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ABBREVIATIONS AND ACRONYMS

CMA	Catchment Management Agency
CCT	City of Cape Town
CRR	Cumulative Risk Rating
DFFE	Department of Forestry, Fisheries and Environment
DEA&DP	Department of Environmental Affairs and Development Planning
DWA	Department of Water Affairs (see DWS)
DWS	Department of Water and Sanitation (previously DWAF and DWA)
E. coli	*Escherichia coli* Bacteria
EPWP	Expanded Public Works Programme
NEMA	National Environmental Management Act 107 of 1998
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act 36 of 1998
PES	Present Ecological State
RWQO	Resource Water Quality Objective
RQIS	Resource Quality Information Services
SANS	South African National Standard
SoEOR	State Of Environment Outlook Report
SWPP	Sustainable Water Protection Plan
SWSA	Strategic Water Source Area
TDS	Total Dissolved Solids
UGEP	Utilisable Groundwater Exploitation Potential
WC/WDM	Water Conservation/Water Demand Management
WHO	World Health Organisation
WCWSS	Western Cape Water Supply System
WMA	Water Management Area
WRA	Water Research Act 34 of 1971
WRC	Water Research Commission
WSA	Water Services Act 108 of 1997
WUA	Water User Association
WWF	World Wide Fund for Nature
WWTW	Wastewater Treatment Works

GLOSSARY

Afforestation	The establishment of forest by natural succession or by the planting of trees on land where they did not formerly grow, for example, establishment of monocultures of pines, eucalyptus, or wattles in primary grasslands in South Africa.
Agrochemical	A chemical used in agriculture, such as a pesticide or a fertilizer.
Aquaculture	The farming of aquatic animals or the cultivation of aquatic plants for food.
Biodiversity	The variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part. The term also includes diversity within species, between species, and of ecosystems.
Contaminants of Emerging Concern	Contaminants of Emerging Concern (CECs) refer to chemicals and toxins discovered in water bodies that may pose ecological or human health risks and are not presently regulated. Among the prevalent CECs found in wastewater are pharmaceuticals and personal care products.
Climate Change	A change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability overserved over comparable time periods.
Desalination	The process of removing dissolved salts from salt- or brackish (slightly salt) water, through the use of a wide spectrum of water treatment technologies, making it fit for consumption by humans or for use for agricultural and other purposes.
Ecological reserve	The water that is necessary to sustain integrity and functioning of aquatic ecosystems, including the associated riparian ecosystems (i.e. aquatic-terrestrial ecosystem ecotones). The ecological reserve specifies both the quantity (volumes and timing) and quality of water that must remain in a water resource. The ecological reserve is determined for all major water resources in the different water management areas to ensure that use does not result in unacceptable degradation.
Ecosystem	A dynamic system of plant, animal (including humans) and micro-organism communities and their non-living physical environment interacting as a functional unit. The basic structural unit of the biosphere, ecosystems are characterised by interdependent interaction between the component species and their physical surroundings. Each ecosystem occupies a space in which macro-scale conditions and interactions are relatively homogenous.
Ecosystem services	Ecological processes or functions which generate outputs from which people derive benefits, which therefore have monetary or non-monetary value to individuals or society at large. Without these benefits, humanity would not be able to survive. These services are frequently classified as (i) supporting services such as productivity or biodiversity maintenance, (ii) provisioning services such as food, fibre, or fish, (iii) regulating services such as climate regulation or carbon sequestration, and (iv) cultural services such as tourism or spiritual and aesthetic appreciation.
Endocrine disrupting compounds	Any substance or chemical that may change endocrine function in human beings or animals. The endocrine system is the collection of glands of an organism that secrete hormones, which regulate the functioning of other tissues, and thus human behaviour.

Eutrophication	A process of nutrient enrichment of aquatic ecosystems, mainly by nitrates and phosphates from agricultural pollution, domestic wastewater effluent and urban runoff, which can stimulate excessive plant growth or algal blooms. This growth in turn reduces dissolved oxygen in the water when dead plant or algal material decomposes and can cause other organisms to die.
Inland Water	All water in natural and manmade inland water bodies and the immediate riparian habitat interacting with those water bodies. It does not include estuaries or coastal waters but it is important to recognise that the interface between inland waters and coastal waters is dynamic (for example, during a flood the water flowing out of an estuary is dominated by inland water).
Present Ecological State (PES)	The status quo estimate of ecological resources. For a water resource, system driver (Geomorphology and Hydrology) and response (Biological) components are measured in terms of the eco classification with an index derived approach used to measures representative changes from a perceived natural reference state to its current state. Components used to measure the PES are Geomophological Index (GI), South African scoring system (SASS), index of habitat integrity (IHI), riparian vegetation index (RVI) and fish assemblage integrity Index (FAII).
Reverse Osmosis	A process by which a solvent, such as water, is purified of solutes by being forced through a semi-permeable membrane.
Riparian habitat	Relating to a river or stream or wetland, typically the area that is the interface between water courses and the land. It includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land area (NWA, Act 36 of 1998).
Strategic Water Source Area	Areas of land that (a) supply a disproportionate quantity of mean annual surface water runoff in relation to their size and are considered nationally important; or (b) have high groundwater recharge and where the groundwater forms a nationally important resource; or (c) areas that meet both criteria (a) and (b).
Western Cape Water Supply System	The Western Cape Water Supply Scheme (WCWSS) comprises several dams, mostly located in the upper regions of the Berg River and Breede River catchments. The system supplies raw water to the City of Cape Town, the West Coast District Municipality for domestic supply to the Swartland, Drakenstein, Saldanha Bay and Berg River local municipalities, the Stellenbosch local municipality to augment the supply to Stellenbosch, and to agricultural users downstream of the Berg River Dam, Voelvlei Dam and Theewaterskloof Dam.

1 INTRODUCTION

The Western Cape is a water scarce area with a growing population that both depends and places pressure on the province's inland water ecosystems. In the face of increasing water scarcity, water resilience is recognised as a provincial priority. Water is essential to all life, all economic activities and essential to achieving sustainable development. The state of the province's water resources is addressed in this "inland water" chapter in the Western Cape State of the Environment Outlook Report (SoEOR).

Inland water is defined as all water in natural and manmade inland water bodies and the immediate riparian habitat interacting with those water bodies. This chapter describes the state of inland water in the Western Cape, as an environmental and social resource and equally essential for the province's economic resilience, as well as the pressures and drivers of change to inland water and responses by all tiers of government to improve the state of inland water resources. Estuaries and coastal waters are addressed in the chapter dealing with Oceans and Coasts.

Importantly, this chapter also needs to reflect on water (and not excluding sanitation, but described to a lesser extent in this chapter and dealt with in more detail in the Human Settlements and Infrastructure chapter of the Western Cape State of Environment Outlook Report 2024) as a right to all South Africa citizens. This chapter will draw linkages to urban environments, societal requirements, and its influence on the water resources of the Western Cape.

The state of inland water described in this chapter is an overview, including only major trends, to provide a sense of the overall state of inland water. Consequently, the state of inland water is tracked in terms of only a few key indicators: water availability, the fitness of water for its intended use and freshwater ecosystem health. These are the same indicators used in the 2013 and 2018 iterations of the SoEOR so that, where possible, trends could be identified. The chapter also discusses major pressures, drivers and responses to the challenges in managing inland water and mechanisms that can enable sustainable water use in the province.

2 DRIVERS AND PRESSURES

This section discusses the pressures on inland water and the primary agents driving those pressures. The main drivers identified for inland water include climate change, human settlements (and associated population dynamics i.e. population growth, pollution of water resources stemming from urban populations, poverty, human behavior and the management of settlements and water use/discharge from settlements), water and land regulation, including compliance with legislation. The main pressures driven by these include over-abstraction, illegal abstraction, discharges to inland water that degrade quality and destroy ecosystems in and around inland water. These drivers and pressures are described in more details below, under the following broad headings: climate change, human settlements, stormwater run-off, agriculture and industry and invasive alien plants.

> There exist various contaminants of emerging concern (CECs) linked to pharmaceuticals and drugs of abuse (DOA) from Western Cape wastewater treatment works (WWTW) which affect surface water around urban settings. A recent case study by the University of Stellenbosch (2023) found a high degree of diffuse pollution from urban communities that present specific challenges to low- or middle-income country (LMICs) settings – full case study access here.

When describing drivers and pressures, the function of investments and financing are central to the discussion. The latest Water Market

Intelligence Report (GreenCape, 2023) showed that the key drivers of growth and long-term investment in both the water and wastewater (W&WW) sector in the Western Cape are three-fold: increasing resilience to recurrent droughts; ensuring water security for sustainable economic recovery and growth; and achieving universal access to wastewater. These three aspects will be discussed in more detail in this chapter.

2.1 Climate change

Climate change is one of the key drivers of environmental change in the province, with the Western Cape identified as particularly vulnerable to climate change as the region is highly dependent on water storage capacity due to the dominant winter rainfall patterns and its coastal location (DEA&DP, 2023).

The World Economic Forum's Global Risk Report for 2022 confirms that the two most severe risks on a global scale over the next ten years are **'Climate action failure'** and **'Extreme weather'**. The Western Cape has, in recent years, felt the impact of a severe drought on its economy and the indications are clear that this will not be the last time the province may face such challenges, as this is exacerbated by climate change. The WCG Growth for Jobs Strategy (2023) note that water scarcity is a restrictive situation that directly impacts food production, industrial production, the transport of goods and services and the ability of people to be productive.

This Western Cape State of the Environment Outlook Report – **Water chapter** – places specific focus on the water quality of the province. The impact of a decrease in the quality and fitness to use water can be catastrophic. J Laubscher confirms that, '*A decrease of only 1% in quality and fitness to use of water in South Africa may cost 200 000 jobs and nearly 6.5% of disposable income per capita and 5% (or R1.8 billion) in government spending* (J. Laubscher 2017) – WCG Growth for Jobs Strategy (2023).

Compared to global rainfall averages, the Western Cape is notably water-stressed, particularly due to its reliance on winter rainfall in the "Atlantic Zone" along the western region. This poses a distinctive challenge as storing winter rain for the subsequent summer growing season relies heavily on dams, crucial for water supply across the region. However, this is complicated by the potential of the province being in a prolonged drought cycle.

As highlighted in the Growth for Jobs Strategy (WCG, 2023), the Western Cape faces significant vulnerability to water shortages, given that approximately 52% of its GDP is attributed to agriculture and Agri-processing industries, including wine and fruit juice production. The inadequacy of water poses a severe threat to these industries even before considering its impact on other sectors. Economic modelling of a water crisis vividly illustrates its repercussions on the Western Cape's GDP and employment.

In the event of a water crisis with a few months of stringent usage restrictions, the Western Cape GDP could decrease by 2.3%, affecting around 49,000 jobs. This impact intensifies to 9.3% if the crisis extends beyond a year, coupled with stringent enforcement of restrictions, potentially impacting approximately 215,000 jobs.

The WCWSS Hydro-economic study (2022) that informs the Western Cape Water Supply System (WCWSS) concluded that the Western Cape economy is water constrained and that supplying water to provincial value chains is the key to economic progress. This surety of supply would have significant benefits in boosting both the capacity of the overall economy as well as in boosting economic confidence in the province, an important precursor to investment.

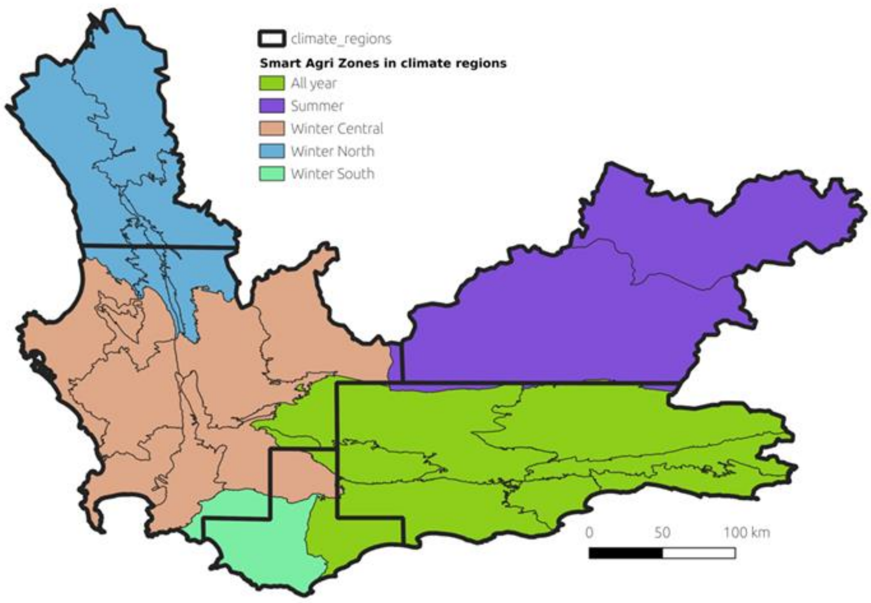


Figure 1 The four climatic regions of the Western Cape

Source: Western Cape Integrated Drought and Water Response Plan (DLG, 2022)

There are a number of specific **challenges** that impact the availability and supply of water in South Africa and the Western Cape (captured in the G4J Strategy 2023, with source information adapted from TIPS, 2022):

- Approximately 98% of South Africa's available surface water is already allocated to users with a high assurance of supply, leaving minimal room for crises and limited capacity for additional economic growth. The projection of continued water demand growth is expected to result in significant gaps in vital industrial areas, potentially reaching a shortfall of up to 17% by 2030 (WRG 2009). While water resources are available, their development, such as storage, deep aquifer groundwater wellfields, treated water reuse, and desalination of seawater or poor groundwater, comes at a substantially higher cost.

- The expansion of water services has occurred at the expense of maintaining existing infrastructure, compounding the challenge of ensuring a reliable water supply. Additionally, as water pollution increases, the need for more water to dilute pollutants rises, making the required treatment more expensive. Effective water management extends beyond physical infrastructure to encompass man-made and ecological aspects, emphasising the critical importance of ecological infrastructure, connectedness, and restoration.

- It is noteworthy that water catchments are under severe pressure, with 65% of South Africa's 792 wetland ecosystems classified as 'threatened,' and 48% deemed critically endangered. The average domestic water usage in South Africa is 233 litres per person/day, significantly higher than the global average of approximately 180 litres per person/day (AquaStat, 2023). This contributes to the perception that South Africans may not sufficiently value or recognise the imperative to conserve water.

2.2 Human settlements

Human settlements are the spaces where we live and include the materials and resources we either bring into these spaces or consume within these spaces. Resource demand and consumption tend to be focused on settlement spaces including water consumption and the discharging of waste water and pollutants contaminating water resources directly and indirectly. Humans use water resources for drinking, washing, cooking (collectively referred to as domestic use) and recreation. Generally, water consumption increases with socio-economic status. See further information on the socio-economic gradient of water availability under Section 3: Water Availability. Water also has spiritual and aesthetic value to many people, even within towns and cities.

In South Africa, access to and use of water often disproportionately affects women, particularly in rural and peri-urban areas where they are primarily responsible for household water collection and management. This gendered responsibility places a significant burden on women's time and physical health, as they must travel long distances to access water, sometimes multiple times a day. In the Western Cape, rural communities have recently faced challenges due to the prolonged 2015 – 2019 drought and unreliable water infrastructure, exacerbating the workload and health risks for women. Studies have shown that inadequate access to clean water also impacts women's ability to engage in income-generating activities and educational opportunities, perpetuating cycles of poverty and gender inequality (Statistics South Africa, 2021; UN Women, 2018). Efforts to improve water infrastructure and management must therefore consider gender dynamics to ensure equitable access and alleviate the burden on women in South Africa, particularly in regions like the Western Cape where water scarcity is a pressing issue (Department of Water and Sanitation, 2020).

In the Western Cape like the rest of South Africa, water services are offered in housing either through an application to the Municipality or via communal services. The South African Constitution (1996) and the Water Service Act (Government of South Africa 1998) established a minimum amount of water for basic needs that should be given for free regardless of people's ability to pay for it. Curtailing unlawful use and ensuring payment for water services is a difficult issue both for poor communities who may use more than the free basic water but also acts as a critical financial issue for Municipalities who may not be compensated for the services and resource actually delivered negatively impacting the financial sustainability of the operations.

The Western Cape Water Resilience Plan (2022) has recently modelled probable economic and population trajectories for each settlement. The primary focus of new economic growth is anticipated in municipalities neighbouring the City of Cape Town, namely Theewaterskloof, Stellenbosch, and Drakenstein. George, Witzenberg, and Bergrivier also expect relatively robust growth, albeit from a smaller base (WCG, 2022). Notably, the highest water demand growth rates were forecasted in Stellenbosch at 4.1% and Drakenstein at 3.9%. The Breede Valley District has been specifically identified as a priority for water infrastructure investment.

In conservative scenarios, the models considered limited economic and population growth, assuming a degree of user behaviour change to reduce demand by 2.7% and 2.3%, respectively. Another conservative scenario explored the impact of the top 10% of large business water users shifting to non-grid/alternative water supplies, resulting in additional reductions in demand predictions ranging from 0.1% to 0.4%.

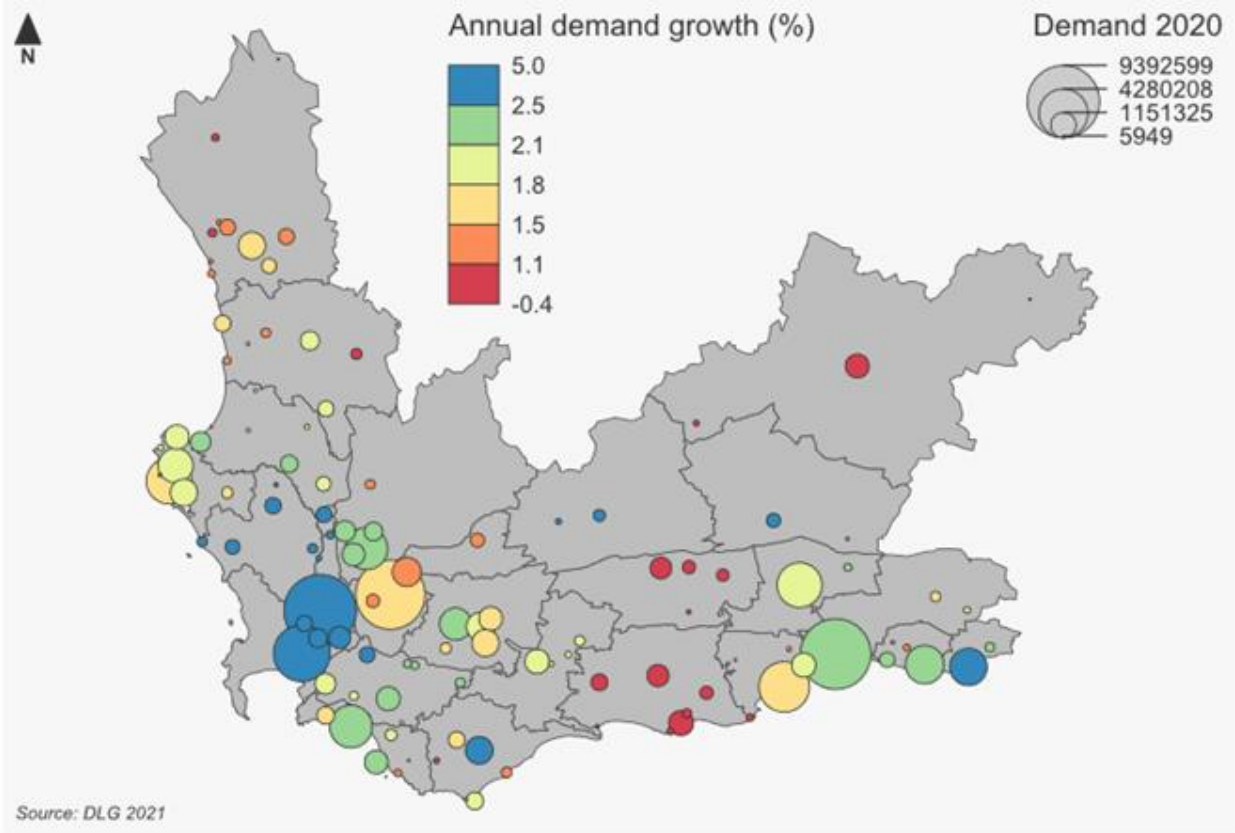


Figure 2 Modelled Water Demand Outlook (2020-2035) across the Western Cape

Source: DLG, 2022

Ensuring government capabilities to address water reconciliation and fiscal impacts becomes crucial, especially considering the anticipated shift in future demand and development being driven by the domestic sector rather than productive (non-domestic) sectors. The **Table 1** below illustrates the calibrated usage per household utilised in the modelling:

Table 1 Calibrated unit water consumption (kℓ/household/month)[1]

	Poor Households (kℓ/household/month)	**Non-Poor households (kℓ/household/month)**
Full service	10.5	23.1
Basic service	2.8	2.8
Inadequate service	2.0	2.0

Source: Western Cape Government (2023)

Within the Non-domestic water users, it is useful to consider how many kilolitres (kℓ) are used per R1000 GVA across different economic sectors. This information underscores the importance of aligning government capacities with the evolving dynamics of water demand, emphasising the need for effective strategies to manage both water resources and fiscal considerations, particularly in response to the increasing influence of the domestic sector on demand and development.

[1] Note: Household size can be very different between rich and poor which results in a much higher per capita consumption by the rich.

Table 2 Default non-residential unit water consumption

Sector	Water demand - million m^3 (Source: CSIR, 2001)		GVA R'000 - 2010 prices (Source: IHS Markit Regional explorer 1497 (2.6d))		Kl/R1000 (2010 ZAR)		
	1997	1998	1997	1998	1997	1998	Averag
Mining	484	453	236,684,336	236,447,651	2.04	1.92	1.98
Manufacturing	216	223	236,684,336	236,447,651	0.91	0.94	0.93
Electricity	237	237	261,443,253	260,920,367	0.91	0.91	0.91
Construction	42	42	58,988,350	55,272,084	0.71	0.76	0.74
Trade	168	176	43,497,573	40,933,666	3.86	4.30	4.08
Transport and communication	123	128	221,550,683	224,430,841	0.56	0.57	0.56
Business services	177	181	118,640,257	125,165,471	1.49	1.45	1.47
Other	194	197	272,469,194	278,741,588	0.71	0.71	0.71
Private services	45	45	411,402,571	414,999,157	0.11	0.11	0.11

*Agricultural municipal water demand assumed to be zero because most of this is non-potable, non-municipal supply. Source: WCG, 2023

Although immediate requirements include that of repairs and maintenance of infrastructure, opportunities are also emerging from the installation of decentralised wastewater treatment systems and particularly smart systems for water and wastewater infrastructure management. The advantage of smart systems as an important component in achieving water security is being demonstrated locally through the reduction of water losses, the improvement of efficiency and compliance, and the value-added asset management that they can offer (GreenCape, 2022).

2.2.1 Informal settlements

The pressures, problems and need are very different in formal and informal settlements. Informal settlements are most prevalent in municipalities with larger urban populations and high growth potential, such as the City of Cape Town and other big towns in the Western Cape. Informal settlements are a major non-point source of pollution for inland water, while at the same time informal settlements are often most at risk from that pollution, although agriculture and recreational users are also affected. Informal settlements, including those in formalised serviced areas, often have poor or limited access to infrastructure and services for solid waste and sanitation. This leads to pollution of the surrounding environment and/or watercourses, either directly or via polluted water entering stormwater drains.

Access to water touches the quantitative and qualitative assessment of the water directly as modern water ethics with the understanding that water is a resource that needs to be maintained (Ramirez et al., 2019). For the Western Cape context and its recent experience with a significant drought (2014-2018), it is also crucial not only to provide accurate, reliable and updated data on water bodies but also to assist with water saving and conservation methods, in addition to the development of alternative water sources. Pollution sources include but are not limited to: inappropriately managed solid waste, organic and inorganic chemicals, heavy metals, excessive nutrients and microorganisms including pathogens. Where proper sanitation facilities are absent, human excrement is often discarded into streams.

When discharged directly into storm water systems or watercourses, these pollution sources lead to polluted inland and coastal water. The pollution load in the storm water is often higher that the waste-water going to the wastewater treatment works for management of the sewerage.

Poor access to water services impinges on inhabitants' health and their opportunities to contribute to the economy. Most residents in informal settlements have access to clean drinking water: a bigger challenge is inadequate sanitation services and the inadequacies in management by local authorities who are responsible for waste management and storm water management and grey water management in respective areas of jurisdiction. This must also be considered at the balance of some locations of settlements bearing unable to be properly serviced.

Grey water is defined as water from baths, showers and hand basins. Wastewater from kitchen sinks, dishwashers and washing machines (except if environmentally friendly detergents are used) is excluded due to its high solids content and the negative impact of softeners and other undesirable chemicals on the environment. Greywater is different from reclaimed water, reclaimed water is wastewater (including black water) that has been treated by a centralised wastewater treatment plant for potable or non-potable re-use (National Norms and Standards for Domestic Water and Sanitation Services, 2017).

In absence of adequate sanitation facilities that are well-serviced and maintained, rivers and open spaces become alternatives for ablution facilities. The problem is aggravated by the lack of sanitation facilities' management – a responsibility of local authorities. Although local authorities are central in this matter, there are other layers of cause and responsibility that should not be overlooked – including the inability to pay for services due to high unemployment rate, the lack of adequate municipal budgets, vandalism, and insufficient space to install services in highly dense informal settlements.

2.2.2 Formal urban settlements

The majority of the population in the Western Cape is located in and around urban nodes. Urban nodes directly impact streams and other inland water ecosystems through the process of land transformation and pollution from urban nodes. Pressure is placed on inland water quality through stormwater, typically contaminated by chemicals and cleaning agents used in residential and commercial properties, as well as other substances disposed into stormwater systems in urban and semi-urban settlements.

> The CISR has estimated that commercial farmers in the Dwars River area of the Western Cape spend around R600,000 annually to combat filamentous algae in their irrigation systems (2016). To address this, the CSIR is developing a tradable permit system, aiming to prevent severe pollution in the river, which is also a crucial water source for Cape Town residents. Dr. Willem de Lange, a CSIR Resource Economist, calculated the cost of eutrophication at approximately R1887.92 per hectare per year, including a management budget for algae mitigation. This calculation facilitates the establishment of a reserve price for filamentous green algae pollution permits, estimated between R2.25 and R111.00 per gram. Tradable permits aim to curb pollution cost-effectively, creating incentives for polluters to reduce their impact and distributing pollution impacts more evenly.

Pollution from malfunctioning or overstretched wastewater treatment works (WWTW) and poorly maintained pipe networks also contributes to poor water quality in the form of microbial and chemical contamination by partially treated effluent (exceeding prescribed discharge standards) entering freshwater systems (WWF, 2016). Partially treated effluent and fertilizers add nutrients to river systems which can cause eutrophication, leading to excessive plant growth or toxic algal blooms should nutrient loads become excessive. This can affect the quality of water, necessitating enhanced treatment of drinking water while also affecting aquatic habitats. Polluted water ultimately reaches estuaries and the ocean, culminating in the rising costs of water treatment.

Development of formal urban settlements are invariably characterised by sealed surfaces (for example, roofs, roads and paving), increased runoff, reduced natural infiltration and groundwater recharge, increasing flooding and particularly flood peaks, with potential for significant damage to property, municipal infrastructure and loss of life.

In many areas, the demand for land for formal housing is urgent, particularly discussed in the Human Settlements chapter. Often, the available vacant land is near wetlands, and development can disrupt their function. Wetland infilling is a significant concern, notably in the City of Cape Town, where wetlands are filled or cut off by housing developments, or in informal areas where structures are built on rubble fill in wetlands or along river banks. Such development can harm water systems, including wetlands, which are crucial for ecological services. For instance, wetlands lost to infilling lose their ability to manage stormwater during floods, reduce water purification, and recharge groundwater.

Population growth and human behaviour drive the development and expansion of human settlements. Domestic water consumption in urban settlements places pressure on water resources. Domestic consumption and discharge can vary greatly from one household to the next, which can affect the extent and nature of pollution entering stormwater systems and inland water.

2.3 Gender disparities

Describing human settlements and water is not a full picture without specific reference to gender disparities in access and use of water. The Constitution of the South Africa enshrines access to clean water as a fundamental human right through its Bill of Rights. Section 27(1)(b) explicitly asserts that "everyone has the right to have access to sufficient food and water." Furthermore, the interconnection between gender and water plays a crucial role in advancing the 2030 Sustainable Development Goals (SDGs) – addressing gender disparities is directly related to eradicating hunger, poverty, and enhancing water security.

It is known that among households with high socio-economic status, the proportion of monthly income spent on water differs. Conversely, greater household water insecurity is linked to lower socio-economic status. Furthermore, an intersectionality approach is needed to fully understand and respond to the relationships between household head gender, self-reported socio-economic status, water affordability (proportion of monthly income spent on water), and water insecurity.

Women face an increased risk of sexual and physical violence when having to fetch water for the household. There may also be increased risk of domestic violence due to the inability to meet domestic responsibilities.and providing inadequate household water. Researchers underscore the **interconnected nature of water insecurity and gender-based violence. Introducing the term 'gender-based water violence' to characterise extreme water-related stressors affecting human health, especially women and girls,** advocates for cross-culturally measures for both gender-based violence and water insecurity.

Source: Tallman, P. S., Collins, S., Salmon-Mulanovich G., Rusvidi, B., Kothadia, A., & Cole, S. (2023). Water insecurity and gender-based violence: A global review of the evidence. Wiley Interdisciplinary Reviews: Water 10(1) e1619.

Key issues in addressing gender and social exclusion should focus on the following issues:

- Water, sanitation, and environmental factors have an impact on the well-being of vulnerable communities. Globally, vulnerable communities with limited access to water and sanitation have reported loss of dignity and low self-esteem, affecting their overall well-being. Due to resource and infrastructure limitations, informal settlement dwellers tend to have limited access to adequate water and sanitation services. Health hazards stem from poor water, waste, and sanitation services. In South Africa, informal settlement dwellers make up 8.1% of the 62 million population (StatsSA, 2023). In the case of rural areas of South Africa, young girls fetching water from isolated water sources face threats of abduction for child marriage and rape (Meyiwa, et al., 2014). In urban areas, particularly informal settlements, similar vulnerabilities are experienced. Gender-based violence studies also show that women and girls face partner and parent violence; a consequence of their inability to perform household responsibilities due to water access related dynamics (Tallman, et al., 2022) Addressing unequal access to water, sanitation and ecosystem services for vulnerable groups must therefore also address key concerns such as safety, particularly for women and children.
- Women's requirements for clean water for menstrual and sexual health as well as maternal health requirements whilst pregnant and breastfeeding, create complex health issues for girls and women not experienced by men.
- Whilst women and vulnerable communities are keen to participate in decision making in the sector, constraints to effective participation make this difficult e.g. lack of transport, lack of technical knowledge, language barriers. Intermediary organisations should be considered to facilitate the discussion and enable effective engagement. Women and vulnerable groups should be supported through leadership development and increasing their participation in

decision making and governance, specifically water management planning, implementation and monitoring. This will be achieved by reducing barriers to their participation, while simultaneously building the capacity and agency of women's organisations and other under-represented groups.

- Increasing the opportunities for employment of women in the green economy is required in traditionally male-dominated work environments, through enabling a conducive work environment. In particular, increasing the participation of women in ecological restoration programmes must explicitly address personal safety concerns, as remote environments can make women more vulnerable to attack.
- Effective participation of vulnerable communities in catchment management requires greater inter-governmental coordination so that citizens are not burdened with bureaucratic processes across multiple mandates.

2.4 Wetlands

The wetlands across the Western Cape are currently facing considerable pressure due to agricultural practices and also due to high volume abstraction of groundwater – for example the Sandveld region, which is impacting groundwater supplies and cumulatively, wetlands.

The conversion of wetland areas for agricultural use, including cultivation and drainage for irrigation, has led to the degradation and loss of these critical ecosystems. Wetlands play a crucial role in maintaining biodiversity, regulating water flow, and providing essential ecosystem services. The alteration of these areas for agricultural purposes not only compromises their ecological integrity but also poses a threat to the associated plant and animal species that depend on these habitats. Sustainable management practices and conservation efforts are essential to address these challenges and ensure the long-term health and resilience of wetlands. More information on Wetlands are provided in Section 3.

2.5 Agriculture and industry

2.5.1 Agriculture

The Western Cape has the largest area under irrigation in South Africa and its economy is strongly influenced by the state of the agricultural sector and the region continues to play a very important role in regional food production and production for the export market. The Western Cape agricultural sectors is particularly exposed to water insecurity as its operational dependence is on either rainfall or allocated water and the relatively low surety of supply compared to municipal supply granted to the agriculture sector under South Africa's water legislation. Western Cape farmers have, however, always had to cope with variable weather, fluctuating levels of political support and mixed fortunes in global market integration and most farmers in the province are proactive, adaptive and resilient as a matter of necessity (Vink and Tregurtha, 2004 as cited in WCG Growth for Jobs Strategy, 2023). These attributes have served the agricultural sector well in recent years. It follows that sufficient, good quality water is critical for agriculture in the Western Cape.

At the same time, agricultural activities also place substantial pressure on water supply and water quality, through water abstraction, return flows from irrigation, the use of agrochemicals and intensive animal husbandry. Contaminated surface water runoff and seepage which contains high levels of phosphates, nitrates and/or which is saline, contribute to pollution of freshwater resources and soils. In addition, agricultural activities often occur in riparian habitats, increasing erosion, damaging riparian habitats and increasing suspended solids (sediment) in water resources.

The total irrigation water requirements in the Western Cape are depicted in figures below:

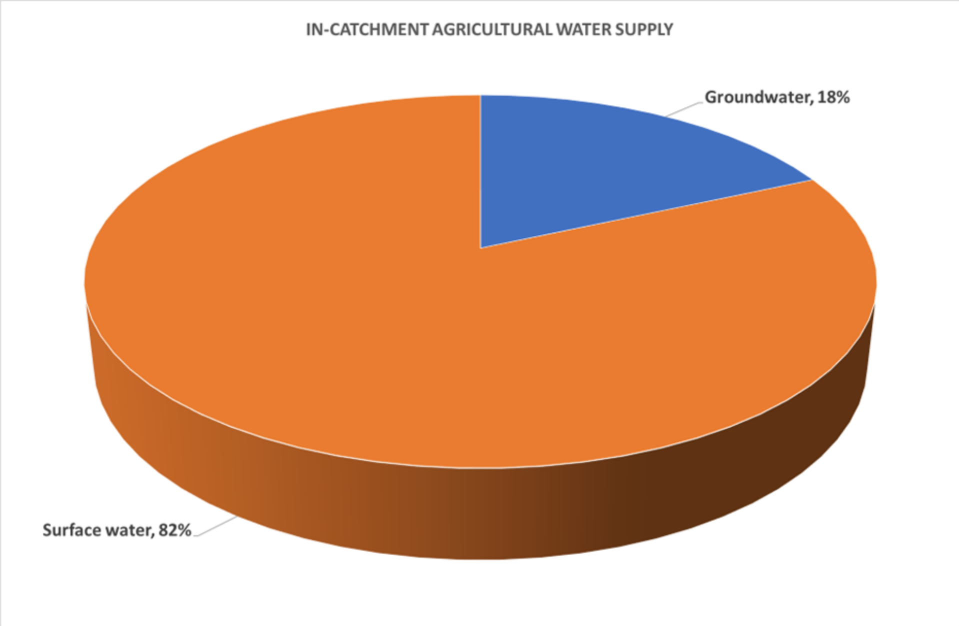


Figure 3 In-catchment Agricultural Water Supply

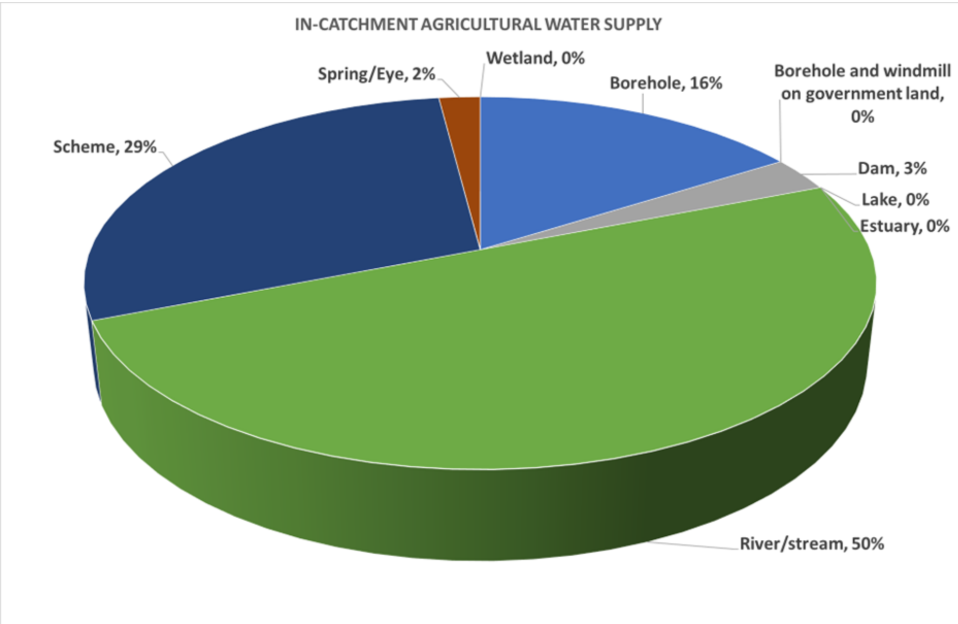


Figure 4 In-catchment Agricultural Water Supply

Source: DWS, 2023a

Note: above figures may include water supply volumes of IBs/WUAs supplied from the WCWSS.

The Water Use Authorisation & Registration Management System (WARMS) current [verified] irrigation water-use amounts to 2,122 million m^3 /annum and the Department of Agriculture updated crop census data indicates 1,722 million m^3 /annum (DWS, 2023a).

The primary factors influencing agricultural water utilisation are farming needs, market dynamics, and climate variations. The optimal potential for irrigated crops depends on favorable climatic conditions and the availability of water for irrigation. Despite boasting the largest irrigated area, the Western Cape exhibits the lowest water usage per unit area in South Africa, amounting to

5,874 m3/ha (WWF, 2018). Where surface water is scarce, groundwater is often used for irrigation. Climate change will drive agriculture not only to seek alternative water sources but also to adjust farming practices towards water efficiency, alternative crop cultivation or a shift in agricultural location (GreenCape, 2017b).

Based on the DWS Reconciliation Strategy, the current allocations within the WCWSS is:

- City of Cape Town – 347 million m^3/annum
- Other urban and industry within WCWSS – 43 million m^3/annum
- Agriculture – 186 million m^3/ annum

It is important to emphasise that the agricultural allocation is capped, and will not increase. Agricultural expansion is therefore reliant on water efficiency and conservation measures to increase the agricultural yield with the same water allocation from the WCWSS.

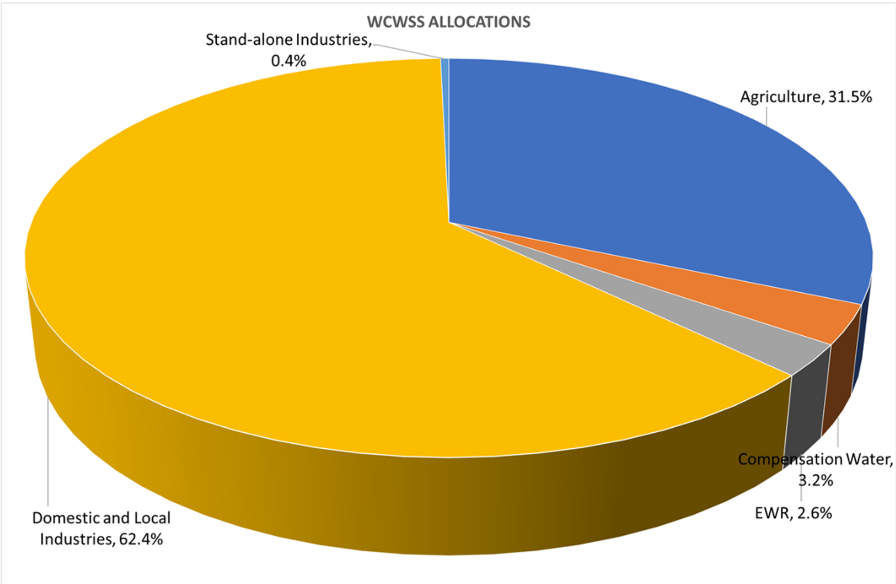


Figure 5 Water outlook from a WCWSS point of view

Source: DWS, 2023a

The above figure indicates the total water requirements within the latest WCWSS, including the City of Cape Town requirements. It is important to reference the total existing lawful use released and supplied from the WCWSS dams (i.e. Theewaterskloof, Voëlvlei, Wemmershoek, Bergrivier, Upper Steenbras, and Lower Steenbras) and which amounts to 599 m^3/a (and excluding compensation water).

Returning focus to the Agricultural sector, the latest information indicates the agricultural water allocation (capped) is 32% of the latest WCWSS:

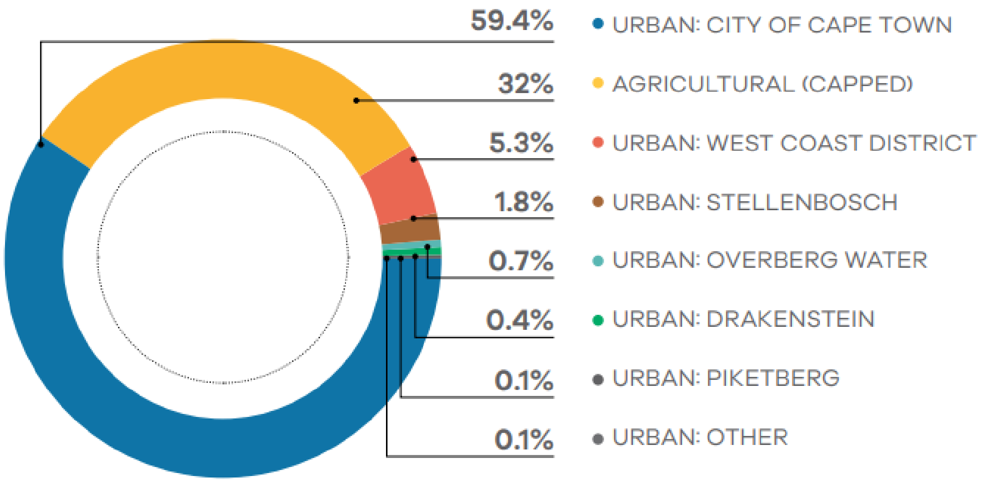


Figure 6 Water allocation

Source: DWS, 2023a

In practice, use is seldom directly measured and is often estimated, based on, for example, requests for water from dam releases/allocations. The DWS has completed the validation and verification project in the Berg Water Management area and is currently undertaking validation and verification in the other water management areas for provincial abstraction and storage. These figures therefore remain estimates and are not necessarily indicative of actual demand.

That said, literature, information and anecdotal evidence does not suggest large increases in agricultural water use in the Western Cape. There has been a drive in recent years to increase the efficiency of irrigation, to promote water conservation and manage demand in the agricultural sector, through for example the FruitLook initiative, which may assist in future comparisons of agricultural water use.

2.5.2 Future in-catchment agricultural irrigation water requirements

All agricultural water has been fully allocated in the Western Cape. The future outlook is that there are no "new" water to satisfy agricultural demand in the Western Cape would be approved in future by the DWS, unless additional water for agriculture becomes available through (DWS, 2023):

Table 3 Future Western Cape in-catchment agricultural irrigation water requirements

Future Western Cape in-catchment agricultural irrigation water requirements	Supplying increased volumes at a lower assurance of supply
	Addressing transmission losses within agricultural supply systems, i.e., losses in canals
	Using current allocated volumes more efficiently
	Unlocking additional infrastructure (i.e., increasing the capacity of existing sources with a specific focus on irrigation development), such as: o the raising of Clanwilliam Dam (5,600 ha) o increasing the capacity of Buffeljags Dam (2,000 ha) o Greater Brandvlei Dam (4,500 ha) o Kleinberg De Doorns (500 ha)

Further potential agreements may allocate additional water to the Agricultural sector, but is subjected to augmented supply and contract negotiation – which is a function of National Department of Water and Sanitation.

2.5.3 Forestry

Predictions are that water demand in South Africa will exceed supply by 10% by 2030, with the primary drivers being decreasing annual precipitation owing to climate change and increased municipal and agricultural demand (Donnenfeld *et al.,* 2018). The Western Cape incurred significant annual rainfall reductions of -6.8mm to -34.88 mm per decade between 1987 and 2017, thus showing a declining trend in rainfall and surface water flow in the region. The 2015 -2017 drought further exacerbated water security to an extent that mitigation meet freshwater demands was to exploit groundwater resources. This in turn, was in direct competition with woody alien plant species – including commercially important species located in the provinces' strategic water areas - as they are known to tap into groundwater when surface water diminishes (Chiloane *et al.,* 2023).

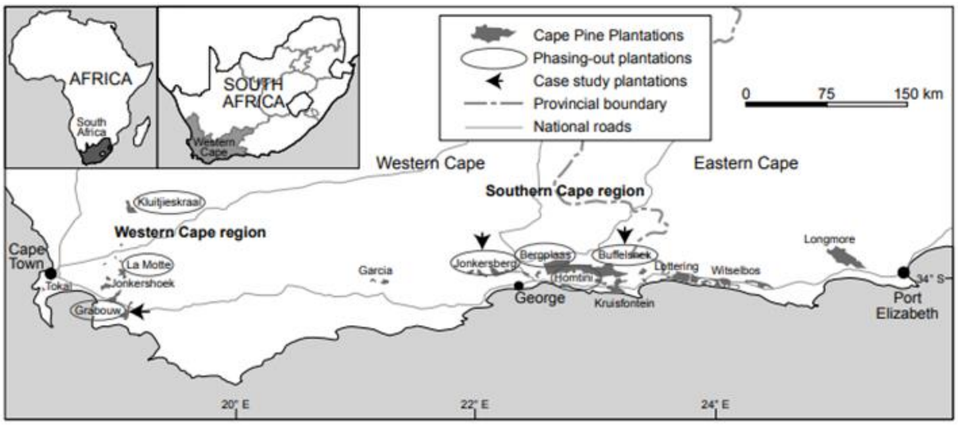


Figure 7 The original 45000 ha plantations decommissioned in 2001, from which 22 000ha are to be recommissioned in on five economically viable packages inclusive of the Boland Plantations, Jonkersberg, Bergplaas, Homtini and Buffelsnek

Source: De Beer et at., 2014

The total afforested state - and privately-owned commercial forestry plantations area in the Western Cape and Southern Cape amount to less than 31 500 ha of the Western Cape's land cover (De Beer *et al.,* 2014, DEFF 2018, FSA 2019). At reginal scale, the forestry sector (forestry products) contributes approximately 0.2% to the Western Cape's GDP. This underscores the matter that water is a key resource to economic growth and economic stability.

Despite the myriad of anthropogenic, and climate change induced pressures incurred in the Western Cape, the Department of Trade, Industry and Competition has developed a National Master Plan for the commercial forestry sector in South Africa. Implemented in September 2021, the Master Plan is intended to fast-track the development of agreed-on actions points and their successful implementation to the benefit of this sector. This includes the restoration of 22 000 ha of state-owned forestry plantations to their full potential through public-private partnerships by driving investments to boost the forestry economy within the Western Cape.

2.5.4 Invasive alien plants

Many invasive alien plant species use more water than indigenous species, reducing the volumes of water reaching freshwater systems (Le Maitre et al. 2016). It was estimated that invasive alien plants account for a reduction in the mean annual runoff (MAR) of between 1 444 million to 2 444 million m3/yr in 2016 (Le Maitre et al, 2016). Invasive alien plants, both terrestrial and aquatic, also impact on biodiversity by transforming vegetation assemblages and impairing ecosystem services. This impacts on the economy as management costs (to remove invasive plants) increase, and as the reduced availability and quality of water leads to agricultural losses (De Lange et al. 2012; Kotze, et al. 2010). Other impacts include loss of indigenous species, increased biomass and fire intensity, increased erosion, reduced river flows and detrimental effects on water quality (Chamier, 2012). Invasive alien plants are present predominantly due to historical planting for forestry, agriculture or horticulture (although some were introduced accidently) and continue to spread through natural seed dispersion.

2.5.5 Aquaculture

Aquaculture is the youngest farming sector in South Africa, having grown by 75%, producing up to 6,000 tonnes since 2013. The sector is reported to contribute to 5% to the Western Capes Gross Domestic Product (GPD), 4% to the country GDP and less than 1% to the country's GDP. The Western Cape Province sits with the largest share or aquaculture producers in the country with 56% of production facilities located in the province. With most facilities located in rural semi-rural areas, the sector contributes immensely through direct on-the farm jobs, thus enhancing and contributing to economic activity.

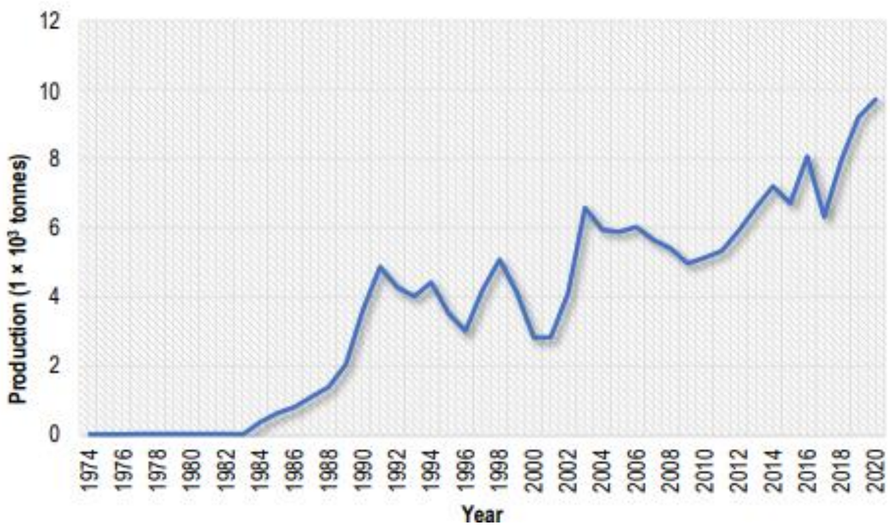


Figure 8 Aquaculture Production in South Africa

Source: Ngaraya *et al.*, 2023

Aside from environmental concerns resulting from feed production and water pollution, the sector carries potential for food security, improved livelihoods. As such, the Operation Phakisa: Oceans initiative economy initiative invested more than ZAR 1.2 billion private and public funds on aquaculture projects in 2017, with most of the projects falling in the SMME bracket (Brown-Webb et al., 2022). As the sector is still in its infancy, key drivers to business successes are underpinned by generated profits and becoming independent, following environmentally friendly farming practices, cultivating good business leadership and management to efficiently identify opportunities and challenges the current economic states. As the aquaculture sector develops in the Western Cape, it is important to ensure that it does not degrade water quality through nutrient buildup and pollution, Sustainable practices like improved management, careful site selection, technological innovation, and strict regulation are crucial for mitigating these negative effects and ensuring the long-term health of freshwater ecosystems.

2.5.6 Other industries

Other industries also place pressure on water availability, contribute to increased flooding due to increased runoff from hardened surfaces and discharge poor quality water into stormwater systems or directly into watercourses. Regulatory interventions can contribute to reducing pollution by placing limits on what industries can discharge to inland water. Local municipal bylaws, for example, require that effluent from industries is discharged (with prior permission) into the sewerage reticulation systems and then treated at WWTWs. Discharges directly into water resources are controlled by authorisation conditions imposed by national government. Poor management of industrial facilities can lead to spills which enter stormwater systems and ultimately discharge to inland water.

Illegal discharges into storm water systems

A critical concern for local authorities is that there are a lot of illegal discharges into the storm water systems and that the quality of the stormwater is not managed properly by local authorities. The WWTW of local authorities in the Western Cape are also not always able to treat some of the pollutants e.g. salts are difficult to treat at WWTWs and will end up in the environment if the WWTW does not have appropriate technology to deal with the parameter.

3 STATE

*Tracked **indicators** of status of **Inland Water**:*

- *Water availability*
- *Fitness for use*
- *Inland water ecosystem health*

Water is a finite resource, requiring sustainable use, in terms of the volumes of water used as well as maintaining the quality of water resources. Understanding the Western Cape's water resources, water availability, ecological systems and resulting development potential are essential for long-term strategic policy guidance specifically towards not only using water resources in excess of the province's actual needs but to also provide the most benefit or cause the least damage to the environment as a whole. Reporting such as this chapter and others such as the State of Rivers report are essential information to identify trends and changes as well as emerging and persistent challenges such as water resource pollution.

This section describes the current state of inland water in the Western Cape in terms of water availability, fitness for use and ecosystem health. In terms of the Provincial Strategic Plan 2019 – 2024, water is a key enabler for Vision Inspired Priority (VIP) 2 for growth and jobs and remains a provincial risk. This is based on increased urbanisation, climate change, failing infrastructure and irresponsible consumer behaviour. Describing the state of inland water is therefore within the context of this provincial risk.

The discussion of the state of inland waters is presented for each of the Water Management Areas (WMAs). Since 2022 (Notice No. 2793, GG No. 47559), the former Berg-Olifants WMA and the Breede-Gouritz WMA fall under the Breede-Olifants CMA and cover most of the Western Cape and the major rivers in each shown in Table 5.

Catchment Management Areas (CMAs) are intended to progressively decentralise management of water resources to give effect to the integrated water resource management ethos in the National Water Act 36 of 1998 (NWA). All four WMAs now fall under Breede-Olifants Catchment management agency (BOCMA).

3.1.1 Strategic Water Source Areas

Surface water Strategic Water Source Areas (SWSA) are priority areas that contribute significant surface water run-off in relation to their size. The total area of surface water SWSAs in South Africa, Lesotho and Swaziland represent approximately 8% of South Africa's surface area yet they produce a mean annual runoff representing approximately 50% of the region's total mean annual runoff (Nel *et al*., 2013). Likewise, groundwater SWSAs provide strategic groundwater resources, many of which are also associated with the surface water SWSAs. Following a national prioritisation process, 22 surface water and 37 groundwater SWSAs were identified as the most important for both people and the environment. This included the establishment of eight focal surface water[2] and eight focal groundwater[3] SWSAs in the Western Cape (Le Maitre *et al*., 2018).

SWSAs accounts for 1 813 516 ha of the Western Cape (14%) and includes the Boland, Groot Winterhoek, Kouga, Langeberg, Outeniqua, Swartberg, Table Mountain and Tsitsikamma.

Table 4 Percentage landcover composition of the Western Cape surface water SWSAs as at 2020

reflects the landcover composition of these eight surface water SWSAs (StatsSA, 2023).

Table 4 Percentage landcover composition of the Western Cape surface water SWSAs as at 2020

SWSA	Natural / semi-natural	Commercial field crops	Orchids and vines	Timber plantations	Urban	Mines
Table Mountain	50.4%	2.7%	1.1%	2.5%	39.8%	0.4%
Boland	69.5%	8.6%	10.9%	2.6%	5.1%	0.1%
Groot Winterhoek	87.1%	6.9%	3.9%	0.2%	0.3%	0%
Langeberg	77.5%	16.6%	0.5%	3.3%	0.5%	0%
Swartberg	98.5%	1.3%	0%	0%	0%	0%
Outeniqua	74.3%	6.9%	0.2%	14.6%	3.0%	0%
Kouga	99.1%	0.1%	0%	0%	0%	0%
Tsitsikamma	74.7%	12.3%	0.4%	9.5%	2.4%	0%

Source: StatsSA, 2023

[2] Table Mountain; Boland; Groot Winterhoek; Langeberg Mountains; Swartberg; Outeniqua; Kougaberg and Tsitsikamma (the latter extends into the Eastern Cape)
[3] George and Outeniqua; Overberg Region; South Western Cape Ranges; Cape Peninsula and Cape Flats; Tulbagh-Aston Valley; North-western Cape Ranges; West Coast Aquifer ; Sandveld

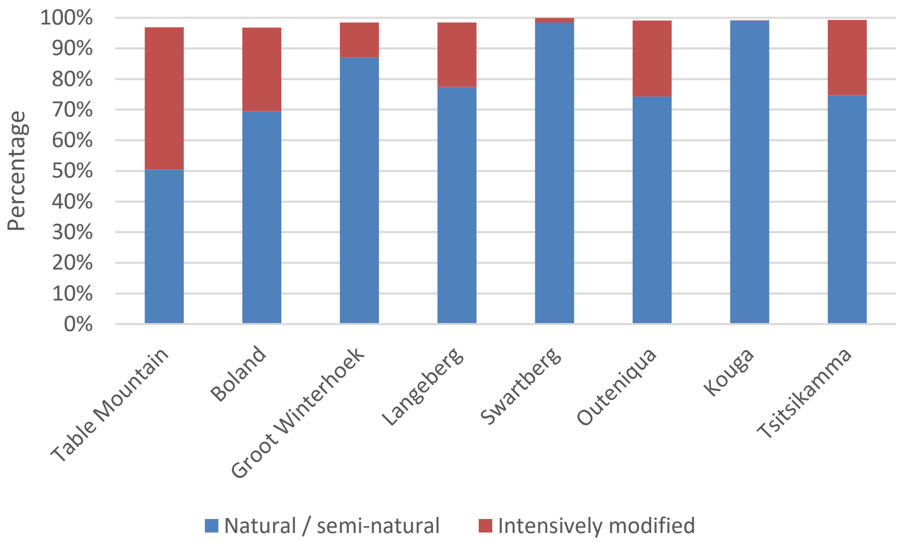


Figure 9 Proportion of Western Cape SWSAs that have been intensively modified as of 2020

Source: StatsSA, 2023

The proportion of SWSAs that have been intensively modified is reflected in Figure 9 Proportion of Western Cape SWSAs that have been intensively modified as of 2020

. These modifications are primarily made up of commercial field crops, subsistence crops, orchids and vines, timber plantations, urban expansion, and a small proportion of mining (StatsSA, 2023).

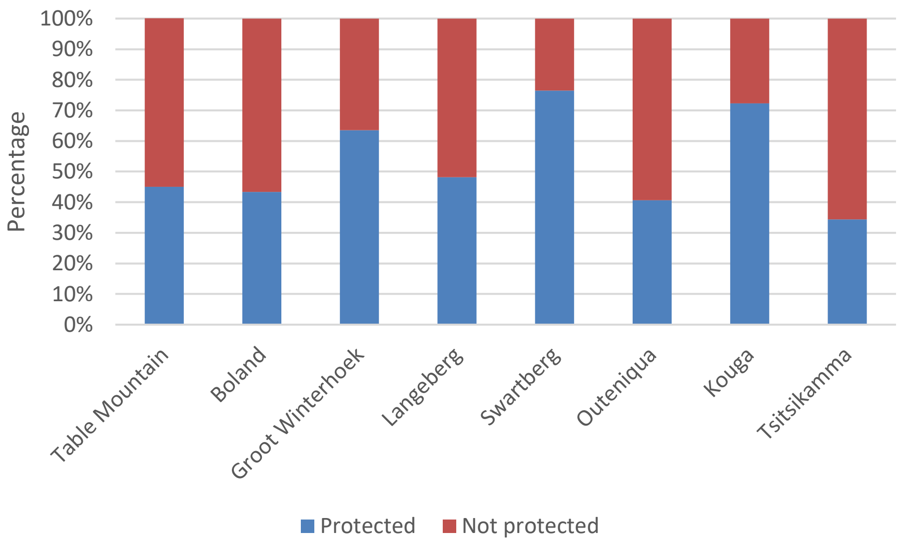


Figure 10 Western Cape SWSA protection levels as of 2020

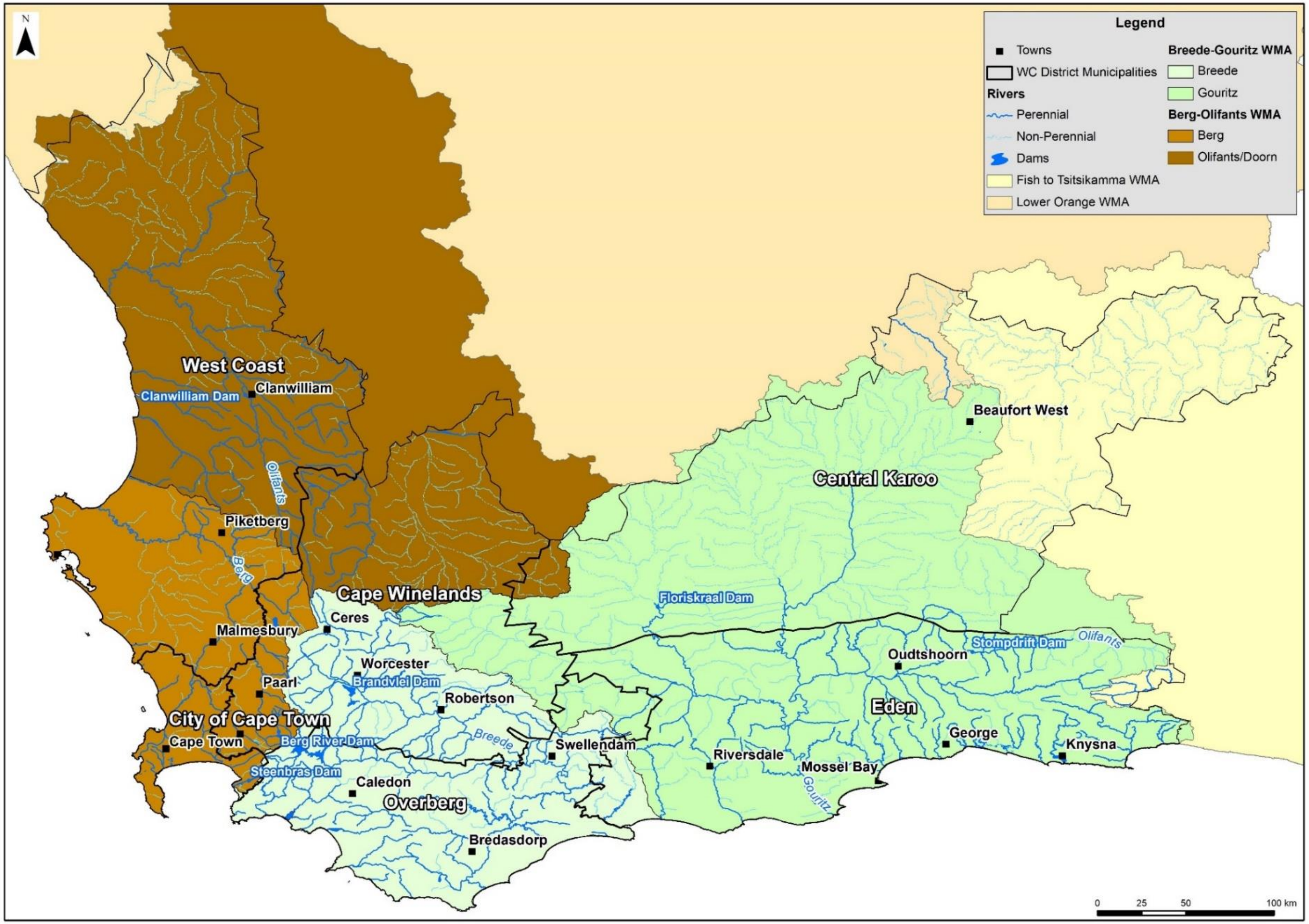
Source: StatsSA, 2023

The SWSA protection levels are reflected in **Error! Reference source not found.**. Despite the i mportance of the SWSAs, the majority of them are only partially protected.

3.1.2 Water management areas and major rivers of the Western Cape

The National Water Resource Strategy (NWRS) 3rd edition (DWS, 2022b) recommended the new WMAs (amalgamation of adjacent WMAs) largely to address skills shortages. The NWRS is the legal instrument and is recognised as the primary mechanism to manage water across all sectors of society towards achieving National Government's development objectives. The first and second editions of the National Water Resources Strategy were published in 2004 and 2013, respectively. The NWRS-3 was gazetted in 2022. The purpose of the NWRS-3 is to ensure water security and to enable equitable access to water and sanitation in support of socio-economic growth and development. This Strategy is for all sectors and stakeholders who use and impact upon South Africa's water resources. It responds to NWA by outlining strategic objectives and strategic actions within various key chapter topics that are aligned and then carried forward for resourcing and implementation under the scope of the National Water and Sanitation Master Plan (NW&SMP).

Figure 11 Western Cape Province: Water Management Areas



As per the above map (Figure 11), the WMAs are not determined by provincial boundaries, but are instead linked to the catchments that feed the major rivers. Hence, catchment management agencies had to be established as the WMAs managed from the Western Cape extend (marginally) beyond the Western Cape borders. For the same reasons other WMAs "overlap" with the Western Cape provincial boundary: the Lower Orange WMA incorporates the north-western portion of the West Coast District and the Fish to Tsitsikamma WMA incorporates the south-eastern portion of the Eden District and the eastern portion of the Central Karoo District.

Table 5 The Western Cape Province: Water Management Areas

Water Management Areas	Previous WMA	Major rivers
Breede-Olifants	Breede - Gouritz	Breede, Sonderend, Sout, Bot, Palmiet and Steenbras Gouritz, Olifants, Kamanassie, Gamka, Buffels, Touws, Goukou and Duiwenhoks
	Berg - Olifants	Berg, Dwars, Eerste, Diep, Leeu, Vier en twintig, Klein Berg and Steenbras along with a number of other rivers occurring within the City of Cape Town e.g. Lourens River, Sir Lowry`s pass River, Sand River Olifants, Doring, Krom, Sand and Sout

3.1.3 Municipal requirements

The following data shows the current municipal requirements (in million m^3/a) across the Western Cape province (DWS, 2023a):

Table 6 Current Municipal Requirements

REQUIREMENTS (A)	AVAILABILITY (A)	AVAILABILITY (B)
Cape Winelands DM	51	80
Central Karoo DM	4	7
Garden Route DM	41	69
Overberg DM	17	37
West Coast DM	23	41
SUB-TOTAL	**136**	**234**
(B – A)	**98**	

Total in-catchment domestic and industrial water requirements in the Western Cape Province amounts to 234 million m³/a. This is categorised as follows (DWS, 2023a):

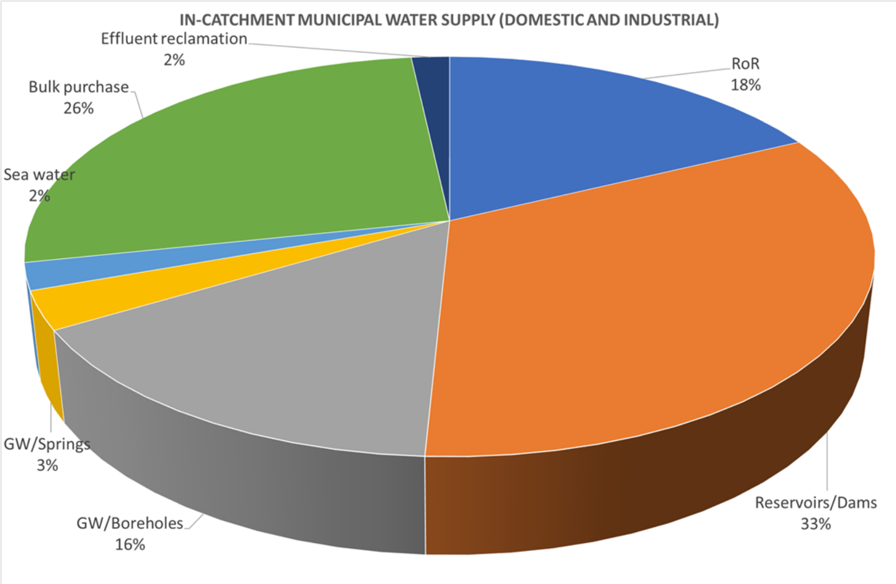


Figure 12 In-catchment municipal water supply (Domestic & Industrial)

3.2 Water availability

Water availability for the Western Cape is not limited to the WCWSS. The total supply from the WCWSS (576 Mm3/a) represents only a small portion of the water used within the entire Western Cape (3,037 Mm3/a) (World Bank, 2022). Importantly, the DWS is not compelled to allocate the entire allocatable water quantity and quality in a specific water resource. Instead, it is essential to apply the Resource Water Quality Objectives (RWQOs) approach in tandem with the mitigation hierarchy for decision-making. This precaution is crucial to avoid the deterioration of water resources to a state where they ultimately become only marginally suitable for use (DWS, 2021).

More broadly, water availability is defined (for the purposes of this report) as the quantity of water that is available and can be sustained for direct human use or to support aquatic ecosystems. Water availability is typically calculated as the balance between the amount of water that can be sustainably supplied with infrastructure currently in place (called water supply in this report) and the amount of water required (called water demand in this report). Understanding long term water balances (as discussed below) will assist in the understanding of water availability.

The WCWSS system plays a crucial role in optimising water resources in the Boland region. It allows for the transfer of water between different dams in different catchments. For instance, if one dam faces a decline in water levels, it can be replenished by transferring water from another dam. Furthermore, excess water from river systems can be stored in dams during periods of abundance (e.g. additional flows available in winter) and later transferred back to the rivers when water levels are low.

For the purpose of long-term planning, the DWS typically employs the 1:50-year Recurrence Interval (RI) yield with a reliability standard of 98% as a benchmark for scenario comparisons. Recognising the increasing risk of climate change, the City of Cape Town has determined that this reliability standard is no longer sufficient. Henceforth, the City will base its water supply planning on a higher reliability standard of 99.5% with a corresponding Recurrence Interval (RI) of 99.5%.

Figure 13 Rainfall and Run-off in the Western Cape

Source: DWS 2023a

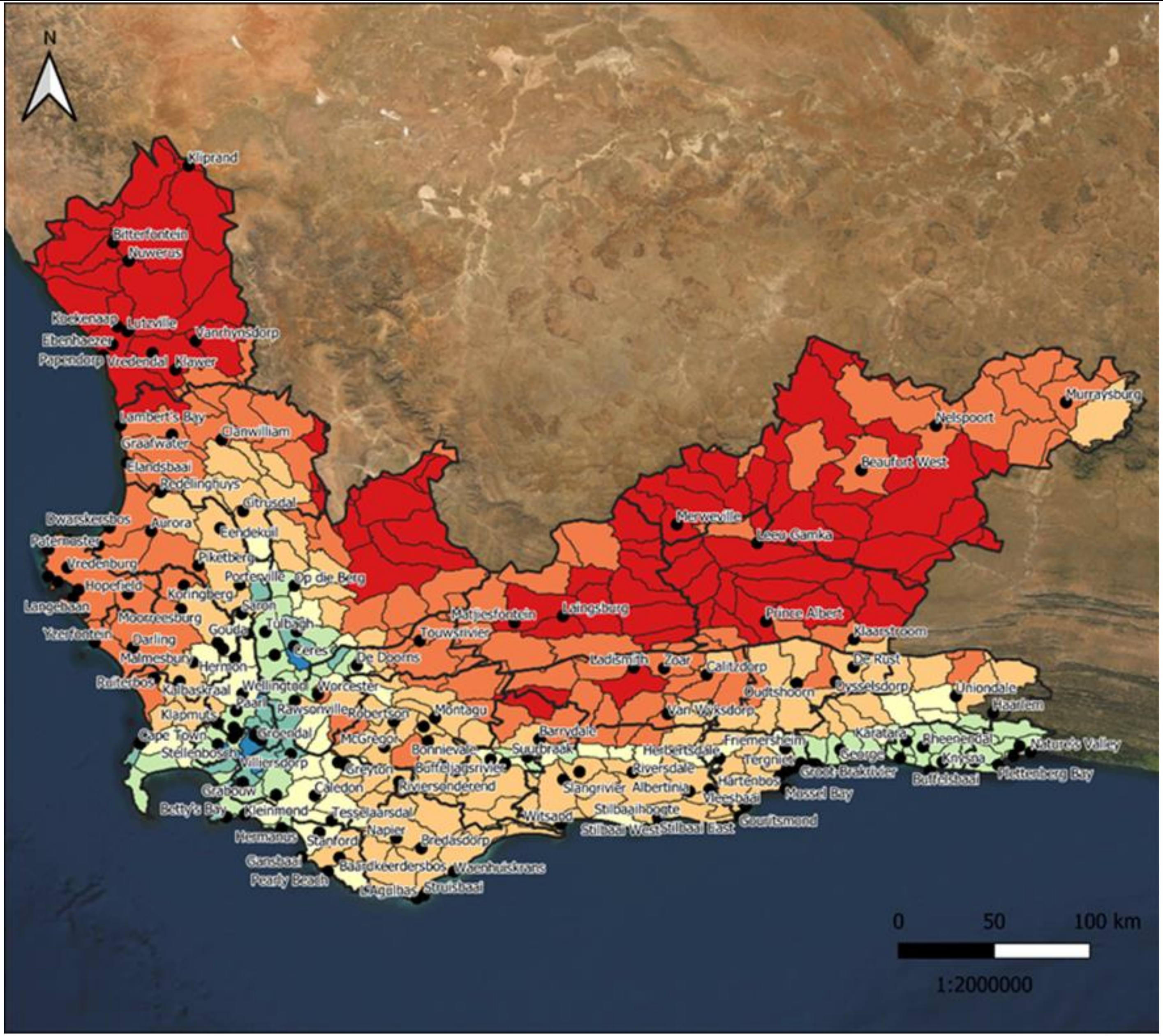
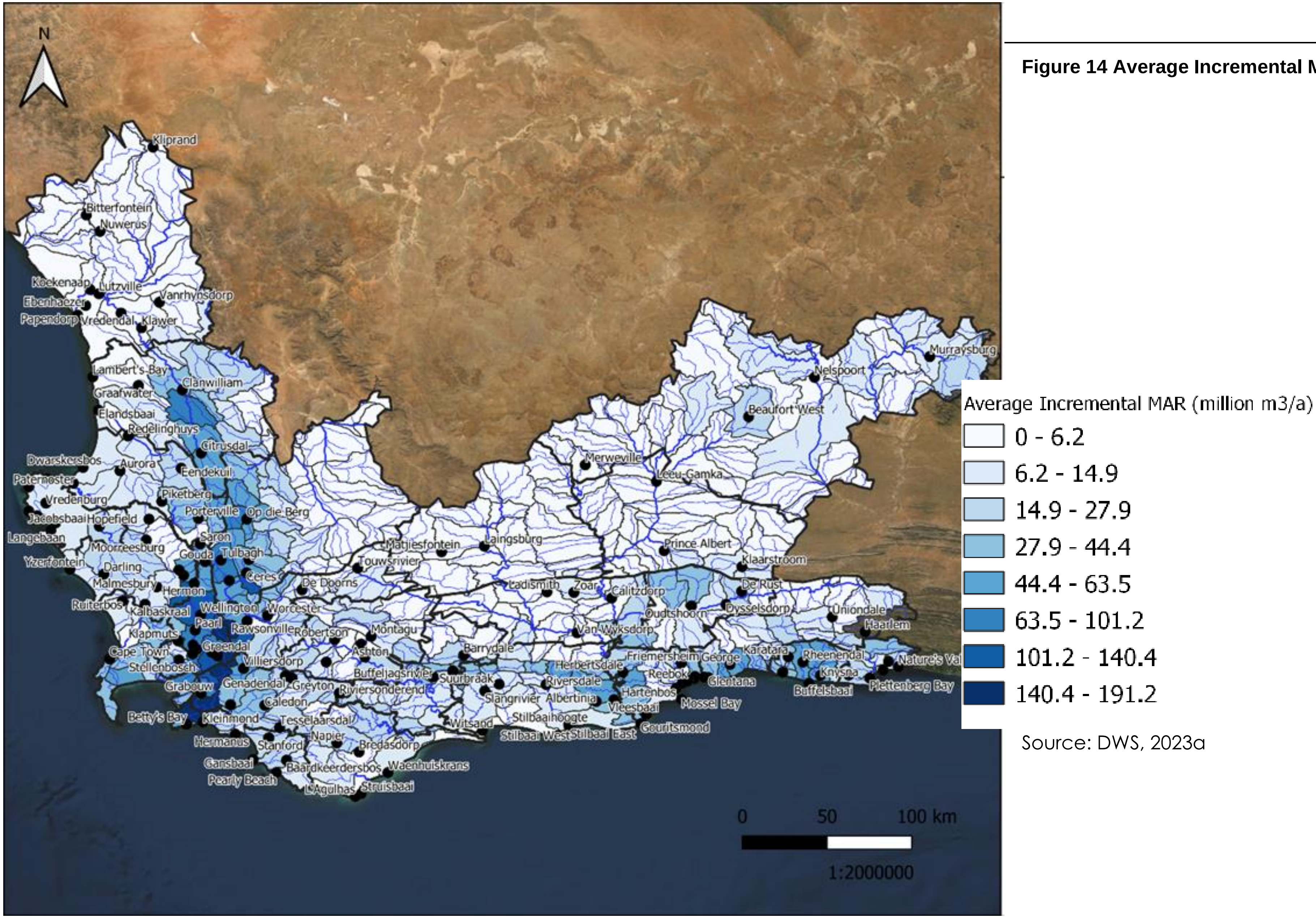


Figure 14 Average Incremental MAR



Source: DWS, 2023a

Supporting Figure 13 and 14, it must be kept in mind that Western Cape rainfall is a product of many atmospheric processes. On average, 'cut-off lows' (COLs) contribute 11% of the annual rainfall over the Western Cape and generally more COLs leads to greater annual rainfall.

The combined storage capacity of large dams in the Western Cape amounts to 1866 million m^3 (DWS, 2023a). Small dams and run-of-river abstractions continue to contribute to the province's water availability and the supply available to municipalities are recorded as below in **Table 7**:

Table 7 Western Cape Water Availability & Supply

Western Cape Region	Water Availability
City of Cape Town	66 million m^3
West Coast	133 million m^3
Cape Winelands	873 million m^3
Overberg	534 million m^3
Garden Route	157 million m^3
Central Karoo	103 million m^3

Source: DWS, 2023a

As previously stated, the potential of the Western Cape to further develop its surface water resources is limited and effort must be placed to develop alternative sources. Recent work captured in the WCWSS and Reconciliation Study 2021/2022, record how the hydrology of the WCWSS was extended to the 2016/2017 hydrological year, and the additional hydrological records were incorporated into the modelling of the system. An overview is available of the updated 1:50, 1:100 and 1:200 stochastic long-term yields of the latest WCWSS in response to the extended hydrology as well as the updates of the Water Resources Yield Model (WRYM). The following has been captured in Table 8:

Table 8 Long-term yield of the WCWSS under various recurrence intervals

Description	**System Yield (million m^3/a)**		
	1:50 Year RI	1:100 Year RI	1:200 Year RI
Legacy stochastic yield with Water Availability Assessment Study (WAAS) naturalised streamflow (1928/29 – 2004/05) ***Assuming no IAPs**	589	562	540
Stochastic yield of updated extended hydrology (1928/29 – 2016/17) based on the updated model ***Assuming no IAPs**	575	547	523
Stochastic yield of updated extended hydrology (1928/29 – 2016/17) based on the updated model ***Existing spread of IAPs**	545	520	500

Source: DWS, 2023a

On-going "Day Zero" for many residents
Due to inequality levels, a considerable portion of Cape Town's poorer residents access water through communal taps, maintaining an ongoing concern referred to as "Day Zero" for many individuals. Formal households, accounting for 66% of the city's water consumption, sharply contrast with informal settlements, where 14% of Cape Town's households reside, utilizing only 4% of the water supply (Ziervogel, 2019). In informal settlements, individual units consume an average of 40 liters per day and may house up to 15 residents (Savelli et al., 2021). There exists a substantial difference in water consumption between high-income and low-income residents in Cape Town. Wealthier neighborhoods consume between 774 and 8,560 liters per person per day, while lower-middle-class areas average between 90 and 350 liters per person per day. In comparison, informal settlements have an average consumption of approximately 10 liters per person per day (Savelli et al., 2021). Despite improvements in water access over the years, usage patterns continue to reflect socio-economic and racial disparities.

3.3 Groundwater development potential

Municipalities of the Western Cape operate groundwater schemes to augment supplies in addition to the WCWSS supply. These are recorded in the Municipal Groundwater Supply Scheme (DWS, 2023a).

The future of water use is anticipated to witness a substantial increase in groundwater use. However, for this escalation to be sustainable, it is imperative to address various challenges associated with groundwater resource management concurrently with the development efforts. These challenges stem from insights drawn from comprehensive groundwater resources management and planning studies conducted in the region over the past approximately 15 years. Notable examples include the Berg WAAS and the Berg, Breede and Gouritz Water Resources Classification Study, along with pertinent research studies that contribute to shaping the understanding of groundwater dynamics in the region. Addressing these management challenges in parallel with development initiatives is essential for ensuring the long-term sustainability of increased groundwater utilisation.

The City of Cape Town (CCT) initiated its "New Water Programme" (NWP) in 2018 to diversify its water supply to improve long-term water security and resilience against future droughts, by implementing alternative bulk water supply options to augment its potable water supply by between 100 and 500 Ml/day by 2030 (CCT 2019). The NWP was established specifically to meet the increasing water demands of an increasing population.

The estimated Utilisable Groundwater Exploitation Potential (UGEP) in the Western Cape is 1049.3 million cubic meters per annum (Mm3/a), dropping to 659 Mm^3/a in a drought year, as shown in Table 3-4. UGEP is intended to regulate the volume of groundwater that may be abstracted, based on a defined 'maximum' allowable water level drawdown – these aspects are under DWS review.

Note that the difference between UGEP in a normal year and UGEP in a drought year does not imply that groundwater reserves decline rapidly in a drought year, but rather that much less water should be abstracted to prevent impacts in subsequent years and long-term reductions in groundwater levels. In practice, over-abstraction may not be evident in the first year of a drought but continued abstraction above the drought year UGEP will put aquifers at risk. Groundwater is not evenly distributed throughout the province, with high UGEP in the Cape Mountain regions and the coastal aquifers but much lower UGEP in the Little and Great Karoo.

Table 9 Utilisable Groundwater Exploitation Potential (UGEP) for each WMA

WMA	Previous WMA	UGEP normal rainfall (Mm^3/a)	UGEP drought year (Mm^3/a)	Groundwater use (Mm^3/a)
Berg-Olifants	Berg	249	168	57
	Olifants	157.5	88	45
Breede-Gouritz	Breede	362.9	238	109
	Gouritz	279.9	165	64
Total		**1049.3**	**659**	**275**

Source: DWS, 2010; DEA&DP, 2013; DEA&DP, 2015

Table 9 demonstrates that on average, groundwater use is much lower than the estimated potential. However, some key aquifers for example, the Sandveld are already over-exploited and others are at their limits (David Le Maître, pers. comm, September 2017). In isolated cases, groundwater abstraction, including over-abstraction for irrigation in the Sandveld has impacted negatively on aquifer yields and water quality (DEA&DP, 2017c) highlighting the importance of managing groundwater abstraction.

The surge in private groundwater utilization from the Cape Flats Aquifer (CFA) during the 2015-2019 drought raised concerns regarding the potential cumulative impact of decentralized use and the associated competition for supply from groundwater resources designated for bulk supply. The aquifer witnessed substantial increases in private usage, encompassing industries, public health facilities, and households employing groundwater for garden watering. This occurred alongside the existing use of the CFA to support agriculture in Philippi during the 2015-2019 drought.

Assessing the cumulative impact of all current and planned groundwater use is contingent upon the availability of data on both existing and future planned groundwater utilisation. Accurate estimation of this impact requires comprehensive information on the extent and intentions of groundwater usage, aiding in the formulation of informed management strategies for the sustainable use of the Cape Flats Aquifer.

The latest WCWSS (DWS, 2023a) emphasised the following:

Groundwater reserve is under scrutiny; recent studies are advocating for the recognition of a broader ecological reserve. This reserve is defined by specific criteria, including a designated volume and quality of water required at a particular time. The water fulfilling this reserve can be sourced from surface water runoff or the contribution of groundwater to baseflow, potentially influencing groundwater availability. However, it is emphasised that the reserved volume of water should not be allocated, in double terms, from both resources (Riemann, 2013 as cited in DWS, 2017b).

Historically, reserve studies have often equated the groundwater portion of the reserve with the total groundwater contribution to baseflow (as seen in DWA, 2013), assuming that reserving all of this is necessary to uphold ecological flows. However, this approach may be an overestimation or overly cautious, as discussed in DWS, 2017b. The ongoing DWS study on the comprehensive groundwater reserve for the Berg River is expected to address these complexities and provide insights into the appropriate management of ecological reserves.

Recent research by Umvoto Africa (2023) alerted to the matter of 'geoethical issues'. It has put forward that the planning and rapid implementation of municipal bulk water supply groundwater schemes under such extreme circumstances as the 2014-2018 Western Cape drought, compounded by local anthropogenic/geogenic complexities within each aquifer system and the hydrological uncertainties associated with contemporary climate change (in a region considered highly susceptible to future recurrence of extreme drought conditions), poses several geoethical issues.

3.3.1 Cumulative impact

The lack of consideration for the cumulative impact of groundwater abstraction stems from the absence of a centralised, accessible, and up-to-date database of groundwater users, as highlighted by the Water Research Commission (2019). Key challenges summarised in the WCWSS (DWS, 2023a) are captured in Table 10:

Table 10 Key Challenges: Western Cape Groundwater Abstraction

Key Challenges: Western Cape Groundwater Abstraction (WCWSS, 2023)
Inaccuracies in the WARMS database hinder accurate knowledge of registered legal use and actual groundwater utilisation. This is rectified with the validation and verification process currently taking place
City of Cape Town by-laws mandate borehole and wellpoint registration, but information on uptake, unregistered users, and yields is insufficient. Even low-use activities like garden watering must be cumulatively considered.
The absence of borehole registration requirements and driller regulations contributes to incomplete borehole drilling information.
Primary groundwater data is held in the private sector, with consultant-collected data often not consistently entered into a central database. Regional studies rely on outdated National Groundwater Archive (NGA) data, which is not actively updated since 2004 and not commonly used.
Over-abstraction is often raised as a concern. In some areas, over-abstraction and or climate variability are lowering groundwater levels. These cases require further investigation to guide management interventions. Groundwater levels appear to be stable in the Western Cape (DWS, 2015b); however the threat of unregulated over-abstraction should not be underestimated.
Challenge identified: It was also identified that the quality of groundwater in the Western Cape is unmonitored. The fact that there is less mining activities across the province doesn't take away the risk/challenge of underground water quality. In response, the Green Climate Fund project (Aquifer Recharge) will be looking into when developing a Funding Proposal that could explore this challenge and potential solutions.

Several local municipalities within the Western Cape (e.g. Beaufort West) has increasingly utilised groundwater to augment water supply, particularly since the 2014-2018 drought. According to DWS, there remains potential to further develop groundwater sources, especially on a local scale although various hydrogeologists warn of caution and the need for strategic management.

It is important to understand the possible impacts of irrigation water demands on the availability of water to the domestic, business, and industrial sectors within the Western Cape, both for the current and the future state. Irrigated agriculture in the Western Cape (predominantly fruit and wine) accounts for 55% – 60% of South Africa's export earnings from agriculture. For this sector access to water is also a function of water allocation regimes that are broadly unfavourable for farmers due the agricultural sector enjoying a lower level of assurance of supply compared to than urban and industrial users. **The Future of Farming in Dryland Areas of the Western Cape (2021),** a recent study by the Department of Agriculture earmarked the potential for agricultural service towns to develop their own "circular" and off-grid water, electricity and solid waste services with farmers at the forefront of the process (Oelofse et al., 2021). Farmers interviewed for the study expressed both dismay and frustration at their inability to secure basic services, and the disruptive impact that this has on operations and connectivity to markets (Oelofse et al., 2021).

3.3.2 Western Cape drought event: 2015-2019

In 2015–2019, the water availability of the Western Cape was severely impacted by a drought that extended over multiple calendar years. This placed the water users of the Western Cape under severe strain – and reference is here made to the five recognised water users as per the NWA. During the time of this drought, the annual rainfall over the province decreased by > 50% of the normal levels (consecutively over the three years) (CSAG, 2020). In 2017, the levels of the dams, which provide water for all activities in the province, dropped to 32% (with the last 10% of dam water being unusable). This led to the most severe drought since 1904 (Otto et al., 2018) and the worst water shortage in the province in the last 113 years (Botai et al., 2017).

Due to persistent drought, the Western Cape was declared a disaster area on 22 May 2017. The severity of the impact of any drought does not just depend on rainfall but also the general preparedness for and response to the drought. In the Western Cape, water supplies are planned for a 1: 50 year assurance of supply, i.e. water supplies should be sufficient during a 1: 50 year drought, therefore planning in the Western Cape does account for a certain degree of drought. Demand in the largest supply scheme, the WCWSS, increased consistently (Muller, 2017) and the predicted demand, even with some demand management in place, is shown to likely exceed supply under certain climate change projections. A series of augmentation projects are proposed to provide for this anticipated demand (see Section 5).

Nevertheless, the impact of the drought on the society of the Western Cape was severely felt and severe water restrictions were imposed, limiting each resident to 50 litres per day. Understanding the economic impact of the 2015-2019 drought is important, as it serves the purpose of allowing for preparedness for similar future events. The 2015-2019 drought resulted in between 28,000 and 35,000 agricultural jobs losses (Pienaar and Boonzaaier, 2018), in addition to other direct economic impacts from water-reliant businesses (such as nurseries, car washes, and construction companies) and the hospitality industry of the Western Cape. The industries impacted by the drought are brought into focus when reviewing the financial value of water sales by sector:

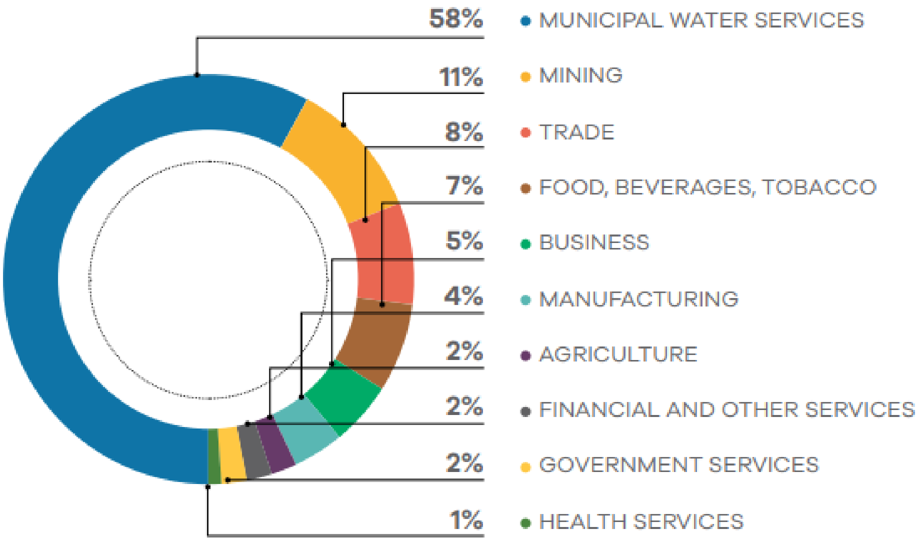


Figure 15 Financial value of water sales by sector

Source: GreenCape 2022; DWS 2023a

Consequent direct and indirect economic losses are estimated to amount to billions of Rands (DEA&DP, 2016a). Crop losses in the West Coast District Municipality, for example, were as high as 50% to 100% (DoA, 2016).

The World Bank has also modelled the drought impact on various economic sectors of the Western Cape, and the following is their outcome:

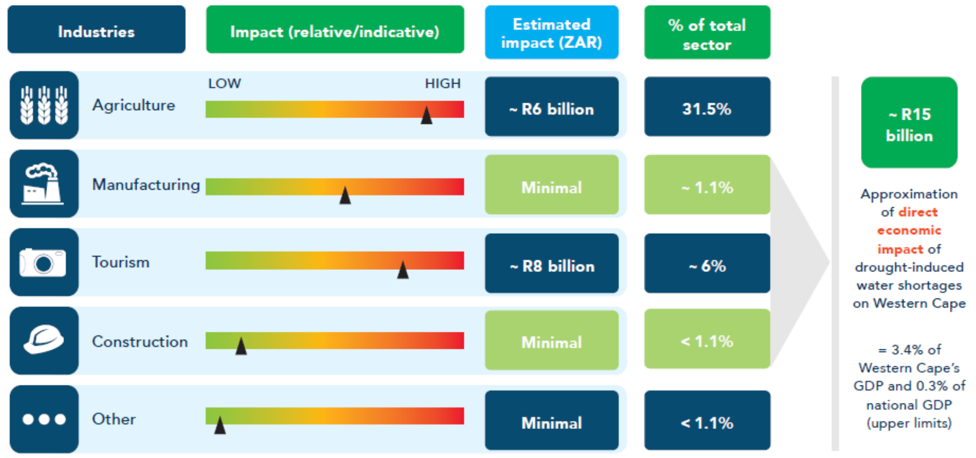


Figure 16 Drought impact on various economic sectors of the Western Cape

Source: World Bank, 2022

Understanding the cause and management of the drought is of paramount importance, especially as severe weather events are likely to increase under climate change projections for the Western Cape. Multiple reviews and studies have been conducted to describe the cause of the 2015-2019 Western Cape drought. The following section draw on some of the findings:

Causes of the 2015-2019 Western Cape drought

- Low rainfall over a number of years-. The low rainfall was attributed to El Nino events and systematic climate change. El Nino events arise from a southward shift of the mid-latitude jet and storm tracks that controls the Western Cape rainfall. The southward shift was due to an expansion of the subtropical anticyclones to the mid-latitudes and a southward shift in atmospheric rivers, leading to a decrease in important moisture transport (Sousa et al., 2018)
- El Nino weakened the remote moisture sources and atmospheric rivers and led to the southward shift in moisture transport and storm tracks, leading to a persistent decrease in moisture transport over the ocean to the west of the Western Cape throughout the drought period (Sousa et al., 2018).
- The COL rainfall contribution differs over the three drought years (2015–2018). In 2015 and 2016, the COL annual rainfall was above average, meaning that the COL rainfall helped to alleviate the severity of the drought in those two years. But in 2017, the COL annual rainfall was below normal, as the COLs mainly occurred further south of the country (CSAG, 2020).-
- Climate change projections indicate increasing severity and frequency of extreme events[4] such as droughts.

The Western Cape heavily relies on winter rainfall and surface water storage, as outlined in Section

[4] An extreme weather event is an event that is rare at a particular place and time of year. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g. drought or heavy rainfall over a season) (IPCC, 2014)

2 and Section 3, making it particularly susceptible to droughts. To enhance resilience in the face of drought challenges, the consideration of a greater diversity of supply options and decentralisation has been proposed (DEA&DP, 2017a).

An illustrative example is the construction of a water reclamation plant in Beaufort West in response to the 2010 drought, which proved instrumental in providing essential relief during the 2015-2019 drought (DEA&DP, 2017a). The significance of a comprehensive analysis of the drought, encompassing its causes, responses, and proactive planning, becomes evident, especially given the potential exacerbation of drought frequency and severity due to climate change.

*The **ecological reserve** is the quantity and quality of water required to protect aquatic ecosystems in order to secure ecologically sustainable development and water use.*

The review of the 2015-2019 Western Cape drought underscores a critical message: the severity of the drought event necessitated an update for the water supply system resulting in a fundamental shift in the overall yield for the Western Cape. Consequently, municipalities have been compelled to explore alternative options to meet future water requirements. The specifics of these future water requirements are elaborated upon in this report, with a focus on the City of Cape Town's New Water Programme, including references to the latest planning and implementation status.

3.3.3 Long term water balances

The climate projections for the Western Cape indicate a warming trend and drying in many areas, with longer periods between increasingly intense rainfall events (DEADP 2018). Within the context of the Western Cape described more broadly in this Western Cape State of Environment Outlook Report 2024, population and economic growth will continue to place demands and likely, increased demands, on water supply and sanitation systems. Careful management from across sectors is required to avoid the situation of decreased water security and quality, which will have a negative impact on the province and consequently the province's economy. The Western Cape local authorities must therefore prioritise alternative and augmented water supply; for cases when surface water supply is disrupted.

According to the Department of Water and Sanitation (DWS), after catering for the ecological reserve, half of South Africa's WMAs are in water deficit (DWA, 2004; DWA, 2010; DEA&DP, 2013). This means that water requirements in that WMA exceed water supply (for a 1:50-year assurance level). The most recent complete dataset for the WMAs shows that the Western Cape mirrors the national pattern. Water use in both the Berg-Olifants and the Breede-Gouritz WMAs exceeds supply as indicated in Table 11. It follows that the drainage areas are stressed and vulnerable to any major perturbations in rainfall.

Table 11 Water resource supply and consumption

WMA	Previous WMA	million m³ per annum (Mm³/a)		
		Water Supply	Water Use	Balance
Berg-Olifants	Berg	709	745	-36
	Olifants/Doorn	372	406	-34
Breede-Gouritz	Breede	1007	998	19
	Gouritz	419	770	-345
Provincial Total				-115

Source: BGCMA Reconciliation Study, 2016 – latest update available

An update for some of the information presented in Table 11, based on the study on Water Resources of South Africa undertaken by the Water Research Commission in 2012 (DWS, 2015c), is presented in Table 12. However, no updated information was available for the Olifants WMA nor for water supply. The data presented in the tables is the best available, but inconsistent (for example, water demand for the Berg includes groundwater demand, which is excluded for the Breede and Gouritz). At face value the updated figures indicate reduced water demand; however, given the inconsistencies in data, this conclusion should be treated with circumspection.

Table 12 Updated water demand for selected WMAs

Previous WMA	Water Use (Mm^3/a)
Berg	690
Breede	850
Gouritz	770

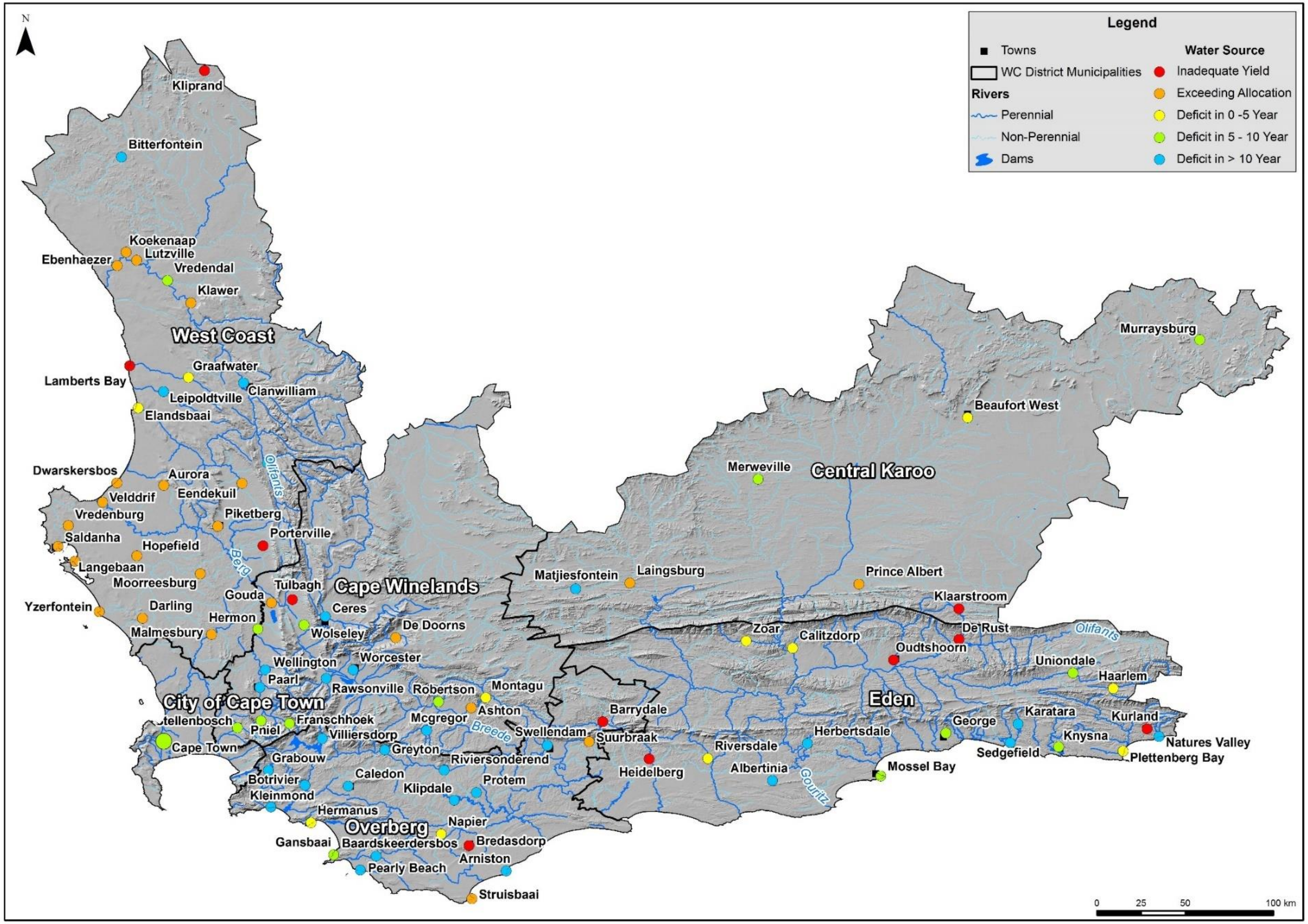
Source: DWS, 2017b; DWS, 2017c; DWA, 2011

More recently, a DWS assessment of water availability in each town was undertaken, based largely on 2014 and 2015 data (DWS, 2015a). Water availability in this assessment is expressed as the number of years until additional water supply is required, based on the projected demand and the 2014/2015 available supply, excluding any water supply expansion plans (DWS, 2015a). Figure 3-5 also indicates (in red) which towns have exceeded water source yields, and are thus experiencing a chronic water shortage (DWS, 2015a). Towns depicted in orange exceed water allocations, but not necessarily water resource yields (DWS, 2015a). A number of towns exceeding yields, allocations or likely to go into deficit in the next five years suggests that water availability is a major issue and will worsen without intervention.

Recent information for the greater Cape Town area contained in the WCWSS Reconciliation Strategy (2021/2022) considered low and high growth demand scenarios and proposed water supply interventions to meet demand. This study shows that supply will exceed demand in the next few years for a 1: 50 year assurance of supply, however the 2015-2019 drought in the Western Cape has already led to revision of the timeframes for implementation of some of the proposed interventions.

Three main alternative bulk water supply options for the CCT and WCWSS, include desalination, water reuse, and the abstraction of groundwater from three major aquifer systems that the city has access to – Atlantis Aquifer, Cape Flats Aquifer and the Table Mountain Group Aquifer.

Figure 17 Water bodies for towns in the Western Cape



3.3.4 Water supply and consumption

To understand water supply it is useful to understand available sources and consumption. Note that maintaining the ecological reserve is not considered a consumptive use, but essential to ensure the healthy functioning of the aquatic systems that we depend on to regulate water flow and quality, and to sustain biodiversity. Key sources of water in the Western Cape include:

- Surface water, which is by far the main source;
- Groundwater;
- Useable return flows (for example, from waste water treatment works);
- Net transfers in (i.e. pumping of water from one WMA or Water Management Area to another);
- Water re-released through removal of commercial forests (deforestation); and
- Eradication of invasive alien vegetation (which is known to consume more water than indigenous vegetation).

On a smaller scale but not to be excluded:

- Rainwater harvesting is increasing across the Western Cape

Key uses (consumers) of water in the province include:

- Irrigation (main use);
- Urban and industrial use (main use);
- Invasive alien species;
- Afforestation; and
- Transfer to other WMAs

3.3.5 Invasive alien vegetation

Invasive alien vegetation is thought to cover approximately 1.8 million (condensed[5]) hectares nationally, with the highest concentrations found in the south-western, southern and eastern coastal belts and the adjacent interior (Le Maitre et al. 2016). The Breede-Gouritz WMA is the worst affected area in the Western Cape. Priority areas include the upper reaches of the Riviersonderend and Upper Breede in the Breede Drainage Area and the Goukou and Duiwenhoks catchments in the Gouritz Drainage Area (Le Maitre et al. 2016). The clearing of invasive alien plants/vegetation has been shown to be one of the most cost-effective measures for adapting to increasing water security threats and climate change in the WCWSS.

Recent modelling of the reduction in mean annual runoff due to evapotranspiration by invasive alien vegetation (Le Maitre et al., 2016) shows that these reductions can be significant and in some locations exceed 30% (Figure 18) – the assumed corollary is that removal of this invasive vegetation could increase water availability by as much as 30% in localised areas. Note that the percentages shown in Figure 17 are the reduction in naturalised runoff and do not take current use into account, so the impacts on current flows are probably greater.

[5] Invasive alien species cover a total of approximately 18.15 million ha nationally, condensed to approximately 10% of that i.e. the equivalent area at 100% cover (Le Maitre et.al, 2016).

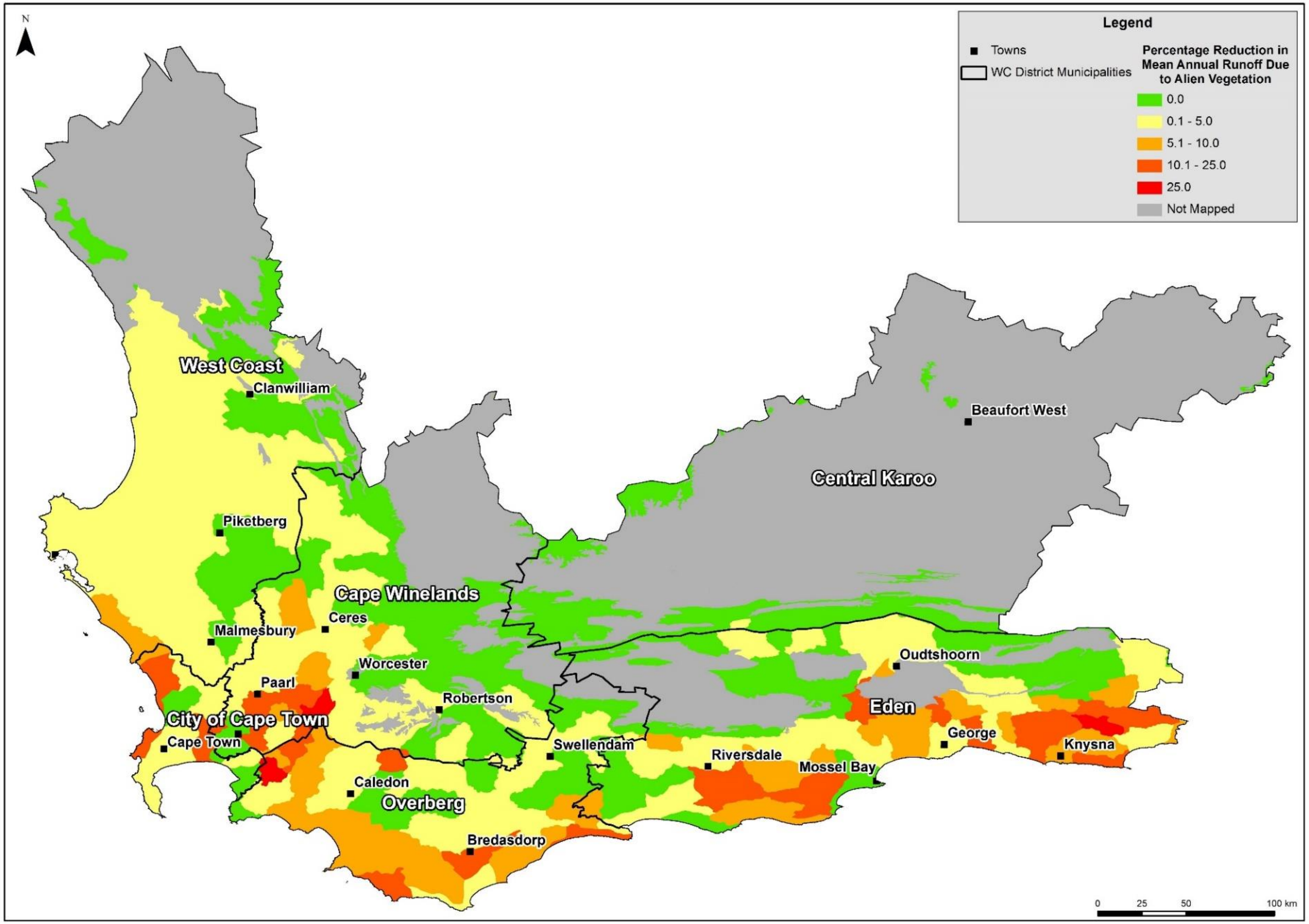


Figure 18 Percentage reduction in mean annual runoff due to alien vegetation

3.3.6 Other water sources

A number of other water sources are utilised on a small scale in the Western Cape. Re-use, water reclamation, artificial recharge and desalination are two examples and remain critical as current and future interventions.

Desalination

Desalination is the process of removing salt from seawater (or other saline waters) to produce freshwater. Desalination is an expensive and energy intensive process and may require relatively large tracts of land within the coastal zone. Environmental externalities/costs such as carbon emissions from electricity generated to power desalination plants, and impacts of brine disposal are associated with the desalination process (DEA&DP, 2017a). However, the technology is continuously improving and desalination is being considered by more municipalities, including the City of Cape Town.

The temporary desalination plants at Strandfontein and Monwabisi were constructed as emergency water supplies during the drought crisis of the 2017/18 hydrological year. A combined total of 5.11 million m3/a (or 14 Mℓ/d) was supplied by these plants for a period of two years as part of the CCCT's Water Resilience Plan. Both plants were decommissioned in accordance with the contractual arrangements that the CoCT had with the contractors (DWS, 2023a).

Based on the knowledge gained and experience in planning and operating the temporary desalinations plants, the CCT's is planning to develop larger permanent desalination plants ranging between 50 Mℓ/d to 150 Mℓ/d capacity. The major benefits will be to reduce the severity of water restrictions to be imposed during drought events. Water quality investigations and a feasibility study of a large desalination plant scheme were undertaken (2020) and a full environmental impact assessment will have to be undertaken prior to the implementation of a large-scale desalination scheme (DWS, 2023a).

In the short to medium term the CCT's development of Phase 1 of a proposed seawater desalination plant will improve the resilience of the CoCT's water supply. The first commercially viable desalination plant is planned to be commissioned by 2030 to supply 8.25 million m3/a (DWS, 2023a).

A recent desalination cost-benefit analysis and review for the CCT concluded the following (WCSS Status Report, 2023a):

- Desalination does not in all cases represent a good financial rate of return. Given the bulk water price, the costs of desalination would only be partially recovered. However, desalination would generate resiliency benefits beyond the provision of bulk water for consumption – its greatest benefit is therefore related to resilience.
- A 60 Mℓ/d sized plant generates a good economic case across all scenarios – balancing cost effectiveness against the risk of over-sizing.

> The CCT initiated its "New Water Programme " (NWP) in earnest in early 2018 to diversify its water supply to improve long-term water security and resilience against future droughts, by implementing alternative bulk water supply options to augment its potable water supply by between 100 and 500 Ml/day by 2030 (CCT 2019). The NWP also aims to meet the demand by an ever-growing urban population under a changing climate (higher temperatures/evaporation, reduced rainfall in the Western Cape; Engelbrecht 2019), improving the standard of living of approximately half of the city's population through meeting the United Nations (UN) Sustainable Development Goals (SDGs) 3, 6, 11 and 131.

- If there is a higher water requirement or a reduction in the supply from other sources, a larger scheme capacity could be justified.
- Electricity price changes have a significant impact on the risk profile of desalination and it would be worth considering if there are ways to mitigate this, such as embedded generation / contractual options.

3.4 Fitness for use

Fitness for use refers to the chemical and biological characteristics of water (often called water quality) that render it usable for a specific purpose. This section summarises the fitness for use of inland water in the Western Cape starting with a general overview and then providing details of key indicators, selected form a large number of potential indicators, but for which only a few have appropriate data.

*What if water is not **"fit for use"** because of **salts** and **nutrients?***

Salts can reduce crop yields (DWAF, 1996) or, if above a certain level, render water undrinkable. Nutrients can cause algal blooms and there is some concern they may even raise certain cancer rates (WHO, 2008). Unfortunately, conventional water treatment does not substantially reduce either nutrients or salts. On the other hand, nutrients can be removed by wetlands which can be both natural or constructed making ecosystem health all the more important.

Fitness for use is therefore a measure to describe the quality of water that is required for different water users. The National Water Act (Act No. 36 of 1998) looks a five "water users" that water quality must be of adequate quality for the specific water use. These five water users are 1) Aquatic Environment 2) Domestic water use 3) Agriculture 4) Industry and 5) Recreational water users. Different water quality is required for different water users and different parameters are used to determine if water quality is fit for use.

Fitness for use is not a simple measure of water quality because it considers both water quality and the intended water use. Water fit for agriculture may not be fit for domestic purposes and it is not necessarily the case that water unfit for drinking has a problem with water quality. For example, some river systems such as the "Sout" and "Brak" Rivers in the Western Cape are naturally saline owing to geological conditions. Nonetheless, most water in its natural state is fit for most uses and thus in most of the cases where water is "unfit" for use, it is because of pollution.

Performance trends from the **Green Drop assessment** are applied in the Western Cape to identify instances of recurring poor performance of waste water treatment works, which have resulted in significant environmental harm over time. This data will inform the adoption of more decisive measures to affect a turnaround – such as long-term intervention through a capacitated local authority or other appropriate means of supporting sanitation services.

The Green Drop Report emphasises the need for substantial investments to restore existing infrastructure and expand capacity for water resources infrastructure, a responsibility primarily held by the national government, as well as for water services infrastructure.

The Green Drop Report Watch Report (DWS, 2023c) and the Western Cape provincial chapter have identified 18 water systems within the province in a critical state, an increase from 9 water systems in 2013. Most of these systems are under the management of Matzikama, Kannaland, Swellendam, and Prince Albert municipalities. The provincial Risk Ratio for treatment plants has remained relatively stable, **changing only slightly from 52.7% in 2013 to 53.1% in 2021 (a movement of 0.4%),** indicating **limited changes in risk levels between 2013 and 2023.** The primary areas of concern revolve around effluent and sludge non-compliance. However, opportunities exist to reduce costs through process optimisation, improve energy efficiency, and make beneficial use of sludge, nutrients, biogas, and other energy resources.

The Provincial Green Drop Analysis (DWS, 2023c) revealed a 100% response rate from the 25 municipalities audited during the 2021 Green Drop process, showcasing a strong dedication to wastewater services in the province. Analysis spanning from 2009 to 2021 shows that many system scores fell within the 50-80% range (Average Performance), with the 80-90% range (Good Performance) being the next most common category. However, the most troubling discovery was that 18 systems were classified as being in a critical state (<31%), a notable increase from the 9 systems in this category in 2013.

The indicators assessed in this section were informed by the key water quality concerns in the Western Cape as summarised in Table 13.

Table 13 Major water quality concerns in the Western Cape

Water Quality Concern	Driver	Effect
Eutrophication	WWTW, Intensive agriculture, winery effluent, fertilizer use, dense un-serviced urban areas (for example, untreated sewage discharge from informal settlements), increased treatment costs	Algal growth, odour, toxic algae, water treatment costs, taste, irrigation clogging, aesthetics, recreational water users (human health risks), eutrophication is also a problem for the environment as the macroinvertabrates and other life in the river is negativey affected e.g. if there is no oxygen in the water
Salinisation	WWTW, agricultural runoff, leaching from natural geology, industrial discharges and seawater intrusion	Water treatment costs, soil salinity, irrigation system clogging - infrastructure will clogg/ form scaling if the hardness of the water is considerable; if the water is too acidic it could equally cause problems
Microbial contamination	WWTW, informal settlements, vandalism of sewerage infrastructure, sewage spills	Disease, recreational users (human health risks), washing and bathing, poor bacterial water quality impacts on downstream users, low dissolved oxygen and ecosystem impacts – important to contextualise that microbial contamination does not harm the ecosystem, only anthropogenic-induced microbial contamination which will also be harmful to humans in the long run as it can bioaccumulate in our tissue
Emerging contaminants	Pesticide and herbicide residues, industrial discharges, contaminated stormwater	Disrupt hormone systems of organisms, ecosystem impacts. Human health impacts include immunotoxicity, neurological disorders, cancer, and other ailments leading to liver damage, kidney damage and respiratory problems.
Microplastics	Consumables made out of plastic and improper disposable and or absence of recycling efforts to avoid plastic materials disposed off in the environment	The reduced size of microplastic makes it prone for intake by aquatic organisms resulting in amassing of noxious wastes, thereby disturbing their physiological functions. Microplastics are abundantly available and exhibit high propensity for interrelating with the ecosystem thereby disrupting the quality of aquatic ecosystems.

3.4.1 Eutrophication and salinisation

The state of chemical water quality in inland rivers, focusing largely on eutrophication and salinisation, was assessed using the Status Quo reports for Reserve determination process (DWS State of Rivers Report 2020-2021). Further eutrophication matters are addressed in the Eutrophication Management Strategy for South Africa (DWS, 2023b).

While both point and diffuse sources of water pollution contribute to the excessive nutrient loading of water resources, current eutrophication management measures primarily target the regulation of point sources of nutrient loading.

These reports classify water quality at selected river stations as either ideal, acceptable, tolerable or intolerable, based on South African guidelines for water quality (DWAF, 1996; WRC, 1998) and taking into consideration the most sensitive user(s) which include:

- Industry (for chloride, TDS, electrical conductivity, pH [upper limit], and sulfate, heavy metals);
- Irrigation (for Nitrate and Nitrite [as Nitrogen]) and pH [lower limit], salinity, sodium absorption ration (SAR);
- Aquaculture (for Nitrate and Nitrite [as Nitrogen]); and
- Aquatic ecosystems (for electrical conductivity [higher ranges], Nitrate and Nitrite [as Nitrogen], phosphate and ammonia.

> Human-induced nutrient enrichment is most noticeable in densely populated and developed regions, where various activities such as industrial discharge, sewage systems, runoff from urban areas, fossil fuel burning, atmospheric deposition, and agricultural practices contribute to increased levels of nutrients entering water bodies. In South Africa, the challenges of eutrophication are worsened by insufficient maintenance and investment in wastewater infrastructure, degradation of ecological systems, recurring droughts influenced by climate variability, the imperative for water resource development, disparities in access to safe sanitation amid population growth, inconsistent or inadequate water use regulations, and a shortage of skilled water scientists and engineers.

Parameters important for environment are dissolved oxygen, temperature, pH and Electrical conductivity. These parameters gives an indication of environmental quality for the aquatic environment. Water considered acceptable for the most sensitive users is also considered acceptable for domestic use. Assigned classifications are illustrated graphically Figure below, with the classification assuming the worst rating for any of the parameters. It is critical to record that in some instances the environment is the most sensitive 'water user' - not humans. The resource quality objectives (RQO`s) specifically considers the needs of the environment in terms of the quantity and quality of the water required.

The quality of inland water resources (in terms of salinity and eutrophication) as shown in Figure 3-10, is rarely ideal and frequently intolerable for all catchments in the Western Cape, particularly the Berg catchment. In other words, inland water is generally not fit for agricultural or industrial use and deleteriously affects aquatic ecosystems if untreated. Water for domestic purposes is treated to the required water quality standards by the water service provider (often the local authority).

Important for the current and future state of the Western Cape's inland water, is the need for a shift in focus to innovative and progressive eutrophication strategies, some of which are described in the Eutrophication Strategy (DWS 2023b):

- Regulating diffuse water pollution, particularly concerning land care and land-use management, and exploring innovative approaches to mitigate nutrient-loading from this source.
- Managing escalating water demands by promoting reuse and recycling strategies to reduce the volume of wastewater return-flows requiring treatment before discharge, thus lowering their contribution to nutrient-loading of water resources.
- Exploring bio-manipulation, fish-harvesting, and food-web manipulation as potential strategies to alleviate eutrophication symptoms.
- Introducing zero-phosphate detergents in South Africa, coupled with consumer education efforts to promote their adoption. However, caution is advised as low-phosphorus detergents may not foam as effectively as phosphate-based ones, potentially leading to increased use of other, more harmful chemicals to compensate.

3.4.2 Microbial contamination

The state of microbial contamination is assessed based on National Microbial Monitoring Programme *Escherichia coli* bacteria (*E. coli*) data from the DWS Resource Quality Information Services (RQIS) resources. The presence of *E. coli* indicates probable contamination by human or animal waste (excrement). Urban runoff or inadequate treatment of effluent at WWTW contribute to *E. coli* contamination in water resource, especially those located in urban areas.

3.4.3 Emerging contaminants

Emerging water contaminants include chemicals that have recently become a concern either because they were previously not detected in tests or were found in much lower concentrations. Chief among these contaminants are pharmaceuticals and veterinary medicines, pesticides, flame retardants, endocrine disrupting compounds and nanomaterials. These chemicals are flushed into water supplies from a variety of sources (Walters, 2017). The most common sources are WWTWs, individual septic systems, hospital and industrial effluent and industrial livestock facilities. Wastewater treatment and reclamation are increasingly crucial for maintaining water security, particularly in regions facing challenges like droughts and rapid population growth such as the Western Cape.

Emerging contaminants are a concern because the risks they pose to human health and the environment are not yet fully understood and some cannot be sterilised by existing water treatment processes (Sorensen, 2015). The SANS 241-2011 specification does not enforce testing to determine the presence or measure the levels of emerging contaminants. This may be because the testing procedures for emerging contaminants are much more complex and expensive compared to testing for regular contaminants like pH or chloride. Most emerging contaminants occur in trace amounts and have to be measured in nanograms per litre (ng/L), making them difficult to detect. These factors strain water and sanitation services, emphasising the need for pollution control.

The state of freshwater quality in Cape Town has seen a gradual decline and the continuing high trophic levels is the result of a number of contributing factors. Similarly, trying to identify the exact reasons for improvements in freshwater quality is incredibly complex, as the City's attention and action relating to freshwater management have increased over time. Contamination of the city's freshwater systems is primarily due to contaminated urban stormwater and raw sewage from informal settlements, leaking sewers and pump stations. The continuously increasing rate of urbanisation, rapid expansion of informal areas and an increase in backyard dwellings further strain the City's capacity to service and build new infrastructure. The City is working towards improving the current state of affairs, and is targeting transformation into a city that could be considered 'water sensitive' by 2040, as stated in commitment 5 of its Water Strategy. The City has established the Water Quality Improvement Programme (WQIP). This strategic intervention seeks to improve 'ambient water quality', which the United Nations defines as natural, untreated water that is affected by a combination of natural influences, anthropogenic activities and other causes of pollution. The primary objective of the WQIP is to address pollution and incrementally improve the water quality of the rivers and waterbodies in Cape Town (City of Cape Town State of Environment, 2022).

3.4.4 Microplastics

Globally, plastic debris is accumulating, and South Africa's poor waste management has exacerbated plastic contamination. Microplastics (MPs), defined as plastic particles smaller than 5 mm, are classified into primary and secondary types based on their origin. They exhibit diverse characteristics such as shape, polymer type, size, and colour. MPs enter the marine environment through various pathways, posing a growing concern as an emerging marine contaminant. The distribution of MPs is influenced by their properties, determining whether they sink or float. Over time, MPs undergo changes in properties due to degradation. The issue stems from the extended durability of plastic products, which often outlast their utility, transforming into waste and entering the marine environment.

A recent case study by the Cape Peninsula University of Technology (Julius et al., 2023) conducted during summer season along the Western Cape coast, aimed to assess microplastic (MP) concentrations in water (particles/L) and sediment (particles/kg). Sampling at fourteen sites revealed that sediment MP concentrations (185.07 ± 15.25 particles/kg) exceeded those in water (1.33 ± 0.15 particles/L). To highlight specific findings:

- Gordon's Bay exhibited the highest sediment concentrations (360 ± 36.74 particles/kg), indicating harbours as the main source.
- Kalk Bay showed the highest water concentrations (4.97 ± 0.18 particles/L), suggesting stormwater outfall pipes and human activities as the sources. Filaments were the dominant MP shape (89%), with black/grey (water) and transparent (sediment) being the most prevalent colours. Dominant sizes were 1000–2000 µm in water and 2000–5000 µm in sediment. Polyethylene terephthalate (PET) (29%) was the most prevalent polymer in water, and natural fibres (mainly cotton) (32%) in sediment.
- The ecological risk assessment identified Mouille Point (site 6) as posing the greatest risk associated with polymers.

Important information from this case study data on microplastic (MP) concentrations and their potential sources in water and sediment along the Western Cape coastline - the findings suggest that the spatial distribution of MPs varies with sources and environmental conditions. Stormwater outfall pipes emerge as a significant source of contamination, particularly with filamentous particles dominating. The risk assessment emphasises elevated to hazardous risks linked to MP polymer types, underscoring the importance of considering the specific types of polymers as potential threats to marine organisms that ingest microplastics.

3.4.5 Groundwater quality

Groundwater is used throughout the Western Cape, albeit less intensively than surface water. In numerous areas the groundwater is naturally saline and unfit for most uses, while contamination of groundwater is not widespread. In the Berg-Olifants WMA, groundwater quality is generally good although in localised areas, such as the Philippi horticultural area in Cape Town and because of the type of aquifer agricultural practices and urban development have affected groundwater quality . In the Breede-Gouritz WMA, groundwater quality is generally stable except for an unexplained long-term decline in sodium chloride (salt) concentrations.

For the Sandveld area, quantity is a greater concern than quality. As far as quality is concerned, salt water intrusion is a concern and require specific management responses.

Localised problems also arise from leakages from fuel stations, effluent from municipal WWTW, runoff from urban areas and inadequately serviced informal settlements and industrial effluent.

Groundwater quality and recharge as emerging priorities are also drawing on innovative adaptation response development – such as the purposeful flooding in agricultural landscapes as intentional groundwater recharge. Under the Green Climate Fund (GCF) this is an innovative adaptation response being explored to improve water availability in the province.

3.5 Inland water ecosystem health

Inland water ecosystem health or aquatic ecosystem health refers to the condition or 'resource quality' of surface water resources. This includes its fauna and flora within in-stream, wetland and riparian habitats (Karr, 1999). An overview of major impairments to ecosystem health for each catchment is shown in Table 14. Although most of the reports are more than 10 years old, there is little reason to believe that the main types of disturbance will have changed.

Table 14 Summarised major disturbances to inland water ecosystems

WMA	Catchment	Major disturbance pressures
Berg-Olifants	Berg	Urban development, stormwater water quality impairment, inter-basin transfers, extensive channel and flow modification, failure to maintain adequate riparian buffers, lack of proper sanitation infrastructure in mismanaged informal settlements, agriculture use return flow turbidity and nutrient loading, alien fish and extensive alien vegetation infestations (notably eucalypts and wattles). The City of Cape Town and its ongoing expansion is a major disturbance pressure.
	Olifants/Doorn	Abstraction for agriculture, agricultural activities within floodlines, agriculture use return flow turbidity and nutrient loading, loss of riparian habitat, alien fish and extensive alien vegetation infestations (notably eucalypts and wattles) and overgrasing by livestock.
Breede-Gouritz	Breede	Extensive abstraction, agricultural activities within floodlines, channel and flow modification, nutrient enrichment from agriculture return flows and extensive alien vegetation infestations.
	Gouritz	Extensive abstraction, agricultural activities within floodlines, channel and flow modification and nutrient enrichment from agriculture return flows and forestry.

Source: DWS State of Rivers Report 2021

A semi-quantitative approach to assessing ecosystem health is to measure Present Ecological State (PES), based on the response of biota (instream and riparian) to human influences that change the integrity of habitats (for example, vegetation, geomorphology and chemical variables) (DEA&DP, 2013). The PES scores are typically categorised from A to F, each representing a defined level of ecosystem health as shown in Table 15 (symbols follow Kleynhans and Louw, 2007). The PES scores were compiled for various rivers and wetlands where available.

Indices used to determine the PES include Geomorphological Index, South African Scoring system (SASS), index of habitat integrity, riparian vegetation index and fish assemblage integrity index and water quality.

Table 15 Present Ecological State (PES) categories and descriptions

Category	PES Description
A	Unmodified, natural.
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the

Category	PES Description
	worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

3.5.1 Rivers

The PES for rivers in the Western Cape is shown in Figure 19. The scores are reasonable, as land-use in upper catchment areas is generally forestry and conservation based and therefore Mountain Catchment Protection Areas are often classed as natural or good. For rivers impacted by agriculture and land development, the cumulative impact as one gets closer to the coast progressively compromises surface water resources, lowering the PES. In addition, the influence of significant urban development is evident from critically modified rivers close to towns. The PES values presented in Figure 18 shows that over 20% of rivers (by length) in the Western Cape are largely or seriously modified and only 50% of rivers are natural or largely natural (category A or B). Fortunately, only a small percentage of rivers are critically modified, mostly in the Berg catchment.

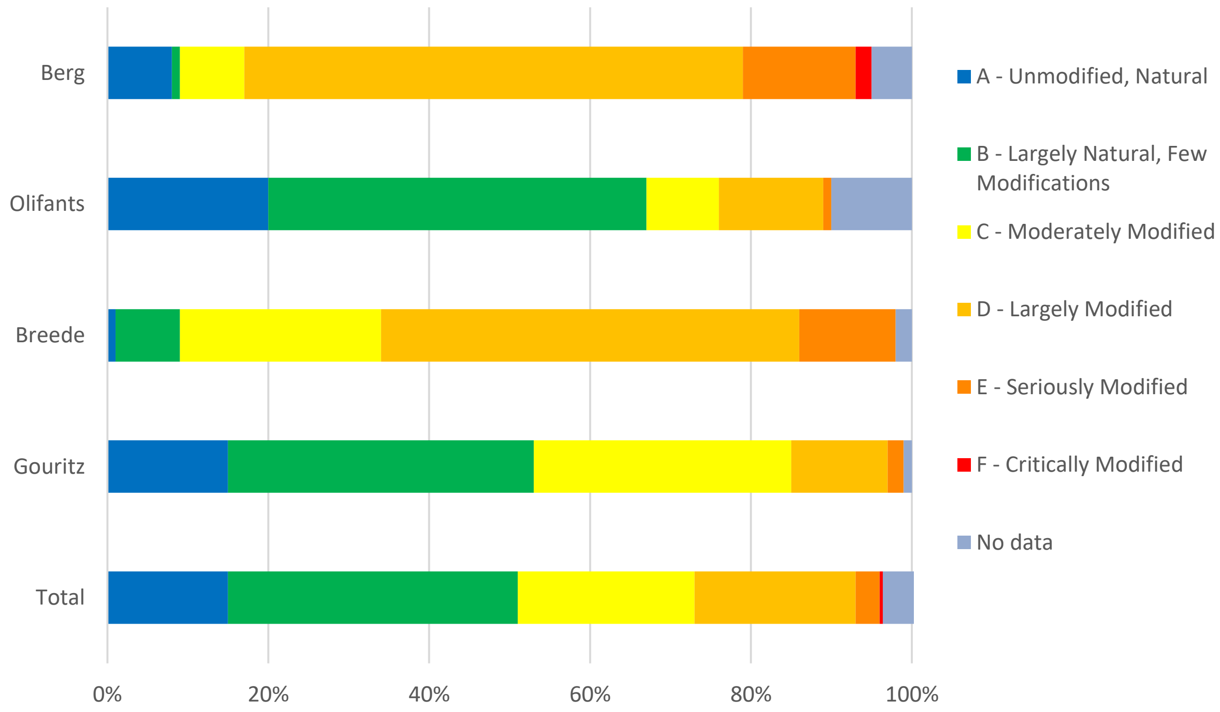


Figure 19 Percentage of river length within each PES category

Source: DWS, 2014b

The PES values could not be compared to those in the previous SoEOR (2018) because the previous PES classification comprised only four categories (natural, good, fair and poor) while the current system uses six categories (A-F) to align with the DWS ecological Reserve and Classification processes.

3.5.2 Wetlands

Wetlands are crucial natural resources, with high environmental, economic, aesthetic, spiritual, cultural and recreational value. Wetlands provide habitat to flora and fauna as well as essential services to humans in the form of water storage, supply and treatment services (De Villiers & Thiart, 2007).

The National Wetland Map 5 (NWM5) (van Deventer et al., 2020) provided an update of wetland extent, type, and condition from the National Freshwater Ecosystem Priority Areas (NFEPA) dataset (Nel et al, 2011). The NWM5 informed the National Biodiversity Assessment 2018 (Skowno et al., 2019, van Deventer et al., 2020) where it was found that wetlands are one of the most threatened ecosystem types in South Africa. A similar trend was observed for the Western Cape where 86% of the wetlands are Critically Endangered, 3% are Endangered, 8% are Vulnerable, and 3% are of Least Concern. Therefore, 97% of the wetlands within the Western Cape are threatened (Critically Endangered, Endangered, or Threatened) (Figure 20).

The National Biodiversity Assessment also included an assessment of wetland protection level and condition (present ecological state). The Western Cape wetlands are largely not protected (60%) or poorly protected (31%), while few wetlands are considered well protected (8%) and moderately protected 2%. Despite their high value, wetlands face significant threats from human activities such as pollution, land use changes, invasive alien vegetation, excessive water abstraction, and over-harvesting. These pressures have contributed to a high proportion of wetlands which are largely to severely/critically modified (80%) and moderately modified (8%). The remaining 11% of wetlands in the province are in good condition (natural to near-natural).

It is acknowledged that wetlands are under mapped in certain parts of the Western Cape (especially the interior) and efforts to improve this foundational spatial layer are underway to ensure the best available information continues to inform their conservation and management. The latest version of the National Wetland Map is version 6 which provides improved distribution of wetlands within the Western Cape. A new condition and threat assessment will be undertaken in late 2024 and published as part of the NBA 2025. The best available extent of wetlands is displayed in Figure 20 - 22.

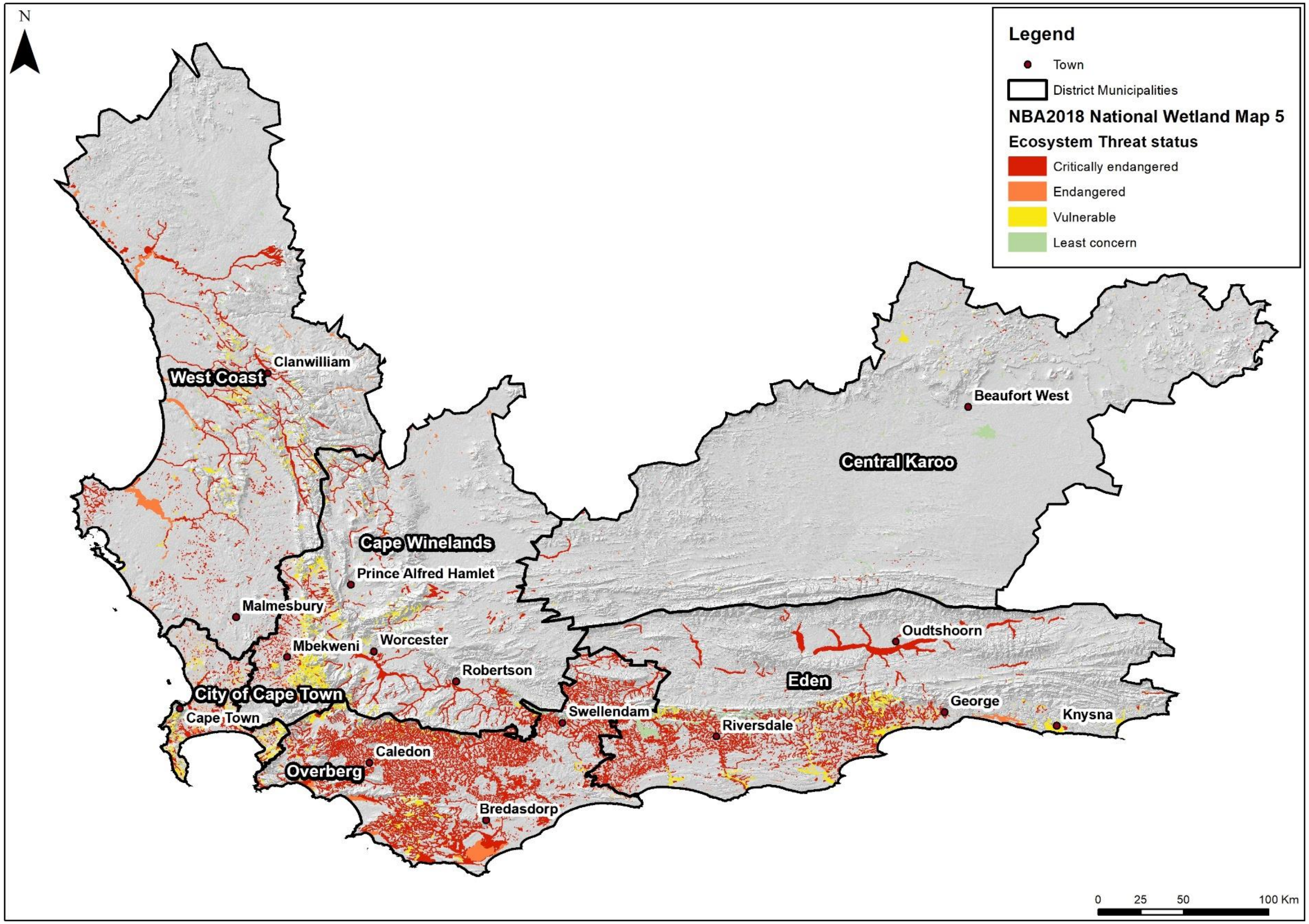


Figure 20 National Biodiversity Assessment 2018 wetland ecosystem threat status

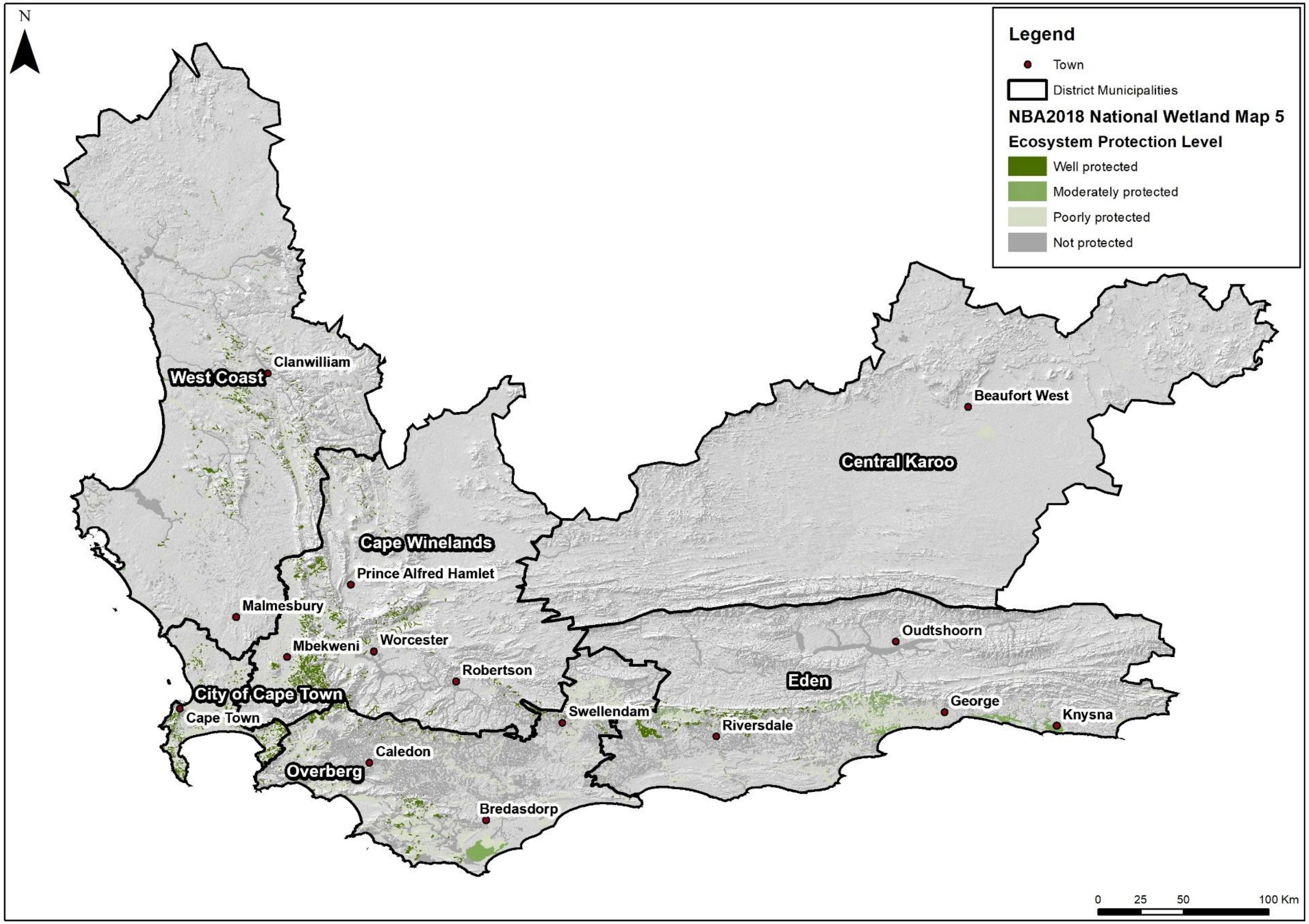


Figure 21 National Biodiversity Assessment 2018 wetland protection level

Table 16 Ecosystem protection level (EPL) thresholds applied for the wetland ecosystem protection level

Ecosystem protection level	Thresholds applied to inland wetland ecosystems
Well Protected	Extent (ha) of inland wetland ecosystem type in natural or near-natural ecological condition (PES = A or B) with ≥ 100% of the biodiversity target located within a formal or de facto protected area.
Moderately Protected	Extent (ha) of inland wetland ecosystem type in natural or near-natural ecological condition (PES = A or B) with between 50 and 99% of the biodiversity target located within a formal or de facto protected area.
Poorly Protected	Extent (ha) of inland wetland ecosystem type in natural or near-natural ecological condition (PES = A or B) with between 5 and 49% of the biodiversity target located within a formal or de facto protected area.
Not Protected	Extent (ha) of inland wetland ecosystem type in natural or near-natural ecological condition (PES = A or B) with ≤ 5% of the biodiversity target located within a formal or de facto protected area.

Table 17 National Biodiversity Assessment 2018 Wetland ecological condition categories

<table>
<tr><th>NBA 2018 wetland ecological condition categories</th><th>NBA 2018 ecological condition categories</th><th>Description of the ecological category</th></tr>
<tr><td rowspan="2">A/B</td><td>A - Natural</td><td>Unmodified, natural.</td></tr>
<tr><td>B - Near-natural</td><td>Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.</td></tr>
<tr><td>C</td><td>C - Moderately modified</td><td>Moderately-modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.</td></tr>
<tr><td rowspan="3">D/E/F</td><td>D - Heavily modified</td><td>Largely-modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred.</td></tr>
<tr><td>E - Severely modified</td><td>Seriously-modified. The loss of natural habitat, biota and basic ecosystem functions are extensive.</td></tr>
<tr><td>F - Critically modified</td><td>Critically or Extremely-modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.</td></tr>
</table>

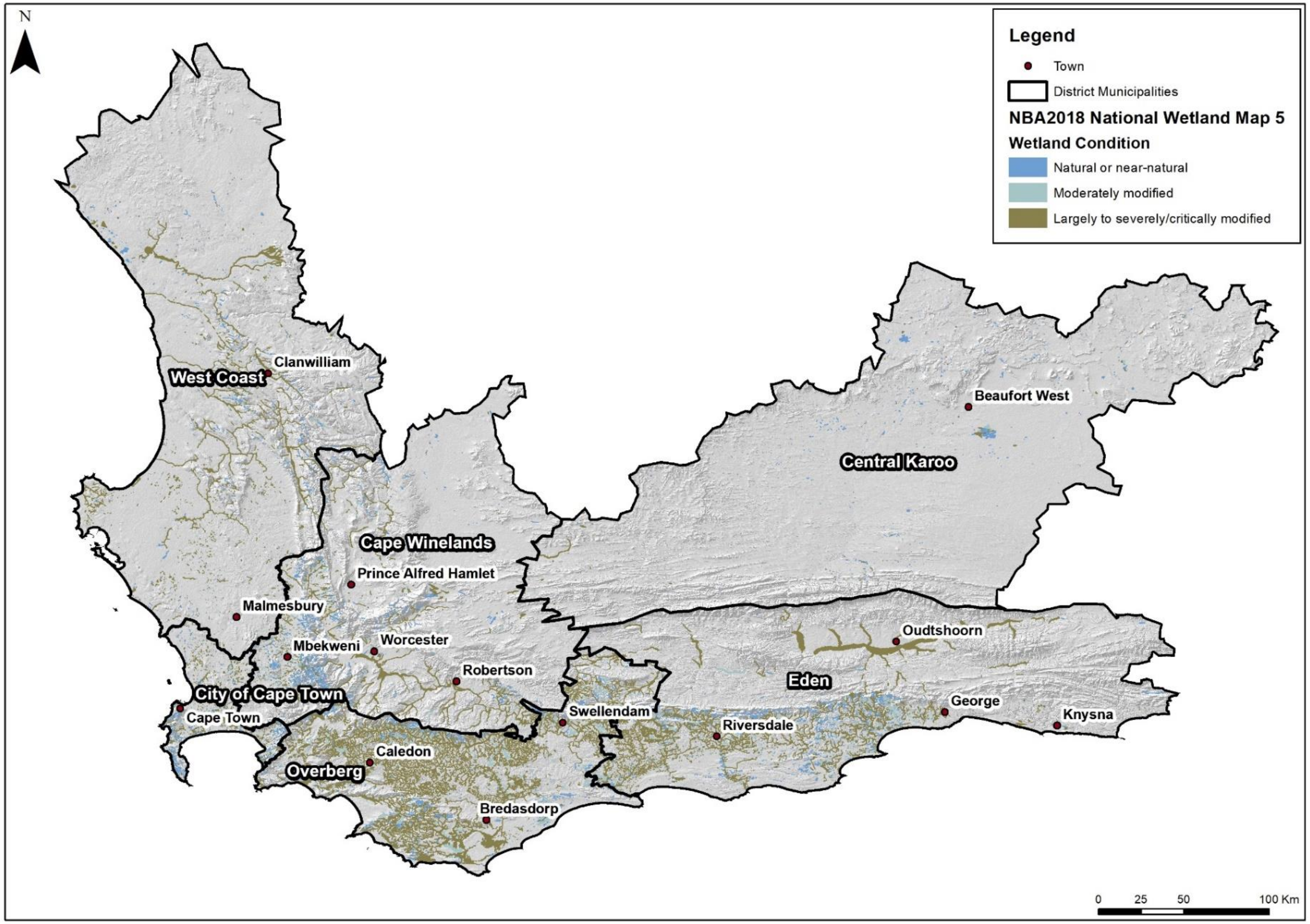


Figure 22 National Biodiversity Assessment 2018 wetland condition determined

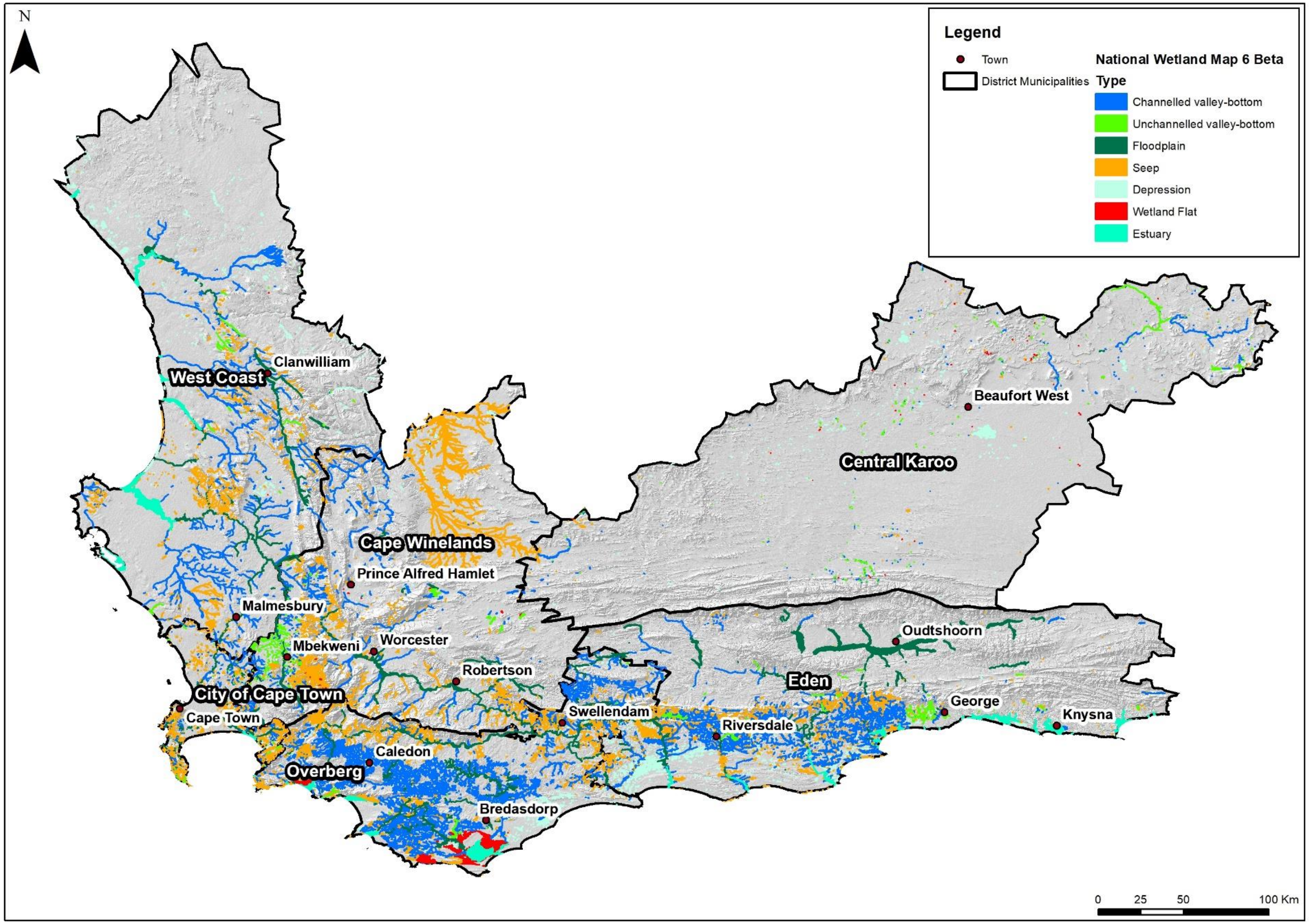


Figure 23 National Wetland Map wetland extent

4 IMPACTS

4.1 Impacts of inadequate water availability

Water availability, or the lack thereof, directly impacts the economy, society and ecosystems.

Economic activity is affected by water availability to such a degree that in 2016, 75% of companies surveyed reported detrimental impacts due to inadequate water supply (GreenCape, 2017). Unsurprisingly, the most affected industries were those directly dependent on a constant, stable supply of water such as beverage manufacture or laundry services. Insufficient water for agriculture reduces crop yields, while car-wash businesses are subject to severe restrictions while the drought persists.

Interventions such as the development of desalination plants and water reclamation plants to increase regional water supply have tax revenue implications. At a household level, the installation of rainwater tanks and grey water systems also have cost implications. Initiatives to increase and optimise runoff from catchments, use less water or reuse water are important as they can potentially reduce these costs and demands.

Ecosystems are also susceptible to the effects of low water availability, with consequent effects to the economy. Reduced water flows could for example affect estuaries which are important fish nurseries supporting commercial fisheries and recreational fishing. Already, large volumes of water are abstracted from natural systems to satisfy basic human needs. In particular, dams alter flow regimes and inter-catchment transfers have a similar effect. Prescribed ecological reserve flows mitigate impacts but even with these flows, ecosystems are modified compromising their integrity and function, including their ability to regulate water quality by processing and absorbing pollutants. In many areas, ecological reserve flows are not adequately implemented, especially during droughts. The ecological flow requirement (EWR) is released from storage dams as part of the operating rules. however factors such as illegal abstraction these flows do not necessary reach the estuaries as intended because the flow if not always measured. Limited water means the soil surface dries and hardens which means when rain does fall there may be flooding due to the soil being unable to absorb the storm flows fast enough.

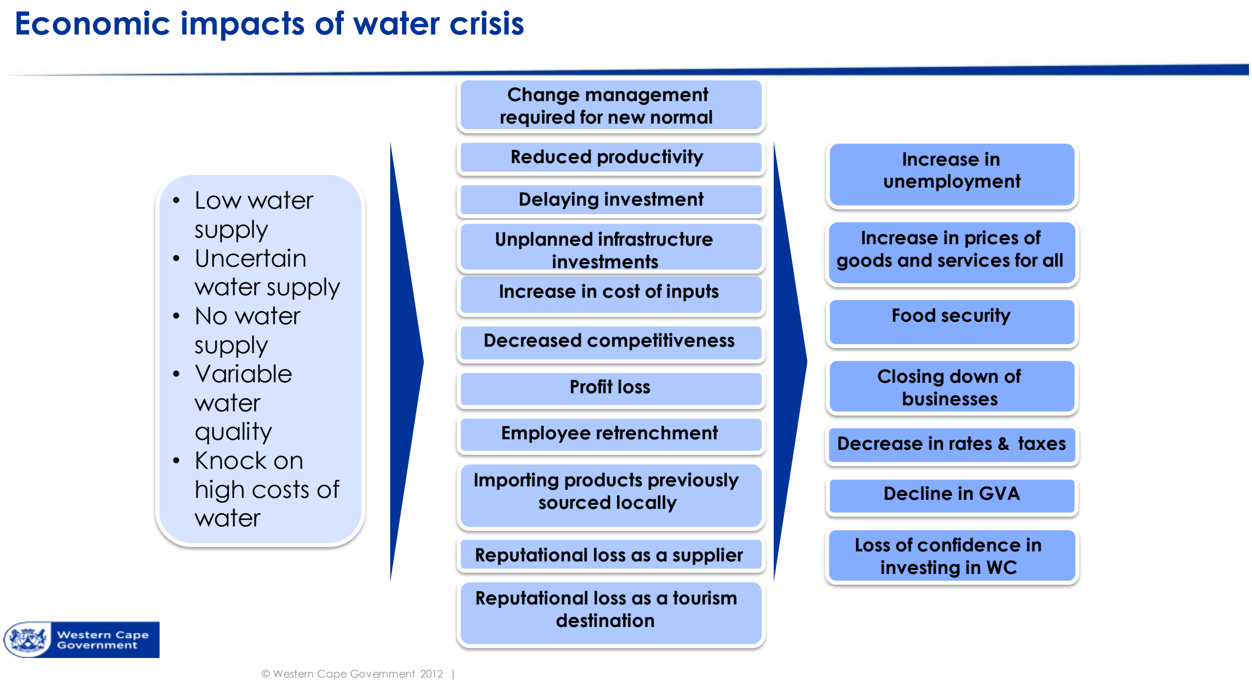


Figure 24 Economic impacts of water crisis

Source: (H Davies, 2018)

4.2 Impacts of poor water quality

Risks to human health, economic costs and impacts on ecosystems reliant on inland water are the main impacts of poor water quality or water not considered fit for use.

Microbial pollution from poorly treated effluent discharged to inland water, and poor sanitation services in informal settlements, pose risks to human health, as contact with the water increases exposure to a range of viruses and diseases. Eutrophication and the concomitant noxious algal blooms also pose a risk and even if affected water is not drunk; consumption of exposed fish can transmit the toxins (Oberholster and Ashton, 2008). These toxins can cause severe respiratory difficulties, gastrointestinal ailments and liver and nerve damage (Oberholster and Ashton, 2008). This is an interlinked and transversal matter between the Departments of Water and Sanitation, and the Department of Agriculture.

The main economic impact of unfit water is the treatment cost, which rises as water quality declines. Fresh (fit for use) inland water need only be filtered and chlorinated to meet potable standards, whereas contaminated water requires expensive, specialised treatment. Eutrophication can also affect irrigation farmers as the algae can clog equipment resulting in ill-operation and costs for repair and maintenance.

Another economic consequence of unfit water, and particularly microbial contamination, is the impact on irrigated agriculture: crops irrigated with water containing *E. coli*, may become a vehicle for transmitting waterborne diseases. Water quality in the Berg river is a critical concern especially for the agricultural sector. Farm managers are obliged to implement costly treatment processes to ensure the health of consumers and - in some instances - comply with strict standards imposed by for example Eurogap, to secure exports. Failure to do so would reduce export revenue accruing to the Western Cape.

Ecosystems can be affected by water quality. Fish populations are affected by poor water quality, and destruction of riparian habitat. Invertebrates can be even more severely affected, hence their frequent use as indicators of water quality. Alien vegetation can alter habitats, and endemic aquatic species fail to thrive or are displaced from rivers if, for example turbidity changes or eutrophication occurs.

4.3 Stormwater and urban run-off

The impact of stormwater and urban runoff presents significant challenges, particularly when not properly managed by local authorities. Besides flooding and erosion, urban runoff can carry pollutants such as oils, heavy metals, and chemicals into water bodies, impacting water quality and aquatic ecosystems. This runoff often stems from impermeable surfaces like roads and rooftops, where rainfall cannot infiltrate into the ground but instead flows over surfaces picking up contaminants. If left unchecked, this runoff exacerbates water pollution and affects biodiversity. Moreover, the focus on managing the quantity of stormwater rather than its quality perpetuates environmental degradation. Effective waste management strategies are crucial to mitigate these impacts, emphasising the need for comprehensive approaches that address both the volume and pollution aspects of stormwater and urban runoff management.

Figure 25 Stormwater run-off in urban areas have an impact on water quality

Photo credit: M. Lintnaar-Strauss (2023)

4.4 Inland water ecosystem health

Inland water ecosystem health also has cumulative impacts on society. Intact ecosystems provide a number of services free of charge which progressively become less effective as ecosystems are degraded. For example, wetlands improve water quality by filtering sediments and contaminants, and some can convert nitrates to harmless nitrogen gas thus decreasing eutrophication. Natural, meandering rivers and streams also offer flood protection and reduce the velocity of flood waters. Wetlands and natural lakes retain floodwaters, acting as natural “detention ponds”, reducing flood peaks. Conversely, modified rivers, particularly those in concrete canals, as is the case in some areas of Cape Town, may exacerbate floods. Furthermore, concrete canals offer little instream habitat and the “self-cleansing” ability of natural streams is absent in these sterile systems.

Inland water ecosystems are popular recreational venues and housing near such features often attracts a premium. In the Western Cape, people kayak, fish, hike and picnic next to rivers and lakes.

5 RESPONSES

This section highlights key responses for each of the key challenges for inland water – water availability, fitness for use and inland water ecosystem health. This section highlights only those most relevant or recent responses.

It is important to emphasise as per the G4J Strategy Water Focus Area - the province aims to optimise and expand water supply, integrate water resource management, and enhance the adaptive capacity of businesses and citizens regarding water usage. This focus aims to improve resilience, competitiveness, and quality of life for all residents, ensuring sufficient water supply to support economic growth ambitions. The Western Cape's vision of success is described that by 2035, the Western Cape envisions achieving economic water security and resilience, instilling confidence in businesses. Industries in the region operate efficiently and sustainably, benefiting from reliable, de-risked local supply chains. Companies are envisions as adhering to best practices in water efficiency, enabling sectors like agriculture, agri-processing, and light manufacturing to expand and diversify. Residents enjoy ready access to clean, drinkable water, enhancing productivity and quality of life. Investments in ecological infrastructure facilitate water release for productive purposes. The Western Cape aims to fosters a thriving water technology sector, exporting innovative solutions globally. The province aims to develop and implement sustainable municipal business models for water management, emphasising efficiency, conservation, and environmental infrastructure to meet future water demands.

5.1.1 Legislation, policy and governance structures

The main act governing inland water resources is the National Water Act 36 of 1998 (NWA). The NWA is under review, pending incorporation of the Water Services Act 108 of 1997 (WSA). Recent developments in the Western Cape includes the former Berg-Olifants WMA and the Breede-Gouritz WMA which now fall under the Breede-Olifants CMA and cover most of the Western Cape and the major rivers in each shown in Table 5.

In terms of governance structures, the NWA stipulates that CMAs will manage water in WMAs. BOCMA is now established where all four WMA's are included and the Resource Quality Objectives and classification of all important resources has been completed.

At local level, the formation of non-statutory Catchment Forums is being encouraged. There are a number of water management forums in the Western Cape as a platform for local involvement in resource management. In addition, irrigation boards are being transformed into more inclusive Water User Associations (WUA), with DWS approved constitutions, responsible for managing water resources in a particular area (UWC, 2012). In the absence of catchment management forums, other forums e.g. estuary management forums and other forums are used to disseminate information about water resources to the public.

5.1.2 Water resource reserve determination

The classification of a water resource is a planning tool to determine the status of a catchment, set quality and flow objectives for that catchment and legislate those objectives. It addresses water availability, fitness for use and ecosystem health, providing support for other planning, management and implementation activities for inland water. Once the classification process for a water resource is completed, it is binding and must be taken into consideration in the relevant area and when applying for a water use authorisation. For the Western Cape, all four water management areas have determined water quality objectives (DWS, 2023a) with implementation now underway.

5.1.3 Forums / Collectives relevant to sustainable water management

In an on-going effort towards sustainable water management across the Western Cape, Several community-based water resilience and sustainability collectives have been established in the Western Cape Province to address the need for co-ordination and collective action in addressing increasing water security risks and challenges. These included, amongst others the Boland & Groot Winterhoek SWSA Collective, the Outeniqua to Tsitsikamma Water Working Group, facilitated by the Garden Route Biosphere Reserve and the Grootvadersbosch Conservancy. The five biosphere reserves (Cape West Coast, Kogelberg, Cape Winelands, Garden Route and Gouritz Cluster) also serve to varying extents as community based collectives that implement ecological infrastructure investment. Full details are captured in the WCSWPP (2024), and the following Table 18 containing a summary of this response:

Table 18 Summary of the collectives steering sustainable water management across the Western Cape

<table>
<tr><td rowspan="6">Collectives and collaboratives</td><td>Boland Groot-Winterhoek Collective: Aimed at protecting the Boland Groot-Winterhoek Strategic Water Source Areas.</td></tr>
<tr><td>Table Mountain Water Source Partnership: Aimed at protecting the Table Mountain Strategic Water-source Area.</td></tr>
<tr><td>Upper Breede Collaborative Extension Group: Focused on coordinating and sharing resources and lessons around alien clearing in the upper Breede catchment.</td></tr>
<tr><td>Breede-Zonderend Catchment Collaborative: Focused on coordinating and sharing resources and lessons around alien clearing in the lower Breede catchment.</td></tr>
<tr><td>Upper Berg River Environmental Network: Focused on coordinating and sharing resources and lessons around alien clearing in the upper Breede catchment.</td></tr>
<tr><td>Ecological Infrastructure for Water Security (EI4WS) project: Focused on integrating ecological infrastructure into planning, finance and development in the water sector to improve water security, with application demonstrated in two water catchments.</td></tr>
<tr><td rowspan="3"></td><td>EIIF Steering Committee: Oversight for the implementation of the EIIF</td></tr>
<tr><td>BRIP Steering Committee: Oversight for the implementation of Berg River Improvement Programme</td></tr>
<tr><td>WCSWMP Steering Committee: Oversight for the implementation of the Sustainable Water Management Plan and other activities</td></tr>
</table>

Provincial steering committees and task teams	**OneHealth Steering Committee:** Coordinate an integrated multi- disciplinary approach to optimise a healthy balance between humans, animals and ecosystems.
	Smart Agri Steering Committee: The SC is tasked with keeping track of SmartAgri, its implementation and actions, to ensure that momentum in reaching its objectives is maintained.
	Water Response Operational or Water Resilience Committee: Was created as a committee to monitor the implementation of the Water Resilience Plan, which is a key action of the provincial Water risk. It also aims to provide inputs into the transversal reporting structures, including the G4J strategy, provincial water risk, etc.
	Western Cape Drought Task Team: To assess the province's drought preparedness and seasonal outlook

Source: WCSWPP, 2024

5.2 Strategies and reconciliation plans for water availability

5.2.1 Water Demand Modelling

The Western Cape Water Supply System (WCWSS) Water Demand modelling by DWS considers high, medium, and low growth scenarios. However, the actual water availability is constrained by the pace of committed bulk infrastructure delivery. The provided Figure 25 outlines five demand growth scenarios and committed supply interventions. It's emphasised that building bulk water infrastructure involves substantial investment, operational commitments, and extended timelines. Planning for infrastructure development should consider uncertainties in future rainfall. Notably, the approach to addressing water scarcity goes beyond building infrastructure; it requires a flexible and long-lasting system to act as a buffer during droughts, as it's not feasible to solely "build your way out of a drought."

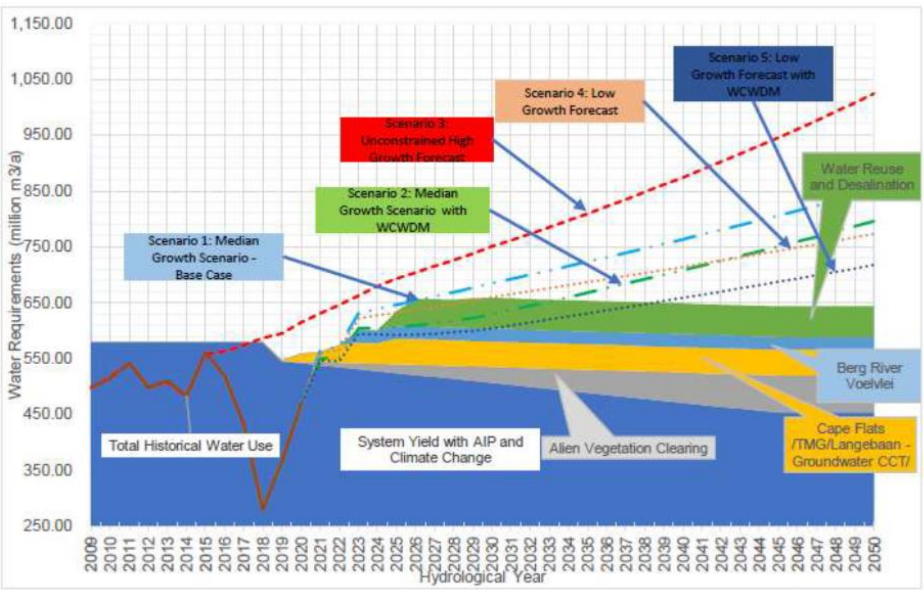


Figure 26 Water Balance Scenario of the committed augmentation options on the Western Cape Water Supply System

Becoming a national leader in water and climate resilience could bring significant economic benefits to the Western Cape. By 2040, the economy has the potential to be 33% better off, experiencing growth of up to 15% and generating more jobs (up to 12.4%). Additionally, regional exports might increase by 6.4%, and the overall cost of living in the province could decrease. This resilience planning would position the Western Cape to stay competitive in a carbon-constrained global economy. It underscores the importance of adopting a long-term perspective and conducting critical assessments for sustainable economic water resilience planning.

5.2.2 Planning

The National Water Resource Strategy (2022) documents South Africa's strategy on water resources, which is summed up as *"sustainable, equitable and secure water for a better life and environment for all"*. In response, local strategies and reconciliations were updated for all towns in the Western Cape and for the WCWSS, the integrated system that supplies Cape Town (DWS, 2023a). The strategies aim to reconcile predicted water demand and availability over a 25 year planning horizon.

As previously recorded in this chapter, the Western Cape Water Supply System (WCWSS) primarily serves the majority of the province's population. Of importance here are the various water balance scenarios.

The **base yield scenario** accounts for yield reduction due to unconstrained growth in invasive alien plants (IAPs) and moderate climate change.

The **most probable scenario**, the Bounceback Medium Linear Growth Per Capita, combined with the base yield scenario, foresees a shortage of 524 million m3/a by 2055 if no further IAP clearing occurs. While identified interventions improve source diversity, only seawater desalination is considered drought-proof. Uncertainty about climate change severity is addressed through different approaches in postulated scenarios. If the WCWSS faces a sudden change in rainfall, adjustments in scenario planning and acceleration of schemes may be required, as current planning assumes a gradual decline in rainfall (DWS, 2023a).

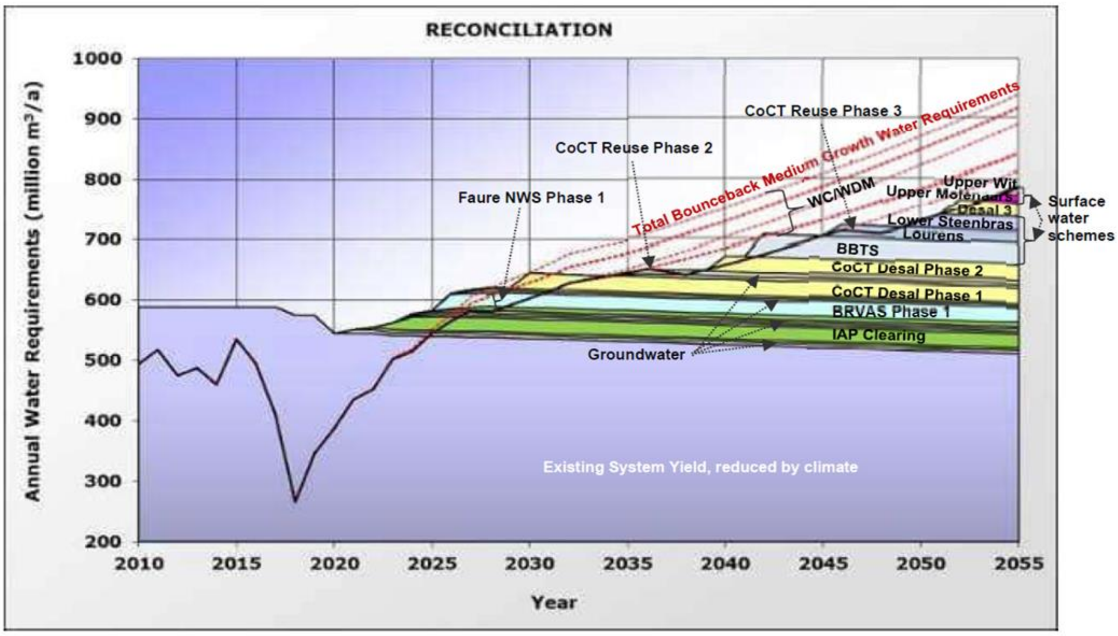


Figure 27 Total bounceback Medium Growth Water Balance Scenario

Source: DWS, 2022a

The WCWSS (DWS, 2023a) notes that the problem of invasive alien species continues to pose a significant threat and coordinated IAP clearing is a high priority. The yields of the Theewaterskloof and Voëlvlei dams are particularly at risk from IAP.

5.2.3 Western Cape Water Resilience Plan

The WCG commissioned the "WC Water Resilience Plan," a 15-Year Integrated Drought and Water Response Plan, in the aftermath of the 2016-2019 drought. Led by the Department of Local Government, this comprehensive set of reports, completed in 2022/2023, provides the most recent situational analysis for water and outlines future supply and demand trajectories in the province. Serving as the evidence base for this chapter, the plan guides economic water resilience interventions. Despite South Africa being ranked as the 30th driest country globally and facing high water stress, the country's consumption stands at approximately 233 litres per capita per day (l/c/d), surpassing the international benchmark of around 180 l/c/d. Key interventions for a secure water future include:

- Diversifying water sources and water quality streams per water user needs.
- Minimising water losses.
- Enhancing effective metering and billing.
- Minimising water consumption.
- Water re-use.
- Water cascading.
- Innovation in water treatment.
- Decentralisation of water supply and wastewater treatment.
- Rainwater harvesting.
- Stormwater harvesting.
- Wastewater reclamation.
- Alien vegetation clearing.
- Protection of wetlands and ecosystem.
- Investment in ecological infrastructure.

Table 19 Water Security Risk Factors unpacked into areas for intervention

CONTRIBUTING FACTORS	HIGH LEVEL RISK AREAS FOR INTERVENTION
Supply	• Climate Change • Deterioration of Water Quality • Electricity Outages resulting in treatment and pumping challenges • Overallocation of Water Supply
Demand	• Consumer Behaviour • Increasing need of and inefficient use of water • Water Losses • Urbanisation and unplanned informal settlement • Increased use of groundwater
Infrastructure	• Failing Regional Bulk Water Infrastructure • Failing Municipal Water Infrastructure and insufficient waste water treatment plants • Uptake of alternative water supply and treatment options not enabled, encouraged and/or sustained • Inadequate protection of and investment in ecological infrastructure • Rapid and unplanned urbanisation • Vandalism and theft of all types of infrastructure • Failing Infrastructure and insufficient maintenance within WCG buildings
Governance	• Inability to take effective regulatory action when cooperative governance fails • Inability to take explicit leadership in the province on water matters due to lack of direct mandate

	• Lack of appropriate policies, regulation and by-laws to promote and entrench water sensitive development • Lack of capacity and synergy in all spheres in the water sector • Lack of effective cooperate governance between all parties in the water sector • Legal framework resulting in overlapping mandates

Source: WCG Enterprise Risk Profile (WCG 2023a)

5.2.4 Growth for Jobs Strategy

Becoming a national leader in water and climate resilience could significantly benefit the Western Cape economy by 2040, potentially improving by 33%, avoiding contraction, and fostering up to 15% growth. This growth could result in a corresponding increase in jobs of up to 12.4%, with regional exports benefiting by 6.4% and an overall decrease in the cost of living in the province. This strategic approach would position the Western Cape to remain competitive in a carbon-constrained global economy. Achieving economic water resilience necessitates a long-term view and critical assessment, with the Growth for Jobs Strategy strategically selecting high-impact interventions to complement existing efforts in both the private and public sectors. Recognising that government alone cannot achieve this goal, an 'all of society' approach involving the public sector, private sector, academia, and civil society is crucial. Improved coordination among various stakeholders in the water sector is identified as a critical factor for success in the future.

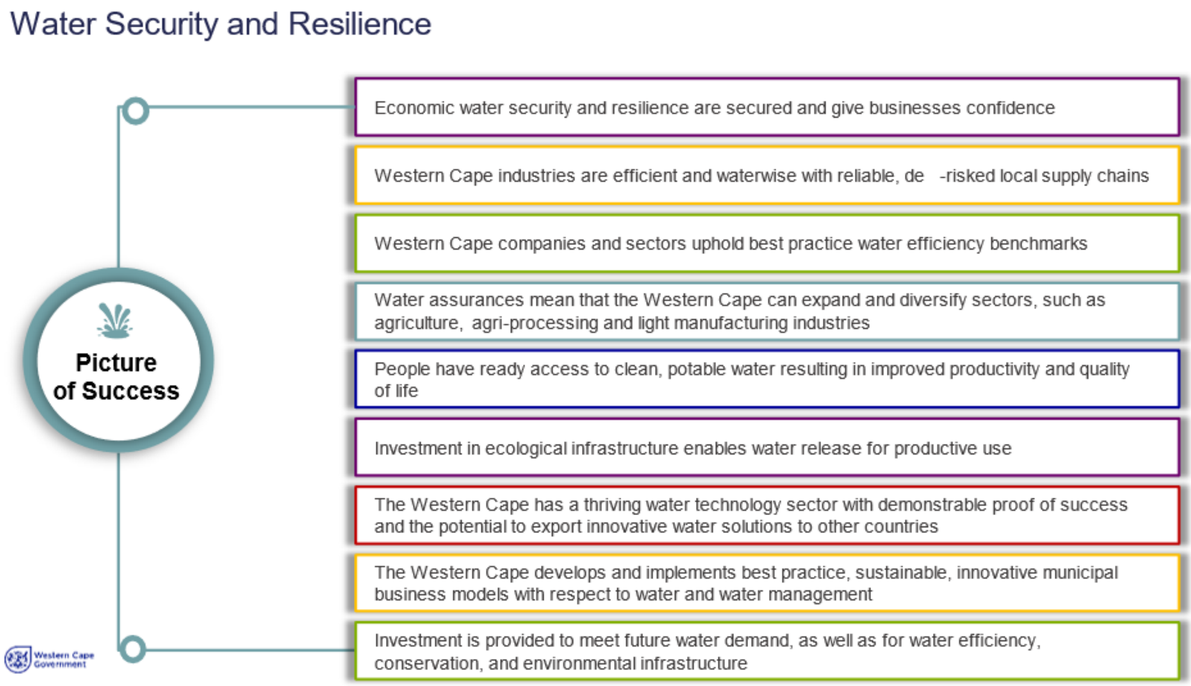


Figure 28 Water Security and Resilience

5.2.5 Sustainable Water Protection Plan

The Western Cape Sustainable Water Management Plan (SWMP) has been revised and aligned with the WCG's 15-year Western Cape Integrated Drought and Water Response Plan for the 2024-2029 period. Renamed the Sustainable Water Protection Plan (SWPP), it now integrates into the province's comprehensive water management strategy. This plan outlines a strategic, step-by-step approach to sustainably manage water in the Western Cape, emphasising integrated pollution management across our catchments. The implementation focuses on three key areas:

Water Quality and Pollution, Ecological Infrastructure, and Water Sensitive Design.

Numerous initiatives have been undertaken as part of the Environmental Resource Protection Programmes, enhancing water security. These include the Water Quality monitoring program and Riparian Rehabilitation projects. Efforts to improve water quality, such as those at the Water Hub in Franschhoek, the promotion of Nature-based Solutions and water sensitive design principles, and the investment framework for water-sensitive design in the Huis River catchment (Barrydale), highlight proactive approaches to bolstering water security. Additionally, assessments of the ecological and economic value of the Kluitjieskraal and Romansrivier wetlands contribute to these efforts.

Furthermore, the plan addresses pollution management reactively, tackling numerous pollution incidents and complaints to enhance water quality and security.

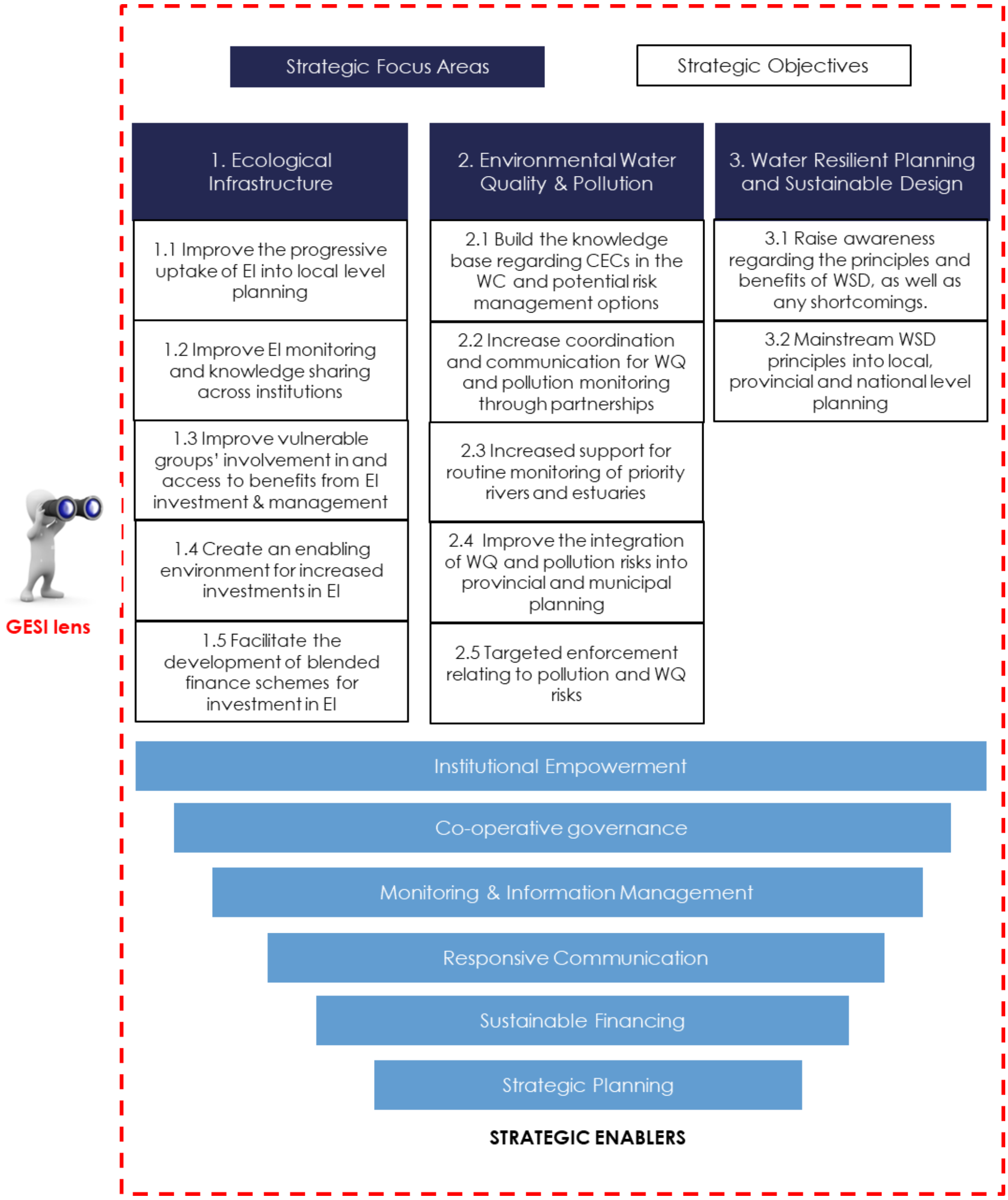


Figure 29 Summary of the strategic framework of the 2024 – 2029 WCSWPP

The WCSWPP incorporates a Gender, Equity, and Social Inclusion (GESI) perspective to guide activities and evaluate strategic goals in the Western Cape, ensuring fairness and non-discrimination. This approach actively addresses inequalities by empowering marginalised groups such as women and youth, challenging unequal power dynamics, and promoting their involvement in sustainable water management decisions. Without GESI considerations, the plan risks inadvertently discriminating based on various factors like gender, race, and cultural beliefs. The GESI framework identifies and addresses root causes of inequality, aiming to foster inclusive participation and equitable outcomes across five key pillars for effective water management and protection.

The WCSWPP is underpinned by the same four Goals as the 2012-2017 WCSWMP. These goals provide the platform to enable effective collaboration for improved water security as a fundamental first step to enable effective co-operative governance for the water resources of the Western Cape Province.

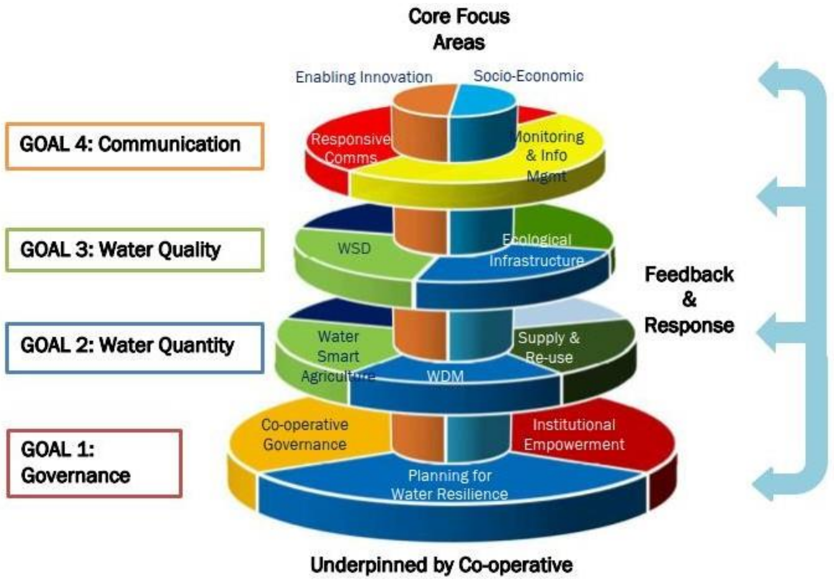


Figure 30 Goals and 12 Focus Areas of the 2017-2022 WCSWMP

Source: WCSWPP (2024)

5.2.6 Implementation

Large water supply projects being implemented in the Western Cape include the Berg River-Voëlvlei (Phase 1) (BRAVAS) Augmentation and preparatory work to raise the Clanwilliam Dam wall has begun (but since stalled).

City of Cape Town continues with the planning and implementation of the various water augmentation projects identified in the Water Strategy and remains committed to developing an additional 300 million litres of water supply from diversified sources by 2030 (CoCT Water Outlook, 2023). This Water Augmentation Plan supports the following implementations at current across the Cape Town:

- Sustainable Groundwater Utilisation
- Monitoring and numeric modelling of aquifer storage and water quality
- Groundwater Protection Plan
- Managed Aquifer Recharge
- Community Outreach Initiatives

An updated schedule showing the latest timing and capacity of the schemes forming part of the City of Cape Town New Water Programme is contained in Table 20. The City of Cape Town remains on track to increase the supply by 300 Ml/d by 2030.

Table 20 City of Cape Town New Water Programme

Description	Revised First Water Date	Capacity (Ml/d)
Table Mountain Steenbras Phase 1	21 to 24	25
Table Mountain Nuweberg Phase 2	Jun-35	15
Table Mountain Groenlandberg Phase 3	Jul-35	12
CFA Strandfontein West	Jun-23	6
Cape Flats Aquifer: Hanover Park	Jun-25	4.8
Cape Flats Aquifer: Strandfontein North & East	Jun-26	18
Cape Flats Aquifer: Philippi	Dec-26	7.2
CFA Mitchells Plain WTP	Jun-27	24
Atlantis Aquifer	Jun-24	13
Berg Voelvlei River Augmentation Scheme	Jun-25	41
Faure New Water Scheme Phase 1	May to Sept-28	70
Desalination Phase 1	Feb 30	50 to 70
Clearing Invasive Alien Plants	July 22 to July 26	~ 30
Optimal management of the WCWSS	Ongoing	~ 25
		~ 341 to 361

Source: City of Cape Town Water Outlook (2023)

Cape Town's water strategy aims to reduce its reliance on surface water schemes by 25% by 2040. This entails focusing future water augmentation efforts on water reuse, desalination, and groundwater schemes. The adaptable program is designed to plan for future water needs without requiring immediate implementation decisions (City of Cape Town Water Outlook, 2023).

5.3 Green Drop programme

The Green Drop Programme for wastewater is an initiative to improve the standard of wastewater management in South Africa and thereby reduce negative impacts on the water bodies into which they discharge. A Green Drop score is awarded to an individual wastewater system based on the audit process which measures performance against 5 Key Performance Areas (KPA), plus a suite of bonuses and penalties. The individual audit scores aggregate as a single (weighted) institutional Green Drop audit score. The score is weighted against the design capacities of the individual treatment plants. This score serves as a Performance Indicator of the capacity, compliance, and good practice that the institution attains against the Green Drop Standards, which have been derived from national and international standards. A wastewater system that achieves ≥90% Green Drop score, is regarded as excellent. A system that achieved <31% is regarded as a dysfunctional system which would require appropriate interventions. (DWS, 2022a).

Despite an upward trend in the Western Cape's previous Green Drop average scores between 2009 and 2013, there was a regression in performance between 2013 and 2021. The number of systems with GD scores of ≥50% decreased from 123 (78%) in 2013 to 109 (69%) in 2021. The number of systems with GD scores of ≤50% increased 35 (22%) in 2013 to 49 (31%) in 2021. The Green Drop Certifications decreased from 26 awards in 2013 to 12 awards in 2021:

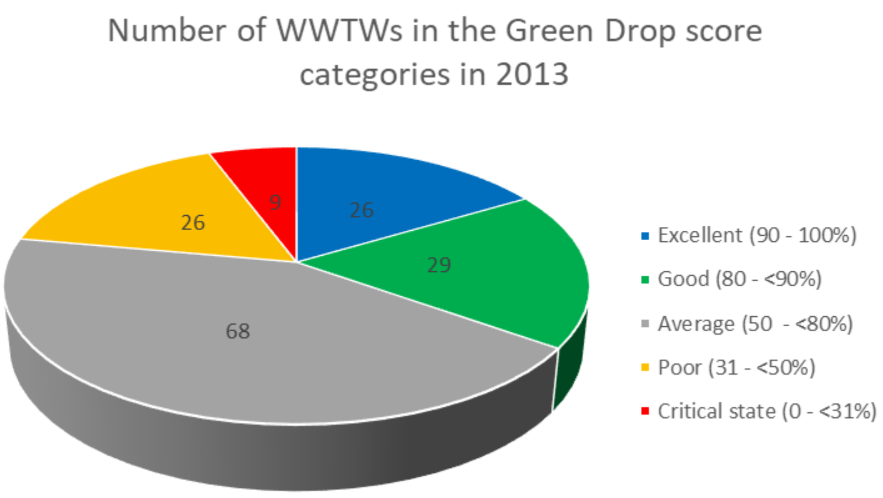


Figure 31 Number of WWTWs in the Green Drop score categories (2013)

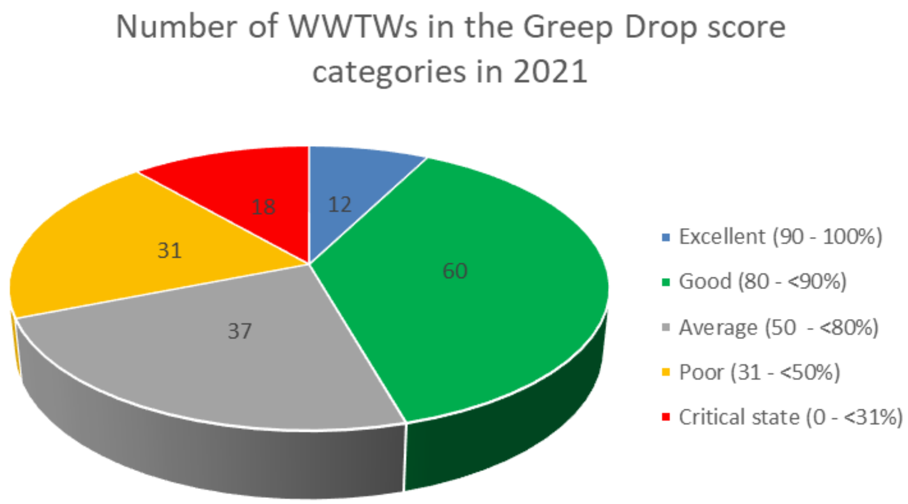


Figure 32 Change in Green Drop status of Western Cape WWTWs between 2013 and 2021

Source: DWS, 2022a

When comparing Green Drop assessments for 2009, 2011, 2013 and 2021, many of the system scores are between 50-80% category (average performance), with the 80-90% (good performance) being the next largest category. The most concerning finding for 2021 is that 18 systems are in critical state (<31%) compared to 9 systems in this category in 2013 (DWS, 2022a).

5.4 Invasive Alien clearing

Improved catchment management, in particular the clearing of alien vegetation, could augment water supplies in many catchments in the Western Cape and is the principal focus of the Working for Water programme. The programme works in partnership with local communities, other government structures, research foundations and private companies. Working for Water has cleared the Upper Berg River riparian zone, the Berg River Dam catchment and the riparian zone near Darling (DWS, 2016). Clearing of the upper reaches of the Berg River yielded an estimated additional 26.5 million cubic metres of water per annum to the system (DWS, 2016).

Although the Working for Water programme is managing to clear some areas, it is not sufficiently resourced to clear enough land to control infestations (Van Wilgen et al. 2008, 2012). The WCSWPP

(2024) highlights that management of catchments require well planned and supported investments in ecological infrastructure. The Western Cape Ecological Infrastructure Investment Framework (EIIF) accordingly aims to proactively protect priority water resources through amongst other mechanisms, management of invasive alien species in a co-ordinated manner.

5.5 Reconciliation strategies

The Reconciliation Strategy of 2021/2022 utilises the 1:50-year recurrence interval yield (98% reliability) for scenario comparisons. However, the City of Cape Town is currently strategising its bulk water supply with a higher reliability standard of 1:200-year recurrence interval yield (99.5% reliability), which amounts to 545 million m3/a. The spread of invasive alien plants has significantly diminished streamflow, particularly upstream of major dams. The occasional substandard water quality in the Berg River, below European Union standards, poses a serious threat to the sustained viability of the irrigated agriculture sector in the export market.

City of Cape Town

This chapter references how the City of Cape Town is enhancing its water security by implementing the committed New Water Program. This program includes the utilisation of groundwater in the Table Mountain Group, Cape Flats, and Atlantis Aquifers, the Faure New Water (reuse) Scheme Phase 1, and Desalination Scheme Phase 1, all scheduled for completion by 2030. In collaboration with other partners through the Greater Cape Town Water Fund, particularly through The Nature Conservancy's implementation, efforts are underway to clear invasive alien plants.

Saldanha Bay Local Municipality

The Saldanha Bay Local Municipality has expanded the Langebaan Road Aquifer. In collaboration with the Greater Cape Town Water Fund, involving the City of Cape Town and other partners, and executed by the not-for-profit organisation The Nature Conservancy, efforts are being made to clear invasive alien plants. Additional organisations have also participated in clearing activities within the strategy area. Although the implementation of the BRVAS Scheme has faced delays due to extended user agreement timelines, notable progress has been achieved.

5.6 Inland water ecosystem health and water quality initiatives

5.6.1 Other river and wetland rehabilitation initiatives

An ongoing project to clean rivers and wetlands was initiated in CCT in 2011, with R21 million allocated for 2016/2017 (GroundUp, 2017). The project regularly cleans 24 rivers, three dams and 22 wetlands. "Cleaning" is undertaken by Expanded Public Works Programme (EPWP) teams and includes litter removal and clearing of invasive alien plants. Some water quality tests suggest that the project has improved local water quality (GroundUp, 2017).

A large number of community initiatives and private-public partnerships have also responded to inland water challenges. For the sake of brevity, only a few are listed as examples:

- Friends of the Liesbeek run a river maintenance project sponsored by the ABAX foundation and the South African Breweries, which includes cleaning the river edge, removing invasive alien plants and replanting of indigenous vegetation;

- Rehabilitation of the Rooi River, near George, is being implemented by Hilland Associates and CapeNature in accordance with the river health programme. It includes removal of alien vegetation and cleanup of debris, such as litter, from the rivers;
- The Berg River improvement Programme has revegetated sections of the upper berg River riparian zone. It is an ongoing programme that aims to enhance the ecological functioning of the Berg River through multi-partner and community interventions (DEA&DP, 2012b; DEA&DP, 2014);
- The Peninsula Paddle draws attention to the state of Cape Town's urban rivers; and
- FruitLook is a project that provides relevant and timeous satellite-based information to the fruit and wine sectors to help them use water more efficiently.

5.7 Research and data management

Water research in South Africa is supported by an act of parliament. The Water Research Commission, and funding thereof, was established by the Water Research Act 34 of 1971 (WRA). The objective of the commission is to establish water research priorities, promote water research and generate new knowledge. It is also a vehicle to fund water management priorities and promote effective transfer of information and technology (WRC, 2017b).

Water research is also a key focus at universities in the Western Cape. Research on water sensitive urban design, which includes stormwater harvesting and rainwater tanks may provide more options to increase water availability.

Data collection and management is also a key response to the challenge of managing inland water. Although it produces no direct results (i.e. collecting data does not in itself save water), it underpins decision-making and can track the efficacy of other responses. DWS has a national data collection network for water quality, ecosystem health, river flows and dam levels, accessible through the DWS website (DWS, 2017). Municipalities also regularly collect and report water supply and consumption data (DWS, 2015a). The status quo reports for Reserve determinations also provide a comprehensive set of data, particularly for ecosystem health (DWS, 2017a; DWS, 2017b; DWA, 2011b).

DWS and the CMA is currently implementing a Validation and Verification Process for abstraction and storage uses in all 4 water management areas, to ascertain and, if necessary, rectify over-allocations, and verify water uses. As part of this process, additional data collection, such as metering of agricultural areas and boreholes, is being implemented. Registration of water uses for wastewater related uses (waste discharge charge system) is also underway. The WCWSS has a decision support system and monitoring network (currently being implemented) with real time monitoring (DWS, 2023a).

5.8 Mitigation and adaptation

Many businesses and individuals are seeking new and innovative ways to respond to water restrictions, for example, installing water efficient devices in bathrooms and cooling systems, in situ grey and blackwater reclamation plants, drilling boreholes etc. While many of these are small scale responses, there could be extensive impacts associated with e.g. over utilisation or pollution of groundwater resources if not adequately managed and monitored.

An integrated approach to innovation to improve water supply, water quality and demand management is required in terms of the SWMP. It is recognised at provincial level, that innovation should extent to the business sector and institutional structures and should include the exploration of models for public-private partnerships.

6 CONCLUSION

OUTLOOK: DECLINING

Multiple factors are contributing to the declining state of the Western Cape water resources. The Western Cape faces multifaceted challenges as its infrastructure experiences degradation, with vandalism and theft posing a significant and largely unaddressed threat due to insufficient security funds. This not only jeopardises the functionality of critical water systems but also contributes to ecosystem degradation. Furthermore, the increased likelihood of extreme weather events, attributed to climate change, magnifies the vulnerability of the area, with a three to fourfold rise in the probability of experiencing events with a 1:200 to 1:400 year recurrence. The insufficient management of catchments and river maintenance exacerbates these risks, particularly for infrastructure vital to transportation and tourism, placing them at increased susceptibility during flooding events. Urgent and comprehensive measures are essential to mitigate these challenges and enhance the resilience of the region's water infrastructure – ultimately to improve the declining water resources trend. Moreover, it relies on a whole-of-society approach and collective management which is key to effective water resilience planning, particularly in rapidly growing urban areas.

The impacts of the poor state of inland water range from increased water treatment costs to loss of biodiversity and ecosystem services in modified rivers. Economic impacts can include infrastructure damaged by floods and reduced crop yields and job losses if water availability is severely restricted. Of particular concern is that human health is at risk especially through contact with water with microbial contamination. Also, water availability is extremely important as any failure in water provision could have major health and economic impacts.

The Western Cape continues to face a critical water resource deficit, a challenge exacerbated by the necessity to allocate water for ecological reserves – which acts as a buffer for social and economic resilience. The water infrastructure is under significant threat of continued deterioration, raising concerns about its long-term sustainability and functionality. Load shedding poses an additional major risk, particularly concerning water quality, as the intermittency in power supply can disrupt essential processes and treatment systems. Furthermore, there is a pronounced inadequacy in the skills and capacity of skilled technicians, hindering effective maintenance and management of the water infrastructure. Addressing these challenges requires a comprehensive approach, including strategic planning, investment in infrastructure upgrades, and initiatives to enhance technical expertise and capacity within the water management sector.

The state of most inland water in the Western Cape is summarised in Table 21.

Due to the decrease in system yield, the Western Cape Water Supply System (WCWSS) is **presently over-allocated.** Consequently, the Western Cape economy faces water constraints, even when the region's dams are full. The inadequate access to water and the lack of reliable supply assurances have a detrimental impact on economic growth. According to projections, economic benefits are anticipated to be realised once these constraints are at least partially alleviated.

The Western Cape planning has improved specifically for planning on water availability, as key lessons have been learnt from the provincial drought event. As a result, the Western Cape has positioned itself well in terms of water planning: water management, water supply, planning and investigations for augmentation. This is to ensures that the Western Cape has additional or alternative sources of water availability when the next major drought event occurs. This strategic planning and management together with good rainfall since 2019 – above average rainfall in 2023 – has seen a water context for the Western Cape that has not necessitated any major water use restrictions to be put in place in the recent years. This chapter has demonstrated that

management of the Western Cape water systems has improved. With climate change leading to an increase in the expectations for drought and extreme drought events, it is imperative for the Western Cape to develop and implement strategies aimed at mitigating these impacts. This involves better managing land use and safeguarding water resources – all of which is currently under way in the Western Cape. Based on DWS recommendations, this chapter also reports on the need for monitoring and enforcing compliance with Reserve and Resource Quality Objectives, as well as undertaking efforts to rehabilitate water resources that have degraded to an unsustainable state.

At local government level, various project and planning work have been implemented to augment supply and as an overall state, the partnerships and relationships between Western Cape water users can be described as stable.

However, due to other variables including the rapid expansion of the Western Cape province, the high demand for water consumption and various long-term water quality issues that have exacerbated in the recent years. The good progress and stable circumstances by itself do not translate into an overall stable or improving state of inland water for the Western Cape. It could perhaps be demonstrated that as a result of the major drought event and resulting water availability shock, much focus has been placed on water quantity – whereas water quality remains a concern and gaps in monitoring and data are still noted. Data (outdated but the only available data) from the State of Rivers Report (2018) indicate that just over 10% of rivers and wetlands have water quality that is considered "ideal" for use, with largely unmodified ecosystems – update from State of Rivers. Areas of concern remain the Western Cape river sites in densely populated regions which have indicated poor conditions due to the lack of proper management and maintenance of sewage treatment works and the exceeding of carrying capacities.

The wetlands across the Western Cape are currently facing considerable pressure due to agricultural practices and also due to high volume abstraction of groundwater – for example the Sandveld region, which is impacting groundwater supplies and cumulatively, wetlands. Individual analyses of each dam within the WCWSS revealed that the yields of several dams are significantly impacted by the current spread of Invasive Alien Plants (IAPs). Among these dams, Theewaterskloof and Voëlvlei dams are particularly affected, experiencing the most pronounced reductions in yield.

The future of the Western Cape Water Supply System (WCWSS) is anticipated to witness a substantial increase in groundwater use. However, for this escalation to be sustainable, it is imperative to address various challenges associated with groundwater resource management concurrently with the development efforts. These challenges stem from insights drawn from comprehensive groundwater resources management and planning studies conducted in the region over the past approximately 15 years. Notable examples include the Berg WAAS and the Berg Water Resources Classification Study, along with pertinent research studies that contribute to shaping the understanding of groundwater dynamics in the region. Addressing these management challenges in parallel with development initiatives is essential for ensuring the long-term sustainability of increased groundwater utilisation. As an illustration of local level implementation, for the City of Cape Town, implementation of its the New Water Programme heightens the likelihood of necessitating water restrictions. Monitoring the growth in water demand is crucial, and adjustments to the implementation of the Adaptable Programme are being made accordingly. It is recognised that water reuse and desalination play pivotal roles in securing long-term water availability, however it requires feasibility and planning studies to ensure readiness for future water demand projections. This is indicative of the on-going effort to ensure that the Western Cape's state of water shifts from a declining state to a stable or improving state.

Table 21 Summary of the outlook for inland water in the Western Cape

Indicator	Quantification	Target/desired State	Trend
Water availability	• The WCWSS is currently over-allocated. • The Western Cape economy faces water constraints, regardless of good rainfall seasons. • All agricultural water has been fully allocated in the Western Cape – effort must be placed to develop alternative sources and to improve agricultural efficiency. • The yields of a number of dams within the WCWSS remain affected by the existing spread of IAPs. Positive factors that can be stressed: • The majority of the Western Cape province is not currently experiencing any droughts. • There has been a significant renewed effort towards expanding water supply capacity in the Western Cape.	No yield exceedances Adequate water supply for all towns	**Decline**
Fitness for use	• 18 water systems within the Western Cape are currently in a critical state; an increase from 9 systems in 2013. • The provincial Risk Ratio for treatment plants has remained relatively stable, changing only slightly from 52.7% in 2013 to 53.1% in 2021.	No intolerable water quality Zero stations with extremely high levels of microbial contamination Ecological functioning	**Decline**
Freshwater ecosystem health	Ecological state of rivers (PES): • 50% unmodified, natural, largely natural • 17% moderately modified • 20% largely or seriously modified Strategic Water Source Areas (SWSA): • Despite the importance of SWSAs, the majority are only partially protected. The quality of water streams in urban is the concern; if this water quality matter is not dealt with the expectation is for this to decline in state for near future. The current stable state is upheld by water authorisations and reviews such as freshwater ecosystems which are consistently considered with new developments and planning. Resource quality objectives are guiding this and act as	No streams seriously or critically modified	**Stable**

	a clear guideline for development. Other than Western Cape urban areas, there is no critical decline in state of rivers based on parameters from habitat assessments etc. which are not indicating a steep decline.		

Addressing the drivers of microbial contamination, such as poverty and informal settlements, may require central government consideration. Lastly, prioritising efforts to rehabilitate inland water ecosystems is essential. Further key aspects for inland water are summarised in Table 22.

Table 22 Overview of key inland water aspects

Aspect	Summary of key points
Pressures	• Infrastructure degrading • Vandalism and theft is a massive threat and very little is being done to deal with behaviour change – insufficient security funds to secure infrastructure which manifests as ecosystem pollution and decline • Climate Change attributions are showing we are 3-4 times more likely to experience 1:200- 1:400 year events • Insufficient catchment management & river maintenance resulting in pressures and flood risks and threats to transport and tourism infrastructure • Human Settlements • Agriculture and industry • Invasive alien species • Climate change (droughts and floods) • Municipal financial stability critical to good water basic services • Water quality at increased risk especially from informal settlements, lack of enforcement and loadshedding • Severe weather events are not receiving sufficient resources to a) reduce risks and b) repair damage • Water services revenue is a high risk for B Municipalities • Non-revenue losses are not being resolved
Impacts	• Loss of ecosystems and ecosystem services • Illness from contact with microbial contamination or other contaminants • Economic – increased treatment costs of poor quality water • Economic – infrastructure damage from flooding • Economic – reduced production leading to job and export losses • Economic – possible loss of revenue • Gender disparities in access and use of water • Gender disparities in impact of water quality on health (menstrual and maternal health) • Disparities in service experiences
Challenges	• Water resource deficit • Allowance for ecological reserve • water infrastructure is at substantial risk of continued deterioration. • Loadshedding is a major risk to Water Quality

	• Skills and capacity for skilled technicians is inadequate
Progress	• Classification and RQO's have been completed • Updated reconciliation studies available • WCWSS and town reconciliation plans that include plans to increase supply and lower demand • Green Drop Programme and infrastructure grant programmes • Work for Water and Working for Wetlands • Community, government and industry initiatives to rehabilitate rivers and wetlands • Groundwater implementation and metering • Validation and verification process for abstraction and storage uses
Critical areas for action	• Supply-side management • Infrastructure Maintenance • Demand-side management • Co-ordinated water infrastructure oversight and investment • Alternative water costing models for municipalities • Regular updates of the hydrology used for modeling are essential for comprehensively understanding the water availability within the Western Cape Water Supply System (WCWSS). • Immediate action is imperative to halt the continued spread of Invasive Alien Plants (IAPs) in the catchments of the WCWSS, with particular emphasis on the upstream catchment area of Theewaterskloof Dam. • Local authorities must actively manage storm water quality in areas of jurisdiction • Continuation of demand management: minimising consumption and losses • Optimisation and increasing of water supply, integrated the management of water resources, and enhanced the adaptive capacity of business and citizens with respect to water usage to improve resilience, competitiveness, and quality of life for all its people, so that the Western Cape has sufficient water supply to achieve its economic growth aspirations. • Poverty alleviation and formalisation of informal settlements to reduce contaminated runoff from these settlements • Minimising impacts of wastewater treatment plants on inland water (for example, through initiatives such as Green Drop Programme and the infrastructure grant programmes) • Reducing eutrophication • Proceed with implementation of Resource Quality Objectives • Protecting streams that remain natural with ecosystems intact and adhering to resource quality objectives • Ongoing data collection and analysis • Aligning leadership and empowering institutions tasked with water management • Diversification of water resources and reducing dependency on surface water

	• Management of water information and effective water billing

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