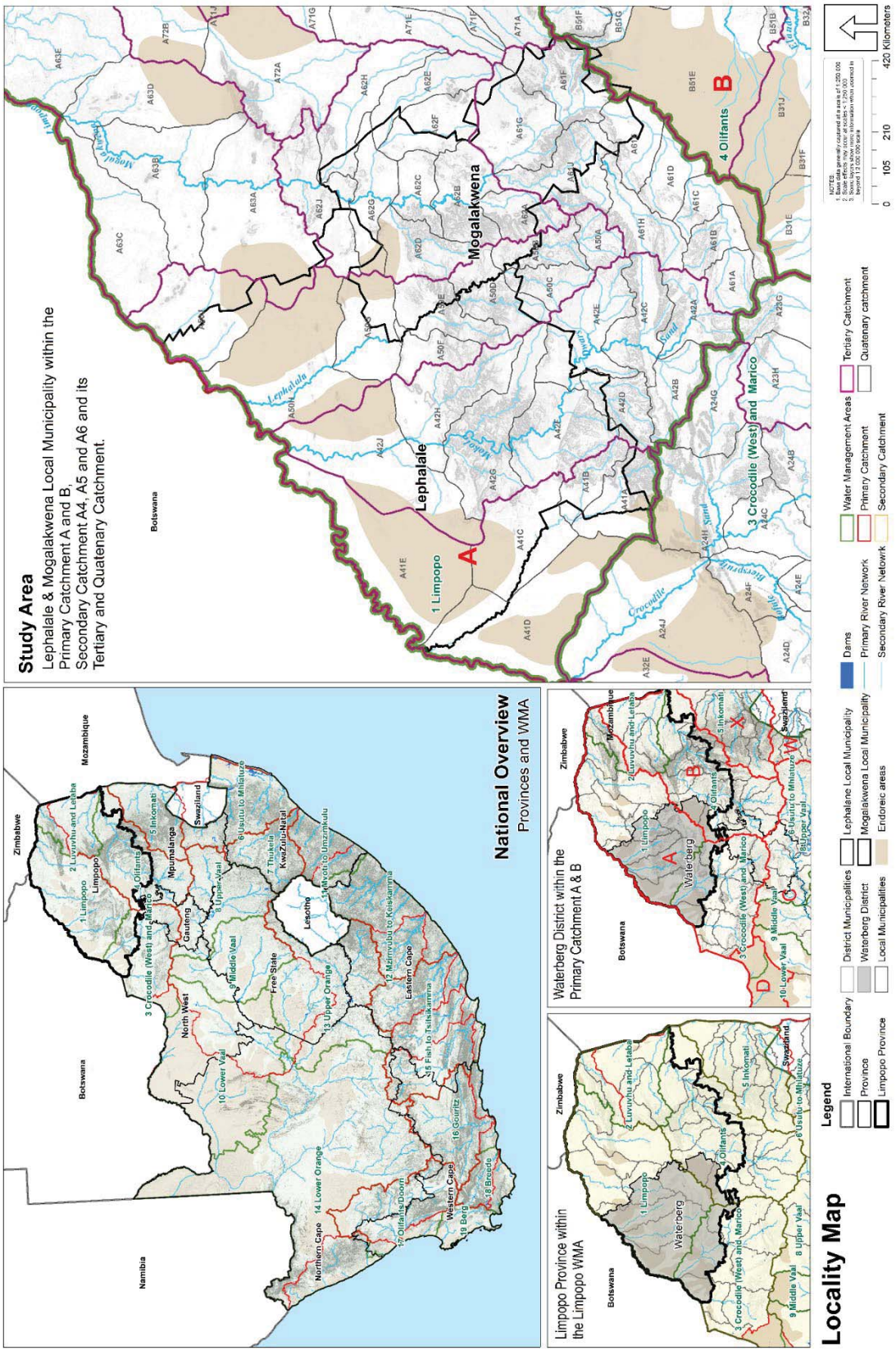


Figure 5.1: Locality of the Lephalale and Mogalakwena local municipalities

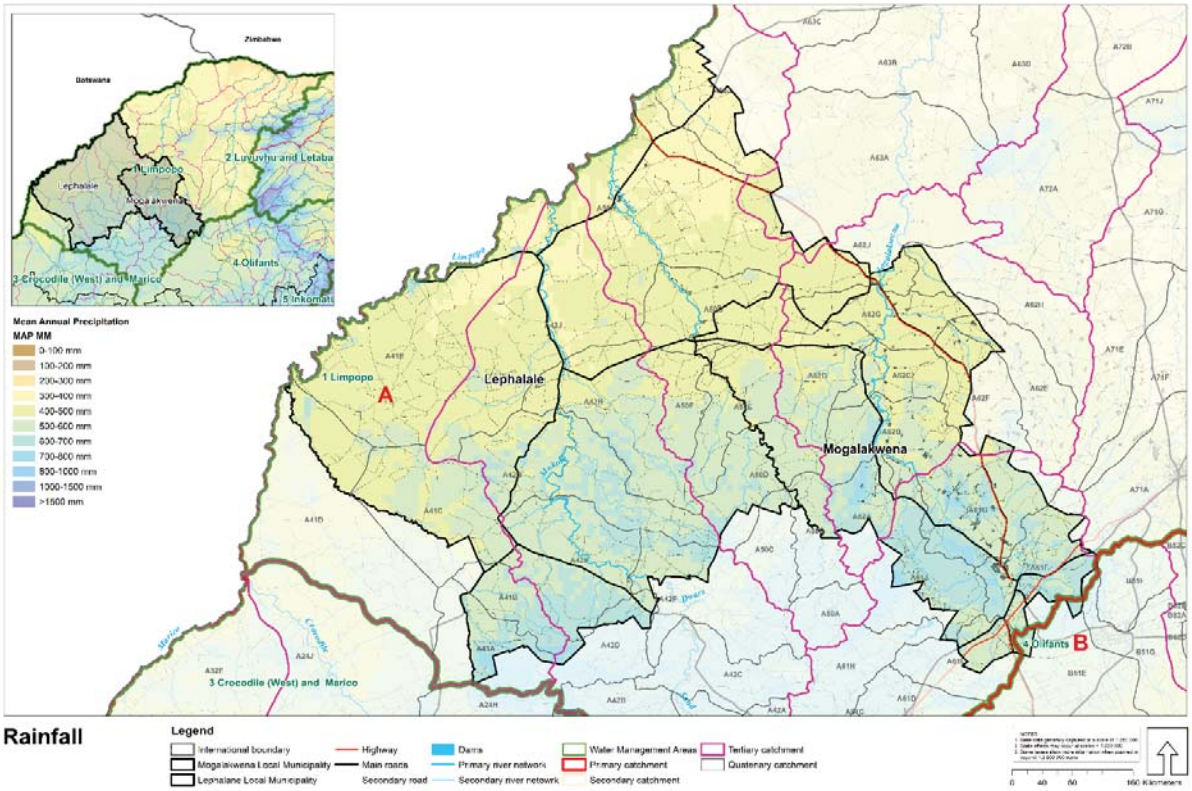


Figure 5.2: Rainfall in the geographical area

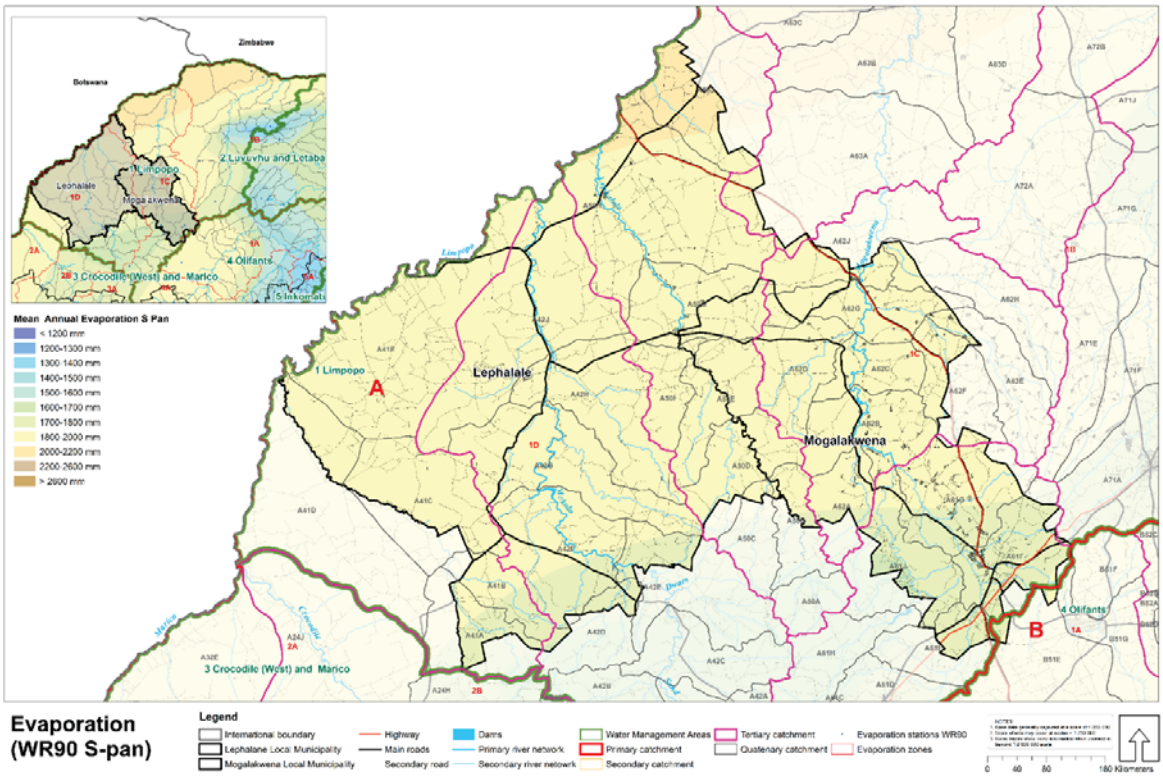


Figure 5.3: Evaporation in the geographical area

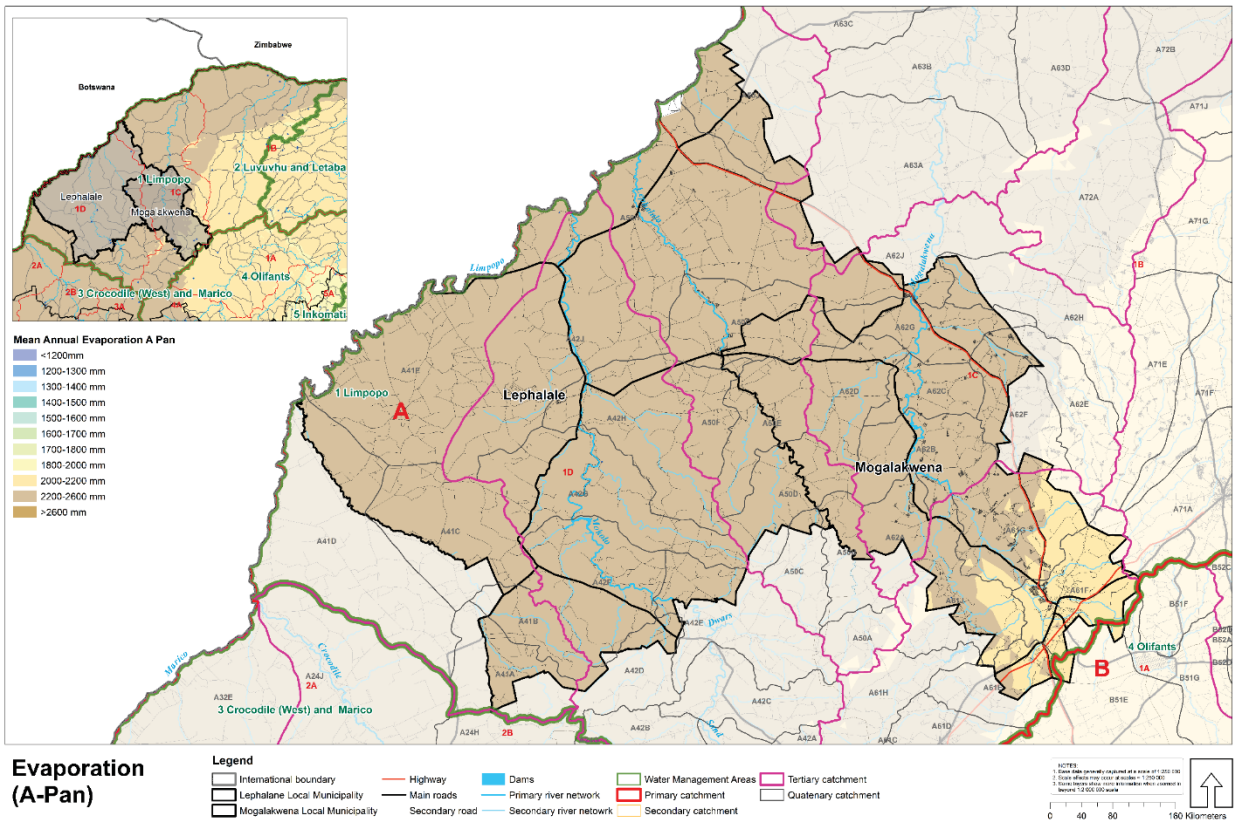


Figure 5.4: Evaporation in the geographical area (A-pan)

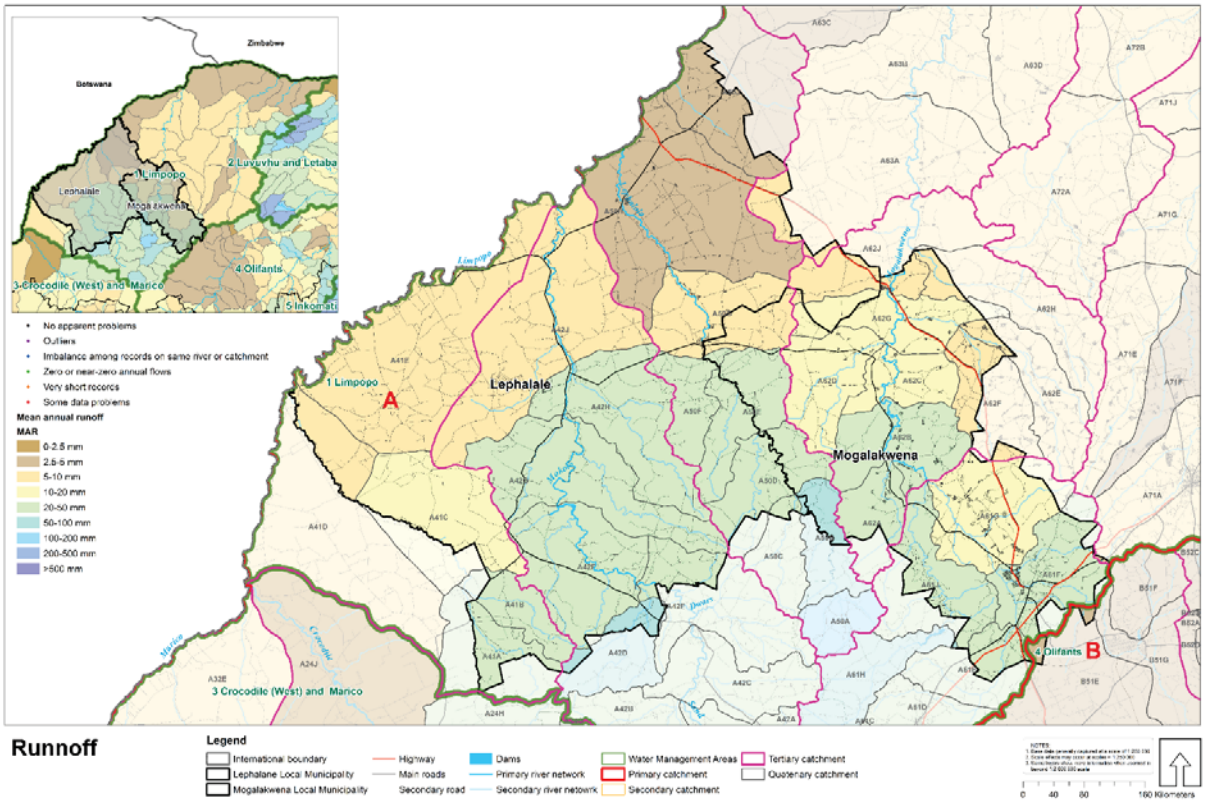


Figure 5.5: Runoff in the geographical area

5.2.2 Population and households

As far as the population and household figures are concerned, the 2016 census statistics of South Africa (Stats SA, 2016) estimated the population of the Lephalale Local Municipality at 115,767, which equates to roughly 42,073 households, the majority of whom occupy formal housing, followed by informal and traditional housing. The population of the Mogalakwena Local Municipality was estimated at 307,682, which equates to roughly 83,604 households, most of whom occupy formal housing, as indicated in Table 5.2.

Table 5.2: The 2016 census population figures

Statistics South Africa	Lephalale Local Municipality	Mogalakwena Local Municipality
Population	115,767	307,682
Households		
Total households	42,073	83,604
Household size	3.2	3.9
Formal housing	32,250	79,387
Traditional housing	629	523
Informal housing	8,877	2,952
Other	298	743
Grants and subsidies received in 2015 as a percentage of total income	26.3%	55.8%

Source: Statistics South Africa, 2016

The Mogalakwena Local Municipality has almost twice as many households (83,604) as the Lephalale Local Municipality residing within its borders. Unfortunately, with this vast number of households, the municipality also has the highest percentage of households that are considered to be "multidimensionally poor" (11.2%). This is a major concern for municipalities as these households depend on social grants and free basic services. According to the 2011 data of Statistics South Africa (Stats SA, 2011), the majority of the Mogalakwena Local Municipality's poor people reside within the rural areas of the municipality, as illustrated by the income distribution by geo-type graph below (see Figure 5.6).

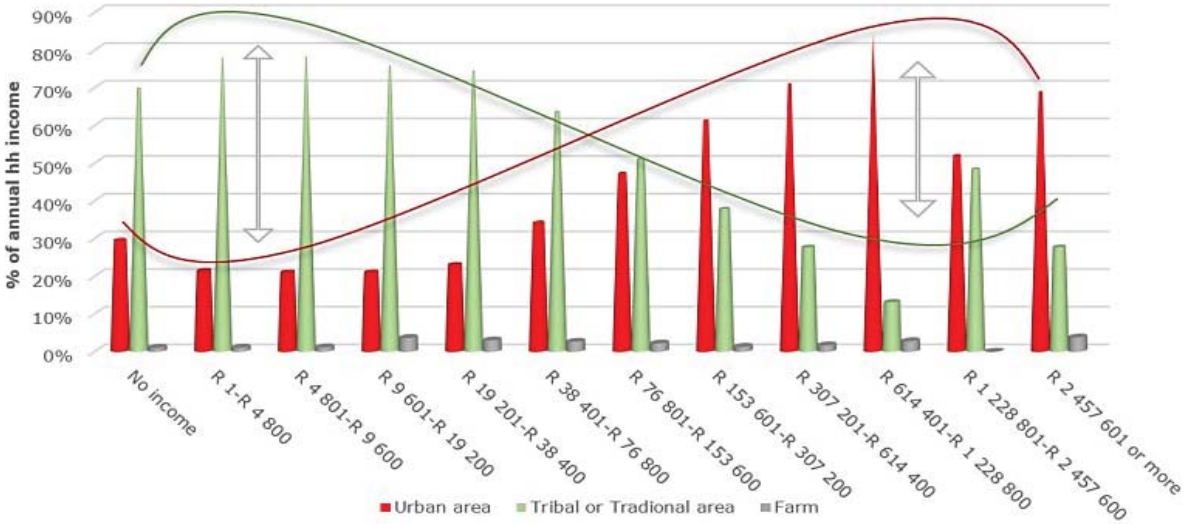


Figure 5.6: The Mogalakwena Local Municipality's annual household income by geo-type

The income distribution by geo-type is similar in the Lephalale Local Municipality, as shown in Figure 5.7. Although the situations are alike, when comparing the two figures, the gap between urban and rural income levels are significantly greater in the higher income categories of Lephalale Local Municipality, meaning that there are far wealthier urban dwellers in this local municipality than in the rural areas, when compared to the Mogalakwena Local Municipality.

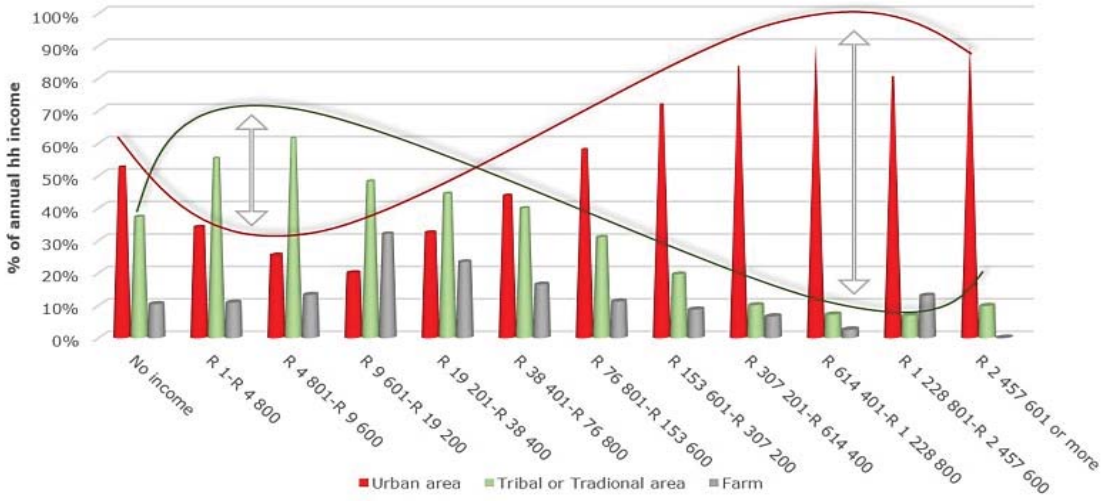


Figure 5.7: Lephalale Local Municipality's annual household income by geo-type

Regarding the economy, all sectors (primary, secondary and tertiary) experienced growth between 2005 and 2015, especially from 2009 onwards. Overall, the Mogalakwena Local Municipality's tertiary sector is by far the strongest sector as it contributed R8,866 million in 2015, almost R7 million more than both the primary and secondary sectors combined. Generally, tertiary economic activities take place in urban environments, as they include wholesale and retail trade, catering and accommodation, transport, storage and communications, finance, insurance, real estate and business services, general government and community services, social and personal services. Mogalakwena Local Municipality has a relatively strong urban core in Mokopane (previously known as Potgietersrus), where most of these tertiary economic activities take place. This is quite the opposite in the Lephalale Local Municipality, as illustrated in Figure 5.8, where the primary sector is by far the strongest economic sector, contributing R6,495 million in 2015. This is, however, mostly mining related as the municipality is known for its coal mines. The main urban area in Lephalale Local Municipality is Ellisras, where most of the tertiary sector generates its income. The extent and nature of the formal and informal settlements will be discussed later in this report.

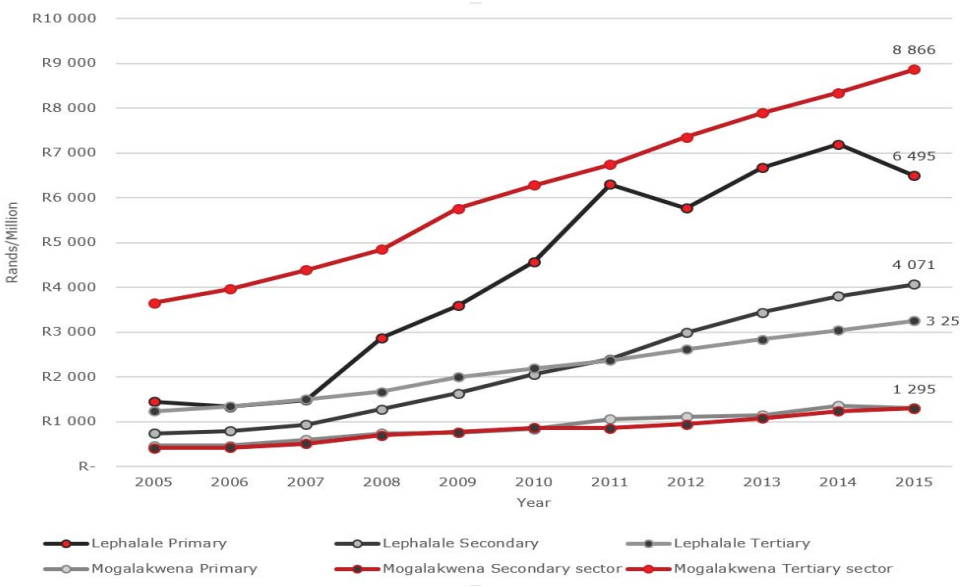


Figure 5.8: Gross value added per economic sector, 1992-2015

5.2.3 Water and sanitation services

5.2.3.1 Access to water and sanitation service

With the majority of poor households residing in rural areas, the provision of free basic services and other infrastructure is far more expensive to construct, operate and maintain. Nonetheless, both local municipalities are WSAs in terms of Section 11 of the National Water Services Act, and according to Statistics South Africa, both municipalities have succeeded in increasing access to basic services since 2001.

Table 5.3 shows that, since 2001, the percentage of households with piped water inside their dwellings in Lephalale Local Municipality increased from 22.4% to 31.4% in 2011. Access to sanitation also increased from 30.1% in 2001 to 39.5% in 2011. Mogalakwena Local Municipality started off with meagre figures of households with access to piped water inside their dwellings in 2001 at 8.7%, which increased to 20.2% in 2011. The increase in access to sanitation services (specifically flush toilets connected to sewerage) is less. However, it still increased from 20.5% in 2001 to 25.8% in 2011.

Table 5.3: Increased access to basic services, 2001-2016

Municipality	Lephalale Local Municipality		Mogalakwena Local Municipality	
Year	Piped water inside dwelling	Flush toilet connected to sewerage	Piped water inside dwelling	Flush toilet connected to sewerage
2001	22.4%	30.1%	8.7%	20.5%
2011	31.4%	39.5%	20.2%	25.8%

More recent data in the 2016 community survey conducted by Statistics South Africa indicates that, in both municipalities, more than 80% of the people have access to piped (tap) water. However, the data does not report on or differentiate whether the access is inside the dwelling or house, inside the yard, community stand or a neighbour's tap, or a public or communal tap. For this reason, the 2016 data cannot be included in Table 5.3, and should be analysed separately.

Nonetheless, the 2016 community survey indicates that more or less 50% of the households in the Lephalale Local Municipality have access to either a flush toilet or a chemical toilet, whereas the other half rely on other sources, such as pit latrines with or without a ventilation pipe, an ecological toilet or a bucket toilet.

The statistics for Mogalakwena Local Municipality shows that fewer households (31% of households) have access to either a flush toilet or a chemical toilet, and almost 69% of households rely on other sources, such as pit latrines with or without a ventilation pipe, ecological toilets or a bucket toilet (this should be seen as an opportunity to introduce off-grid or "green infrastructure" solutions).

Table 5.4: The 2016 Community survey: access to water and sanitation services

Water and sanitation	Lephalale Local Municipality	Mogalakwena Local Municipality
Piped water	81.5% (34,291 households)	83.3% (69,643 households)
Other sources of potable water	18.5% (7,782 households)	16.7% (13,960 households)
Flush or chemical toilet	50.1% (21,059 households)	31.2% (26,086 households)
Other sources as toilet facilities	46.3% (19,474 households)	66.5% (55,566 households)
No toilet facility	3.7% (1,540 households)	2.3% (1,952 households)

Source: Statistics South Africa, 2011

The DWS also differentiates between access to water infrastructure, which generally corresponds to the figures presented by Statistics South Africa, and access to reliable supply. The difference is that even though there might be water distribution infrastructure, the system integrity (physical, hydraulic and chemical) could, in fact, have been compromised by several factors, such as leaks, lack of water pressure and contamination of water.

According to Table 5.5, despite the fact that 82.38% of people living in urban areas have access to water, only 67.22% of them have a reliable water supply. A similar situation is found in rural areas, as 32.76% of the population with access to infrastructure does not have access to a reliable source of water. In Lephalale Local Municipality, more people have access to both a reliable water supply and access to infrastructure in urban and rural areas than in Mogalakwena Local Municipality. However, the percentage of individuals with a reliable source of water is less.

Table 5.5: Reliable water supply, 2017

Local municipality	Urban population				Rural population			
	Access to water	No water	Reliable supply	Non-reliable supply	Access to water	No water	Reliable supply	Non-reliable supply
Mogalakwena	82.38%	17.62%	67.22%	32.78%	82.41%	17.59%	67.24%	32.76%
Lephalale	84.95%	15.05%	62.33%	37.67%	85.35%	14.65%	62.45%	37.55%

Figures 5.9 and 5.10 show that, in both municipalities, the number of people with access to water and the number of people with access to a reliable water supply differs vastly.

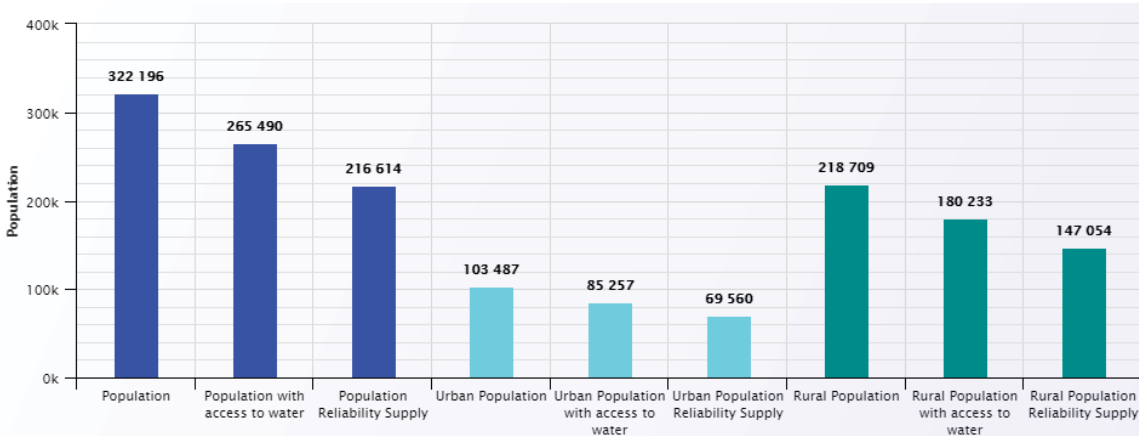


Figure 5.9: Mogalakwena Local Municipality's population with reliable water supply, 2017

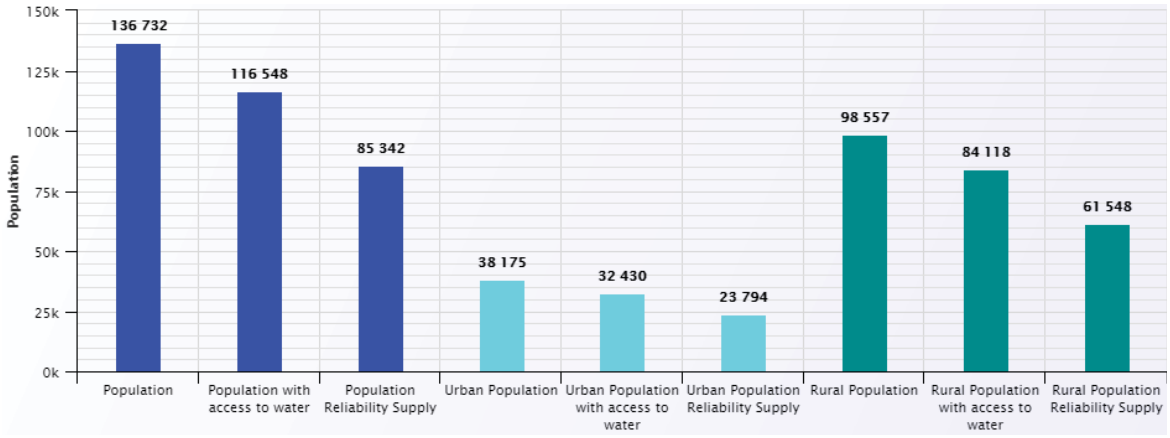


Figure 5.10: Lephalale Local Municipality's population with reliable water supply, 2017

5.2.3.2 High water consumption

Water and sanitation services are provided by water services providers appointed by the municipality in terms of the Water Services Act. Lephalale Local Municipality has two registered WSPs: Exxaro Resources (formerly Khumba Resources) and Eskom, which operate the Zeeland and Matimba supply systems. In 2012, the Zeeland supply system provided water services to 20,373 people and calculated an average daily consumption of 893.34 ℓ per person per day, whereas the Matimba supply system serviced 15,000 people and calculated an average daily consumption of 586.67 ℓ per person per day. In 2012, Exxaro's Zeeland WTW was awarded the prestigious Blue Drop certification. However, in 2014, this status could not be maintained and it scored 85% (below the certification level). Reasons for the downgrade are currently unknown.

Mogalakwena Local Municipality has one registered WSP, Lepelle Northern Water, which operates the Doorndraai and Mahwelereng WTW. Between 2010 and 2011, the municipality's Blue Drop rating rocketed from 47% to 78%, and it was commended for its significant improvement in the management of its drinking water quality in 2011. Unfortunately, the rating declined to 60% in 2014 as the chemical quality of the water did not comply with the excellence requirements of the South African National Standard (SANS) for drinking water (SANS 241). In 2012, the Doorndraai WTW served 125,137 people with an average daily consumption of 95.89 ℓ per person per day, and the Mahwelereng WTW served 36,522 people with an average daily consumption of 54.76 ℓ per person per day.

Figure 5.11 compares the average water use per person per day for all of Limpopo's WTWs. The Zeeland WTW has by far the highest water consumption, followed by Lethaba/Modjadji, which provides water services throughout the Mopani District Municipality. The third highest is Matimba, which is one of Lephalale Local Municipality's WTW.

The Mogalakwena's Local Municipality's WTW presents a fairly more appropriate or acceptable picture in terms of its consumer behaviour, as the Doomdraai WTW is ranked 23rd and the Mahwelereng WTW is ranked 13th (the lowest) out of 64 WTWs. This trend should raise serious questions as to why consumer behaviour is what it is (for a water-scarce country, the degree of consumption should be below 200 ℓ per person per day).

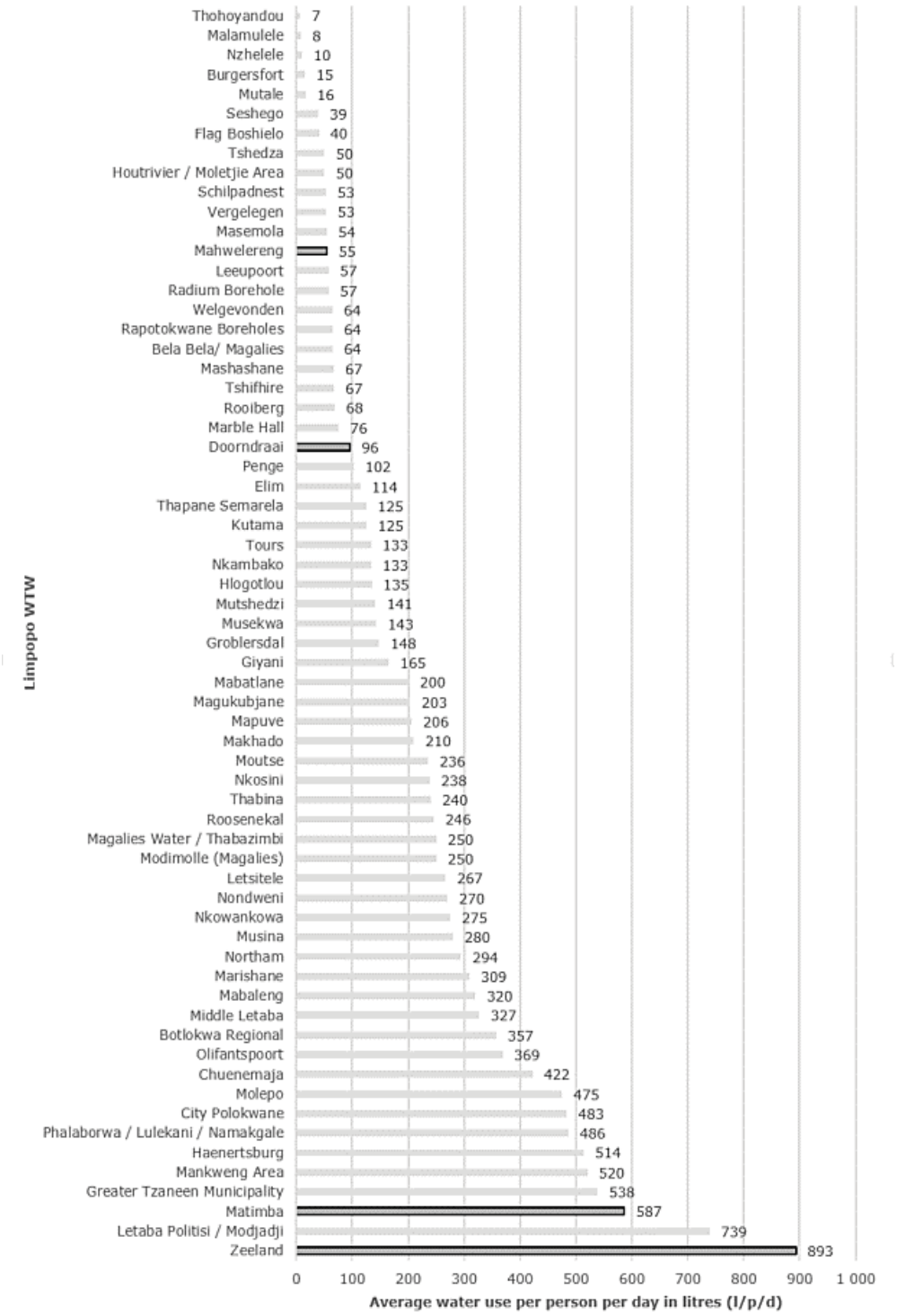


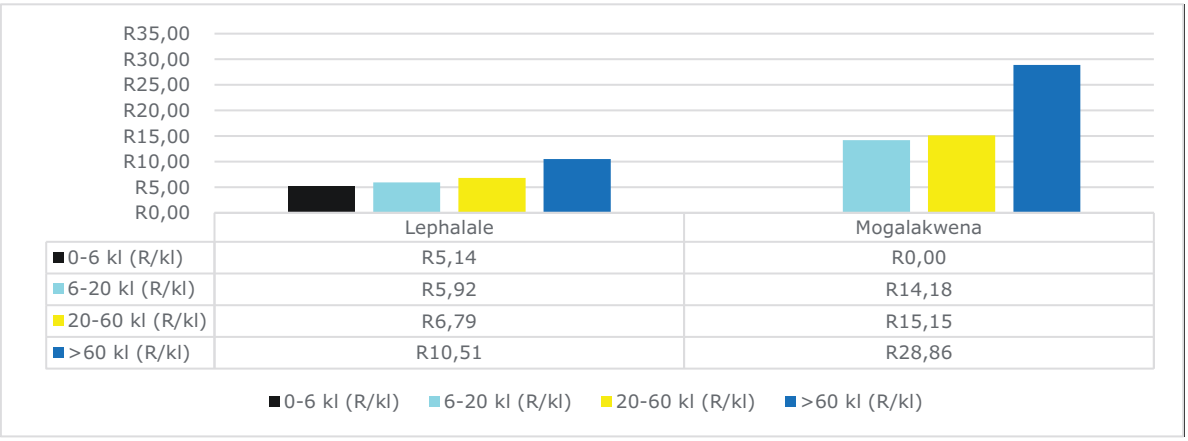
Figure 5.11: Average water use per person per day: Limpopo's WTW

Source: Author's own, 2017, derived from the 2012 Limpopo Blue Drop Report (DWS, 2012)

5.2.3.3 Water tariffs and non-revenue water

One explanation for the high-water usage in the Lephalale Local Municipality could, in fact, be related to the generally low cost of water, as well as the economic activities compared to the Mogalakwena Local Municipality. Figure 5.12 shows the cost of water per kℓ.

The cost of water consumption between 6 and 20 kℓ differs with R8.23, as Lephalale Local Municipality only charges R5.95 per kℓ, while Mogalakwena Local Municipality charges R14.18 per kℓ. The biggest tariff difference is seen when more than 60 kℓ is used. Mogalakwena Local Municipality charges R28.86 per kℓ, while Lephalale Local municipality only charges R10.51 per kℓ.



	Lephalale	Mogalakwena
0-6 kl (R/kl)	R5,14	R0,00
6-20 kl (R/kl)	R5,92	R14,18
20-60 kl (R/kl)	R6,79	R15,15
>60 kl (R/kl)	R10,51	R28,86

Figure 5.12: Municipal tariffs, 2015 (Lephalale and Mogalakwena local municipalities compared)

Another major issue that is faced by both local municipalities is the high percentage of NRW, which increased between 2008 and 2010 from 13% to 16% in Lephalale Local Municipality (see Figure 5.13). In Mogalakwena Local Municipality, the percentage of NRW is extremely high, at 44% (4,000,000 kℓ) in 2011 (see Figure 5.14). It is uncertain at this stage whether NRW includes the 0 to 6 kℓ usage category.

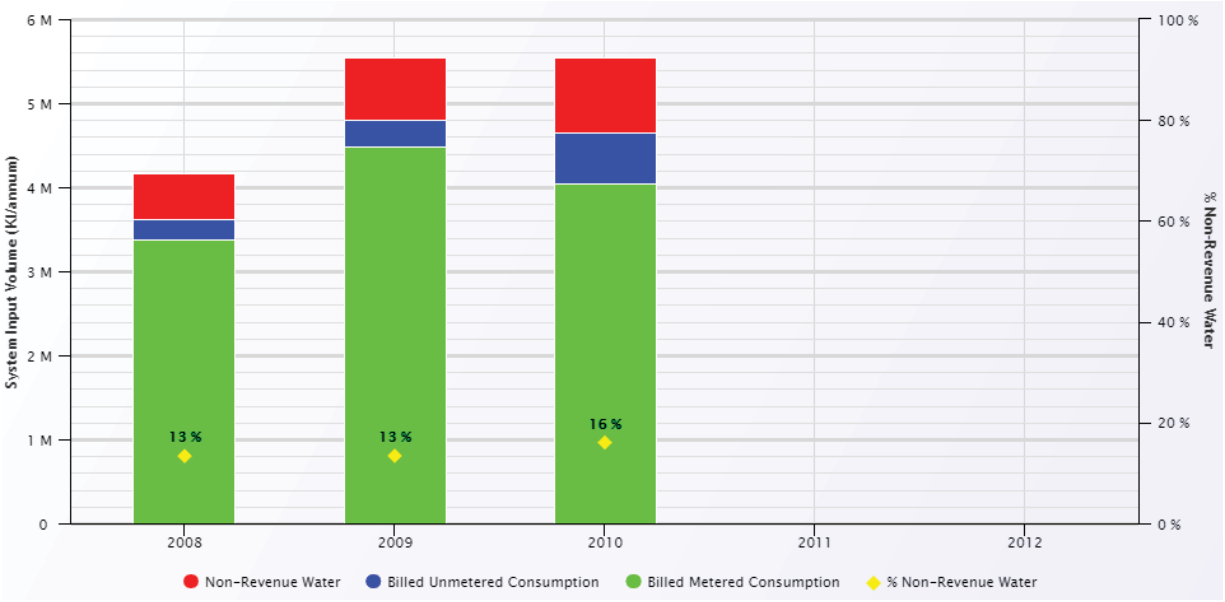


Figure 5.13: Lephalale Local Municipality's non-revenue water, 2008-2010

Table 5.6: Lephalale Local Municipality's non-revenue water, 2008-2010

Lephalale Local Municipality	2008	2009	2010
Non-revenue water	556,326 kℓ	741,902 kℓ	887,800 kℓ
Billed unmetered consumption	235.974 kℓ	310,698 kℓ	608,000 kℓ
Billed metered consumption	3,377,700 kℓ	4,487,400 kℓ	4,044,200 kℓ
Percentage of NRW	13%	13%	16%

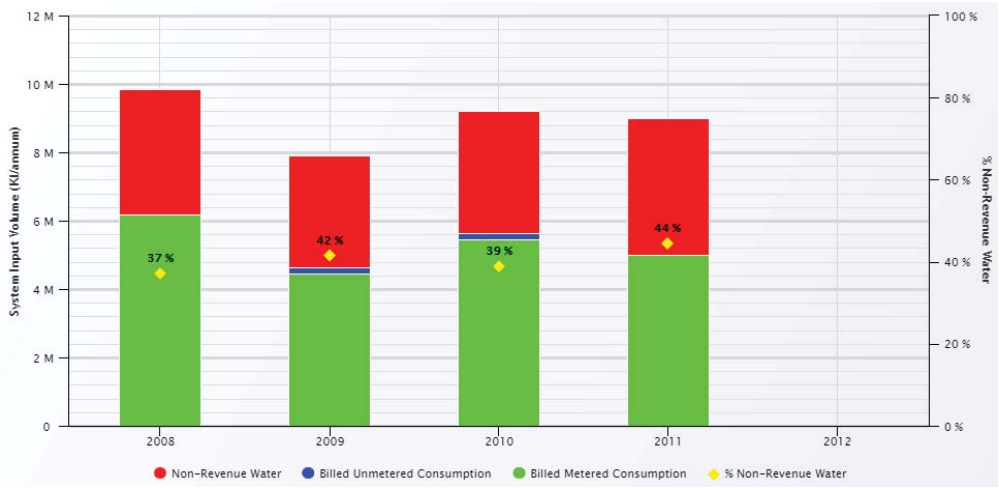


Figure 5.14: Mogalakwena Local Municipality's non-revenue water, 2008-2011

Table 5.7: Mogalakwena Local Municipality's non-revenue water, 2008-2011

Mogalakwena Local Municipality	2008	2009	2010	2011
Non-revenue water	3,659,898 kℓ	3,291,493 kℓ	3,576,462 kℓ	4,000,000 kℓ
Billed unmetered consumption	0 kℓ	185,309 kℓ	175,300 kℓ	
Billed metered consumption	6,195,102 kℓ	4,447,422 kℓ	5,450,340 kℓ	5,000,000 kℓ
Percentage of NRW	37%	42%	39%	44%

5.2.4 Key findings

Both case study areas typify those areas addressed within the current WSUD framework for South Africa where the country's urban water resources are managed through the integration of the various disciplines of engineering, social and environmental sciences, while acknowledging that South Africa is a water-scarce country; access to adequate potable water is a basic human right; the management of water should be based on a participatory approach; water should be recognised as an economic good; and water is a finite and vulnerable resource, which is essential to sustaining all life and supporting development and the environment at large. Both study areas are considered "arid", and characterised by low rainfall, high temperatures and low surface water run-off. The populations of both study areas generally cannot afford to pay for basic services. Water use in these areas seems to be very high (especially in Lephalale). Water is also relatively cheap and therefore does not appear to reflect the value of the resource. Even though the majority of households have access to water services infrastructure, this may not always be a reliable service.

The next section of this chapter will investigate the SDF and LUS of each municipality to indentify the extent to which water sensitivy is addressed.

5.3 REVIEW OF PLANNING DOCUMENTS

In view of the above discussion, the planning documents (specifically the municipal SDF) were scrutinised to assess the way in which these documents could contribute to ensuring water availability and quality. A simple framework was drawn up to assess the extent to which each planning tool addresses water-related issues. The following colour coding was used in the assessment:

Table 5.8: Assessment legend: review of planning documents

Adequate	The planning document analyses the specific variable adequately.
Moderate	The planning document addresses the specific issue in question, but not in as much detail as would be desired.
Not at all	The issue is not addressed in the planning document whatsoever.

5.3.1 Lephalale Local Municipality's SDF, 2017

Table 5.9: Assessment of Lephalale Local Municipality's SDF, 2017

Theme	Question	Comment	Assessment (Adequate / Moderate / Not at all)
SPLUMA principles: spatial justice, spatial sustainability, spatial efficiency, spatial resilience and good administration	1.1. Does the SDF redress the past spatial imbalances such as confining particular groups to limited space, and the unfair allocation of public and natural resources?	One of the key thrusts of Lephalale's SDF is the integration of Marapong and Onverwacht. Marapong is a previously disadvantaged community located approximately 18 km from Onverwacht (a major node with plenty of economic opportunities and high-order community facilities). The SDF provides for a specific growth direction that will allow these communities to integrate with each other over time.	Adequate
	1.2. Does the SDF give effect to sustainable development patterns by promoting land development in locations that are sustainable and limit urban sprawl (compact, integrated human settlements)?	The SDF calls for a more compact city. This should be achieved by implementing two growth management tools. The first is a conservative urban edge (or urban development boundary) that seeks to optimise existing infrastructure and limit urban sprawl. The second is financial disincentives. Vacant properties within the city's boundaries should be taxed more to promote quicker development and prevent speculation. This should also lead to the municipality achieving return on infrastructure investment through property rates and taxes, as well as payment for services such as water, sanitation and electricity.	Adequate
	1.3. Does the SDF give special consideration to the protection of prime and unique agricultural land?	Lephalale does not exhibit much agricultural potential with dry and hot conditions prevailing. Game farming occurs in certain areas. In the rural focus area, many families depend on subsistence agriculture as the main economic activity. Those areas of existing agriculture have been identified in the SDF with "settlement edges" demarcated to prevent villages from sprawling onto agricultural land. One of the key proposals for the rural focus areas is the establishment of farmer production units in three of the key nodes in support of government's agri-parks policy.	Moderate
	1.4. Does the SDF uphold consistency of land use measures in accordance with environmental management instruments?	Yes, the SDF incorporates the district environmental management framework. Conservation areas are protected as areas of no development, while development is limited in CBAs. Proposals in the SDF are made for two overlay zones, which could add legal protection by incorporating these zones in the municipal LUS.	Adequate
	1.5. Does the SDF consider all current and future costs to all parties for the provision of infrastructure services and social services in land development?	The SDF includes chapters on infrastructure provision and its corresponding challenges. It identifies the number of community facilities that would be required to accommodate growth in households over time, but does not address the need for water, sanitation and electricity. It furthermore does not quantify the cost of future infrastructure.	Not at all
	1.6. Does the SDF optimise the use of existing resources and infrastructure?	See 1.2 above. The municipality has an oversupply of vacant proclaimed erven. The SDF proposes a struct urban edge and financial instruments aimed at limiting sprawl and developing existing vacant stands. The SDF further proposes that future mining activity (located some kilometres away from the main node) rather contributes to developing vacant land within the urban edge as opposed to establishing human settlements far away from the urban core. The SDF also promotes higher densities and infill development, as well as spatial targeting for service provision in the rural focus area.	Moderate
	1.7. Does the SDF make provision for sustainable livelihoods in communities more likely to suffer the impact of economic and environmental shocks?	The SDF focuses on the agri-park principle to improve the livelihoods of the poorest communities. Part of the implementation plan furthermore sets objectives for sector departments to ensure the successful implementation of the agri-park principle. Informal settlements are ignored.	Moderate
	1.8. Is the SDF aligned with other sector plans, e.g. the WSDP?	No mention is made of the WSDP, nor is there alignment with other water sector-related documents.	Not at all
Written and spatial representation of a five-year spatial development plan	2.1. How does the proposed five-year spatial form impact on water resources? (Does it protect landscapes with high groundwater recharge potential, wetlands, rivers and river buffers?)	Rivers, buffers and wetlands are protected though the protection of CBAs. This is basically seen as a constraint to development, not really as an environmental resource to be protected. No mention is made of groundwater recharge potential.	Moderate
	2.2. Does the proposed five-year spatial form direct development away from ecological infrastructure (e.g. rivers, wetlands, intact green open spaces)?	Yes. Rivers, wetlands, floodplains, environmentally sensitive areas and protected areas are all protected.	Adequate

Theme	Question	Comment	Assessment Adequate Moderate Not at all
	2.3. Does the SDF promote the development of blue-green corridors inside and outside built-up areas (ecological corridors)?	No mention is made of blue-green corridors.	
	2.4. Does the SDF address the potential impact of the proposed five-year spatial form on stormwater and does the SDF identify space for the implementation of SUDS or other green infrastructure technologies?	No.	
Spatial vision	3.1. Does the SDF have a longer-term spatial vision?	"Ensure sustainable livelihoods for those households residing in the rural areas of the municipality through proper planning, adequate linkage to rural development programmes and products, while at the same time protecting valuable environmental and agricultural resources."	
	3.2. Is environmental sustainability (or more specifically water sustainability) a component of this vision?	The vision proposes the protection of valuable environmental and agricultural resources, but does not suggest any link with resource planning, efficiency or sustainability.	
Structuring and restructuring elements	4.1. Do the spatial structuring elements of the SDF include high groundwater recharge potential, wetlands, rivers and river buffers?	To a certain extent. Once again, CBAs were included.	
	4.2. Does the SDF specifically identify the cost or implication of proposed development on the quantity of water?	No. Many of the proposals are for new mining (coal) or energy generation. No indication or research was done as to how much water these proposals would consume or any concern expressed as to where it will come from.	
	4.3. Does the SDF specifically identify the cost or implication of proposed developments on the quality of water?	No. Many of the proposals are for new mining (coal) or energy generation. No indication or research was done as to the implications on water pollution (either surface or groundwater).	
Estimating growth	5.1. Does the SDF provide for five-year population growth estimates?	Yes	
	5.2. Does the SDF indicate any water-related (availability of resources or infrastructure requirements) implications associated with the five-year population growth estimate?	No	
	5.3. Does the SDF provide estimates on housing units across different socio-economic categories?	Yes	
	5.4. If yes, does the SDF indicate the planned location and density of the housing units?	Yes	
	5.5. Are the proposed locations within existing built-up areas?	Yes, although integration between two major nodes is also proposed.	
	5.6. Will any ecological infrastructure be compromised if and when this development takes place (FEPAs, CBAs, ESAs and high groundwater recharge areas)?	No, research was included regarding water recharge areas. In general, development is steered away from CBAs and ESAs. No mention is made of FEPAs.	
	5.7. Does the SDF include estimates on economic activities (agriculture, mining, manufacturing)?	Yes	
	5.8. Does the SDF identify any water-related implications or concerns associated with the specific economic activity (water demand, water pollution)?	No	
	5.9. If yes, does the SDF make any proposals on how to deal with the specific water-related issue (spatial location of mines, dry crop agricultural practices, stormwater and effluent discharge regulations)?	No	
Engineering services, levels of service and water	6.1. Does the SDF identify and quantify the requirements of engineering infrastructure and services provision for the existing and future development needs for the next five years?	No	
	6.2. Does the SDF provides for different levels of services (hierarchy) linked to a spatial location? (What is the basic level of services?)		
	6.3. Does the SDF promote alternative infrastructure as future solutions (rainwater harvesting, stormwater harvesting, groundwater utilisation, water reuse)?	No	
Environmental assessment	7.1. Does the SDF provide for a detailed and strategic assessment of the environmental pressures and opportunities within the municipal area?	It incorporates the Waterberg Biodiversity Plan.	
	7.2. Does environmental assessment relate to the protection and sustainable use of water as a resource (e.g. condition of wetlands, rivers, catchments and groundwater resources)?	The assessment does not specifically make provision for or mention water as a scare resource that must be protected.	
	7.3. Does the SDF provide for a clear delineation of areas where development should be prohibited specifically to protect water resources or ensure that water is not polluted?	No	

5.3.2 Lephalale Local Municipality's LUS, 2017

Table 5.10: Assessment of Lephalale Local Municipality's LUS, 2017

Question	Comment	Assessment (Adequate / Moderate / Not at all)
1.1. During the compilation of the LUS, was any water sector department, water utility or water board present at the meetings as an interested or affected party?	No	
1.2. Does the existing LUS contain any special considerations (zonings, development controls, etc.), specifically focusing on water sustainability?	No	
1.3. Was the scheme revision informed or influenced in any way by the municipality's WSDP?	No	
1.4. Does the scheme cover the entirety of the municipality (wall-to-wall LUS)?	Yes	
1.5. Are there any linkages between the municipality's SDF and LUS?	Yes – the environmental data identified in the SDF is incorporated as an overlay zone.	
1.6. Are sensitive environmental areas protected in some way through the LUS?	Only protected areas (as identified in the South African Protected Areas database)	
1.7. Do these environmentally sensitive areas include any areas specifically related to water (e.g. FEPA, ground water recharge zones, catchment areas, etc.)?	No.	
1.8. Are any of these areas zoned accordingly or as "agriculture" (the typical zoning given to areas outside the urban development boundary)?	No	
1.9. Does the LUS include any measures to ensure a compact city?	No	
1.10. Does the LUS include any development controls to limit the impact on stormwater (e.g. permeable paving, etc.)?	No	
1.11. Does the scheme contain any clauses or development controls or incentives to promote rainwater harvesting in any way?	No	
1.12. Are the maximum size of pools limited in any way?	No	
1.13. Does the LUS include any form of alternative zoning (e.g. management overlay or overlay zone) to ensure that certain areas are protected from land use activities that may pollute surface water and groundwater?	Yes. The 1:00 year floodline in the rural area is a management overlay. However, this is more to protect the people than the environment.	
1.14. Does the LUS provide for any incentives that could promote water sensitivity?	No	
1.15. Where boreholes are present, are there any protective measures in the scheme to limit any land uses in close proximity that may pollute the borehole and subsequently groundwater?	No	
1.16. Does the LUS make provision for mean aquifer recharge zones (areas where groundwater easily penetrates)?	No	

5.3.3 Mogalakwena Local Municipality's SDF, 2009

Theme	Question	Comment	Assessment (Adequate / Moderate / Not at all)
SPLUMA principles: spatial justice, spatial sustainability, spatial efficiency, spatial resilience and good administration	1.1. Does the SDF redress the past spatial imbalances such as confining particular groups to limited space, and the unfair allocation of public and natural resources?	Land development must take place in an integrated manner, both spatially and institutionally. Historical distorted development patterns must be corrected by means of physical and social integration and the redirection of investment to areas with the highest value and accessibility.	
	1.2. Does the SDF give effect to sustainable development patterns by promoting land development in locations that are sustainable and limit urban sprawl (compact, integrated human settlements)?	Uncoordinated urban development must be discouraged, and more compact and efficient development patterns must be promoted.	
	1.3. Does the SDF give special consideration to the protection of prime and unique agricultural land?	Agricultural activities in Mogalakwena are divided into two major zones: crop farming (high-potential intensive agricultural activities) and ranching (low-intensity cattle and game ranching activities). The SDF also states that agricultural land with a high potential should be protected.	
	1.4. Does the SDF uphold consistency of land use measures in accordance with environmental management instruments?	No. Before SPLUMA's SDF, no CBAs were considered. The SDF does, however, consider some conservation areas, as well as river systems.	
	1.5. Does the SDF consider all current and future costs to all parties for the provision of infrastructure services and social services in land development?	The SDF includes chapters on infrastructure provision and its corresponding challenges, and provides estimates for future social services, but does not address the need for water, sanitation and electricity. It furthermore does not quantify the cost of future infrastructure.	
	1.6. Does the SDF optimise the use of existing resources and infrastructure?	The SDF proposes a strict urban edge aimed at limiting sprawl and developing existing vacant stands.	
	1.7. Does the SDF make provision for sustainable livelihoods in communities more likely to suffer the impact of economic and environmental shocks?	The SDF mentions that sustainable rural development should be promoted by identifying suitable locations for the development of rural and resource-based industries, as well as rural service centres. Except for this statement, however, there is no clear indication how this should be achieved.	
	1.8. Is the SDF aligned with other sector plans, e.g. WSDP?	No mention is made of the WSDP, nor is there alignment with other water sector-related documents.	

Theme	Question	Comment	Assessment (Adequate / Moderate / Not at all)
Written and spatial representation of a five-year spatial development plan	2.1. How does the proposed five-year spatial form impact on water resources? (Does it protect landscapes with high groundwater recharge potential, wetlands, rivers and river buffers?)	Rivers and buffers are protected through the buffer zones. This is basically seen as a constraint to development. No mention is made of groundwater recharge potential.	
	2.2. Does the proposed five-year spatial form direct development away from ecological infrastructure (e.g. rivers, wetlands, intact green open spaces)?	The SDF is a pre-SPLUMA SDF, but rivers, wetlands, floodplains and conservation areas are all protected.	
	2.3. Does the SDF promote the development of blue-green corridors inside and outside built-up areas (ecological corridors)?	No mention is made of blue-green corridors.	
	2.4. Does the SDF address the potential impact of the proposed five-year spatial form on stormwater and does the SDF identify space for the implementation of SUDS or other green infrastructure technologies.	No	
Spatial vision	3.1. Does the SDF have a longer-term spatial vision?	No	
	3.2. Is environmental sustainability (or more specifically water sustainability) a component of this vision?	No	
Structuring and restructuring elements	4.1. Do the spatial structuring elements of the SDF include high groundwater recharge potential, wetlands, rivers and river buffers?	To a certain extent.	
	4.2. Does the SDF specifically identify the cost or implication of the proposed development on the quantity of water?	No	
	4.3. Does the SDF specifically identify the cost or implication of the proposed development on the quality of water?	No.	
Estimating growth	5.1. Does the SDF provide for five-year population growth estimates?	No, although it does give household growth estimates.	
	5.2. Does the SDF indicate any water-related (availability of resources or infrastructure requirements) implications associated with the five-year population growth estimate?	No	
	5.3. Does the SDF provide estimates of housing units across different socio-economic categories?	No	
	5.4. If yes, does the SDF indicate the planned location and density of the housing units?	-	
	5.5. Are the proposed locations within existing built-up areas?	-	
	5.6. Will any ecological infrastructure be compromised if and when this development takes place (FEPAs, CBAs, ESAs and high groundwater recharge areas)?	No mention is made of CBAs or ESAs.	
	5.7. Does the SDF include estimates on economic activities (agriculture, mining, manufacturing)?	Yes	
	5.8. Does the SDF identify any water-related implications or concerns associated with the specific economic activity (water demand, water pollution)?	No	
	5.9. If yes, does the SDF make any proposals on how to deal with the specific water-related issue (spatial location of mines, dry crop agricultural practices, stormwater and effluent discharge regulations)?	-	
Engineering services, levels of service and water	6.1. Does the SDF identify and quantify the requirements of engineering infrastructure and services provision for existing and future development needs for the next five years?	No	
	6.2. Does the SDF provide for different levels of services (hierarchy) linked to a spatial location? (What is the basic level of services?)	Yes	
	6.3. Does the SDF promote alternative infrastructure as future solutions (rainwater harvesting, stormwater harvesting, groundwater utilisation, water reuse)?	No	
Environmental assessment	7.1. Does the SDF provide for a detailed and strategic assessment of the environmental pressures and opportunities within the municipal area?	The SDF provides an adequate assessment of environmental pressures	
	7.2. Does environmental assessment relate to the protection and sustainable use of water as a resource (e.g. condition of wetlands, rivers, catchments and groundwater resources)?	The assessment does not specifically relate to the protection of the sustainable use of water as a resource. However, the SDF mentions that the availability of water is a major constraint and can have an impact on development.	
	7.3. Does the SDF provide for a clear delineation of areas where development should be prohibited specifically to protect water resources or ensure that water is not polluted?	The SDF does not specifically provide a clear delineation of areas where development should be prohibited specifically related to protecting water and water quality. However, the SDF makes provision for river buffers that should not be disturbed by any development.	

5.3.4 Mogalakwena Local Municipality's LUS, 2017

	Question	Comment	Assessment Adequate Moderate Not at all
1.1	During the compilation of the LUS, was any water sector department, water utility or water board present at the meetings as an interested or affected party?	No	
1.2	Does the existing LUS contain any special considerations (zonings, development controls, etc.) specifically focusing on water sustainability?	No	
1.3	Was the scheme revision informed or influenced in any way by the WSDP of the municipality?	No	
1.4	Does the scheme cover the entirety of the municipality (wall-to-wall LUS)?	No. However, the municipality is in the process of revising its LUS. The intention is to compile a wall-to-wall LUS.	
1.5	Are there any linkages between the municipality's SDF or LUS?	No. The two instruments do not align with each other in any way.	
1.6	Are sensitive environmental areas protected in any way through the scheme?	Only protected areas (as identified in the South Africa Protected Areas database). These areas are zoned as "conservation". The scheme does not consider any sensitive areas that are not declared as conservation areas.	
1.7	Do these environmentally sensitive areas include any areas specifically related to water (e.g. FEPAs, ground water recharge zones, catchment areas, etc.)?	No.	
1.8	Are any of these areas zoned accordingly or as "agriculture" (the typical zoning given to areas outside the urban development boundary)?	No, land outside the urban area is zoned as "agriculture".	
1.9	Does the LUS include any measures to ensure a compact city?	No	
1.10	Does the LUS include any development controls to limit the impact on stormwater (e.g. permeable paving, etc.)?	No	
1.11	Does the scheme contain any clauses or development controls or incentives to promote rainwater harvesting in any way?	No	
1.12	Are the maximum size of pools limited in any way?	No	
1.13	Does the LUS include any form of alternative zoning (e.g. management overlay or overlay zone, etc.) to ensure that certain areas are protected from land use activities that may pollute surface water and groundwater?	No.	
1.14	Does the LUS provide for any incentives that could promote water sensitivity?	No	
1.15	Where boreholes are present, are there any protective measures in the scheme to limit any land uses in close proximity that may pollute the borehole and subsequently groundwater?	No	
1.16	Does the LUS make provision for mean aquifer recharge zones (areas where groundwater easily penetrates)?	No	

5.3.5 Key findings

- Both planning instruments (the SDF and the LUS) are required by law. Both these instruments are key policy instruments that inform current and future development. The SDF provides an indication of what type of future development could occur in areas of the municipality, and is used in the adjudication of development applications. However, the LUS is the only planning tool that has the force of law and can therefore be used to declare developments illegal or can be used to enforce certain conditions or requirements on the development before it takes place.
- In both cases, the SDF indicates in some measure where sensitive environmental areas are located. It is clear that the identification of these areas was more a factor of available data (at the time) than conscious thought as to the protection of all natural resources. In fact, more attention is given to the occurrence of mineral resources (coal in the case of Lephalale and gold in the case of Mogalakwena) than the occurrence and protection of water resources.
- While the SDFs quantify the extent of future development, they fall drastically short in considering the implications of future development on the availability and quality of water. It would seem as if there is a basic assumption that, no matter what type of development will occur in future, water will always be available to support this type of development.
- There is no alignment between the municipality's SDF and its WSDP. In fact, in both cases, there is no mention of the WSDP whatsoever. Furthermore, there is no mention of the SDF in either of the two municipalities' WSDPs. These documents must be aligned to ensure the adequate provision and protection of water resources and the sustainable delivery of water services.

- While many SDFs contain the words “sustainability” and “resilience” in their vision statements, only one of the documents provide any indication of how to achieve this. The Lephalale SDF Implementation Plan contains several actions for future consideration. Examples include the following:
    - Reduce loss of biodiversity and protect ecological areas as part of the municipal LUS
    - Develop a municipal Invasive Alien Plant Control Management Plan, which monitors the performance and change actions as necessary
    - Appoint a service provider to develop a Lephalale Urban Design Plan, which focuses on the integration of urban blue-green corridors, WSUD and city beautification
    - Regulate and promote efficient building design and construction
- There is no alignment between the national SDF and the municipal SDFs. This is obvious since the NSDF was completed after the municipal SDFs. Future iterations of the municipal SDFs must take their cue from the NSDF and incorporate sections on climate change and water dependence.
- Both LUSs are completely ignorant of water sensitivity. Water-sensitive areas such as FEPAs and groundwater recharge zones often occur in the rural hinterland of the municipality. Most often these areas are zoned as “agriculture” without even considering whether they should be used for agricultural activities, or what the impact of these activities would be.
- It is clear that town and regional planners (as the authors of the SDF and LUS) do not have the skills set to deal with issues related to water sensitivity. This is often seen as either an “environmental” subject or an “engineering” one. Skills development in this area is a necessity if water sensitivity is to be considered in these planning instruments.

CHAPTER 6: FRAMEWORK FOR WATER-SENSITIVE SPATIAL PLANNING AND LAND USE MANAGEMENT

The purpose of this document is to provide a broad framework that can be used to include and address water sensitivity in municipal planning documents. The accompanying document (also a key deliverable of this project) will take each component of the framework and provide detailed guidelines on how to implement it. The framework relies on the typical approach taken by town planners (as well as the framework and guidelines prescribed by the DRDLR) and adds additional objectives, actions and outcomes that will ensure that water sensitivity is addressed in the municipality's spatial planning documents.

A diagram of the framework is given in Figure 6.1.

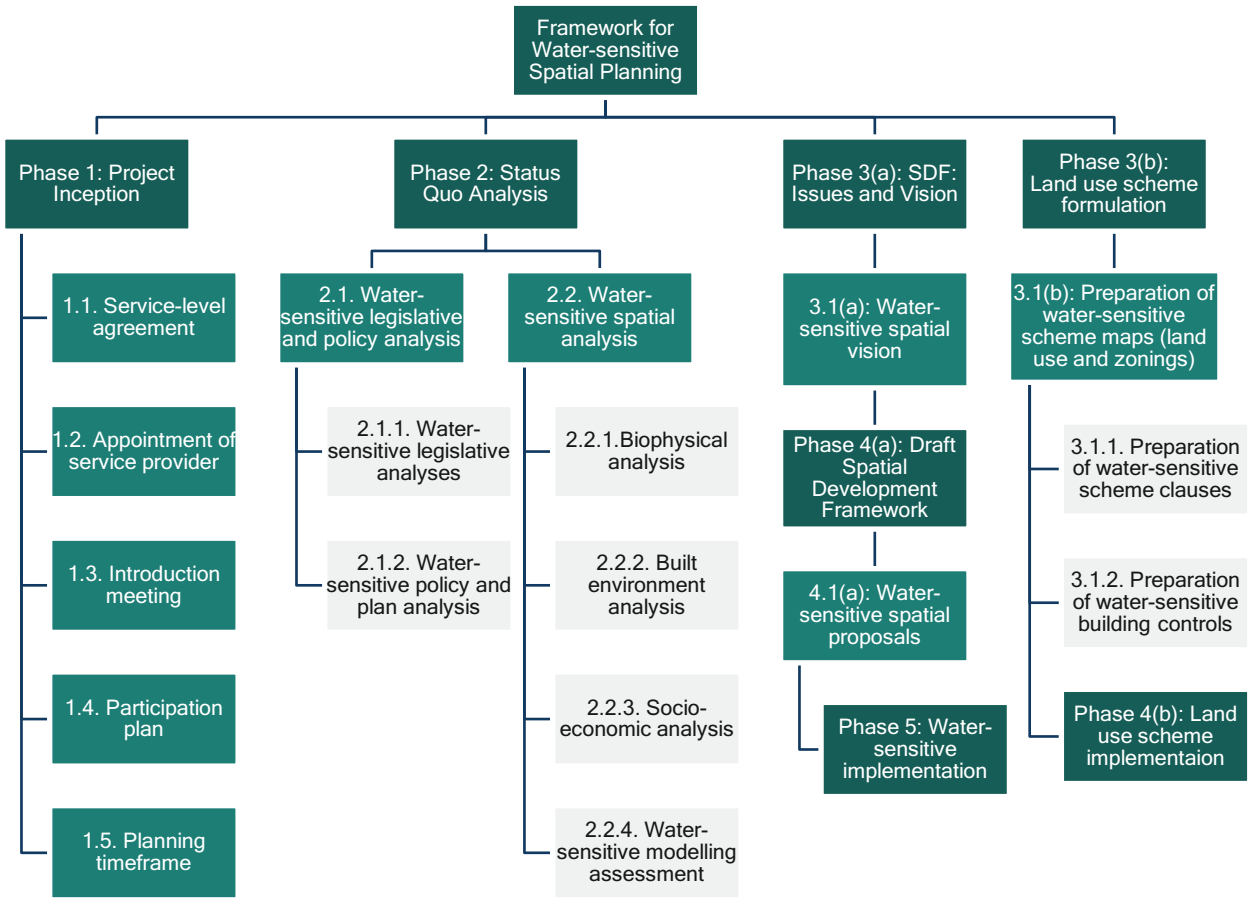


Figure 6.1: Framework for water-sensitive spatial planning

Each of the major elements will be discussed in more detail below.

Table 6.1: Water-sensitive spatial planning framework

Phase	Water-sensitive objectives	Water-sensitive outcome
Phase 1: Project Inception		
1.1. Service-level agreement	Most municipalities appoint private sector service providers to compile the spatial planning documents required by law using an open tender process. Most often, the professional team requirements for a service provider are only a registered professional town and regional planner. Water-sensitive planning requires additional input, e.g. a certified water efficiency professional or a civil engineer specialising in water and sanitation. A major skills requirement is also a GIS specialist to assist in the modelling of spatial data.	A professional service provider with the necessary skills and competencies to ensure that planning documents adhere to water-sensitive guidelines.
1.2. Appointment of service provider		
1.3. Introduction meeting	The introduction meeting is set to be the first engagement between the municipality's project coordinator and the service provider. This meeting also presents an opportunity for the service provider, together with the municipal or district project coordinator, to discuss possible stakeholders to be invited to the inception meeting. During this meeting, the water-sensitive spatial planning framework must be introduced to the service provider to ensure that the framework is used during the process of compiling an SDF and LUS that address water sensitivity. This meeting should also be used as an opportunity for the project coordinator to share existing documents and data applicable to the project.	A professional service provider and project owner who are aware of the objectives of water-sensitive SDFs and LUSs, capacitated with a framework and guideline to influence normal planning methodology.
1.4. Participation plan	Different forms of participation occur during the planning process. Firstly, a steering committee must include representatives of WSAs, as well as the DWS. Secondly, the plan should make provision for consultation with water sector professionals to ensure that other sectors are presented with the proposals, and have time to provide input into the process. Lastly, even though it is the responsibility of the Municipal Council to approve and adopt the LUS and SDF, it would be good practice to also have the WSA (if not the municipality), as well as the DWS, sign off on the final plan.	A plan that will also ensure the water sector ample opportunity to do the following: • Provide input into the process • Share documents, policies and plans • Have the opportunity to approve the plan and ensure alignment with other water sector policies and plans
Phase 2: Status Quo Analysis		
2.1.1. Water-sensitive legislative analyses	The aim of this phase is to establish a baseline legal and institutional framework for the planning and management of land, water and environmental resources.	Identified legislation (inclusive of water and environmental legislation) that will ensure alignment (and therefore compliance) of the municipality's spatial planning documents with the legislation.
2.1.2. Water-sensitive policy and plan analysis	The objectives of a water-sensitive policy analysis are to do the following: • Identify development principles and strategies, regulations, norms and standards, visions and goals, and, if available, development targets and other collaborative development initiatives by outlining the key spatial informants or directives. • Strengthen the inter-governmental alignment of development priorities and ensure that the plans and programmes are coordinated, consistent and in harmony with each other. • Act as a platform for stakeholder identification.	Identified policies that can be included or will impact on the compilation of a water-sensitive SDF and LUS. Furthermore, a gap analysis on where policies may differ, and a plan on how to ensure alignment.

Phase	Water-sensitive objectives	Water-sensitive outcome
2.2.1. Biophysical analysis	The objective of a water-sensitive biophysical analysis is to limit the expansion of the built footprint onto areas of ecological importance, to protect and expand ecological infrastructure and restore ecological functionality, specifically in FEPAs. The aims of a water-sensitive biophysical analysis are to do the following: • Determine the climate, hydrological and geological characteristics of the municipality. • Determine areas of ecological significance. • Determine spatial areas with groundwater resources of a high value.	Spatially identified areas of ecological importance, as well as areas that require protection in order to ensure security and quality of water over time. This analysis should result in GIS layers than can be used to inform the later stages of the SDF and LUS.
2.2.2. Built environment analysis	Land use has both a water resource quality and quantity impact and should be planned for. Like the CBAs and ESAs, natural and near-natural landscapes provide ecosystem services that are vital to the local hydrological cycle as it regulates the flow, encourages infiltration and purifies water. The objective of the built environment analysis is to determine which areas within the municipality are still in a natural of near-natural condition and how much of the municipality's surface areas have been transformed to accommodate desired anthropogenic land uses.	A GIS dataset identifying, among others, areas in a natural or near-natural state, which provide ecosystem services, which should be protected in the SDF and LUS.
2.2.3. Socio-economic analysis	The socio-economic analysis strongly relates to the ability of the biophysical and built environment to provide services to the municipalities' residents and economic sectors. The socio-economic analysis makes use of statistical information to count the number of households, as well businesses, industries and institutions.	A base profile of the number of consumers (of water) in the municipality, together with attributes describing their characteristics, which can be used to express current water consumption, as well as predicted future water demand.
2.2.4. Water-sensitive modelling assessment	Water-sensitive modelling uses all information collected above in order to do the following: • Determine areas of environmental conflict. • Determine potential areas that can be used to expand protected areas. • Determine surface water protection and conservation zones. • Determine groundwater protection and conservation zones. • Delineate blue-green corridors. • Determine current and future water demand patterns and potential for rainwater harvesting.	• A detailed analysis and key datasets that must be used to inform the SDF (and form part of the final SDF). • Detailed GIS datasets that will provide the basis of an overlay zone that will be used in the LUS in order to protect sensitive areas and keep development away from areas under pressure (or limit it).
Phase 3(a): Issues and Vision		
3.1(a): Water-sensitive spatial vision	The key objective (with regard to water sensitivity) as far as the spatial vision of the SDF is concerned, is to ensure that water sensitivity is, in some way or form, entrenched in the spatial vision of the SDF. Most often, it is not. At best, some aspects related to "sustainability" can be found in vision statements.	A spatial vision statement that incorporates water sensitivity that will guide the development of the SDF.

Phase	Water-sensitive objectives	Water-sensitive outcome
Phase 4(a): Draft Spatial Development Framework		
4.1. Water-sensitive spatial proposals	The objectives of water-sensitive spatial proposals are to do the following: • Improve water quality: reduce sprawl and rapid land cover change, which, in turn, reduces the rate and volume of stormwater runoff. This reduces stormwater pollution and increased groundwater recharge. Water quality, as well as surrounding ecosystems, is likely to improve as more water is available to infiltrate in surrounding areas, instead of feeding built infrastructure. • Mitigate water scarcity by limiting the extent of development or directing it where development can take place. A compact settlement form can be achieved through spatial growth management tools.	Water-sensitive input into spatial proposals, which will form the municipality's adopted SDF.
Phase 5: Water-sensitive implementation		
Phase 5: Water-sensitive implementation and monitoring	The municipality's SDF must be reviewed at least every five years. It should also contain an implementation plan that includes projects and research (inclusive of budgets and responsibilities). A water-sensitive SDF should identify projects, research and responsible sectors to ensure that the SDF is implemented, and improved on every five-year cycle.	• A water-sensitive implementation plan that identifies water-sensitive projects and plans • Gaps or future research required to improve on the SDF in the next five-year cycle.
Phase 3(b): LUS: Land use scheme formulation		
3.1.1. Preparation of water-sensitive scheme clauses	From a water-sensitivity perspective, additional areas may require some form of protection than most land use schemes currently offer. These areas may not necessarily be declared "protected areas" and, as such, may in fact be included under the agricultural zoning with no regard to water sensitivity. Water- sensitive scheme clauses aims to do the following: • Establish overlay zones that identify areas that require immediate intervention in order to protect them from harmful development activities. • Establish overlay zones that identify areas of future concern where development should be prohibited or limited. • Establish water-sensitive development controls that promote rainwater harvesting and prevent stormwater runoff that could be used at the source to limit excessive water consumption (e.g. permeability).	Water-sensitive scheme clauses (including overlay zones and development controls) that can be legally enforced to ensure the protection of water resources and limit the water consumption footprint of future development.
3.1.2. Preparation of water-sensitive building controls	At the time of writing, no national standard for water efficiency in buildings could be found. The LUS could be used to bridge this gap until such a time as water efficiency is similarly dealt with. This would imply that a specific chapter (or clause) be added to the LUS specifically dealing with water efficiency in buildings.	• Water-sensitive building controls that can be legally enforced to limit the water consumption footprint of future development.

CHAPTER 7: CONCLUSION

South Africans only recently woke up to the fact that we all stay in a relatively dry country. All indicators point to the fact that we can expect temperatures to rise because of global warming. At the same time, the population and corresponding water demand grow every day. Linked with rapid urbanisation, we can expect populated areas and cities to increasingly experience pressure to ensure reliable and safe water for its citizens and consumers. Planning for water and spatial planning have existed side by side for many years. To date, these two disciplines (although water is a key requirement of all development) fail to inform each other on a municipal scale. This framework attempts to link planning for water and spatial planning in a way that can inform the legal and policy documents of municipalities that must be compiled, implemented and monitored. If successfully implemented, this framework could be the start to ensure water sustainability in future.

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