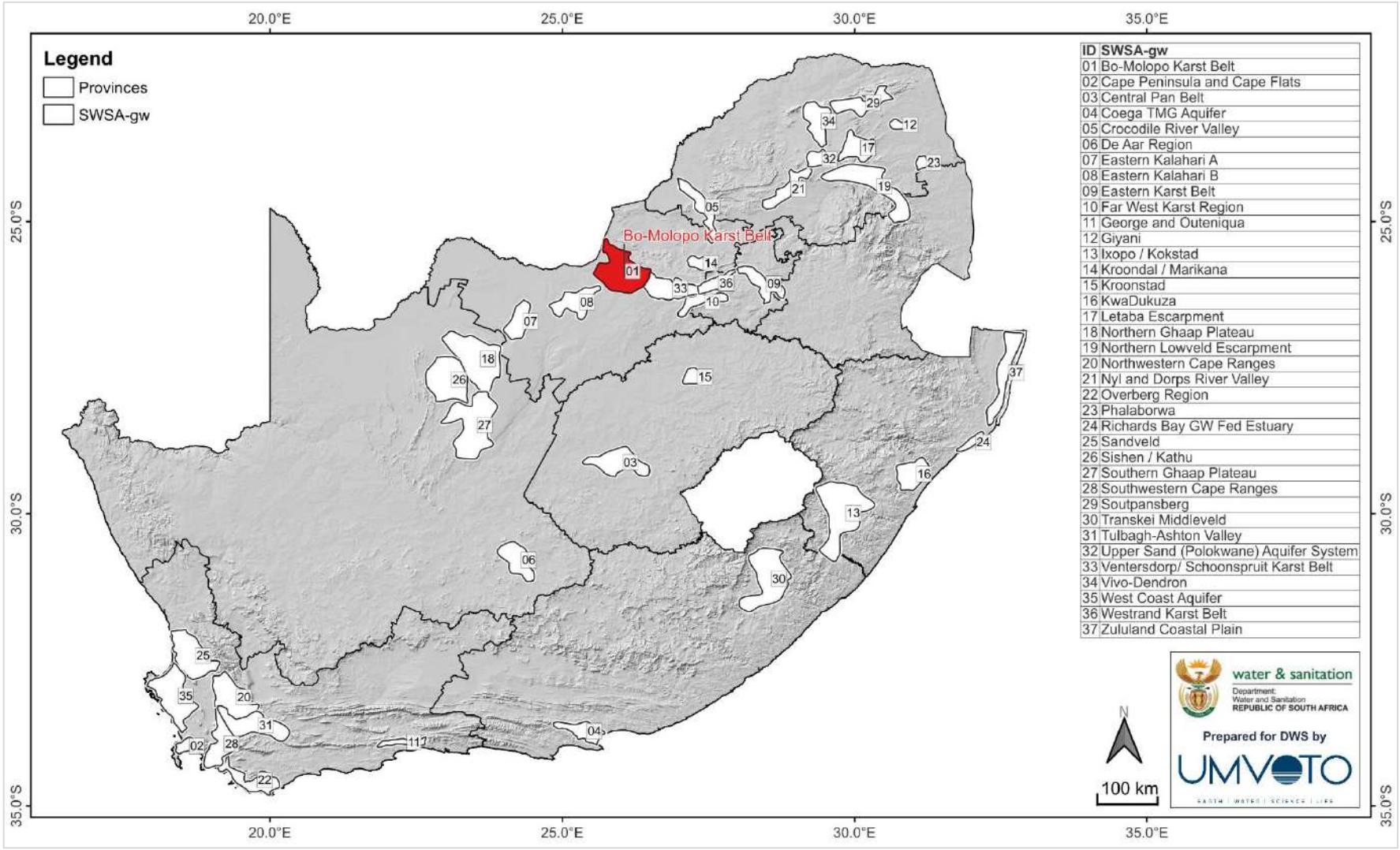
APPENDIX 01

BO-MOLOPO KARST BELT SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE BO-MOLOPO KARST BELT SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

1 Bo-Molopo Karst Belt

1.1 Description

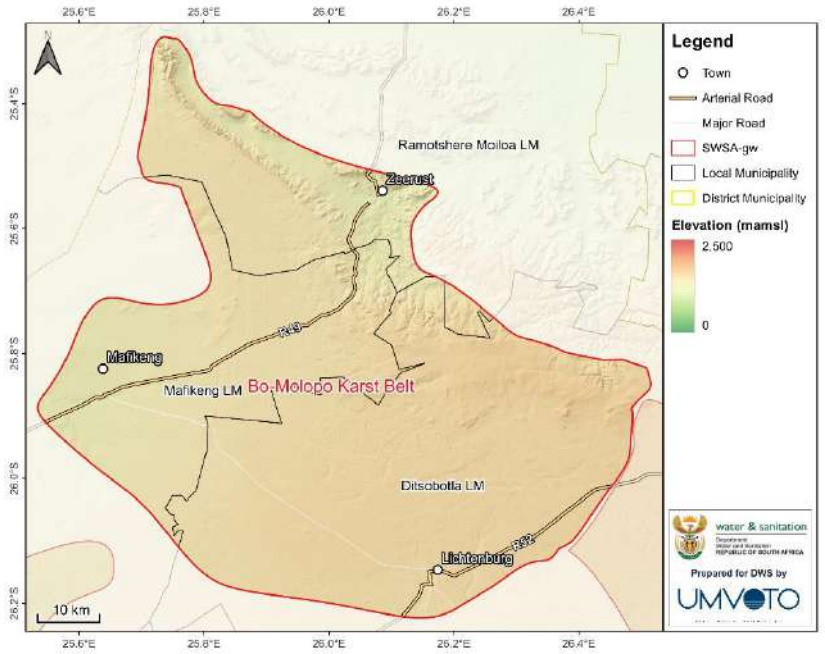
SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km^2
Elevation:	1150 to 1637 mamsl

Geospatial Context

The topography of the Bo-Molopo Karst Belt SWSA-gw, as depicted in the map, is characterized by gently undulating plains, low hills, and scattered rocky outcrops, typical of the transition between the Highveld and Bushveld. The Lichtenburg area is predominantly flat to gently rolling, while dolomitic sinkholes and shallow depressions are common due to the area's limestone-rich geology. Towards Zeerust, the terrain becomes more rugged, with low ridges and rocky hills emerging as part of the Bushveld landscape, interspersed with dry riverbeds and shallow valleys.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	North West
District Municipality	Ngaka Modiri Molema
Local Municipality	Ditsobotla, Mafikeng, Ramotshere and Moiloa
Towns	Zeerust, Litchtenburg, Libertas, Mafikeng and Seweding
Major Roads	R52, R49 and N4
Major Water Supply Networks	



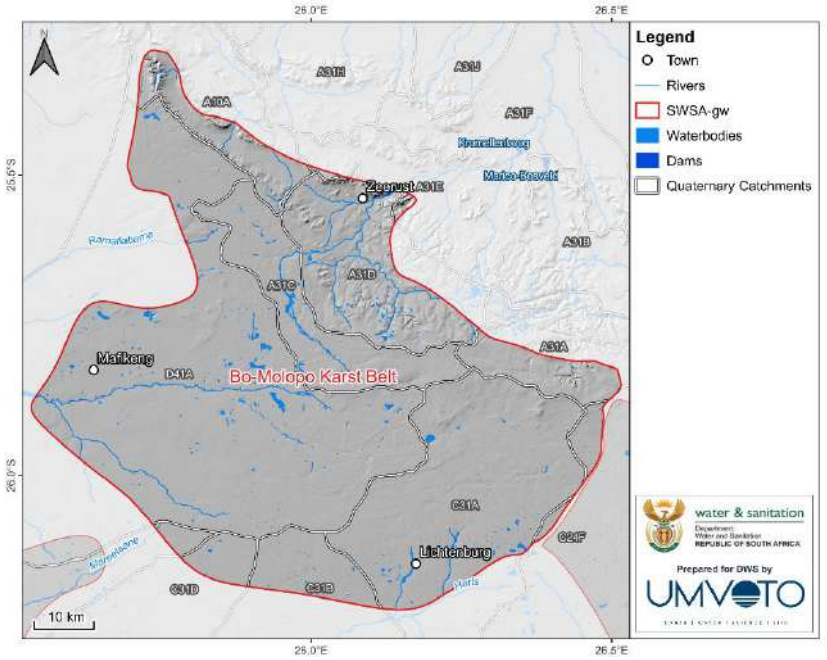
Locality map of Major Towns, District and Local Municipalities in the Bo-Molopo Karst Belt SWSA-gw.

SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km^2
Elevation:	1150 to 1637 mamsl

Hydrology and Drainage

The Bo-Molopo Karst Belt SWSA-gw and surrounding areas include a few major surface water systems, summarised below and displayed in the map on the right. The D4 catchment feeds the Lotlamoreng and Cookes Lake reservoirs, while the Little Marico Poort and Manana026IP reservoirs are fed by the A3 catchment. There are also several perennial rivers flowing in varying directions. Klerkskraal reservoir and Mooi and Skoonspruit perennial rivers, flowing north and south respectively, are fed by the C2 catchment.

Quaternary Catchments	D41A, C31D, C31B, C31A, C24F, A31A, A31D, A31C, A31E and A10A
Rivers	Perennial: Polfonteinspruit, Klein-Marico, Kareespruit, Harts, Rhenosterfontein
	Ephemeral: Klein-Harts, Lotlhakane, Molopo, Malmanieloop, Ramatlabama
Natural and manmade water bodies	
Major Dams:	Lotlamoreng, Cookes Lake, Little Marico and Poort Manana026IP
Water Management Areas:	Vaal Orange and Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Bo-Molopo Karst Belt SWSA-gw.

SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km^2
Elevation:	1150 to 1637 mamsl
Geology	

Geology

Quaternary surface deposits, soil cover, and Tertiary deposits of calcrete, calcified pandune, and surface limestone are predominantly found along the western edge of the Bo-Molopo Karst Belt area.

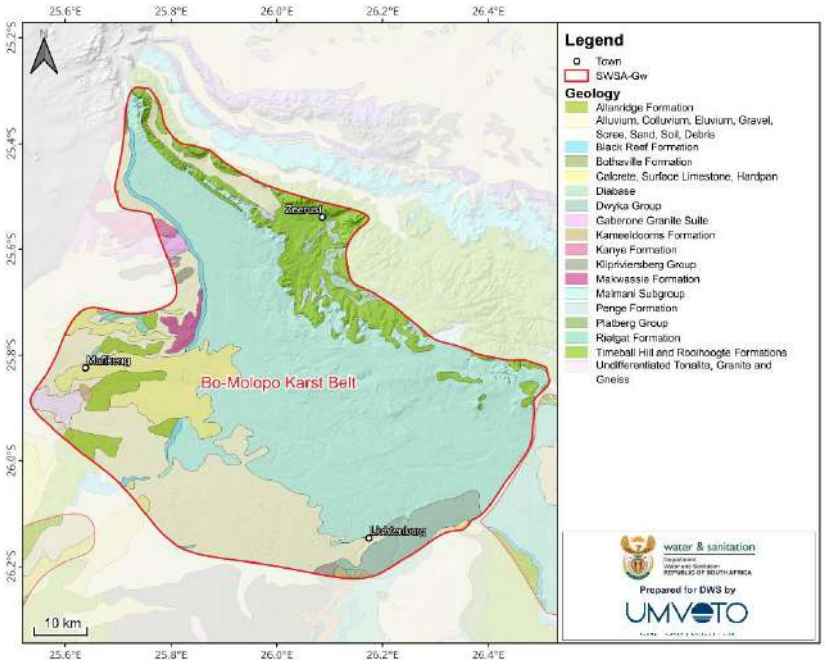
In the southern section, the Dwyka Group of the Karoo Supergroup outcrops, consisting of diamictite, varved shale, mudstone with dropstones, and fluvioglacial gravel.

The majority of the area is covered by the Transvaal Supergroup. The Chuniespoort Group curves through the centre of the region, extending from the north to the east, with the Black Reef Formation outcropping to the south and the Pretoria Group to the north. The Chuniespoort Group is dominated by the Malmani Subgroup, which consists of dolomites, cherts, and minor shale and limestone. The Pretoria Group is characterised by quartzites, mudrocks, and breccias.

The Ventersdorp Supergroup outcrops in the western section, located between the Quaternary and Tertiary deposits, are comprised of andesitic lavas, tuffs, breccia, conglomerate, greywacke and shale.

Hydrostratigraphy

Shallow, unconfined intergranular aquifers occur in Quaternary and Tertiary deposits along the western edge, while deeper secondary aquifers are found in fractured volcanic and sedimentary rocks. The Chuniespoort Group, dominated by karstic dolomites, forms a secondary aquifer system. The Ventersdorp Supergroup consists of fractured volcanic rocks, creating secondary fractured aquifers. In the Lower Vaal and North West regions, chert-rich dolomites form karstic aquifers.



Geology Map of the Bo-Molopo Karst Belt SWSA-gw region.

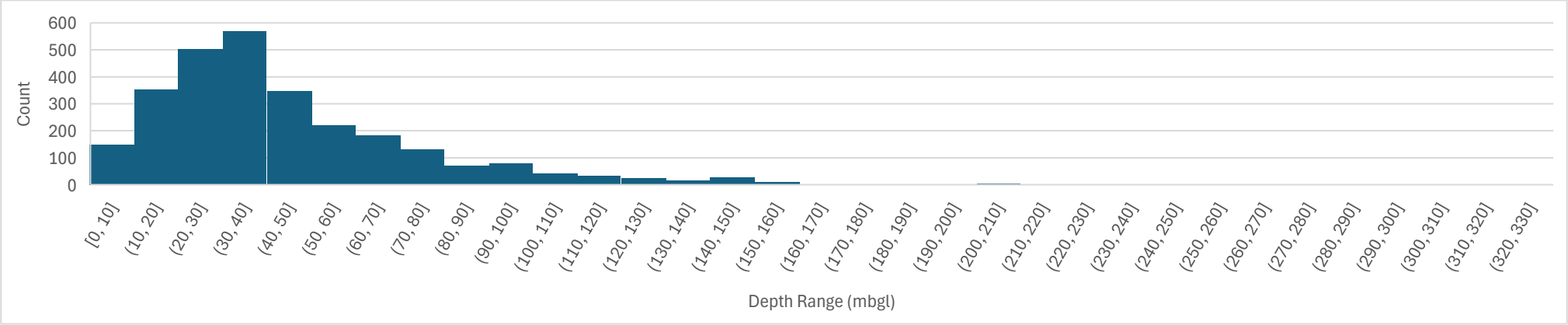
1.2 Current Status

SWSA-gw Name:	**Bo-Molopo Karst Belt**
Area:	**5268 km²**
Elevation:	**1150 to 1637 mamsl**
Quantity & Quality	
Aquifer Classification	

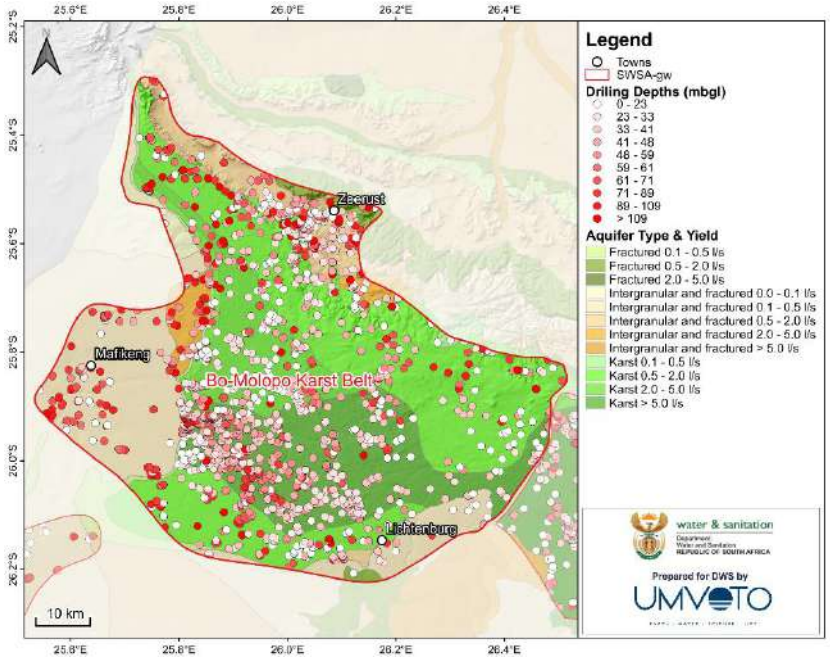
The aquifer systems within the Bo-Molopo Karst Belt SWSA-gw exhibit varying yields across karst and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is a combination of major and minor aquifer systems. The major aquifer system has an average karst yield ranging from 0.1 to over 5.0 l/s, as well as an average dual-porosity yield between 0.1 to 0.5 l/s. The minor aquifer system has a dual-porosity yield ranging from 0.0 to 0.5 l/s, with a karst yield of 0.5 to 5.0 l/s.
Groundwater Targets	The average drilling depth is 46 mbgl, and the most common depth is around 30 mbgl. The majority of the boreholes target the shallow karst aquifer system, with minimal deeper boreholes (> 200 mbgl) targeting the fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 25 and 57 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 21 mbgl, with values ranging from 0 to 91 mbgl and a standard deviation of ~ 13 mbgl.

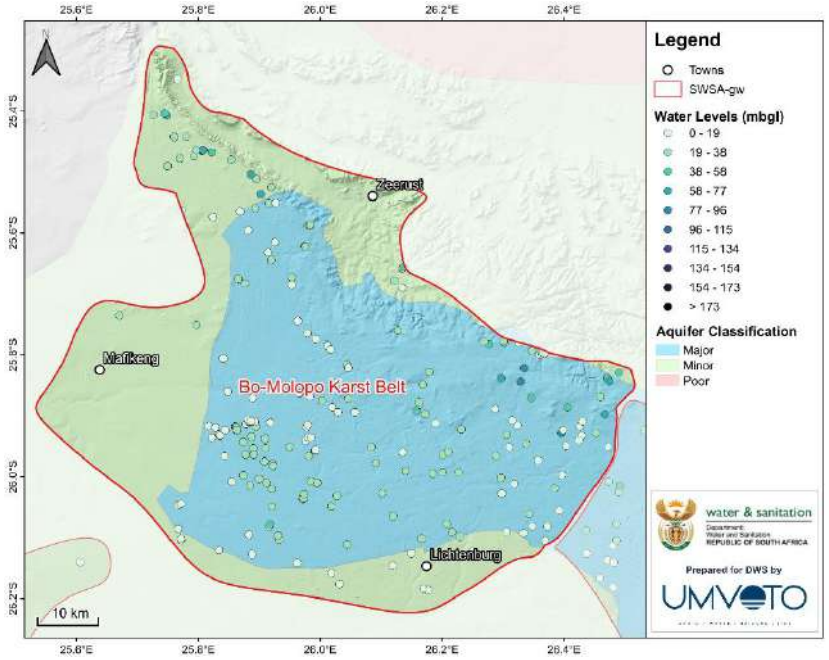
Graph of NGA drilling depths of the Bo-Molopo Karst Belt SWSA-gw region



SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km^2
Elevation:	1150 to 1637 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Bo-Molopo Karst Belt SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Bo-Molopo Karst Belt SWSA-gw region.

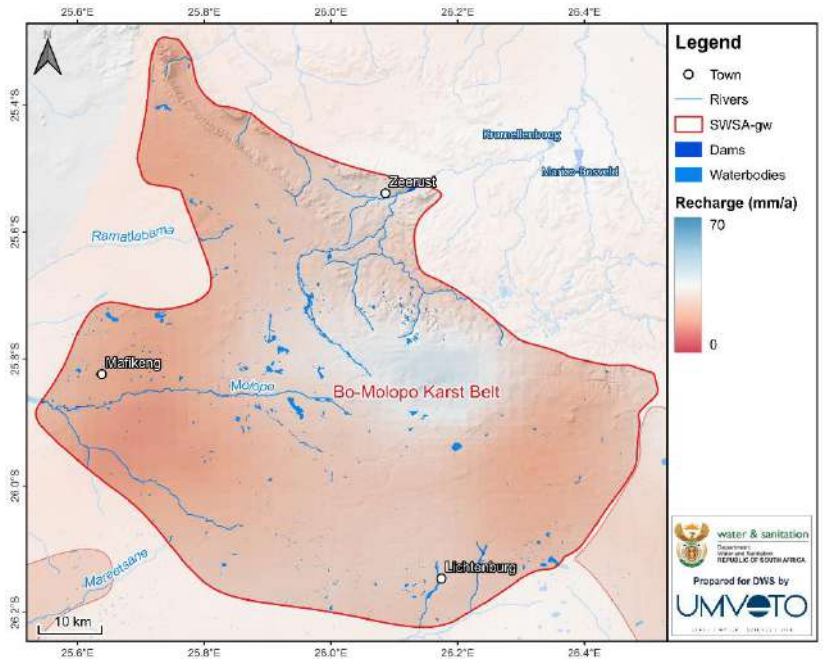
SWSA-gw Name:	**Bo-Molopo Karst Belt**
Area:	**5268 km^2**
Elevation:	**1150 to 1637 mamsl**

Quantity & Quality

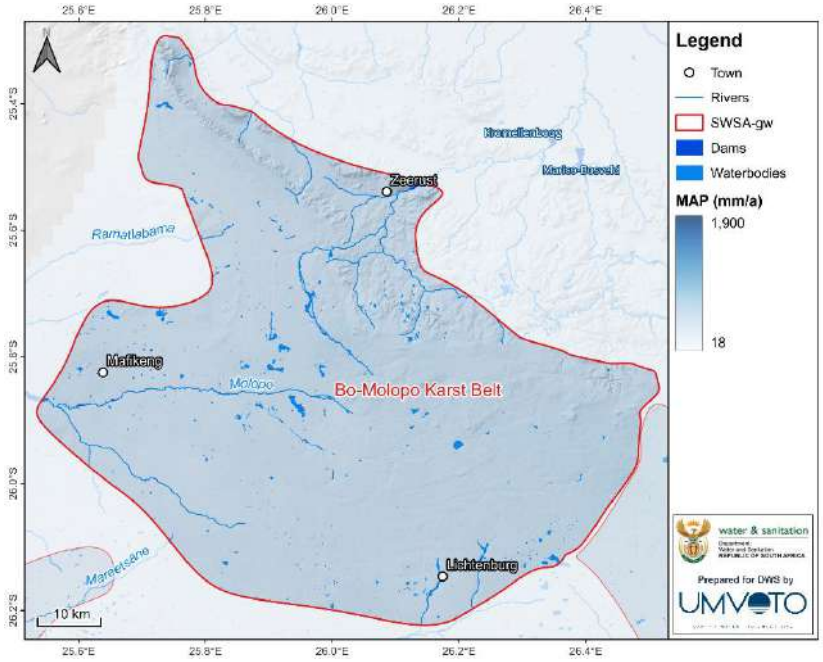
Groundwater Recharge

The Bo-Molopo Karst Belt receives a total MAP volume of 2820 Mm^3/a, with an average rainfall of 535 mm/a. However, only 130.7 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 4.6% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Bo-Molopo Karst Belt	2820	535	130.7	24.8	4.6%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km^2
Elevation:	1150 to 1637 mamsl

Quantity & Quality

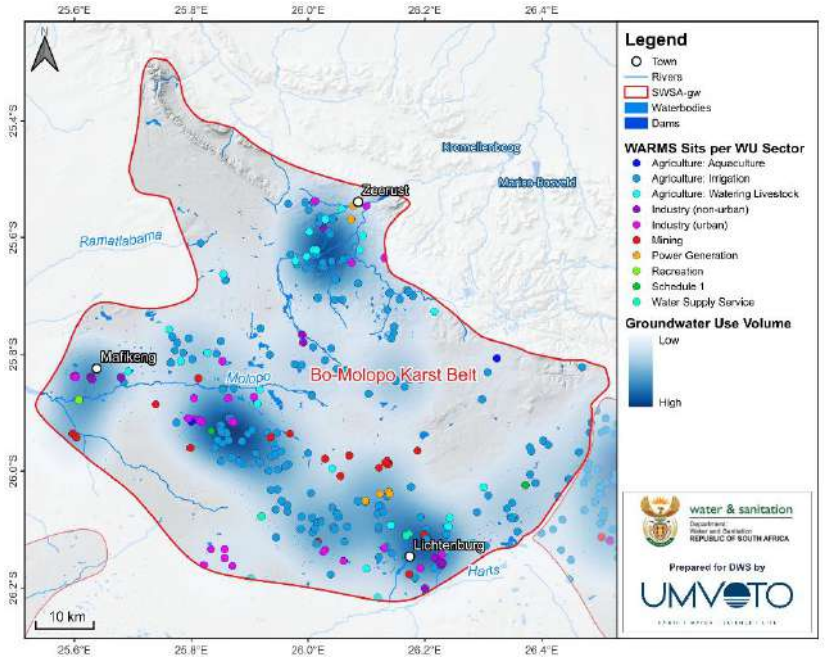
Groundwater Use

The Bo-Molopo Karst Belt SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Mahikeng (Conjunctive), Litchenburg (Groundwater), Ottoshoop (Groundwater), Zeerust (Groundwater) and Lehurutshe (Groundwater), which rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 44.9 Mm^3/ a to sustain crop production. The irrigation use is scattered throughout the region. Around the towns like Lichenburg, Mafikeng and Zeerust, there tends to be a higher density. This indicates that groundwater is an important resource for agriculture in the area.
- Municipal water supply services, at 5 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. However, the municipal supply is more pronounced in the southern areas of the map surrounding Lichtenberg, this makes sense as Lichtenburg is a groundwater-dependent town.
- Mining use has 2.5 Mm^3/a allocated. Water is a vital resource in the mining process. Groundwater can offer a reliable water source in water-scarce or remote areas. Mining activities, like municipal water supply, are mostly in the southern areas of the map.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Zeerust and Lichenburg, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Aquacultre	0.02
	Agriculture: Irrigation	44.9
	Agriculture: Watering Livestock	0.4
	Industry (Non-urban)	0.7
	Industry (Urban)	2.5
	Mining	2.5
	Power Generation	0.1
	Recreation	0.01
	Water Supply Service	5
	Total	**56.1**



Water use map for the Bo-Molopo Karst Belt SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km²
Elevation:	1150 to 1637 mamsl

Quantity & Quality

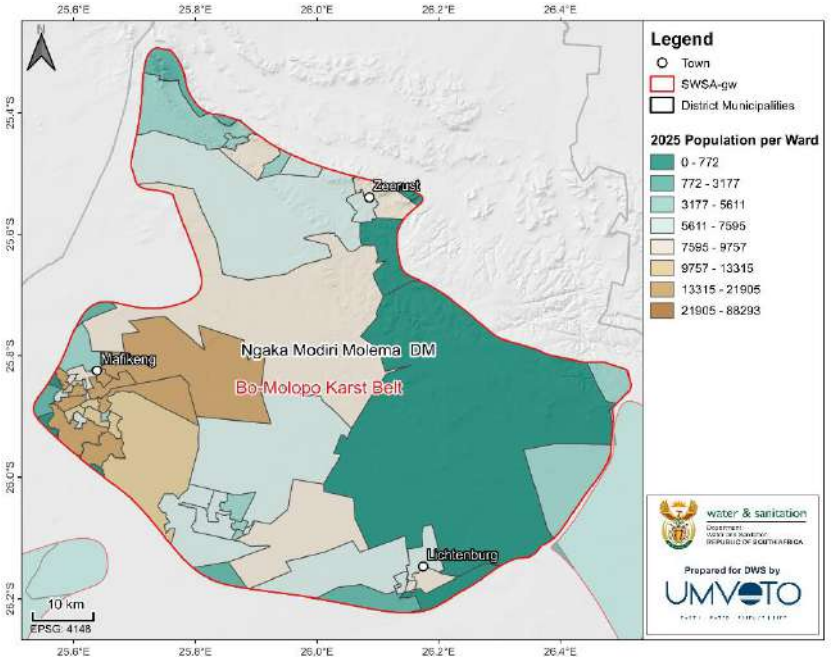
Socio Economic & Governance

The Bo-Molopo Karst Belt SWSA-gw is located within both the Vaal-Orange Water Management Area (WMA, 2023) and the Limpopo-Olifants WMA (2023). The groundwater resources within the Bo-Molopo Karst Belt SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA) and Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA and LOCMA are responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA and LOCMA to manage water resources in the Vaal-Orange WMA and Limpopo-Olifants. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA and LOCMA are the regional authorities responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA and Limpopo-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA/WSP	The Ngaka Modiri Molema District Municipality is the Water Service Authority and responsible Water Service Provider for this region.

The estimated 2025 population within the Bo-Molopo Karst Belt SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 0.16% per year, resulting in a projected population of approximately 397,870.

As shown in the map and table below, Mafikeng Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 246,453, followed by Ditsobotla LM with 99,695.



Projected population distribution in 2025 for the Bo-Molopo Karst Belt SWSA-gw.

SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km²
Elevation:	1150 to 1637 mamsl

Quantity & Quality

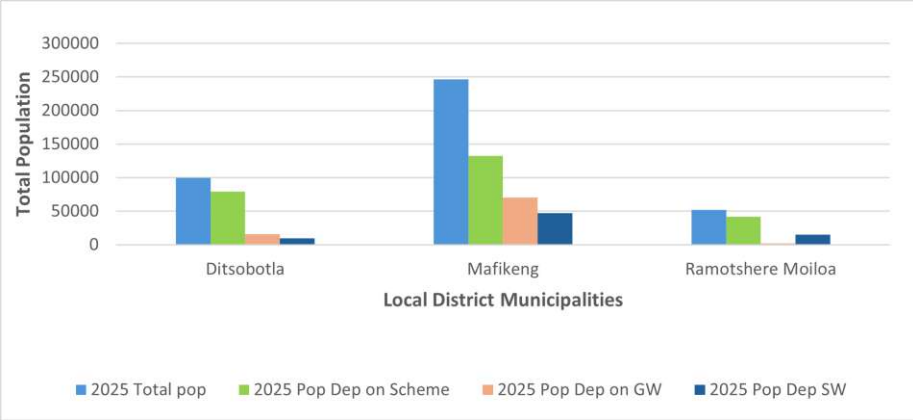
Socio Economic & Governance

In terms of water reliance within the Bo-Molopo Karst Belt SWSA-gw, an estimated 63.3% of the population depends on the regional water supply scheme, 22.1% on groundwater sources (including boreholes and springs), and 18.1% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources).

Among the LMs, the Mafikeng LM has the highest proportion of groundwater reliance, with approximately 28.6% of its population depending on groundwater and 19.3% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Ditsobotla	99,695	79,221	15,618	9,635
Mafikeng	246,453	132,450	70,557	47,443
Ramotshere Moiloa	51,722	41,506	1,745	14,986
Total	**397,870**	**253,177**	**87,919**	**72,065**



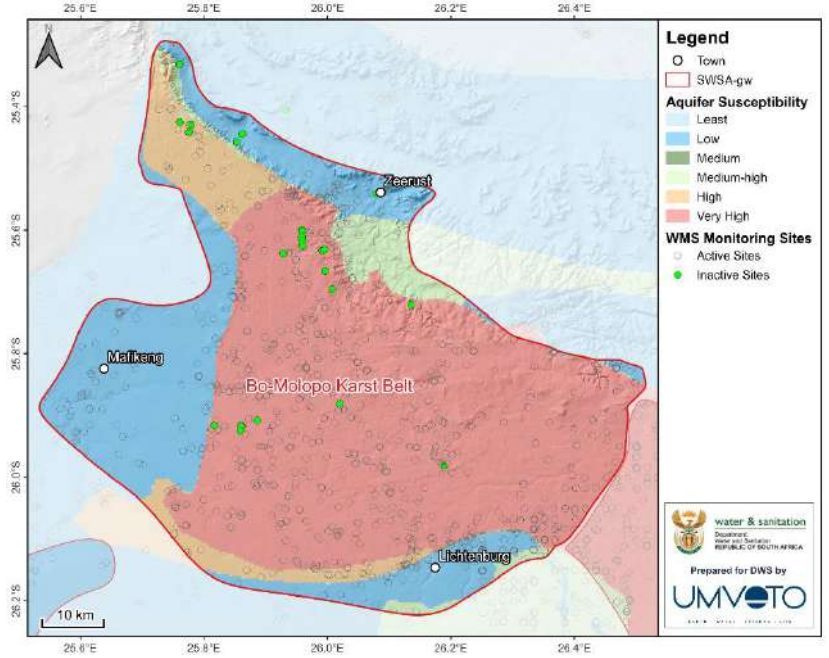
Projected population dependence on water sources in 2025.

SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km^2
Elevation:	1150 to 1637 mamsl
Quantity & Quality	
Groundwater Quality	

The Bo-Molopo Karst Belt SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 1342.79 km^2, which is 25.49% of the Bo-Molopo Karst Belt SWSA-gw total area. Urban/Built-up areas cover 299.63 km^2 (5.69%), while mines and quarries account for 25.94 km^2 (0.49%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 35.42 - 179.5 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 1.47 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.02 - 28.73 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.4 - 8.98 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0.6 - 96.99 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Bo-Molopo Karst Belt**
Area:	**5268 km²**
Elevation:	**1150 to 1637 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Bo-Molopo Karst Belt SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	22	14.01	157	50.18	mS/m	3.62 - 88.4 mS/m (Avg.: 39.75 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <70 mS/m.	35.42 - 179.5 mS/m (Avg.: 54.07 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024), except for values above the upper limit.
Fluoride	21	13.46	156	0.31	mg/L	0.025 - 0.81 mg/L (Avg.: 0.18 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <0.5 - 1.5 mg/L.	0.025 - 1.47 mg/L (Avg.: 0.37 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	22	14.01	157	1.21	mg/L	0.05 - 9.69 mg/L (Avg.: 1.40 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	2014-2024 GW Geosites: <11 mg/L.	0.02 - 28.73 mg/L (Avg.: 1.13 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024), except for values above the upper limit.
pH	22	14.01	157	8.19	pH unit	6.08 - 8.81 (Avg.: 8.13). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: 7-9.	6.4 - 8.98 (Avg.: 8.21). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	22	14.01	157	9.15	mg/L	1 - 54.94 mg/L (Avg.: 5.76 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <200 mg/L.	0.6 - 96.99 mg/L (Avg.: 10.51 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the Bo-Molopo Karst Belt SWSA-gw, taken from the WMS database from 2000-2024.*

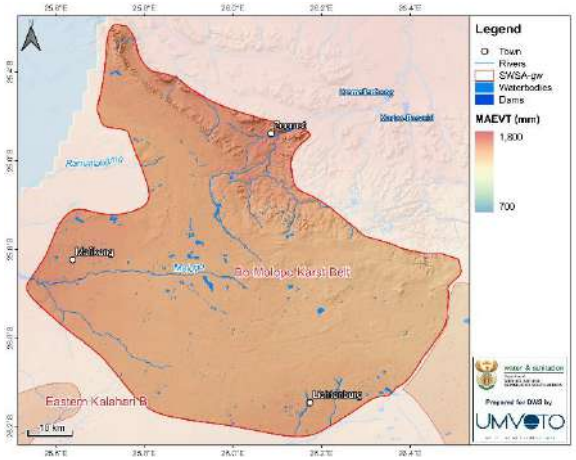
SWSA-gw Name:	**Bo-Molopo Karst Belt**
Area:	**5268 km²**
Elevation:	**1150 to 1637 mamsl**

Threats & Risks

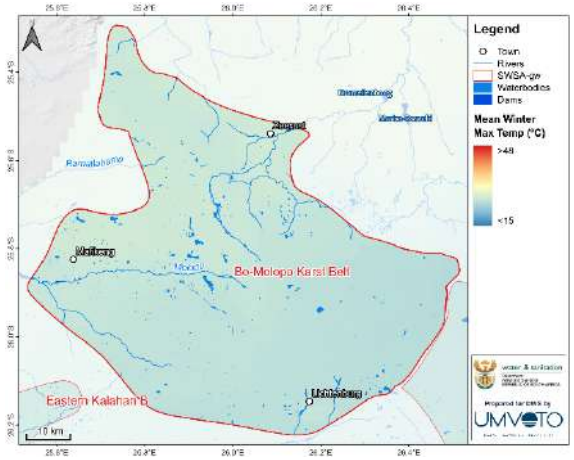
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Bo-Molopo Karst Belt SWSA-gw has a predominantly BSk, cold semi-arid, type climate characterised by cold winters and warm to hot summers. Along the north and western edges BSh, hot semi-arid, type climate characterised by hot summers, warm to cool winters, and little to no precipitation Along the east a Cwa, humid subtropical, type climate characterised by hot and humid summers and cool to mild winters changing into a Cwb, subtropical highland, type climate characterised by warm summers and dry winters. Temperatures in the SWSA-gw range from -1.9 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

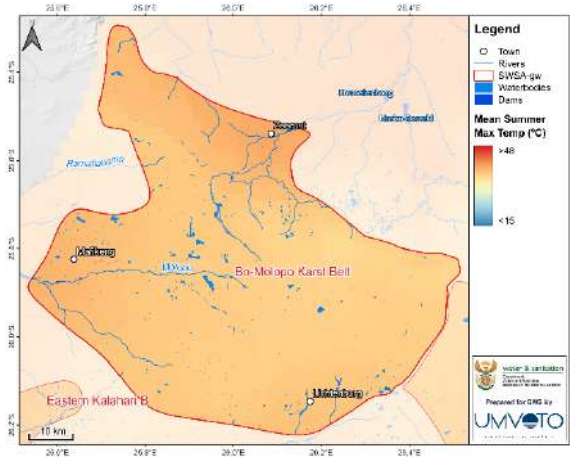
Temperature	Summer: 27 to 31 °C, Winter: -1.9 to 4 ºC
Evapotranspiration	Maximum value of 1660 mm/a with an average value of 1544 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, and a small decline in recharge (ranging from ~ -2.3 to 7.8 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Bo-Molopo Karst Belt SWSA-gw region.



Mean winter temperatures of the Bo-Molopo Karst Belt SWSA-gw region.



Mean summer temperatures of the Bo-Molopo Karst Belt SWSA-gw region.

SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km^2
Elevation:	1150 to 1637 mamsl

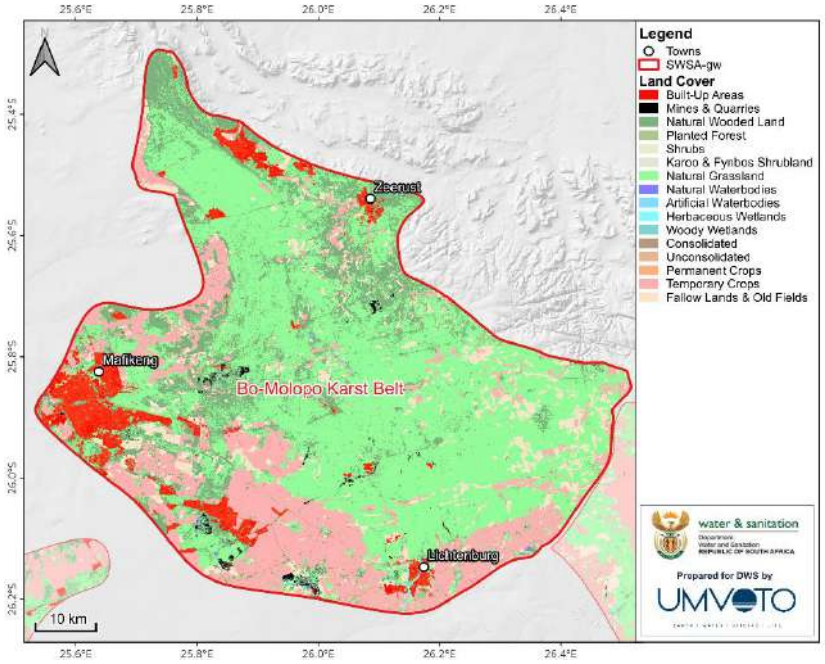
Threats & Risks

Land Use

Approximately half of the Bo-Molopo Karst Belt SWSA-gw is covered by grassland (DFFE, 2022). The southern edge of the SWSA-gw is mainly covered by cultivated land, which consists of temporary crops, permanent crops, fallow lands and old fields. There is minimal development in the SWSA-gw with built-up areas, made up of residential, industrial and commercial areas, concentrated around the towns of Mafikeng, Lichtenburg and Zeerust.

The majority of the grassland and forest land, which includes natural wooded land and planted forest, falls within the Bo-Molopo SGWCA, the boundary of which can be seen in the map under the Biodiversity and Conservation table below. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.5% of the area, located predominantly in the northwest of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	4	0.1
Built-Up	300	5.7
Cultivated	1343	25.5
Forest Land	925	17.6
Grassland	2650	50.3
Mines and quarries	26	0.5
Shrubland	2	0.03
Waterbodies	10	0.2
Wetlands	8	0.1



Land Cover 24-class map to show the types of land use and extent of each occurring in the Bo-Molopo Karst Belt SWSA-gw.

SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km^2
Elevation:	1150 to 1637 mamsl

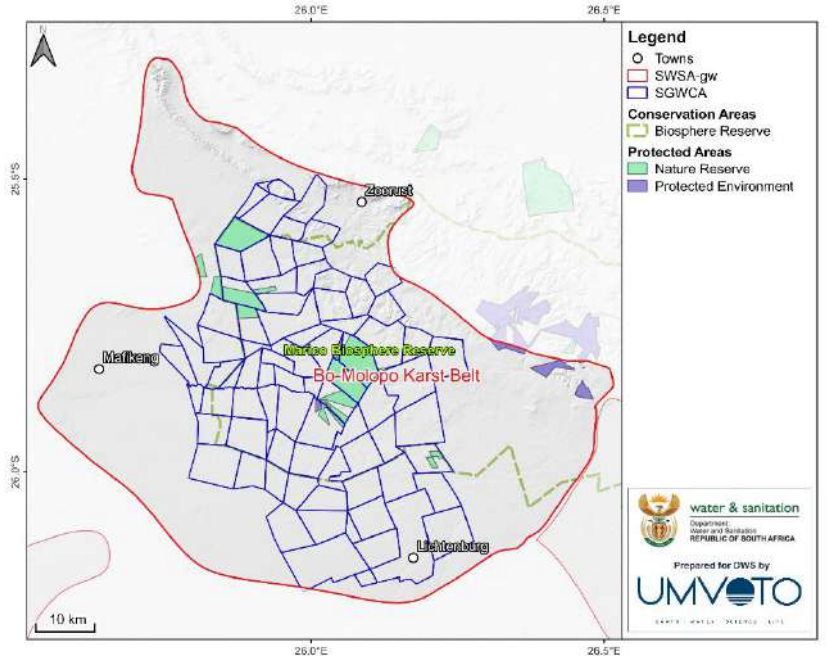
Protection Status and Ecosystems

Biodiversity and Conservation

The Marico Biosphere Reserve covers (DFFE, 20204) a significant portion of the Bo-Molopo Karst Belt SWSA-gw along its eastern side to mid-section. Within the biosphere reserve are the three larger nature reserves of the SWSA-gw: Molemane Eye Nature Reserve (centre), Olyvenbult Private Nature Reserve (northernmost) and Druprenella Private Nature Reserve (just south of Olyvenbult) (DFFE, 2024).

The Bo-Molopo subterranean government water control area (SGWCA) (CSIR, 1998) covers about 47% of the Bo-Molopo Karst Belt SWSA-gw and shows the area where the government controlled groundwater on private land under the Water Act No. 54 of 1956 (DWA, 2010).

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Marico Biosphere Reserve	2181.83	1
Protected Areas	• Marico Protected Environment • Molopo Private Protected Environment • Molemane Eye Nature Reserve • Druprenella Private Nature Reserve • Olyvenbult Private Nature Reserve • And a few other small nature reserves	185.89	8
SGWCA	• Bo-Molopo	2479.49	1
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Bo-Molopo Karst Belt SWSA-gw that have protection status.

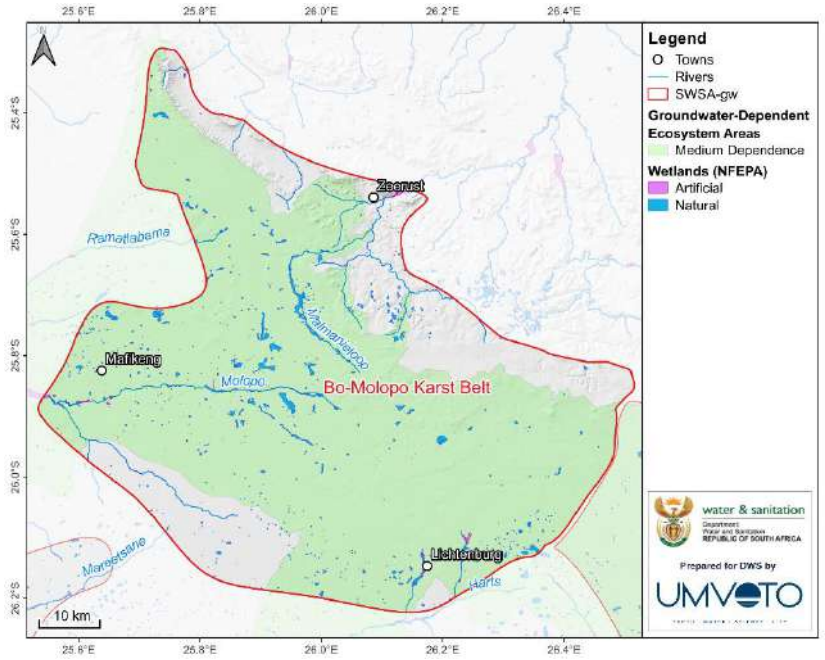
SWSA-gw Name:	Bo-Molopo Karst Belt
Area:	5268 km^2
Elevation:	1150 to 1637 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

There are many seeps and depression wetlands (CSIR, 2011) within the Bo-Molopo Karst Belt SWSA-gw, falling within a wider area of Dolomite vegetation. These wetlands are considered to have a potentially medium dependence on groundwater (DWA, 2010).

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various small natural and artificial wetlands	65	

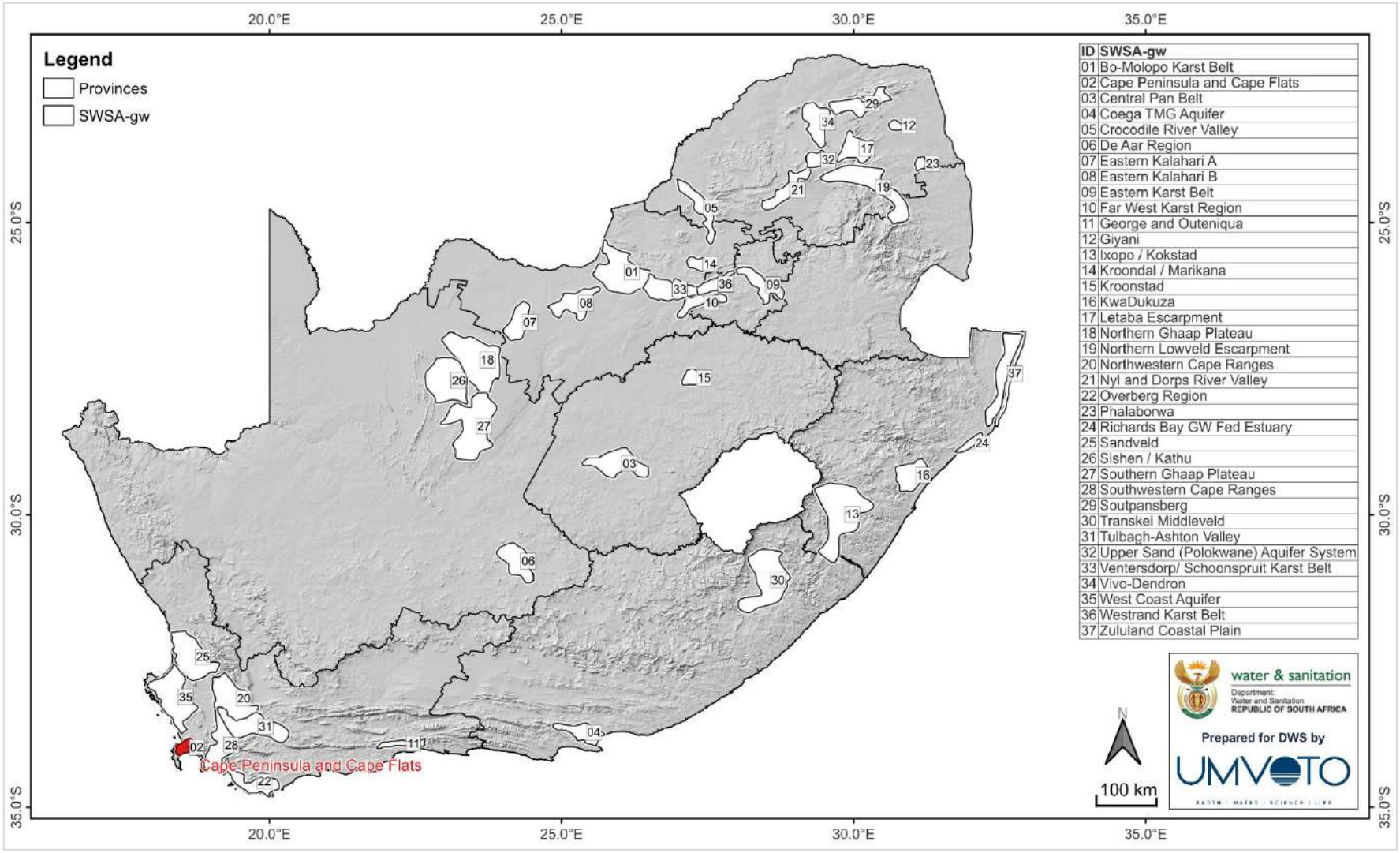


Map showing the major water bodies, Ramsar sites and GDEs in the Bo-Molopo Karst Belt SWSA-gw.

APPENDIX 02

CAPE PENINSULA AND CAPE FLATS SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE CAPE PENINSULA AND CAPE FLATS SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

2. Cape Peninsula and Cape Flats

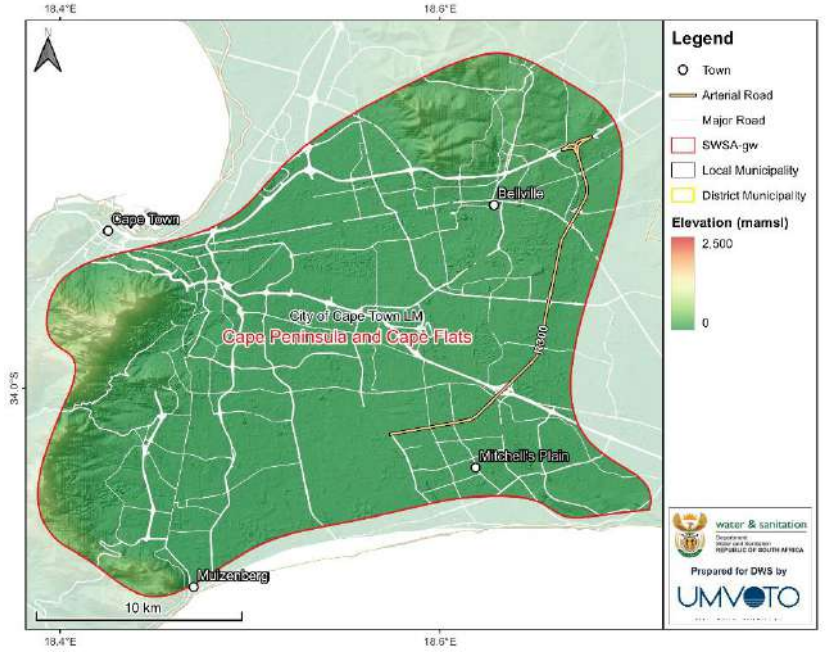
2.1. Description

SWSA-gw Name:	**Cape Peninsula and Cape Flats**
Area:	**600 km²**
Elevation:	**6 to 1072 mamsl**
Geospatial Context	

The topography of the Cape Peninsula and Cape Flats SWSA-gw, as depicted in the map, transitions from the rugged mountainous terrain of the Table Mountain range in the west, near Cape Town and Hout Bay, to the low-lying, flat expanse of the Cape Flats, which includes Mitchells Plain and Khayelitsha. This flat area consists of unconsolidated sand deposits and gently sloping plains. Further north and northeast, towards Durbanville, Brackenfell, and Kuilsriver, the landscape becomes slightly more undulating as it rises into the foothills of the Tygerberg Hills and surrounding elevated areas.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Western Cape Province
Metropolitan Municipality	City of Cape Town
Towns	Bellville, Blue Downs, Brackenfell, Durbanville, Elsiesrivier, Khayelitsha, Kraaifontein, Kuilsrivier, Milnerton, Mitchells Plain and Parow
Major Roads	N1, N2, N7, R101, R102, R300, R302 and R310
Major Water Supply Networks	City Of Cape Town Bulk Scheme



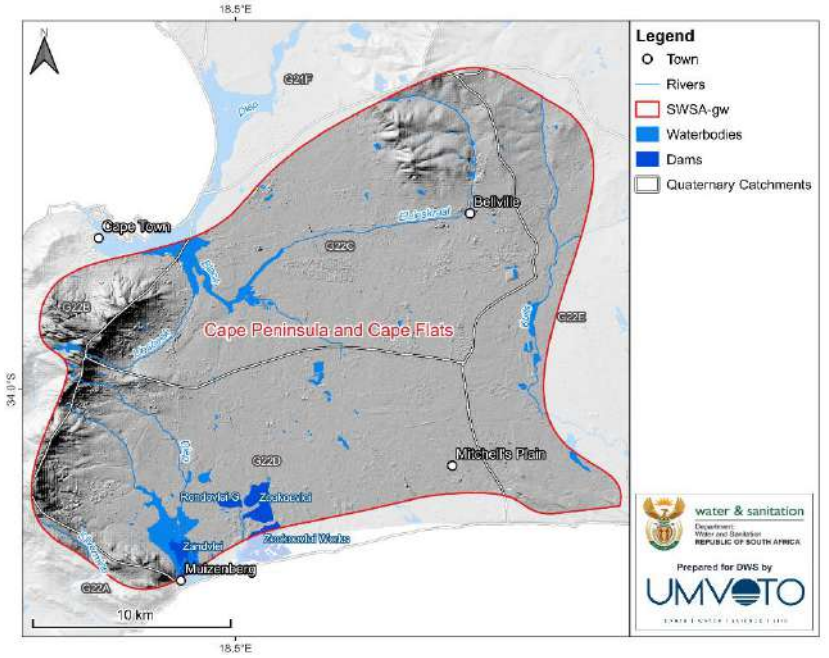
Locality map of Major Towns, District and Local Municipalities in the Cape Peninsula and Cape Flats SWSA-gw.

SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km²
Elevation:	6 to 1072 mamsl

Hydrology and Drainage

The Cape Peninsula and Cape Flats SWSA-gw and surrounding areas include major surface water systems, along with several unnamed seeps and floodplains, which are summarised below and displayed on the map to the right. The primary surface water features include Zeekoevlei, Rondevlei G, Zandvlei, and the Sout (West) Estuary, all of which are fed by the G2 catchment. Several perennial rivers flow through the area, either north towards the Sout (West) Estuary or south towards Zeekoevlei, Rondevlei, and Zandvlei.

Quaternary Catchments	G22C, G22D, G22E, G22B as well as small sections of G22A and G21E.
Rivers	Perennial: Black, Bottelary, Diep, Hout Bay, Kuils, Liesbeek, Silvermine, Soutvlei and Vyekraal
	Ephemeral: Elsieskraal
Natural and manmade water bodies	Sout (West) Estuary, Zeekoevlei, Rondevlei and Zandvlei Cape Flats Waste Water Treatment Works and several seeps and floodplains
Major Dams:	
Water Management Areas:	Breede Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Cape Peninsula and Cape Flats SWSA-gw.

SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km²
Elevation:	6 to 1072 mamsl
Geology	

Geology

Quaternary deposits in the north and east of the area include alluvium, calcareous soils, gravelly clay, sandy soils, loam, and Piedmont gravel. The southern region is covered by the Sandveld Group, including the Langebaan and Witzand Formations, which comprise shelly sand, aeolian calcarenite, and calcareous dune sand.

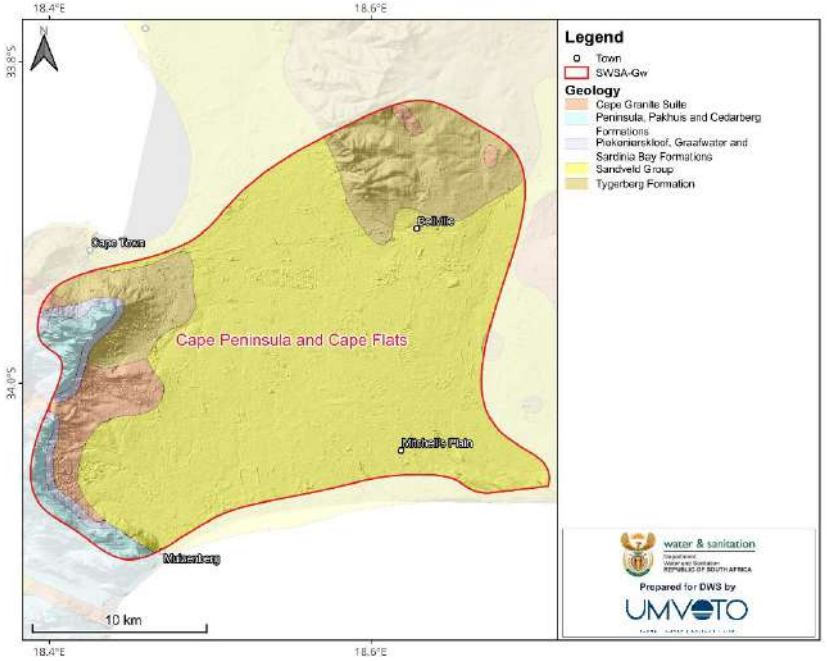
There are multiple dykes intruded into the area as part of the Cretaceous period Fals Bay Suite.

Sedimentary rocks of the Table Mountain Group, including the Graafwater, Pakhuis, and Peninsula Formations, outcrop along the western section. These formations consist of quarzitic sandstone, reddish mudstone with scattered pebbles and cobbles, and minor conglomerate.

Plutons and batholiths of the Cape Granite Suite outcrop in the northern and western sections of the area. The Tygerberg Formation of the Malmesbury Group consists of shale, greywacke, quartzite, and minor volcanic rocks.

Hydrostratigraphy

The Quaternary deposits form a primary, intergranular aquifer system, while the Table Mountain Group sandstones constitute a secondary, fractured-rock aquifer system with variable confinement. The Cape Granite Suite and Tygerberg Formation act as a low-permeability basement, with limited groundwater interaction except where weathered or fractured.



Geology Map of the Cape Peninsula and Cape Flats SWSA-gw region.

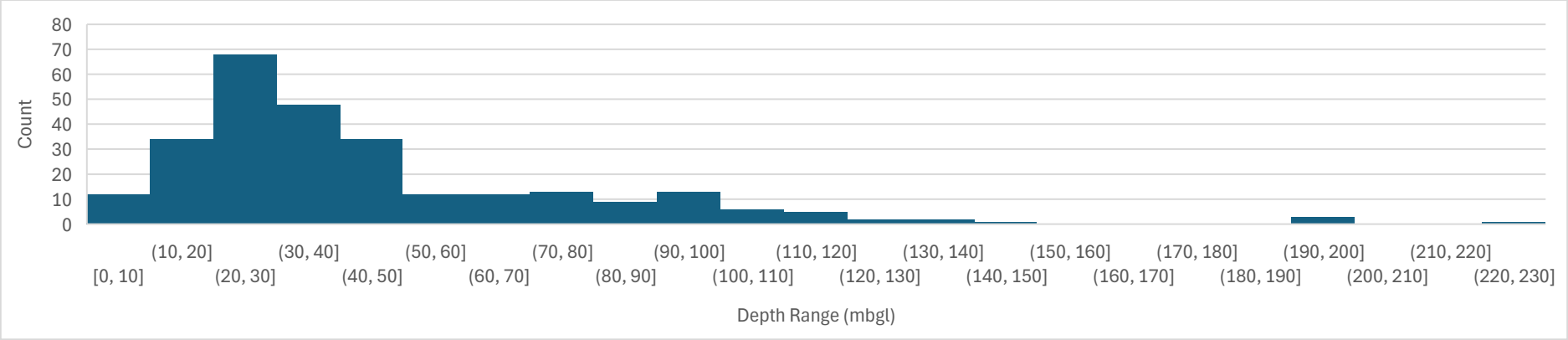
2.2. Current Status

SWSA-gw Name:	**Cape Peninsula and Cape Flats**
Area:	**600 km²**
Elevation:	**6 to 1072 mamsl**
Quantity & Quality	
Aquifer Classification	

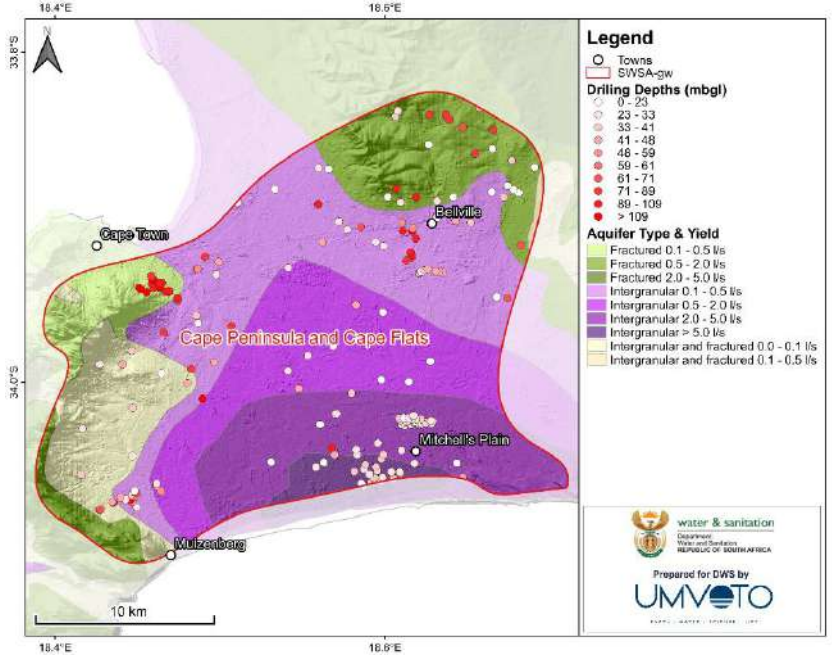
The aquifer systems within the Cape Peninsula and Cape Flats SWSA-gw exhibit varying yields across intergranular and fractured aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is predominantly a Major aquifer system, with a Minor aquifer system along the western edge. The Major aquifer system has an average intergranular yield ranging from 0.1 to over 5.0 l/s, increasing towards the southern coastline. The Minor aquifer system has an average fractured yield between 0.1 and 0.5 l/s.
Groundwater Targets	The average drilling depth is 47 mbgl, and the most common depth is around 30 mbgl. Boreholes primarily target the shallow intergranular aquifer. Deeper boreholes, particularly in the northern half of the region, reaching >150 mbgl, indicate potential targeting of the fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 25 and 60 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 4 mbgl, with values ranging from 1 to 17 mbgl and a standard deviation of ~ 2 mbgl.

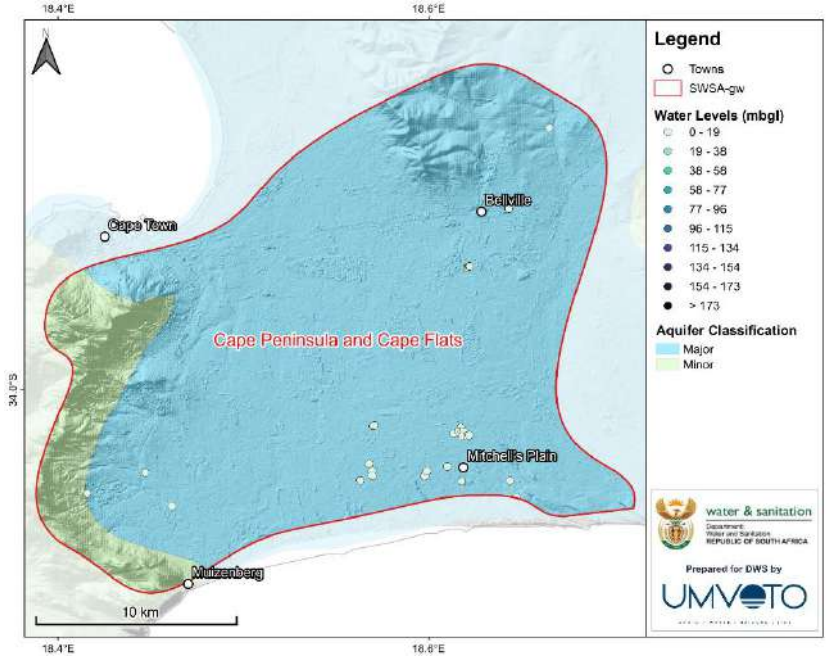
Graph of NGA drilling depths of the Cape Peninsula and Cape Flats SWSA-gw region



SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km²
Elevation:	6 to 1072 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Cape Peninsula and Cape Flats SWSA-gw region.



Map of the Aquifer Classification of the Cape Peninsula and Cape Flats SWSA-gw region.

SWSA-gw Name:	**Cape Peninsula and Cape Flats**
Area:	**600 km²**
Elevation:	**6 to 1072 mamsl**

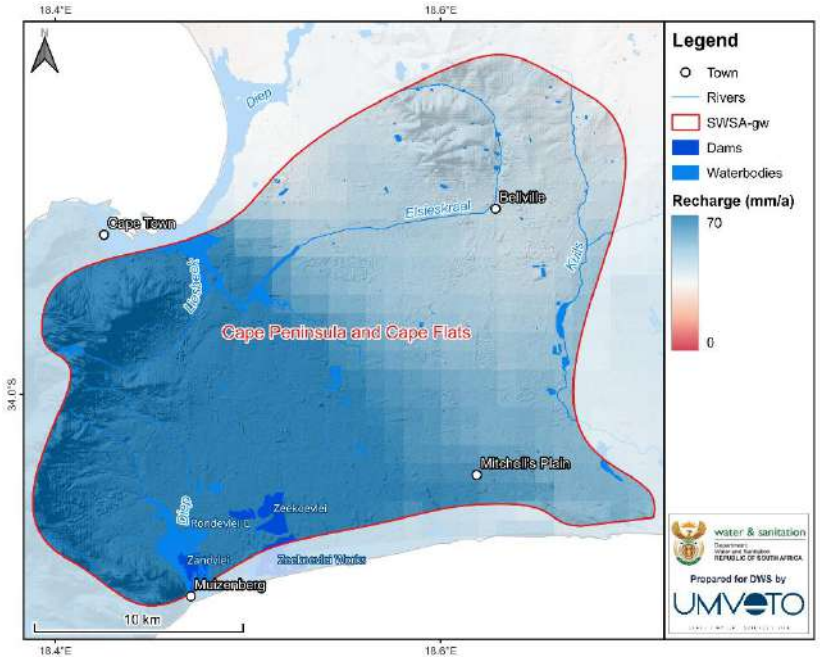
Quantity & Quality

Groundwater Recharge

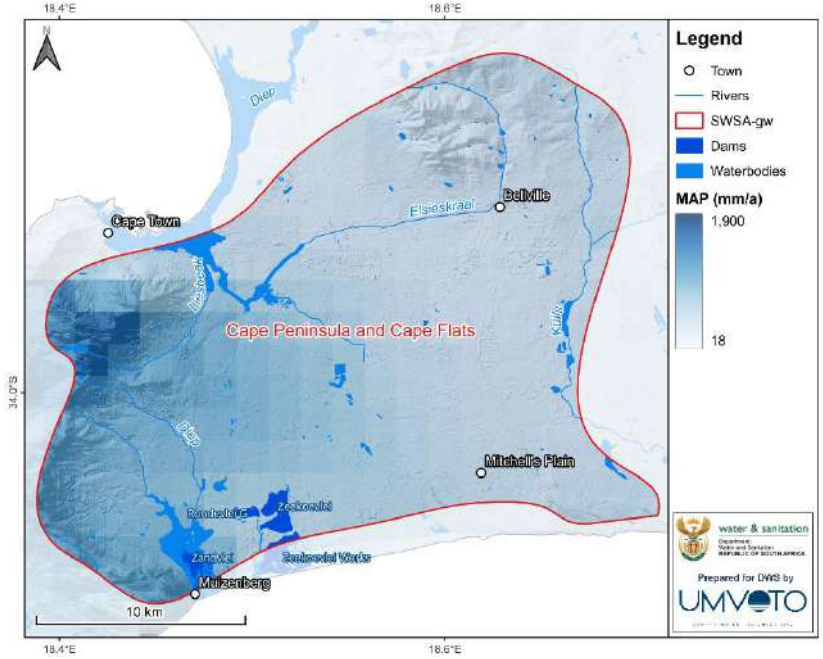
The Cape Peninsula, Cape Flats receives total Mean Annual Precipitation (MAP) volume of 436 Mm^3/a, with a significantly high average rainfall of 726 mm/a. Despite this, only 48.9 Mm^3/a contributes to groundwater recharge, resulting in a moderate recharge of 11.2% of MAP. This suggests that while the area experiences relatively high rainfall, a substantial portion is still lost to runoff, evaporation, or surface water flow, though recharge efficiency is better compared to drier regions.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of map mm/a	Sum of Recharge Vol Mm^3/a	Average of recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Cape Peninsula and Cape Flats	436	726	48.9	81.8	11.2%

X



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km²
Elevation:	6 to 1072 mamsl

Quantity & Quality

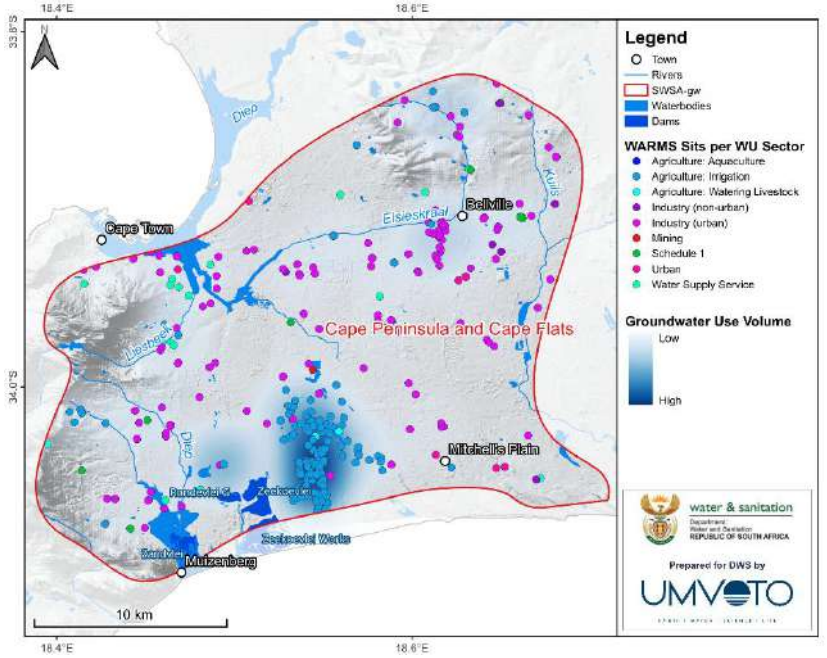
Groundwater Use

The Cape Peninsula and Cape Flats SWSA-gw play a crucial role in sustaining water demand across multiple sectors. While no towns in this region rely primarily on groundwater for municipal supply, industrial use, or agriculture (see Table below), an analysis of active groundwater use licenses from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 13.9 Mm^3/a to sustain crop production. This is primarily concentrated in the southern region, with a huge cluster west of Mitchells Plain. Given the water scarcity in these regions, many farmers have opted to use groundwater as a more reliable source.
- Urban industrial follows closely, using 7.4 Mm^3/a allocated for manufacturing, processing, and other industrial activities in urban centres. Unlike agricultural irrigation, the distribution from this sector is relatively more even. However, there are urban industries which rely on groundwater more heavily like Parow, Elsiesriveier and Bellville.
- Municipal water supply services, at 2.4 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. This sector's use is primality in the western parts of the area, particularly the northwest near Cape Town.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Bellville, Parow and Durbanville, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	13.9
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	1.2
	Industry (Urban)	7.4
	Mining	0.4
	Schedule 1	0.02
	Urban (excluding industrial/ domestic)	0.05
	Water Supply Service	2.4
	Total	**25.6**



Water use map for the Cape Peninsula and Cape Flats SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

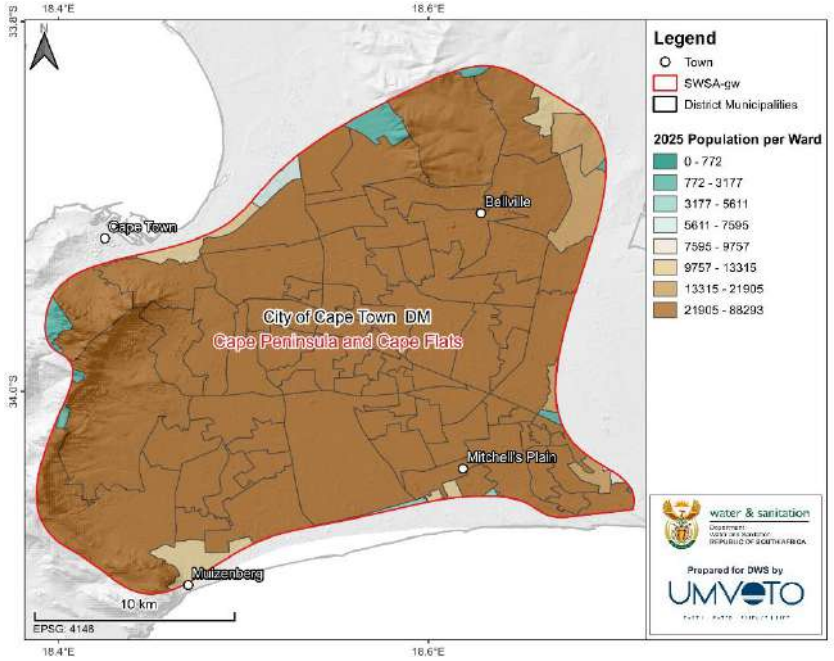
SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km²
Elevation:	6 to 1072 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Cape Peninsula and Cape Flats SWSA-gw is located within the Breede-Olifants Water Management Area (WMA, 2023). The groundwater resources within the Cape Peninsula and Cape Flats SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Breede-Olifants Catchment Management Agency (BOCMA), which was formed as part of a national restructuring process that consolidated CMAs. BOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the BOCMA to manage water resources in the Breede-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	BOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Breede-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	Brandvlei WUA is the local water management group that assists the CMA with allocation decisions among water users and oversees groundwater infrastructure and monitoring within the SWSA-gw.
WSA & WSP	Local municipalities are the Water Service Authorities (WSA), while the City of Cape Town DM is the Bulk Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Cape Peninsula and Cape Flats SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 1.21% per year, resulting in a projected population of approximately 2,873,155.

As shown in the map and table below, population concentrations are highest in the City of Cape Town LM, particularly around the towns of Bellville and Mitchell's Plain.



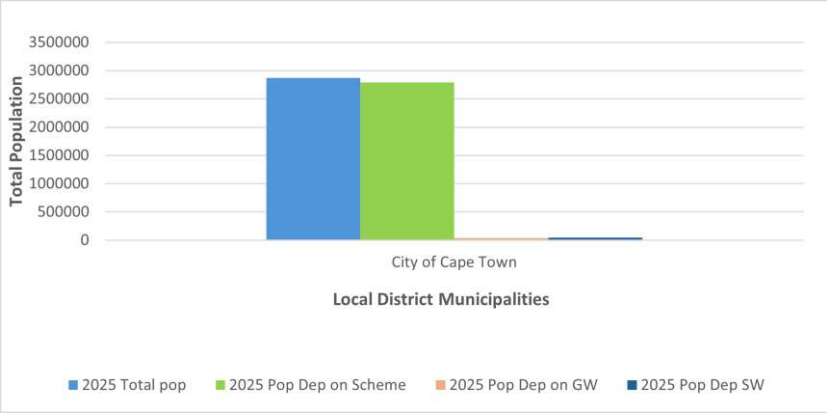
Projected population distribution in 2025 for the Cape Peninsula and Cape Flats SWSA-gw.

SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km²
Elevation:	6 to 1072 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Cape Peninsula and Cape Flats SWSA-gw, an estimated 97.0% of the population depends on the regional water supply scheme, 1.6% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 1.2% on groundwater sources (including boreholes and springs). The City of Cape Town LM is highly dependent on the regional water supply scheme.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
City of Cape Town	2,873,155	2,787,999	35,774	44,981
Total	**2,873,155**	**2,787,999**	**35,774**	**44,981**



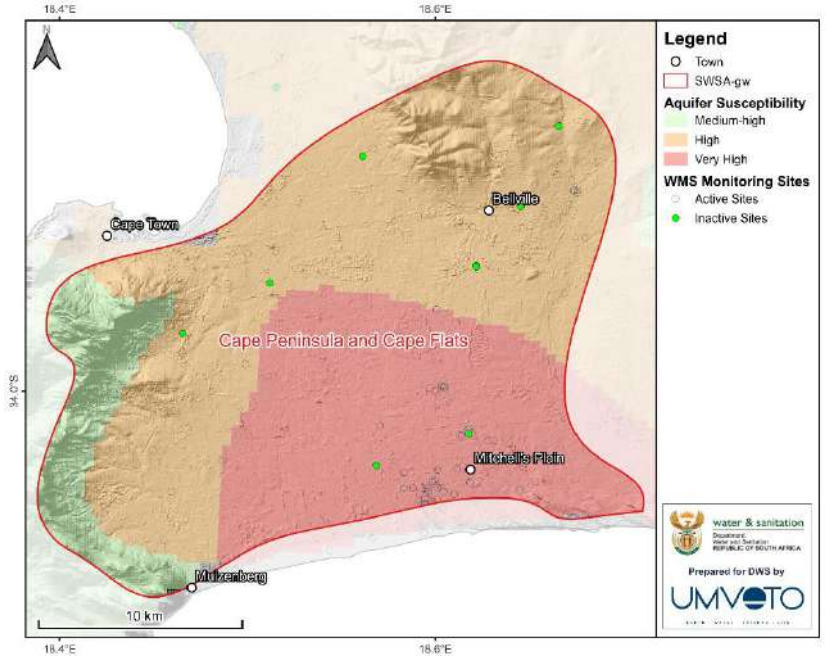
Projected population dependence on water sources in 2025.

SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km²
Elevation:	6 to 1072 mamsl
Quantity & Quality	
Groundwater Quality	

The Cape Peninsula and Cape Flats SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), Urban/Built-up areas cover a total of 419.55 km^2, which is 69.99% of the Cape Peninsula and Cape Flats SWSA-gw total area. This is the most extensively urbanised/built-up of the SWSAs-gw. Cultivated areas cover 30.00 km^2 (5.00%), while mines and quarries account for 3.66 km^2 (0.61%) of the total area. These land uses contribute to diffuse contamination sources. Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 14.19 – 1760 mS/m in the Major aquifer system. Coastal aquifers typically show an EC gradient, with higher values near the coastline due to seawater intrusion or marine aerosol deposition.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 1.54 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate and nitrite concentrations range from 0.02 - 6.18 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 1 - 8.58 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0.6 - 1095.96 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km²
Elevation:	6 to 1072 mamsl

Quantity & Quality

Groundwater Quality

Water Quality Parameters and Aquifer Vulnerability Categorization across the Cape Peninsula and Cape Flats SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	11	39.29	28	123.12	mS/m	-	2014-2024 GW Geosites: 0 - 150 mS/m. No WMS results (2000-2024).	14.19 - 1760 mS/m (Avg.: 123.12 mS/m). 2014-2024 GW Geosites: 0 - 370 mS/m. Mostly consistent with WMS (2000-2024), except for values above the upper limit.
Fluoride	10	37.04	27	0.36	mg/L	-	2014-2024 GW Geosites: <0.5 mg/L. No WMS results (2000-2024).	0.025 - 1.54 mg/L (Avg.: 0.36 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	10	37.04	27	0.63	mg/L	-	2014-2024 GW Geosites: 0 - 11 mg/L. No WMS results (2000-2024).	0.02 - 6.18 mg/L (Avg.: 0.63 mg/L). 2014-2024 GW Geosites: 0 - 11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	11	39.29	28	7.57	pH unit	-	2014-2024 GW Geosites: 5.7 - 9. No WMS results (2000-2024).	1 - 8.58 (Avg.: 7.57). 2014-2024 GW Geosites: 5.7 - 9. Mostly consistent with WMS (2000-2024).
Sulphate	11	40.74	27	68.23	mg/L	-	2014-2024 GW Geosites: 0 - 500 mg/L. No WMS results (2000-2024).	0.6 - 1095.96 mg/L (Avg.: 68.63 mg/L). 2014-2024 GW Geosites: 0 - 500 mg/L. Mostly consistent with WMS (2000-2024), except for values above the upper limit.

- *"Average" refers to the average concentrations for the Total Active Sites of the Cape Peninsula and Cape Flats SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

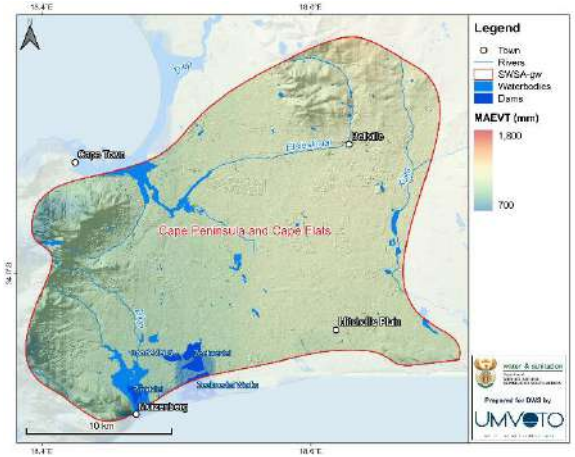
SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km²
Elevation:	6 to 1072 mamsl

Threats & Risks

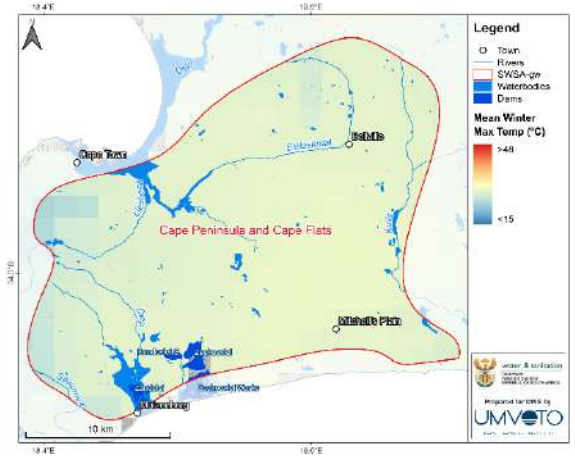
Climate

According to the Köppen-Geiger Climate Classification (Beck et al., 2018), the Cape Peninsula and Cape Flats SWSA-gw predominantly has a Csb, Mediterranean-type climate characterised by hot, dry summers and mild, wet winters. Temperatures in the SWSA-gw range from 6.1 – 26.9 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

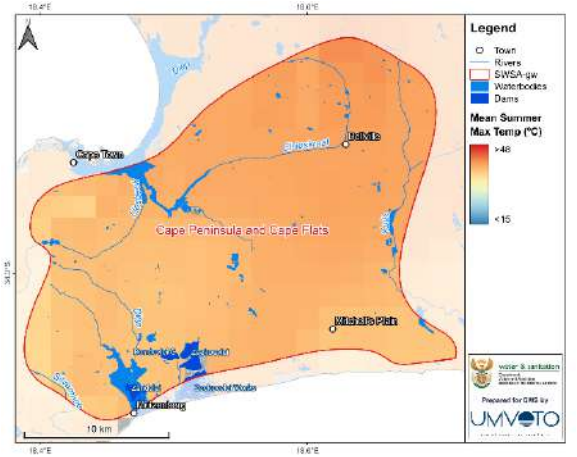
Temperature	Summer: 24.7 to 26.9 °C, Winter: 6.1 to 8 ºC
Evapotranspiration	Maximum value of 1307 mm/a with an average value of 1084 mm/a
Climate Change Prediction	Increased temperatures, disrupted rainfall patterns and a decline in recharge (ranging from ~-4.1 to 0.8 mm/a). The DART Index indicates a combination of stable and worsening drought conditions.



Mean annual A-Pan evaporation of the Cape Peninsula and Cape Flats SWSA-gw region.



Mean winter temperatures of the Cape Peninsula and Cape Flats SWSA-gw region.



Mean summer temperatures of the Cape Peninsula and Cape Flats SWSA-gw region.

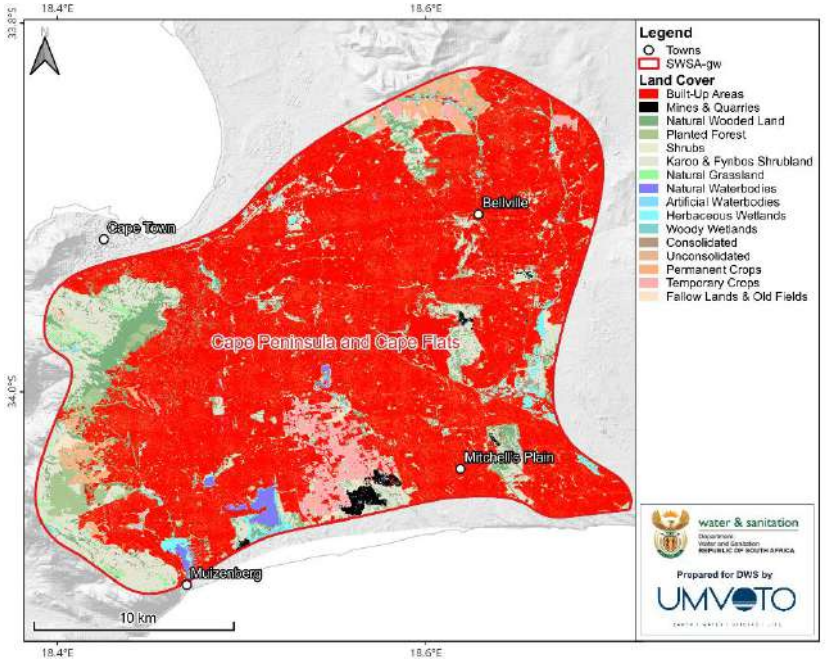
SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km^2
Elevation:	6 to 1072 mamsl

Threats & Risks

Land Use

Built-up areas, consisting of residential, residential, commercial and industrial areas, are the dominant land cover (DFFE, 2022), covering 70% of the Cape Peninsula and Cape Flats SWSA-gw, indicating significant urban development. Specifically, the commercial and industrial areas reflect a strong economic presence, supporting business and manufacturing activities. Shrublands, including the Karoo & Fynbos Shrubland, remain a notable natural feature, concentrated to the eastern edge of the SWSA-gw within the Table Mountain National Park, and contribute to the region's biodiversity and ecological balance. Forested land, which is natural wooded land, provides green spaces that enhance environmental sustainability within the developed areas. Wetlands and waterbodies, both natural and artificial, occupy a small portion of the land and are concentrated to the southwestern edge of the SWSA-gw. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.6% of the area, located predominantly in the south and east of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	5	0.8
Built-Up	420	70
Cultivated	30	5.0
Forest Land	46	7.7
Grassland	5	0.9
Mines and quarries	4	0.6
Shrubland	77	12.8
Waterbodies	6	1.0
Wetlands	7	1.2



Land Cover 24-class map to show the types of land use and extent of each occurring in the Cape Peninsula and Cape Flats SWSA-gw.

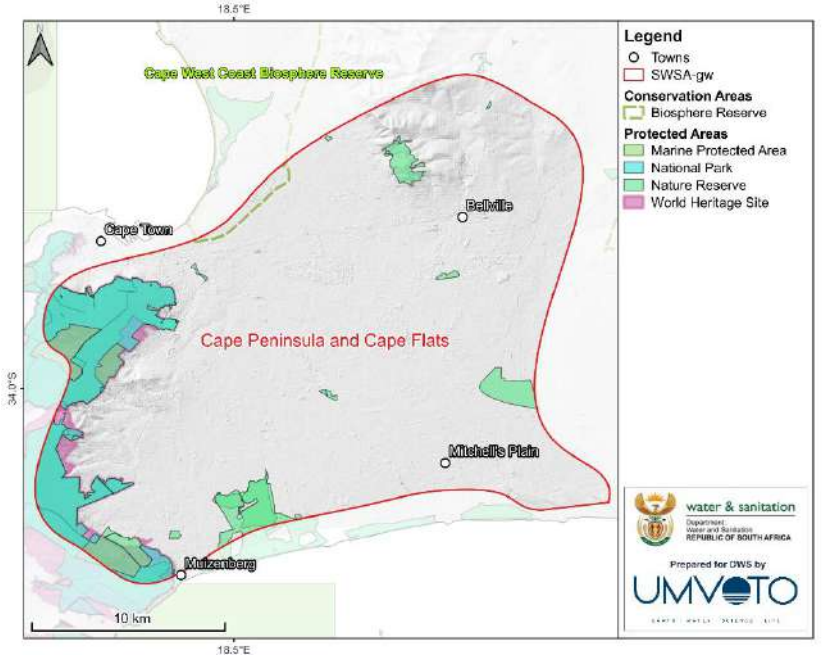
SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km²
Elevation:	6 to 1072 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Cape Peninsula and Cape Flats SWSA-gw contain a diverse network of protected areas spanning 127.08 km², including key reserves like the Cape Floral Region Protected Areas and False Bay Nature Reserve (DFFE, 2024). Table Mountain National Park, covering 42.23 km², is the largest national park in the region and a critical ecological and recreational asset and which covers the Cape Peninsula Nature Area and Silvermine Nature Reserve. Additionally, the Cape West Coast Biosphere Reserve, though relatively small at 4.22 km² (DFFE, 2024), contributes to broader conservation efforts. The entire western stretch of protected areas is also part of the Cape Floral Region Protected Areas, which is considered a world heritage site.

Protection Status	Names	Area (km²)	Count
Conservation Areas	• Cape West Coast Biosphere Reserve	4.22	1
Protected Areas	• Cape Floral Region Protected Areas • Cape Peninsula Nature Area • Silvermine Nature Reserve • False Bay Nature Reserve • Zeekoevlei Local Nature Reserve • Driftsands Nature Reserve • Tygerberg Nature Reserve • And various other small nature reserves	127.08	12
SGWCA	None		0
National Parks	• Table Mountain National Park	42.23	1



Biospheres, Protected Areas and SGWCAs to show the portions of the Cape Peninsula and Cape Flats SWSA-gw that have protection status.

SWSA-gw Name:	Cape Peninsula and Cape Flats
Area:	600 km^2
Elevation:	6 to 1072 mamsl

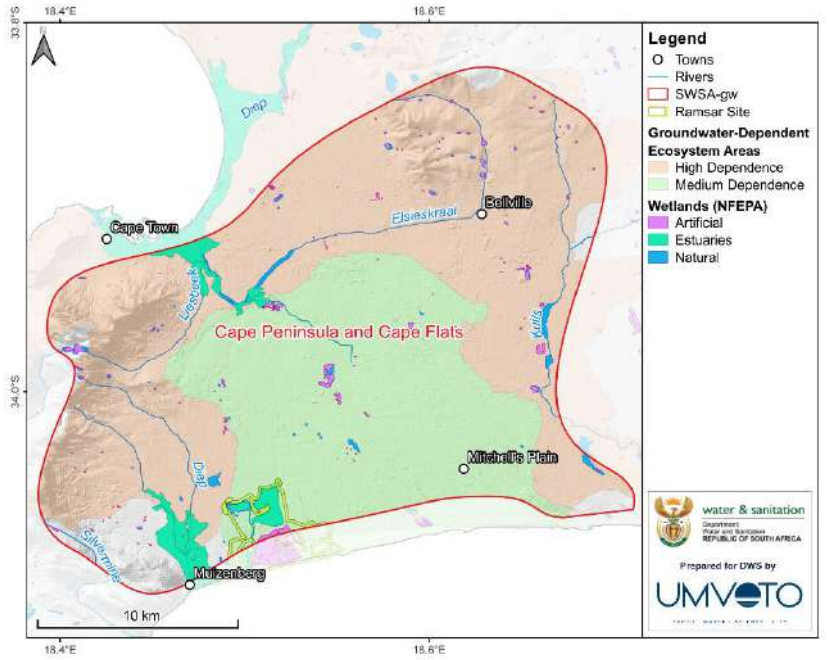
Protection Status and Ecosystems

Biodiversity and Conservation

A significant portion of the Cape Peninsula and Cape Flats SWSA-gw is covered by wetlands (CSIR, 2018) that form part of groundwater-dependent ecosystems. Wetlands (CSIR, 2011) located in the centre portion of the SWSA-gw have a medium dependence on groundwater, while wetlands falling along the edges of the SWSA-gw have a high dependence on groundwater (DWA, 2010).

The False Bay Nature Reserve is a Ramsar-protected area (DFFE, 2024), which falls along the False Bay coast on the southern end of the SWSA-gw and which covers the Zeekoevlei Estuary.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Zandvlei Estuary • Zeekoevlei Estuary • Soutvlei (Wes) Estuary	14.09	3
Ramsar Sites	• False Bay Nature Reserve	8.08	1
Wetlands	Various natural, artificial and estuary wetlands	22	

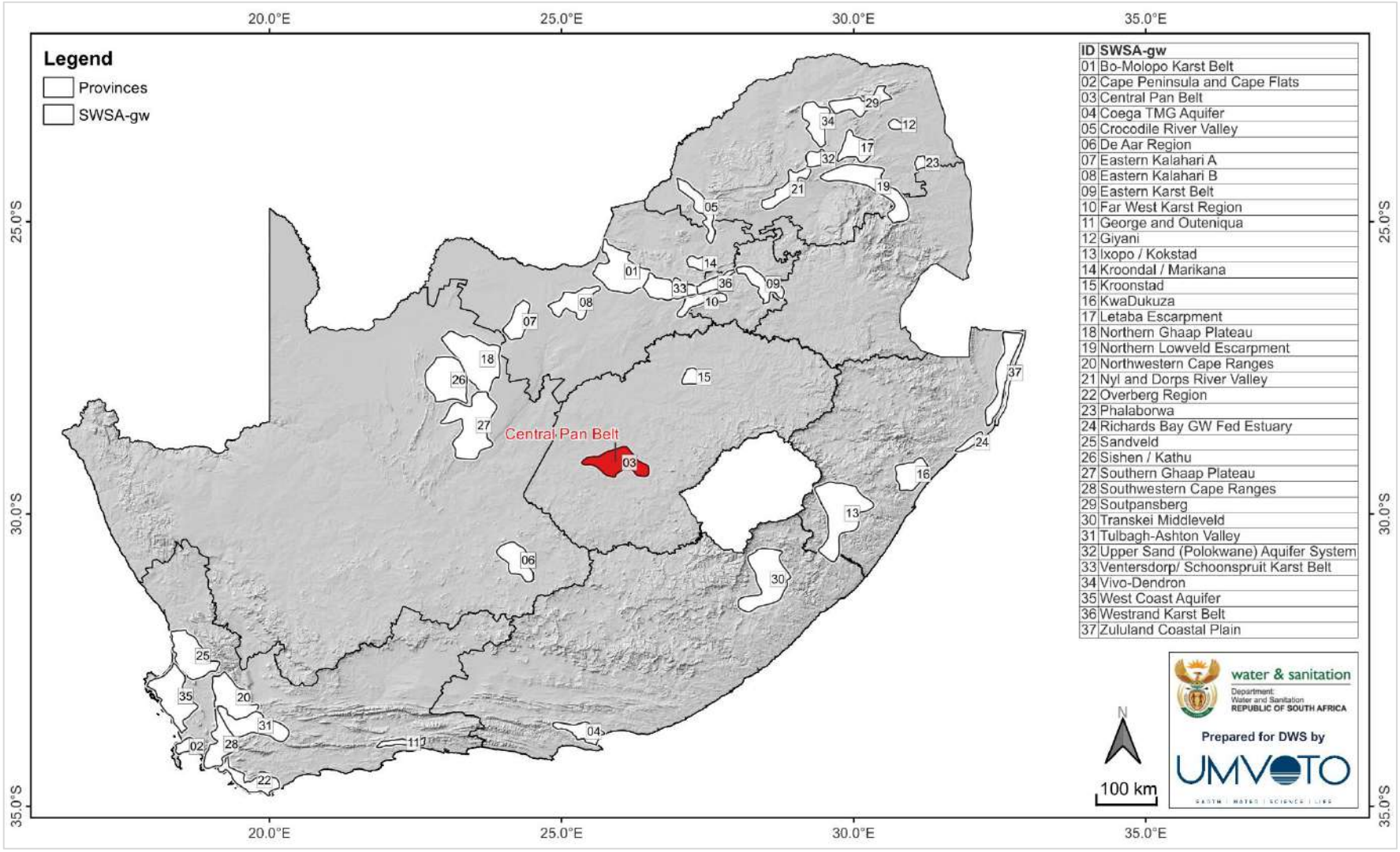


Map showing the major water bodies, Ramsar sites and GDEs in the Cape Peninsula and Cape Flats SWSA-gw.

APPENDIX 03

CENTRAL PAN BELT SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE CENTRAL PAN BELT SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

3. Central Pan Belt

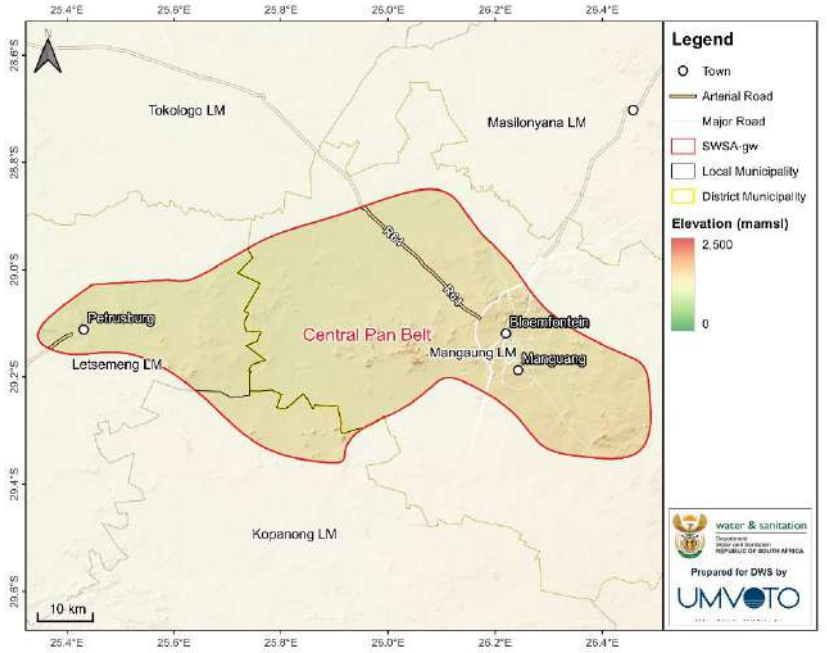
3.1. Description

SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl
Geospatial Context	

The topography of the Central Pan Belt SWSA-gw, as depicted in the map, consists of a predominantly flat to gently undulating landscape characteristic of the central Free State plateau. The terrain is largely open, with occasional low hills and ridges interrupting the otherwise expansive grassland and agricultural fields. Bloemfontein itself is situated on a slightly elevated plateau, and the terrain around the city features gently rolling hills.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Free State
Metropolitan Municipality	Mangaung Metropolitan
District Municipality	Xhariep
Local Municipality	Letsemeng and Kopanong
Towns	Bloemfontein
Major Roads	N8, N1 and R64
Major Water Supply Networks	Mangaung Scheme



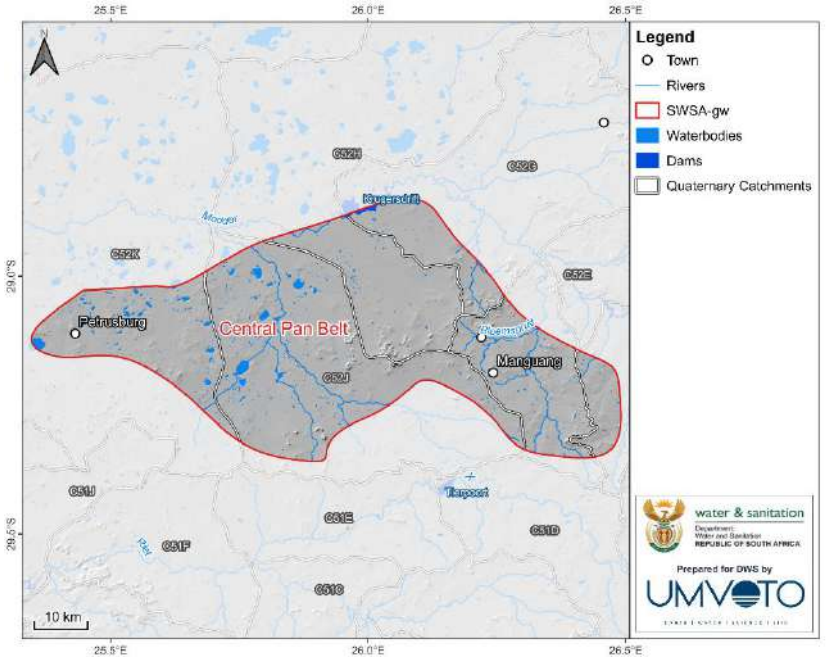
Locality map of Major Towns, District and Local Municipalities in the Central Pan Belt SWSA-gw.

SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl

Hydrology and Drainage

The Central Pan Belt SWSA-gw and surrounding areas include a few large surface water systems, summarised below and displayed on the map to the right. The Krugersdrift Reservoir is fed by the C5 catchment. Furthermore, there are two perennial rivers in the area, the Bloemspruit and Kaalspruit rivers, both flowing in a northern direction, also fed by the C5 catchment.

Quaternary Catchments	C52D, C52F, C52G,C52H, C52J and C52K
Rivers	Perennial: Bloemspruit, Modder
	Ephemeral: Bloemspruit, Kaalspruit, Koringspruit, Matjiespruit, Renosterspruit, Stinkhoutspruit
Natural and manmade water bodies	
Major Dams:	Krugersdrift
Water Management Areas:	Vaal Orange



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Central Pan Belt SWSA-gw.

SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl
Geology	

Geology

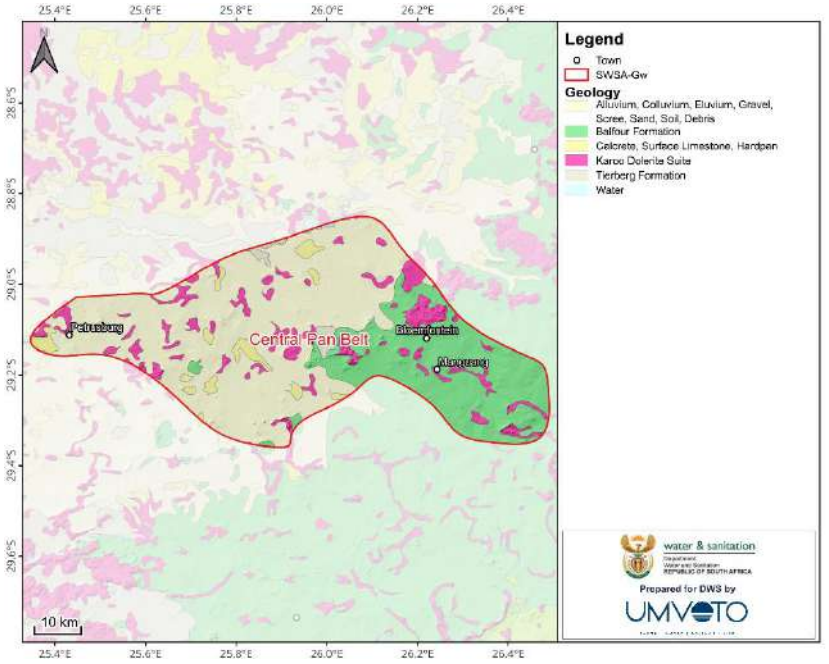
Quaternary deposits and the Kalahari Group cover the western section of the area. These deposits consist of aeolian sands, including cover sands and dunes, alluvium, calcrete, and surface limestone.

The Karoo Supergroup comprises mudrock with subordinate sandstone and grey shale, interbedded with siltstones.

Intruding into both the Kalahari and Karoo Supergroups is the extensive network of dolerite sills, sheets, and dykes, collectively known as the Karoo Dolerite Suite.

Hydrostratigraphy

Shallow, unconfined intergranular aquifers occur in the Quaternary and Kalahari Group deposits, while deeper confined aquifers are found in the fractured and weathered dolerite zones. Fractured sandstone and shale of the Karoo Supergroup form a secondary aquifer system. In the Middle Vaal area, chert-rich Karoo Dolerite Suite intrusions form karstic aquifer systems.



Geology Map of the Central Pan Belt SWSA-gw region.

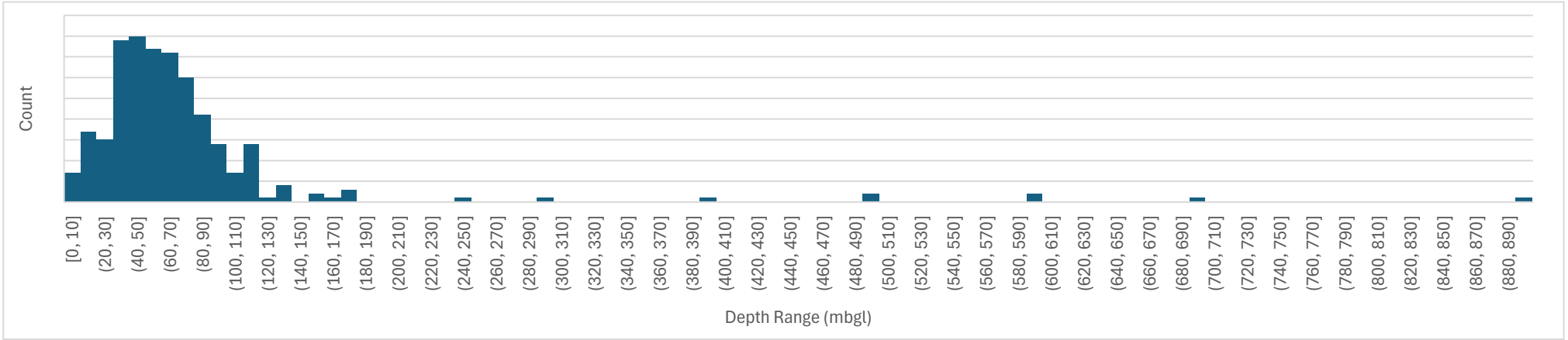
3.2. Current Status

SWSA-gw Name:	**Central Pan Belt**
Area:	**3368 km²**
Elevation:	**1200 to 1553 mamsl**
Quantity & Quality	
Aquifer Classification	

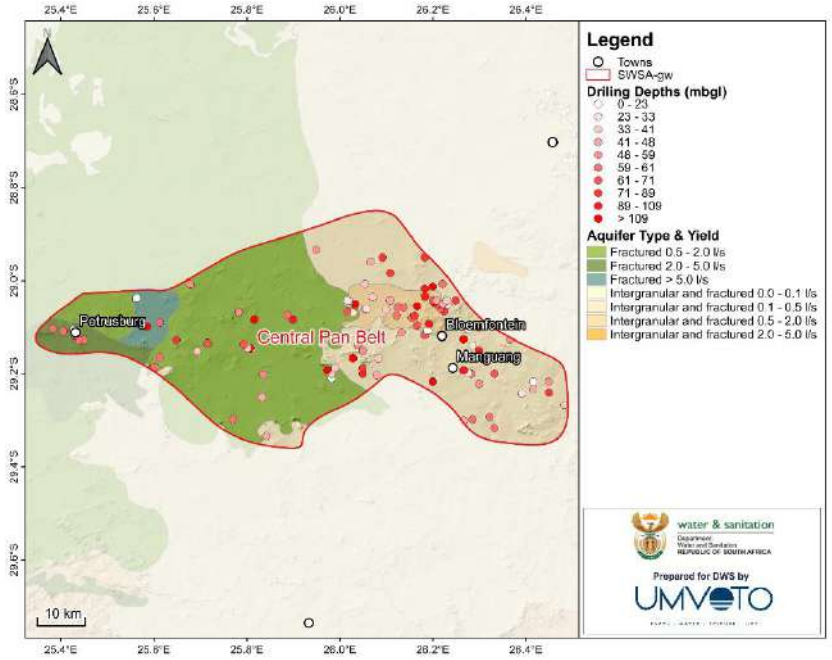
The aquifer systems within the Central Pan Belt SWSA-gw exhibit varying yields across fractured and intergranular aquifers, as summarised in the table and maps below.

Aquifer Classification	The majority of the SWSA-gw area consists of a minor aquifer system, with a Major aquifer system at the westernmost edge. The major aquifer system has an average fractured yield ranging from 0.5 to 5.0 l/s. The minor aquifer system has a fractured yield with an average range of 0.5 to occasionally over 5.0 l/s, along with a dual-porosity yield between 0.1 and 2.0 l/s.
Groundwater Targets	The average drilling depth is 76 mbgl, and the most common depths are between 40 to 70 mbgl. Some boreholes, particularly near the northeastern border, reach depths > 200 mbgl, likely indicating targeting of the underlying fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 40 and 84 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 11 mbgl, with values ranging from 1 to 23 mbgl with a standard deviation of ~ 6 mbgl.

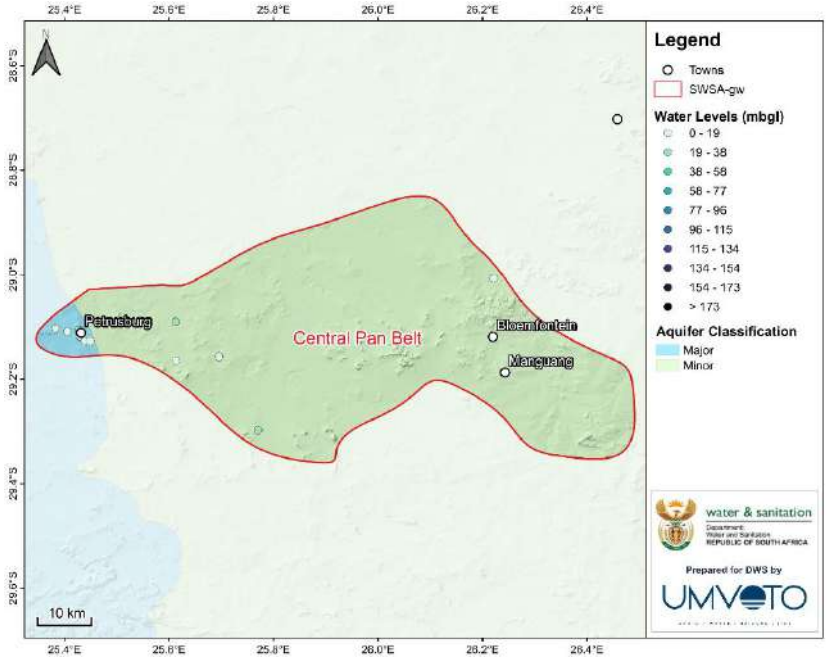
Graph of NGA drilling depths of the Central Pan Belt SWSA-gw region



SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depth of the Central Pan Belt SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Central Pan Belt SWSA-gw region.

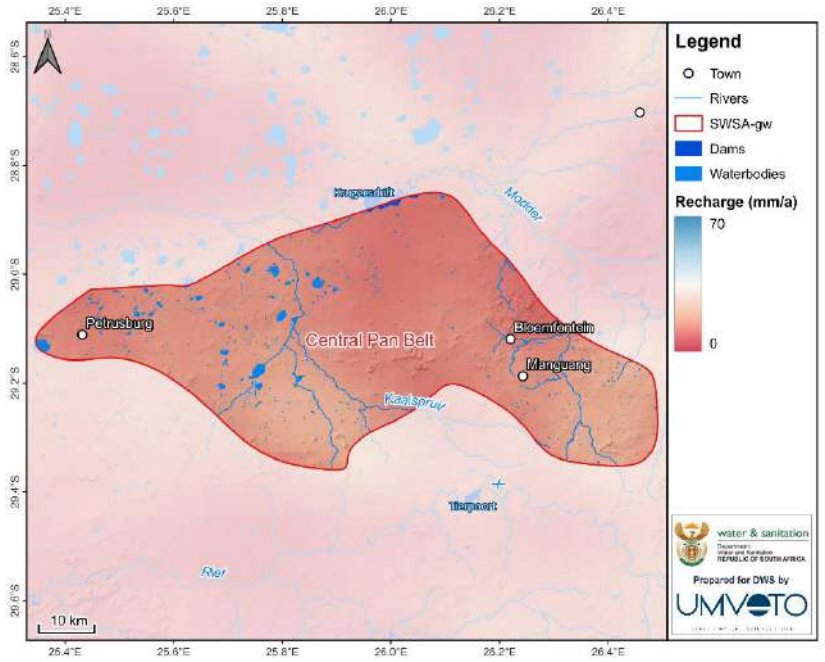
SWSA-gw Name:	**Central Pan Belt**
Area:	**3368 km²**
Elevation:	**1200 to 1553 mamsl**

Quantity & Quality

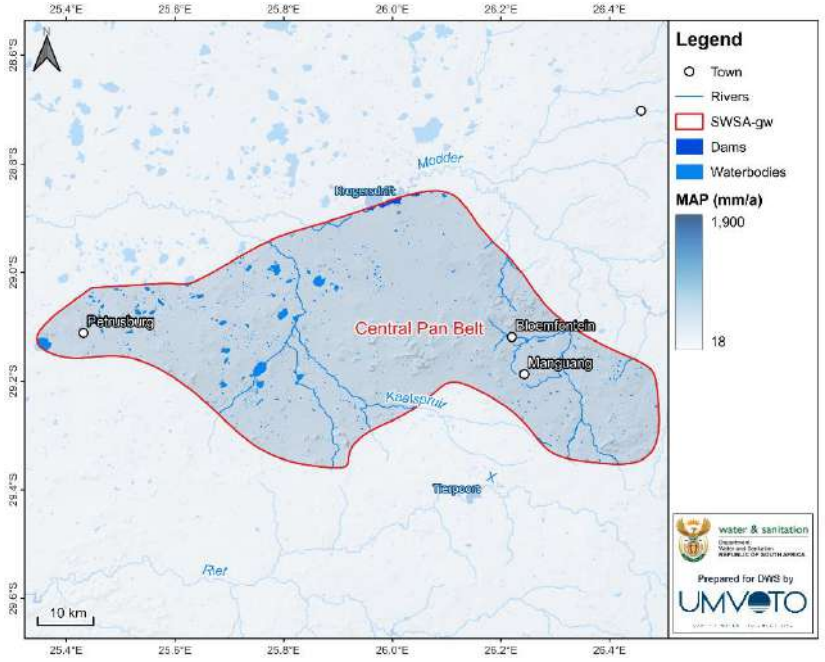
Groundwater Recharge

The Central Pan Belt receives a total MAP volume of 1534 Mm^3/a, with an average rainfall of 454 mm/a. However, only 47.1 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a very low recharge of 3.7% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Central Pan Belt	1534	454	47.1	14	3.1%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl

Quantity & Quality

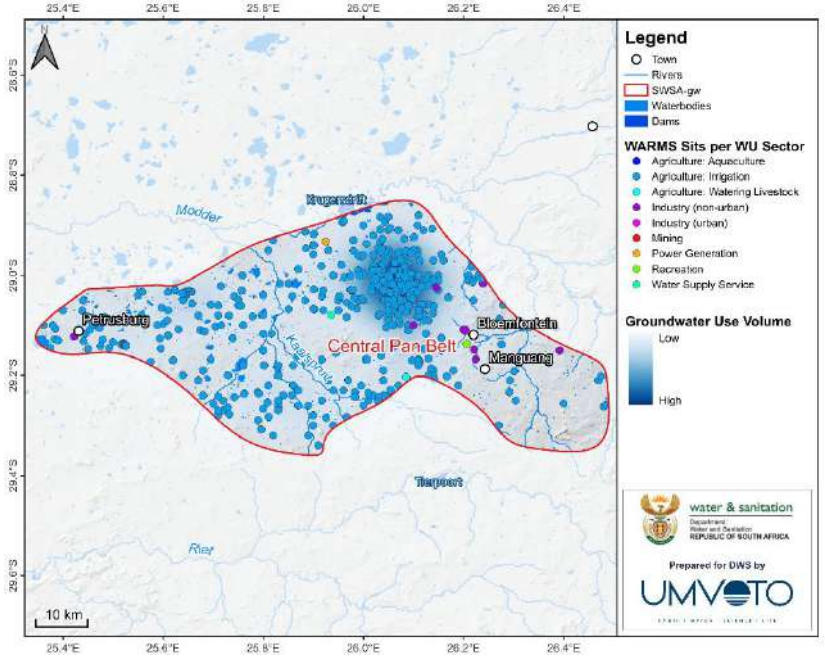
Groundwater Use

The Central Pan Belt SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Petrusburg, which relies significantly on groundwater resources for agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 48.6 Mm^3/a to sustain crop production. A large proportion of the region relies on groundwater use for this sector. Interestingly, use is concentrated just above Bloemfontein, but to the east of this cluster, there are hardly any points compared to the rest of the map.
- Non-urban industrial follows, using 0.5 Mm^3/a for manufacturing, processing, and other industrial activities outside urban centres. This sector's use is significantly less than agricultural irrigation. The distribution of points is also quite different, with the points mainly being south of Bloemfontein as opposed to being scattered around the region or clustered in the north.
- Mining use has 0.03 Mm^3/a allocated. Mining has even less use than the non-urban industrial sector. Mining is only located in the east of the region. This is almost the opposite of the first two trends.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Bloemfontein, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	48.6
	Industry (Non-urban)	0.5
	Industry (Urban)	0.02
	Mining	0.03
	Power Generation	0.01
	Total	**49.1**



Water use map for the Central Pan Belt SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

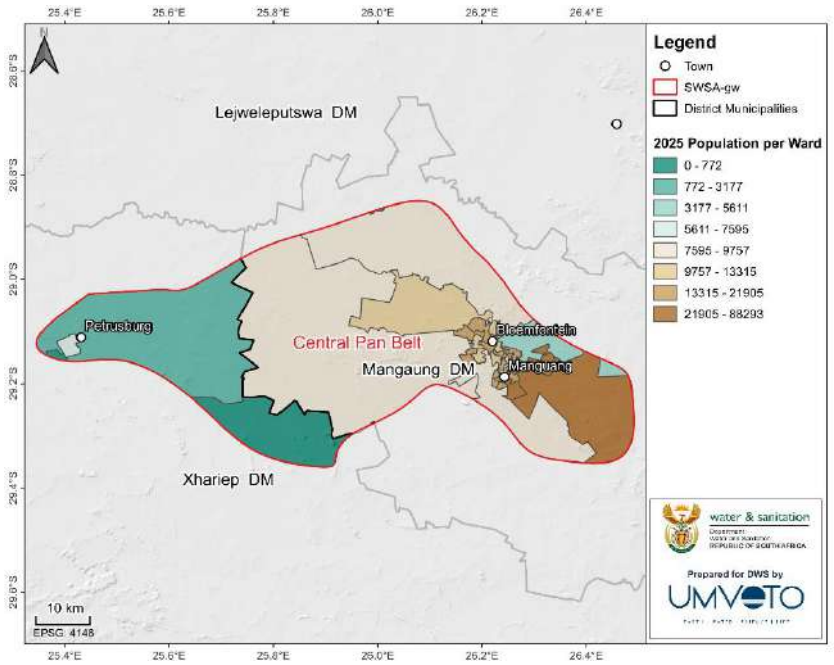
SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Central Pan Belt SWSA-gw is located within the Vaal-Orange Water Management Area (WMA, 2023). The groundwater resources within the Central Pan Belt SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities are the Water Service Authorities (WSA) for their jurisdiction, while the Mangaung Metro is the WSA and Water Service Provider (WSP) for its jurisdiction.

The estimated 2025 population within the Central Pan Belt SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of -0.21% per year, resulting in a projected population of approximately 438,211.

As shown in the map and table below, Mangaung Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 430,339. Population concentrations within the SWSA-gw are highest in and around the town of Bloemfontein.



Projected population distribution in 2025 for the Central Pan Belt SWSA-gw.

SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl

Quantity & Quality

Socio Economic & Governance

In terms of water reliance within the Central Pan Belt SWSA-gw, an estimated 96.0% of the population depends on the regional water supply scheme, 2.7% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 1.6% on groundwater sources (including boreholes and springs).

Among the LMs, the Kopanong LM has the highest proportion of groundwater reliance, with approximately 12.0% of its population depending on groundwater with minimal reliance on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Kopanong	396	272.8	47.5	11.2
Letsemeng	7,469	6,949.4	193.1	697.9
Mangaung	430,339	413,237.3	6,672.8	11,124.7
Masilonyana	7	5.6	0.3	3.0
Total	**438,211**	**420,465**	**6,914**	**11,837**



Projected population dependence on water sources in 2025.

SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl

Quantity & Quality

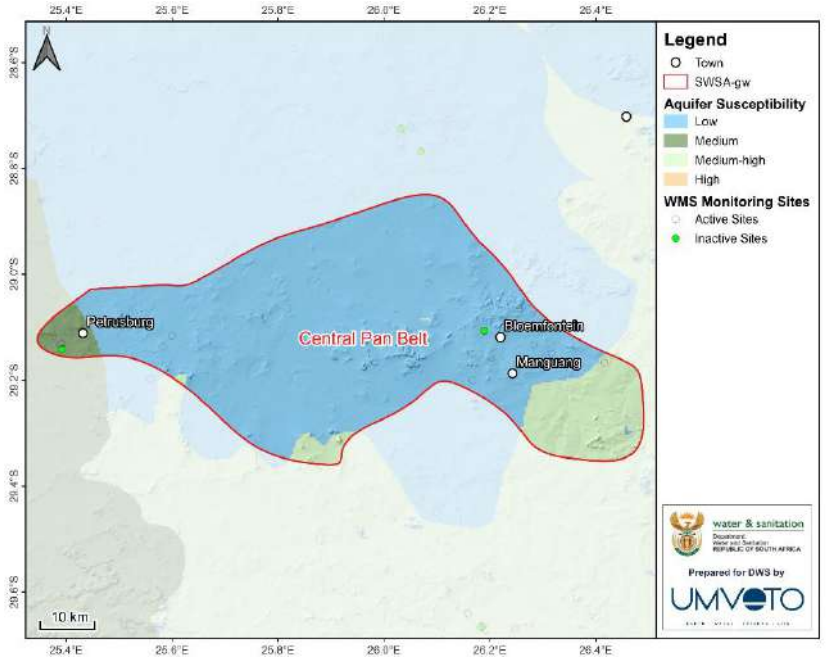
Groundwater Quality

The Central Pan Belt SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 1406.22 km^2, which is 41.76% of the Central Pan Belt SWSA-gw total area. Urban/Built-up areas cover 307.54 km^2 (9.13%), while mines and quarries account for 4.30 km^2 (0.13%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major aquifer consists of areas with moderate aquifer vulnerability and is found on the western corner of the aquifer. However, WMS data is unavailable for most vulnerable aquifer areas in the Major aquifer system. The Minor aquifer system accounts for a majority of the Central Pan Belt aquifer, with areas of least aquifer vulnerability covering the majority. Areas of moderate vulnerability cover the eastern, southwestern edges of the aquifer.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 35.8 – 258 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.15 – 0.95 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.04 – 14.5 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 7.11 – 8.74 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 10.23 - 131.66 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Central Pan Belt**
Area:	**3368 km²**
Elevation:	**1200 to 1553 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Central Pan Belt SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	2	33.33	6	71.97	mS/m	53.6 - 258 mS/m (Avg.: 88.79 mS/m). 2014-2024 GW Geosites: 70-150 mS/m, some 300-500 mS/m. Consistent with WMS (2000-2024).	35.8 - 85 mS/m (Avg.: 54.69 mS/m). 2014-2024 GW Geosites: 70-150 mS/m. Consistent with WMS (2000-2024).	-
Fluoride	2	33.33	6	0.45	mg/L	0.16 - 0.72 mg/L (Avg.: 0.42 mg/L). 2014-2024 GW Geosites: <0.5-1.5 mg/L, some >5 mg/L. Consistent with WMS (2000-2024).	0.37 - 0.95 mg/L (Avg.: 0.48 mg/L). 2014-2024 GW Geosites: <0.5-1.5 mg/L. Consistent with WMS (2000-2024).	-
Nitrate + Nitrite Nitrogen	2	33.33	6	3.33	mg/L	0.05 - 14.5 mg/L (Avg.: 3.16 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	0.04 - 6.33 mg/L (Avg.: 3.52 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	-
pH	2	33.33	6	8.15	pH unit	7.11 - 8.72 (Avg.: 8.15). 2014-2024 GW Geosites: 7 - 9. Mostly consistent with WMS (2000-2024).	7.19 - 8.74 (Avg.: 8.15). 2014-2024 GW Geosites: 7 - 9. Mostly consistent with WMS (2000-2024).	-
Sulphate	2	33.33	6	36.48	mg/L	10.83 - 131.66 mg/L (Avg.: 55.43 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	10.23 - 39.18 mg/L (Avg.: 15.85 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Central Pan Belt SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

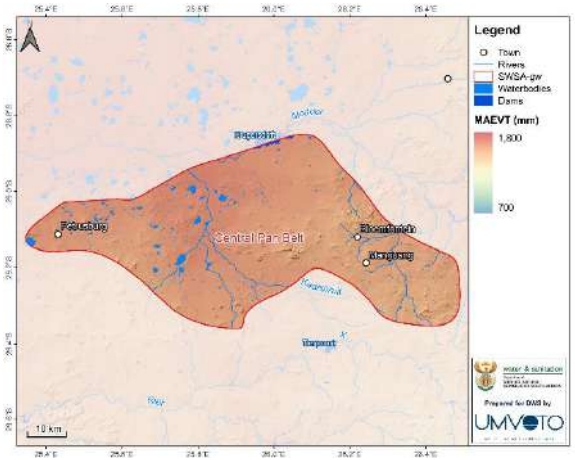
SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl

Threats & Risks

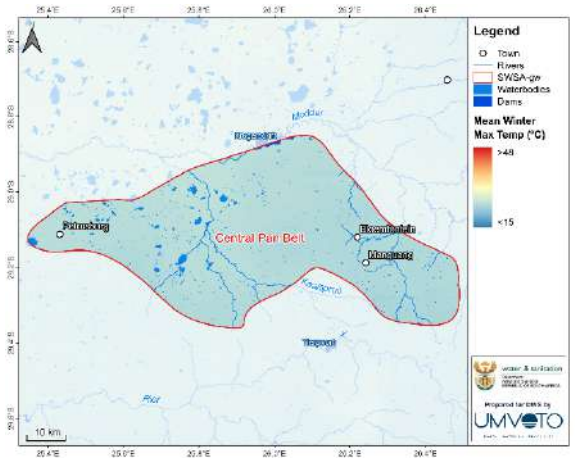
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Central Pan Belt SWSA-gw has a BSk, cold semi-arid, type climate characterized by cold winters, large temperature swings, and hot, dry summers. Temperatures in the SWSA-gw range from -1.9 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

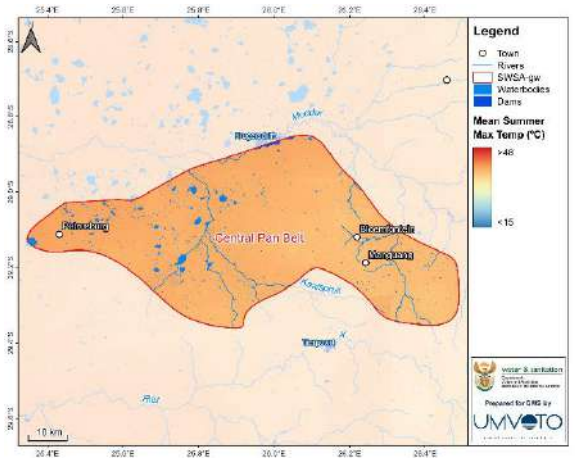
Temperature	Summer: 27 to 31 °C, Winter: -1.9 to 2 ºC
Evapotranspiration	Maximum value of 1669 mm/a with an average value of 1593 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, but an increase in recharge (ranging from ~4.4 to 11.3 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Central Pan Belt SWSA-gw region.



Mean winter temperatures of the Central Pan Belt SWSA-gw region.



Mean summer temperatures of the Central Pan Belt SWSA-gw region.

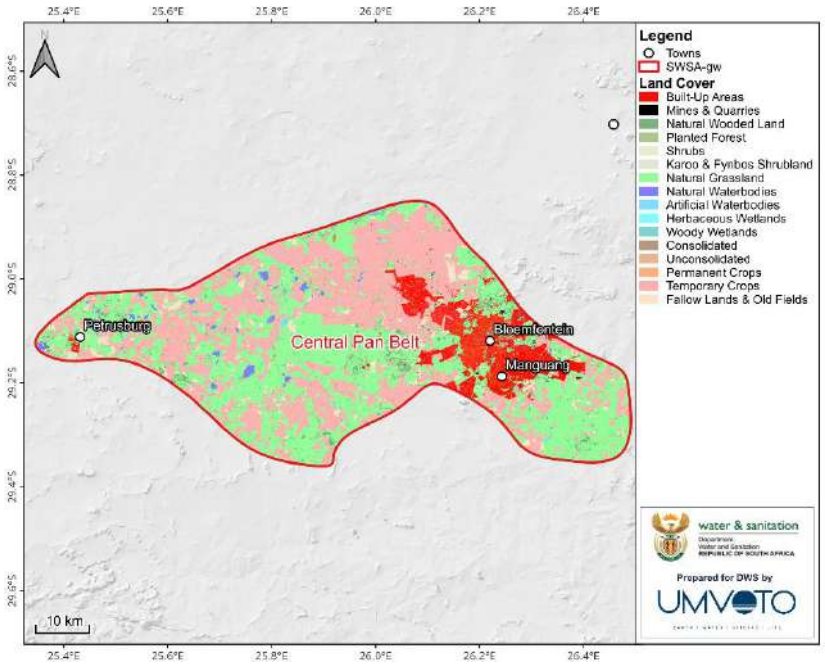
SWSA-gw Name:	Central Pan Belt
Area:	3368 km^2
Elevation:	1200 to 1553 mamsl

Threats & Risks

Land Use

The Central Pan Belt SWSA-gw consists mainly of grassland and cultivated lands, which consists of permanent crops, temporary crops, fallows and old fields, making up 84.6% of land cover (DFFE, 2022) and indicating a strong interplay between natural vegetation and agricultural activities. Agricultural land is concentrated in the central northern section of the SWSA-gw and dissipates towards the east of the SWSA-gw. The built-up area, which includes residential, commercial, small holdings and industrial areas, comprises 9.1% of the total land cover and is concentrated by the towns of Bloemfontein and Manguang. There are many small waterbodies scattered around the eastern half of the SWSA-gw. There are a small percentage of mines and quarries which includes surface infrastructure extraction sites and waste and resource dumps, that take up a small percentage of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	6	0.2
Built-Up	308	9.1
Cultivated	1406	41.8
Forest Land	139	4.1
Grassland	1440	42.8
Mines and quarries	4	0.1
Shrubland	5	0.2
Waterbodies	52	1.5
Wetlands	7	0.2



Land Cover 24-class map to show the types of land use and extent of each occurring in the Central Pan Belt SWSA-gw.

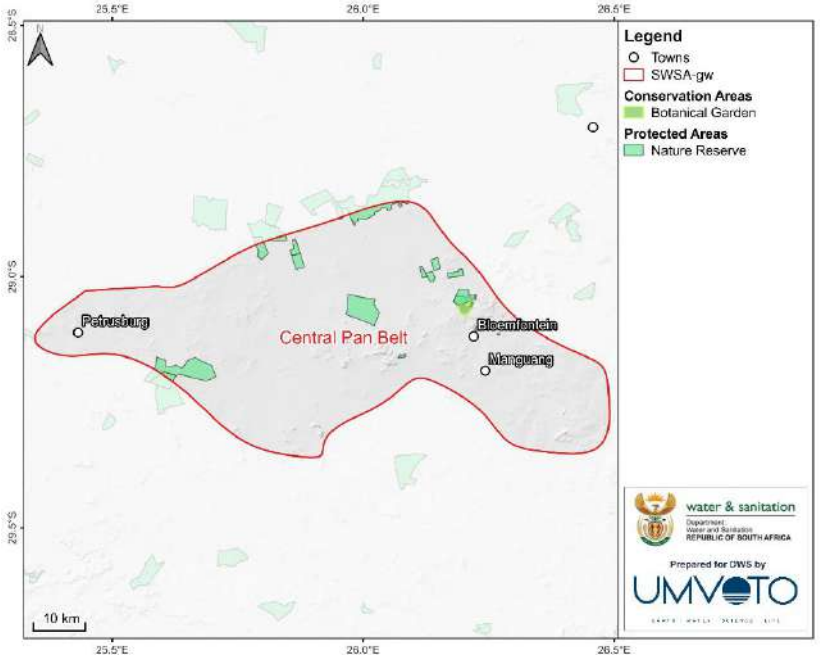
SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Central Pan Belt SWSA-gw includes one conservation area (DFFE, 2024), the Free State National Botanical Garden, covering 5.67 km², which helps preserve local flora. Additionally, there are 12 protected areas totalling 125.87 km², such as Chesas Peak Private Nature Reserve and Soetdoring Nature Reserve, underscoring the role of smaller or private reserves in conservation efforts. Conservation in this region largely depends on the existing botanical garden and the network of smaller protected reserves.

Protection Status	Names	Area (km²)	Count
Conservation Areas	• Free State National Botanical Garden	5.67	1
Protected Areas	• Chesas Peak Private Nature Reserve • Highlands Reserve • Soetdoring Nature Reserve • Buffalo Valley • Phakwe Restcamp • And various other small nature reserves	125.87	12
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Central Pan Belt SWSA-gw that have protection status.

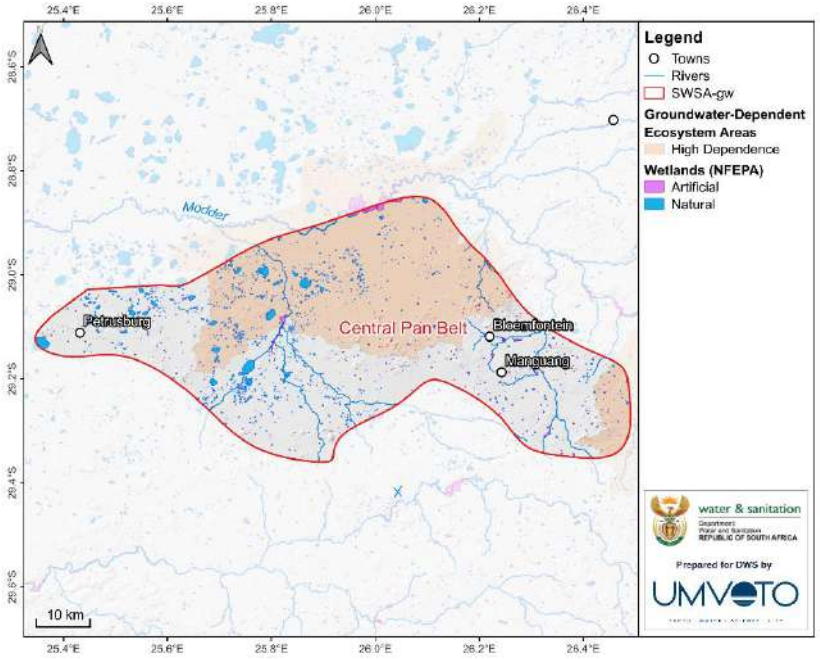
SWSA-gw Name:	Central Pan Belt
Area:	3368 km²
Elevation:	1200 to 1553 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Central Pan Belt SWSA-gw contains one major waterbody, Krugersdrift Dam, covering 4.78 km², which is vital for local water supply. The wetlands (CSIR, 2018) of potentially high-dependence groundwater-dependent ecosystems (DWA, 2010) are extensive, spanning 88 km².

Protection Status	Names	Area (km²)	Count
Major Waterbodies	• Krugersdrift Dam	4.78	1
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	88	

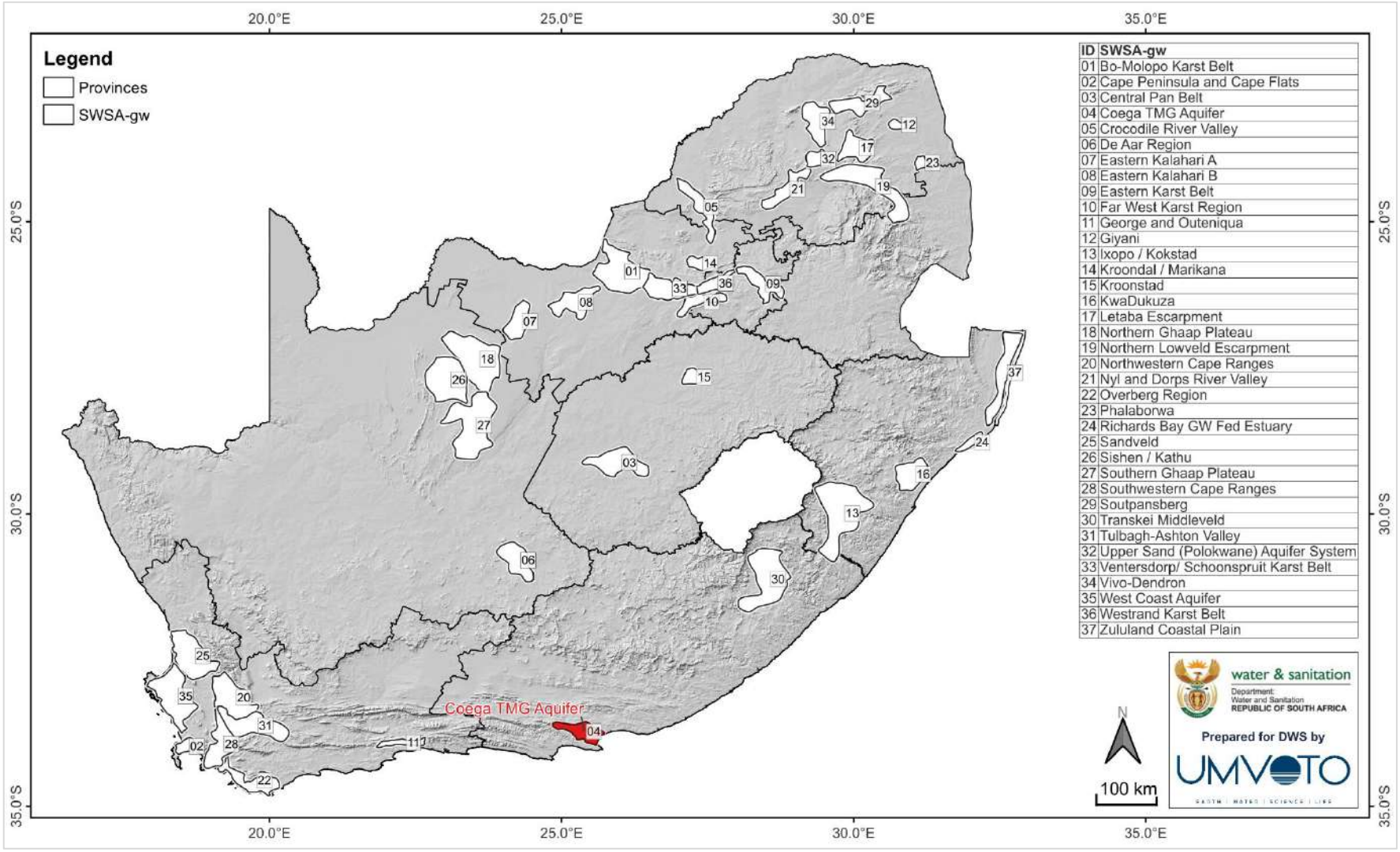


Map showing the major water bodies, Ramsar sites and GDEs in the Central Pan Belt SWSA-gw.

APPENDIX 04

COEGA TMG AQUIFER SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE COEGA TMG AQUIFER SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

4. Coega TMG Aquifer

4.1. Description

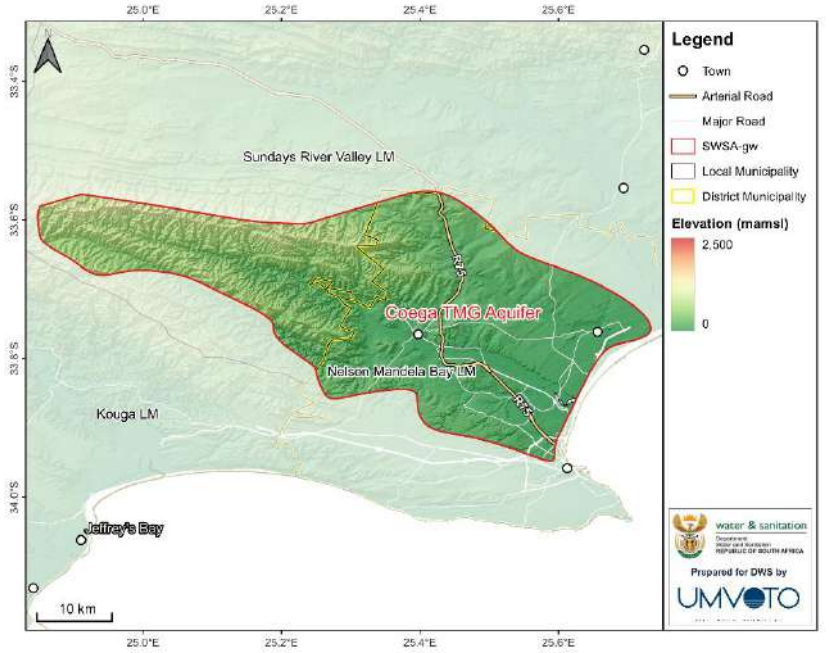
SWSA-gw Name:	**Coega TMG Aquifer**
Area:	**1681 km²**
Elevation:	**16 to 1391 mamsl**

Geospatial Context

The topography of the Coega TMG Aquifer SWSA-gw, as depicted in the map, is characterized by a combination of coastal plains, river valleys, and rugged inland terrain. The western and southern portions, particularly around Port Elizabeth (Gqeberha) and Despatch, exhibit relatively low-lying coastal plains with elevations near sea level. Moving inland towards Uitenhage and further northwest, the terrain becomes more undulating, transitioning into the foothills and ridges of the Cape Fold Belt, which introduces more pronounced topographic variation. The Sundays River Valley, located to the northeast, marks a significant low-lying corridor, while the northern and northwestern areas show increasing elevation with rugged relief shaped by ancient geological formations.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Eastern Cape
Metropolitan Municipality	Nelson Mandela Bay
District Municipality	Sarah Baartman
Local Municipality	Sundays River Valley
Towns	Port Elizabeth, Ibhayi, Zwide, Wells Estate, Despatch and Uitenhage
Major Roads	N2, R75 and R102
Major Water Supply Networks	



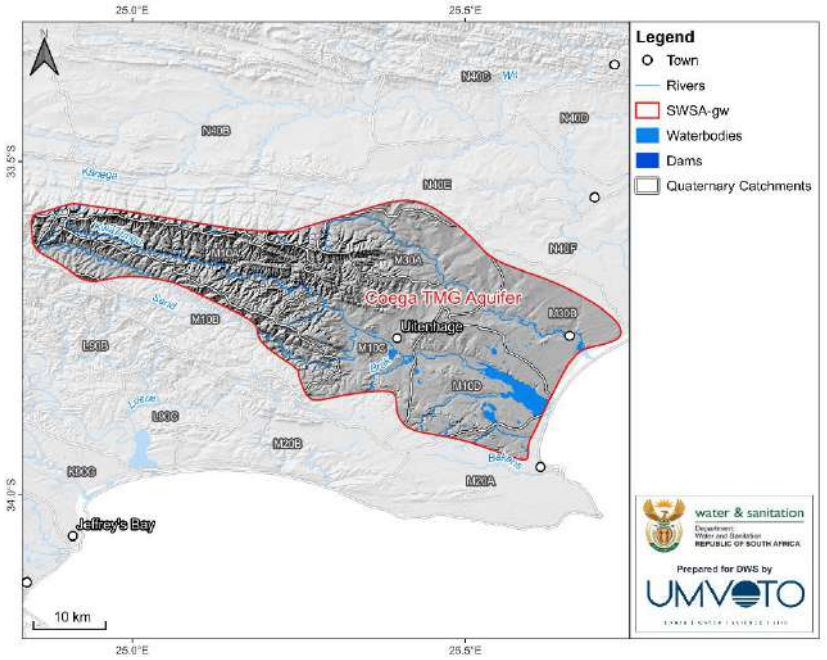
Locality map of Major Towns, District and Local Municipalities in the Coega TMG Aquifer SWSA-gw.

SWSA-gw Name:	Coega TMG Aquifer
Area:	1681 km²
Elevation:	16 to 1391 mamsl

Hydrology and Drainage

The Coega TMG Aquifer SWSA-gw and surrounding areas include a few large surface water systems, along with several unnamed seeps and floodplains, which are summarised below and displayed on the map to the right. The primary surface water features include the Groendal Reservoir and Swartkops Estuary, both fed by the M1 catchment, as well as the Coega Estuary, which is fed by the M3 catchment. Several perennial and ephemeral rivers flow through the area, with varying flow directions.

Quaternary Catchments	L70F, L70G, M10A, M10B, M10C, M10D, N40B, N40E as well as a small section of L90A, M20A, M30A and M30B
Rivers	Perennial: Elands, Kariega, KwaZungu, Noagas, Swartkops and Papkuilsrivier
	Ephemeral: Bezuidenhouts, Brak, Chatty, Coega and Holbak
Natural and manmade water bodies	Swartkops Estuary and Coega Esturary
Major Dams:	Groendal
Water Management Areas:	Mzimvubu Tsitsikamma



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in Coega TMG Aquifer SWSA-gw.

SWSA-gw Name:	Coega TMG Aquifer
Area:	1681 km²
Elevation:	16 to 1391 mamsl
Geology	

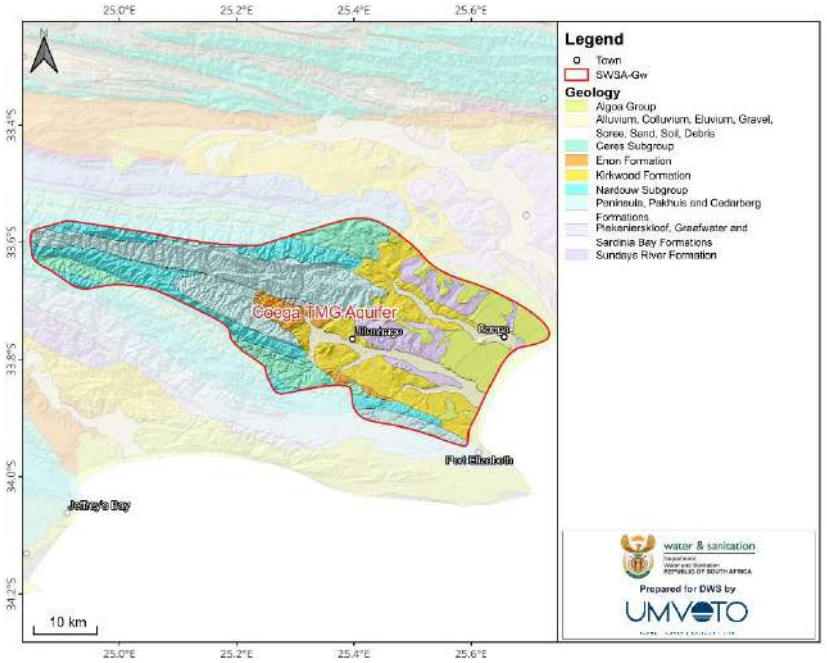
Geology

The eastern section of the area contains Cenozoic terrace gravel deposits, including Quaternary deposits and the Algoa Group (~41–100 Ma). These deposits are characterised by calcareous sandstone, gravel, coquinite, shelly limestone, sandy limestone, and large-scale cross-bedding. Additionally, the Tertiary deposits of the Uitenhage Group (~183–100 Ma) include conglomerates with lenticular sandstones and claystones, variegated silty mudstone and sandstone, as well as grey shale, siltstone, and sandstone.

The western section of the area comprises the Cape Supergroup. The Bokkeveld Group is primarily composed of sandstone with minor siltstone and mudstone. It also features feldspathic sandstone, subordinate mudrock, siltstone, arenite, wacke, and grey shale. The Table Mountain Group consists of quartzitic sandstone and feldspathic sandstone along with minor conglomerate and shale.

Hydrostratigraphy

Alluvial deposits form shallow, unconfined primary aquifers, while deeper artesian secondary aquifer systems are controlled by the fractured quartzites of the Table Mountain Group, with mudstones acting as aquitards that regulate groundwater flow.



Geology Map of the Coega TMG Aquifer SWSA-gw region.

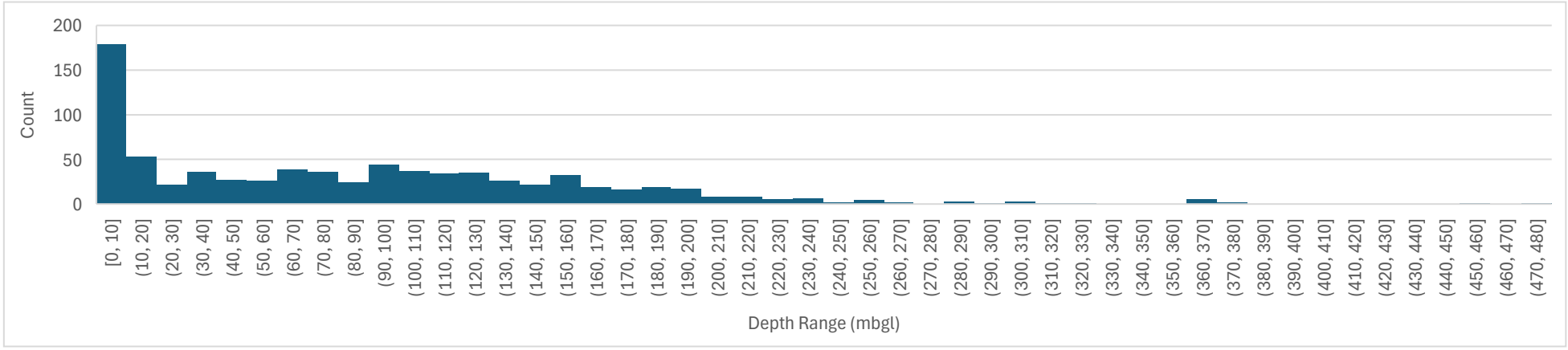
4.2. Current Status

SWSA-gw Name:	**Coega TMG Aquifer**
Area:	**1681 km²**
Elevation:	**16 to 1391 mamsl**
Quantity & Quality	
Aquifer Classification	

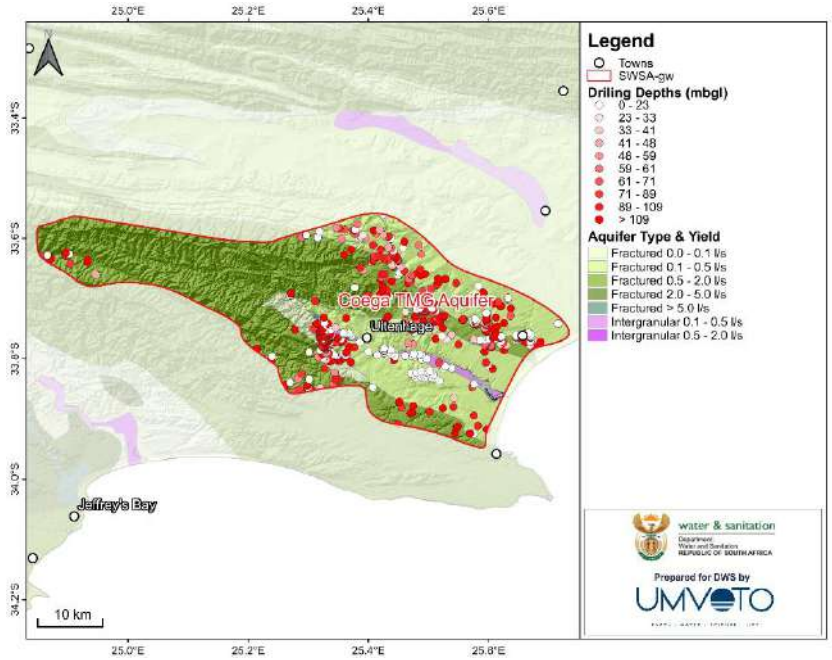
The aquifer systems within the Coega TMG Aquifer SWSA-gw exhibit varying yields across fractured and intergranular aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw predominantly consists of a combination of poor and minor aquifer systems, with a major aquifer system in the centre. The major aquifer system has a fractured yield averaging between 0.0 and over 5.0 l/s, with an intergranular yield ranging from 0.1 to 0.5 l/s. The minor aquifer system has an average fractured yield of 0.1 to 2.0 l/s and an intergranular yield of 0.1 to 0.5 l/s.
Groundwater Targets	The average drilling depth is 86 mbgl. Mixed targets are observed, with the majority of boreholes drilled at around 10 mbgl, targeting the fractured aquifer system, while a smaller number exceed 200 mbgl, potentially tapping deeper groundwater reserves. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 13 and 132 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 25 mbgl, with values ranging from 0 to 70 mbgl with a standard deviation of ~ 13 mbgl.

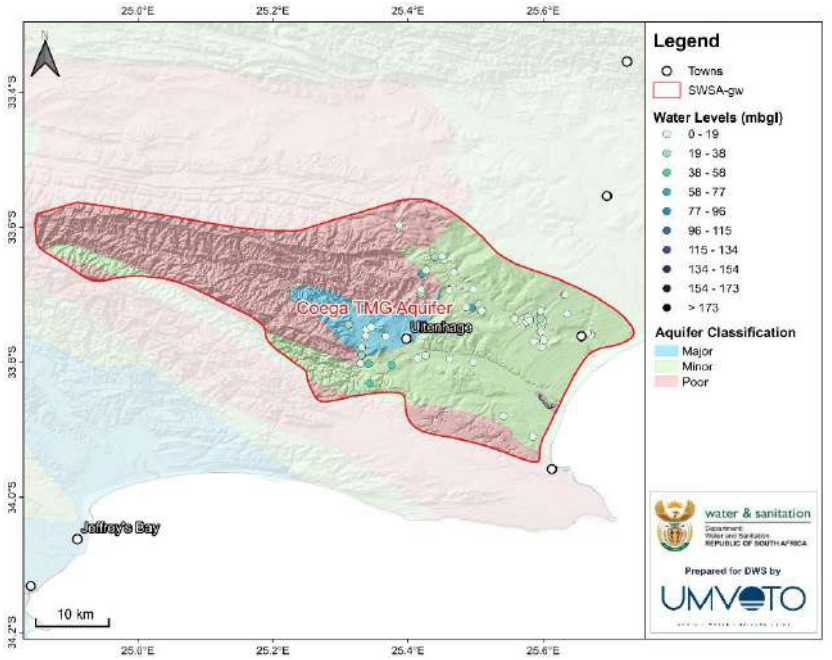
Graph of NGA drilling depths of the Coega TMG Aquifer SWSA-gw region



SWSA-gw Name:	Coega TMG Aquifer
Area:	1681 km²
Elevation:	16 to 1391 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depts of the Coega TMG Aquifer SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Coega TMG Aquifer SWSA-gw region.

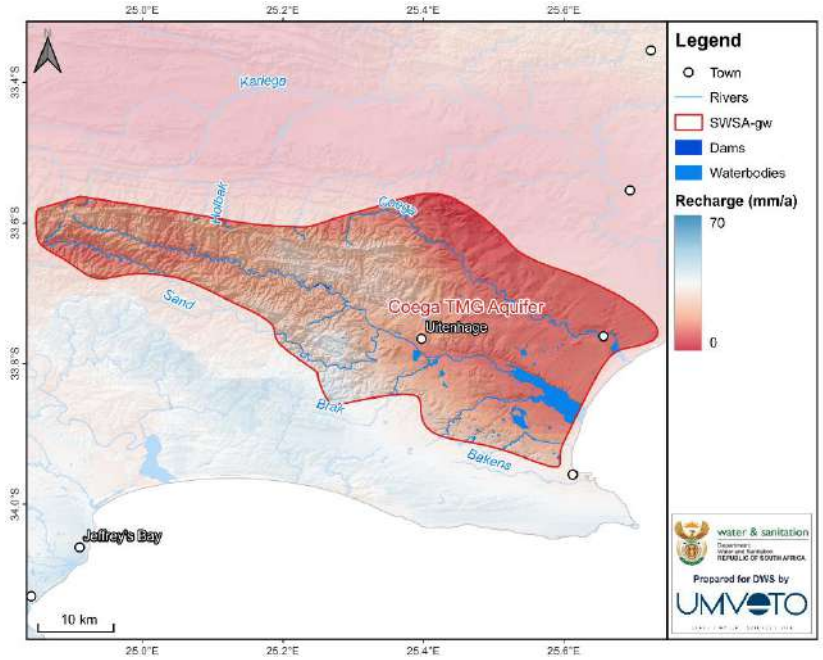
SWSA-gw Name:	**Coega TMG Aquifer**
Area:	**1681 km²**
Elevation:	**16 to 1391 mamsl**

Quantity & Quality

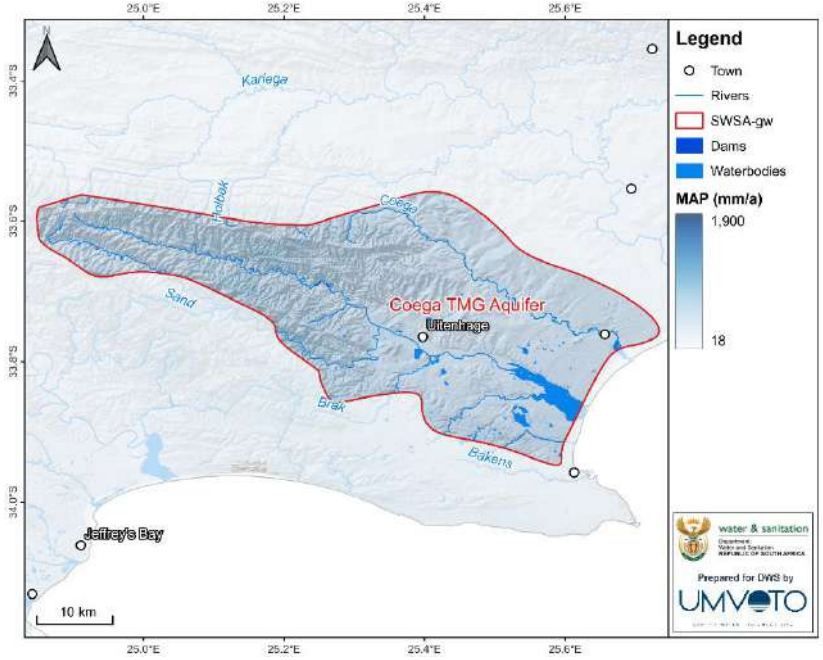
Groundwater Recharge

The Coega TMG Aquifer receives a total MAP volume of 838 Mm^3/a, with an average rainfall of 504 mm/a. However, only 27.5 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 3.3% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Coega TMG Aquifer	838	504	27.5	16.4	3.3%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Coega TMG Aquifer
Area:	1681 km²
Elevation:	16 to 1391 mamsl

Quantity & Quality

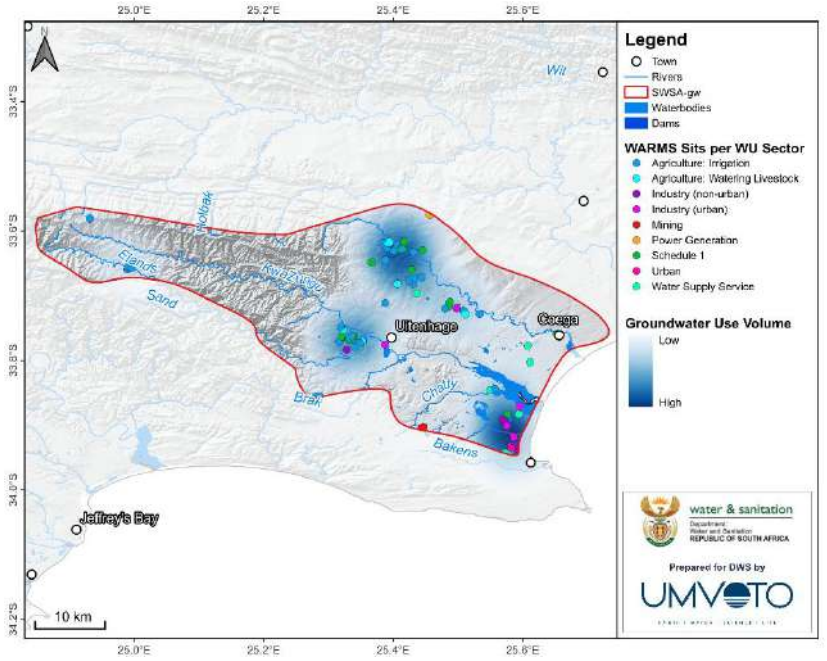
Groundwater Use

The Coega TM Aquifer SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. While no towns in this region rely primarily on groundwater for municipal supply, industrial use, or agriculture (see Table below), an analysis of active groundwater use licenses from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Municipal water supply services have the highest use, with 6.6 Mm^3/a. They provide essential water for groundwater-dependent towns with limited surface water access. Bigger towns are larger consumers of this source like in iBhayi, Uitenhage and Gqeberha. This makes sense as there are generally more people living in towns compared to other areas, so naturally there will be more use in those areas as well.
- Agricultural irrigation follows, with 1.9 Mm^3/a to sustain crop production. Given the arid conditions of the West Coast, groundwater is essential for farming, supporting food production and local economies. Interestingly, this use type is not scattered around the entire area but concentrated in the northern parts of the map in the areas surrounding Uitenhage, suggesting that agriculture is located primarily in this area.
- Non-urban industrial, using 0.5 Mm^3/a allocated for manufacturing, processing, and other industrial activities outside of urban centres. Non-industrial urban groundwater use is seen mostly in the southern parts of the map around IBhayi and Gqeberha.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Uitenhage and IBhayi, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	1.9
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	0.5
	Industry (Urban)	0.5
	Schedule 1	0.3
	Urban (excluding industrial/ domestic)	0.04
	Water Supply Service	6.6
	Total	**9.9**



Water use map for the Coega TMG Aquifer SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

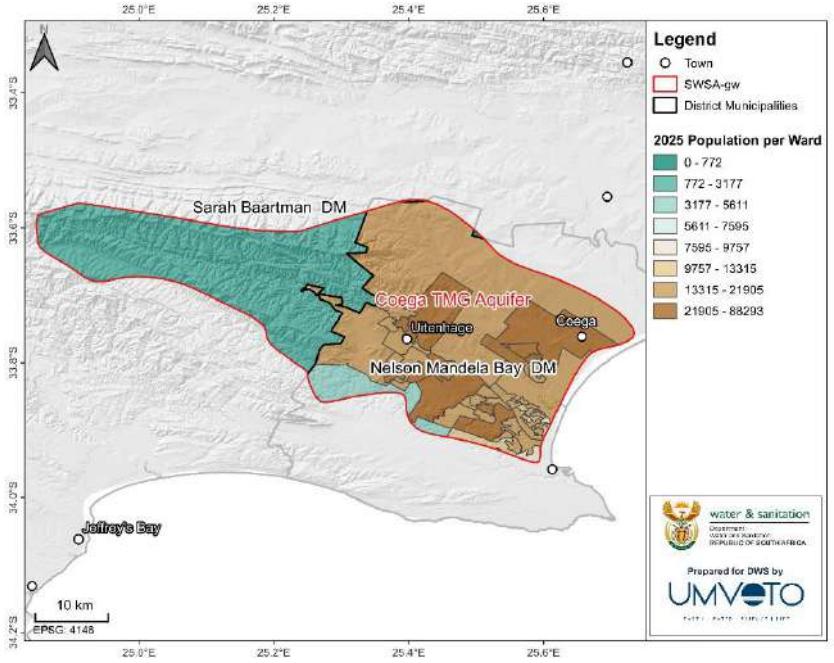
SWSA-gw Name:	Coega TMG Aquifer
Area:	1681 km²
Elevation:	16 to 1391 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Coega TMG Aquifer SWSA-gw is located within the Mzimvubu-Tsitsikamma Water Management Area (WMA, 2023). The groundwater resources within the Northwestern Cape Ranges SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Mzimvubu-Tsitsikamma Catchment Management Agency (MTCMA), which was formed as part of a national restructuring process that consolidated CMAs. MTCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the MTCMA to manage water resources in the Mzimvubu-Tsitsikamma WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	MTCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Mzimvubu-Tsitsikamma WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	Lower Sundays River WUA is a the local water management group that assist the CMA with allocation decisions and water resource management among water users within the SWSA-gw.
WSA & WSP	Sundays River Local Municipality and Nelson Mandela Bay Metro are the Water Service Authorities (WSA) for their jurisdiction.

The estimated 2025 population within the Coega TMG Aquifer SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of -0.80 % per year, resulting in a projected population of approximately 867,773.

As shown in the map and table below, Nelson Mandela Bay Metropolitan Municipality (MM) has the highest estimated population within the SWSA-gw, with approximately 866,369. Population concentration is highest around the towns of Coega and Uitenhage.



Projected population distribution in 2025 for the Coega TMG Aquifer SWSA-gw.

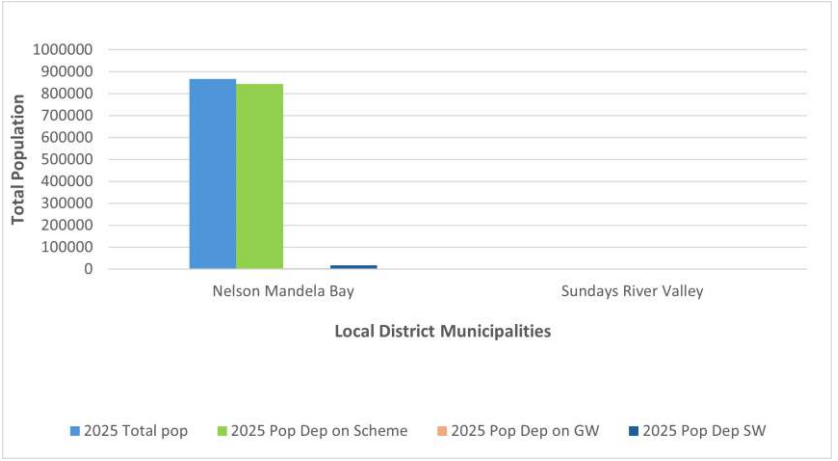
SWSA-gw Name:	Coega TMG Aquifer
Area:	1681 km²
Elevation:	16 to 1391 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Coega TMG Aquifer SWSA-gw, an estimated 97.4% of the population depends on the regional water supply scheme, 2.2% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 0.5% on groundwater sources (including boreholes and springs).

Among the LMs, the Sunday River Valley LM has the highest proportion of surface water reliance, with approximately 59.0% of its population depending on surface water and 1.9% on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Nelson Mandela Bay	866,369	844,883.9	4,413.2	17,856.3
Sundays River Valley	1,404	559.7	26.5	828.4
Total	**867,773**	**845,444**	**4,440**	**18,685**



Projected population dependence on water sources in 2025.

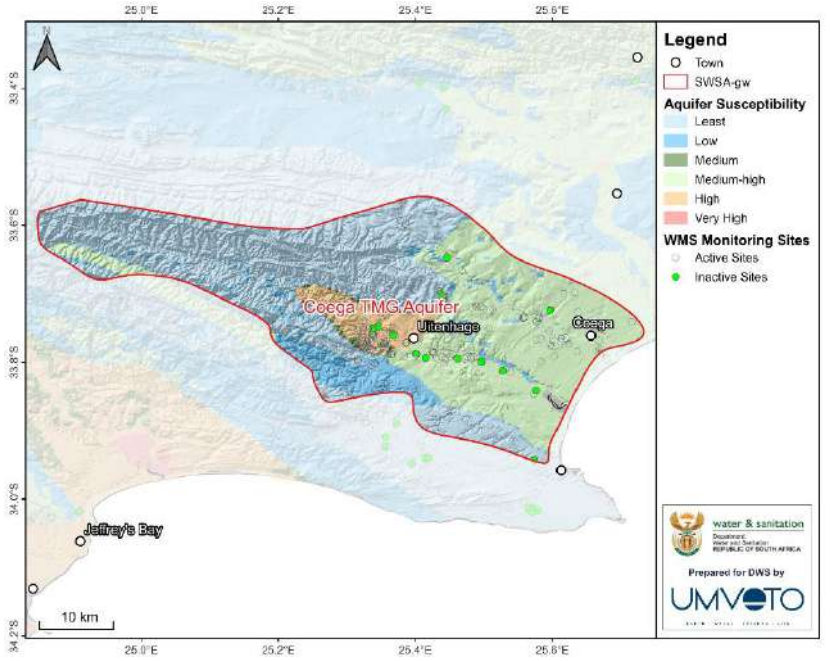
SWSA-gw Name:	Coega TMG Aquifer
Area:	1681 km²
Elevation:	16 to 1391 mamsl
Quantity & Quality	
Groundwater Quality	

The Coega TMG Aquifer SWSA-gw consists of Poor, Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), Urban/Built-up areas cover a total of 165.20 km^2, which is 9.82% of the Coega TMG Aquifer SWSA-gw total area. Cultivated areas cover 70.47 km^2 (4.19%), while mines and quarries account for 4.04 km^2 (0.24%) of the total area. These land uses contribute to diffuse contamination sources, with urban areas being the primary concern. Urban areas tend to include informal settlements and townships, and this places the groundwater source under a high risk of contamination (Le Maitre et al., 2018). Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major Aquifer consists of areas with moderate and high aquifer vulnerability. The majority of the Major Aquifer is characterized by areas that have the most vulnerability, while moderate vulnerability areas are found along the western and northern edges of the major aquifer.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. EC ranges from 22.6 – 9020 mS/m in the Major aquifer system. Coastal aquifers typically show an EC gradient, with higher values near the coastline due to seawater intrusion or marine aerosol deposition.
- **Fluoride** naturally occurs in groundwater, benefiting dental health at optimal levels but posing a concern if concentrations are too high or low. The fluoride levels range from 0.05 – 2.80 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite, concentrations range from 0.005 - 60.35 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.81 – 8.49 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 8.80 – 7039.67 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Coega TMG Aquifer**
Area:	**1681 km²**
Elevation:	**16 to 1391 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Coega TMG Aquifer SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	15	50.00	30	992.52	mS/m	12.87 - 191 mS/m (Avg.: 24.03 mS/m). 2014-2024 GW Geosites: 70 - 150 mS/m, some >500 mS/m. Consistent with WMS (2000-2024), except for values above the upper limit.	104.7 - 9020 mS/m (Avg.: 1688.12 mS/m). 2014-2024 GW Geosites: 70 - 150 mS/m, some >500 mS/m. Consistent with WMS (2000-2024), except for values above the upper limit.	22.6 - 1125 mS/m (Avg.: 536.98 mS/m). 2014-2024 GW Geosites: 70 - 150 mS/m. Mostly consistent with WMS (2000-2024), except for values above the upper limit.
Fluoride	15	50.00	30	0.46	mg/L	0.025 - 0.36 mg/L (Avg.: 0.12 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	0.05 - 1.22 mg/L (Avg.: 0.55 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	0.12 - 2.80 mg/L (Avg.: 0.98 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	14	48.28	29	1.42	mg/L	0.025 - 2.18 mg/L (Avg.: 0.20 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	0.005 - 60.35 mg/L (Avg.: 1.23 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024), except for values above the upper limit.	0.02 - 53.69 mg/L (Avg.: 5.72 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024), except for values above the upper limit.
pH	15	50.00	30	7.28	pH unit	4.35 - 8.25 (Avg.: 6.22). 2014-2024 GW Geosites: 5.7 - 7. Mostly consistent with WMS (2000-2024).	6.81 - 8.49 (Avg.: 7.87). 2014-2024 GW Geosites: 5.7 - 9. Mostly consistent with WMS (2000-2024).	7.01 - 8.21 (Avg.: 7.68). 2014-2024 GW Geosites: 5.7 - 7. Mostly consistent with WMS (2000-2024).
Sulphate	15	50.00	30	610.57	mg/L	0.38 - 63.6 mg/L (Avg.: 8.52 mg/L). 2014-2024 GW Geosites: <200 mg/L, 500 - 800 mg/L. Mostly consistent with WMS (2000-2024), except the 500 - 800 mg/L hexagon.	56.7 - 7039.67 mg/L (Avg.: 993.66 mg/L). 2014-2024 GW Geosites: <200 mg/L and 500 - >800 mg/L. Consistent with WMS (2000-2024).	8.80 - 1780.17 mg/L (Avg.: 601 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024), except for values above the upper limit.

- *"Average" refers to the average concentrations for the Total Active Sites of the Coega TMG Aquifer SWSA-gw, taken from the WMS database from 2000-2024.*

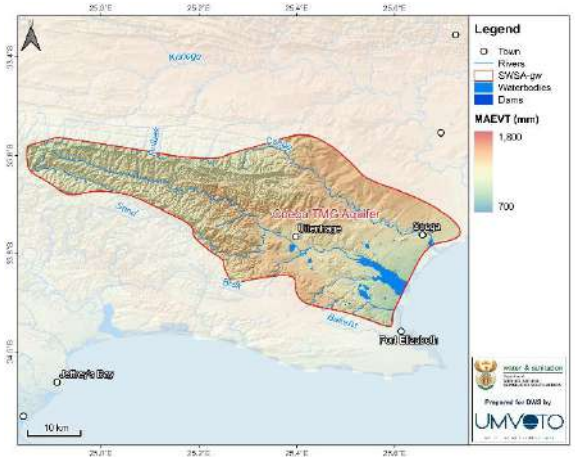
SWSA-gw Name:	**Coega TMG Aquifer**
Area:	**1681 km²**
Elevation:	**16 to 1391 mamsl**

Threats & Risks

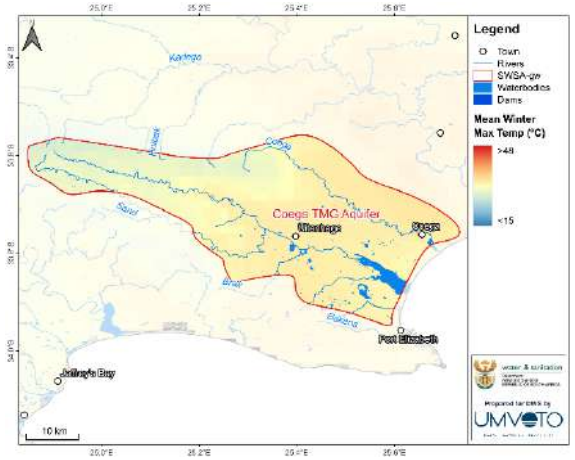
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Coega TMG Aquifer SWSA-gw has a predominately BSk and BSh, semi-arid, type climate characterised by hot dry summers, with colder winters inland. Temperatures in the SWSA-gw range from 4.1 – 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

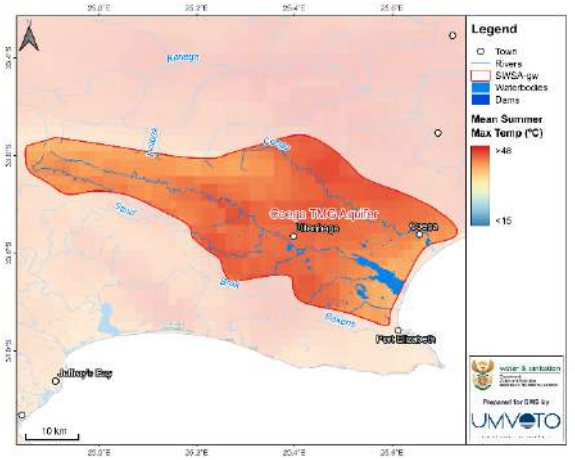
Temperature	Summer: 25.6 to 29.2 °C, Winter: 4.1 to >8 ºC
Evapotranspiration	Maximum value of 1500 mm/a with an average value of 1320 mm/a
Climate Change Predictions	Increased temperatures, decreasing rainfall, but a slight increase in recharge (ranging from ~-2.3 to 6.1 mm/a). The DART Index indicates a combination of stable with some improving conditions.



Mean annual A-Pan evaporation of the Coega TMG Aquifer SWSA-gw region.



Mean winter temperatures of the Coega TMG Aquifer SWSA-gw region.



Mean summer temperatures of the Coega TMG Aquifer SWSA-gw region.

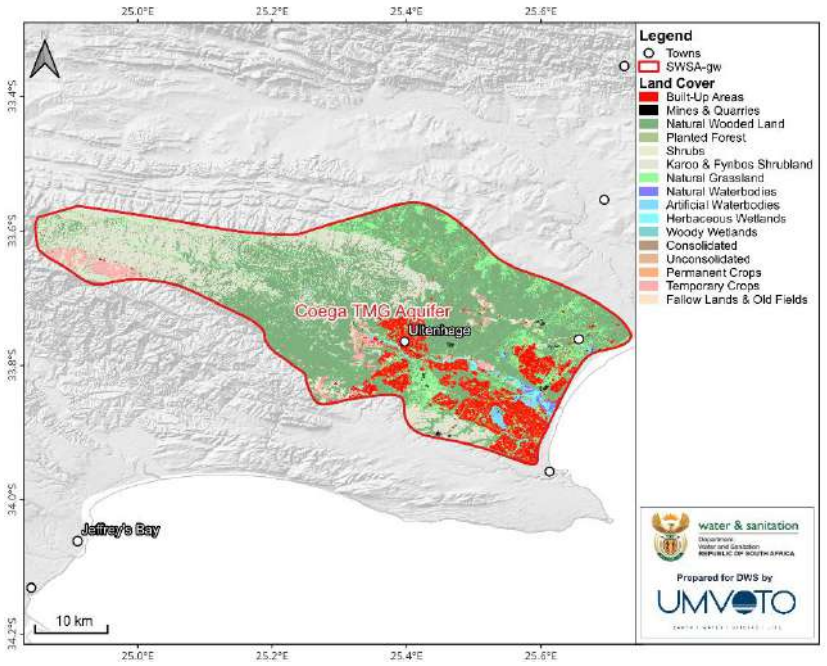
SWSA-gw name:	Coega TMG Aquifer
Area:	1681 km^2
Elevation:	16 to 1391 mamsl

Threats & Risks

Land Use

The Coega TMG Aquifer SWSA-gw is covered predominantly by forest land, which is natural wooded land and shrublands, specifically Karoo & Fynbos shrubland, making up approximately 72.1% of the SWSA-gw (DFFE, 2024). The Karoo & Fynbos Shrubland is concentrated in the eastern portion of the SWSA-gw, and the forested land and grassland are concentrated in the centre and northern sections of the SWSA-gw, as displayed on the map. Grassland also plays a significant role, covering 11.7%, while built-up areas, which include residential, commercial and industrial areas, make up 9.8%, indicating moderate human settlement. The built-up area is concentrated on the western section of the SWSA-gw, around the towns of Port Elizabeth, Uitenhage and Coega. Cultivated land is relatively limited, consisting of temporary crops and covering only 4.2%. Waterbodies and wetlands make up a small percentage of the SWSA-gw. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.2% of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	3	0.2
Built-Up	165	9.8
Cultivated	70	4.2
Forest Land	833	49.5
Grassland	197	11.7
Mines and quarries	4	0.2
Shrubland	380	22.6
Waterbodies	14	0.9
Wetlands	14	0.9



Land Cover 24-class map to show the types of land use and extent of each occurring in the Coega TMG Aquifer SWSA-gw.

SWSA-gw Name:	Coega TMG Aquifer
Area:	1681 km^2
Elevation:	16 to 1391 mamsl

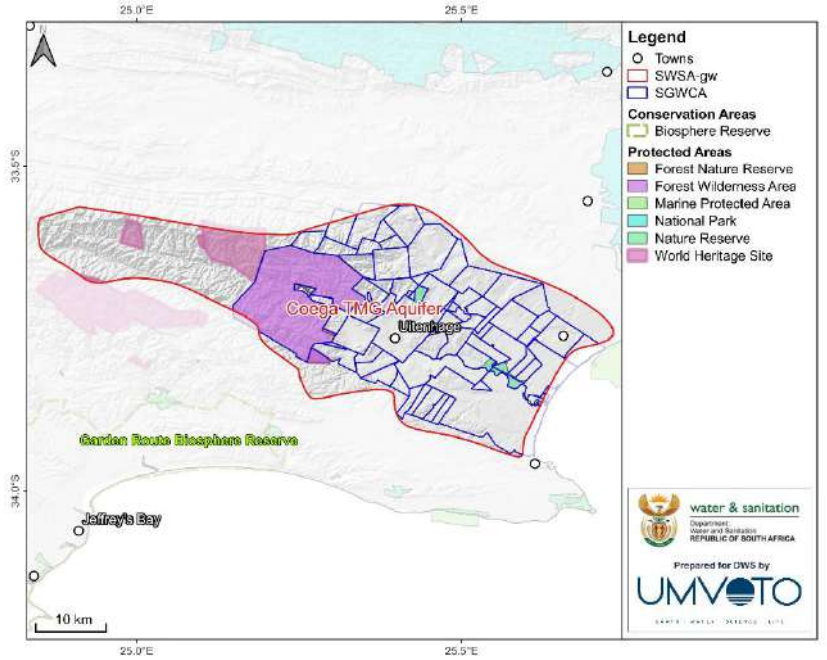
Protection Status and Ecosystems

Biodiversity and Conservation

The Coega TMG Aquifer SWSA-gw contains 300.11 km^2 of protected areas (DFFE, 2024), consisting of a few nature reserves that are small but have a large forest wilderness area in their centre called the Groendal Wilderness Area. There are also portions of the Cape Floral Region Protected Areas world heritage site situated in this SWSA-gw, showing the easternmost end of this floral kingdom.

Approximately 70% of the SWSA-gw is covered by the Uitenhage SGWCA (CSIR, 1998), which shows the areas where the government had control over groundwater on private land under the Water Act No. 54 of 1956 (DWA, 2010).

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	• Groendal Wilderness Area • Uitenhage Nature Reserve • Zwartkops Valley Nature Reserve • Cape Floral Region Protected Areas	300.11	4
SGWCA	• Uitenhage	1200.44	1
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Coega TMG Aquifer SWSA-gw that have protection status.

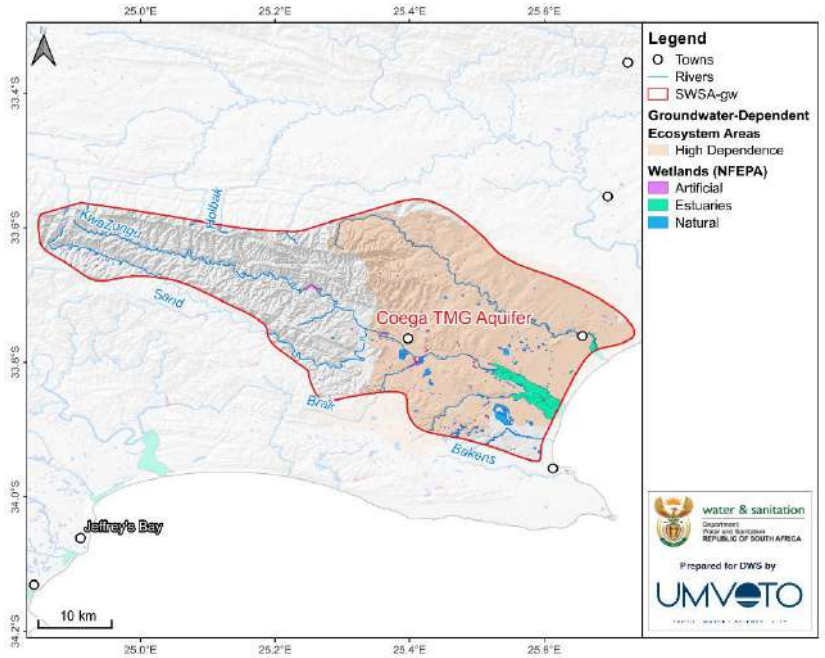
SWSA-gw Name:	Coega TMG Aquifer
Area:	1681 km^2
Elevation:	16 to 1391 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Swartkops Estuary is a major wetland (CSIR, 2011) area that runs along the Swartkops River towards the river mouth leading into the Indian Ocean coastal waters. This estuary lies within the wetland areas (CSIR, 2018) of vegetation that is highly dependent on groundwater.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Swartkops Estuary	25.21	3
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	43	

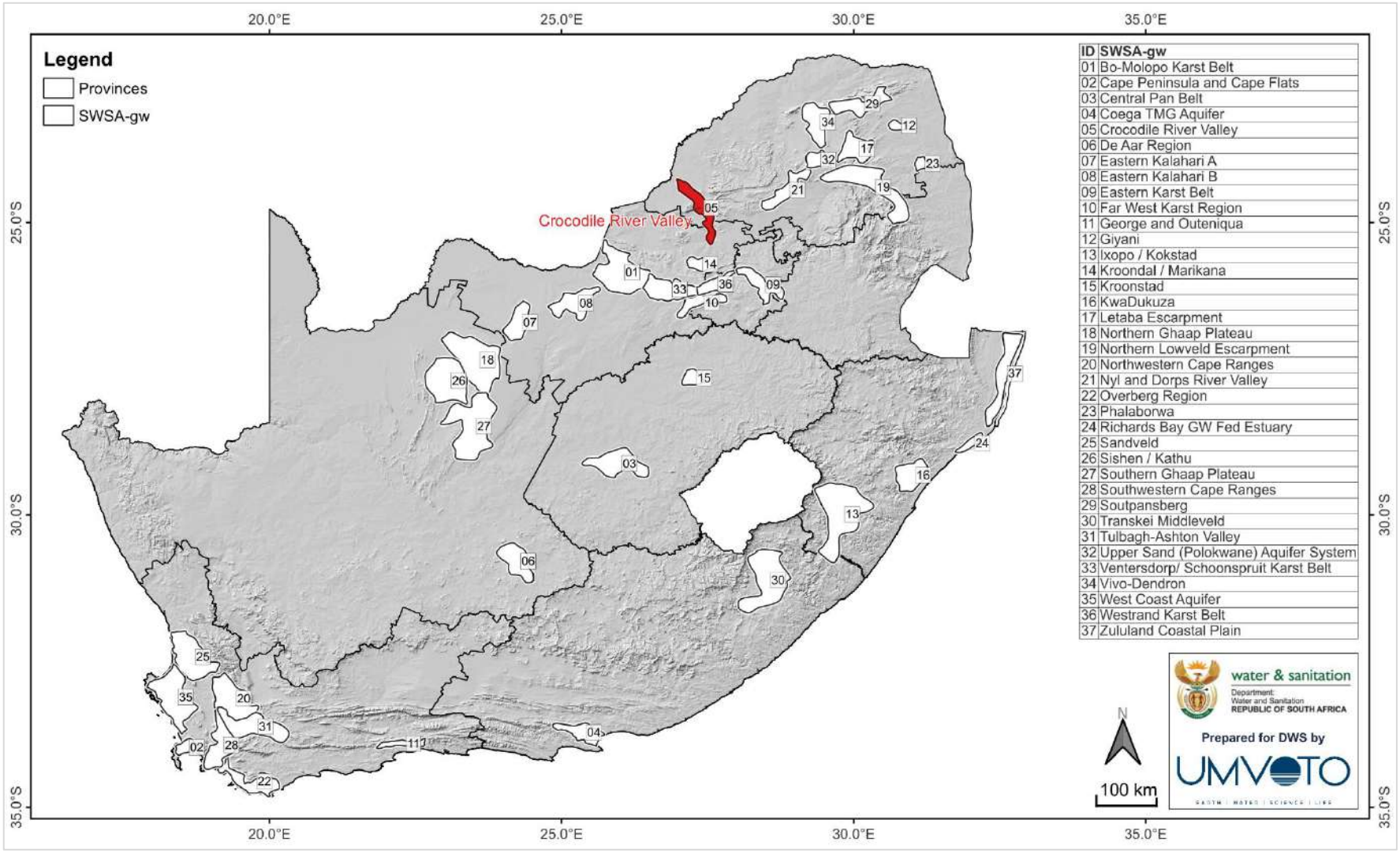


Map showing the major water bodies, Ramsar sites and GDEs in the Coega TMG Aquifer SWSA-gw.

APPENDIX 05

CROCODILE RIVER VALLEY SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE CROCODILE RIVER VALLEY SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

5. Crocodile River Valley

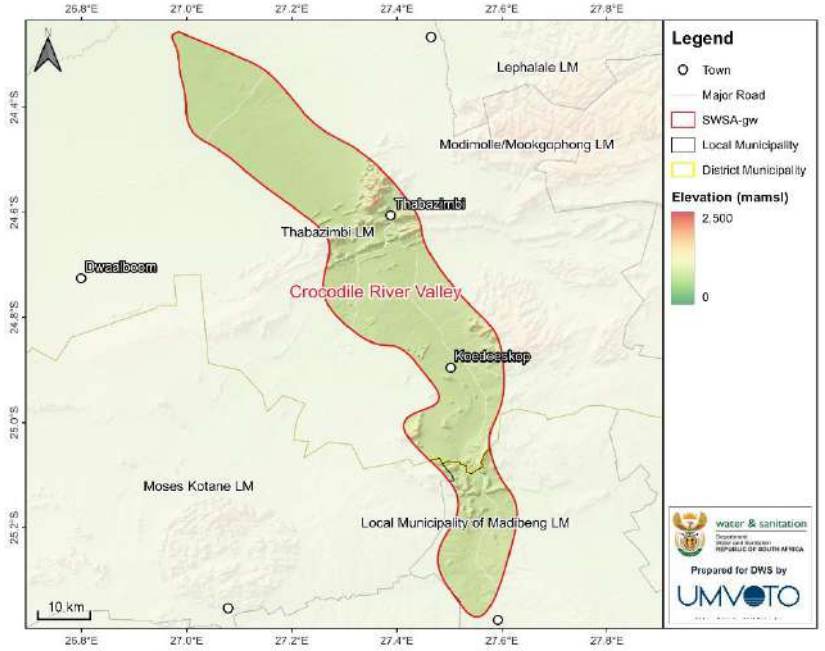
5.1. Description

SWSA-gw Name:	Crocodile River Valley
Area:	2163 km²
Elevation:	871 to 1635 mamsl
Geospatial Context	

The topography of the Crocodile River Valley SWSA-gw, as depicted in the map, is characterized by a mix of gently rolling hills, plateaus, and open plains. The landscape is influenced by the Bushveld Complex, with undulating terrain that includes both rugged ridges and small valleys. Moving towards the Botswana border from Thabazimbi, the landscape becomes more flat and open.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Limpopo and North West
District Municipality	Waterberg and Bojanala
Local Municipality	Thabazimbi and Madibeng
Towns	Thabazimbi and Kwaggasvlakte
Major Roads	
Major Water Supply Networks	



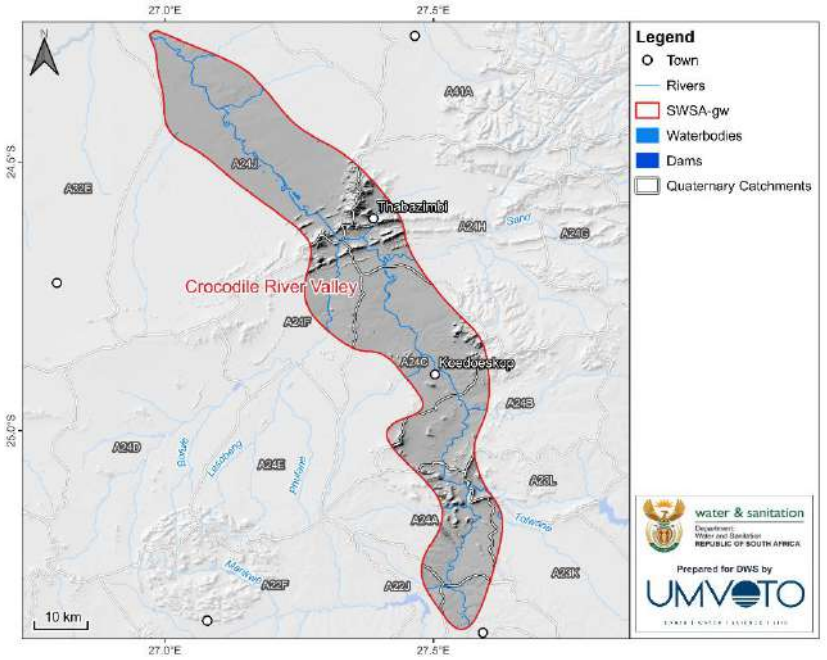
Locality map of Major Towns, District and Local Municipalities in the Crocodile River Valley SWSA-gw.

SWSA-gw Name:	Crocodile River Valley
Area:	2163 km²
Elevation:	871 to 1635 mamsl

Hydrology and Drainage

The Crocodile River Valley SWSA-gw and surrounding areas include major surface water systems, summarised below and displayed in the map on the right. The Bierspruit, Crocodile, Elands, Pienaars, Sand, and Tolwane rivers are fed by the A2 catchment and flow in a northern direction.

Quaternary Catchments	A21L, A24A, A24B, A24C, A24F, A24H, A24J and a small section of A22J, A23K, A23L
Rivers	Perennial: Bierspruit, Crocodile, Elands, Pienaars, Sand, Tolwane
	Ephemeral: Klipspruit, Majadibodu, Matshikiti, Motlhabe, Sleepfonteinspruit
Natural and manmade water bodies	
Major Dams:	
Water Management Areas:	Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Crocodile River Valley SWSA-gw.

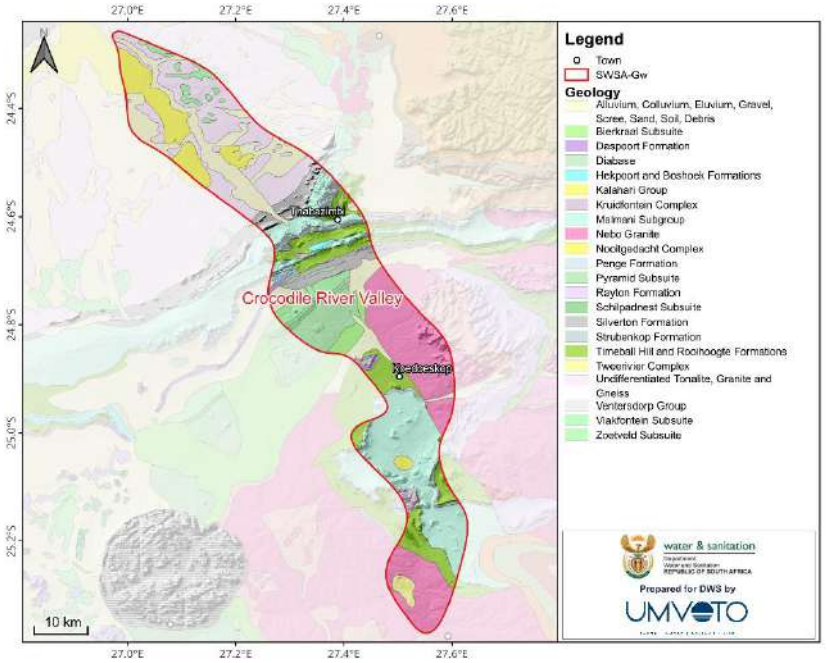
SWSA-gw Name:	Crocodile River Valley
Area:	2163 km²
Elevation:	871 to 1635 mamsl
Geology	

Geology

The western section of the area comprises Quaternary surface deposits and the Rustenburg Layered Suite of the Bushveld Complex, featuring magnetite-rich gabbro with layers of magnetite and anorthosite. In the southernmost section, the Lebowa Granite Suite of the Bushveld Complex outcrops, characterised by coarse-grained granite. The southern section contains the Pretoria Group of the Transvaal Supergroup. The Chuniespoort Group of the Transvaal Supergroup outcrops across the central section, consisting of dolomite, subordinate chert, minor carbonaceous shale, limestone, and quartzite.

Hydrostratigraphy

Shallow intergranular aquifers occur in Quaternary deposits, while deeper secondary aquifers are found in fractured sedimentary and igneous rocks of the Pretoria Group and Bushveld Complex. Karstic dolomites of the Chuniespoort Group form a highly permeable secondary aquifer system.



Geology Map of the Crocodile River Valley SWSA-gw region.

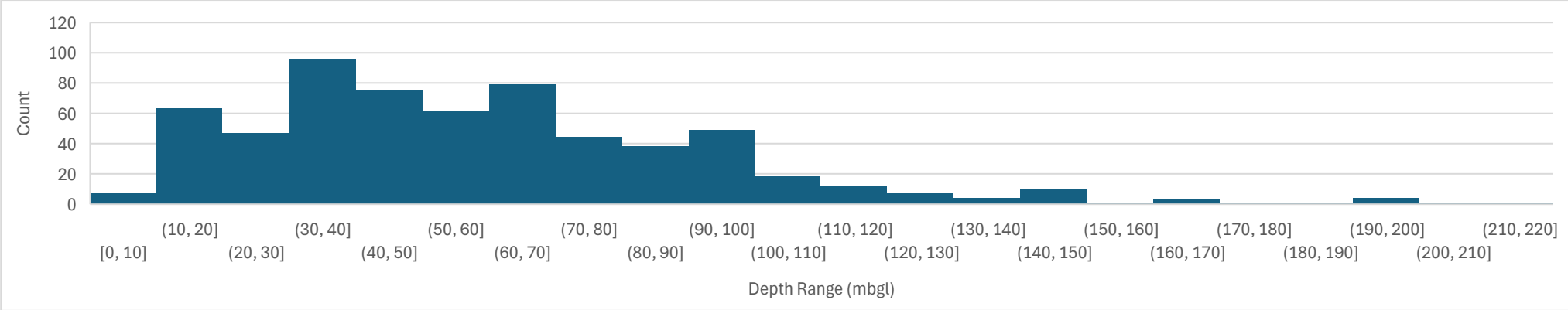
5.2. Current Status

SWSA-gw Name:	**Crocodile River Valley**
Area:	**2163 km²**
Elevation:	**871 to 1635 mamsl**
Quantity & Quality	
Aquifer Classification	

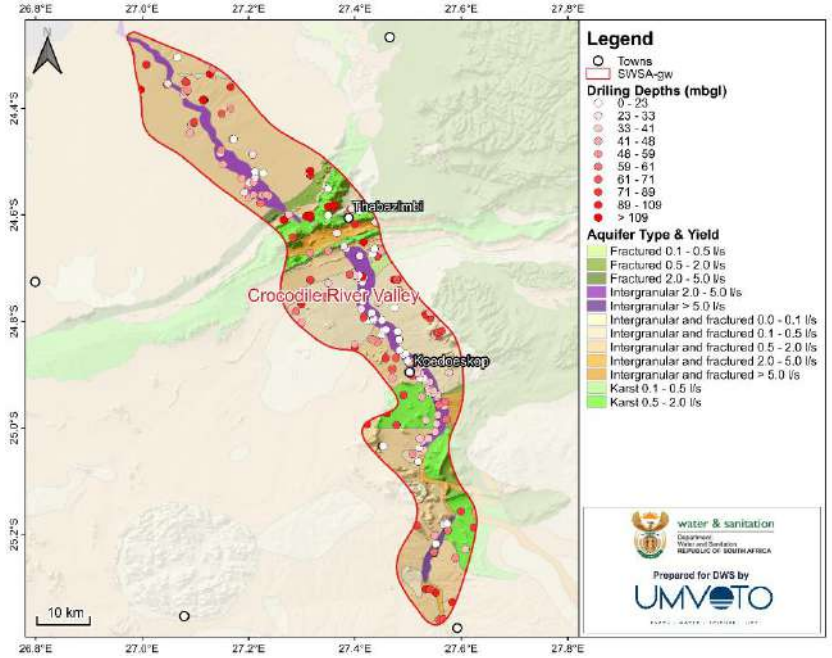
The aquifer systems within the Crocodile River Valley SWSA-gw exhibit varying yields across dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is a Minor aquifer system. The Minor aquifer system has an average dual-porosity yield ranging from 0.0 to over 5.0 l/s, with an average karst yield of 0.5 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 59 mbgl, and the most common depths are between 40 and 60 mbgl. The majority of the boreholes with a depth of < 40 mbgl are found along the intergranular aquifers in the centre, with the deeper boreholes (> 40 mbgl) targeting the dual-porosity and krast aquifers. Some boreholes in the northern half of the SWSA-gw reach depths of > 200 mbgl, suggesting that they target the underlying fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 35 and 79 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 11 mbgl, with values ranging from 0 to 47 mbgl, and a standard deviation is ~ 6 mbgl. Statistical analysis of the available NGA data reveals a trend of dropping groundwater levels during this period.

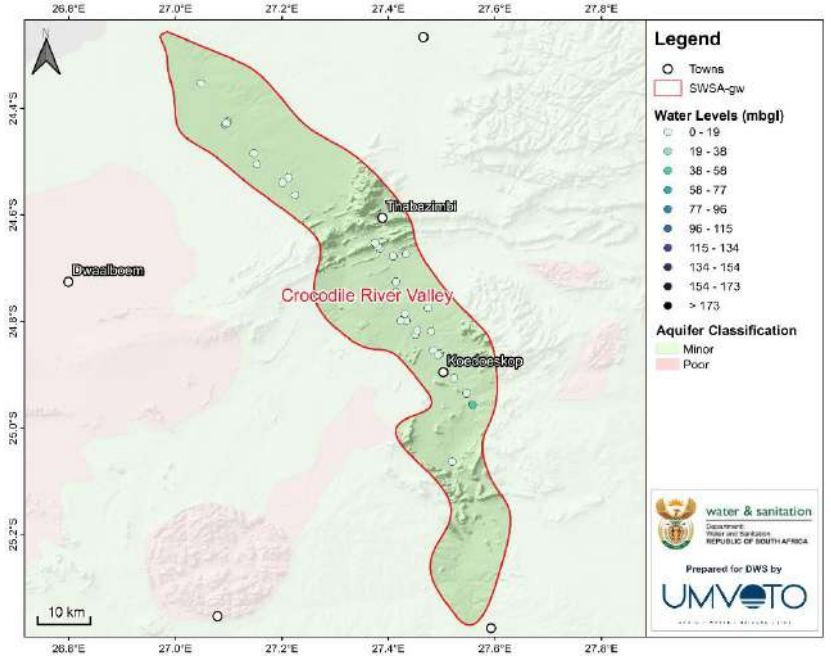
Graph of NGA drilling depths (after DWS, n.d.) of the Crocodile River Valley SWSA-gw region



SWSA-gw Name:	Crocodile River Valley
Area:	2163 km²
Elevation:	871 to 1635 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Crocodile River Valley SWSA-gw region.



Map of the Aquifer Type and Associated Yield and NGA water levels of the Crocodile River Valley SWSA-gw region.

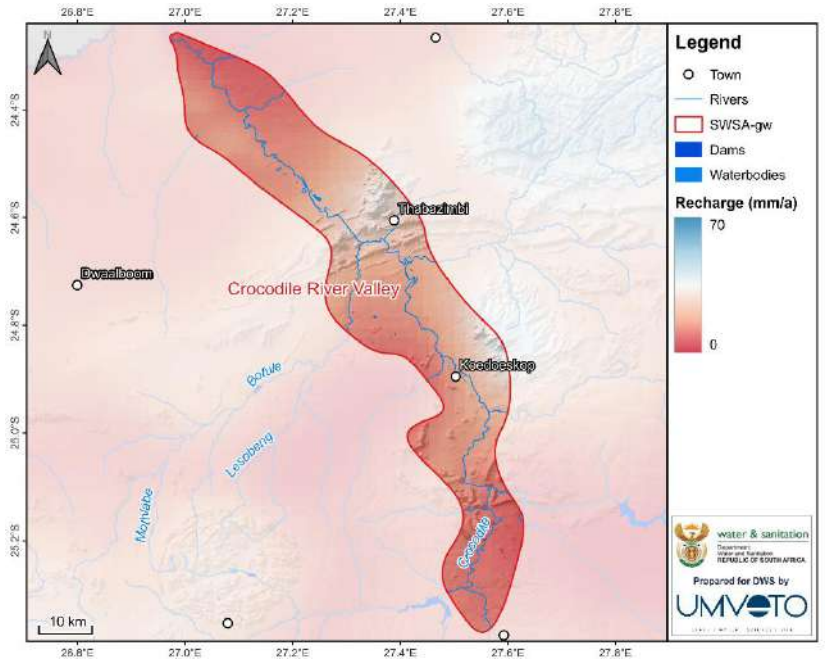
SWSA-gw Name:	**Crocodile River Valley**
Area:	**2163 km²**
Elevation:	**871 to 1635 mamsl**

Quantity & Quality

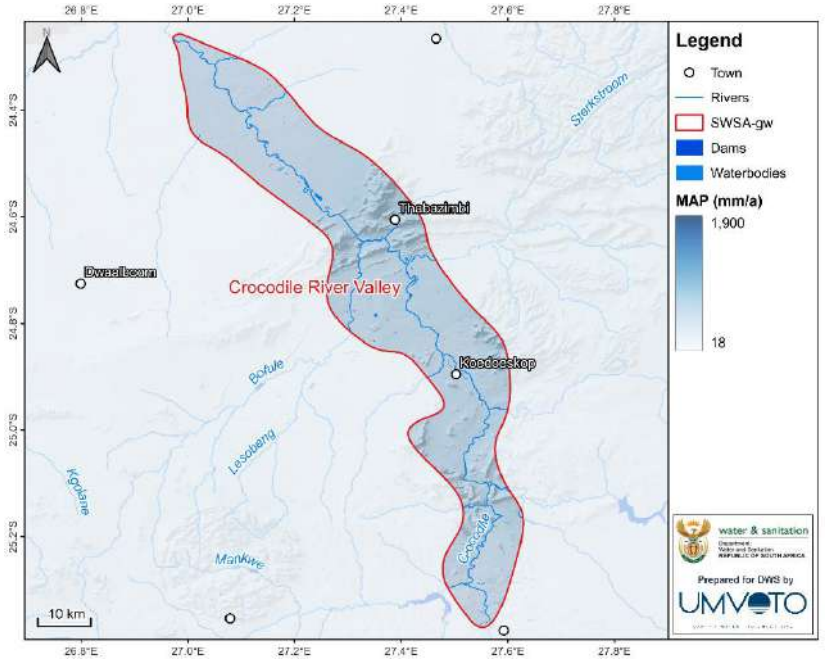
Groundwater Recharge

The Crocodile River Valley receives a total MAP volume of 1208 Mm^3/a, with an average rainfall of 558 mm/a. However, only 35.5 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a very low recharge of 2.9% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Crocodile River Valley	1208	558	35.5	16.3	2.9%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Crocodile River Valley
Area:	2163 km²
Elevation:	871 to 1635 mamsl

Quantity & Quality

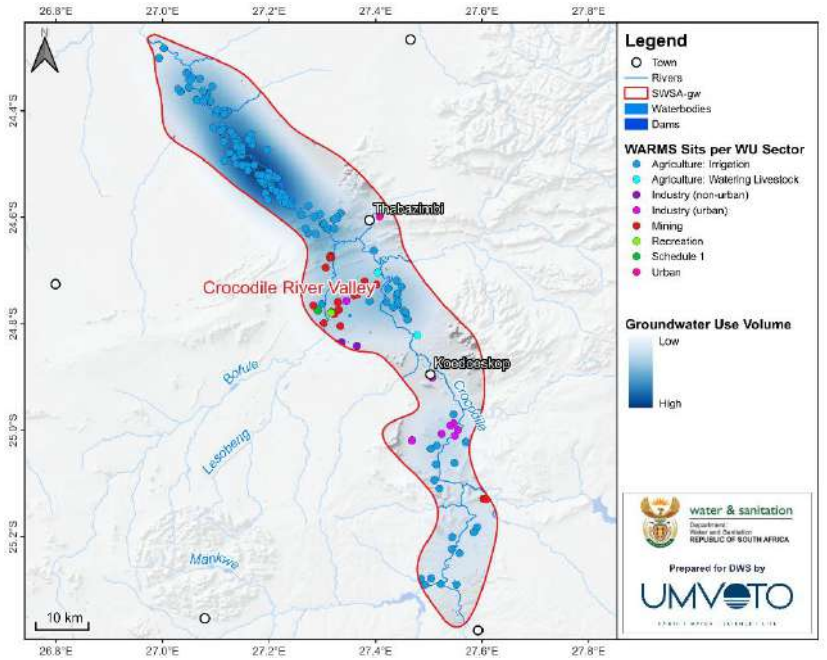
Groundwater Use

The Crocodile River Valley SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Thabazimbi (Conjunctive), which relies significantly on groundwater resources for mining, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 46.8 Mm^3/ a to sustain crop production. Use is particularly dense in the northern areas of the region above Thabazimbi. However, there is quite a lot of use throughout the rest of the region as well like the south. In these areas, groundwater is essential for farming, supporting food production and local economies.
- Mining use has 11.7 Mm^3/a allocated. Water is a vital resource in the mining process. Unlike irrigation, mining is concentrated mainly in the northern regions south of Thabazimbi.
- Urban industrial follows, using 0.8 Mm^3/a allocated for manufacturing, processing, and other industrial activities in urban centres. The distribution of urban industry tends to be in the southern parts of the region. This suggests that the groundwater sectors are quite stratified in terms of distribution, with irrigation mainly in the north, followed by mining, south of that, and urban industrial southernmost. However, there are many exceptions to this, and it is more of a general pattern than a hard rule.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Thabazimbi, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	46.8
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	0.1
	Industry (Urban)	0.8
	Mining	11.7
	Schedule 1	0.1
	Total	**59.6**



Water use map for the Crocodile River Valley SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

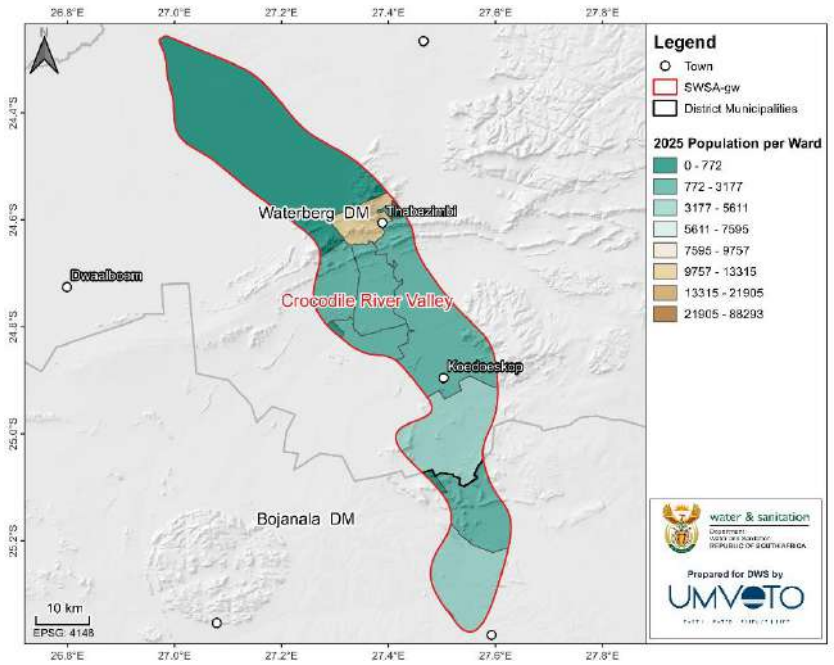
SWSA-gw Name:	Crocodile River Valley
Area:	2163 km²
Elevation:	871 to 1635 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Crocodile River Valley SWSA-gw is located within the Limpopo-Olifants Water Management Areas (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. LOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the LOCMA to manage water resources in the Limpopo-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	LOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Crocodile River Valley SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of -0.89% per year, resulting in a projected population of approximately 30,886.

As shown in the map and table below, Thabazimbi LM has the highest estimated population within the SWSA-gw, with approximately 24,644, followed by the Local Municipality of Madibeng (6,075). Population concentrations within the SWSA-gw are highest around the Thabazimbi LM.



Projected population distribution in 2025 for the Crocodile River Valley SWSA-gw.

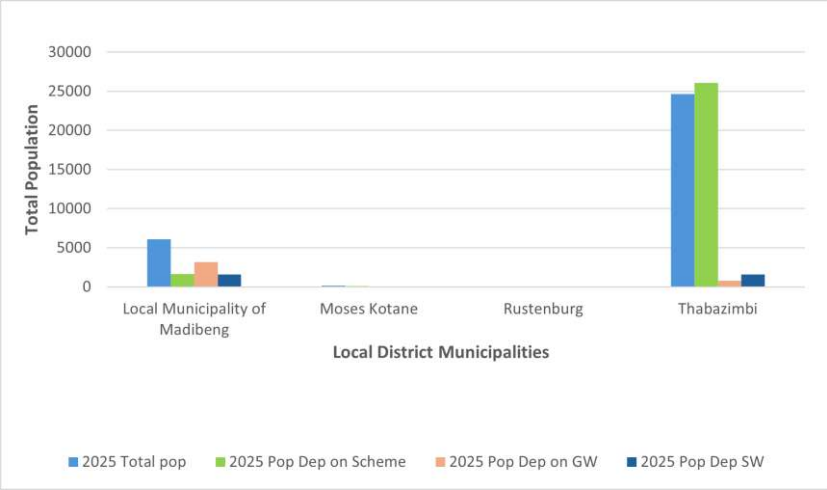
SWSA-gw Name:	Crocodile River Valley
Area:	2163 km²
Elevation:	871 to 1635 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Crocodile River Valley SWSA-gw, an estimated 90.2% of the population depends on the regional water supply scheme, 12.8% on groundwater sources (including boreholes and springs), and 10.3% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources).

Among the LMs, the Madibeng LM has the highest proportion of groundwater reliance, with approximately 51.8% of its population depending on groundwater and 26.0% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Madibeng	6,075	1,667	3,149	1,577
Moses Kotane	146	91	23	5
Rustenburg	21	21	0	1
Thabazimbi	24,644	26,078	775	1,594
Total	**30,886**	**27,857**	**3,948**	**3,177**



Projected population dependence on water sources in 2025.

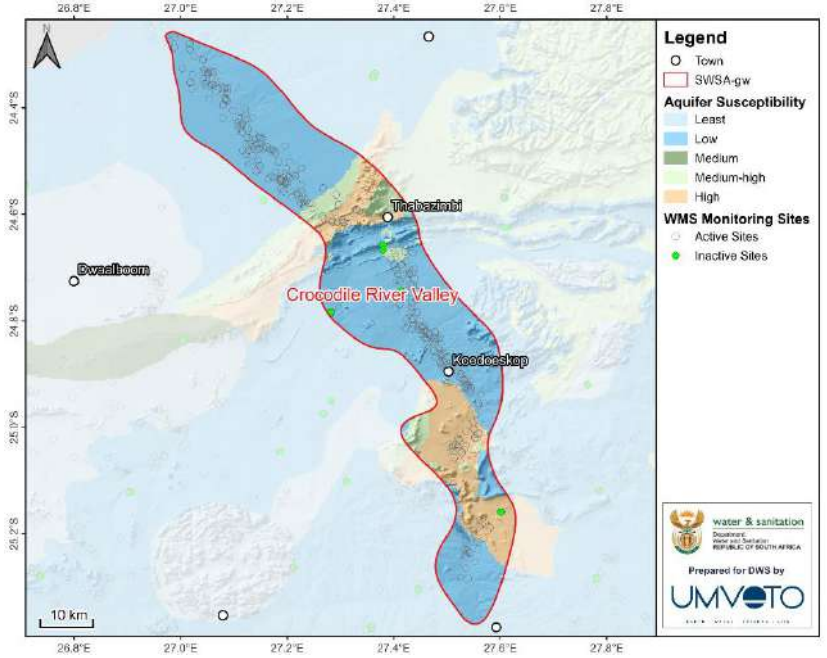
SWSA-gw Name:	Crocodile River Valley
Area:	2163 km²
Elevation:	871 to 1635 mamsl
Quantity & Quality	
Groundwater Quality	

The Crocodile River Valley SWSA-gw consists of Minor and Poor aquifer systems, classified based on their yield and water quality. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 431.28 km^2, which is 19.94% of the Crocodile River Valley SWSA-gw total area. Mine and quarry areas cover 25.58 km^2 (1.04%), while urban/built-up areas account for 19.22 km^2 (0.89%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Poor aquifer system covers a small section on the WSW corner of the Crocodile River Valley aquifer, and the minor aquifer system covers the rest of the aquifer. WMS data is available for the least and most vulnerable aquifer areas in the Minor Aquifer System.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 46.2 – 130.71 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 13.2 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.025 – 25.21 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.31 – 9.58 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 1.5 - 27.3 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Crocodile River Valley**
Area:	**2163 km²**
Elevation:	**871 to 1635 mamsl**
Quantity & Quality	
Socio Economic & Governance	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Crocodile River Valley SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	6	75.00	8	88.68	mS/m	46.2 - 130.71 mS/m (Avg.: 79.74 mS/m). 2014-2024 GW Geosites: 70 - 150 mS/m. Consistent with WMS (2000-2024), except for values above the upper limit.	2014-2024 GW Geosites: 70 - 150 mS/m.	48 - 114.3 mS/m (Avg.: 93.37 mS/m). 2014-2024 GW Geosites: 70 - 150 mS/m. Consistent with WMS (2000-2024), except for values above the upper limit.
Fluoride	5	71.43	7	1.43	mg/L	0.025 - 13.2 mg/L (Avg.: 4.84mg/L). 2014-2024 GW Geosites: <0.5 mg/L, >1.5-5.0 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <0.5 mg/L, >1.5-5.0 mg/L.	0.17 - 1.32 mg/L (Avg.: 0.500 mg/L). 2014-2024 GW Geosites: <0.5 mg/L, >1.5-5.0 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	6	75.00	8	3.34	mg/L	0.117 - 25.21 mg/L (Avg.: 7.42 mg/L). 2014-2024 GW Geosites: <11-50 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	2014-2024 GW Geosites: <11-20 mg/L.	0.025 - 2.29 mg/L (Avg.: 1.25 mg/L). 2014-2024 GW Geosites: <11-50 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	6	75.00	8	8.18	pH unit	6.9 - 9.58 (Avg.: 8.34). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: 7-9.	6.31 - 8.7 (Avg.: 8.10). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	6	75.00	8	9.58	mg/L	1.5 - 24.64 mg/L (Avg.: 8.96 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024), except for values above the upper limit.	2014-2024 GW Geosites: <200 mg/L.	3 - 27.3 mg/L (Avg.: 9.86 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024), except for values above the upper limit.

- *"Average" refers to the average concentrations for the Total Active Sites of the Crocodile River Valley SWSA-gw, taken from the WMS database from 2000-2024.*

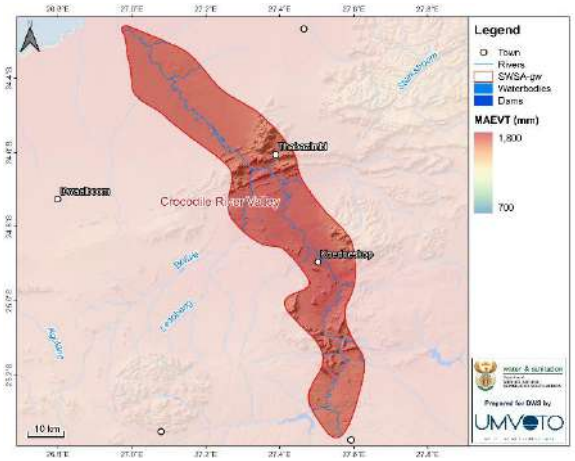
SWSA-gw Name:	Crocodile River Valley
Area:	2163 km²
Elevation:	871 to 1635 mamsl

Threats & Risks

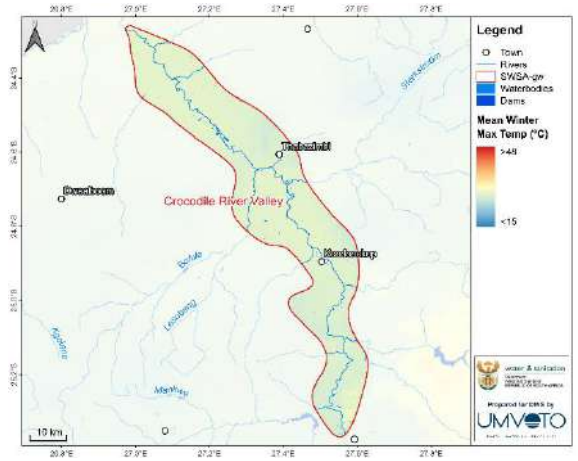
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Crocodile River Valley SWSA-gw has a predominantly BSh. hot semi-arid, type climate characterized by hot summers, warm to cool winters, and little to no precipitation as well as small sections of Cwa, humid subtropical, type climate with dry winters. Temperatures in the SWSA-gw range from 2.1 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

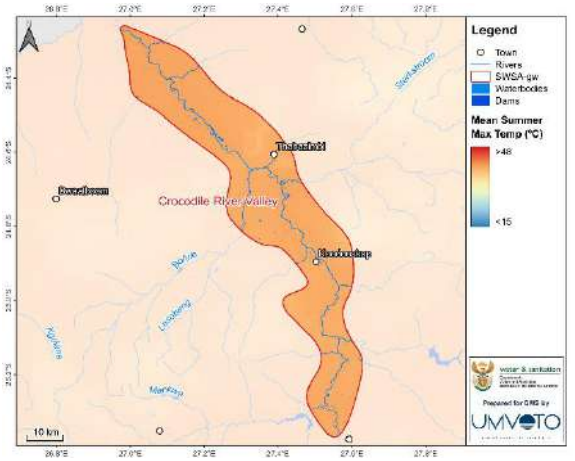
Temperature	Summer: 29.3 to > 31 ºC, Winter: 2.1 to 6 °C
Evapotranspiration	Maximum value of 1804 mm/a with an average value of 1724 mm/a
Climate Change Predictions	Increased temperatures, Disrupted rainfall patterns, and an increase in recharge (ranging from ~ 14.8 to 21.8 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Crocodile River Valley SWSA-gw region.



Mean winter temperatures of the Crocodile River Valley SWSA-gw region.



Mean summer temperatures of the Crocodile River Valley SWSA-gw region.

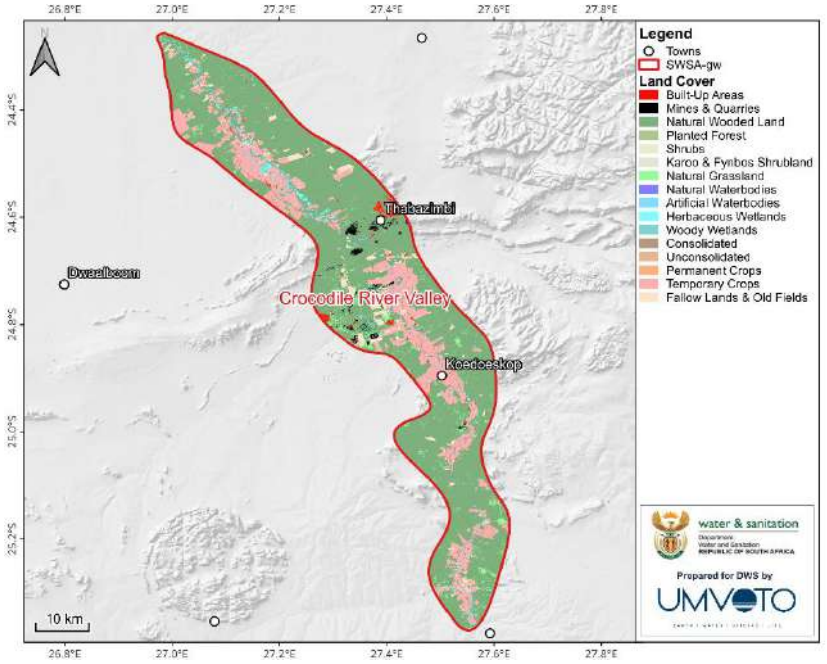
SWSA-gw Name:	Crocodile River Valley
Area:	2163 km^2
Elevation:	871 to 1635 mamsl

Threats & Risks

Land Use

Forested land, which consists of natural wooded land and planted forests, overwhelmingly dominates the Crocodile River Valley SWSA-gw, covering 73% of the area (DFFE, 2022) and indicating a robust forest ecosystem. Cultivated land, made up of temporary crops, permanent crops, fallow lands and old fields, contributes significantly at 20%. Smaller natural features—grasslands, wetlands, and waterbodies—together account for just over 5% of the total area. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, remain minimal, underscoring the largely natural character of the region.

Land Use Type	Area (km^2)	Area (%)
Barren Land	2	0.1
Built-Up	19	0.9
Cultivated	431	20
Forest Land	1575	73
Grassland	69	3.2
Mines and quarries	23	1
Waterbodies	17	0.8
Wetlands	26	1.2



Land Cover 24-class map to show the types of land use and extent of each occurring in the Crocodile River Valley SWSA-gw.

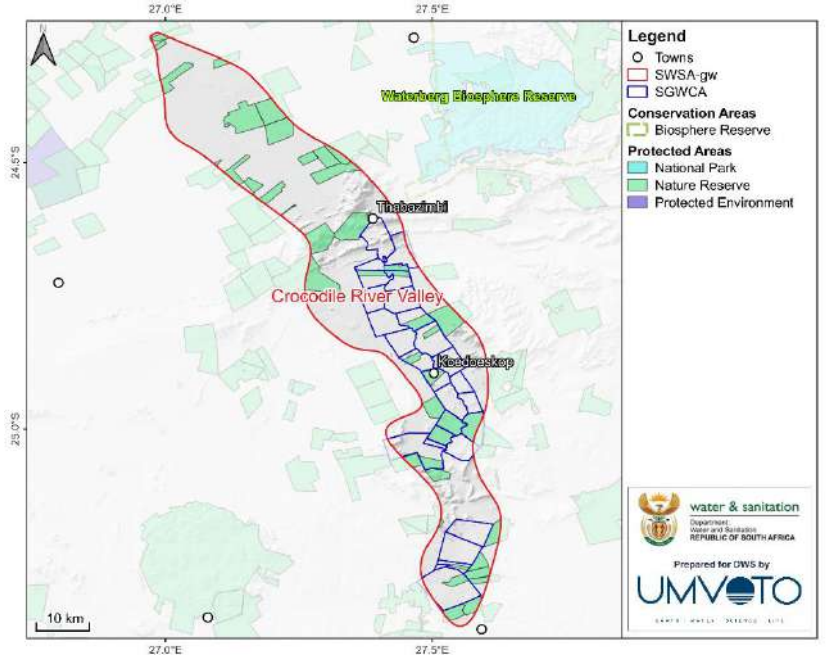
SWSA-gw Name:	Crocodile River Valley
Area:	2163 km^2
Elevation:	871 to 1635

Protection Status and Ecosystems

Biodiversity and Conservation

The Crocodile River Valley SWSA-gw conservation efforts rely primarily on privately managed nature reserves (DFFE, 2024), which cover 436.95 km² across 35 individual sites. The Crocodile River Valley subterranean government water control area (SGWCA) (CSIR, 1998) falls fully within the Crocodile River Valley SWSA-gw and shows the area where the government had control over groundwater on private land under the Water Act No. 54 of 1956 (DWA, 2010). There are no designated conservation areas or national parks.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	• Robco Private Nature Reserve • Agen Landgoed Private Nature Reserve • Buffelsfontein Private Nature Reserve • Du Plessis No 2 Private Nature Reserve • Die Kraal Private Nature Reserve • Knopieskop Private Nature Reserve • And various other small nature reserves	436.95	35
SGWCA	• Crocodile River Valley	643.21	1
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Crocodile River Valley SWSA-gw that have protection status.

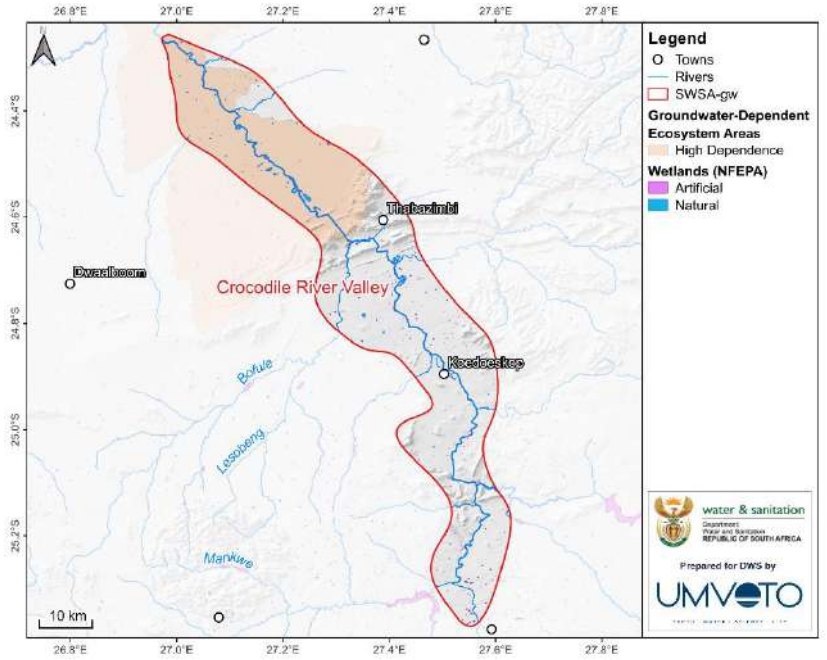
SWSA-gw Name:	Crocodile River Valley
Area:	2163 km^2
Elevation:	871 to 1635

Protection Status and Ecosystems

Biodiversity and Conservation

The Crocodile River Valley SWSA-gw includes one major waterbody—the Crocodile River floodplain wetland—highlighting the SWSA-gw's key hydrological feature. Other wetlands (CSIR, 2018) within the group of potentially high-dependence GDEs (DWA, 2010) are found in the northern part of the SWSA-gw, emphasizing their ecological importance.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Crocodile River floodplain wetland		1
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	48	

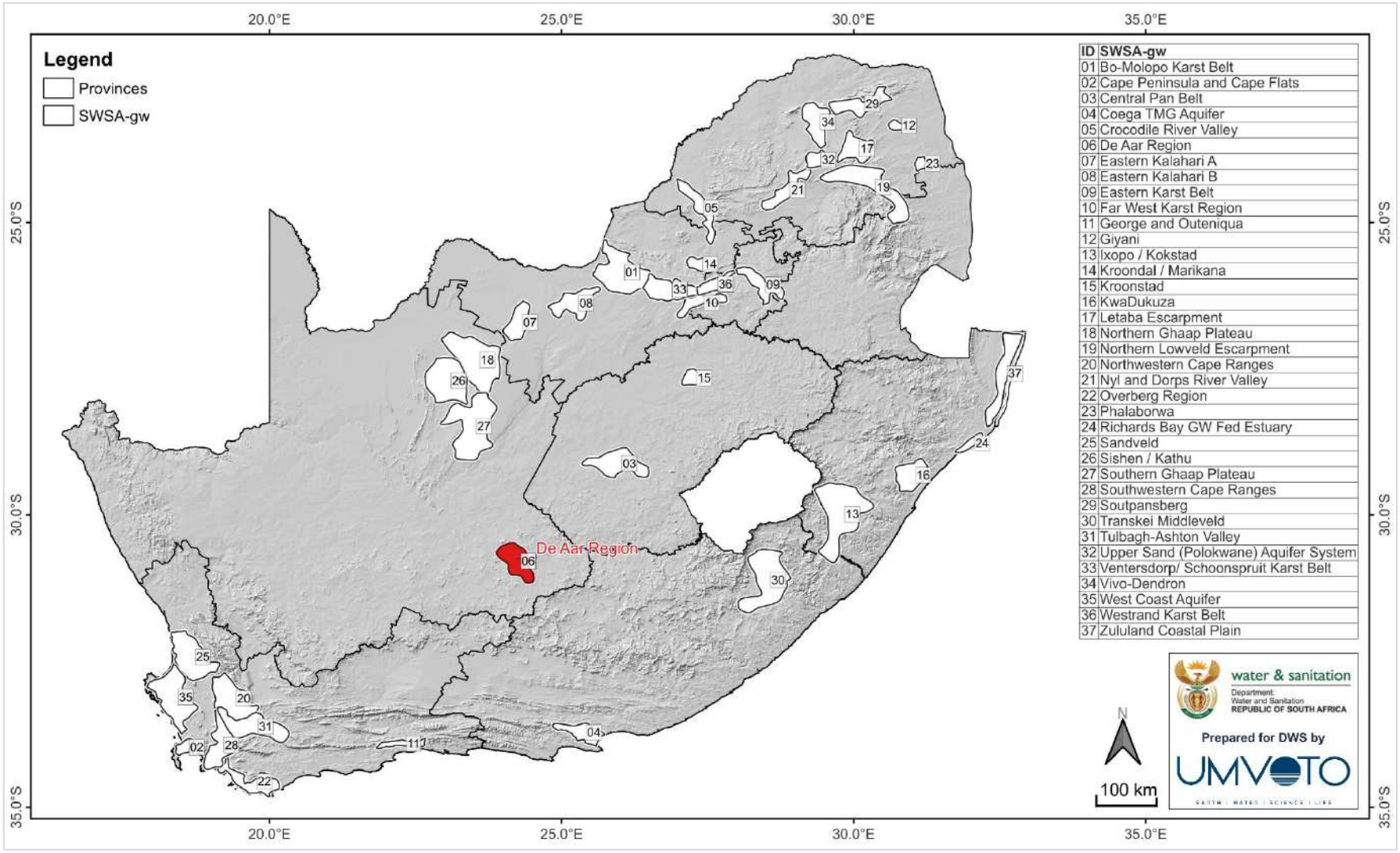


Map showing the major water bodies, Ramsar sites and GDEs in the Crocodile River Valley SWSA-gw.

APPENDIX 06

DE AAR REGION SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE DE AAR REGION SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

6. De Aar Region

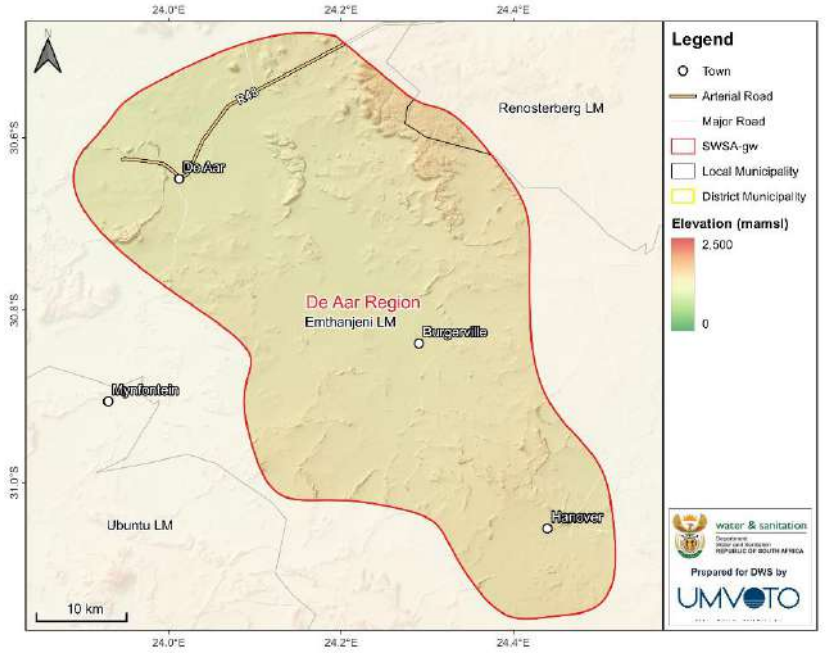
6.1. Description

SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl
Geospatial Context	

The topography of the De Aar Region SWSA-gw, as depicted in the map, is characterized by a semi-arid, high-altitude plateau with flat to gently undulating terrain. The landscape consists of vast, open plains typical of the Great Karoo, with occasional low ridges, isolated hills, and shallow valleys formed by seasonal river systems.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Northern Cape
District Municipality	Pixley ka Seme
Local Municipality	Emthanjeni and Renosterberg
Towns	De Aar and Hanover
Major Roads	N10, N1, R48, R348
Major Water Supply Networks	



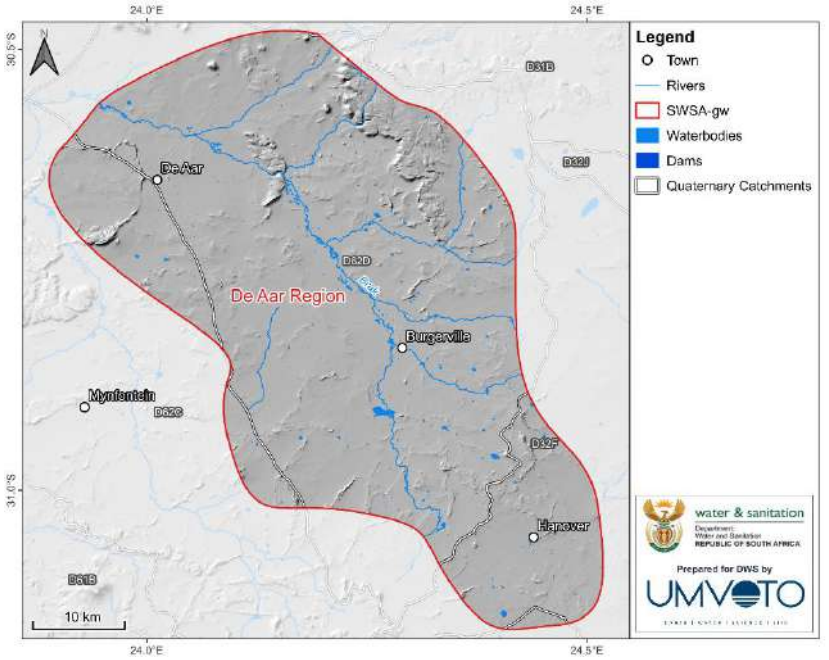
Locality map of Major Towns, District and Local Municipalities in the De Aar Region SWSA-gw.

SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl

Hydrology and Drainage

The De Aar Region SWSA-gw and surrounding areas include a few surface water systems, summarised below and displayed in the map on the right. All the rivers in the area are ephemeral, fed by the D6 catchment and flow towards the north.

Quaternary Catchments	D41J, D41K and a small section of D73A, D41L
Rivers	Perennial: None
	Ephemeral: Brak
Natural and manmade water bodies	
Major Dams:	No major dams
Water Management Areas:	Vaal Orange



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the De Aar Region SWSA-gw.

SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl
Geology	

Geology

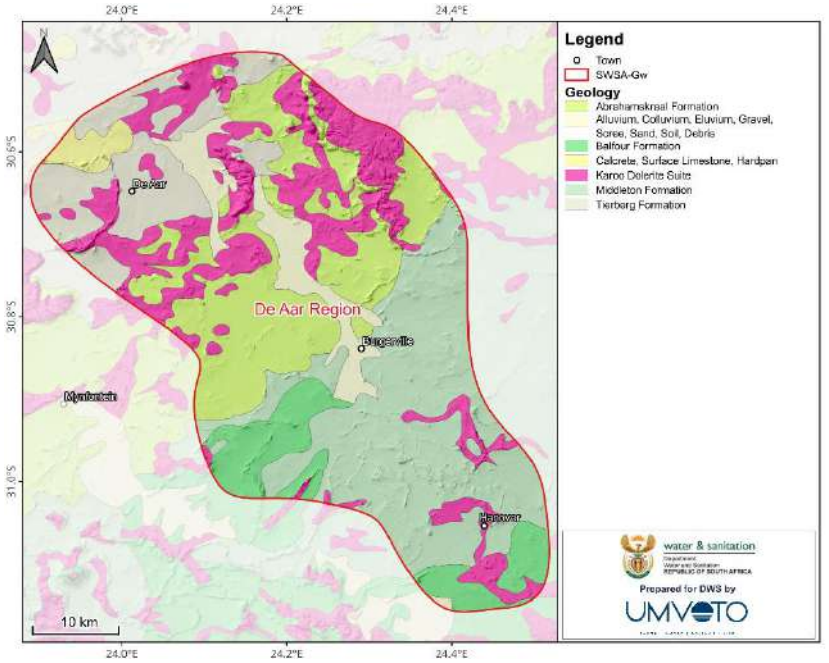
Quaternary alluvium deposits occur sporadically across the De Aar Region.

The Karoo Dolerite forms a network of sills, sheets, and dykes that intrude into the Karoo Supergroup and outcrop sporadically throughout the area, with a concentration in the northern section.

The Beaufort Group of the Karoo Supergroup dominates the region, covering the majority of the area except for the northwesternmost section. This group is characterised by greenish to bluish-grey and greyish-red mudstone with subordinate sandstone. The Ecca Group of the Karoo Supergroup outcrops in the northwestern section, comprising grey shale with interbedded siltstones in the upper part.

Hydrostratigraphy

Shallow intergranular aquifers occur in Quaternary alluvium deposits, while deeper secondary aquifers are found in the fractured sandstones and shales of the Karoo Supergroup. Dolerite intrusions enhance permeability locally, creating secondary fractured aquifers where extensive fracturing occurs.



Geology Map of the De Aar Region SWSA-gw region.

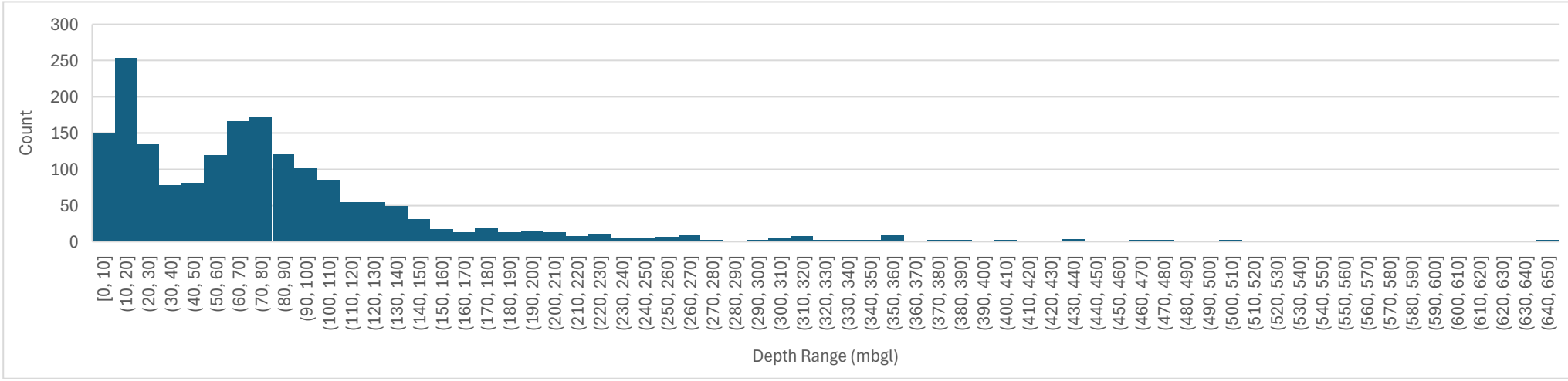
6.2. Current Status

SWSA-gw Name:	**De Aar Region**
Area:	**2475 km²**
Elevation:	**1186 to 1628 mamsl**
Quantity & Quality	
Aquifer Classification	

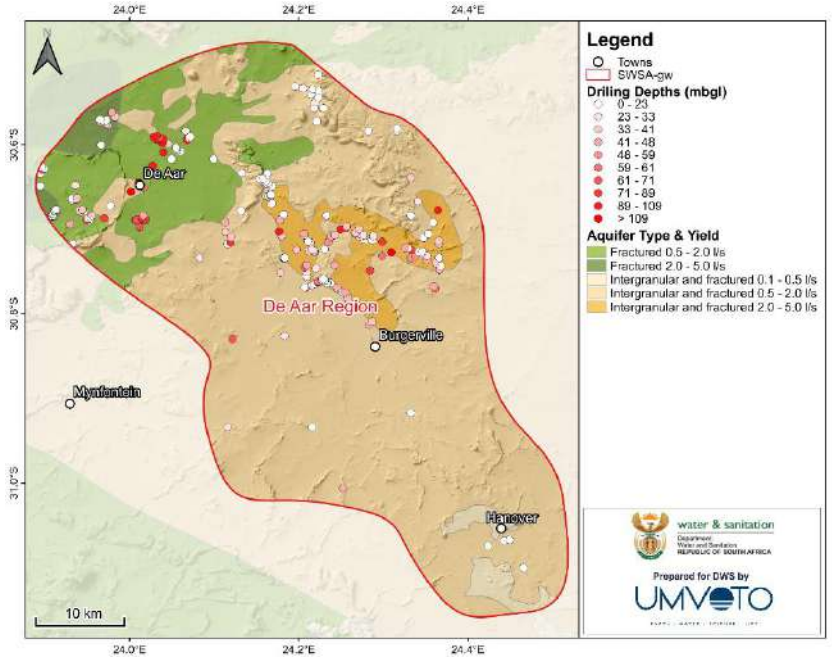
The aquifer systems within the De Aar Region SWSA-gw exhibit varying yields across fractured and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is a major aquifer system, with an average dual-porosity yield ranging from 0.5 to 2.0 l/s and an average fractured yield ranging from 0.5 to 5.0 l/s.
Groundwater Targets	The average drilling depth is 82 mbgl, and the most common depths are between 10 and 20 mbgl, suggesting mixed targets. The majority of the boreholes target the high-yielding dual-porosity aquifer, with minor, deeper boreholes (> 200mbgl) likely targeting the fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 13 and 36 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 6 mbgl, with values ranging from 0 to 71 mbgl and a standard deviation of ~ 2 mbgl.

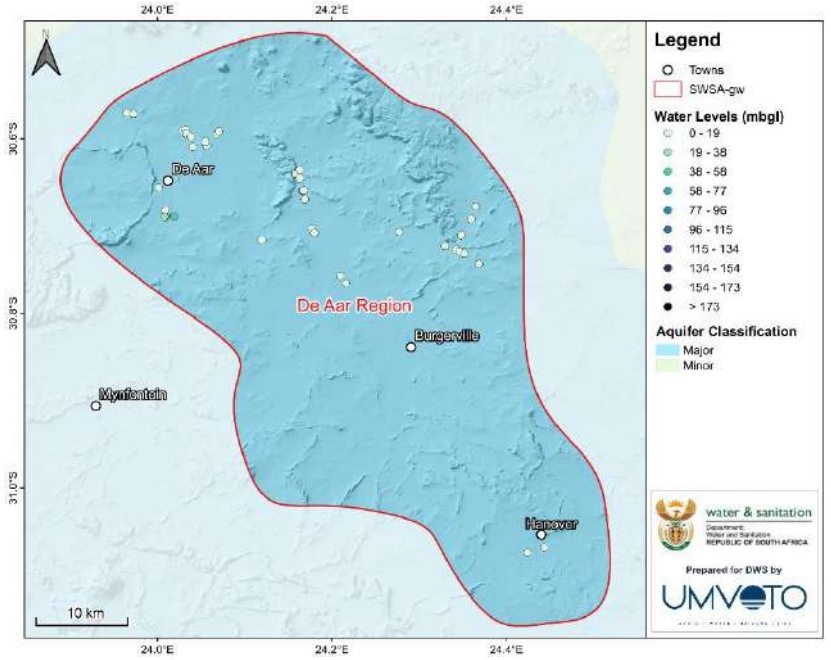
Graph of NGA drilling depths of the De Aar Region SWSA-gw region



SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depth of the De Aar Region SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the De Aar Region SWSA-gw region.

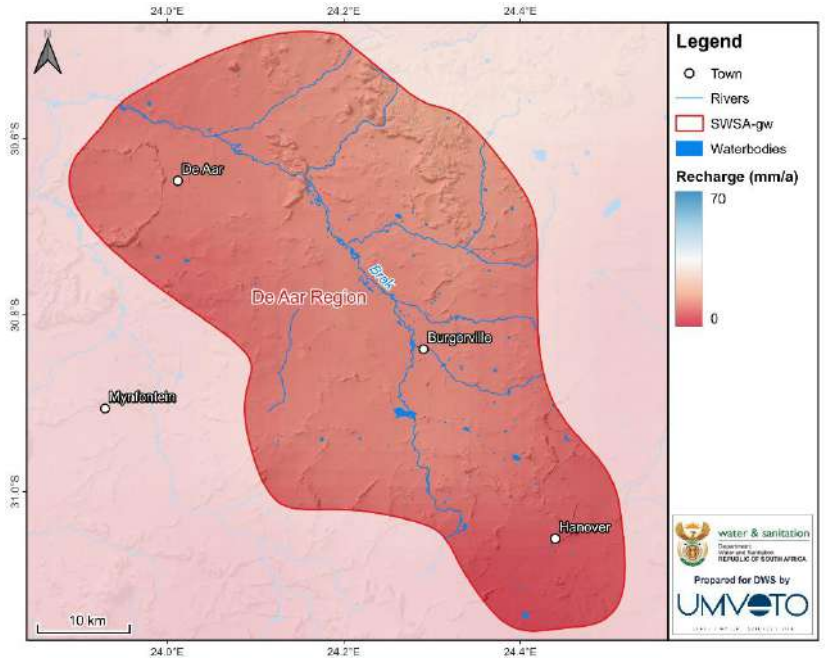
SWSA-gw Name:	**De Aar Region**
Area:	**2475 km²**
Elevation:	**1186 to 1628 mamsl**

Quantity & Quality

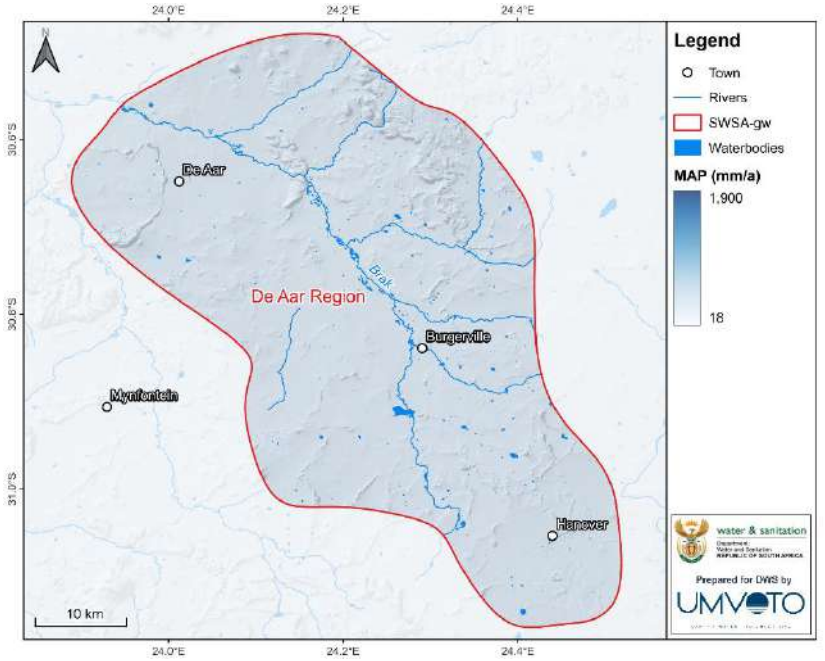
Groundwater Recharge

The De Aar Region receives a total MAP volume of 718 Mm³/a, with an average rainfall of 290 mm/a. However, only 27.7 Mm³/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 3.9% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm³/a	Average of MAP mm/a	Sum of Recharge Vol Mm³/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm³/a)
De Aar Region	718	290	27.7	11.1	3.9%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl

Quantity & Quality

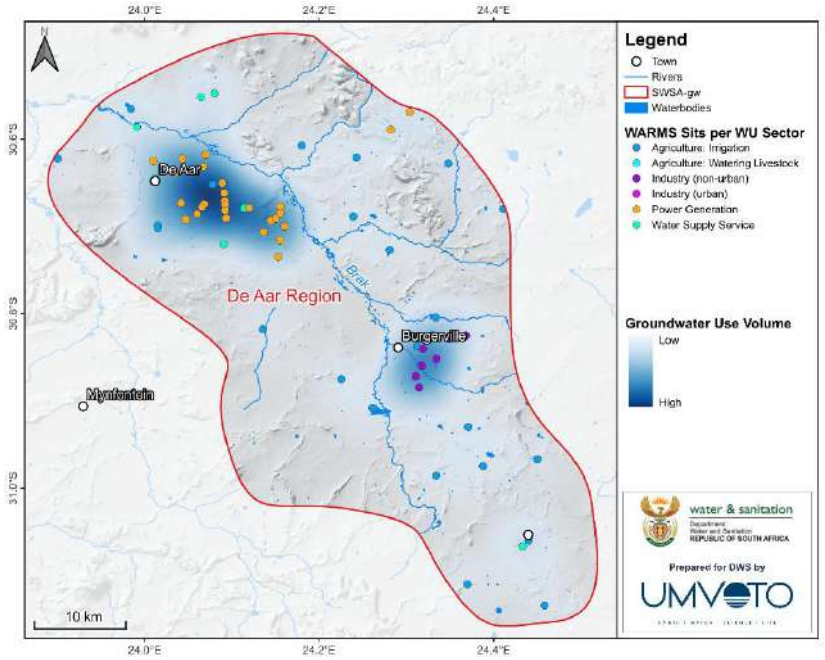
Groundwater Use

The De Aar Region SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include De Aar (Groundwater) and Richmond (Groundwater), which rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Municipal water supply services, at 5.9 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. These are primarily located in the towns in the area like Hanover and near De Aar.
- Agricultural irrigation use, with 0.9 Mm^3/a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. Use is scattered across the region, there is some concentration near De Aar and Hanover. Generally, there is irrigation water used throughout the region, which indicates there is a lot of reliance on groundwater in the area.
- Non-urban industrial follows, using 0.2 Mm^3/a for manufacturing, processing, and other industrial activities outside urban centres. This is mostly in the central area of the region. The non-urban industrial use is less evenly distributed than the other two.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around De Aar and Hanover, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	0.9
	Agriculture: Watering Livestock	0.001
	Industry (Non-urban)	0.2
	Industry (Urban)	0.003
	Power Generation	0.2
	Water Supply Service	5.9
	Total	**7.2**



Water use map for the De Aar Region SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

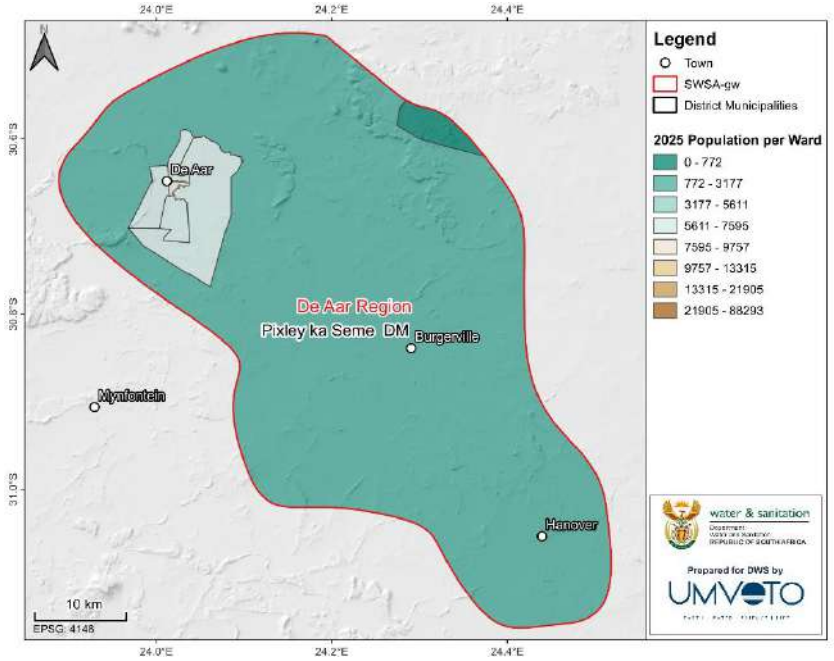
SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl
Quantity & Quality	
Socio Economic & Governance	

The De Aar Region SWSA-gw is located within the Vaal-Orange Water Management Area (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the De Aar Region SWSA-gw was calculated using Census 2011 2011 and 2022 data to determine a population growth rate of -0.05% per year, resulting in a projected population of approximately 34,716.

As shown in the map and table below, Emthanjeni LM has the highest estimated population within the SWSA-gw, with approximately 34,680. Population concentrations within the SWSA-gw are highest around the town of De Aar.



Projected population distribution in 2025 for the De Aar Region SWSA-gw.

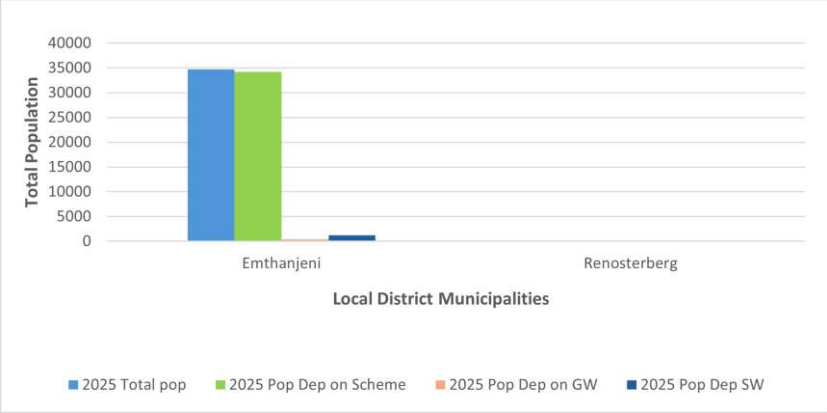
SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the De Aar Region SWSA-gw, an estimated 98.6% of the population depends on the regional water supply scheme, 3.5% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 1.2% on groundwater sources (including boreholes and springs).

Among the LMs, the Renosterberg LM has the highest proportion of groundwater reliance, with approximately 5.8% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Emthanjeni	34,680	34,213	427	1,224
Renosterberg	35	29	2	1
Total	**34,680**	**34,242**	**429**	**1,225**



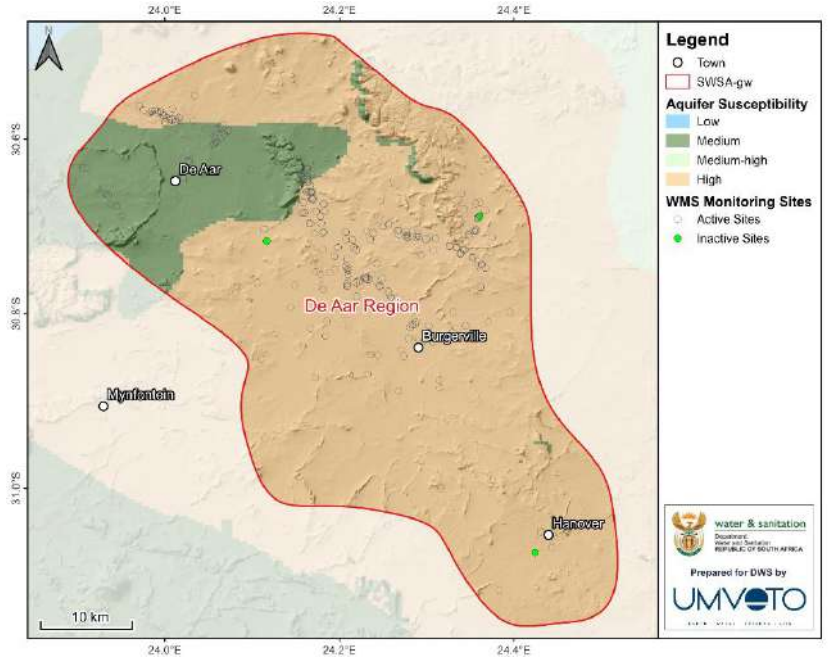
Projected population dependence on water sources in 2025.

SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl
Quantity & Quality	
Groundwater Quality	

The De Aar Region SWSA-gw consists of the Major aquifer system, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), Urban/Built-up areas cover a total of 23.99 km^2, which is 0.97% of the De Aar Region SWSA-gw total area. Cultivated areas cover 20.77 km^2 (0.84%), while mines and quarries account for 2.61 km^2 (0.11%) of the total area. These land uses contribute to diffuse contamination sources, with urban areas being the primary concern. Urban areas tend to include informal settlements and townships, and this places the groundwater source under a high risk of contamination (Le Maitre et al., 2018). Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 29.5 – 767 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 1.05 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.05 - 17.36 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 7.55 - 8.9 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 13.6 - 76.3 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**De Aar Region**
Area:	**2475 km^2**
Elevation:	**1186 to 1628 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the De Aar Region SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	3	7.50	40	97.22	mS/m	2014-2024 GW Geosites: N/A	2014-2024 GW Geosites: <70 - 150 mS/m.	29.5 - 767 mS/m (Avg.: 97.22 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Mostly consistent with WMS (2000-2024), except for values above the upper limit.
Fluoride	3	7.50	40	0.61	mg/L	2014-2024 GW Geosites: N/A	2014-2024 GW Geosites: <0.5 - 1.5 mg/L.	0.025 - 1.05 mg/L (Avg.: 0.61 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	3	7.50	40	6.98	mg/L	2014-2024 GW Geosites: N/A	2014-2024 GW Geosites: <11 mg/L	0.05 - 17.36 mg/L (Avg.: 6.98 mg/L). 2014-2024 GW Geosites: <11 - 20 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	3	7.50	40	8.21	pH unit	2014-2024 GW Geosites: N/A	2014-2024 GW Geosites: 7-9.	7.55 - 8.9 (Avg.: 8.21). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	3	7.50	40	48.65	mg/L	2014-2024 GW Geosites: N/A	2014-2024 GW Geosites: <200 mg/L.	13.6 - 76.3 mg/L (Avg.: 48.65 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the De Aar Region SWSA-gw, taken from the WMS database from 2000-2024.*
- *"N/A" refers to Not Applicable*

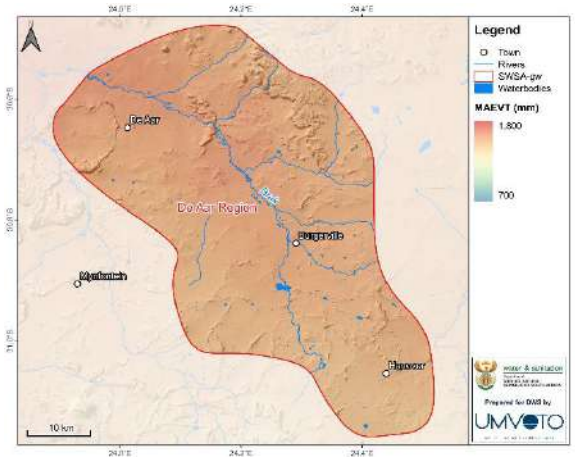
SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl

Threats & Risks

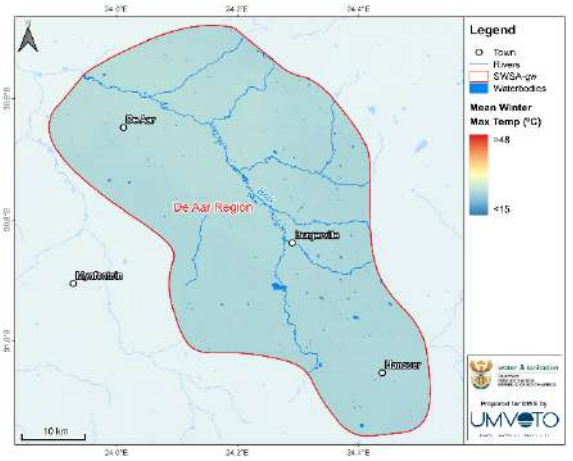
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the De Aar Region SWSA-gw predominantly has a BSk, cold semi-arid, type climate characterised by cold winters and warm to hot summers. Just north of De Aar, the climate shifts to a BWk, a cold desert climate type with hot, dry summers, low precipitation and high evaporation and transpiration. Temperatures in the SWSA-gw range from -1.9 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

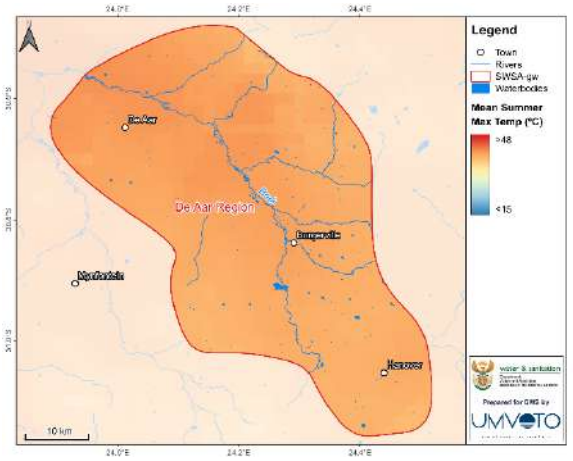
Temperature	Summer: 24.7 to 31 °C, Winter: -1.9 to 2 ºC
Evapotranspiration	Maximum value of 1620 mm/a with an average value of 1540 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, and a small decline in recharge (ranging from ~ -6 to -0.6 mm/a). The DART Index indicates mostly stable conditions.



Mean annual A-Pan evaporation (Schulze, 2009) of the De Aar Region SWSA-gw region.



Mean winter temperatures (Schulze, 2009) of the De Aar Region SWSA-gw region.



Mean summer temperatures (Schulze, 2009) of the De Aar Region SWSA-gw region.

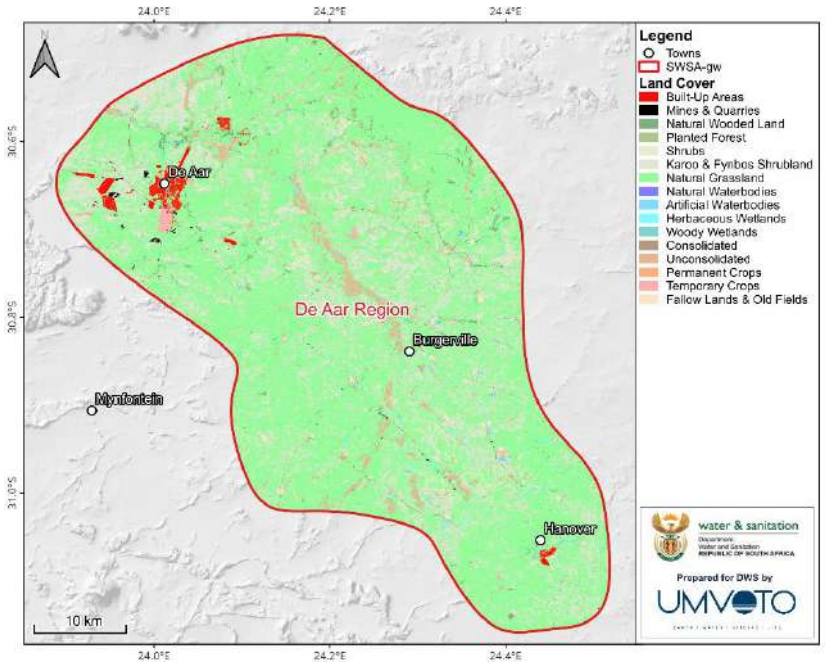
SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl

Threats & Risks

Land Use

Grassland dominates the landscape (DFFE, 2022), covering 68.94% of the De Aar Region SWSA-gw, indicating a vast expanse of open land that may support grazing and conservation. Shrubland, specifically Karoo & Fynbos Shrubland, also plays a significant role, contributing to the region's biodiversity and semi-arid ecosystem. Forest land, along with wetlands and waterbodies, makes up a small portion of the landscape, emphasizing the limited availability of forested and water-rich areas. Built-up areas, made up of residential, commercial and industrial areas, are minimal, indicating low urban development and a predominantly natural environment. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.1% of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	73	2.9
Built-Up	24	1.0
Cultivated	21	0.8
Forest Land	26	1.1
Grassland	1706	68.9
Mines and quarries	3	0.1
Shrubland	608	24.6
Waterbodies	5	0.2
Wetlands	10	0.4



Land Cover 24-class map to show the types of land use and extent of each occurring in the De Aar Region SWSA-gw.

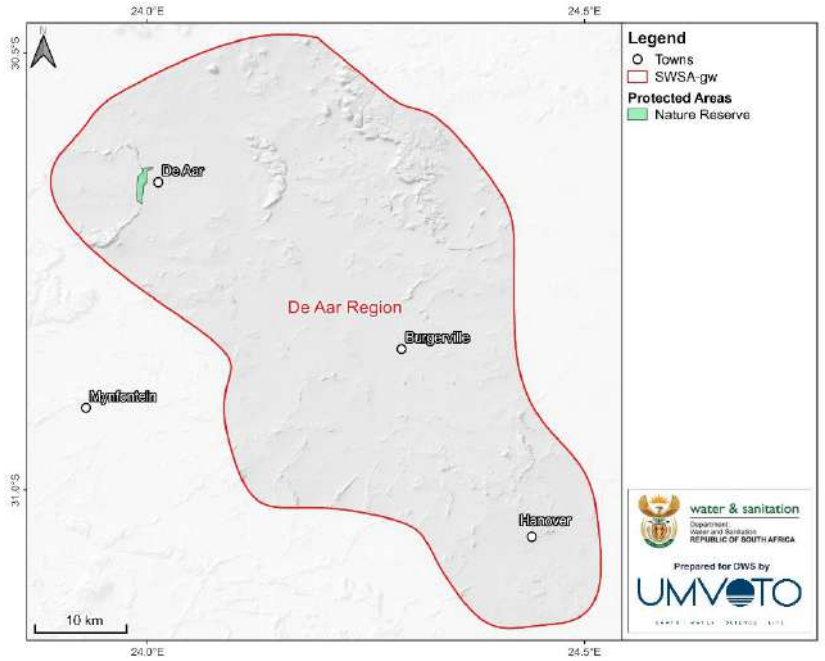
SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The De Aar Region SWSA-gw has one small nature reserve (DFFE, 2024) located in the town of De Aar, as can be seen on the map.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	• De Aar Nature Reserve	3.33	1
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the De Aar Region SWSA-gw that have protection status.

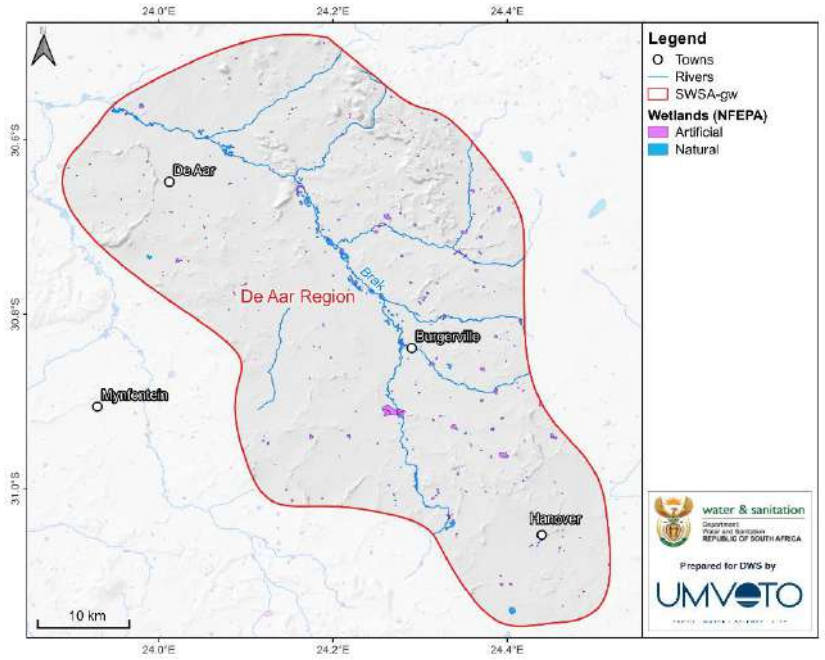
SWSA-gw Name:	De Aar Region
Area:	2475 km^2
Elevation:	1186 to 1628 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

There are no major water bodies, Ramsar sites or groundwater-dependent ecosystems in the De Aar Region SWSA-gw. However, there are small natural and artificial wetlands in the SWSA-gw (CSIR, 2011).

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural and artificial wetlands	18	

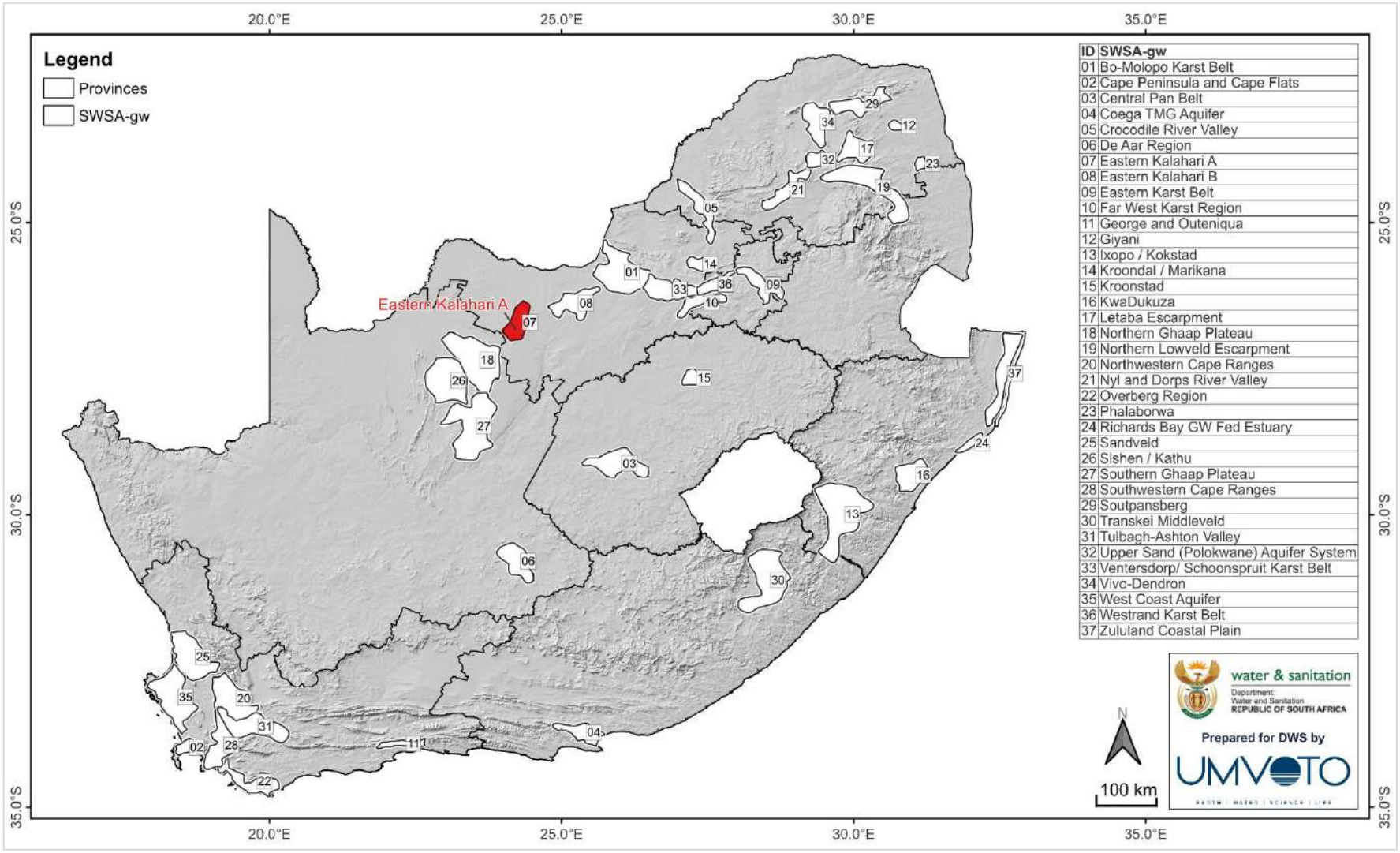


Map showing the major water bodies, Ramsar sites and GDEs in the De Aar Region SWSA-gw.

APPENDIX 07

EASTERN KALAHARI A SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE EASTERN KALAHARI A SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

7. Eastern Kalahari A

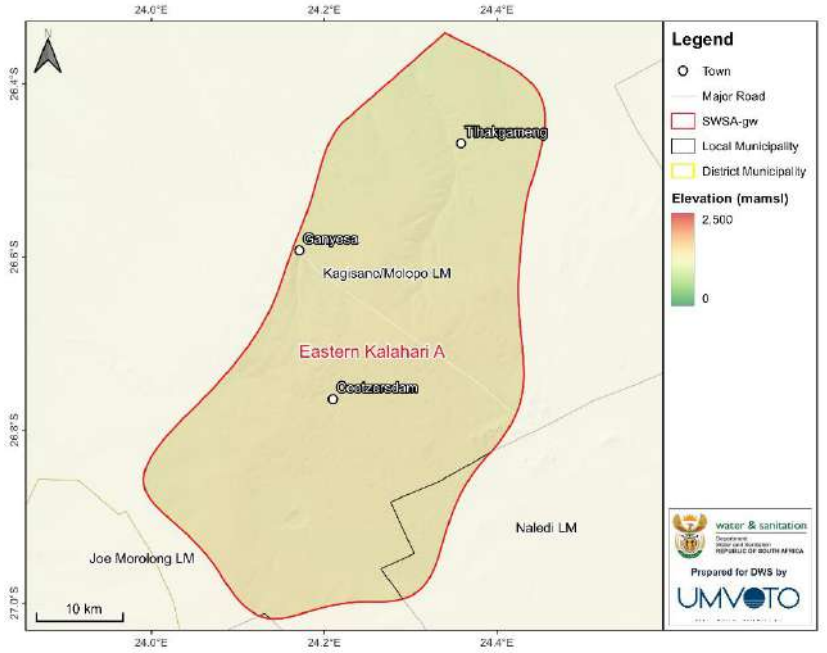
7.1. Description

SWSA-gw Name:	**Eastern Kalahari A**
Area:	**2010 km²**
Elevation:	**1197 to 1380 mamsl**
Geospatial Context	

The topography of the Eastern Kalahari A SWSA-gw, as depicted in the map, is characterized by occasional low ridges and isolated rocky outcrops, overall, the relief is relatively mild. Moving towards the north, the topography gradually becomes more undulating, with some small hills and occasional river valleys.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Northern Cape
District Municipality	Dr Ruth Segomotsi Mompati
Local Municipality	Kagisano/Molopo, Naledi and Greater Taung
Towns	Ganyesa and Tlhakgameng
Major Roads	R378
Major Water Supply Networks	



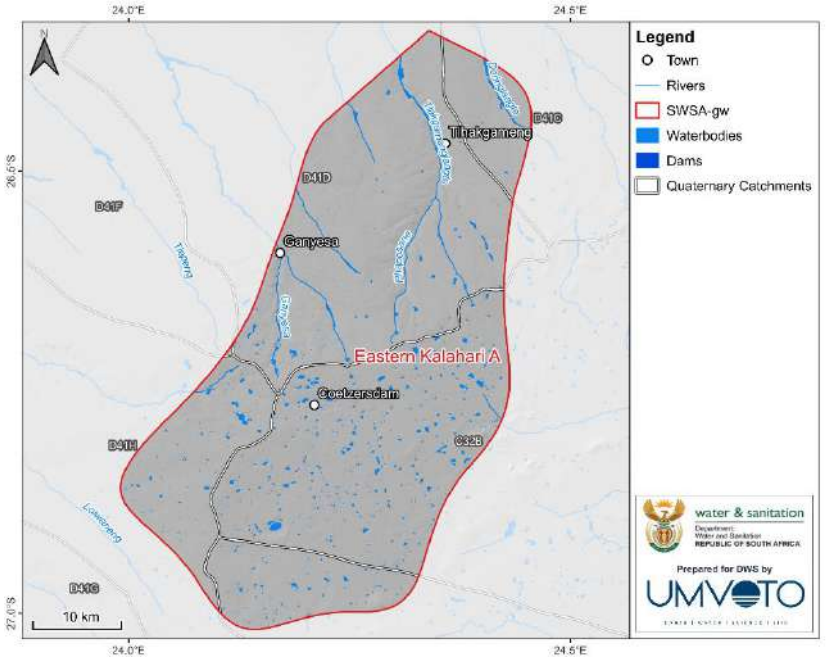
Locality map of Major Towns, District and Local Municipalities in the Eastern Kalahari A SWSA-gw.

SWSA-gw Name:	Eastern Kalahari A
Area:	2010 km²
Elevation:	1197 to 1380 mamsl

Hydrology and Drainage

The Eastern Kalahari A SWSA-gw and surrounding areas include no major surface water systems other than a few ephemeral rivers summarised below and displayed in the map on the right. The rivers flow predominantly in a northern direction and are fed by the D4 catchment.

Quaternary Catchments	C32B, C32D, D41C, D41D, D41H and a small section of D41F
Rivers	Perennial: None
	Ephemeral: Doringlaagte, Ganyesa, Ganyesalaagte, Kgokgole, Phaposane and Tlakgamenglaagte
Natural and manmade water bodies	
Major Dams:	No major dams
Water Management Areas:	Vaal Orange



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Eastern Kalahari A SWSA-gw.

SWSA-gw Name:	Eastern Kalahari A
Area:	2010 km²
Elevation:	1197 to 1380 mamsl
Geology	

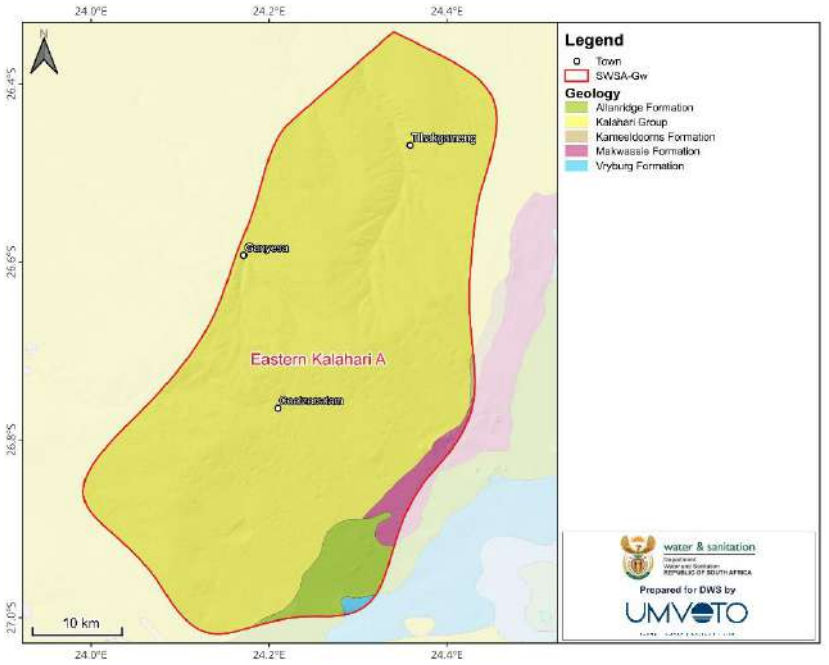
Geology

The Kalahari Group covers the majority of the area, consisting of aeolian sand, including cover sands and sand dunes. Karoo dolerite dike intrusions extend throughout the region.

The Ventersdorp Supergroup outcrops in the southeastern section of the area and comprises andesitic lavas, tuffs, shale, conglomerate, and greywacke.

Hydrostratigraphy

The Kalahari Group consists of unconsolidated aeolian sands, forming shallow, unconfined intergranular aquifers with limited groundwater storage. The Ventersdorp Supergroup comprises volcanic and sedimentary rocks, hosting secondary fractured aquifers, where groundwater occurs in fractures and weathered zones. Karoo dolerite dike intrusions create localized, secondary fractured aquifers.



Geology Map of the Eastern Kalahari A SWSA-gw region.

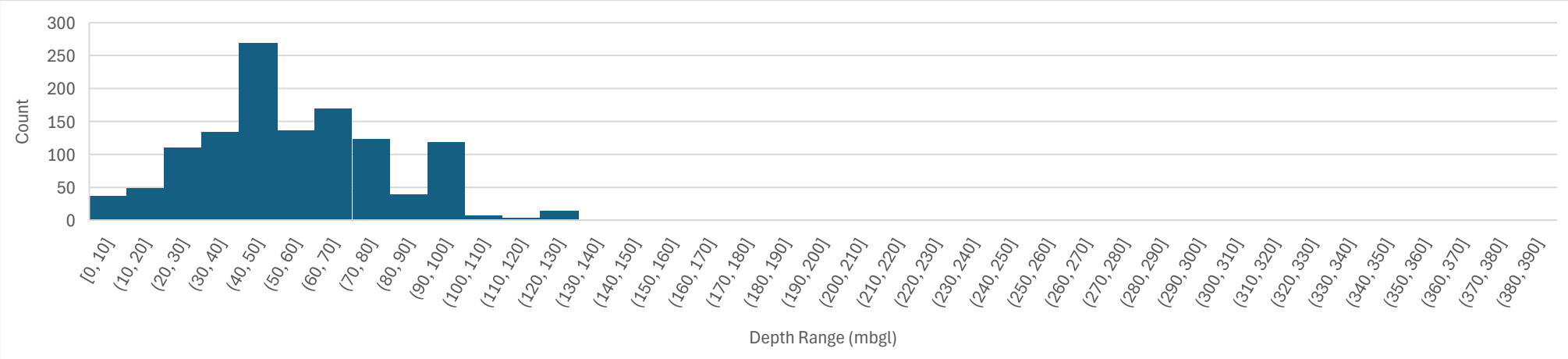
7.2. Current Status

SWSA-gw Name:	**Eastern Kalahari A**
Area:	**2010 km²**
Elevation:	**1197 to 1380 mamsl**
Quantity & Quality	
Aquifer Classification	

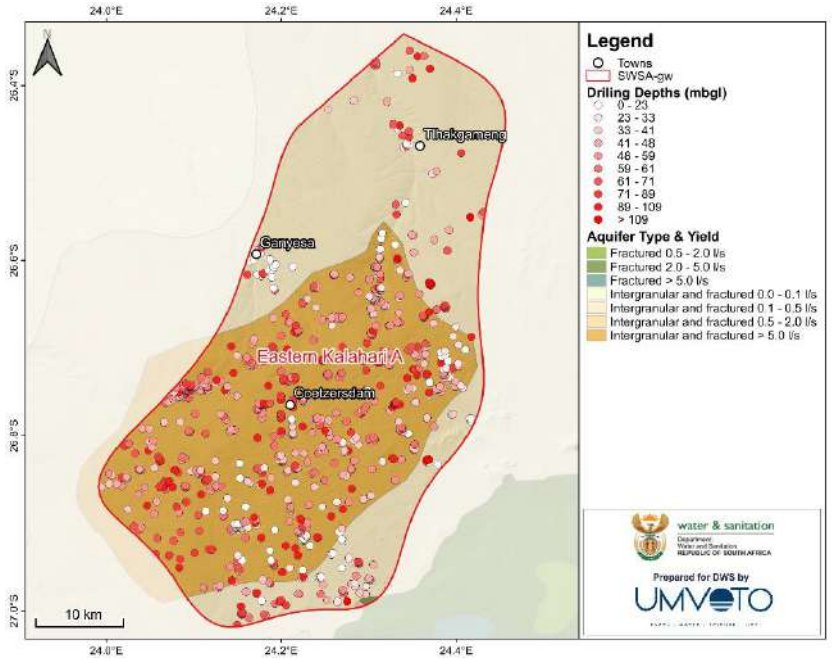
The aquifer systems within the Eastern Kalahari A SWSA-gw exhibit varying yields across dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The majority of the SWSA-gw comprises a Major aquifer system, with a Minor aquifer system in the northern section. The Major aquifer system has an average dual-porosity yield ranging from 1.0 to over 5.0 l/s, while the Minor aquifer system has an average dual-porosity yield of 0.1 to 0.5 l/s.
Groundwater Targets	The average drilling depth is 55 mbgl, and the most common depth is around 50 mbgl. Most boreholes in the region target the shallow high-yielding dual-porosity aquifer systems with limited deeper boreholes (>250 mbgl) likely tapping into the fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 39 and 70 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 29 mbgl, with values ranging from 2 to 61 mbgl and a standard deviation of ~ 8 mbgl.

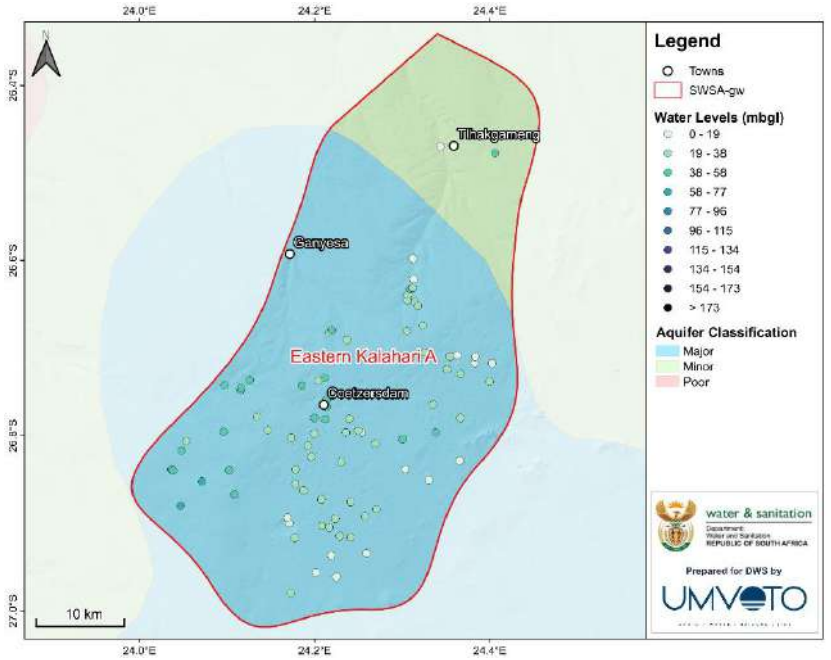
Graph of NGA drilling depths of the Eastern Kalahari B SWSA-gw region



SWSA-gw Name:	**Eastern Kalahari A**
Area:	**2010 km²**
Elevation:	**1197 to 1380 mamsl**
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Eastern Kalahari A SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Eastern Kalahari A SWSA-gw region.

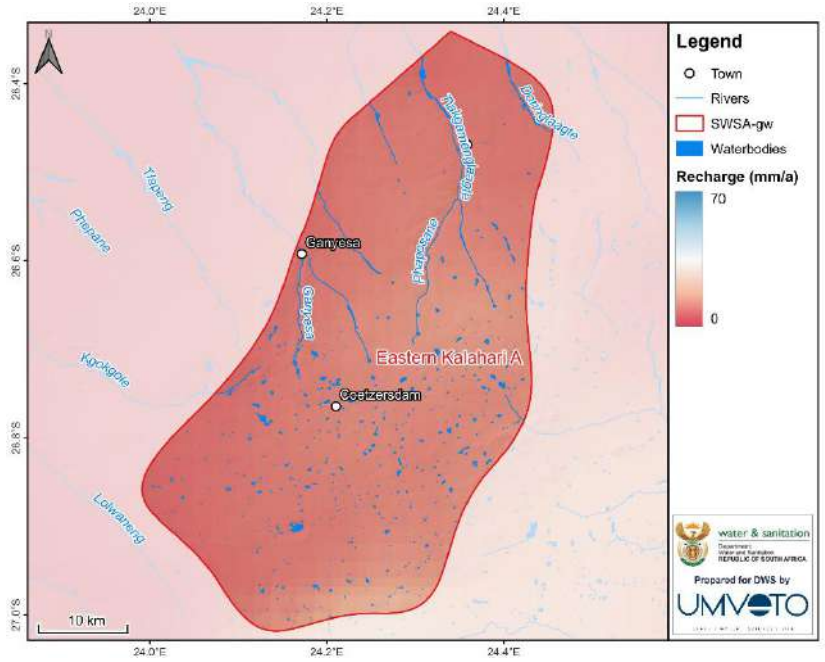
SWSA-gw Name:	**Eastern Kalahari A**
Area:	**2010 km²**
Elevation:	**1197 to 1380 mamsl**

Quantity & Quality

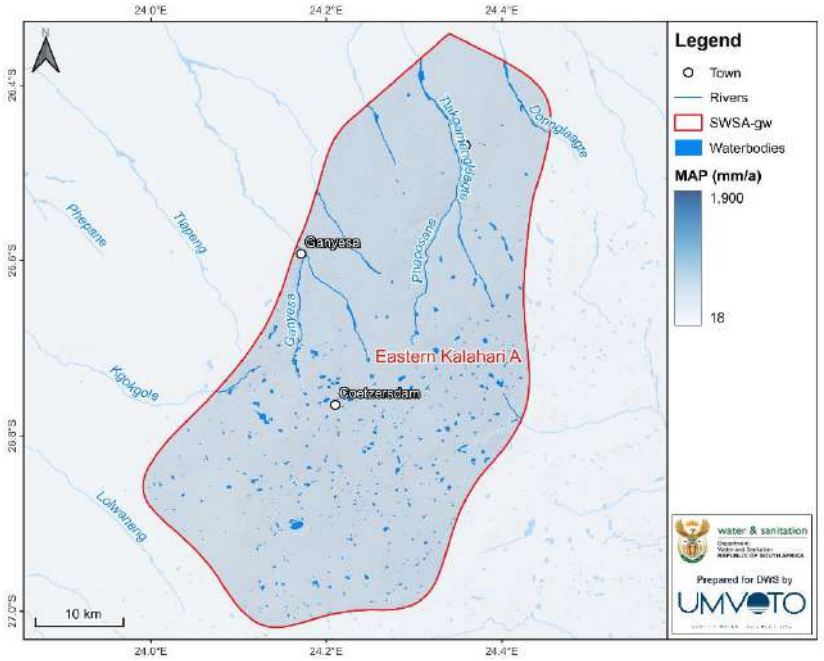
Groundwater Recharge

Eastern Kalahari A receives a total MAP volume of 787 Mm^3/a, with an average rainfall of 392 mm/a. However, only 24 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 3.1% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Eastern Kalahari A	787	392	24	11.9	3.1%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Eastern Kalahari A
Area:	2010 km²
Elevation:	1197 to 1380 mamsl

Quantity & Quality

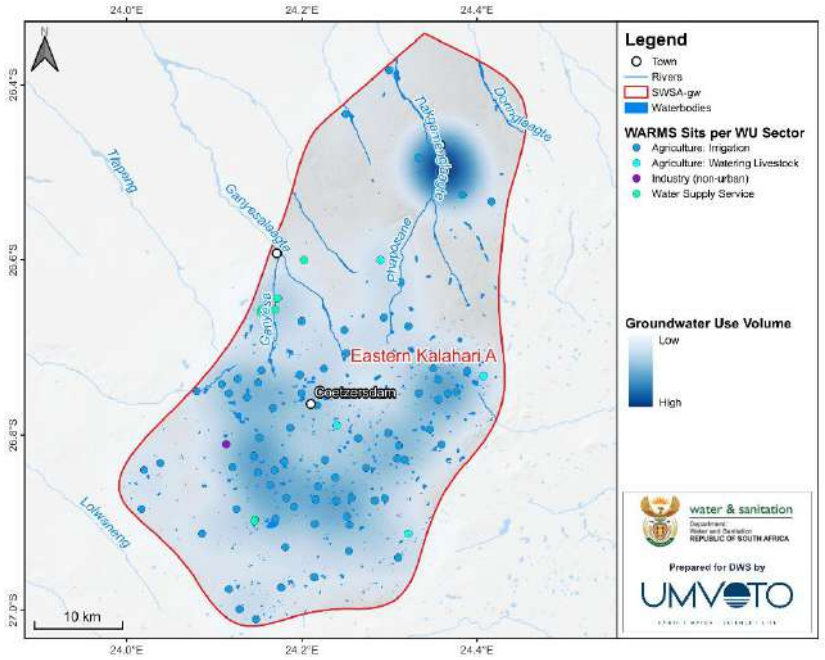
Groundwater Use

The Eastern Kalahari A SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. While no towns in this region rely primarily on groundwater for municipal supply, industrial use, or agriculture (see Table below), an analysis of active groundwater use licenses from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 30.81 Mm^3/a to sustain crop production. These are mostly scattered in the southern parts of the region, with a few clusters in the north. This indicates that the south is more reliant on groundwater than the north.
- Municipal water supply services, at 0.81 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. This sector's water use is significantly less than agricultural irrigation. Water supply services are mainly in the centre of the region, clustered to the west, with a few scattered points in the south.
- Agricultural watering of livestock is the third highest with 0.06 Mm^3/a. The Kalahari region is quite dry which makes watering of livestock challenging. In the southeastern parts of the region, they combat this by using groundwater to sustain the animals.

The map highlights water use hot spots, indicating areas of high groundwater abstraction, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	30.81
	Agriculture: Watering Livestock	0.06
	Industry (Non-urban)	0.01
	Water Supply Service	0.81
	Total	**31.7**



Water use map for the Eastern Kalahari A SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

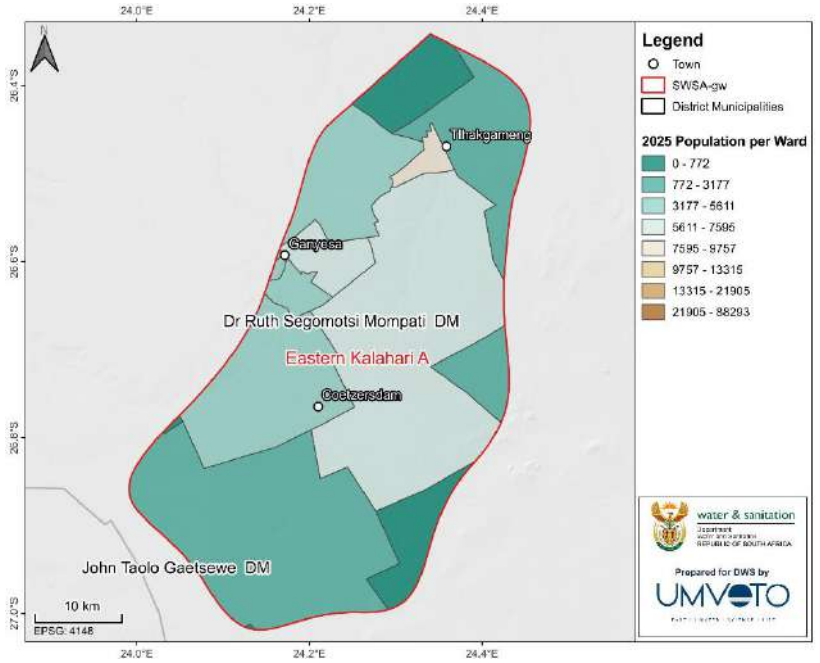
SWSA-gw Name:	Eastern Kalahari A
Area:	2010 km²
Elevation:	1197 to 1380 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Eastern Kalahari A SWSA-gw is located within the Vaal-Orange Water Management Area (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	Local municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Eastern Kalahari A SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 2.72% per year, resulting in a projected population of approximately 228,782.

As shown in the map and table below, the Greater Taung Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 188,402. Population concentrations within the SWSA-gw are highest around the towns of Ganyesa and Tlhakgameng.



Projected population distribution in 2025 for the Eastern Kalahari A SWSA-gw.

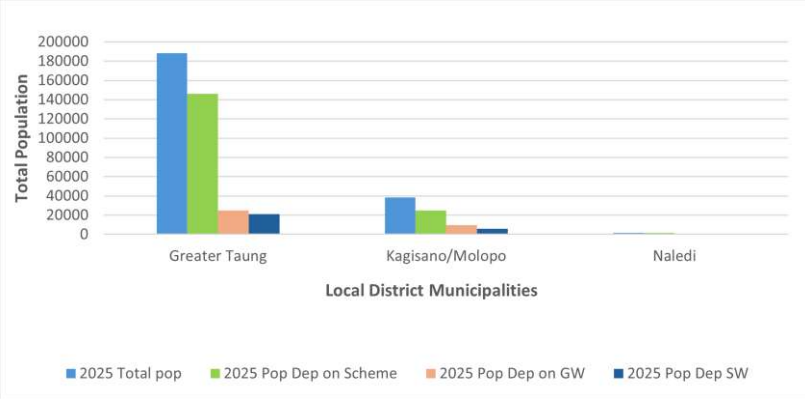
SWSA-gw Name:	Eastern Kalahari A
Area:	2010 km²
Elevation:	1197 to 1380 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Eastern Kalahari A SWSA-gw, an estimated 75.3% of the population depends on the regional water supply scheme, 15.1% on groundwater sources (including boreholes and springs), and 11.9% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources).

Among the LMs, the Kagisano/Molopo LM has the highest proportion of groundwater reliance, with approximately 24.7% of its population depending on groundwater and 15.8% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Greater Taung	188,402	146,082	24,927	21,009
Kagisano/Molopo	38,530	24,768	9,503	6,102
Naledi	1,849	1,473	173	84
Total	**228,782**	**172,323**	**34,604**	**27,196**



Projected population dependence on water sources in 2025.

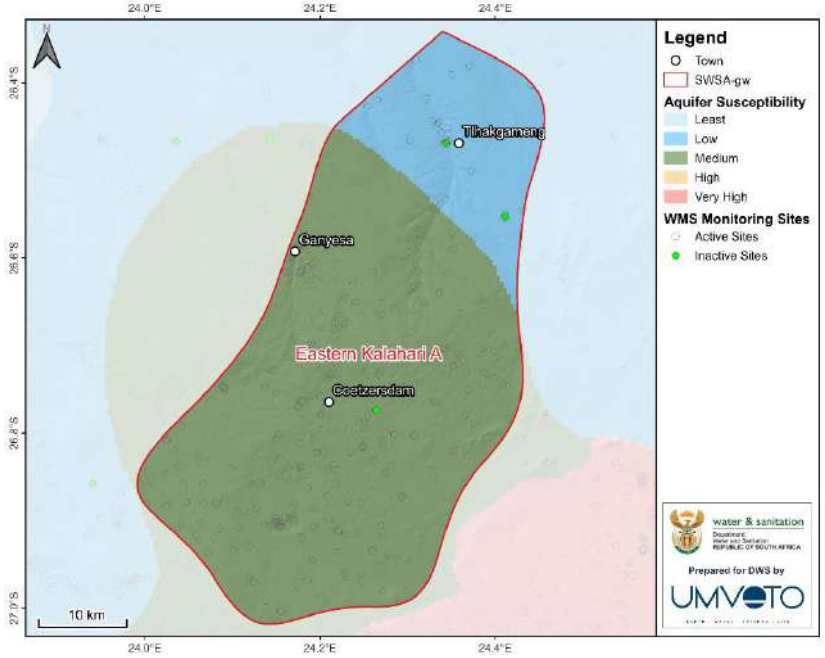
SWSA-gw Name:	Eastern Kalahari A
Area:	2010 km²
Elevation:	1197 to 1380 mamsl
Quantity & Quality	
Groundwater Quality	

The Eastern Kalahari A SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 1020.65 km^2, which is 50.77% of the Eastern Kalahari A SWSA-gw total area. Urban/Built-up areas cover 59.98 km^2 (2.98%), while mines and quarries account for 0.07 km^2 (0.003%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major aquifer consists of areas with moderate aquifer vulnerability and a majority of the aquifer. However, WMS data is unavailable for moderately vulnerable aquifer areas in the Major aquifer system. The Minor Aquifer system accounts for the rest of the aquifer, with areas of least aquifer vulnerability accounting for this system. The areas of least vulnerability cover the northeastern corner of the aquifer.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 78.76 - 135.80 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.1 - 1.1 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 3.97 - 37.49 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 7.11 - 8.61 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 24.40 - 52.38 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	Eastern Kalahari A
Area:	2010 km²
Elevation:	1197 to 1380 mamsl
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Eastern Kalahari A SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	1	12.50	8	99.82	mS/m	78.76 - 135.80 mS/m (Avg.: 99.82 mS/m). 2014-2024 GW Geosites: 70-150 mS/m. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <70 mS/m.	-
Fluoride	1	12.50	8	0.43	mg/L	0.1 - 1.1 mg/L (Avg.: 0.43 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <0.5 mg/L.	-
Nitrate + Nitrite Nitrogen	1	12.50	8	12.39	mg/L	3.97 - 37.49 mg/L (Avg.: 12.39 mg/L). 2014-2024 GW Geosites: <11-20 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	2014-2024 GW Geosites: <11 mg/L.	-
pH	1	12.50	8	8.13	pH unit	7.11 - 8.61 (Avg.: 8.13). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: 7-9.	-
Sulphate	1	12.50	8	37.06	mg/L	24.40 - 52.38 mg/L (Avg.: 37.06 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Eastern Kalahari A SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

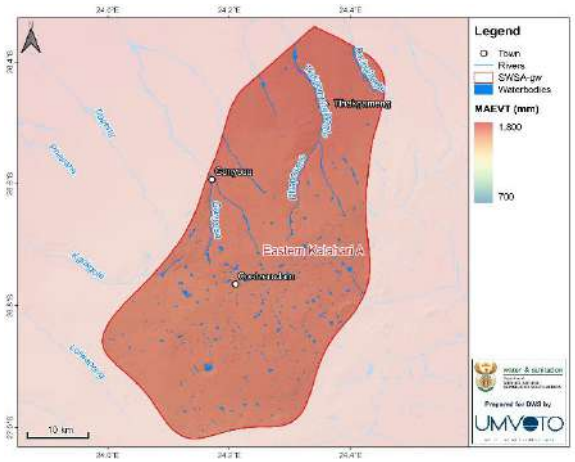
SWSA-gw Name:	**Eastern Kalahari A**
Area:	**2010 km²**
Elevation:	**1197 to 1380 mamsl**

Threats & Risks

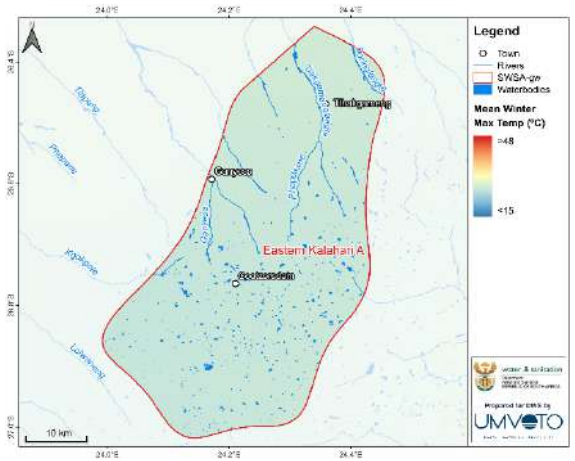
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Eastern Kalahari A SWSA-gw has a combination of BSh and BSk, semi-arid, type climates characterized by hot, dry summers and cold winters. Rainfall increases towards the southeastern section. Temperatures in the SWSA-gw range from -1.9 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

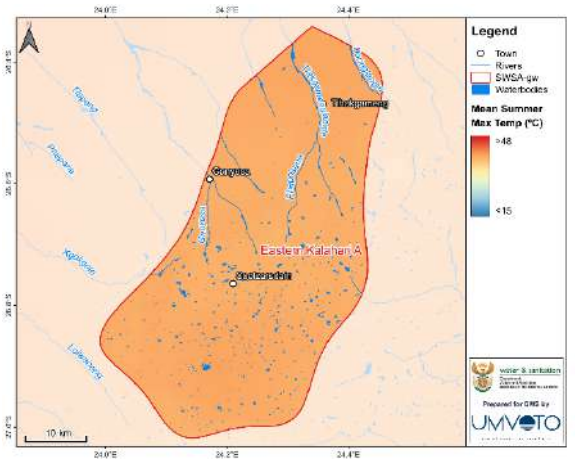
Temperature	Summer: 29.3 to >31 ºC, Winter: -1.9 to 2 °C
Evapotranspiration	Maximum value of 1728 mm/a with an average value of 1677 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, and a small increase in recharge (ranging from ~ 7.8 to 14.8 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Eastern Kalahari A SWSA-gw region.



Mean winter temperatures of the Eastern Kalahari A SWSA-gw region.



Mean summer temperatures of the Eastern Kalahari A SWSA-gw region.

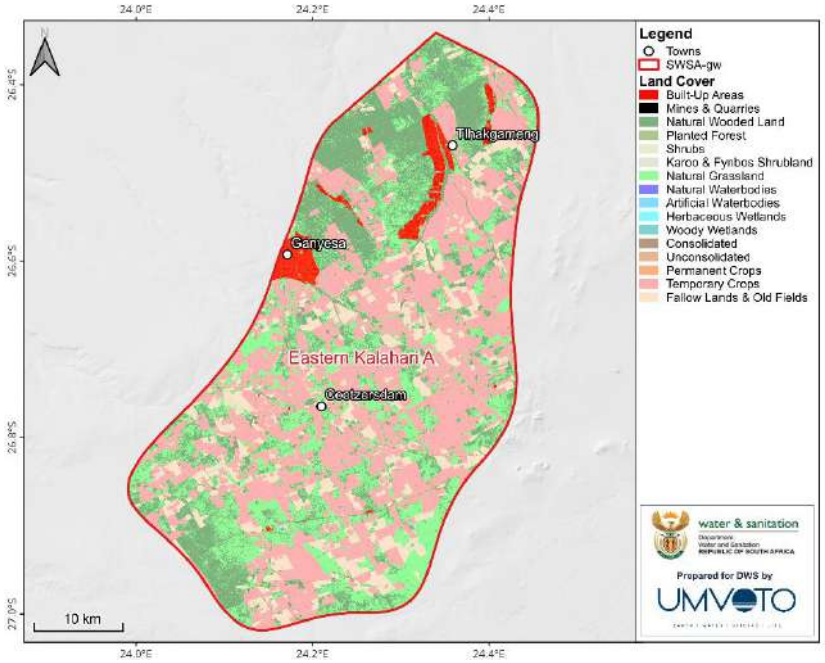
SWSA-gw Name:	Eastern Kalahari A
Area:	2010 km^2
Elevation:	1197 to 1380 mamsl

Threats & Risks

Land Use

The Eastern Kalahari A SWSA-gw, as depicted in the land cover map, is predominantly cultivated land, made up of temporary crops, permanent crops, fallow land and old fields, making up the largest land use (DFFE, 2022). Grassland and forested land, which consists of natural wooded land and planted forest, are widespread, covering 46% of the SWSA-gw and supporting biodiversity and ecological balance. Built-up areas, which consist of residential, commercial and industrial areas, concentrated around the towns of Ganyesa, Tlhakgameng, and Coetzersdam, highlight small but notable urban settlements. The near absence of wetlands and minimal waterbodies emphasize the region's dry landscape, reinforcing the need for effective water resource management.

Land Use Type	Area (km^2)	Area (%)
Barren Land	1	0.02
Built-Up	60	3
Cultivated	1021	50.8
Forest Land	459	22.8
Grassland	469	23.3
Mines and quarries	0.07	0.003
Shrubland	0.7	0.03
Waterbodies	0.5	0.02
Wetlands	0.00	0.00



Land Cover 24-class map to show the types of land use and extent of each occurring in the Eastern Kalahari A SWSA-gw.

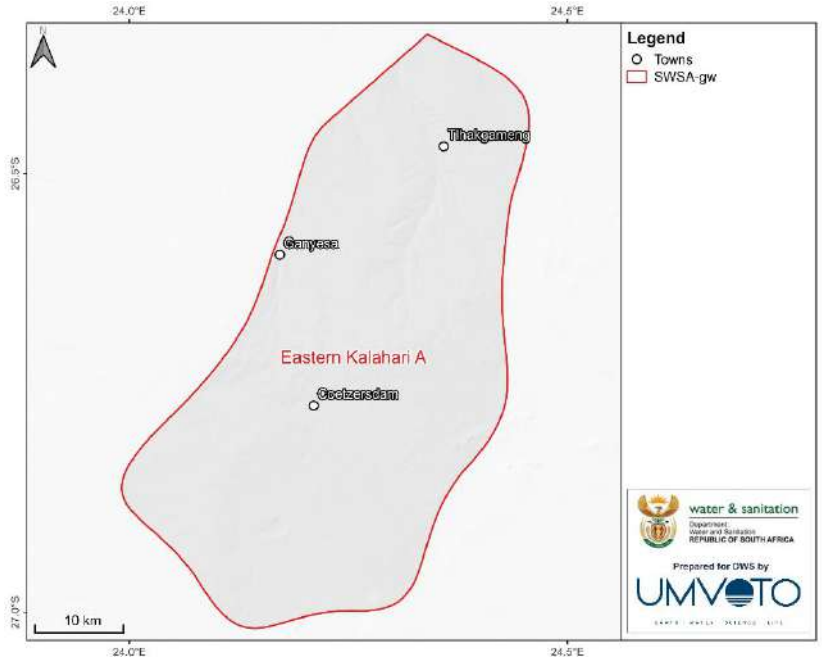
SWSA-gw Name:	Eastern Kalahari A
Area:	2010 km^2
Elevation:	1197 to 1380 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Eastern Kalahari A SWSA-gw does not contain any conservation or protected areas.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	None		0
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Eastern Kalahari A SWSA-gw that have protection status.

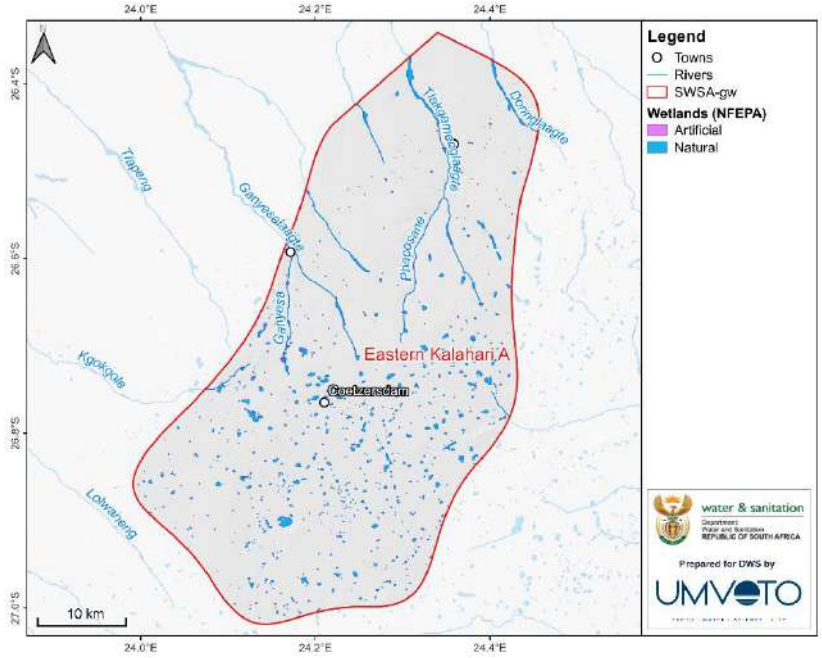
SWSA-gw Name:	Eastern Kalahari A
Area:	2010 km^2
Elevation:	1197 to 1380 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Eastern Kalahari A SWSA-gw does not contain any major waterbodies, Ramsar sites or groundwater-dependent ecosystems (GDE). Most wetlands are not considered GDEs.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	42	

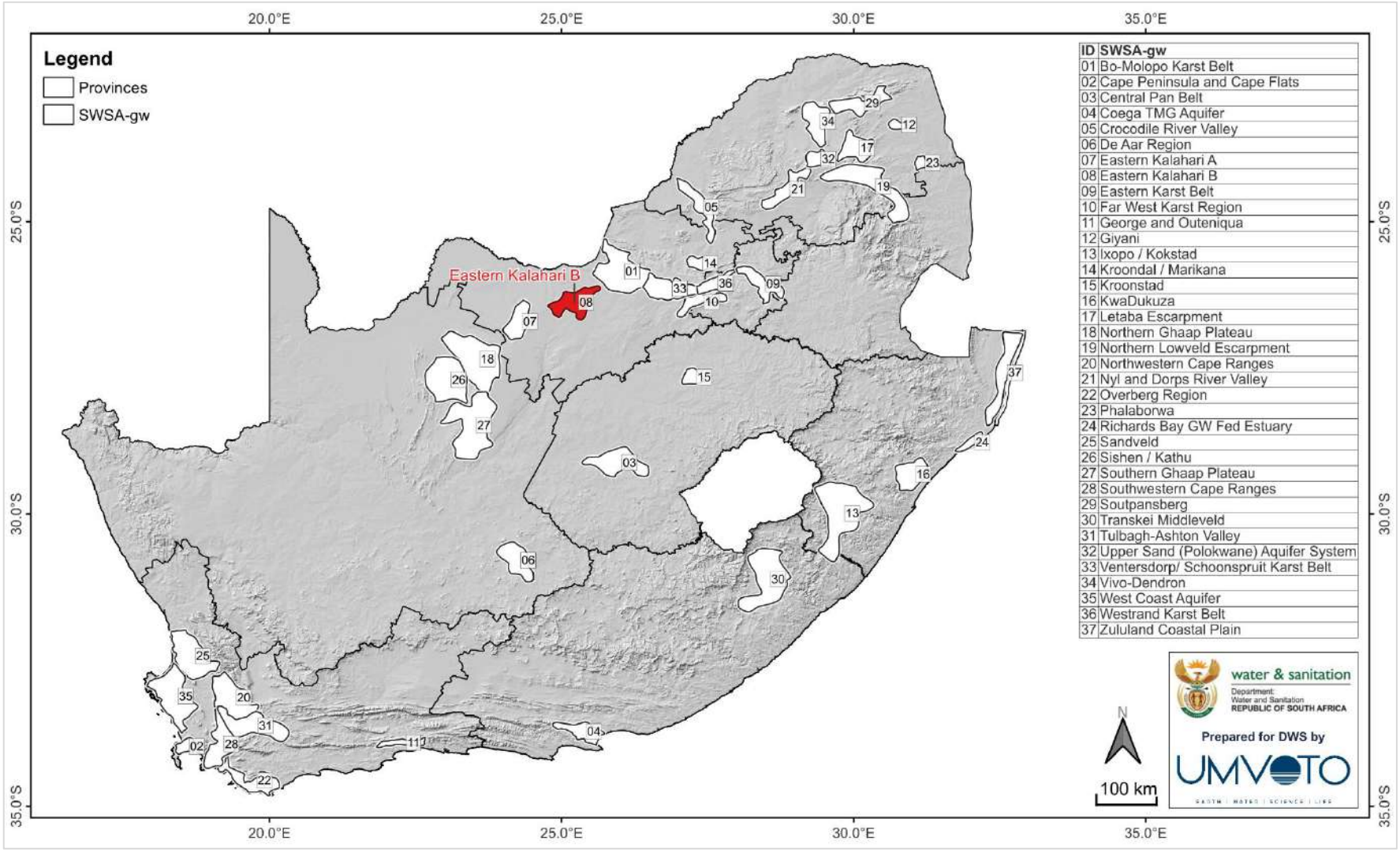


Map showing the major water bodies, Ramsar sites and GDEs in the Eastern Kalahari A SWSA-gw.

APPENDIX 08

EASTERN KALAHARI B SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE EASTERN KALAHARI B SWSA-GW



8. Eastern Kalahari B

8.1. Description

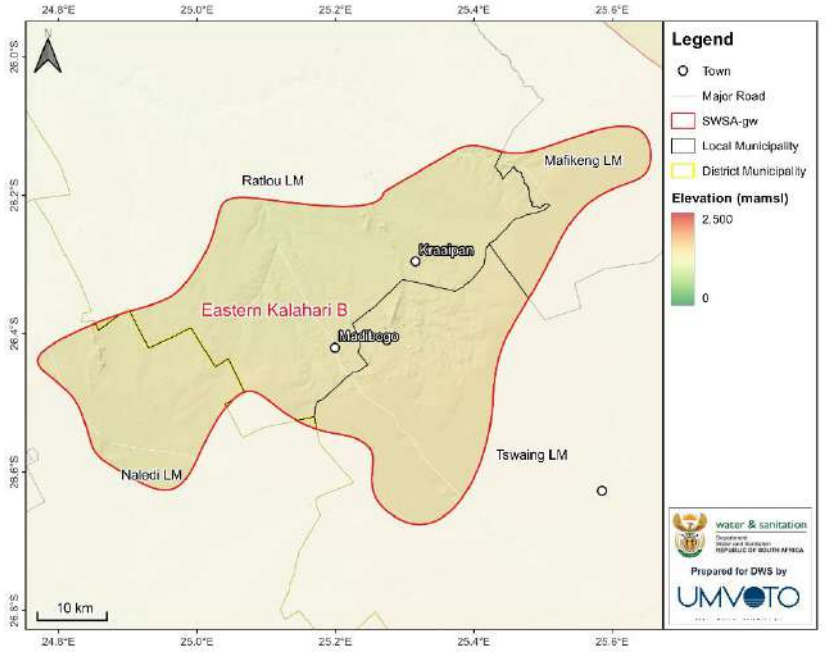
SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km²
Elevation:	1192 to 1420 mamsl

Geospatial Context

The topography of the Eastern Kalahari B SWSA-gw, as depicted in the map, is characterized by flat to gently undulating terrain with some scattered small ridges and isolated hills. While the terrain remains predominantly flat, there are occasional dry riverbeds and small valleys, particularly near areas such as Madibogo and Nooitgedacht.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	North-West
District Municipality	Dr Ruth Segomotsi Mompati and Ngaka Modiri Molema
Local Municipality	Naledi, Ratlou, Mafikeng and Tswaing
Towns	Madibogo and Stella
Major Roads	N18, R507 and R375
Major Water Supply Networks	



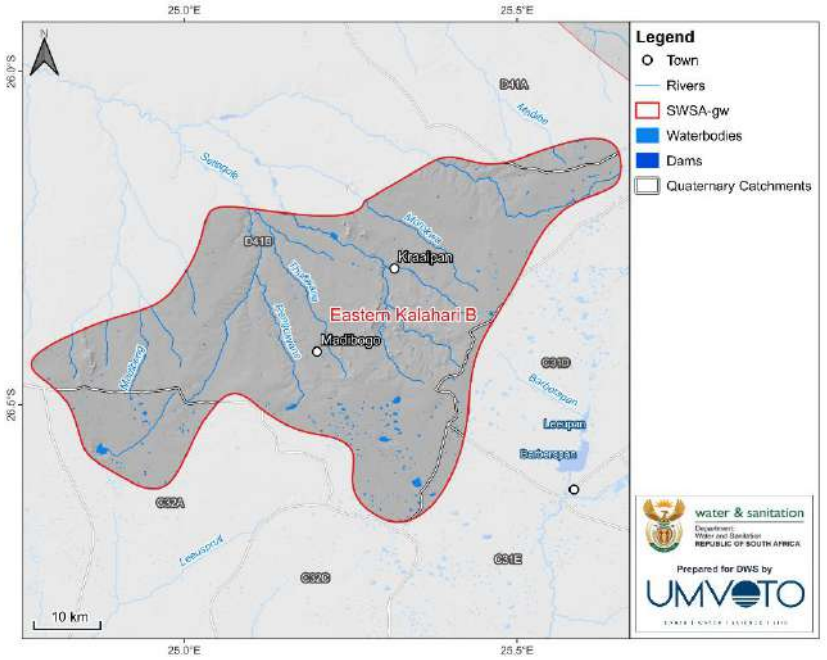
Locality map of Major Towns, District and Local Municipalities in the Eastern Kalahari B SWSA-gw.

SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km²
Elevation:	1192 to 1420 mamsl

Hydrology and Drainage

The Eastern Kalahari B SWSA-gw and surrounding areas include no major surface water systems, only a few ephemeral rivers, which are summarised below and displayed on the map to the right. The rivers, flowing predominantly in a north-northeasterly direction, are fed by the D4 catchment.

Quaternary Catchments	C32A, D41B and a small section of C31D, C31E and D41A
Rivers	Perennial: None
	Ephemeral: Koedoespruit, Madibe, Madibeng, Mareetsane, Morokwa, Mosime, Rangolwane, Sepane, Setlagole, Thutlwane, Tlhakajeng and Tlhalatau
Natural and manmade water bodies	
Major Dams:	No major dams
Water Management Areas:	Vaal Orange



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Eastern Kalahari B SWSA-gw.

SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km²
Elevation:	1192 to 1420 mamsl

Geology

Geology

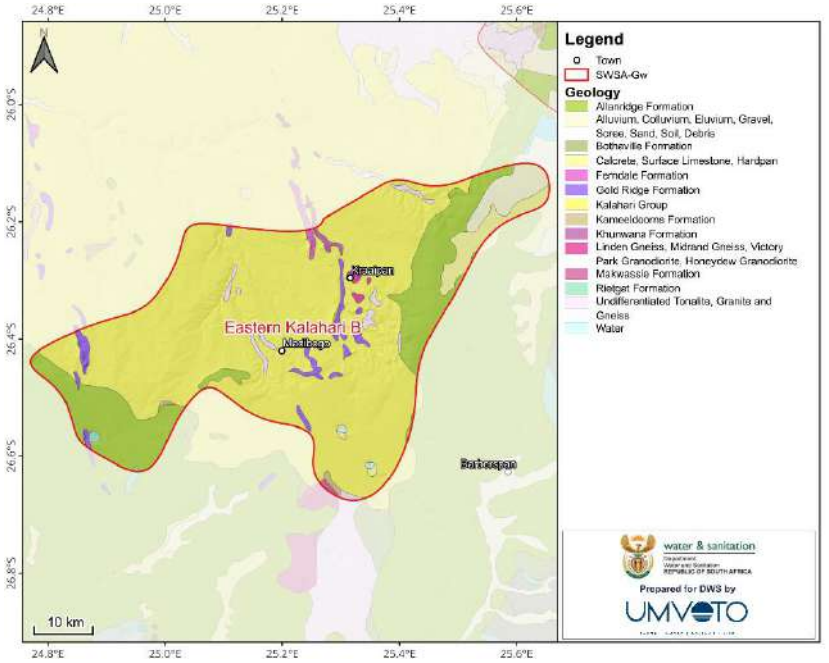
Quaternary deposits, comprising gravel, river sand, and alluvium, can be found along the southern section and the central to northeastern part of the area. The Kalahari Group, present in the central and northwestern sections of the study area, consists of aeolian sand, including cover sands and dunes.

Karoo dolerite dike intrusions are mostly found in the northern part of the area.

The Platberg Group of the Ventersdorp Supergroup, located in the western and eastern sections of the study area, consists of andesitic lavas, tuffs, conglomerate, quartzite, greywacke, shale, acid lavas (quartz porphyry), ash flows, and tuffaceous sediments.

Hydrostratigraphy

Quaternary deposits form shallow, unconfined intergranular aquifers. The unconsolidated aeolian sands of the Kalahari Group also create shallow, unconfined intergranular aquifers, while Karoo dolerite dike intrusions and the Platberg Group form secondary fractured aquifers.



Geology Map of the Eastern Kalahari B SWSA-gw region.

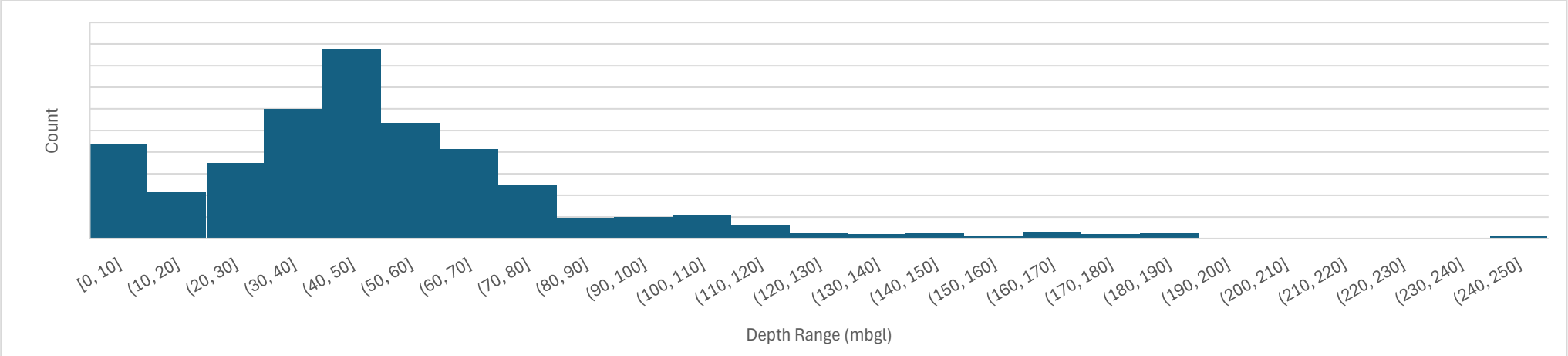
8.2. Current Status

SWSA-gw Name:	**Eastern Kalahari B**
Area:	**2656 km²**
Elevation:	**1192 to 1420 mamsl**
Quantity & Quality	
Aquifer Classification	

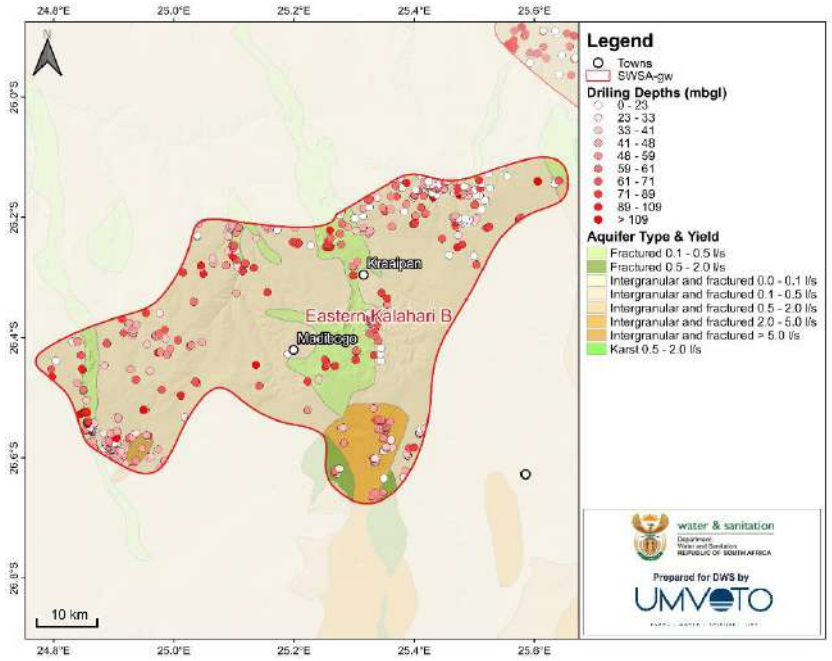
The aquifer systems within the Eastern Kalahari B SWSA-gw exhibit varying yields across dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw has minor aquifer systems on the eastern and western sides, while the centre is a poor aquifer system. The minor aquifer system has an average dual-porosity yield of 0.1-0.5 l/s and occasionally above 5 l/s
Groundwater Targets	The average drilling depth is 52 mbgl, and the most common depth is around 50 mbgl. Most boreholes in the region target the shallow dual-porosity aquifer systems. Some boreholes in the area reach depths of > 200 mbgl, suggesting that they target the underlying fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 31 and 61 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~18 mbgl, with values ranging from 1 to 48 mbgl and a standard deviation of ~ 7 mbgl.

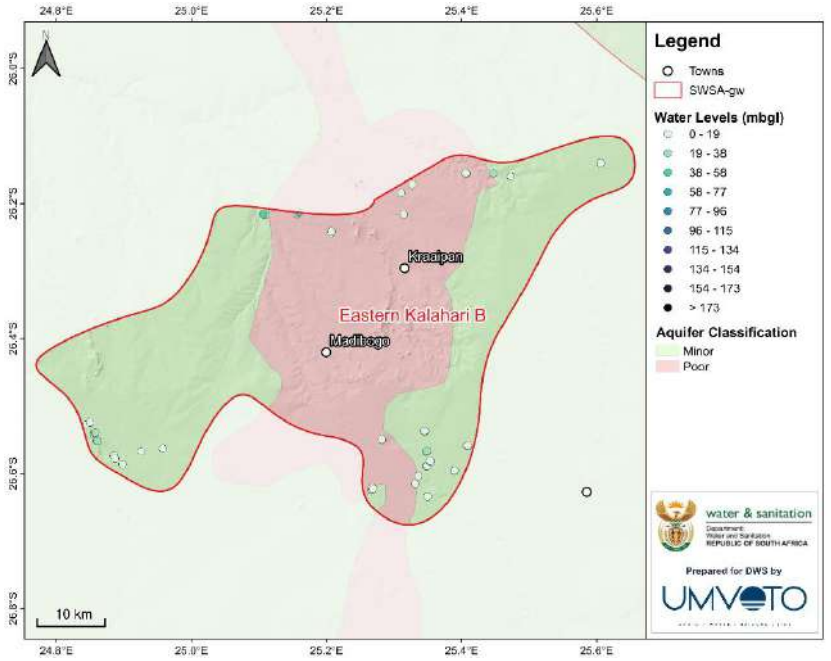
Graph of NGA drilling depths in the Eastern Kalahari B SWSA-gw region



SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km²
Elevation:	1192 to 1420 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Eastern Kalahari B SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Eastern Kalahari B SWSA-gw region.

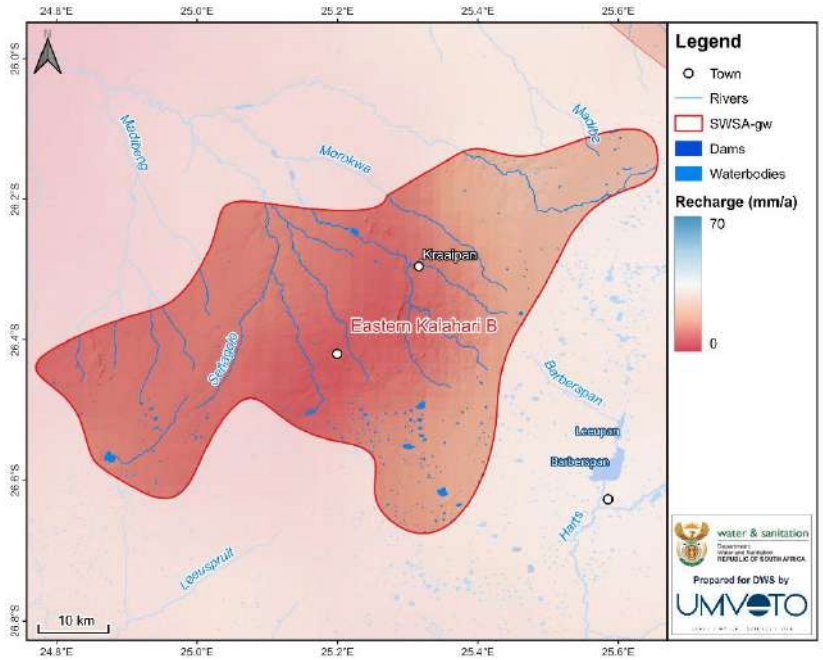
SWSA-gw Name:	**Eastern Kalahari B**
Area:	**2656 km²**
Elevation:	**1192 to 1420 mamsl**

Quantity & Quality

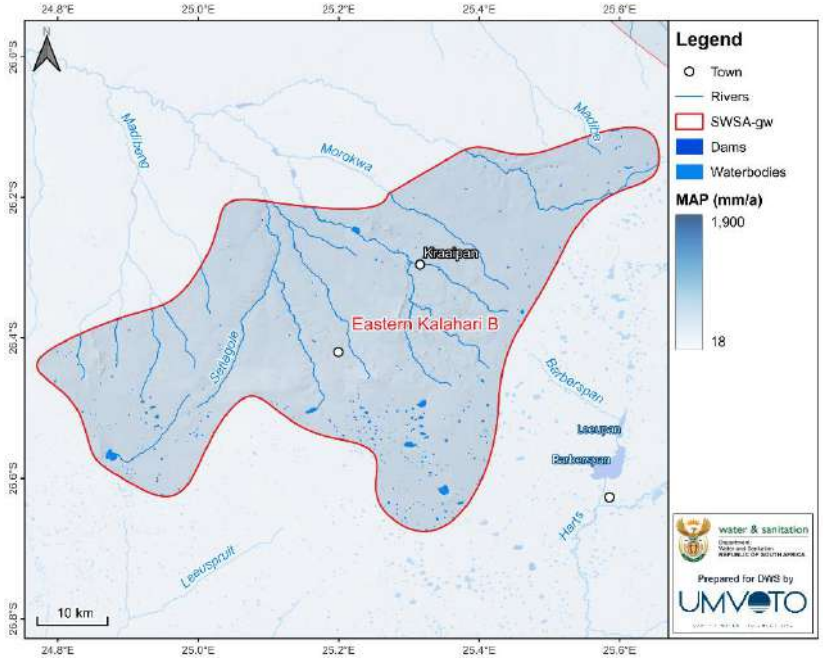
Groundwater Recharge

The Eastern Kalahari B receives a total MAP volume of 1155 Mm^3/a, with an average rainfall of 436 mm/a. However, only 34.3 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a very low recharge of 3% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Eastern Kalahari B	1155	436	34.3	13	3%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km²
Elevation:	1192 to 1420 mamsl

Quantity & Quality

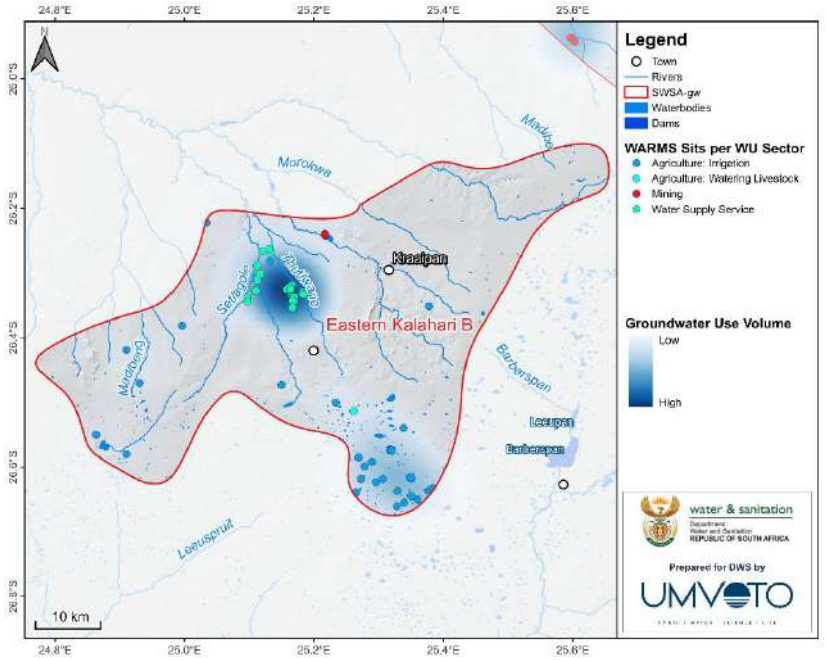
Groundwater Use

The Eastern Kalahari B SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Setlagole (Groundwater) and Stella (Groundwater), which rely significantly on groundwater resources for municipal supply, mining, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 7.8 Mm^3/a to sustain crop production. Given the arid conditions of the Northern Cape, groundwater is essential for farming, supporting food production and local economies. The use is predominantly in the southern parts of the region and around Stella.
- Municipal water supply services, at 0.8 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. There is a large cluster of municipal water services just above Madibogo indicating that that region is highly dependent on groundwater supply.
- Mining use has 0.1 Mm^3/a allocated. Water is a vital resource in the mining process. Groundwater can offer a reliable water source in water-scarce or remote areas. Mining use in this region is mainly north of the Madiboo area. This suggests that mining in this area is heavily reliant on groundwater.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Madibogo and Stella, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	7.8
	Agriculture: Watering Livestock	0.01
	Mining	0.1
	Water Supply Service	0.8
	Total	**8.7**



Water use map for the Eastern Kalahari B SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

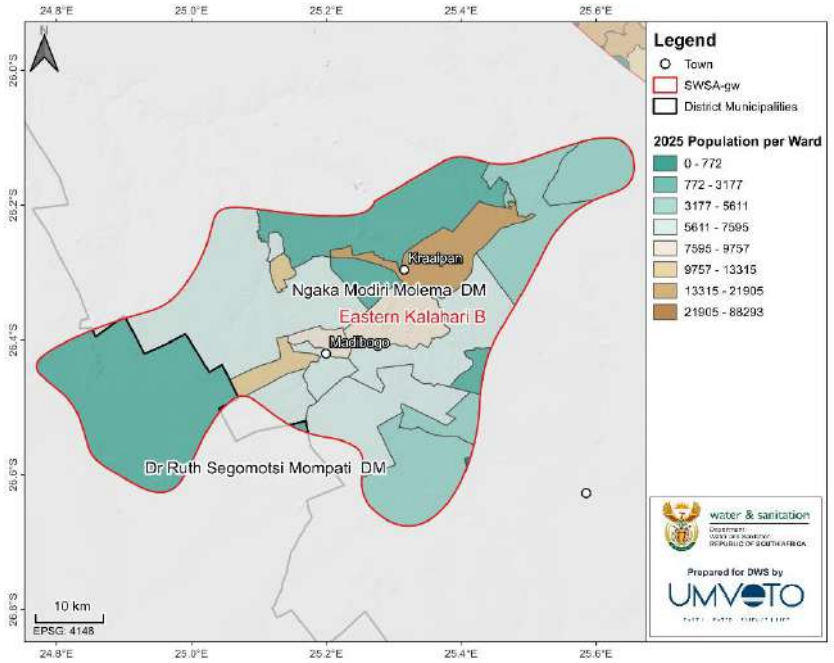
SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km²
Elevation:	1192 to 1420 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Eastern Kalahari B SWSA-gw is located within the Vaal-Orange Water Management Area (WMA, 2023). The groundwater resources within the Eastern Kalahari B SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	Ngaka Modiri Molema DM and Dr Ruth Segomotsi Mompati DM are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Eastern Kalahari B SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 2.43% per year, resulting in a projected population of approximately 117,485.

As shown in the map and table below, Ratlou LM Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 75,068, followed by Tswaing LM with 27,699. Population concentrations within the SWSA-gw are highest around Ratlou LM and the town of Kraaipan.



Projected population distribution in 2025 for the Eastern Kalahari B SWSA-gw.

SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km²
Elevation:	1192 to 1420 mamsl

Quantity & Quality

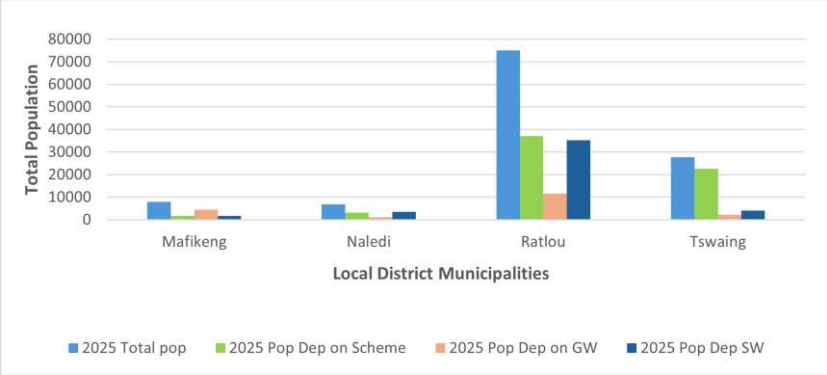
Socio Economic & Governance

In terms of water reliance within the Eastern Kalahari B SWSA-gw, an estimated 55.0% of the population depends on the regional water supply scheme, 38.1% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 16.6% on groundwater sources (including boreholes and springs).

Among the LMs, the Mafikeng LM has the highest proportion of groundwater reliance, with approximately 55.5% of its population depending on groundwater and 22.0% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Mafikeng	7953	1,655	4,417	1,752
Naledi	6765	3,094	1,227	3,504
Ratlou	75068	37,182	11,687	35,285
Tswaing	27699	22,670	2,192	4,180
Total	**117,485**	**64,601**	**19,523**	**44,722**



Projected population dependence on water sources in 2025.

SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km²
Elevation:	1192 to 1420 mamsl

Quantity & Quality

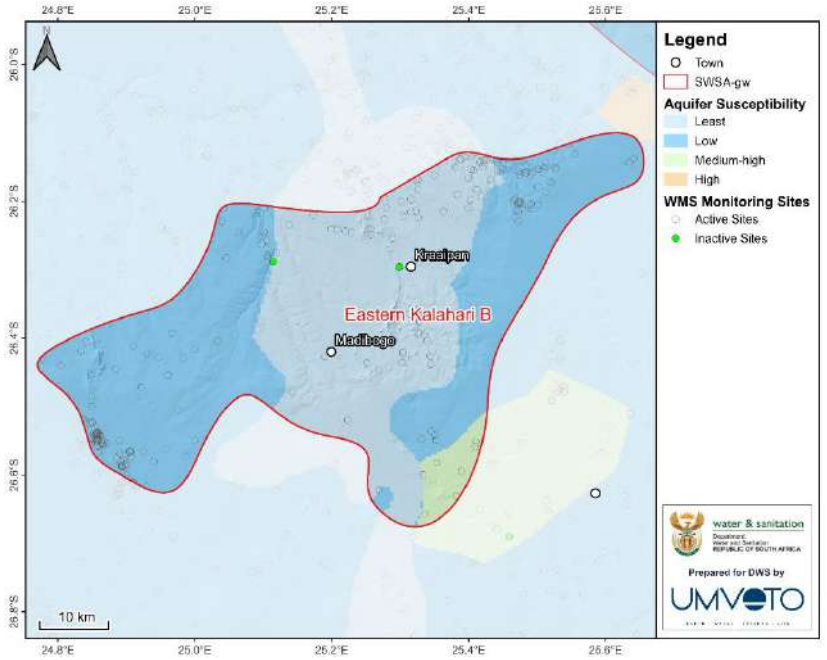
Groundwater Quality

The Eastern Kalahari B SWSA-gw consists of Minor and Poor aquifer systems, classified based on their yield and water quality. The Minor aquifer system is moderately productive and has variable water quality. (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 1276.97 km^2, which is 48.08% of the Eastern Kalahari B SWSA-gw total area. Urban/Built-up areas cover 169.07 km^2 (6.37%), while mines and quarries account for 1.38 km^2 (0.05%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Poor aquifer system covers the central part of the Eastern Kalahari B SWSA-gw, and the minor aquifer system covers the remaining eastern and western parts of the aquifer. WMS data is available for the least vulnerable aquifer areas in the Minor Aquifer System.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 29.9 - 161.4 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater but poses a concern if concentrations are too high or too low. The fluoride levels range from 0.20 - 0.73 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.60 - 10.12 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 7.23 - 8.70 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 1.5 - 86.13 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Eastern Kalahari B**
Area:	**2656 km²**
Elevation:	**1192 to 1420 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Eastern Kalahari B SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	1	7.69	13	72.74	mS/m	29.9 - 161.4 mS/m (Avg.: 72.74 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: 70 - 150 mS/m.	-
Fluoride	1	7.69	13	0.40	mg/L	0.20 - 0.73 mg/L (Avg.: 0.40 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: 0.5 - 1.5 mg/L.	-
Nitrate + Nitrite Nitrogen	1	7.69	13	3.46	mg/L	0.60 - 10.12 mg/L (Avg.: 3.46 mg/L). 2014-2024 GW Geosites: <11-20 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	2014-2024 GW Geosites: 11 - 20mg/L.	-
pH	1	7.69	13	8.17	pH unit	7.23 - 8.70 (Avg.: 8.17). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: 7-9.	-
Sulphate	1	7.69	13	27.05	mg/L	1.5 - 86.13 mg/L (Avg.: 27.05 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Eastern Kalahari B SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

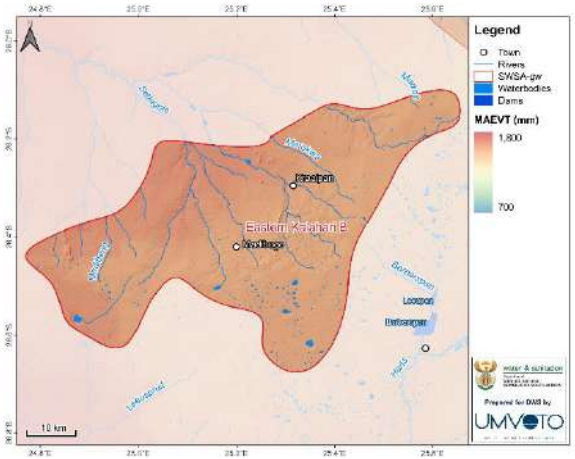
SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km²
Elevation:	1192 to 1420 mamsl

Threats & Risks

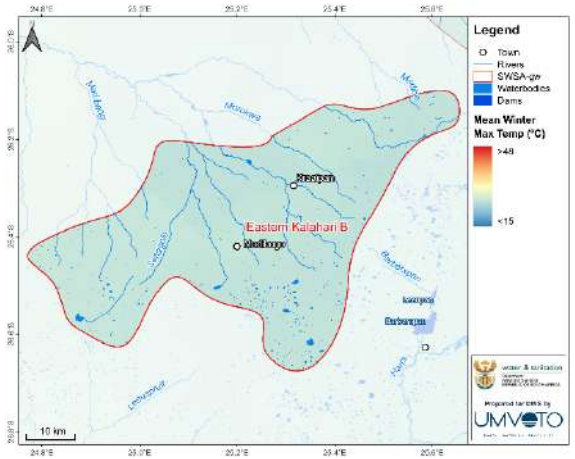
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Eastern Kalahari B SWSA-gw has a combination of BSh and BSk, semi-arid, type climate characterized by hot, dry summers and cold winters. Temperatures in the SWSA-gw range from -1.9 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

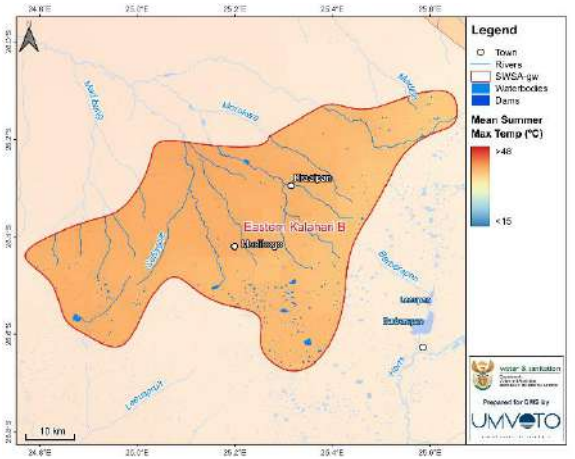
Temperature	Summer: 27 to 31 ºC, Winter: -1.9 to 2 °C
Evapotranspiration	Maximum value of 1659 mm/a with an average value of 1581 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, and a small increase in recharge (ranging from ~ 9.6 to 16.5 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Eastern Kalahari B SWSA-gw region.



Mean winter temperatures of the Eastern Kalahari B SWSA-gw region.



Mean summer temperatures of the Eastern Kalahari B SWSA-gw region.

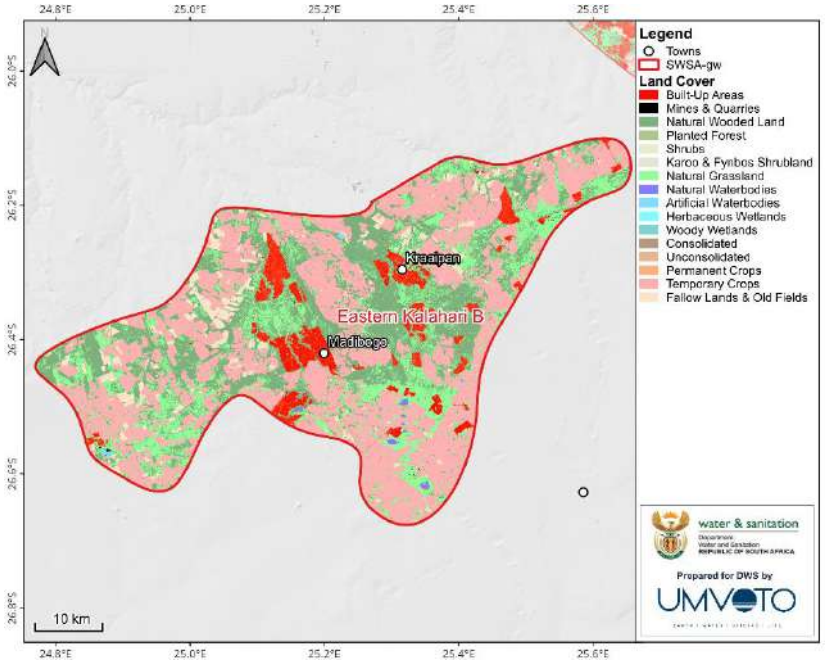
SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km^2
Elevation:	1192 to 1420 mamsl

Threats & Risks

Land Use

The Eastern Kalahari B SWSA-gw landscape is predominantly cultivated land, which includes temporary crops, permanent crops, fallow lands and old fields, covering 48.1% of the area (DFFE, 2022). Forested land, which contains natural wooded land and planted forests, and grassland, provide ecological value, making up 45% of the SWSA-gw land cover. Built-up areas, which include residential, commercial and residential areas, occupy a smaller portion concentrated to the towns of Madibogo and Kraaipan and an area just north of Madibogo. Waterbodies and wetlands are minimal, suggesting limited surface water availability. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, cover a small area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	6	0.2
Built-Up	169	6.4
Cultivated	1277	48.1
Forest Land	702	26.4
Grassland	491	18.5
Mines and quarries	1	0.1
Shrubland	1	0.03
Waterbodies	10	0.4
Wetlands	0	0.01



Land Cover 24-class map to show the types of land use and extent of each occurring in the Eastern Kalahari B SWSA-gw.

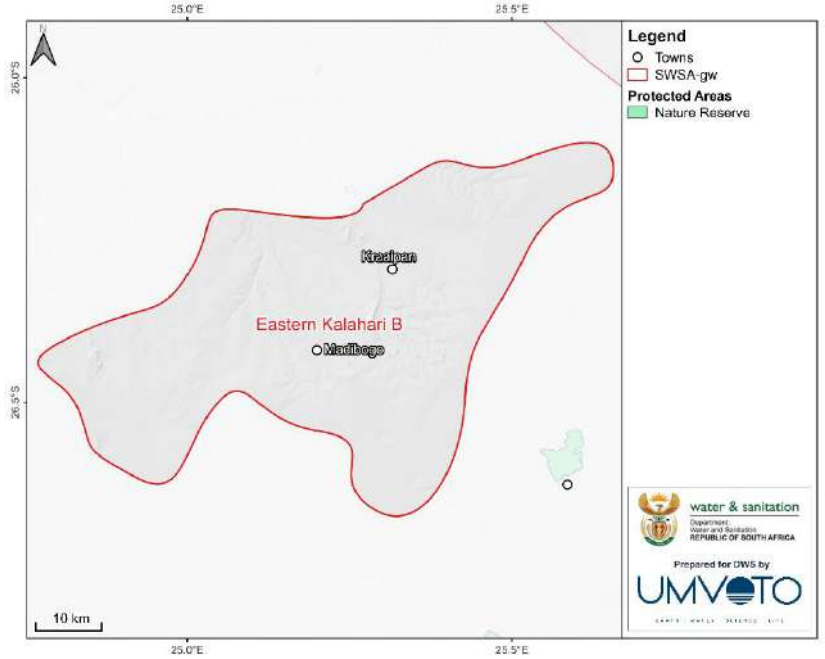
SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km^2
Elevation:	1192 to 1420 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Eastern Kalahari B SWSA-gw does not contain any conservation or protected areas.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	None		0
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Eastern Kalahari B SWSA-gw that have protection status.

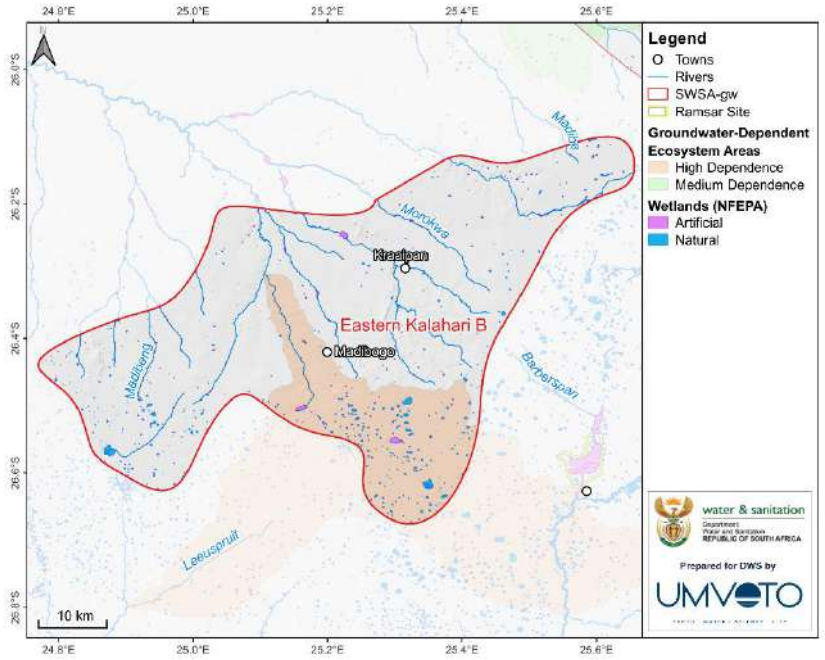
SWSA-gw Name:	Eastern Kalahari B
Area:	2656 km^2
Elevation:	1192 to 1420 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

Wetlands (CSIR, 2018) with vegetation that is potentially highly dependent on groundwater (DWA, 2010) are present within the Eastern Kalahari B SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	28	

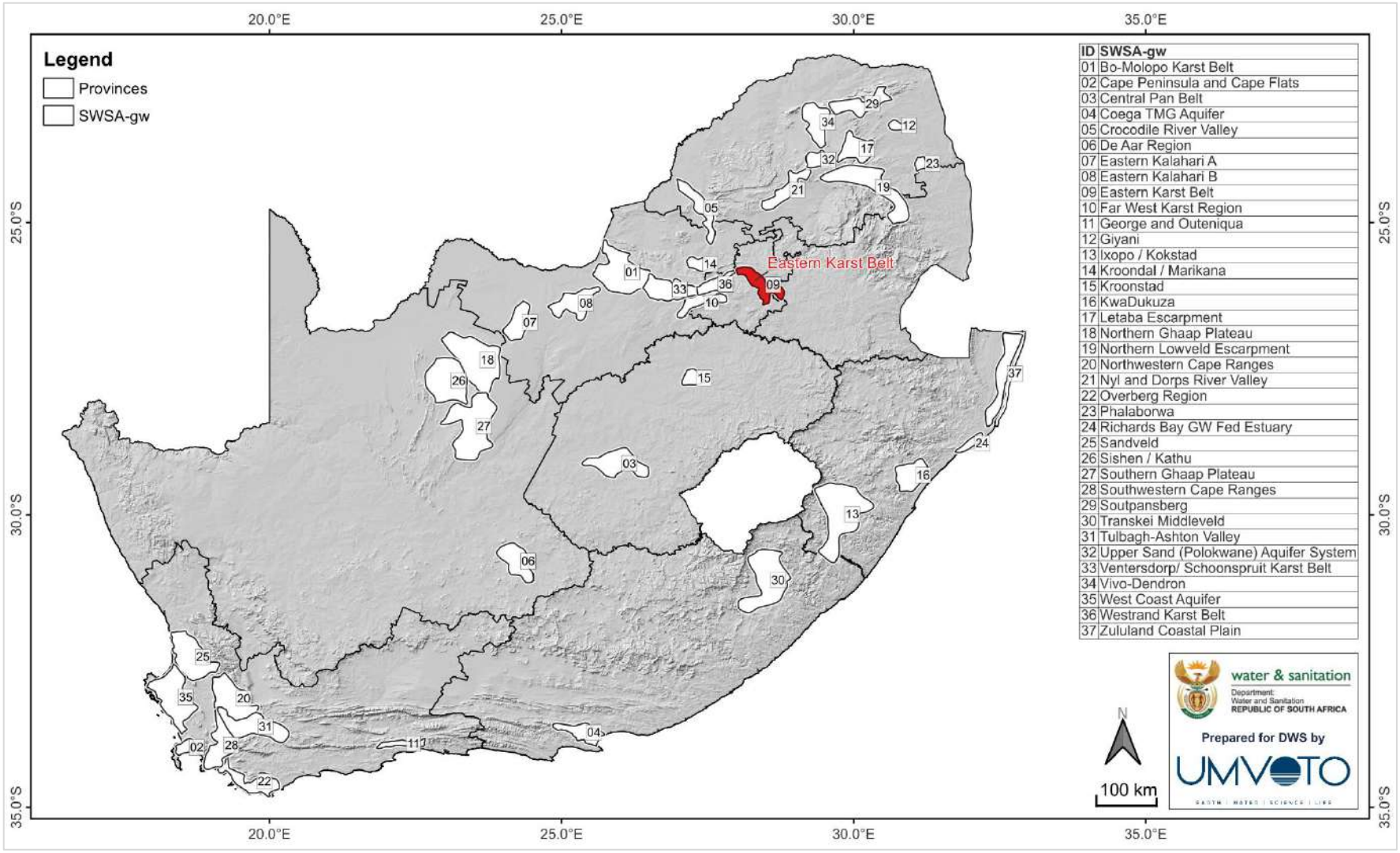


Map showing the major water bodies, Ramsar sites and GDEs in the Eastern Kalahari B SWSA-gw.

APPENDIX 09

EASTERN KARST BELT SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE EASTERN KARST BELT SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

9. Eastern Karst Belt

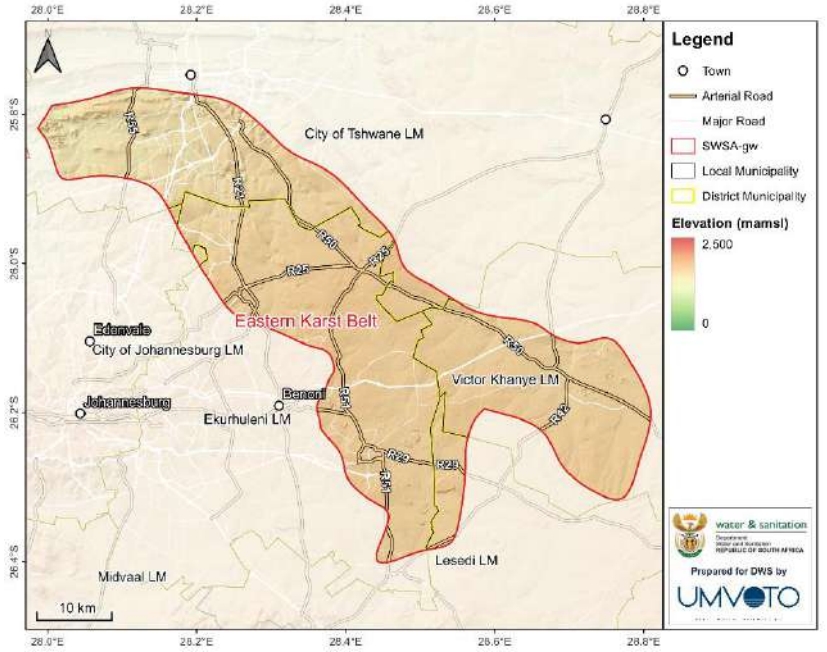
9.1. Description

SWSA-gw Name:	**Eastern Karst Belt**
Area:	**1984 km²**
Elevation:	**1280 to 1674 mamsl**
Geospatial Context	

The topography of the Eastern Karst Belt SWSA-gw, as depicted in the map, is characterised by a mix of elevated plateaus, rolling hills, and gently undulating terrain. The region lies along the Magaliesberg escarpment; the mountains to the north provide a dramatic elevation change in the surrounding landscape. Pretoria sits on a relatively high plateau, while areas to the southeast, such as Nigel and Delmas, feature more rugged topography with small ridges and valleys.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Gauteng and Mpumalanga
Metropolitan Municipality	City of Tshwane and Ekurhuleni
District Municipality	Sedibeng and Nkangala
Local Municipality	Victor Khanye and Lesedi
Towns	Brakpan, Centurion, Daveyton, Delmas, Etwatwa, Irene, Kempton Park, Midrand, Nigel, Pretoria, Pretoriusstad and Springs
Major Roads	R21, R50, R25, R562, R55 and R51
Major Water Supply Networks	



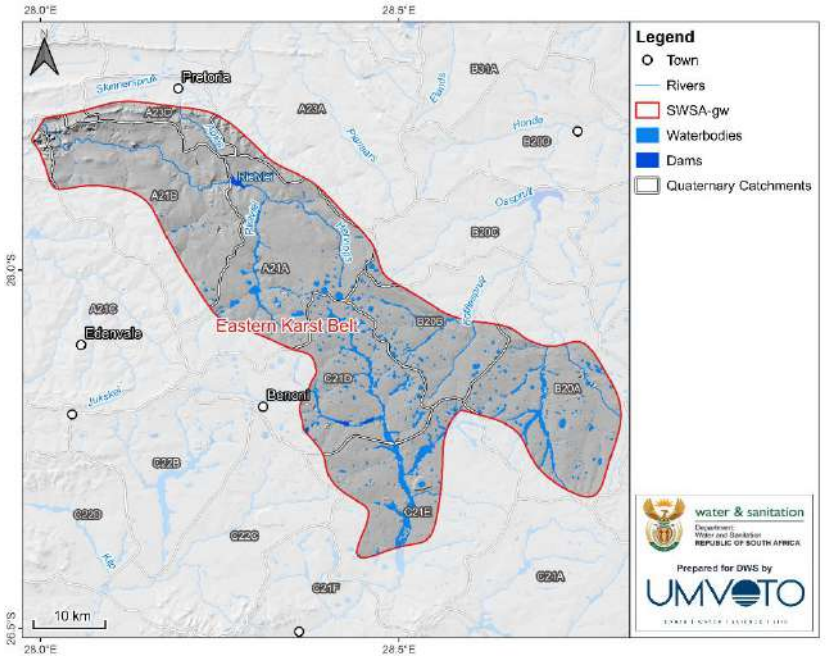
Locality map of Major Towns, District and Local Municipalities in the Eastern Karst Belt SWSA-gw.

SWSA-gw Name:	Eastern Karst Belt
Area:	1984 km²
Elevation:	1280 to 1674 mamsl

Hydrology and Drainage

The Eastern Karst Belt SWSA-gw and surrounding areas include major surface water systems, along with several unnamed seeps and floodplains, summarised below and displayed in the map on the right. The Rietvlei dam and Apies, Hennops, and Rietvlei rivers are fed by the A2 catchment and flow in an easterly direction. The Alexander, Cowles and Jan Smuts dams and Blesbokspruit river are fed by the C2 catchment and flow in a southeasterly direction. The Bronkhorstspruit, Koffiespruit and Moretele rivers are fed by the B2 catchment and flow north.

Quaternary Catchments	A21A, A21B, A23D, B20A, B20B, C21D, C21E and a small section of A21C, A21H, A23A, B20C
Rivers	Perennial: Apies, Bronkhorstspruit, Hennops, Koffiespruit, Moretele and Rietvlei
	Ephemeral: Blesbokspruit
Natural and manmade water bodies	
Major Dams:	Alexander, Cowles, Jan Smuts and Rietvlei
Water Management Areas:	Vaal Orange and Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Eastern Karst Belt SWSA-gw.

SWSA-gw Name:	Eastern Karst Belt
Area:	1984 km²
Elevation:	1280 to 1674 mamsl
Geology	

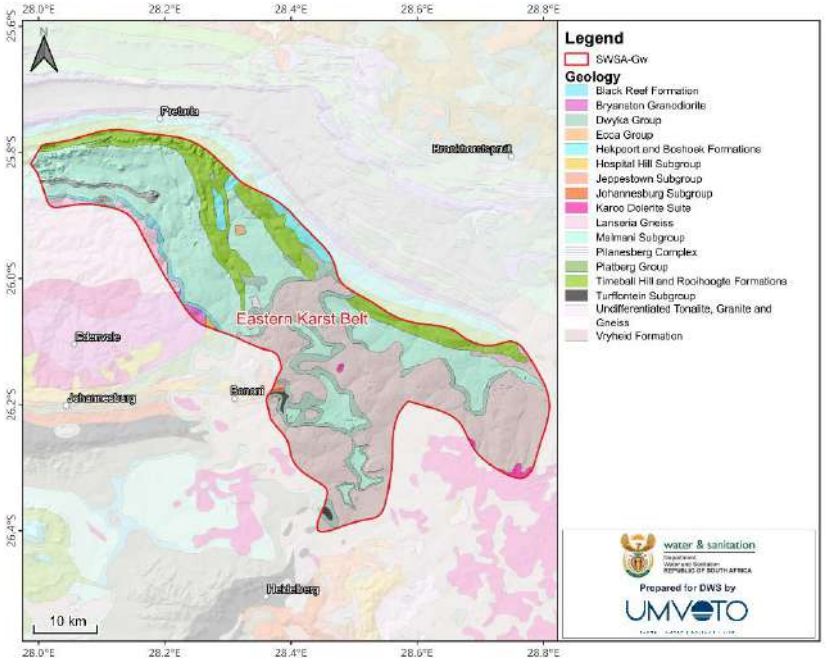
Geology

A dolerite dyke intrudes into the westernmost section of the area. In the southern section, the Ecca Group of the Karoo Supergroup consists of fine- to coarse-grained sandstone, shale, and coal seams. Small sections of the Dwyka Group of the Karoo Supergroup outcrop across the central section of the area.

The Chuniespoort Group of the Transvaal Supergroup outcrops in the northern section, as well as within the Karoo Supergroup in the east. It features dolomite, subordinate chert, minor carbonaceous shale, limestone, and quartzite. The Pretoria Group of the Transvaal Supergroup outcrops along the northeastern section of the study area.

Hydrostratigraphy

The Malmani Subgroup dolomites form a karst aquifer system with high permeability due to extensive dissolution and secondary fissures. The Ecca and Dwyka Groups of the Karoo Supergroup form a secondary, fractured aquifer system.



Geology Map of the Eastern Karst Belt SWSA-gw region.

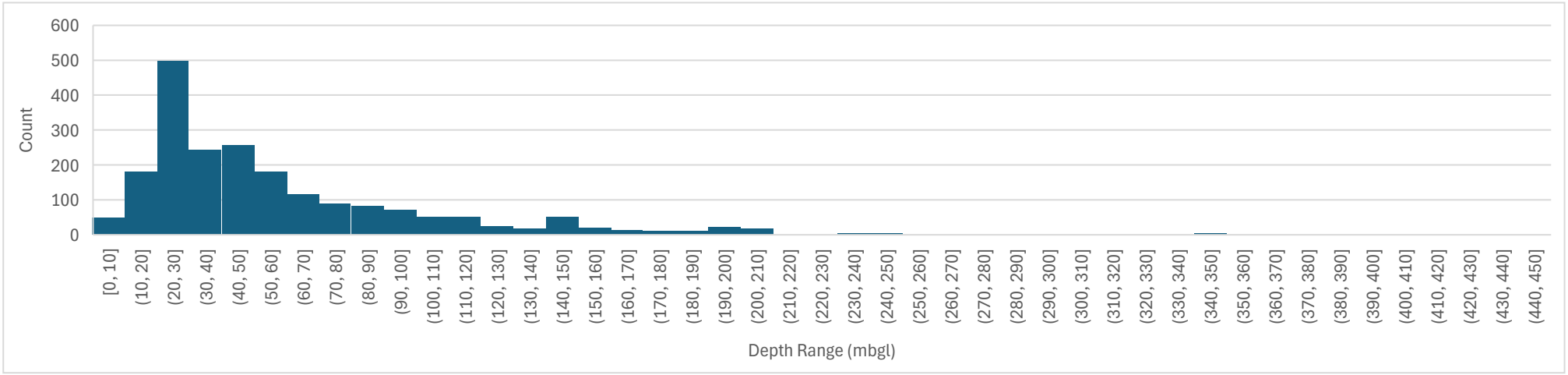
9.2. Current Status

SWSA-gw Name:	**Eastern Karst Belt**
Area:	**1984 km²**
Elevation:	**1280 to 1674 mamsl**
Quantity & Quality	
Aquifer Classification	

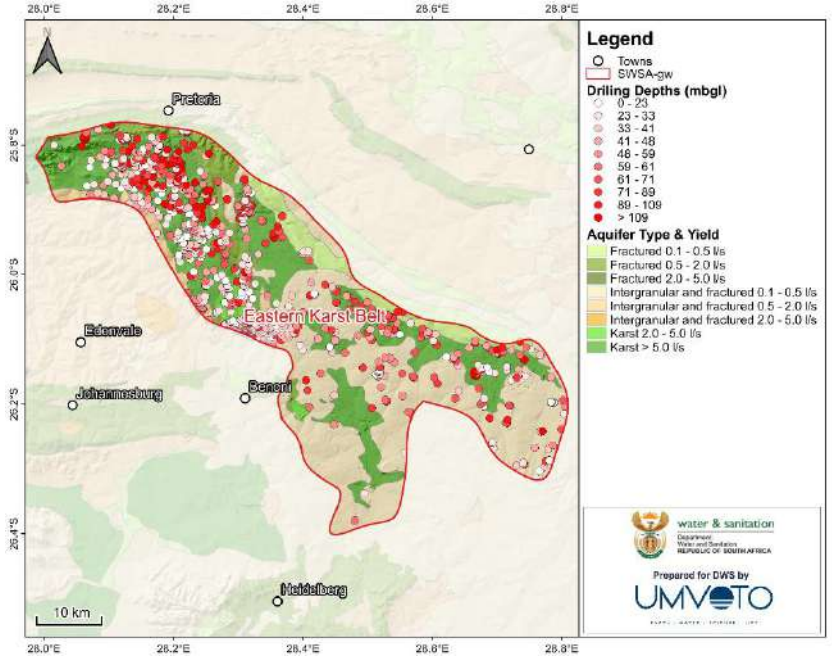
The aquifer systems within the Eastern Karst Belt SWSA-gw exhibit varying yields across karst and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw consists of a combination of major and minor aquifer systems. The major aquifer systems have an average karst yield ranging from 2.0 to over 5.0 l/s, while the minor aquifers have an average dual-porosity yield of 0.1 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 59 mbgl, and the most common depth is around 30 mbgl. The majority of the boreholes target the shallow karst aquifer. There is minimal deeper drilling (> 200) mbgl predominantly in the north, suggesting the targeting of the underlying fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 30 and 73 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 19 mbgl, with values ranging from 0 to 183 mbgl and a standard deviation of ~ 20 mbgl.

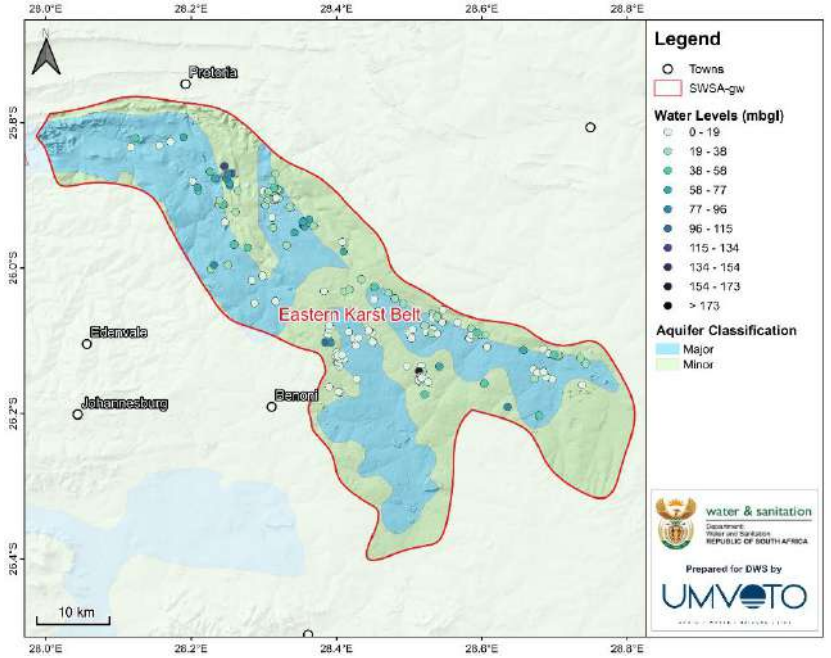
Graph of NGA drilling depths (after DWS, n.d.) of the Eastern Karst Belt SWSA-gw region



SWSA-gw Name:	Eastern Karst Belt
Area:	1984 km²
Elevation:	1280 to 1674 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Eastern Karst Belt SWSA-gw region.



Map of the Aquifer Type and Associated Yield and NGA water levels of the Eastern Karst Belt SWSA-gw region.

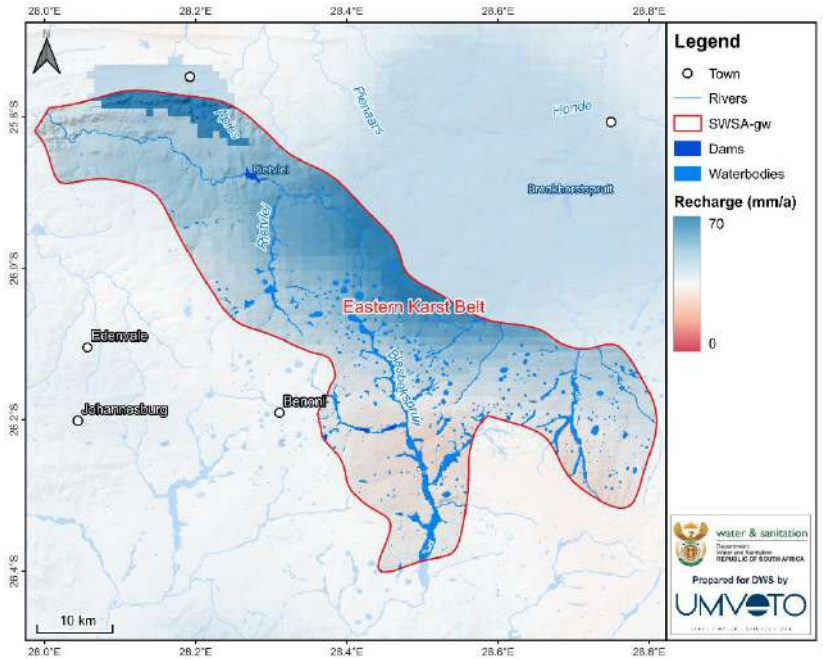
SWSA-gw Name:	**Eastern Karst Belt**
Area:	**1984 km²**
Elevation:	**1280 to 1674 mamsl**

Quantity & Quality

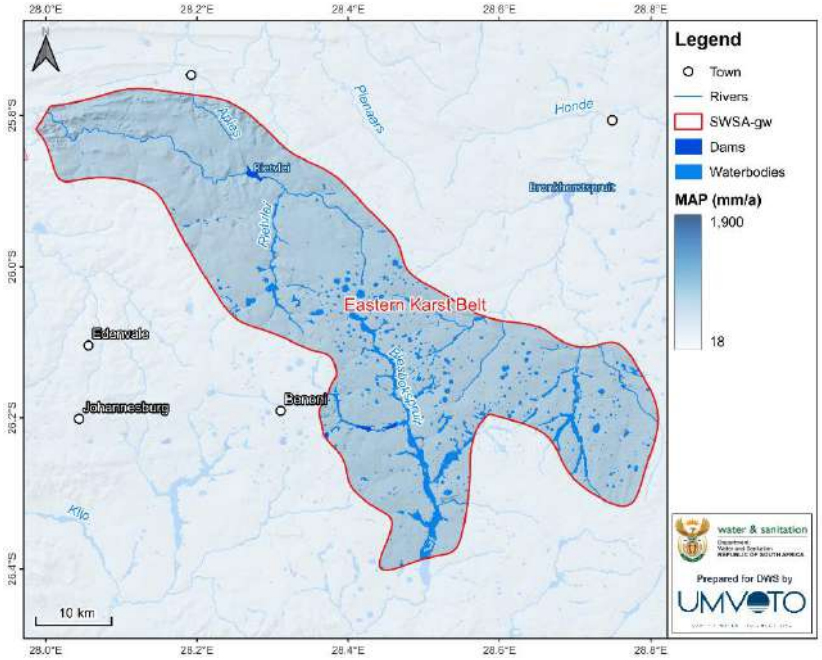
Groundwater Recharge

The Eastern Karst Belt receives a total MAP volume of 1314 Mm^3/a, with an average rainfall of 663 mm/a. However, only 95.6 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 7.3% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Eastern Karst Belt	1314	663	95.6	48.2	7.3%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Eastern Karst Belt
Area:	1984 km²
Elevation:	1280 to 1674 mamsl

Quantity & Quality

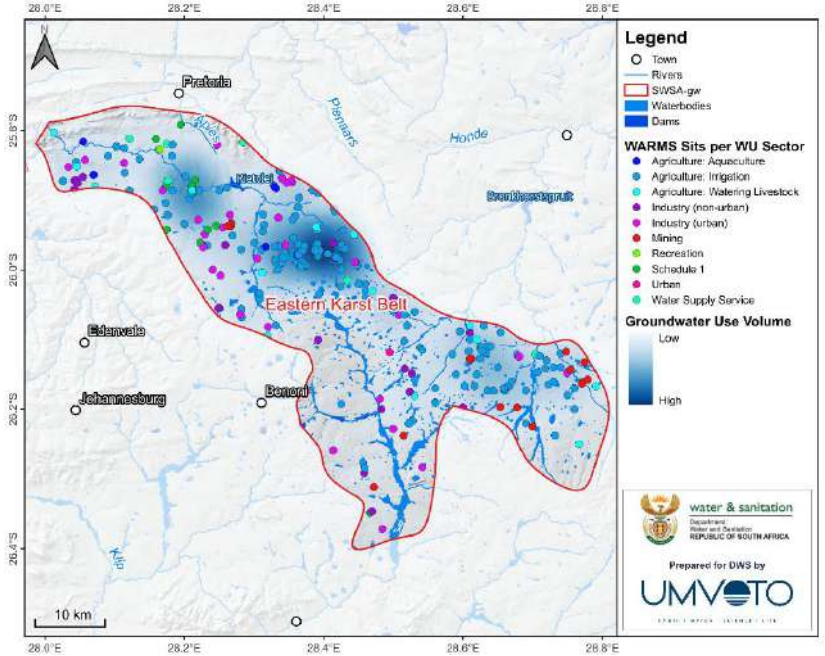
Groundwater Use

The Eastern Karst Belt SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Delmas (Conjunctive) and Centurion (Conjunctive), which rely significantly on groundwater resources for municipal supply, Schedule 1 use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 34.5 Mm^3/a to sustain crop production. Use is scattered around the entire region, but there are clusters in certain places, like Delmas, Irene and Centurion, as well as north of Etwatwa.
- Schedule 1 use follows, using 19.2 Mm^3/a, used by households for domestic use. This includes cooking and cleaning, which are important. This is particularly important in the north of the region around Irene and Centurion.
- Municipal water supply services, at 6.1 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. The use of municipal groundwater is primarily around the towns like Centurion, Delmas and Irene, This makes sense as the former two towns conjunctively depend on groundwater for water supply.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Irene and Delmas, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Aquaculture	0.2
	Agriculture: Irrigation	34.5
	Agriculture: Watering Livestock	0.6
	Industry (Non-urban)	0.4
	Industry (Urban)	4.7
	Mining	3.3
	Recreation	0.1
	Schedule 1	19.2
	Urban (excluding industrial/domestic)	0.02
	Water Supply Service	6.1
	Total	**69.2**



Water use map for the Eastern Karst Belt SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

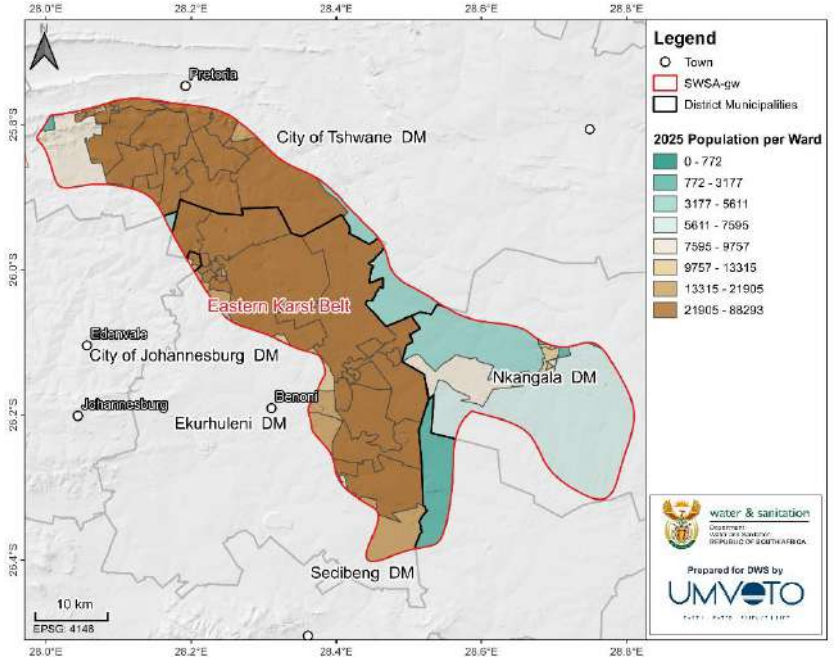
SWSA-gw Name:	Eastern Karst Belt
Area:	1984 km²
Elevation:	1280 to 1674 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Eastern Karst Belt SWSA-gw is located within both the Limpopo-Olifants Water Management Area (2023) and the Vaal-Orange WMA (WMA, 2023). The groundwater resources within the Bo-Molopo Karst Belt SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Limpopo-Olifants Catchment Management Agency (LOCMA) and Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. LOCMA and VOCMA are responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the LOCMA and VOCMA to manage water resources in the Limpopo-Olifants WMA and Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	LOCMA and VOCMA are the regional authorities responsible for water allocation, monitoring, and compliance in the Limpopo-Olifants WMA and Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities and metropolitan municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction. Rand Water is the WSP for the City of Tshwane, Ekurhuleni and Sedibeng.

The 2025 estimated population within the Eastern Karst Belt SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 1.66% per year, resulting in a projected population of approximately 1,822,105.

As shown in the map and table below, Ekurhuleni Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 1,058,814, followed by the City of Tshwane (624,598). Population concentrations within the SWSA-gw are highest around the Ekurhuleni and City of Tshwane LMs.



Projected population distribution in 2025 for the Eastern Karst Belt SWSA-gw.

SWSA-gw Name:	Eastern Karst Belt
Area:	1984 km²
Elevation:	1280 to 1674 mamsl

Quantity & Quality

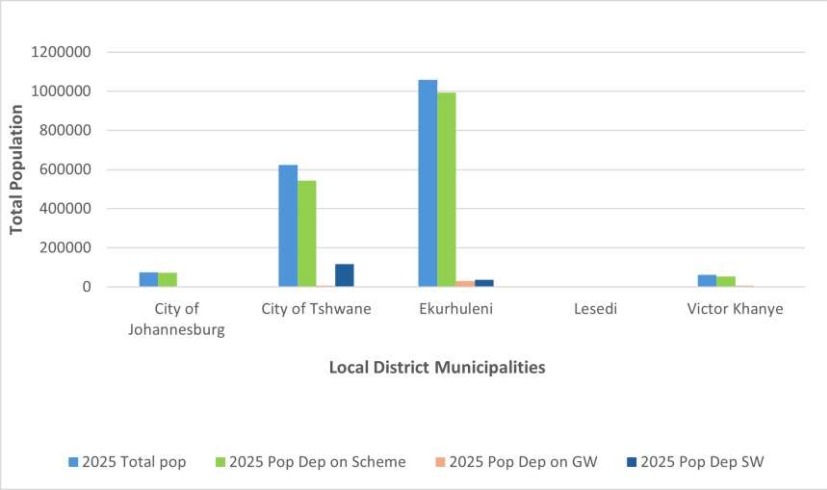
Socio Economic & Governance

In terms of water reliance within the Eastern Karst Belt SWSA-gw, an estimated 91.2% of the population depends on the regional water supply scheme, 8.7% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 2.6% on groundwater sources (including boreholes and springs),

Among the LMs, the Victor Khanye LM has the highest proportion of groundwater reliance, with approximately 11.9% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
City of Johannesburg	74,339.23	71,534	1,012	1,731
City of Tshwane	624,597.77	542,749	7,840	116,782
Ekurhuleni	1,058,814.25	993,745	30,253	35,885
Lesedi	1,659.30	1,172	151	43
Victor Khanye	62,694.38	53,288	7,449	3,243
Total	**1,822,105**	**1,662,487**	**46,705**	**157,685**



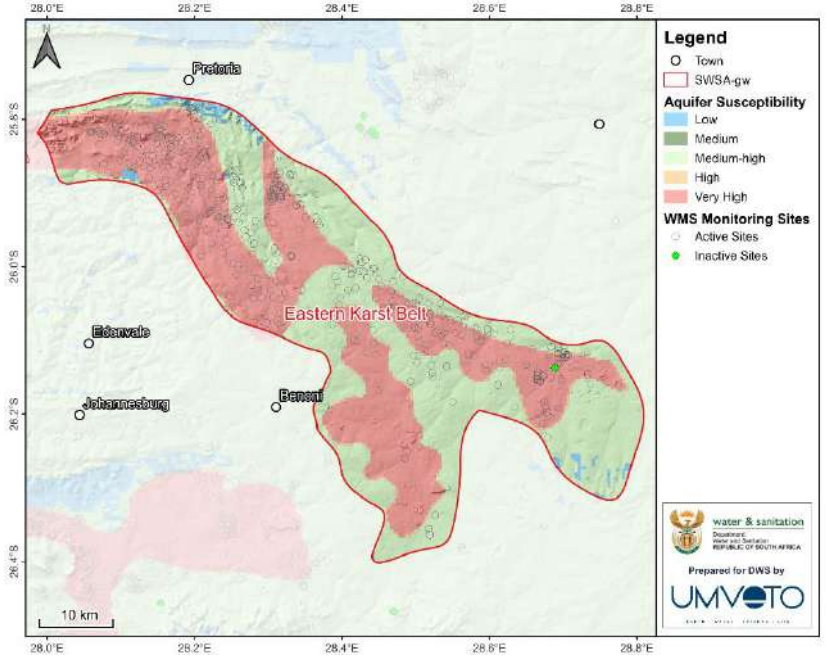
Projected population dependence on water sources in 2025.

SWSA-gw Name:	Eastern Karst Belt
Area:	1984 km²
Elevation:	1280 to 1674 mamsl
Quantity & Quality	
Groundwater Quality	

The Eastern Karst Belt SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 696.22 km^2, which is 35.09% of the Eastern Karst Belt SWSA-gw total area. Urban/Built-up areas cover 465.21 km^2 (23.45%), while mines and quarries account for 54.75 km^2 (2.76%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC is 30.6 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride concentration is 0.17 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations are 0.37 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH is 8.10 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. The sulphate concentration is 11.06 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Eastern Karst Belt**
Area:	**1984 km²**
Elevation:	**1280 to 1674 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Eastern Karst Belt SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	1	1.96	51	30.60	mS/m	2014-2024 GW Geosites: <70 mS/m.	2014-2024 GW Geosites: <70 - 150 mS/m.	30.6 mS/m. 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024), except for values above the upper limit.
Fluoride	1	2.00	50	0.17	mg/L	2014-2024 GW Geosites: <0.5 mg/L.	2014-2024 GW Geosites: <0.5 mg/L.	0.17 mg/L. 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	1	1.96	51	0.37	mg/L	2014-2024 GW Geosites: <11 mg/L.	2014-2024 GW Geosites: <11 mg/L.	0.37 mg/L. 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	1	1.96	51	8.10	pH unit	2014-2024 GW Geosites: 7-9.	2014-2024 GW Geosites: 7-9.	8.10. 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	1	1.96	51	11.06	mg/L	2014-2024 GW Geosites: <200 - 500 mg/L.	2014-2024 GW Geosites: <200 - 500 mg/L.	11.06 mg/L. 2014-2024 GW Geosites: <200 - 500 mg/L. Mostly consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the Eastern Karst Belt SWSA-gw, taken from the WMS database from 2000-2024.*

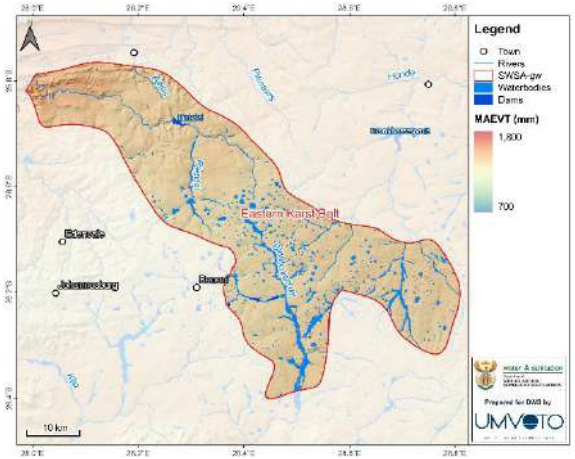
SWSA-gw Name:	**Eastern Karst Belt**
Area:	**1984 km²**
Elevation:	**1280 to 1674 mamsl**

Threats & Risks

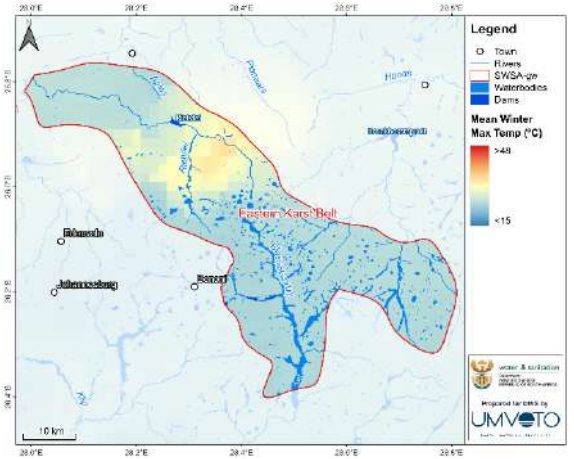
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Eastern Karst Belt SWSA-gw has a Cwb, a subtropical highland-type climate characterized by warm summers and cold, dry winters. Temperatures in the SWSA-gw range from -1.9 – 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

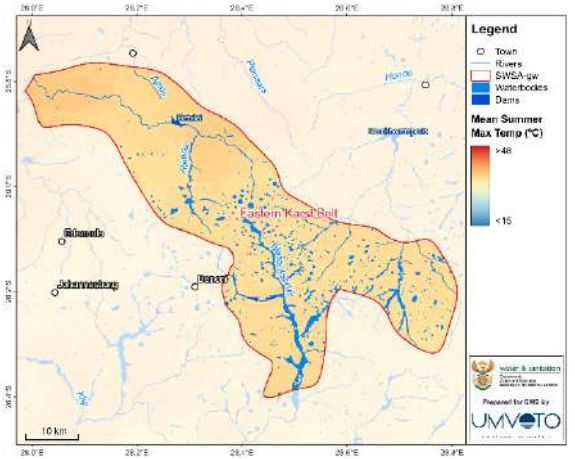
Temperature	Summer: 24.7 to 29.2 ºC, Winter: -1.9 to 4 °C
Evapotranspiration	Maximum value of 1533 mm/a with an average value of 1392 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, and an increase in recharge (ranging from ~ 13.2 to 19.9 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Eastern Karst Belt SWSA-gw region.



Mean winter temperatures of the Eastern Karst Belt SWSA-gw region.



Mean summer temperatures of the Eastern Karst Belt SWSA-gw region.

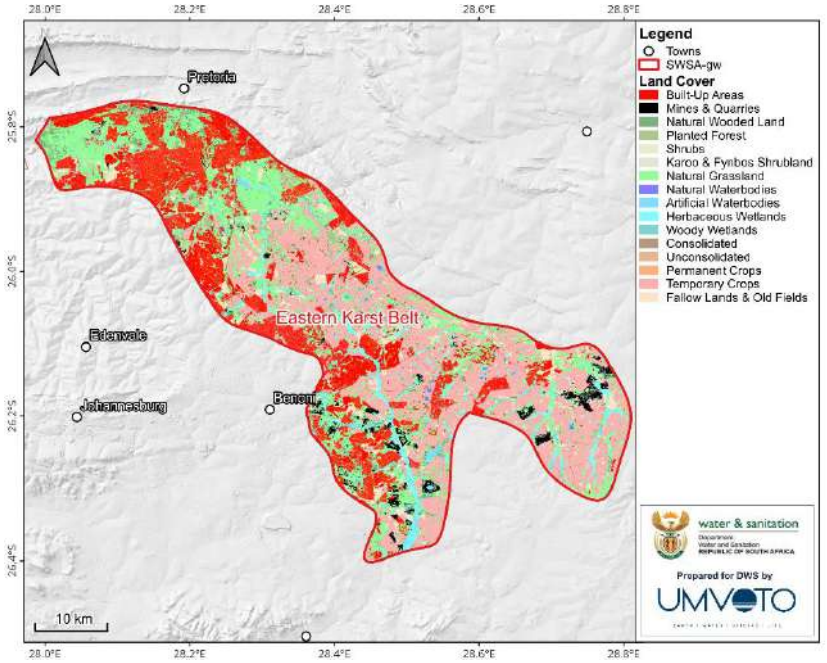
SWSA-gw Name:	Eastern Karst Belt
Area:	1984 km^2
Elevation:	1280 to 1674 mamsl

Threats & Risks

Land Use

The Eastern Karst Belt SWSA-gw is primarily cultivated land, which consists of temporary and permanent crops, covering 35% of the area (DFFE, 2022). Grassland and forested land, which consists of natural wooded land and planted forests, make up 8.2% of the SWSA-gw and provide important ecological functions, while built-up areas, which consist of residential, commercial and industrial areas, which are concentrated to the northwestern and southern portions, indicate significant urban expansion. Wetlands and waterbodies make up 6% of the SWSA-gw and play a crucial role in the region's hydrology. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 2.8% of the area, located predominantly in the south of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	9	0.5
Built-Up	465	23.4
Cultivated	696	35.1
Forest Land	163	8.2
Grassland	470	23.7
Mines and quarries	55	2.8
Shrubland	4	0.2
Waterbodies	30	1.5
Wetlands	92	4.6



Land Cover 24-class map to show the types of land use and extent of each occurring in the Eastern Karst Belt SWSA-gw.

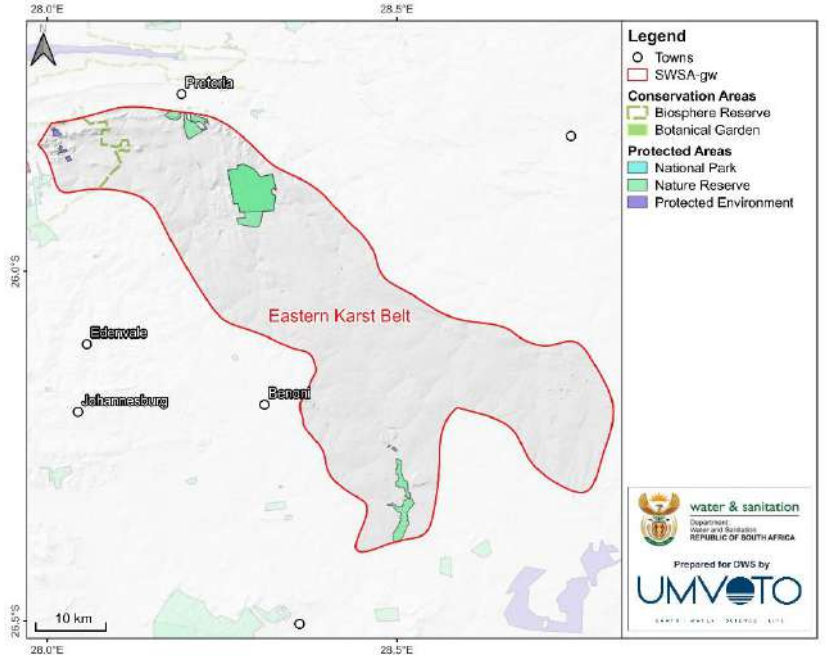
SWSA-gw Name:	Eastern Karst Belt
Area:	1984 km²
Elevation:	1280 to 1674 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Eastern Karst Belt SWSA-gw features a notable conservation area (DFFE, 2024), the Magaliesberg Biosphere Reserve, covering 98.26 km² and serving as a key ecological and cultural asset. In addition, six protected areas (DFFE, 2024)—including Marievale, Van Riebeeck, Groenkloof, Voortrekker Monument, Klapperkop Nature Reserves, and the Crocodile River Reserve Protected Environment—together span 111.05 km², underscoring targeted efforts to safeguard natural heritage. There are no designated SGWCA or national parks.

Protection Status	Names	Area (km²)	Count
Conservation Areas	• Magaliesberg Biosphere Reserve	98.26	1
Protected Areas	• Marievale Nature Reserve • Van Riebeeck Nature Reserve • Groenkloof Nature Reserve • Voortrekker Monument Nature Reserve • Klapperkop Nature Reserve • Crocodile River Reserve Protected Environment	111.05	6
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Eastern Karst Belt SWSA-gw that have protection status.

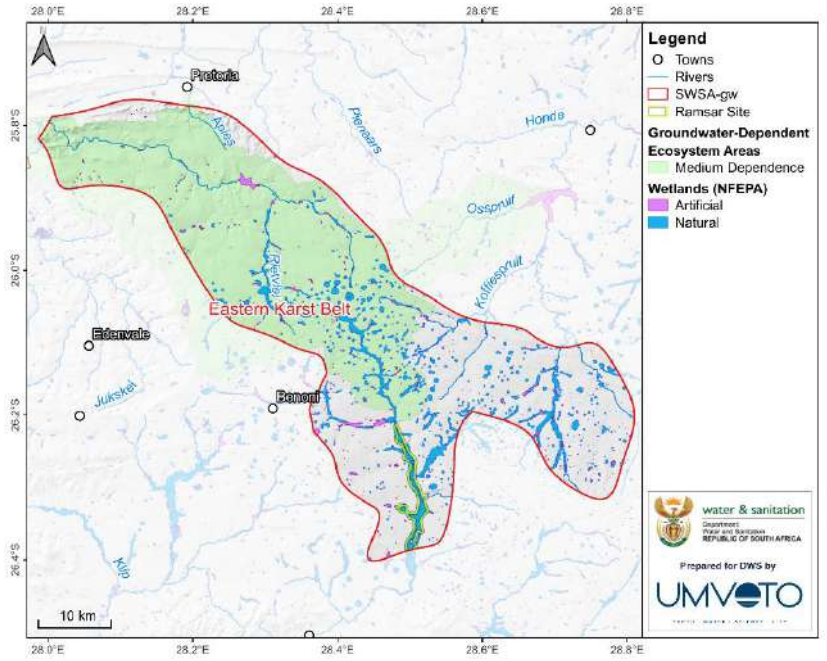
SWSA-gw Name:	Eastern Karst Belt
Area:	1984 km^2
Elevation:	1280 to 1674 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Eastern Karst Belt SWSA-gw has wetlands (CSIR, 2018) that are potentially groundwater-dependent ecosystems (DWA, 2010). The SWSA-gw also has many depressions and floodplain wetlands (CSIR, 2011), one of which includes the Blesbokspruit, a Ramsar-protected wetland (DFFE, 2024). There are also small dams (DWS, 2011) located within the SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Cowles Dam • Alexander Dam • Rietvlei Dam • Jan Smuts Dam	4.05	4
Ramsar Sites	• Blesbokspruit	18.85	1
Wetlands	Various natural, artificial and estuary wetlands	136	

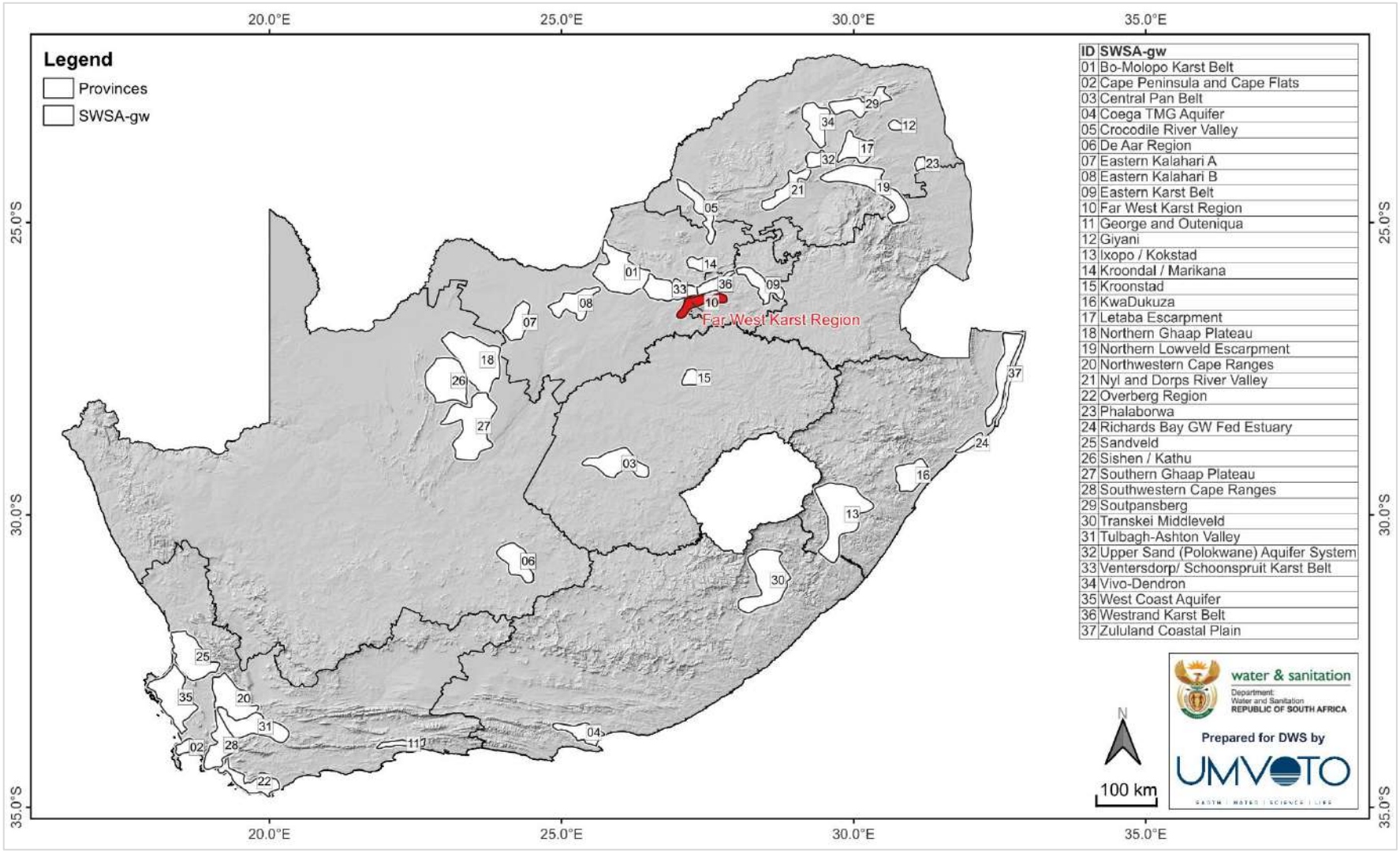


Map showing the major water bodies, Ramsar sites and GDEs in the Eastern Karst Belt SWSA-gw.

APPENDIX 10

FAR WEST KARST REGION SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE FAR WEST KARST REGION SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

10. Far West Karst Region

10.1. Description

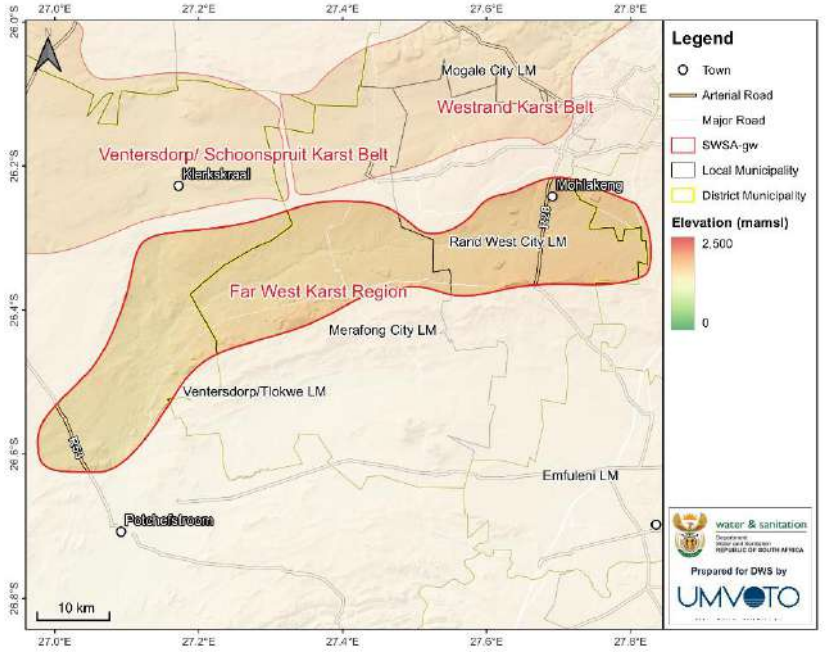
SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360-1761 mamsl

Geospatial Context

The topography of the Far West Karst Region SWSA-gw, as depicted in the map, is characterized by a gently undulating Highveld landscape. The terrain consists mainly of rolling plains, low hills, and broad valleys, with occasional rocky outcrops and ridges associated with geological formations such as the Witwatersrand Supergroup. The area around Carletonville is heavily influenced by gold mining activity, with large mine dumps, sinkholes, and subsidence areas due to extensive underground mining operations.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	North West and Gauteng
Metropolitan Municipality	City of Johannesburg
District Municipality	Dr Kenneth Kaunda and West Rand
Local Municipality	Ventersdorp/Tlokwe, Merafong City and Rand West City
Towns	Carletonville and Lenasia
Major Roads	N2, R28, R501 and R53
Major Water Supply Networks	



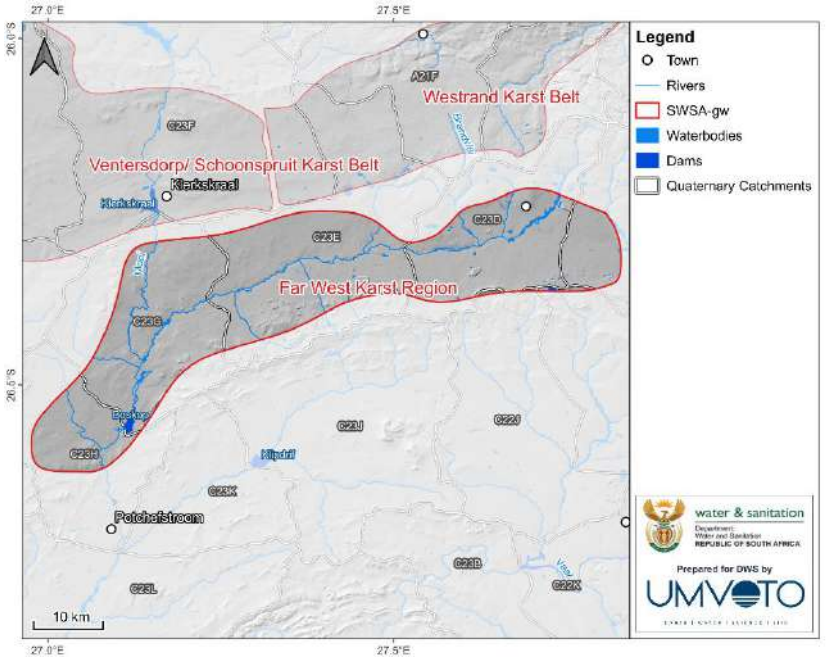
Locality map of Major Towns, District and Local Municipalities in the Far West Karst Region SWSA-gw.

SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360-1761 mamsl

Hydrology and Drainage

The Far West Karst Region SWSA-gw and surrounding areas include major surface water systems, summarised below and displayed in the map on the right. Boskop and Peter Wright reservoirs and several perennial rivers, flowing in the southwesterly and south direction, are fed by the C2 catchment.

Quaternary Catchments	C22A, C23D, C23E, C23G, C23H and a small section of C22H and C22J
Rivers	Perennial: Klip, Mooi, Mooirivierloop, Rietfonteinspruit, Wonderfonteinspruit
	Ephemeral: Middelvleispruit
Natural and manmade water bodies	
Major Dams:	Boskop and Peter Wright
Water Management Areas:	Vaal Orange



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Far West Karst Region SWSA-gw.

SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360-1761 mamsl
Geology	

Geology

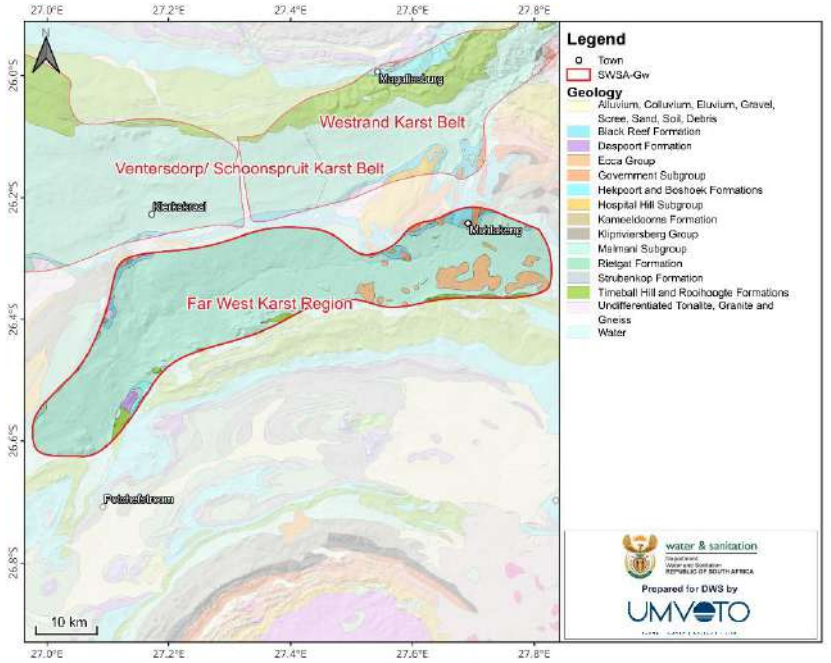
Minor outcroppings of Quaternary river sand and alluvium are found on the western side of the Far West Karst Region.

Outcroppings of the Ecca Group of the Karoo Supergroup occur in the eastern section of the area and are characterised by shale with sandstone-rich units and coal seams, primarily located towards the basin margins in the south, west, and northeast.

The Chuniespoort Group of the Transvaal Supergroup dominates the region, comprising dolomite, subordinate chert, minor carbonaceous shale, limestone, and quartzite. The Pretoria Group outcrops along the southern border of the area, consisting of multiple formations that include andesitic lava, pyroclastic rocks, quartzite, shale, conglomerate, mudrock, and siltstone.

Hydrostratigraphy

The aquifers in this region are primarily karstic, with significant secondary permeability due to dissolution and fracturing. The Pretoria Group, comprising various volcanic and sedimentary rocks, contributes to fractured aquifer systems, with groundwater stored and transmitted through fractures and bedding planes.



Geology Map of the Far West Karst Region SWSA-gw region.

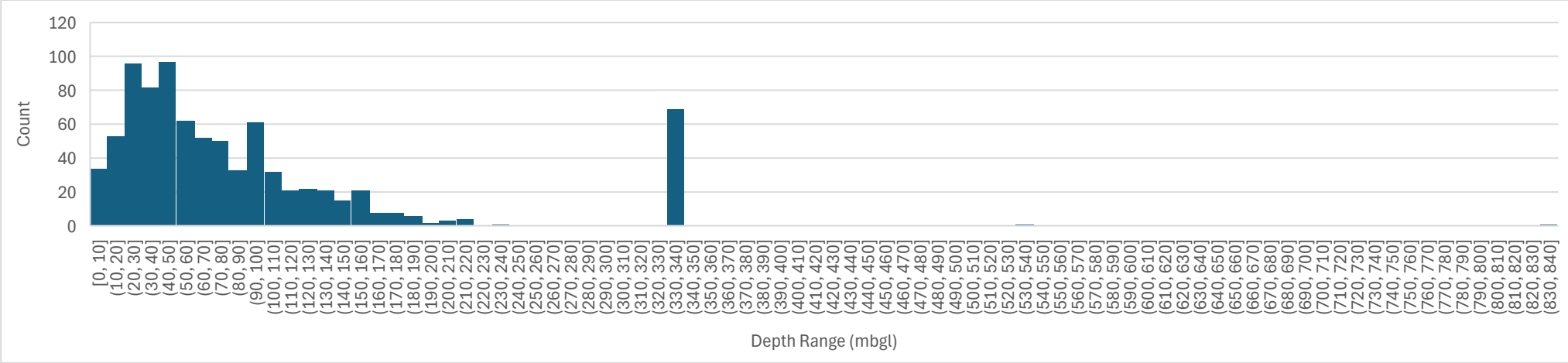
10.2. Current Status

SWSA-gw Name:	**Far West Karst Region**
Area:	**1382 km²**
Elevation:	**1360-1761 mamsl**
Quantity & Quality	
Aquifer Classification	

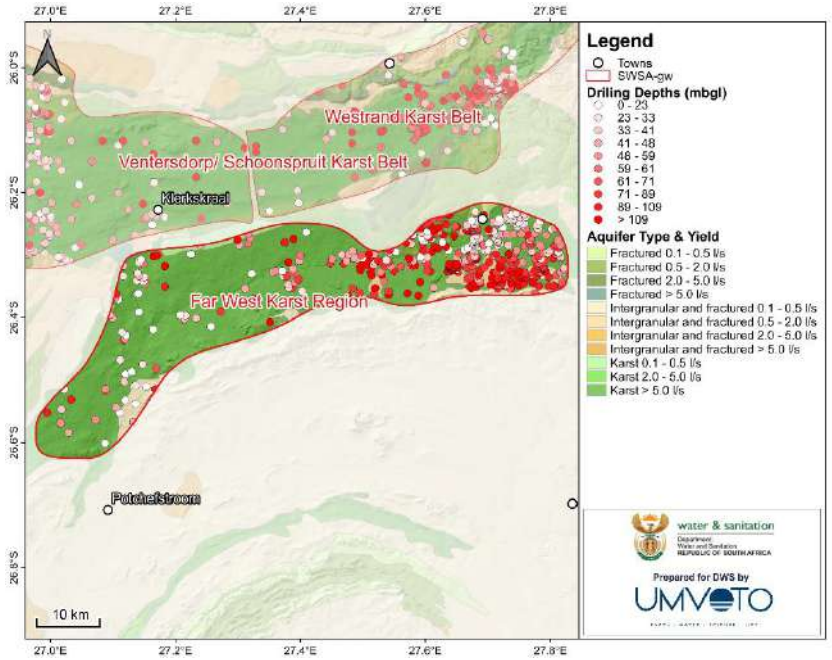
The aquifer systems within the Far West Karst Region SWSA-gw exhibit varying yields across karst and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is predominantly a major aquifer system, with some minor aquifer systems along the edges. The major aquifer systems have an average karst yield of over 5.0 l/s and a dual-porosity yield ranging from 0.5 to 2.0 l/s. The minor aquifer system has an average dual-porosity yield between 0.1 to 0.5 l/s.
Groundwater Targets	The average drilling depth is 90 mbgl and the most common depths are between 30 to 50 mbgl, suggesting mixed targets. The majority of the boreholes target the high-yielding karst aquifer, and deeper boreholes (> 200 mbgl) likely access the fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 34 and 107 mbgl. Based on the past 25 years of NGA water level data, the average groundwater level in the region is ~30 mbgl, with values ranging from 3 to 160 mbgl and a standard deviation of ~ 21 mbgl.

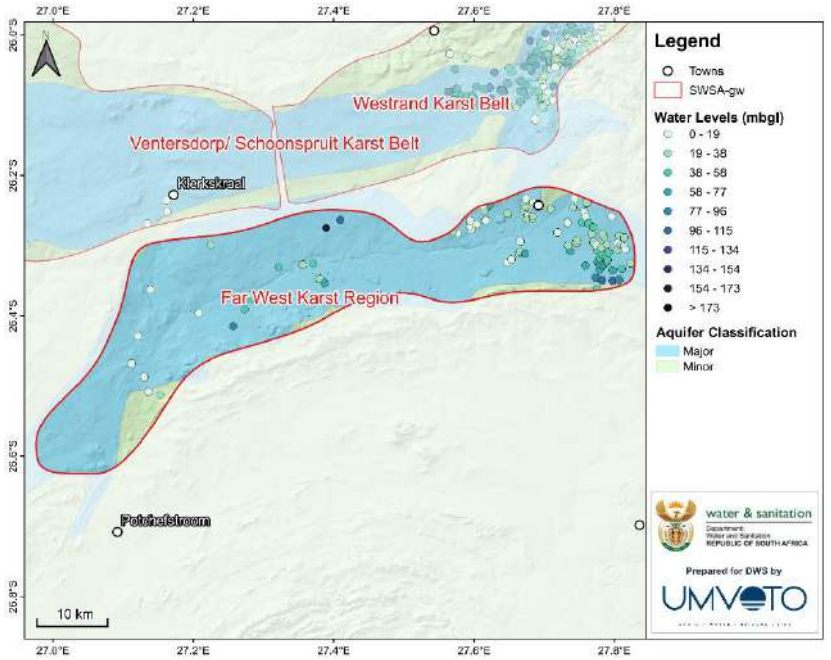
Graph of NGA drilling depths of the Far West Karst Region SWSA-gw region



SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360-1761 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Far West Karst Region SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Far West Karst Region SWSA-gw region.

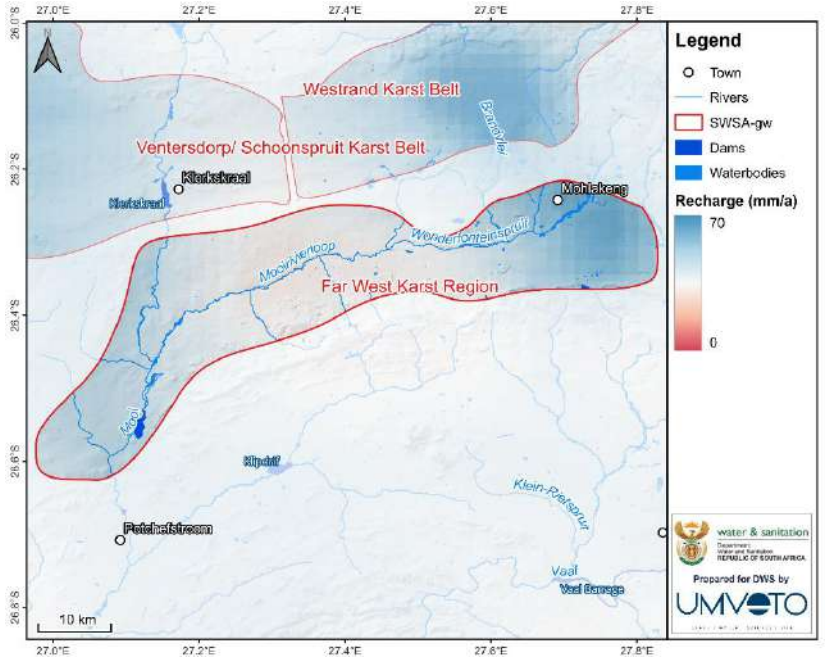
SWSA-gw Name:	**Far West Karst Region**
Area:	**1382 km^2**
Elevation:	**1360-1761 mamsl**

Quantity & Quality

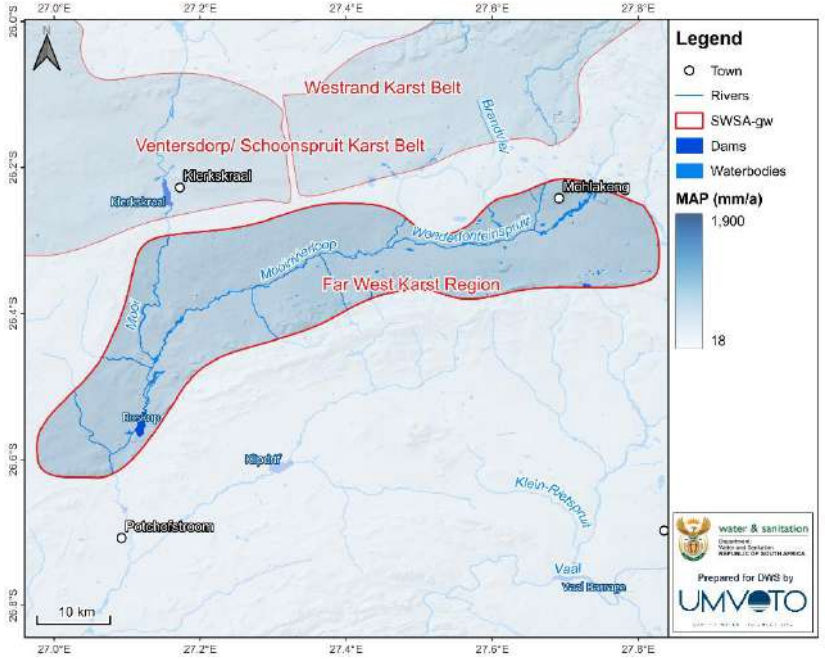
Groundwater Recharge

The Far West Karst Region receives a total MAP volume of 852 Mm^3/a, with an average rainfall of 618 mm/a. However, only 58.5 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 6.9% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Far West Karst Region	852	618	58.5	42.5	6.9%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

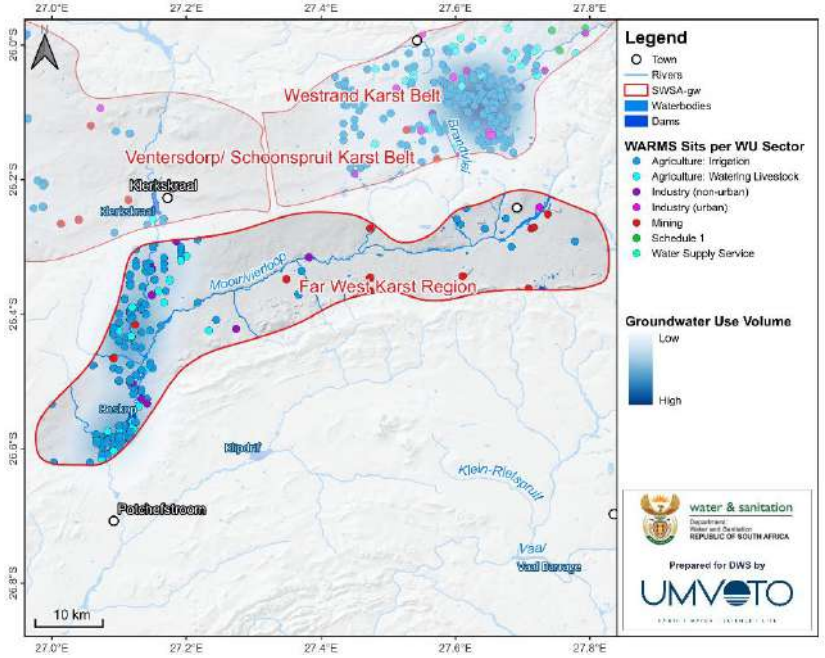
SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360-1761 mamsl
Quantity & Quality	
Groundwater Use	

The Far West Karst Region SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Carletonville (Conjunctive), who rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Mining use has 71.7 Mm^3/a allocated. This is significantly more than the other use types. Water is a vital resource in the mining process. Despite the large proportion of groundwater used for mining, there are relatively few areas where it is used. This indicates that a few mines are using the majority of the groundwater for their activities. This is primarily near Carletonville and in the west.
- Agricultural irrigation use is the largest, with 5.2 Mm^3/a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. Like mining, irrigation is scattered throughout the area. However, there is a higher concentration of irrigation on the west of the map.
- Non-Urban industrial follows, using 0.1 Mm^3/a, for manufacturing, processing, and other industrial activities outside urban centres. The non-urban industrial areas are on the western parts of the region.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Carletonville, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	5.2
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	0.1
	Industry (Urban)	0.1
	Mining	71.7
	Total	**77**



Water use map for the Far West Karst Region SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

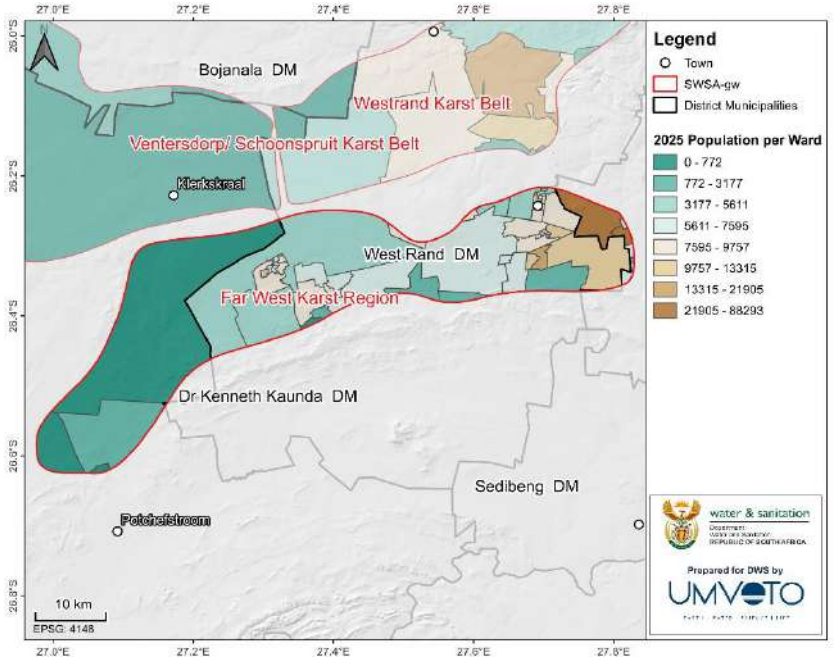
SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360-1761 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Far West Karst Region SWSA-gw is located within the Vaal-Orange Water Management Area (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities as well as the City of Johannesburg Metro are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction, with Rand Water being the Bulk Water Service Provider for Johannesburg and West Rand DM..

The estimated 2025 population within the Far West Karst Region SWSA-gw was calculated using Census 2011 2011 and 2022 data to determine a population growth rate of 0.04% per year, resulting in a projected population of approximately 368,145.

As shown in the map and table below, Rand West City Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 178,752, followed by Merafong City LM with 106,819. Population concentrations within the SWSA-gw are highest in the City of Johannesburg and Rand West City LMs.



Projected population distribution in 2025 for the Far West Karst Region SWSA-gw.

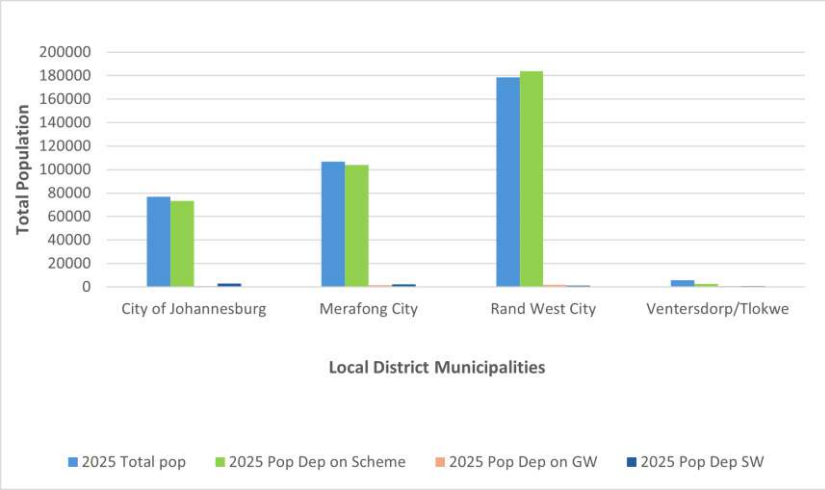
SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360-1761 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Far West Karst Region SWSA-gw, an estimated 98.9% of the population depends on the regional water supply scheme, 2.0% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 1.3% on groundwater sources (including boreholes and springs).

Among the LMs, the Ventersdorp/Tlokwe LM has the highest proportion of groundwater reliance, with approximately 13.8% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
City of Johannesburg	76,841	73,470	696	3,038
Merafong City	106,819	103,792	1,381	2,239
Rand West City	178,752	183,981	2,026	1,249
Ventersdorp/Tlokwe	5,733	2,696	792	840
Total	**368,145**	**363,938**	**4,896**	**7,367**



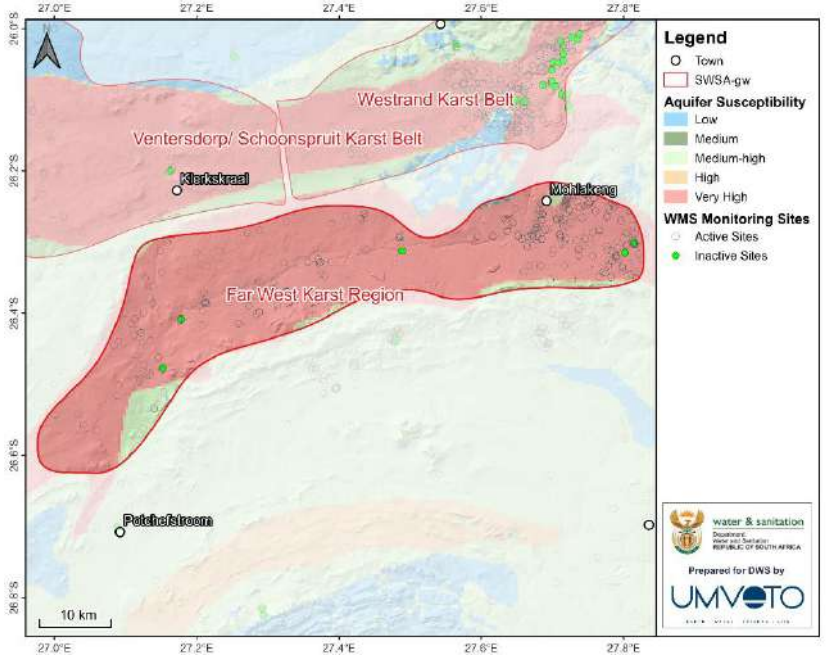
Projected population dependence on water sources in 2025.

SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360-1761 mamsl
Quantity & Quality	
Groundwater Quality	

The Far West Karst Region SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 393.16 km^2, which is 28.45% of the Far West Karst Region SWSA-gw total area. Urban/Built-up areas cover 115.39 km^2 (8.35%), while mines and quarries account for 17.01 km^2 (1.23%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 24.1 – 145 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 0.86 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.02 - 9.22 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 5.93 to 8.9 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 5 - 2220 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Far West Karst Region**
Area:	**1382 km^2**
Elevation:	**1360-1761 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Far West Karst Region SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	5	13.89	36	78.16	mS/m	2014-2024 GW Geosites: N/A	2014-2024 GW Geosites: 70 - 150 mS/m.	24.1 - 145 mS/m (Avg.: 78.16 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024).
Fluoride	5	13.89	36	0.14	mg/L	2014-2024 GW Geosites: N/A	2014-2024 GW Geosites: <0.5 mg/L.	0.025 - 0.86 mg/L (Avg.: 0.14 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	5	13.89	36	2.35	mg/L	2014-2024 GW Geosites: N/A	2014-2024 GW Geosites: <11 mg/L	0.02 - 9.22 mg/L (Avg.: 2.35 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	5	13.89	36	8.05	pH unit	2014-2024 GW Geosites: N/A	2014-2024 GW Geosites: 7-9.	5.93 - 8.9 (Avg.: 8.08). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	5	13.89	36	154.39	mg/L	2014-2024 GW Geosites: N/A	2014-2024 GW Geosites: <200 mg/L.	5 - 2220 mg/L (Avg.: 154.39 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024), except for values above the upper limit.

- *"Average" refers to the average concentrations for the Total Active Sites of the Far West Karst Region SWSA-gw, taken from the WMS database from 2000-2024.*
- *"N/A" refers to Not Applicable.*

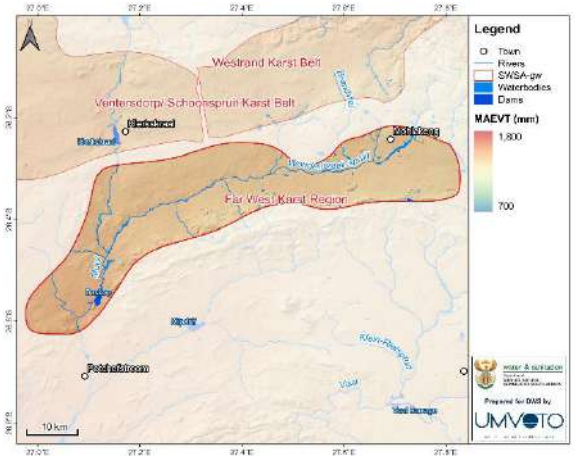
SWSA-gw Name:	**Far West Karst Region**
Area:	**1382 km²**
Elevation:	**1360-1761 mamsl**

Threats & Risks

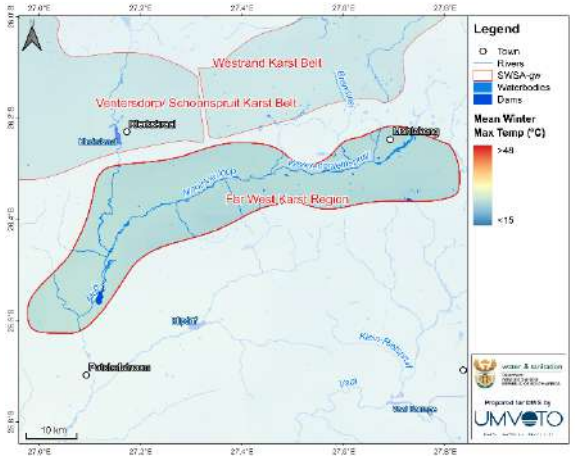
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Far West Karst Region SWSA-gw predominantly has a Cwb, subtropical highland, type climate characterized by warm summers and dry winters, towards the south west it changes to a BSk, cold semi-arid, type climate characterised by cold winters and warm to hot summers. Temperatures in the SWSA-gw range from -1.9 – 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

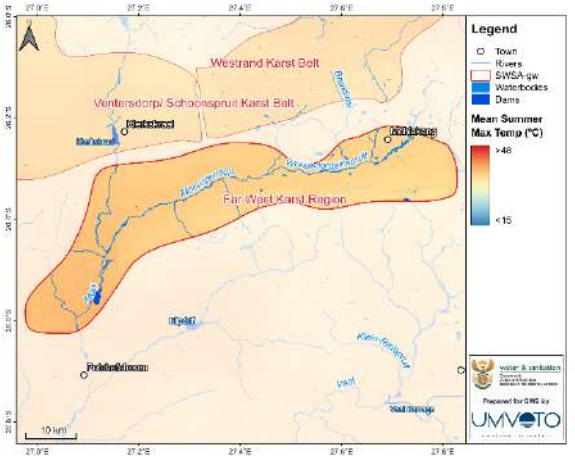
Temperature	Summer: 24.7 to 29.2 °C, Winter: -1.9 to 2 ºC
Evapotranspiration	Maximum value of 1531 mm/a with an average value of 1443 mm/a
Climate Change Predictions	Increased temperatures, decreasing rainfall, but an increase in recharge (ranging from ~ -4.1 to 2.5 mm/a). The DART Index indicates mostly stable conditions.



Mean annual A-Pan evaporation of the Far West Karst Region SWSA-gw region.



Mean winter temperatures of the Far West Karst Region SWSA-gw region.



Mean summer temperatures of the Far West Karst Region SWSA-gw region.

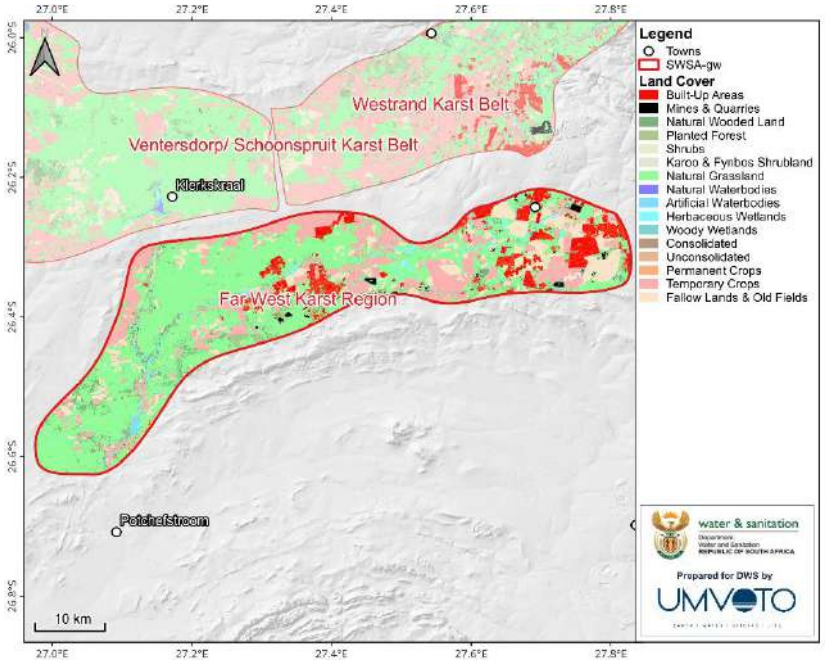
SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360-1761 mamsl

Threats & Risks

Land Use

The Far West Karst Region SWSA-gw is predominantly covered by grassland (DFFE, 2022), highlighting its ecological significance and potential for grazing. Cultivated land, consisting of temporary crops, permanent crops, fallow lands and old fields, indicates a notable agricultural presence. Built-up areas, consisting of residential, industrial and commercial areas and smallholdings, show moderate human settlement, concentrated near towns like Mohlakeng. The presence of artificial and natural waterbodies, though minimal, is crucial for the region's hydrology, as seen in the mapped distribution of wetlands and water features. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 1.2% of the area, located predominantly in the northwest of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	3	0.2
Built-Up	115	8.3
Cultivated	393	28.4
Forest Land	95	6.9
Grassland	713	51.6
Mines and quarries	17	1.2
Shrubland	4	0.3
Waterbodies	8	0.5
Wetlands	33	2.4



Land Cover 24-class map to show the types of land use and extent of each occurring in the Far West Karst Region SWSA-gw.

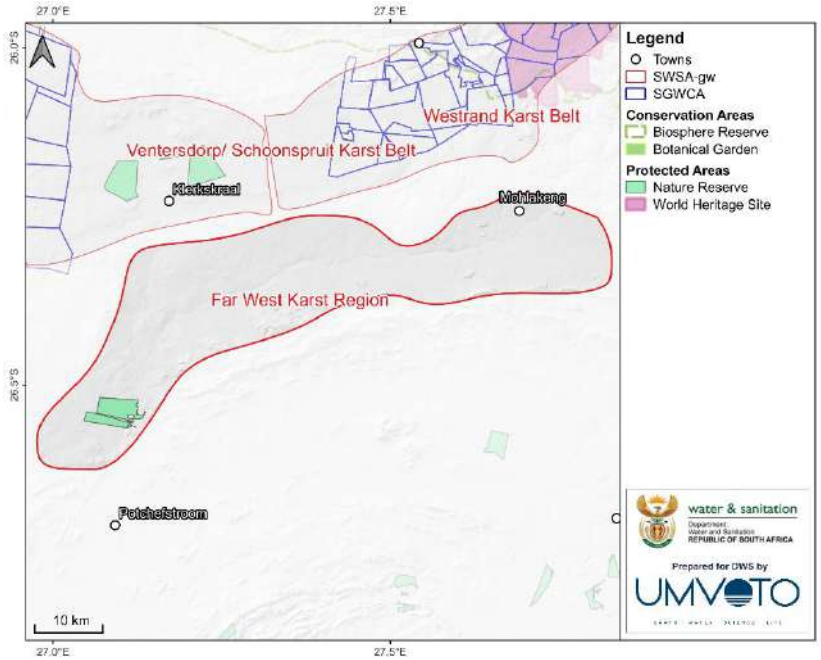
SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360 to 1761 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Far West Karst Region SWSA-gw has one nature reserve (DFFE, 2024), split into two parts but adjacent to each other, on the southwestern end of the SWSA-gw, as displayed on the map.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	• Boskopdam Nature Reserve	26.71	1
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of Far West Karst Region SWSA-gw that have protection status.

SWSA-gw Name:	Far West Karst Region
Area:	1382 km^2
Elevation:	1360 to 1761 mamsl

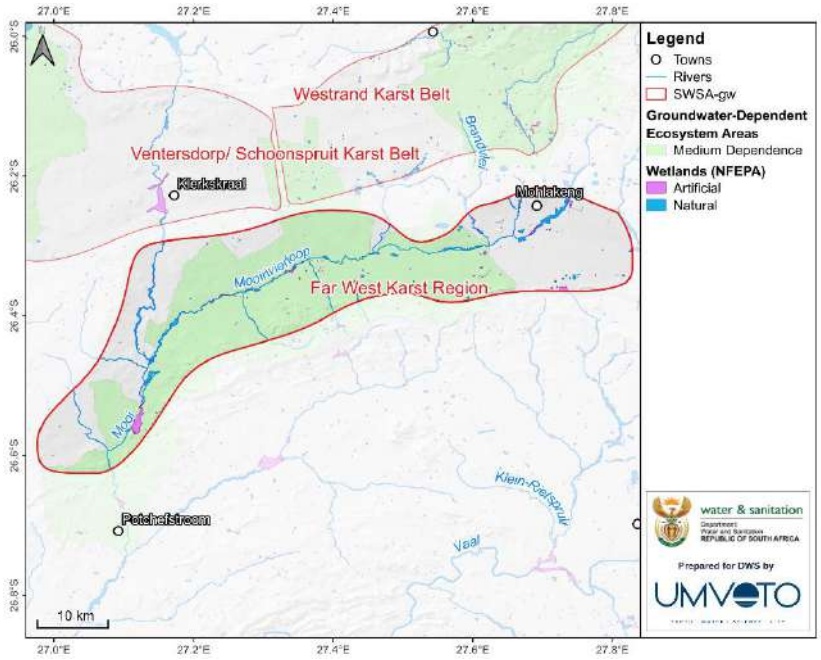
Protection Status and Ecosystems

Biodiversity and Conservation

The Boskop Dam lies (DWS, 2011) on the Mooirivierloop River, which runs lengthwise through the centre of the Far West Karst SWSA-gw. The Mooirivierloop River valley also contains many channelled valley-bottom wetlands and artificial wetlands (CSIR, 2011) on its river course and alongside it.

These wetlands belong to a wider group of Dolomite vegetation wetlands with a potentially medium dependence on groundwater (DWA, 2010) covering a broad area of the SWSA-gw, as highlighted on the map.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Boskop Dam	3.63	1
Ramsar Sites	None		0
Wetlands	Various natural and artificial wetlands	23	

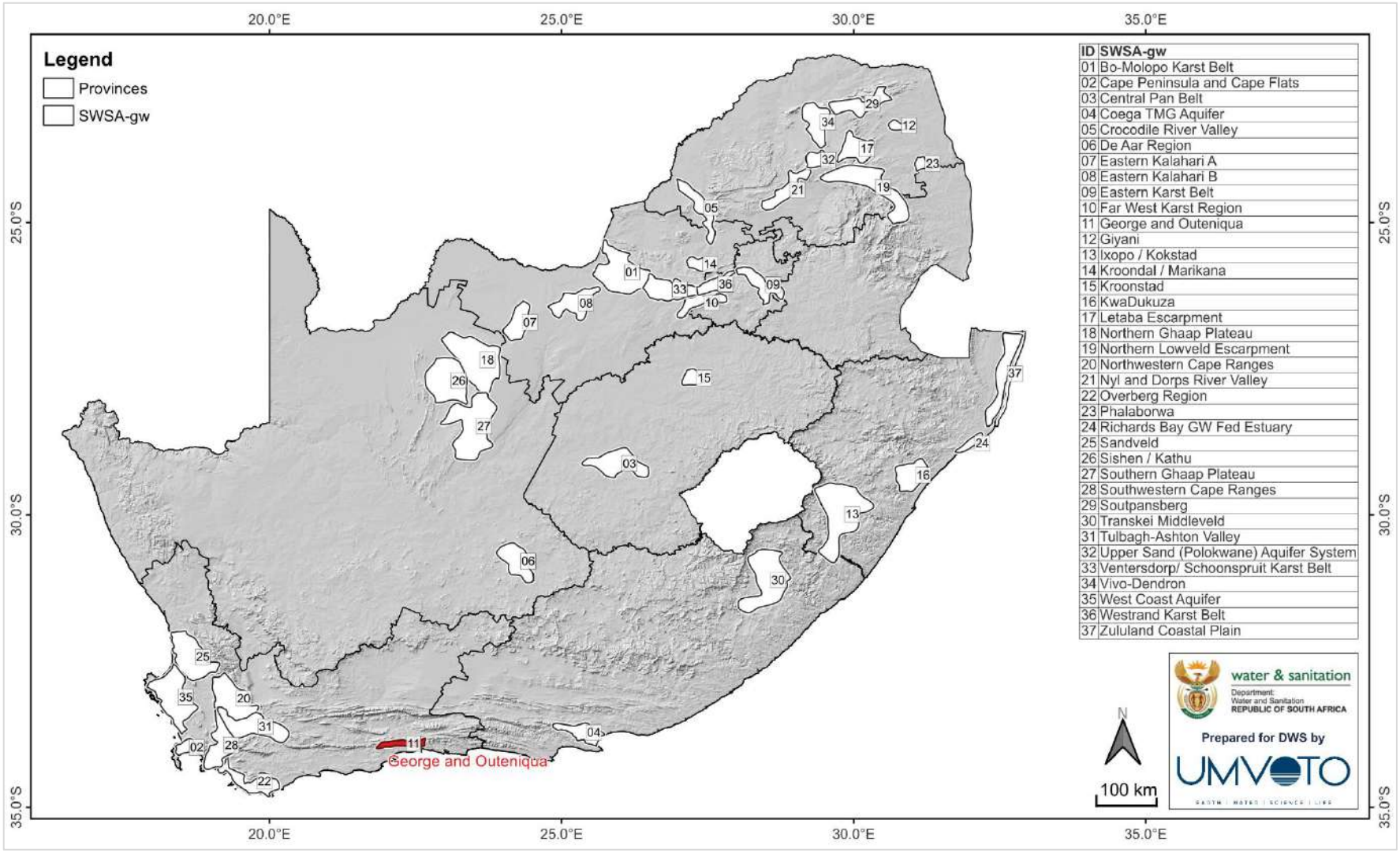


Map showing the major water bodies, Ramsar sites and GDEs in the Far West Karst Region SWSA-gw.

APPENDIX 11

GEORGE AND OUTENIQUA SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE GEORGE AND OUTENIQUA SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

11. George and Outeniqua

11.1. Description

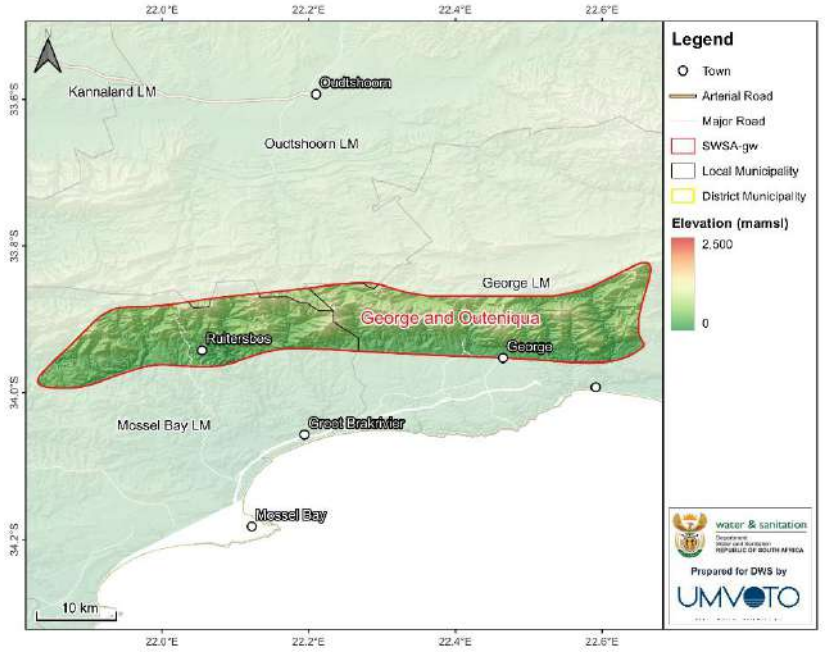
SWSA-gw Name:	George and Outeniqua
Area:	727 km^2
Elevation:	93 to 1519 mamsl

Geospatial Context

The topography of the George and Outeniqua SWSA-gw, as depicted in the map, is dominated by rugged, mountainous terrain associated with the Outeniqua Mountains, which form a prominent east-west-trending range. These mountains exhibit steep slopes, sharp ridges, and deep valleys. The terrain gradually descends southward towards George, where it transitions into lower-lying coastal plains. To the north, the landscape remains elevated with a complex drainage system feeding into the valleys.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Western Cape Province
District Municipality	Garden Route
Local Municipalities	Mossel Bay, George, and Oudtshoorn.
Towns	George
Major Roads	N9, N12, R328, and R404
Major Water Supply Networks	No information available/ unknown



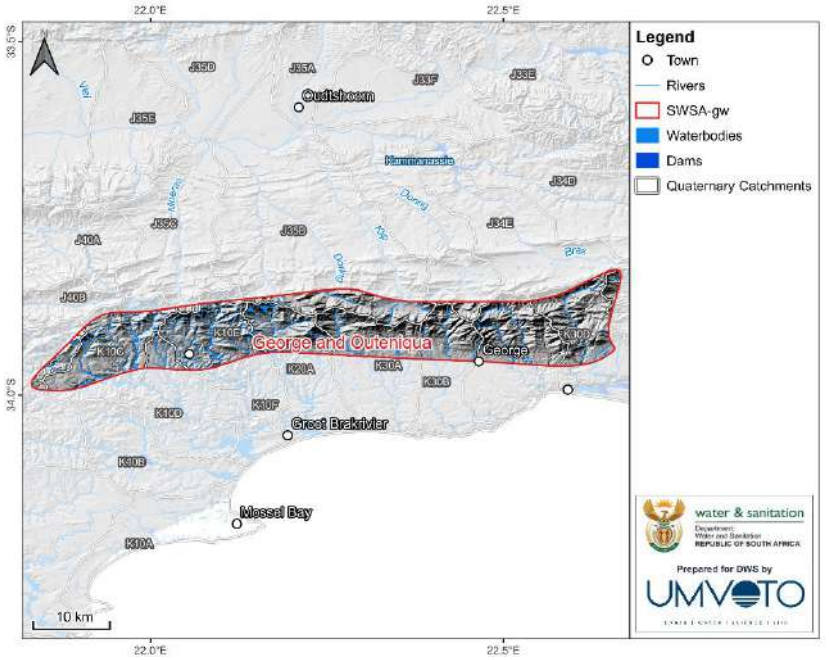
Locality map of Major Towns, District and Local Municipalities in the George and Outeniqua SWSA-gw.

SWSA-gw Name:	George and Outeniqua
Area:	727 km^2
Elevation:	93 to 1519 mamsl

Hydrology and Drainage

The George and Outeniqua SWSA-gw and surrounding areas include a few major surface water systems summarised below and displayed in the map on the right. The Ernest Robertson, Swart River and Garden Rout reservoirs, as well as several perennial rivers flowing south, are fed by the J4, J3, K1, K2, K3 and K4 catchments.

Quaternary Catchments	J34E, J34F, J35B, J35C, J40C, J40D, K10C, K10D, K10E, K10F, K20A, K30A, K30B, K30C, K30D and K40A
Rivers	Perennial: Doring, Duiwe, Groot Brak, Haelkraal, Kaaimans, Kandelaars, Klein Keurboom, Klip, Kouma, Langtou, Maalgate, Malgas, Moeras, Moordkuil, Swart and Touws
	Ephemeral: Beneke, Diep, Rooi and Ruiterbos
Natural and manmade water bodies	
Major Dams:	Ernest Robertson, Swart River and Garden Route reservoirs
Water Management Areas:	Breede Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the George and Outeniqua SWSA-gw.

SWSA-gw Name:	George and Outeniqua
Area:	727 km²
Elevation:	93 to 1519 mamsl
Geology	

Geology:

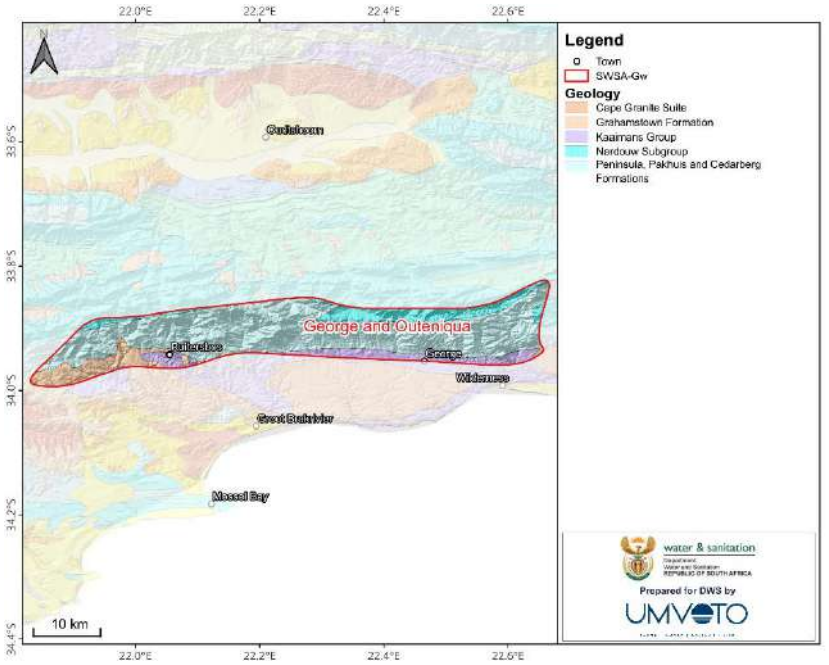
The majority of the George and Outeniqua area is covered by the Table Mountain group of the Cape supergroup comprising Quartzitic sandstone, minor conglomerate and shale., Brownish-weathering, quartzitic sandstone, subordinate shale and siltstone, Thick-bedded, medium- to coarse-grained, cross-bedded, white-weathering, quartzitic sandstone

The Grahamstown formation outcrops in the lower western section as silcrete.

The Kaaimans group also outcrops in the lower section along the border of the area comprising Quartzite, schist, phyllite, thinly interlayered psammites and semipelites

Hydrostratigraphy:

The Table Mountain Group sandstones form a major fracture-rock aquifer system.



Geology Map of the George and Outeniqua SWSA-gw region.

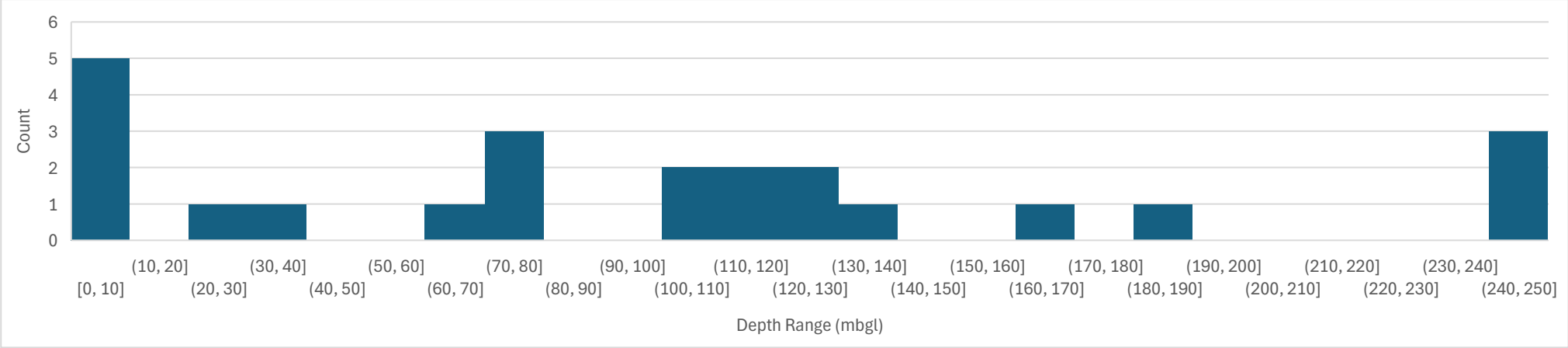
11.2. Current Status

SWSA-gw Name:	**George and Outeniqua**
Area:	**727 km2**
Elevation:	**93 to 1519 mamsl**
Quantity & Quality	
Aquifer Classification	

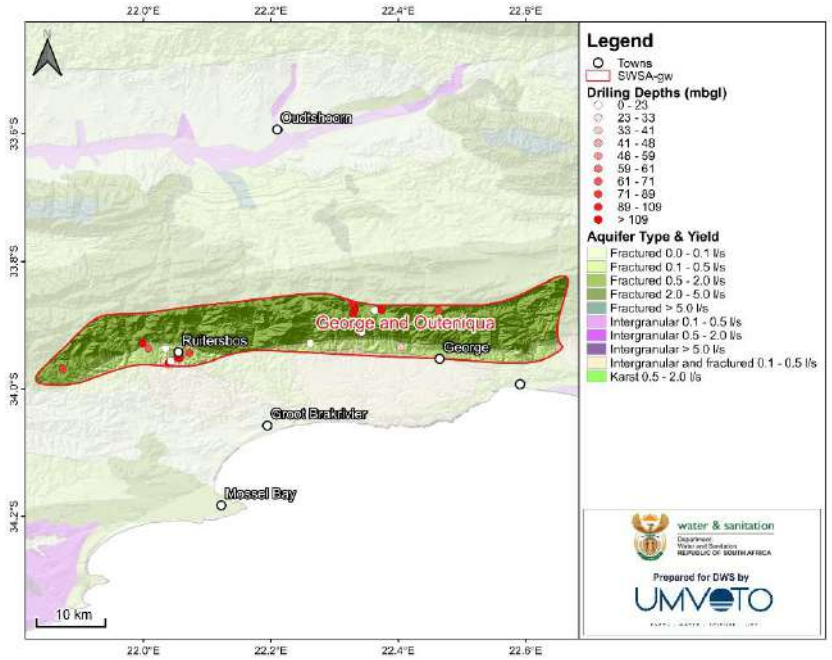
The aquifer systems within the George and Outeniqua SWSA-gw exhibit varying yields across fractured aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is predominantly a major aquifer system, with a minor aquifer system along the southern edge. The major aquifer system has an average fractured yield ranging from 0.5 to 2.0 l/s, while the minor aquifer system has a fractured yield ranging from 0.1 to 0.5 l/s.
Groundwater Targets	The average drilling depth is 100 mbgl, and the most common depth is around 10 mbgl, suggesting mixed targets. The boreholes target the fractured aquifer system. Some deeper boreholes in the centre reach depths of > 200 mbgl, extending into fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 33 and 130 mbgl. Based on the past 25 years of NGA water level data, the average groundwater level in the region is ~ 13 mbgl, with values ranging from 4 to 28 mbgl and a standard deviation of ~ 9 mbgl.

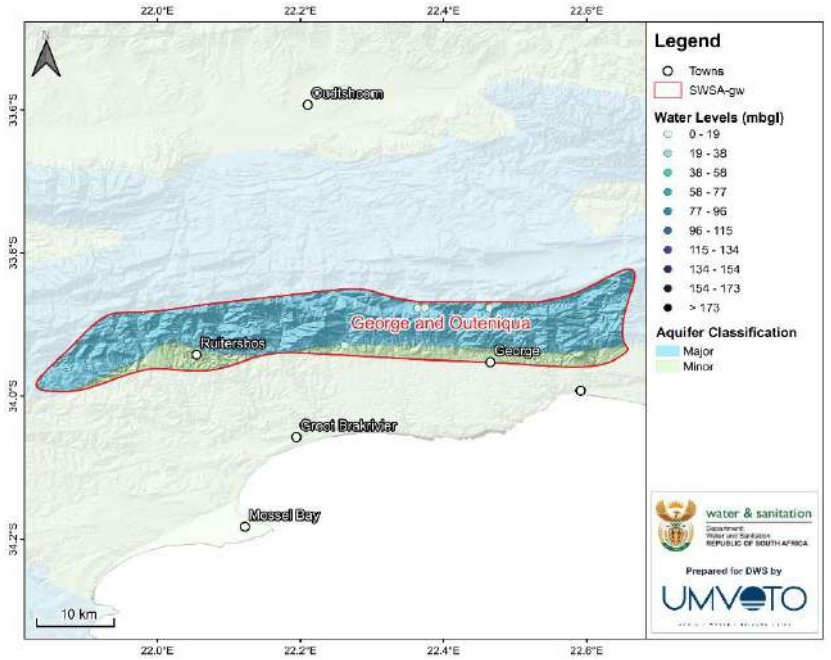
Graph of NGA drilling depths of George and Outeniqua SWSA-gw region



SWSA-gw Name:	**George and Outeniqua**
Area:	**727 km2**
Elevation:	**93 to 1519 mamsl**
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the George and Outeniqua SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the George and Outeniqua SWSA-gw region.

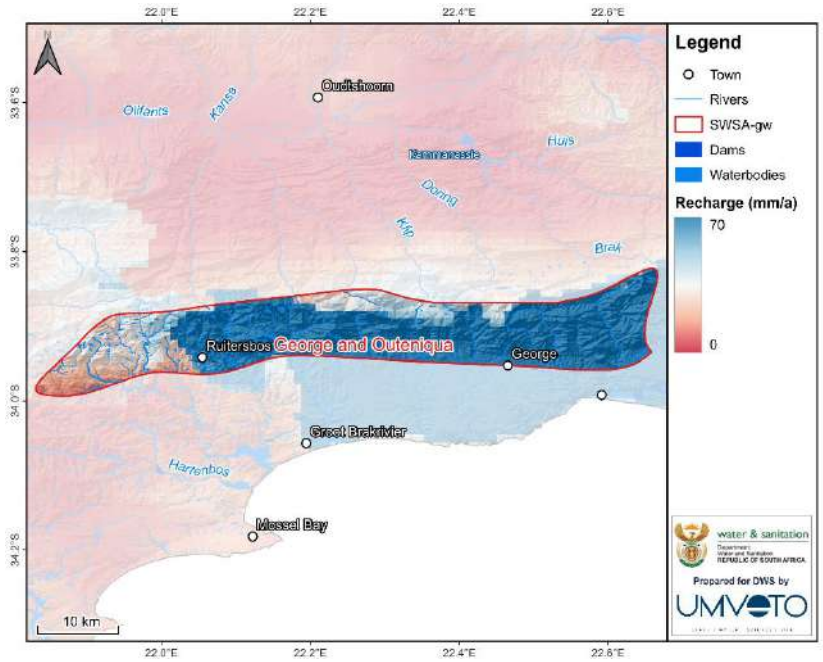
SWSA-gw Name:	**George and Outeniqua**
Area:	**727 km2**
Elevation:	**93 to 1519 mamsl**

Quantity & Quality

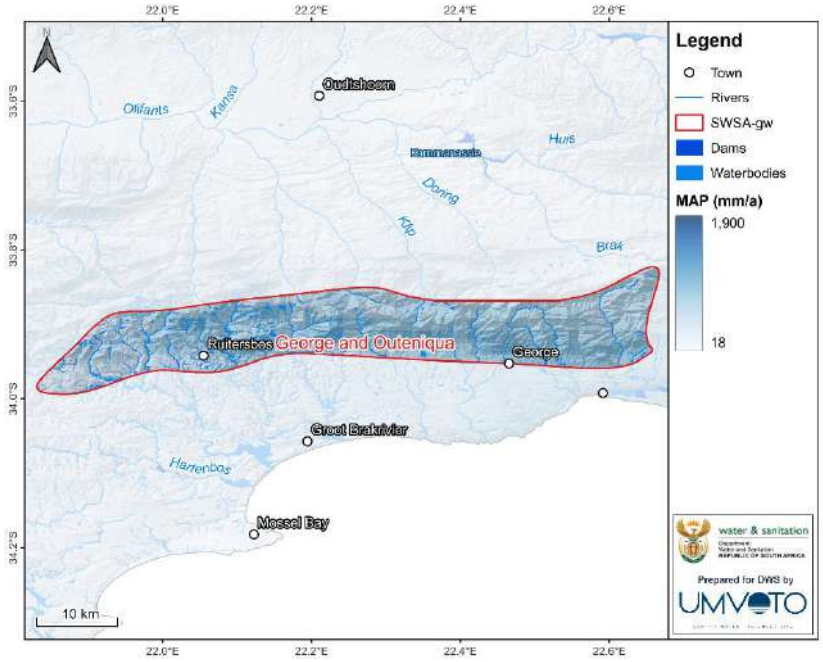
Groundwater Recharge

The George and Outeniqua region receives a total Mean Annual Precipitation (MAP) Volume of 516 Mm^3/a, with an average rainfall of 686 mm/a. 85 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a recharge of 16.5% of MAP. This relatively higher recharge rate indicates that a significant portion of the rainfall is reaching the groundwater, likely due to favourable soil and geological conditions that promote infiltration, making it a more sustainable aquifer compared to drier regions.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
George and Outeniqua	516	686	85	111.8	16.5%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	George and Outeniqua
Area:	727 km2
Elevation:	93 to 1519 mamsl

Quantity & Quality

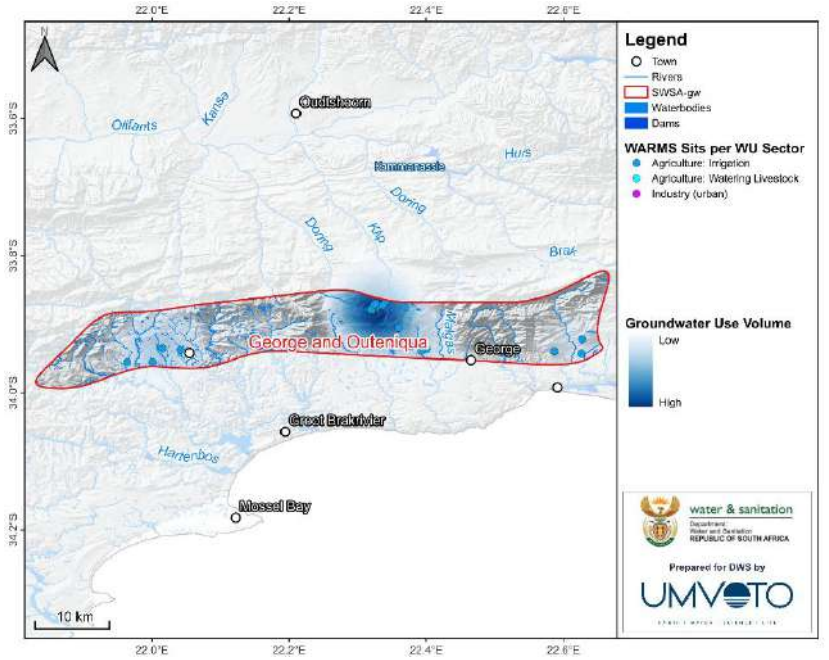
Groundwater Use

The George and Outeniqua SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater use is for agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that two sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 1.2 Mm^3/ a to sustain crop production. Distribution of use is quite scattered, with the southern region having more use. However, there is a clustering to the northwest of George.
- Agricultural livestock watering follows closely, using 0.1 Mm^3/a to provide water for livestock animals to drink and graze. Groundwater offers a reliable method for ensuring animals are hydrated, especially when water supply services are low. This is seen only in the western area.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located in the Outeniqua, where groundwater use is highest due to agricultural activities.

Active Groundwater Use Licences	Water User Sector	Registered Volume (Mm^3/a)
	Agriculture: Irrigation	1.2
	Agriculture: Watering Livestock	0.1
	Total	**1.3**



Water use map for the George and Outeniqua SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

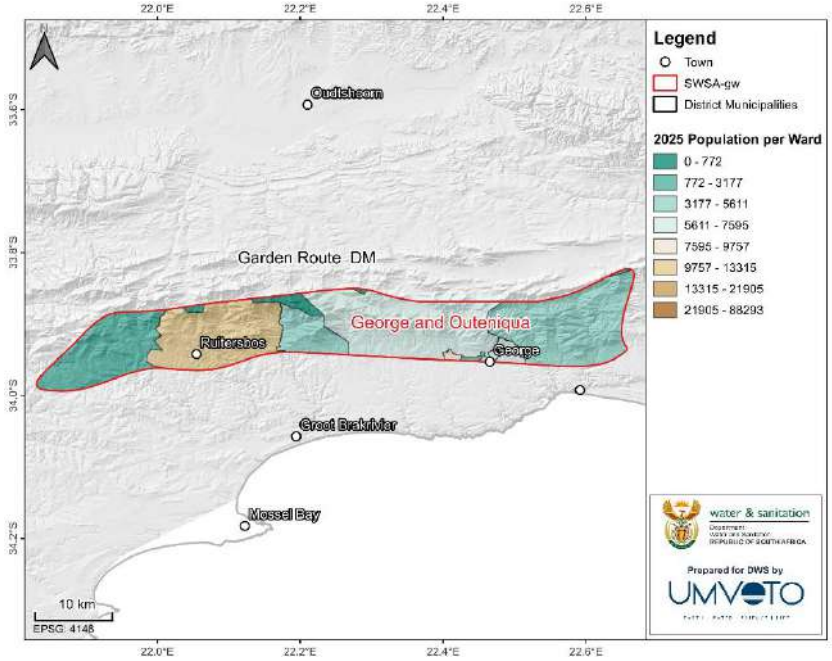
SWSA-gw Name:	George and Outeniqua
Area:	727 km2
Elevation:	93 to 1519 mamsl
Quantity & Quality	
Socio Economic & Governance	

The George and Outeniqua SWSA-gw is located within the Breede-Olifants Water Management Area (WMA, 2023). The groundwater resources within the Cape Peninsula and Cape Flats & and Table Mountain SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Breede-Olifants Catchment Management Agency (BOCMA), which was formed as part of a national restructuring process that consolidated CMAs. BOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the BOCMA to manage water resources in the Breede-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	BOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Breede-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA/WSP	The local municipalities are the Water Service Authorities and responsible Water Service Providers in this region.

The estimated 2025 population within the George and Outeniqua SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 2.95% per year, resulting in a projected population of approximately 44,486.

As shown in the map and table below, George Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 31,216. Population concentrations are highest in the George LM and around the town of Ruitersbos.



Projected population distribution in 2025 for the George and Outeniqua SWSA-gw.

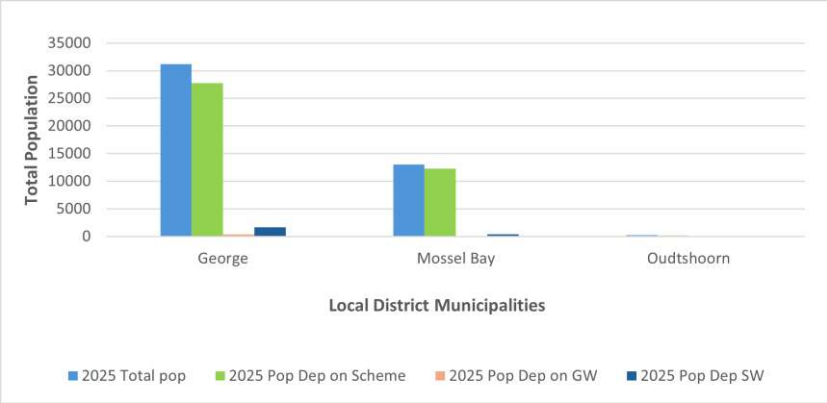
SWSA-gw Name:	George and Outeniqua
Area:	727 km2
Elevation:	93 to 1519 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the George and Outeniqua SWSA-gw, an estimated 90.6% of the population depends on the regional water supply scheme, 4.8% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources and 1.1% on groundwater sources (including boreholes and springs).

Among the LMs, the Oudtshoorn LM has the highest proportion of surface water reliance, with approximately 9.0% of its population depending on surface water and minimal dependence on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
George	31,216.02	27,790	424	1,698
Mossel Bay	13,032.47	12,304	70	396
Oudtshoorn	237.74	190	5	21
Total	44,486	40,283	499	2,115



Projected population dependence on water sources in 2025.

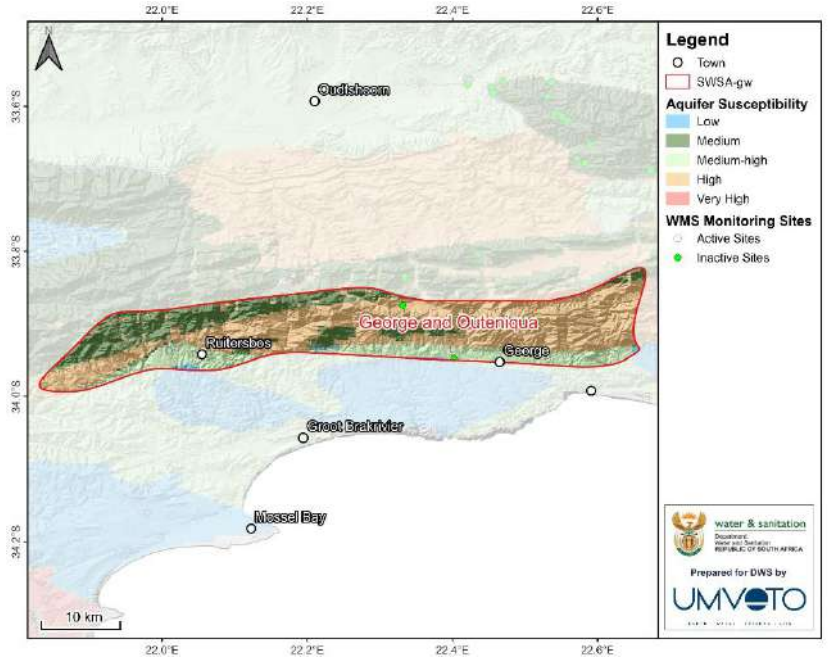
SWSA-gw Name:	George and Outeniqua
Area:	727 km^2
Elevation:	93 to 1519 mamsl
Quantity & Quality	
Groundwater Quality	

The George and Outeniqua SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 79.21 km^2, which is 10.89% of the George and Outeniqua SWSA-gw total area. Urban/Built-up areas cover 8.37 km^2 (1.15%), while mines and quarries account for 0.09 km^2 (0.01%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major aquifer consists of areas with moderate and most aquifer vulnerability. The majority of the Major aquifer is characterized by areas that have the most vulnerability, while the moderately vulnerable areas are found in the central and northwestern parts of the aquifer.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 19.11 – 300 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 0.48 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 1.77 - 23.5 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.31 - 7.9 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 2 - 26.8 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**George and Outeniqua**
Area:	**727 km²**
Elevation:	**93 to 1519 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the George and Outeniqua SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	2	18.18	11	34.82	mS/m	-	19.11 - 66.1 mS/m (Avg.: 27.21 mS/m). 2014-2024 GW Geosites: <70 mS/m. Consistent with WMS (2000-2024).	28.1 - 300 mS/m (Avg.: 69.59 mS/m). 2014-2024 GW Geosites: <70 mS/m. Consistent with WMS (2000-2024), except for values above the upper limit.
Fluoride	2	20.00	10	0.10	mg/L	-	0.025 - 0.48 mg/L (Avg.: 0.32 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).	0.05 - 0.10 mg/L (Avg.: 0.32 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	2	20.00	10	7.18	mg/L	-	1.77 - 13.29 mg/L (Avg.: 7.13 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	4.34 - 23.5 mg/L (Avg.: 7.89 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	2	18.18	11	7.04	pH unit	-	6.37 - 7.9 (Avg.: 7.04). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	6.31 - 7.5 (Avg.: 7.03). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	2	18.18	11	8.31	mg/L	-	2 - 26.8 mg/L (Avg.: 9.45 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	2 - 14.00 mg/L (Avg.: 4.00 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the George and Outeniqua SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

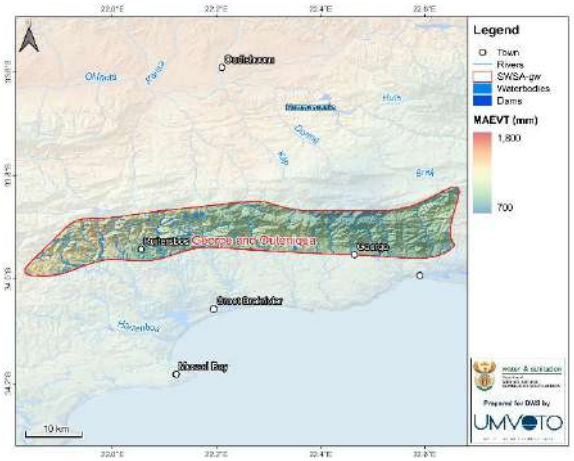
SWSA-gw Name:	**George and Outeniqua**
Area:	**727 km^2**
Elevation:	**93 to 1519 mamsl**

Threats & Risks

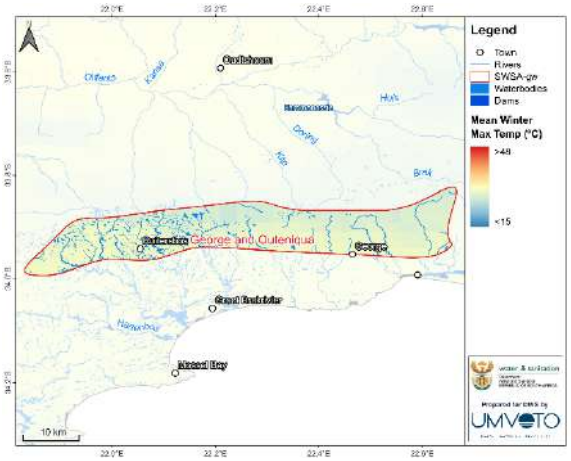
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the George and Outeniqua SWSA-fw has a predominantly BSk, cold semi-arid, type climate characterised by cold winters and warm to hot summers. Towards the east, the climate type changes to a Cfb, humid marine, type climate characterised by mild winters and short, dry summers. Temperatures in the SWSA-gw range from 4.1 – 29.9 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

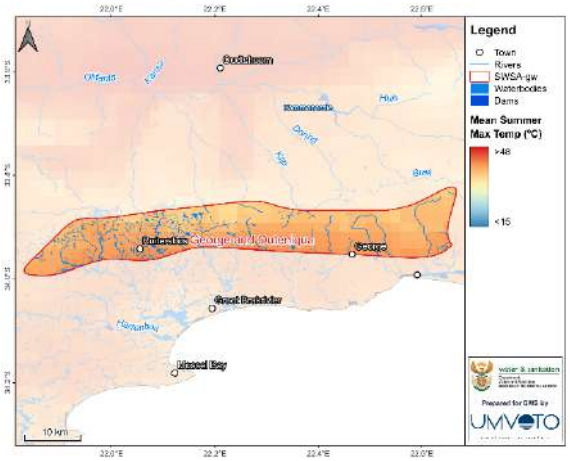
Temperature	Summer: 24.7 to 29.9 °C, Winter: 4.1 to 8 ºC
Evapotranspiration	Maximum value of 1352 mm/a with an average value of 1062 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, but an increase in recharge (ranging from ~ 0.9 to 9.6 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the George and Outeniqua SWSA-gw region.



Mean winter temperatures in the George and Outeniqua SWSA-gw region.



Mean summer temperatures of the George and Outeniqua SWSA-gw region

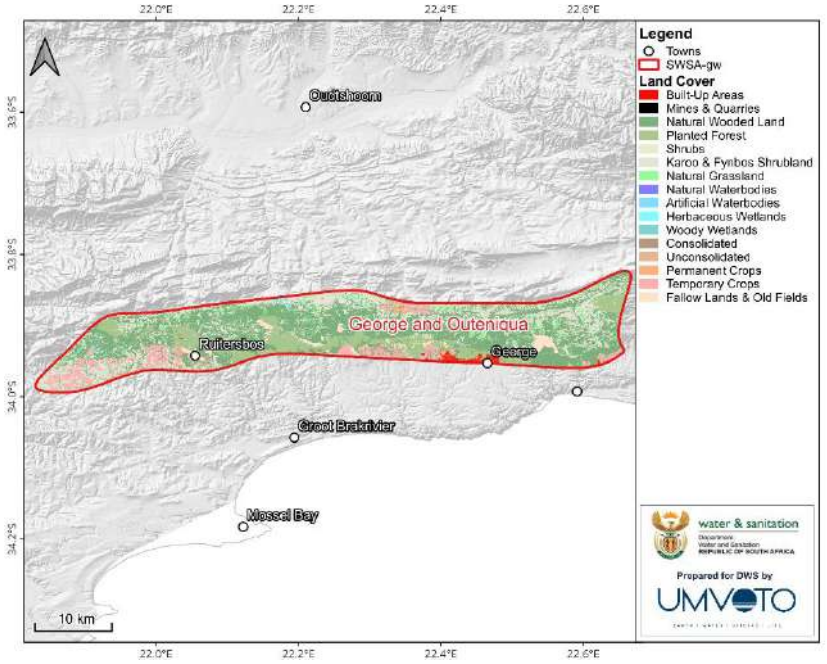
SWSA-gw Name:	George and Outeniqua
Area:	727 km^2
Elevation:	93 to 1519 mamsl

Threats & Risks

Land Use

The George and Outeniqua SWSA-gw is primarily covered by forest land, which is made up of natural wooded land and planted forest (DFFE, 2022), which plays a crucial role in maintaining biodiversity and ecosystem stability. Shrublands, specifically Karoo & Fynbos shrubland, are also a significant land cover type, highlighting the area's semi-arid characteristics. Cultivated land, which includes temporary crops, permanent crops, fallow land and old fields, covers about 10.9% of the SWSA-gw, indicating moderate agriculture, contributing to land use diversity. Built-up areas, consisting of residential, commercial and industrial areas, remain minimal, indicating low urban development. The presence of wetlands is limited, and waterbodies are nearly absent, underscoring potential water scarcity challenges in the region of the SWSA-gw.

Land Use Type	Area (km^2)	Area (%)
Barren Land	1	0.2
Built-Up	8	1.2
Cultivated	79	10.9
Forest Land	424	58.3
Grassland	21	2.9
Mines and quarries	0.1	0.01
Shrubland	187	25.7
Waterbodies	1	0.1
Wetlands	6	0.8



Land Cover 24-class map to show the types of land use and extent of each occurring in the George and Outeniqua SWSA-gw.

SWSA-gw Name:	George and Outeniqua
Area:	727 km^2
Elevation:	93 to 1519 mamsl

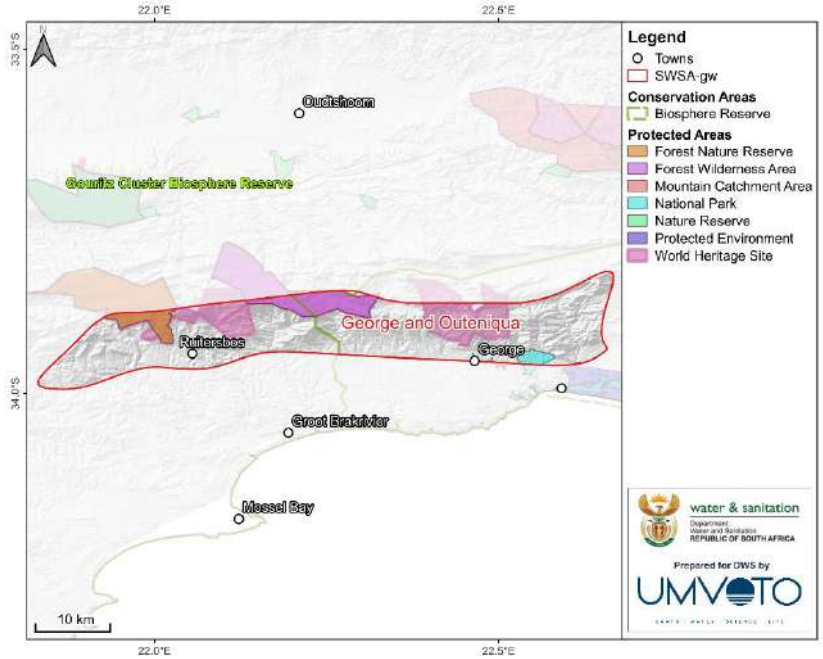
Protection Status and Ecosystems

Biodiversity and Conservation

The George and Outeniqua SWSA-gw is fully covered by two biosphere reserves (DFFE, 2024). The western half of the SWSA-gw is covered by the Gouritz Cluster Biosphere Reserve and the eastern half by the Garden Route Biosphere Reserve.

A significant portion of the SWSA-gw is covered by the Cape Floral Region Protected Areas world heritage site, particularly across the Langeberg and Outeniqua Mountain ranges at the northern edge of the SWSA-gw (DFFE, 2024).

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Gouritz Cluster Biosphere Reserve • Garden Route Biosphere Reserve	727.16	2
Protected Areas	• Cape Floral Region Protected Areas • Attakwaskloof Nature Reserve • Doringrivier Wilderness Area • Van Kervel Nature Reserve • Katrivier Nature Reserve • Wilderness National Lake Area	229.20	6
SGWCA	None		0
National Parks	• Garden Route National Park	9.66	1



Biospheres, Protected Areas and SGWCAs to show the portions of the George and Outeniqua SWSA-gw that have protection status.

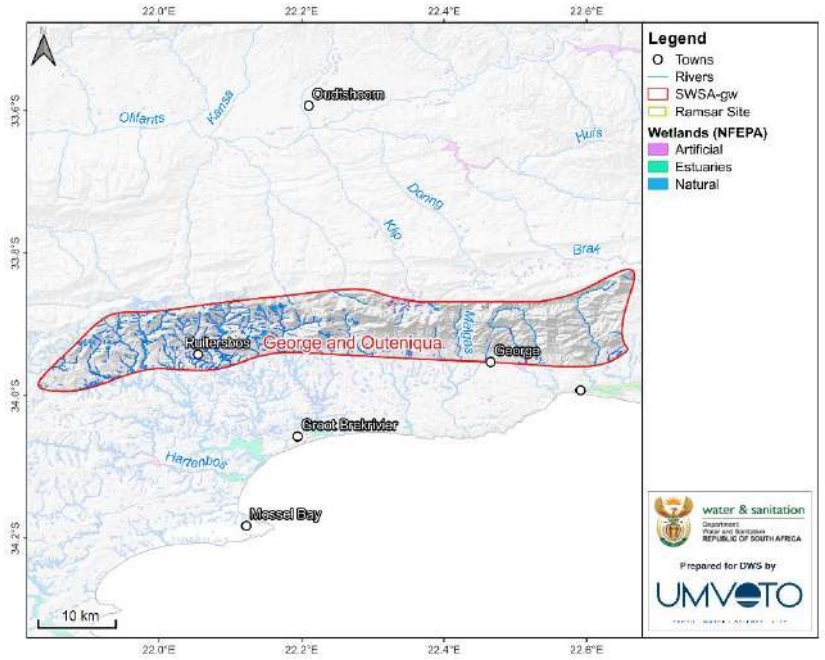
SWSA-gw Name:	George and Outeniqua
Area:	727 km^2
Elevation:	93 to 1519 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

There are no major waterbodies, Ramsar sites nor groundwater-dependent ecosystems identified in the George and Outeniqua SWSA-gw. There is, however, a network of rivers consisting of channelled valley-bottom wetlands and seeps (CSIR, 2011) on the western half of the SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various small natural and artificial wetlands	38	

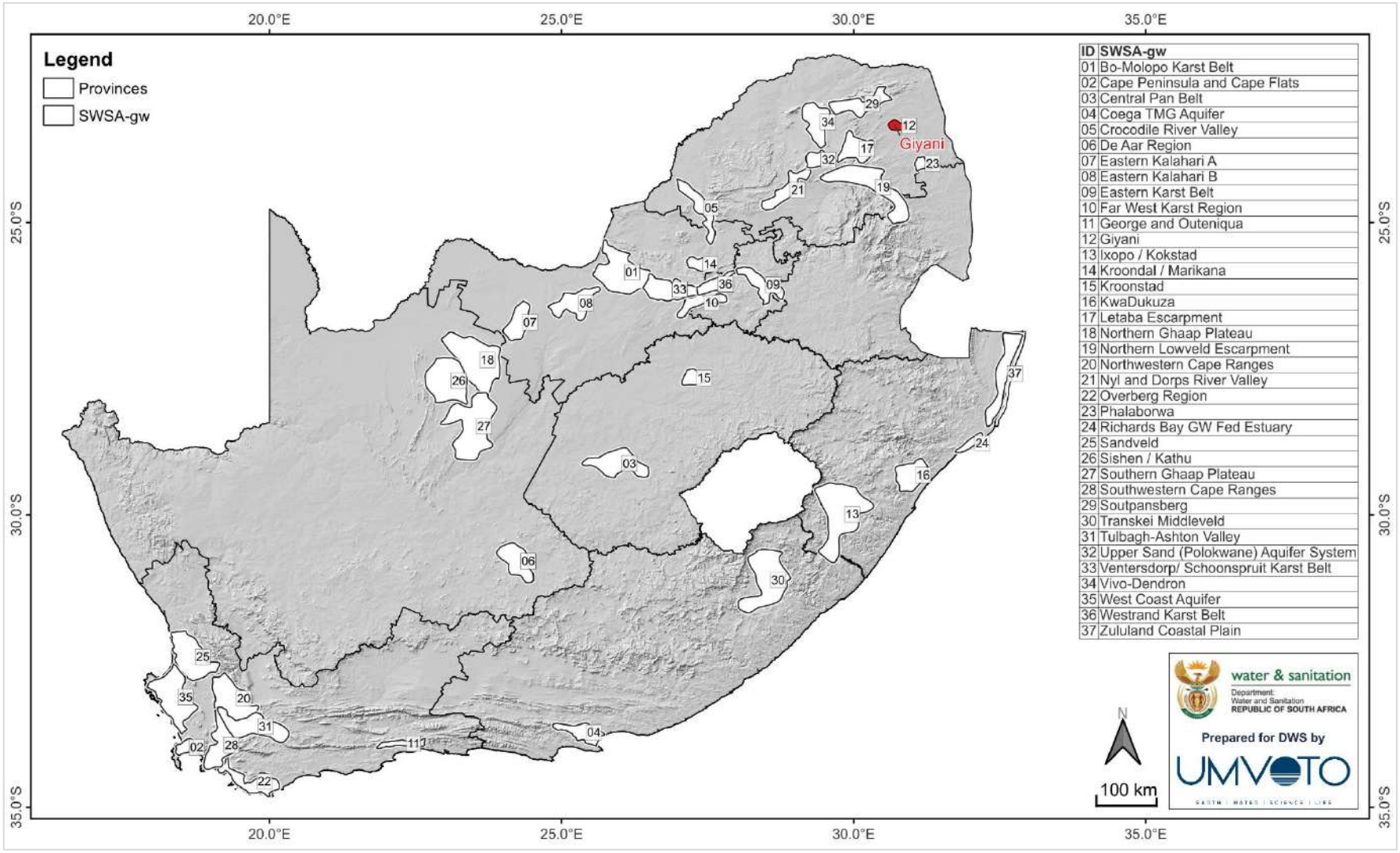


Map showing the major water bodies, Ramsar sites and GDEs in the George and Outeniqua SWSA-gw.

APPENDIX 12

GIYANI SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE GIYANI SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

12. Giyani

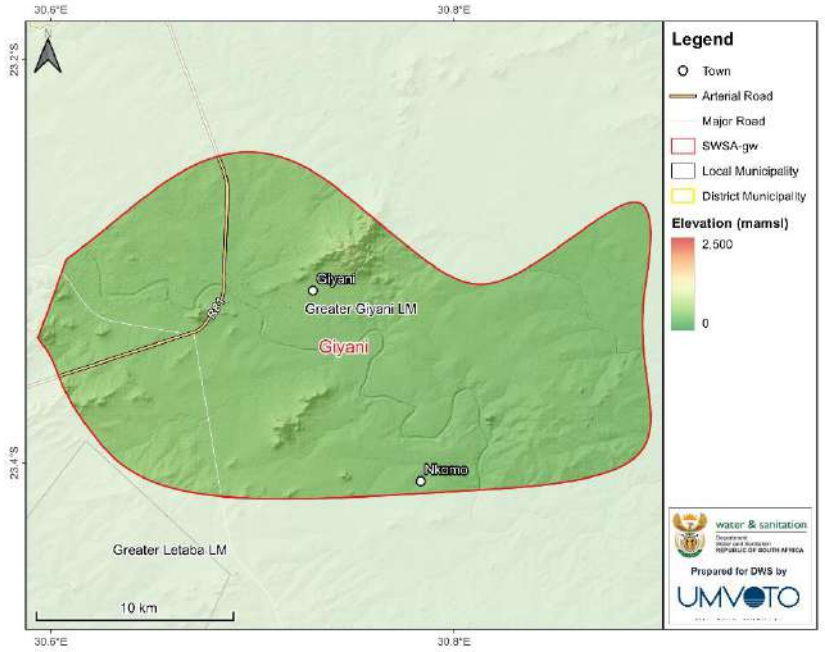
12.1. Description

SWSA-gw Name:	Giyani
Area:	438 km²
Elevation:	390-816 mamsl
Geospatial Context	

The topography of the Vivo-Dendron SWSA-gw, as depicted in the map, is characterized by gently undulating plains, low hills, and valleys. The landscape consists of broad savanna woodlands with occasional rocky outcrops and dry riverbeds scattered throughout the region. The terrain is more gently sloping in the southern areas, while parts of the northern and eastern sections feature slightly more elevated ridges and drainage channels.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Limpopo
District Municipality	Mopani
Local Municipality	Giyani
Towns	Kremetart and Giyani
Major Roads	R529 and R81
Major Water Supply Networks	



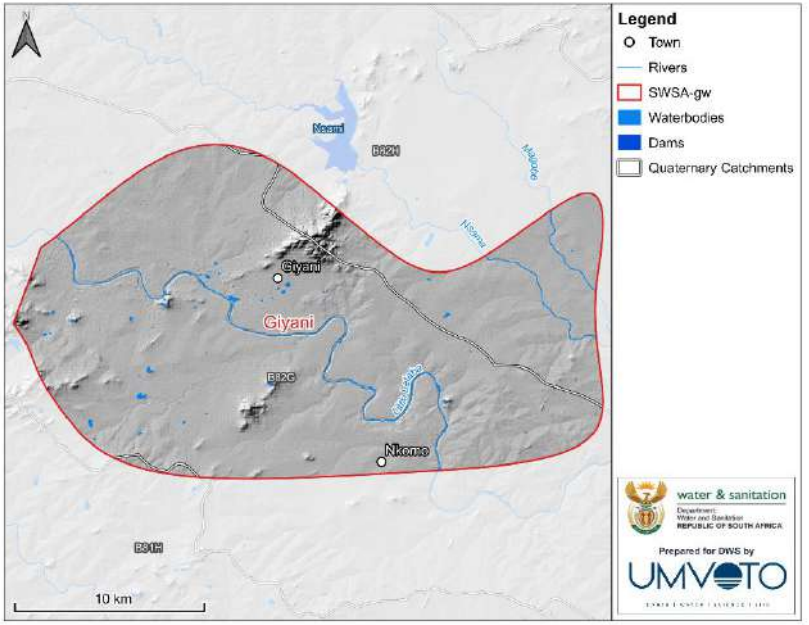
Locality map of Major Towns, District and Local Municipalities in the Giyani SWSA-gw.

SWSA-gw Name:	Giyani
Area:	438 km²
Elevation:	390-816 mamsl

Hydrology and Drainage

The Giyani SWSA-gw and surrounding areas include a few major surface water systems summarised below and displayed in the map on the right. The two perennial rivers, Little Letaba and Nsama, are fed by the B8 catchment, flowing in a south-easterly direction.

Quaternary Catchments	A71A, A71D, A71E, A71F, A71G, A71J, A72A and small sections of A71C
Rivers	Perennial: Little Letaba and Nsama
	Ephemeral: Magobe
Natural and manmade water bodies	
Major Dams:	No major dams
Water Management Areas:	Limpop Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Giyani SWSA-gw.

SWSA-gw Name:	Giyani
Area:	438 km²
Elevation:	390-816 mamsl
Geology	

Geology

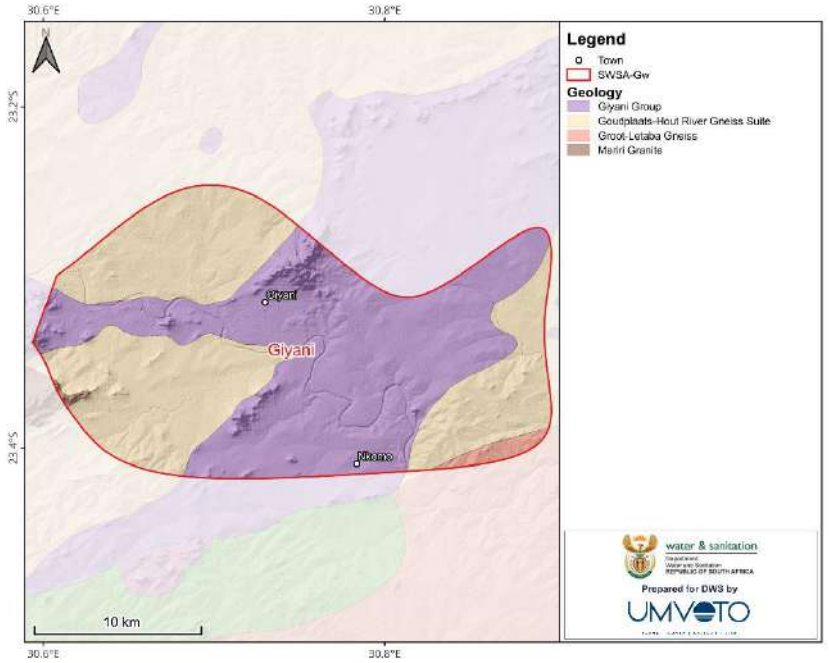
Small sections of Quaternary scree are present across the area. Diabase dike intrusions can be found near the northern, eastern, and western edges of the area.

In the eastern and western sections, the Goudplaats-Hout River Gneiss dominates, consisting of leucocratic, strongly migmatized biotite gneiss, greyish weakly migmatized biotite gneiss, minor leucogneiss, and dark grey biotite gneiss.

In the central section, the Giyani Group is exposed, characterised by acid lava, iron formation, quartzitic schist, garnetiferous schist, quartzite, dolomite, metaquartzite, calc-silicate rocks, and granulite. It also includes ultramafic rocks rich in chlorite, amphibole, talc, and serpentine, as well as subordinate amphibolites, acid igneous rocks, and sedimentary rocks. In the western section, small outcrops of the Meriri Granite are present, consisting of fine- to medium-grained, well-foliated, leucocratic tonalitic biotite granite.

Hydrostratigraphy

The Goudplaats-Hout River Gneiss and Meriri Granite form secondary fractured rock aquifers. The Giyani Group, with its diverse lithologies, supports a mixed aquifer system where groundwater occurs in both fractured and intergranular zones.



Geology Map of the Giyani SWSA-gw region.

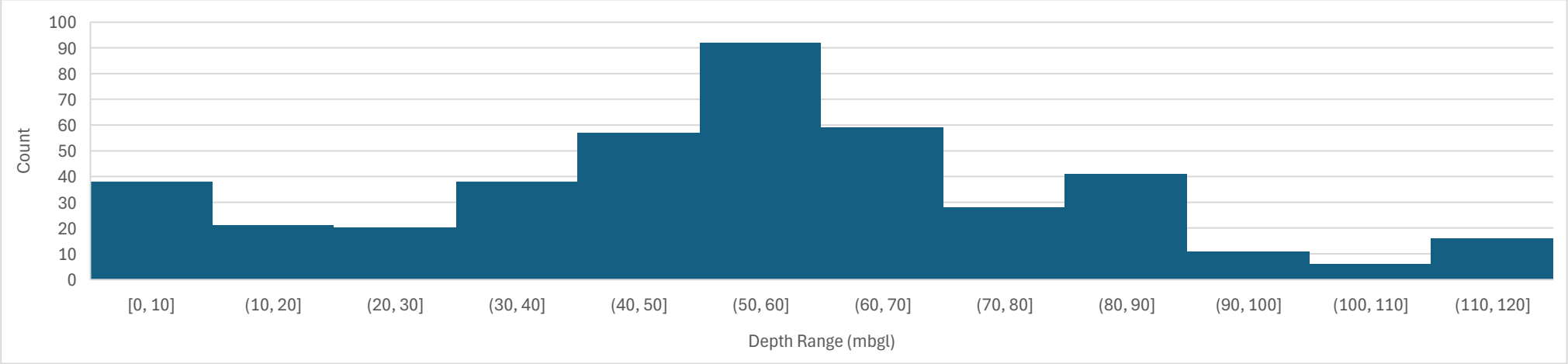
12.2. Current Status

SWSA-gw Name:	**Giyani**
Area:	**438 km²**
Elevation:	**390-816 mamsl**
Quantity & Quality	
Aquifer Classification	

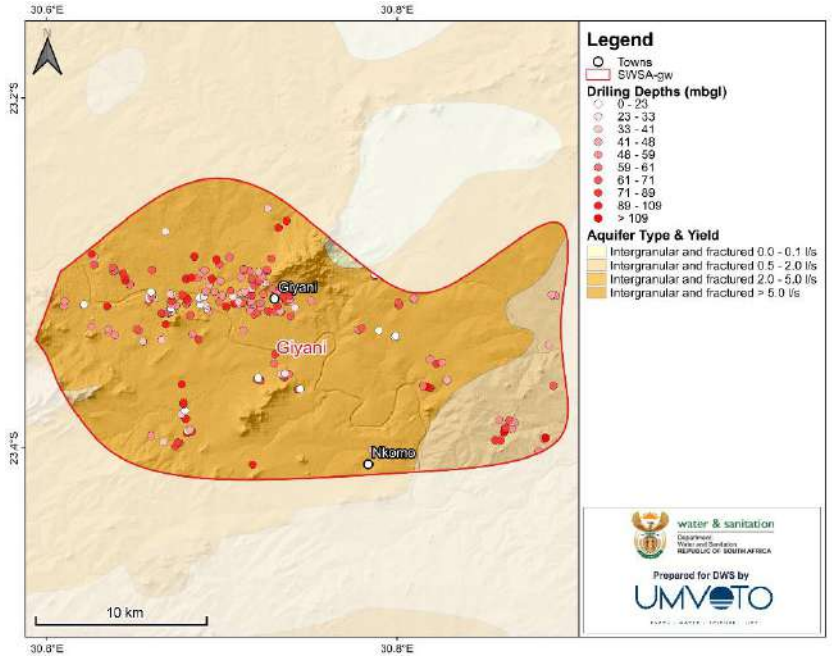
The aquifer systems within the Giyani SWSA-gw exhibit varying yields across fractured aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is a minor aquifer system with an average dual-porosity yield ranging from 0.5 to 5.0 l/s
Groundwater Targets	The average drilling depth is 55 mbgl, and the most common depths are between 50 and 60 mbgl. The majority of the boreholes target the shallow dual-porosity aquifer system. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 40 and 70 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 10 mbgl, with values ranging from 1 to 32 mbgl and a standard deviation of ~ 8 mbgl. Statistical analysis of the available NGA data reveals a dropping trend in the groundwater levels during this period.

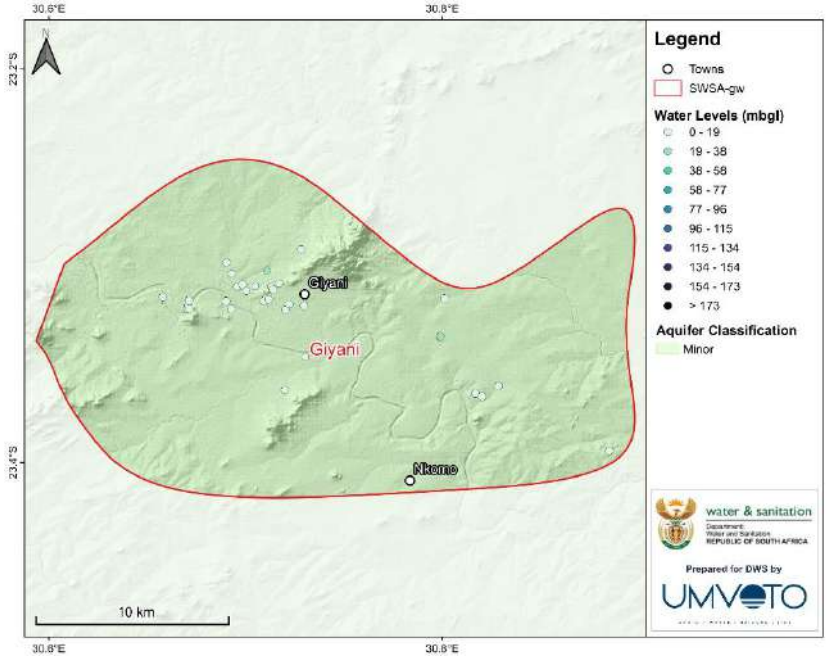
Graph of NGA drilling depths of the Giyani SWSA-gw region



SWSA-gw Name:	Giyani
Area:	438 km²
Elevation:	390-816 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depth of the Giyani SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Giyani SWSA-gw region.

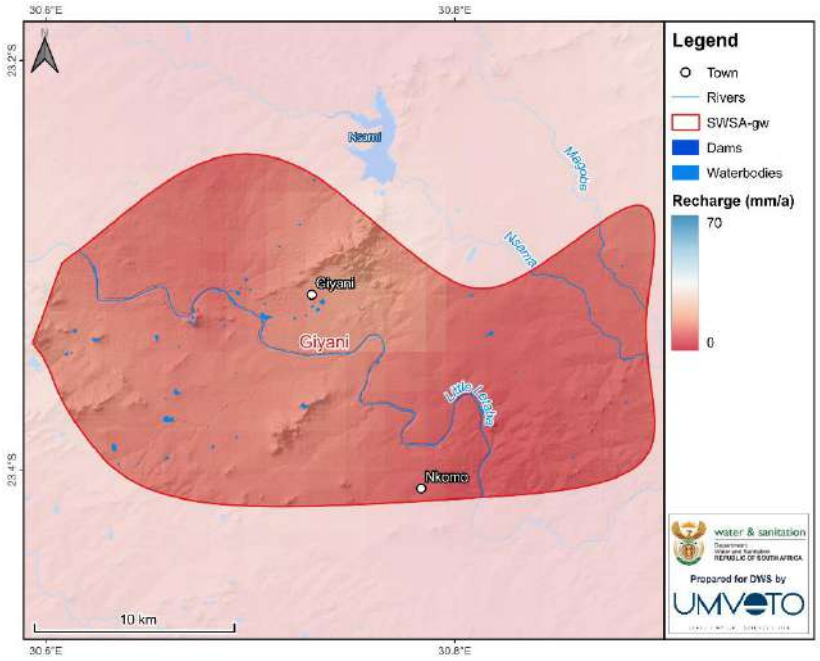
SWSA-gw Name:	**Giyani**
Area:	**438 km²**
Elevation:	**390-816 mamsl**

Quantity & Quality

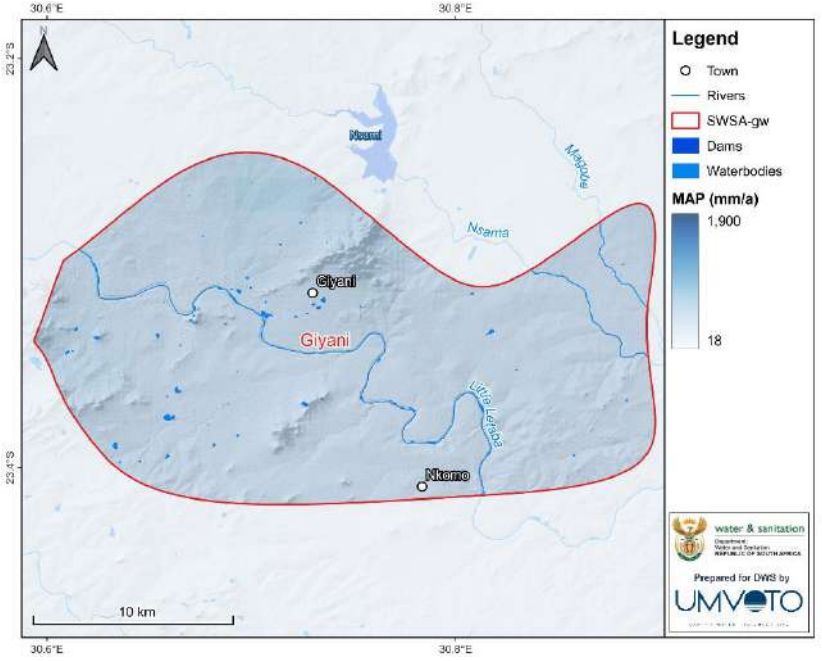
Groundwater Recharge

The Giyani receives a total MAP volume of 235 Mm^3/a, with an average rainfall of 538 mm/a. However, only 4.9 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 2.1% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Giyani	235	538	4.9	11	2.1%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

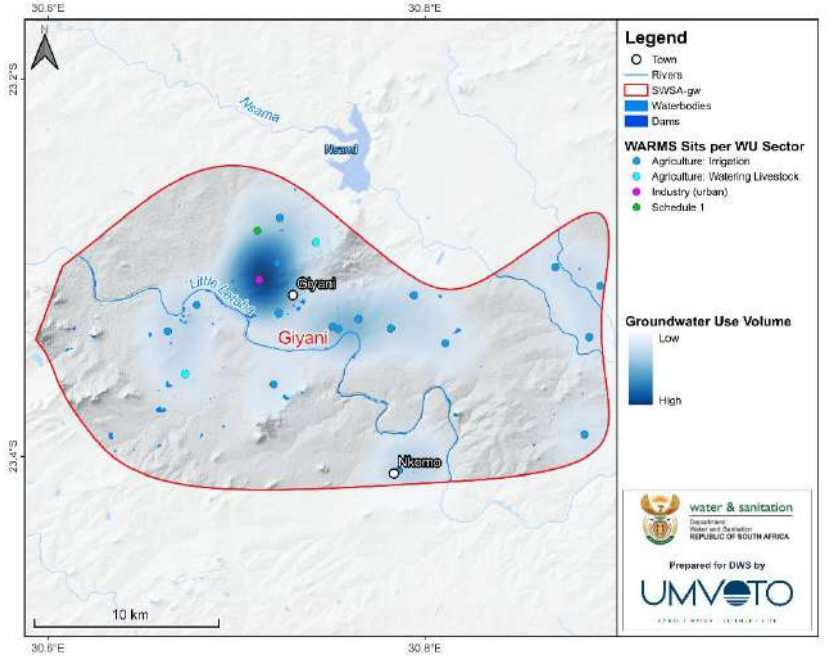
SWSA-gw Name:	Giyani
Area:	438 km²
Elevation:	390-816 mamsl
Quantity & Quality	
Groundwater Use	

The Giyani SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. While no towns in this region rely primarily on groundwater for municipal supply, industrial use, or agriculture (see Table below), an analysis of active groundwater use licenses from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 0.7 Mm^3/ a to sustain crop production. This region relies on groundwater less than the others in terms of volume. Irrigation is quite reliant on groundwater in many parts of the region. This can be seen near Giyani and in the east.
- Agricultural livestock watering follows, using 0.01 Mm^3/a to provide water for livestock animals to drink and graze. Livestock watering is less common in the region, there are a few points near Giyani and Kremetart.
- Urban industrial follows, using 0.01 Mm^3/a for manufacturing, processing, and other industrial activities in urban centers. This is primarily located around Giyani.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Giyani, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	0.7
	Agriculture: Watering Livestock	0.01
	Industry (Urban)	0.01
	Total	**0.7**



Water use map for the Giyani SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

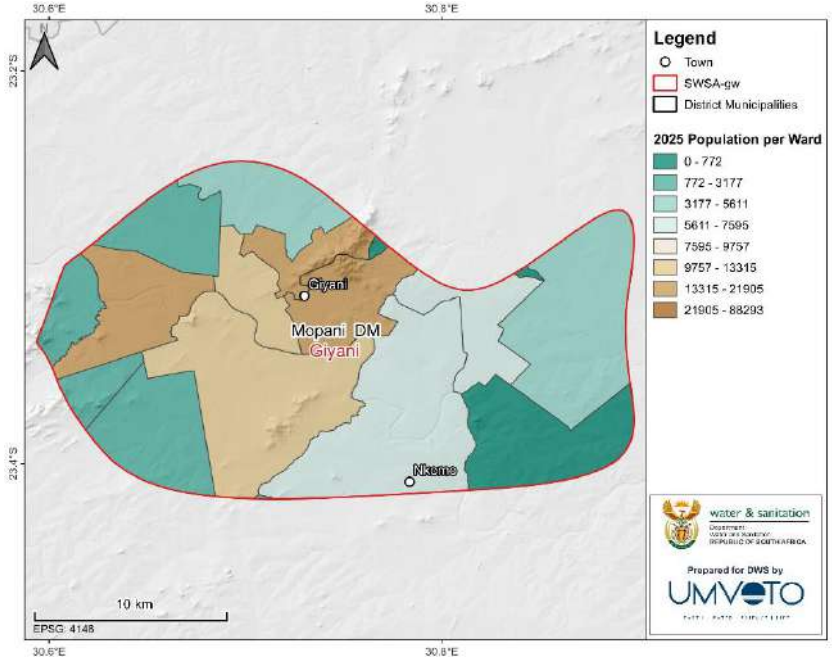
SWSA-gw Name:	Giyani
Area:	438 km²
Elevation:	390-816 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Giyani SWSA-gw is located within the Limpopo-Olifants Water Management Areas (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. LOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the LOCMA to manage water resources in the Limpopo-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	LOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The district municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Giyani SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 2.0% per year, resulting in a projected population of approximately 92,197.

As shown in the map and table below, Greater Giyani Local Municipality (LM) has an estimated population within the SWSA-gw of approximately 92,197. Population concentrations are highest around the Greater Giyani LM and the town of Giyani.



Projected population distribution in 2025 for the Giyani SWSA-gw.

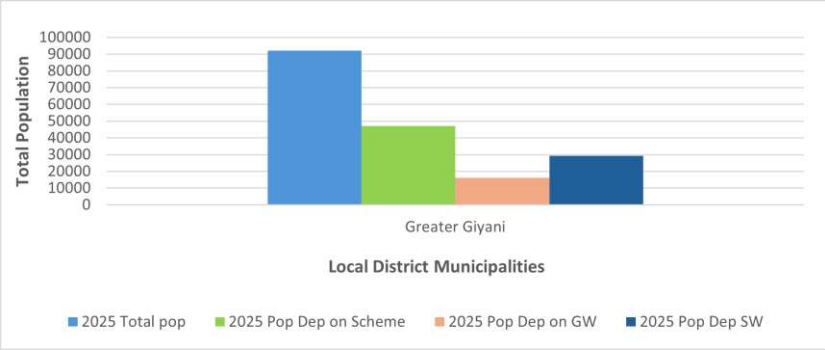
SWSA-gw Name:	Giyani
Area:	438 km²
Elevation:	390-816 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Giyani SWSA-gw, an estimated 51.0% of the population depends on the regional water supply scheme, 31.9% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 17.6% on groundwater sources (including boreholes and springs).

The Greater Giyani LM relies heavily on a regional water supply scheme, with approximately 17.6% of its population depending on groundwater and 31.9% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Greater Giyani	92,197.41	47,035	16,200	29,371
Total	**92,197**	**47,035**	**16,200**	**29,371**



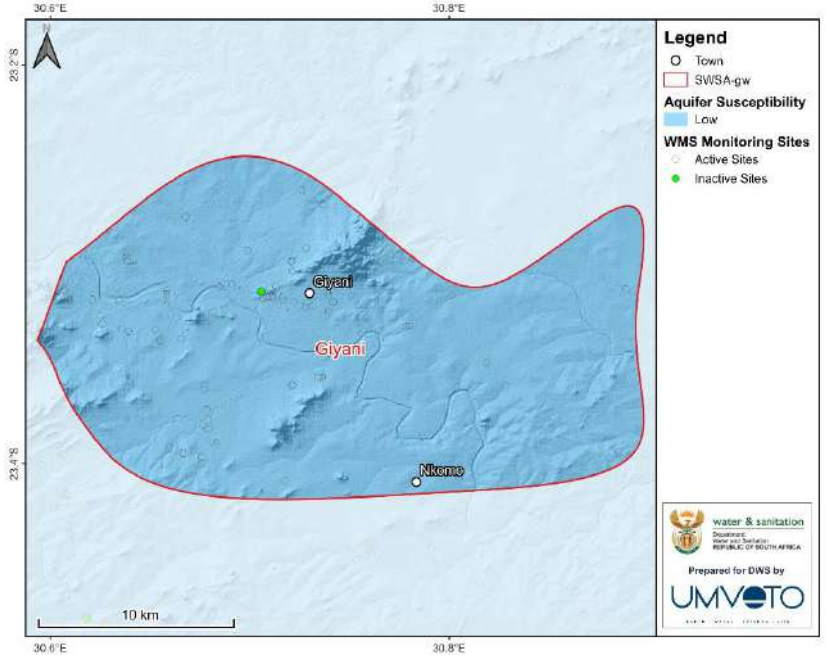
Projected population dependence on water sources in 2025.

SWSA-gw Name:	Giyani
Area:	438 km²
Elevation:	390-816 mamsl
Quantity & Quality	
Groundwater Quality	

The Giyani SWSA-gw consists of the Minor aquifer system, classified based on their yield and water quality. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 126.82 km^2, which is 28.97% of the Giyani SWSA-gw total area. Urban/Built-up areas cover 59.90 km^2 (13.68%), while mines and quarries account for 0.57 km^2 (0.13%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 16.25 - 295 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 1.03 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.005 - 61.35 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 7.13 - 8.51 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 1.5 - 148.42 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Giyani**
Area:	**438 km²**
Elevation:	**390-816 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Giyani SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	1	1.85	54	50.48	mS/m	16.25 - 295 mS/m (Avg.: 50.48 mS/m). 2014-2024 GW Geosites: 70 - 150 mS/m. Mostly consistent with WMS (2000-2024).	-	-
Fluoride	1	1.85	54	0.37	mg/L	0.025 - 1.03 mg/L (Avg.: 0.44 mg/L). 2014-2024 GW Geosites: <0.5-1.5 mg/L. Mostly consistent with WMS (2000-2024).	-	-
Nitrate + Nitrite Nitrogen	1	1.85	54	3.67	mg/L	0.005 - 61.35 mg/L (Avg.: 3.67 mg/L). 2014-2024 GW Geosites: <11-20 mg/L. Mostly consistent with WMS NO_3+NO_2 (2000-2024).	-	-
pH	1	1.85	54	8.10	pH unit	7.13 - 8.51 (Avg.: 8.10). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	-	-
Sulphate	1	1.85	54	14.08	mg/L	1.5 - 148.42 mg/L (Avg.: 14.08 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	-	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Giyani SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

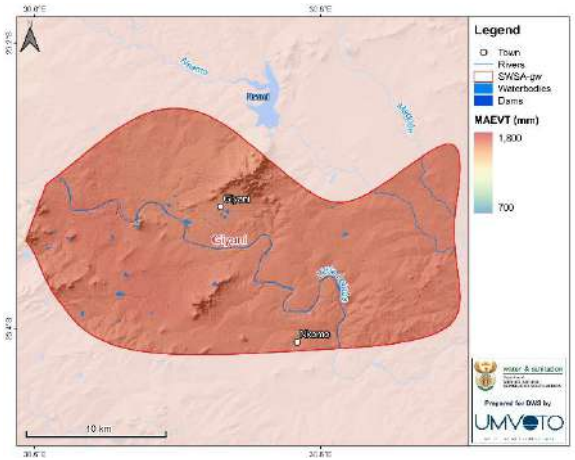
SWSA-gw Name:	Giyani
Area:	438 km²
Elevation:	390-816 mamsl

Threats & Risks

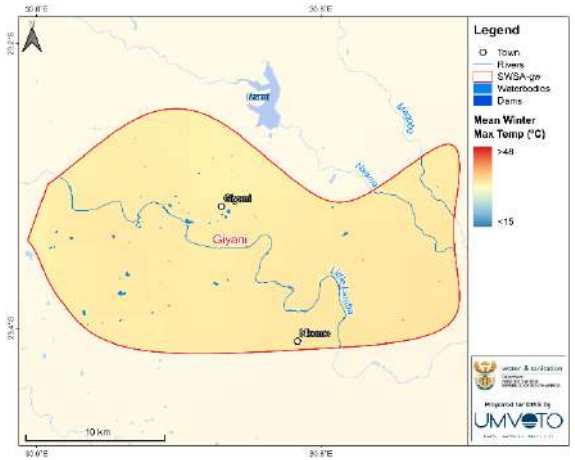
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Giyani SWSA-gw has a predominantly a BSh, hot semi-arid, type climate characterized by hot summers, warm to cool winters, and little to no precipitation, the climate changes to a Cwa, humid subtropical, type climate characterized by hot and humid summers in the northeast. Temperatures in the SWSA-gw range from 6.1 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

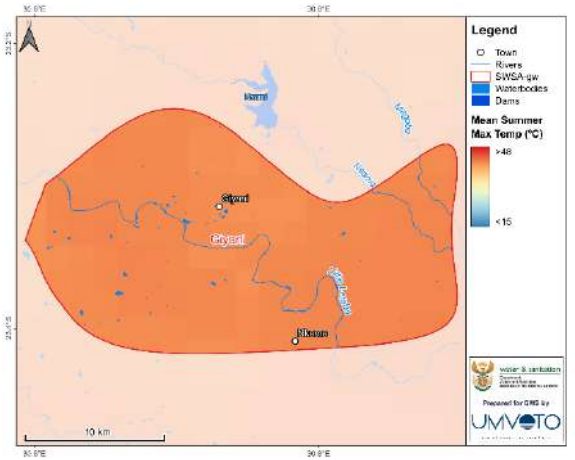
Temperature	Summer: 29.3 to >31 ºC, Winter: 6.1 to >8 °C
Evapotranspiration	Maximum value of 1692 mm/a with an average value of 1663 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, but a small increase in recharge (ranging from ~ 9.6 to 16.5 mm/a). The DART Index indicates mostly stable conditions.



Mean annual A-Pan evaporation) of the Giyani SWSA-gw region.



Mean winter temperatures (Schulze, 2009) of the Giyani SWSA-gw region.



Mean summer temperatures of the Giyani SWSA-gw region.

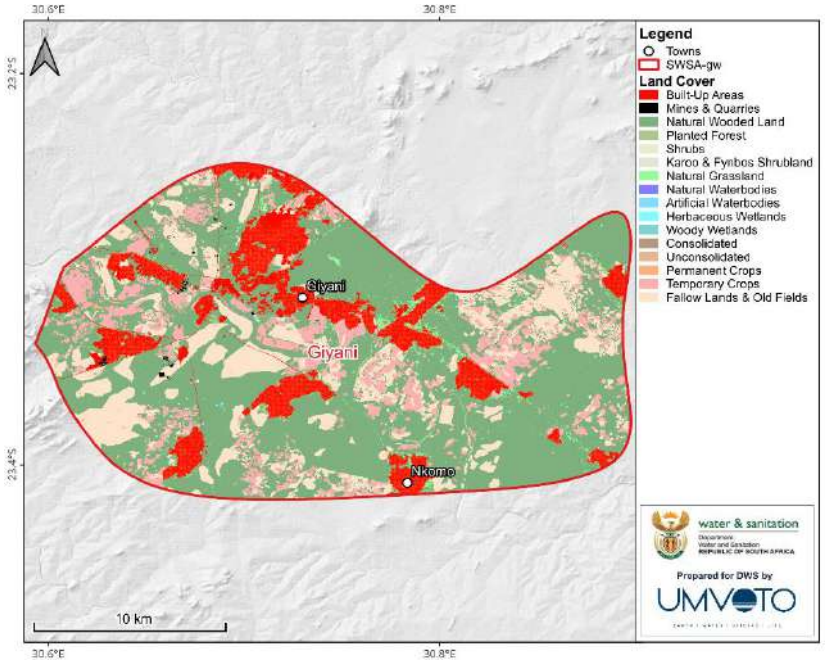
SWSA-gw Name:	Giyani
Area:	438 km²
Elevation:	390 to 816 mamsl

Threats & Risks

Land Use

The Giyani SWSA-gw is predominantly covered by forest land, made up of natural wooded land and planted forest (DFFE, 2022), which serves as a key ecological feature supporting biodiversity and environmental stability. Built-up areas, which consist of residential, commercial and industrial areas, indicate moderate human settlement, reflecting some degree of urbanization, covering scattered portions of the SWSA-gw. Cultivated land, made up of permanent crops, temporary crops, fallow land and old fields, contributes to agricultural activity, though it occupies a smaller proportion of the land compared to natural vegetation. The minimal presence of grassland, wetlands and waterbodies highlights potential limitations in water resources and the region's predominantly wooded landscape.

Land Use Type	Area (km²)	Area (%)
Barren Land	2	0.4
Built-Up	60	13.7
Cultivated	127	29.0
Forest Land	241	55.1
Grassland	7	1.6
Mines and quarries	1	0.1
Shrubland	0.004	0.0
Waterbodies	0.25	0.06
Wetlands	0.16	0.04



Land Cover 24-class map to show the types of land use and extent of each occurring in the Giyani SWSA-gw.

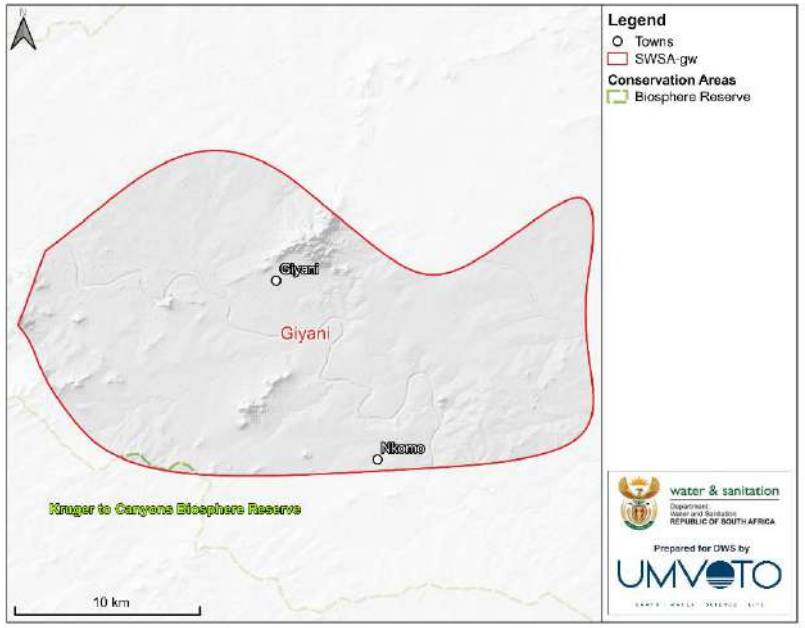
SWSA-gw Name:	Giyani
Area:	438 km^2
Elevation:	390 to 816 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

There are no protected areas in the Giyani SWSA-gw, and the Kruger to Canyons Biosphere Reserve (DFFE, 2024) covers a very small portion of the SWSA-gw, as can be seen on the map.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Kruger to Canyons Biosphere Reserve	1.27	1
Protected Areas	None		0
SGWCA	None		
National Parks	None		0

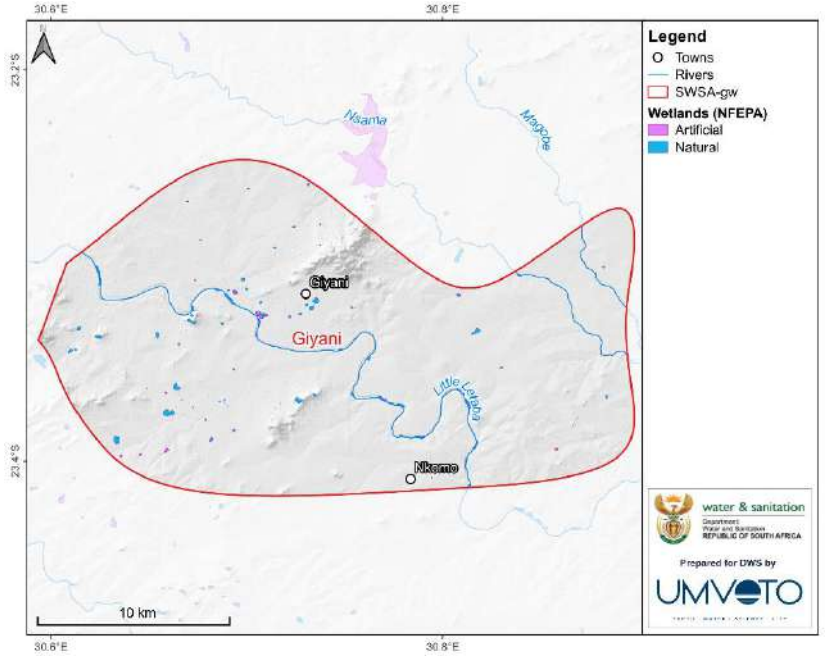


Biospheres, Protected Areas and SGWCAs to show the portions of the Giyani that have protection status.

SWSA-gw Name:	Giyani
Area:	438 km^2
Elevation:	390 to 816 mamsl
Protection Status and Ecosystems	
Biodiversity and Conservation	

There are a few small natural and artificial wetlands (CSIR, 2011) in the Giyani SWSA-gw. The Little Letaba River runs through the centre of the SWSA-gw, but there are no major water bodies, Ramsar sites, or groundwater-dependent ecosystems.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	2	

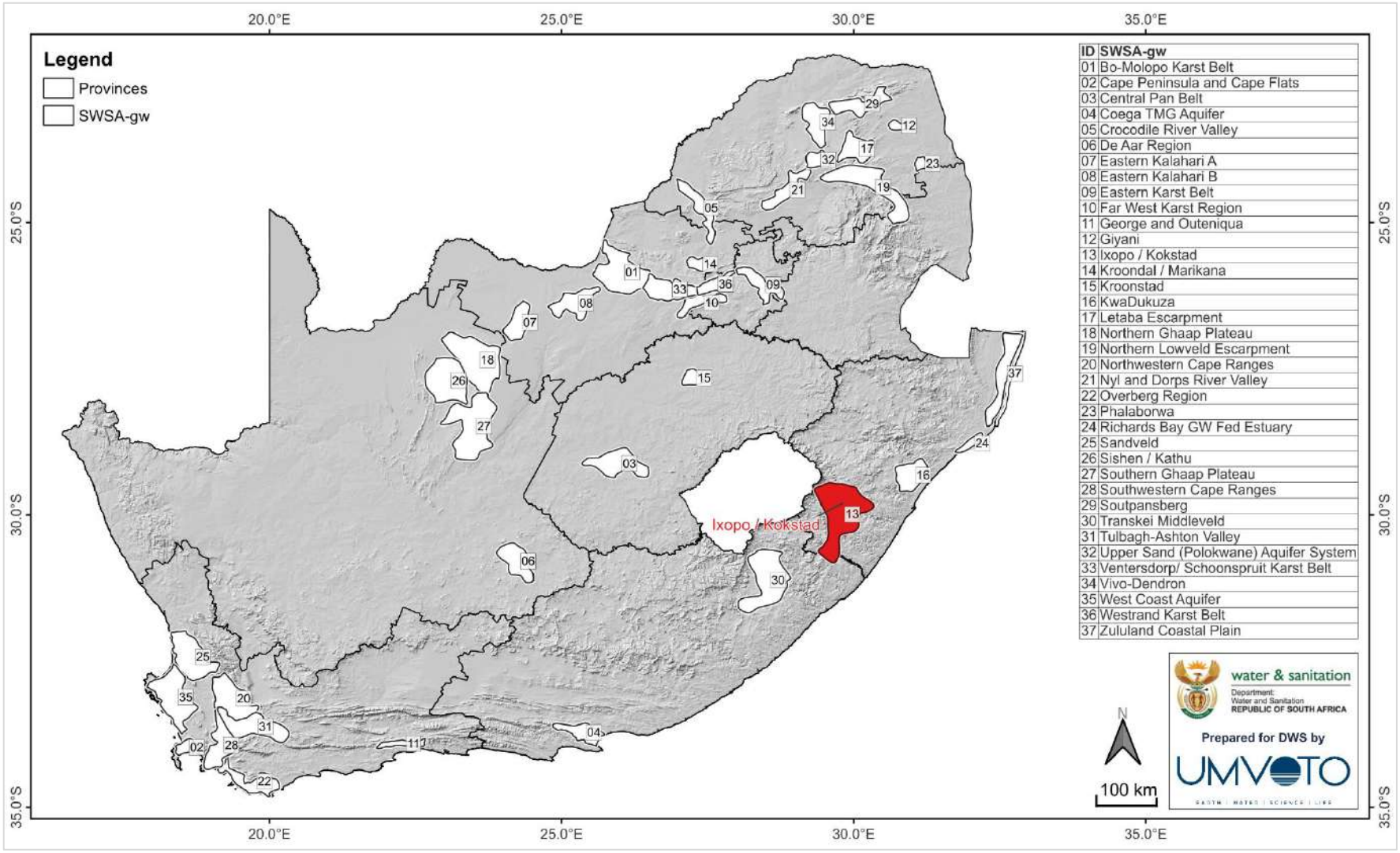


Map showing the major water bodies, Ramsar sites and GDEs in the Giyani SWSA-gw.

APPENDIX 13

IXOPO / KOKSTAD SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE IXOPO / KOKSTAD SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

13. Ixopo/Kokstad

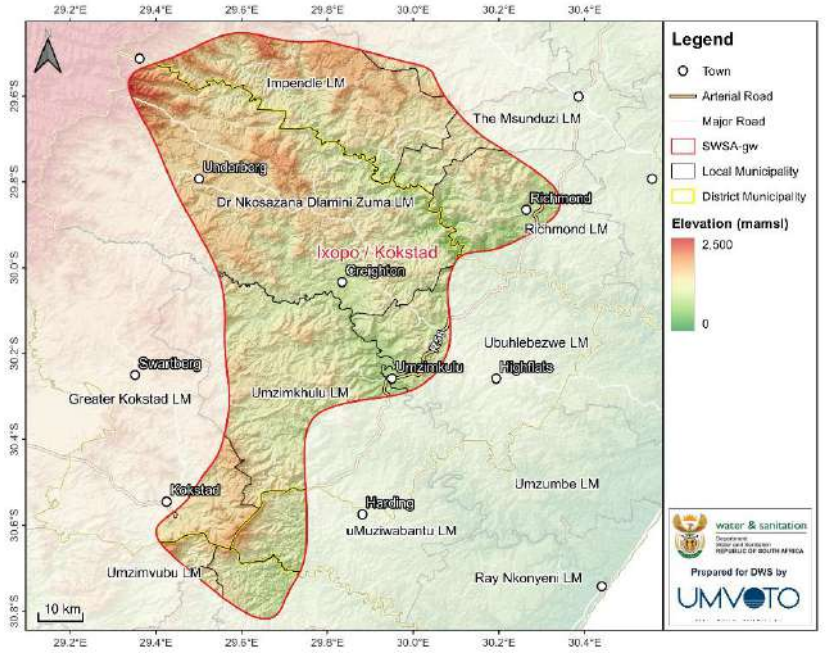
13.1. Description

SWSA-gw Name:	**Ixopo / Kokstad**
Area:	**7150 km^2**
Elevation:	**463 to 2430 mamsl**
Geospatial Context	

The topography of the Ixopo/Kokstad SWSA-gw, as depicted in the map, transitions from the rugged, mountainous terrain of the Drakensberg foothills in the west to the rolling hills and valleys further east. The Kokstad and Mount Ayliff areas feature steep slopes, deep river valleys, and high-altitude plateaus, while moving towards Richmond and Edendale, the terrain becomes more undulating, with ridges and numerous drainage systems shaping the landscape. Elevations generally decrease from west to east, with higher plateaus and mountain ranges giving way to lower-lying hills and river valleys.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	KwaZulu-Natal and Eastern Cape Province
District Municipality	Harry Gwala, Umgungundlovu, Alfred Nzo, and Ugu.
Local Municipalities	Impendle, The Msunduzi, uMngeni, Dr Nkosazana Dlamini Zuma, Richmond, Ubuhlebezwe, Umzimkhulu, Greater Kokstad, uMuziwabantu, Mbizana, Ntabankulu, and Umzimvubu.
Towns	Underberg, Kokstad, and Richmond
Major Roads	N2, R56, R612, and R617
Major Water Supply Networks	No information available



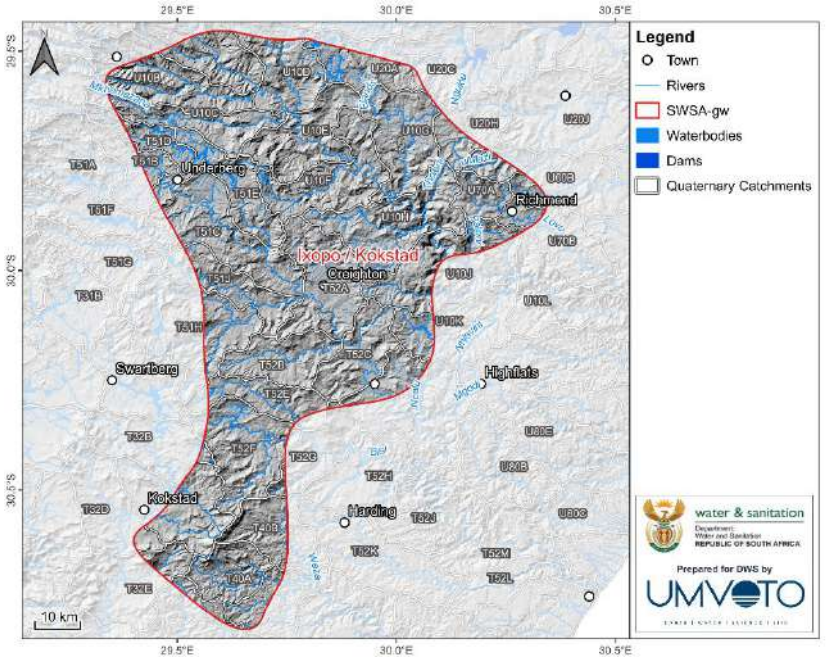
Locality map of Major Towns, District and Local Municipalities in the Ixopo/Kokstad SWSA-gw.

SWSA-gw Name:	Ixopo / Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl

Hydrology and Drainage

The Ixopo / Kokstad SWSA-gw and surrounding areas include major surface water systems, summarised below and displayed on the right map. The Riverdale1800 reservoir is fed by the U7 catchment. There are many perennial rivers in the area spread over multiple catchments (T4, T5, T3, T6, U1, U7, U6 and U2); the rivers predominantly flow southeast.

Quaternary Catchments	T40C, T50B, T32G, T40A, T40B, T60B, T32C, T32B, T52F, T52G, T52E, T52D, T52B, T52C, U10K, U10J, T52A, T51J,T51C, T51E, T51B, T51D, T51H, U10H, U10F, U10E, U70A, U70B, U60B, U60A, U20H, U10G, U20C, U20A, U10D, U10A, U10B, and U10C.
Rivers	Perennial rivers: Goxe, Cabane, Elands, aManzamnyama, Gungununu, Gqishi, Little Bisi, Lufafa, Luhane, Ludeke, KuNtlamvukazi, Lovu, Lotheni, Mbumba, Malenge, Mkhomazana, Mbandana, Mafadobo, Mill Stream, Mkomazi, Mtamvuna, Mzalanyoni, Mkuzane, Mqatsheni, Mvalweni, Mkobeni, Mzintlava, Mzimkhulu, Ngwangwane, Ngudwini, Nhlathimbe
Natural and manmade water bodies	Wetlands: No information available/ unknown. Dams: Riverdale1800, Nooitgedacht903, and Singis.
Major Dams:	Riverdale1800
Water Management Areas:	Pongola Mtamvuna and Mzimvubu Tsitsikamma



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Ixopo / Kokstad SWSA-gw.

SWSA-gw Name:	Ixopo / Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl
Geology	

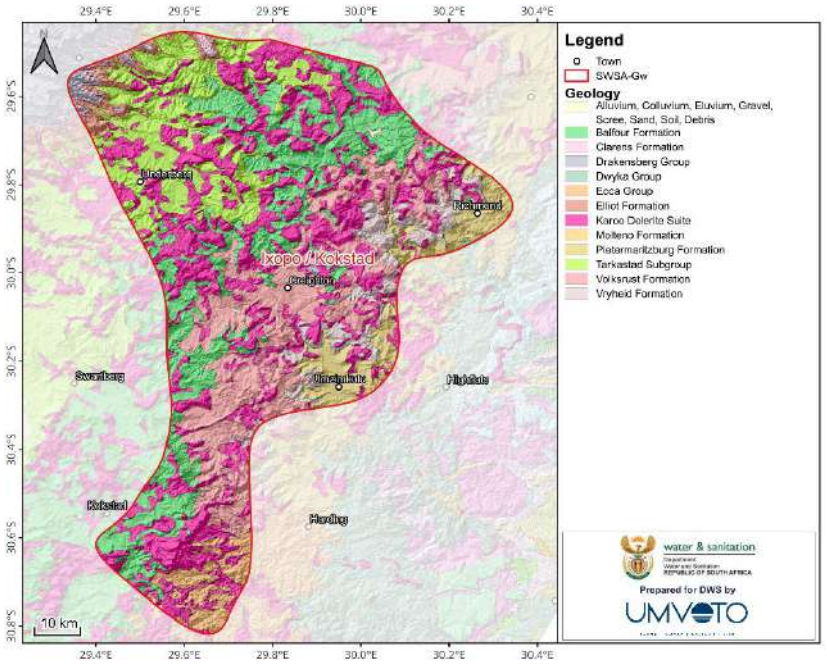
Geology

The Ixopo/Kokstad area is primarily covered by the Karoo Supergroup. The Beaufort Group of the Karoo Supergroup consists of green-grey and (at the top) red mudstone and siltstone, grey shale and rhythmite, sandstone, and fine- to medium-grained sandstone. The Ecca Group outcrops on the eastern side of the area, composed of shale with thin siltstones and sandstones in the uppermost part, as well as mudrock and shale with sandstone-rich units, particularly towards the basin margins in the south, west, and northeast. Coal seams are also present in the northeast.

The Karoo Dolerite Suite is spread across the area, forming a network of dolerite sills, sheets, and dykes, primarily intrusive into the Karoo Supergroup.

Hydrostratigraphy

The Beaufort and Ecca Groups form secondary, fractured rock aquifer systems. The Karoo Dolerite Suite, consisting of dykes and sills, enhances secondary porosity. In some areas, shallow weathered zones and alluvial deposits support minor primary intergranular aquifers.



Geology Map of the Ixopo / Kokstad SWSA-gw region.

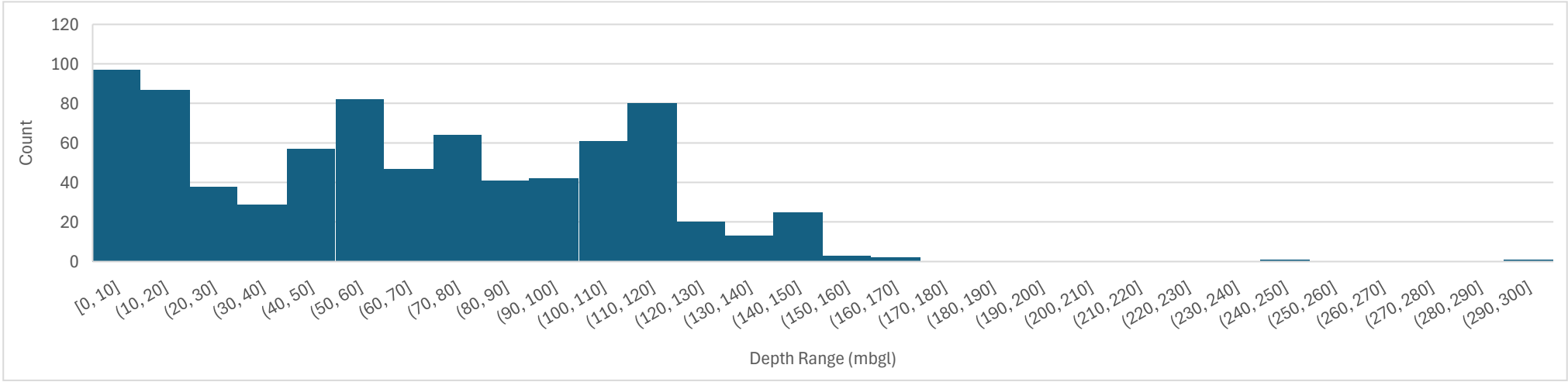
13.2. Current Status

SWSA-gw Name:	**Ixopo / Kokstad**
Area:	**7150 km^2**
Elevation:	**463 to 2430 mamsl**
Quantity & Quality	
Aquifer Classification	

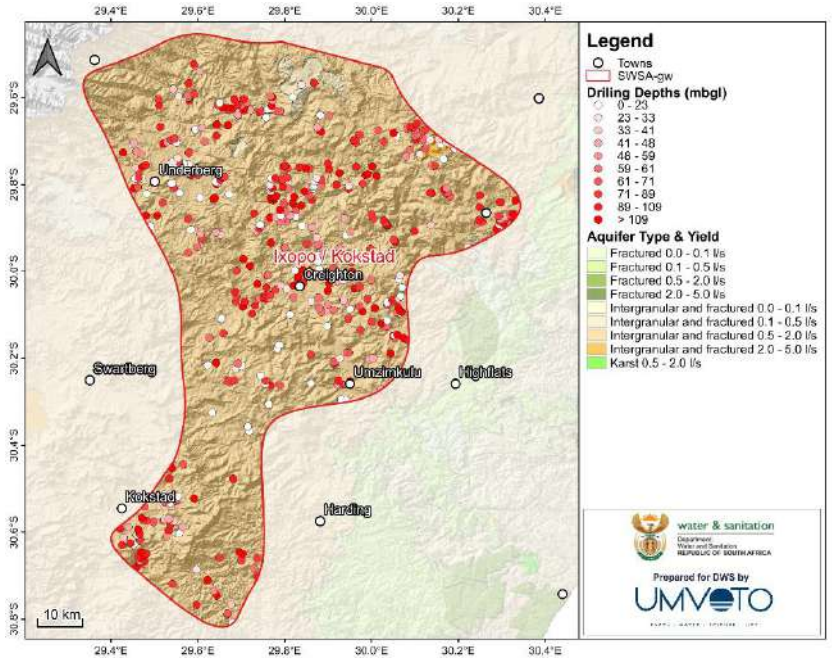
The aquifer systems within the Ixopo / Kokstad SWSA-gw exhibit varying yields across dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is a minor aquifer system with an average dual-porosity yield of 0.5 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 66 mbgl, and the most common depths are around 10mbgl and between 100 to 120 mbgl, suggesting mixed targets. Some deeper boreholes in the centre reach depths of > 200 mbgl, extending into fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 30 and 102 mbgl. Based on the past 25 years of NGA water level data, the average groundwater level in the region is ~ 22 mbgl, with values ranging from 0 to 131 mbgl and a standard deviation of ~ 23 mbgl.

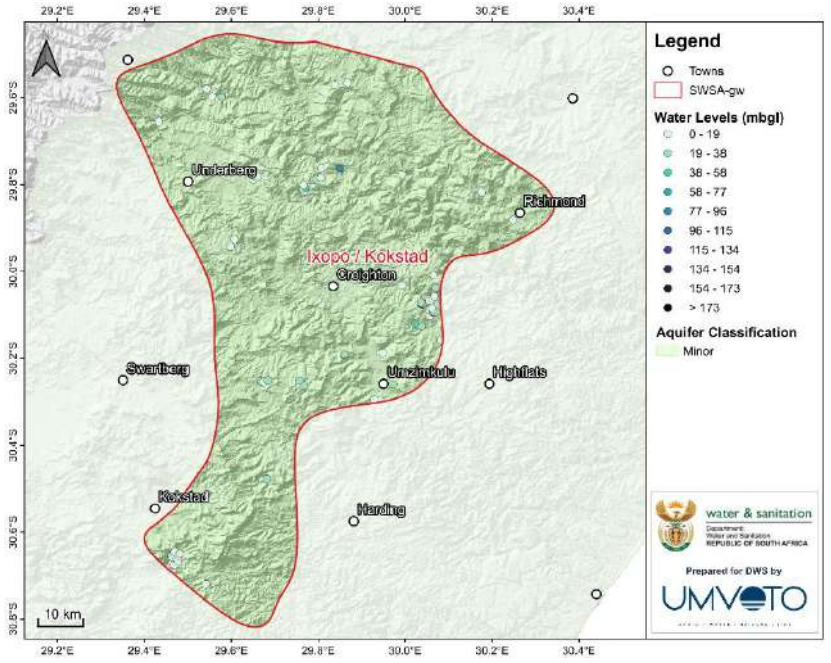
Graph of NGA drilling depths of the Ixopo / Kokstad SWSA-gw region



SWSA-gw Name:	Ixopo / Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Ixopo / Kokstad SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Ixopo / Kokstad SWSA-gw region.

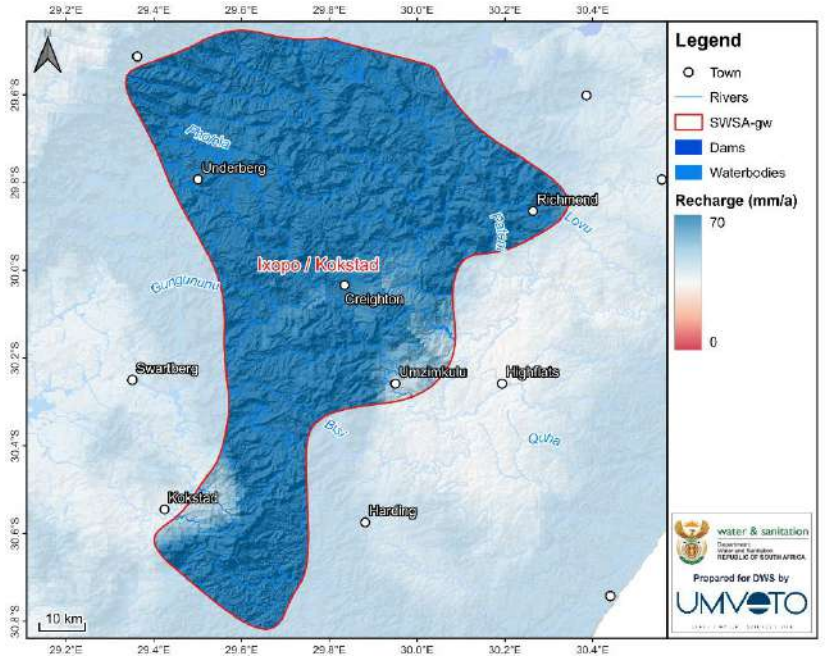
SWSA-gw Name:	**Ixopo / Kokstad**
Area:	**7150 km^2**
Elevation:	**463 to 2430 mamsl**

Quantity & Quality

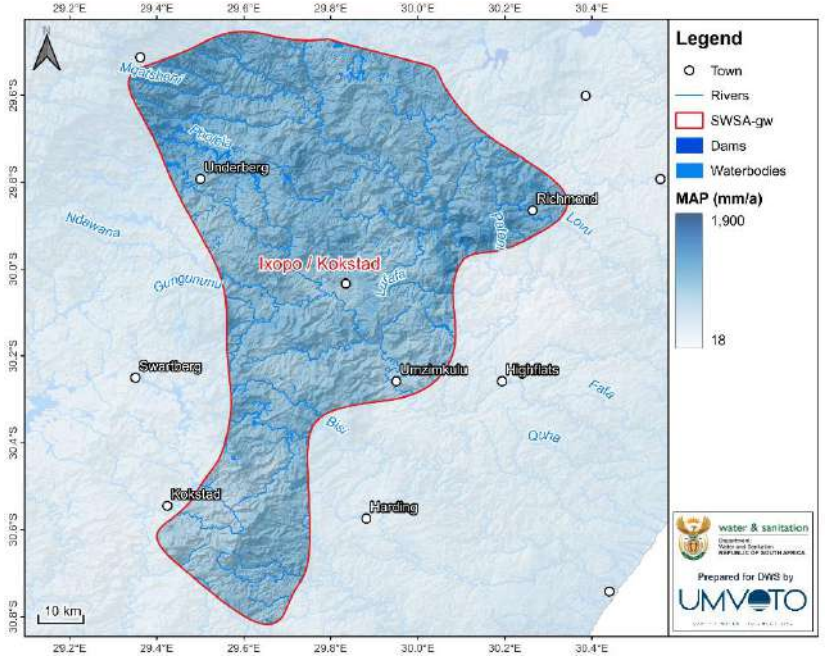
Groundwater Recharge

The Ixopo/ Kokstad Region receives a total MAP volume of 6521 Mm^3/a, with a significantly high average rainfall of 911 mm/a. Despite this, only 681.2 Mm^3/a contributes to groundwater recharge, resulting in a moderate recharge of 10.5% of MAP. This suggests that while the area experiences relatively high rainfall, a substantial portion is still lost to runoff, evaporation, or surface water flow, though recharge efficiency is better compared to drier regions.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Ixopo / Kokstad	6521	911	681.2	95.2	10.5%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Ixopo / Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl

Quantity & Quality

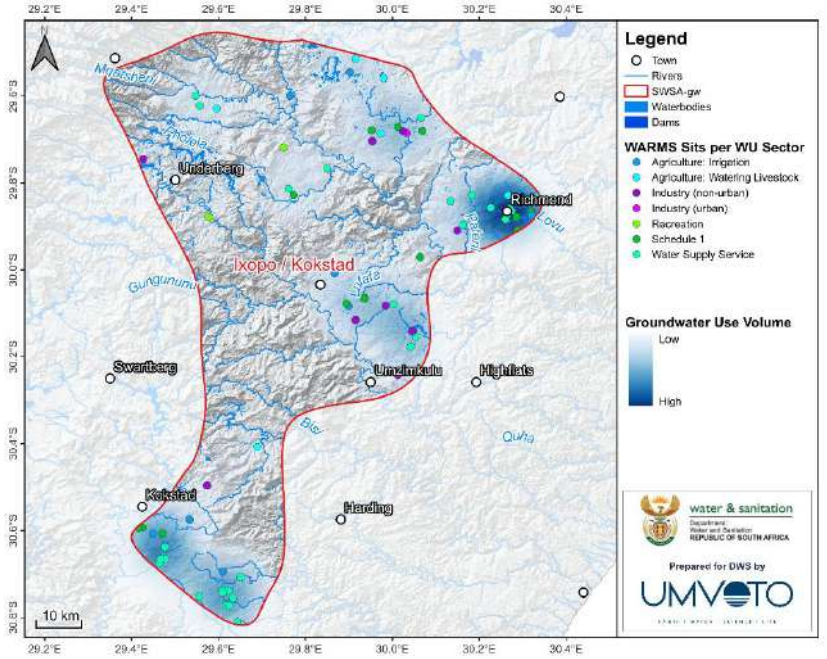
Groundwater Use

The Ixopo Kokstad SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Bulwer (Conjunctive) and Richmond (Conjunctive), which rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Municipal water supply services, at 1.6 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. Use is concentrated in the area surrounding Richmond as well as the southernmost part of the region.
- Agricultural irrigation use, with 0.5 Mm^3/a to sustain crop production. The distribution of use is like the municipal water supply, suggesting that both households and agriculture are quite reliant on the groundwater.
- Non-Urban industrial follows, using 0.1 Mm^3/a, for manufacturing, processing, and other industrial activities outside urban centres. This is mainly located in the northern parts of the area around Richmond.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Richmond, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	0.5
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	0.1
	Industry (Urban)	0.1
	Schedule 1	0.04
	Water Supply Service	1.6
	Total	**2.3**



Water use map for the Ixopo Kokstad SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

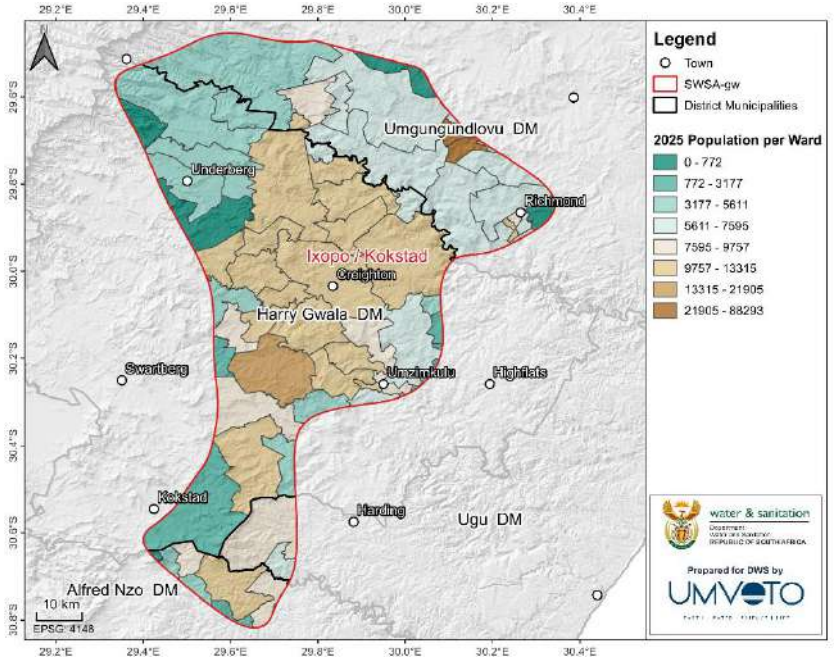
SWSA-gw Name:	Ixopo / Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Ixopo / Kokstad SWSA-gw is located within the Pongola-Mtamvuna Water Management Area (WMA, 2023). The groundwater resources within the Zululand Coastal Plain SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Pongola-Mtamvuna Catchment Management Agency (PUCMA), which was formed as part of a national restructuring process that consolidated CMAs. PUCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the PUCMA to manage water resources in the Pongola-Mtamvuna WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	PUCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Pongola-Mtamvuna WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA/WSP	In both provinces, the district municipalities are the relevant Water Service Authorities and Water Services Providers.

The estimated 2025 population within the Ixopo / Kokstad SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 0.16% per year, resulting in a projected population of approximately 358,959.

As shown in the map and table below, Dr Nkosazana Dlamini Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 86,559, followed by Umzimkhulu LM with 80,049.



Projected population distribution in 2025 for the Ixopo / Kokstad SWSA-gw.

SWSA-gw Name:	Ixopo / Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl

Quantity & Quality

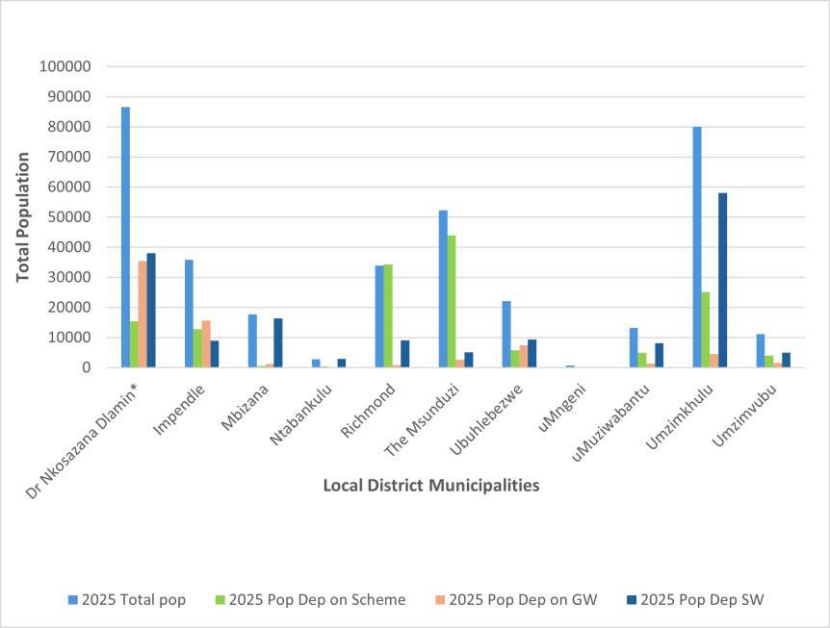
Socio Economic & Governance

In terms of water reliance within the Ixopo / Kokstad SWSA-gw, an estimated 45.0% of the population depends on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources), 41.3% on regional water supply scheme and 20.0% on groundwater sources (including boreholes and springs).

Among the LMs, the Impendle LM has the highest proportion of groundwater reliance, with approximately 43.7% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Dr Nkosazana Dlamin*	86,558.89	15,382	35,379	37,977
Greater Kokstad	2,493.75	833	700	383
Impendle	35,900.86	12,767	15,692	8,950
Mbizana	17,678.18	645	1,346	16,399
Ntabankulu	2,844.65	503	55	2,944
Richmond	33,894.02	34,282	874	9,132
The Msunduzi	52,361.70	43,902	2,686	5,115
Ubuhlebezwe	22,132.11	5,840	7,464	9,306
uMngeni	710.10	85	105	87
uMuziwabantu	13,237.94	4,993	1,434	8,154
Umzimkhulu	80,048.47	25,095	4,574	58,020
Umzimvubu	11,097.97	3,985	1,509	5,004
Total	**358,959**	**148,312**	**71,816**	**161,473**



Projected population dependence on water sources in 2025.

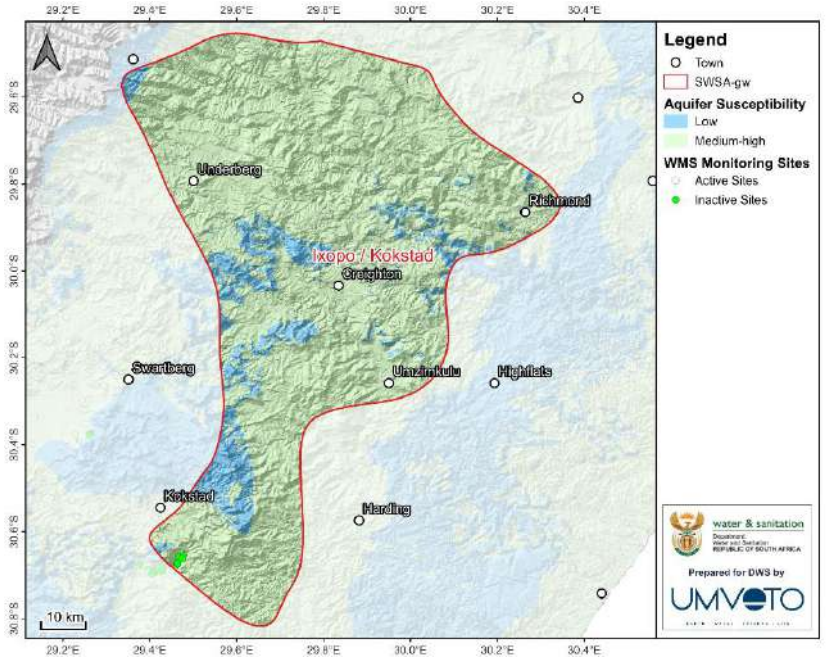
SWSA-gw Name:	Ixopo / Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl
Quantity & Quality	
Groundwater Quality	

The Ixopo / Kokstad SWSA-gw consists of the Minor aquifer systems, classified based on their yield and water quality. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 1119.18 km^2, which is 15.65% of the Ixopo / Kokstad SWSA-gw total area. Urban/Built-up areas cover 564.11 km^2 (7.89%), while mines and quarries account for 35.10 km^2 (0.49%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

WMS data is only available for the moderately vulnerable aquifer areas in the Minor Aquifer system.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 22 – 26 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.08 - 0.17 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 2.47 - 2.79mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 7.7 - 7.9 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 2.64 - 2.74 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Ixopo / Kokstad**
Area:	**7150 km^2**
Elevation:	**463 to 2430 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Ixopo / Kokstad SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	3	30.00	10	24.67	mS/m	2014-2024 GW Geosites: <70 mS/m. Consistent with WMS (2000-2024).	22 - 26 mS/m (Avg.: 24.67 mS/m). 2014-2024 GW Geosites: <70 mS/m. Consistent with WMS (2000-2024).	-
Fluoride	3	30.00	10	0.12	mg/L	2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	0.08 - 0.17 mg/L (Avg.: 0.12 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	-
Nitrate + Nitrite Nitrogen	3	30.00	10	2.62	mg/L	2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	2.47 - 2.79 mg/L (Avg.: 2.62 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	-
pH	3	30.00	10	7.83	pH unit	2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	7.7 - 7.9 (Avg.: 7.83). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	-
Sulphate	3	30.00	10	2.68	mg/L	2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	2.64 - 2.74 mg/L (Avg.: 2.68 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Ixopo / Kokstad SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

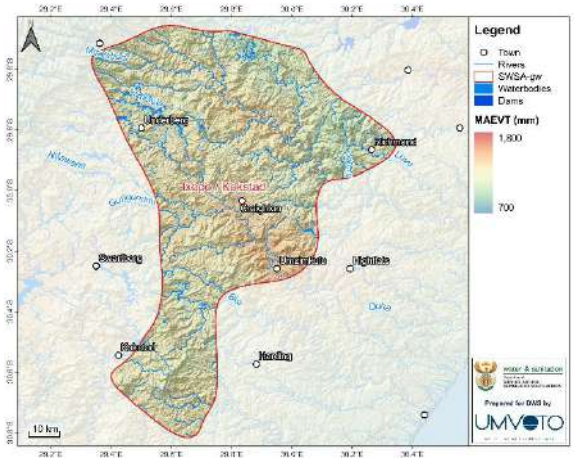
SWSA-gw Name:	Ixopo / Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl

Threats & Risks

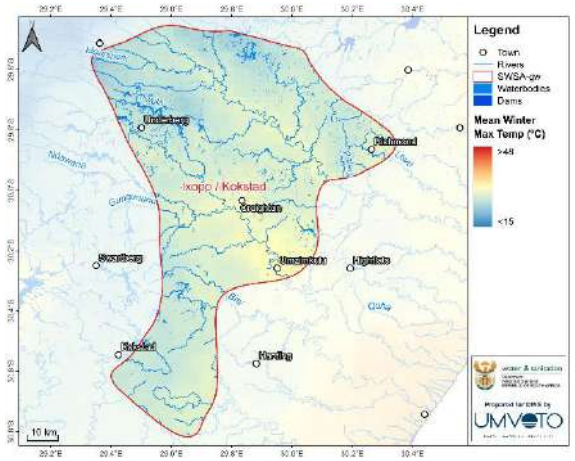
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Ixopo / Kokstad SWSA-fw has a predominantly a Cwb, subtropical highland, type climate characterised by warm summers and dry winters changing to a Cwa, humid subtropical, type climate characterised by hot summers and cool winters towards the eastern border. Temperatures in the SWSA-gw range from -1.9 – 29.2 ºC (i.e., winter min and summer max), MAP generally increases towards the north, and the average MAP is ~ 981 mm/a. For more details, see the table and maps below.

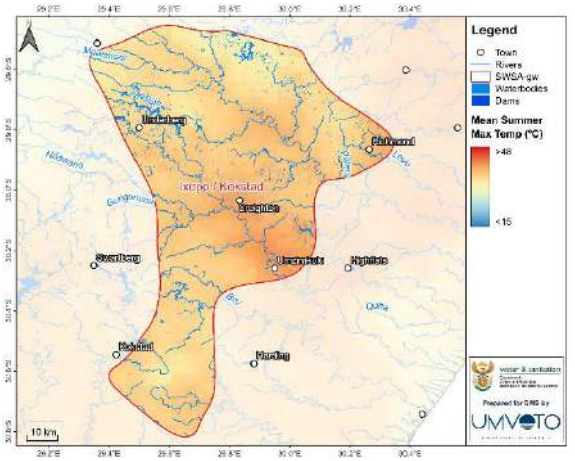
Temperature	Summer: 24.7 to 29.2 °C, Winter; -1.9 to >8 ºC
Evapotranspiration	Maximum value of 1485 mm/a with an average value of 1266 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, but an increase in recharge (ranging from ~ 2.5 to 13.2 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Ixopo / Kokstad SWSA-gw region.



Mean winter temperatures of the Ixopo / Kokstad SWSA-gw region.



Mean summer temperatures of the Ixopo / Kokstad SWSA-gw region.

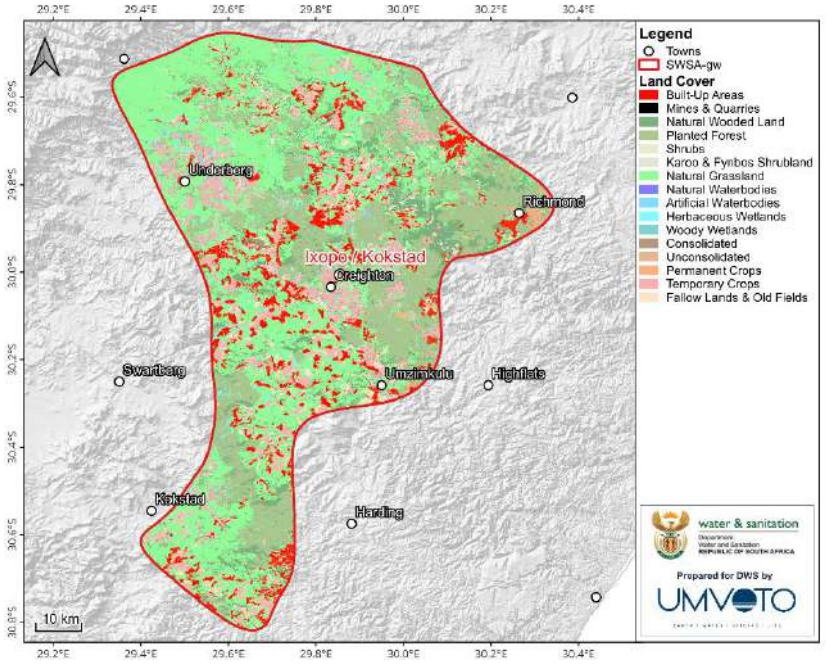
SWSA-gw Name:	Ixopo/Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl

Threats & Risks

Land Use

The dominant land cover in the Ixopo/Kokstad SWSA-gw is grassland (DFFE, 2022), which plays a crucial role in supporting biodiversity and maintaining ecosystem balance. Forest land, which includes planted forests and natural wooded land, forms a significant portion of the landscape, indicating extensive forestry activities. Cultivated land, including temporary crops, permanent crops, fallow lands and old fields, contributes to land use, though they are less prominent than natural vegetation. Built-up areas, made up of residential, commercial and industrial areas, suggest moderate human settlement, while wetlands and waterbodies indicate limited but vital water resources. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.5% of the area, located predominantly in the northwest of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	21	0.3
Built-Up	564	7.9
Cultivated	1119	15.7
Forest Land	2256	31.6
Grassland	2968	41.5
Mines and quarries	35	0.5
Waterbodies	37	0.5
Wetlands	149	2.1



Land Cover 24-class map to show the types of land use and extent of each occurring in the Ixopo/Kokstad SWSA-gw.

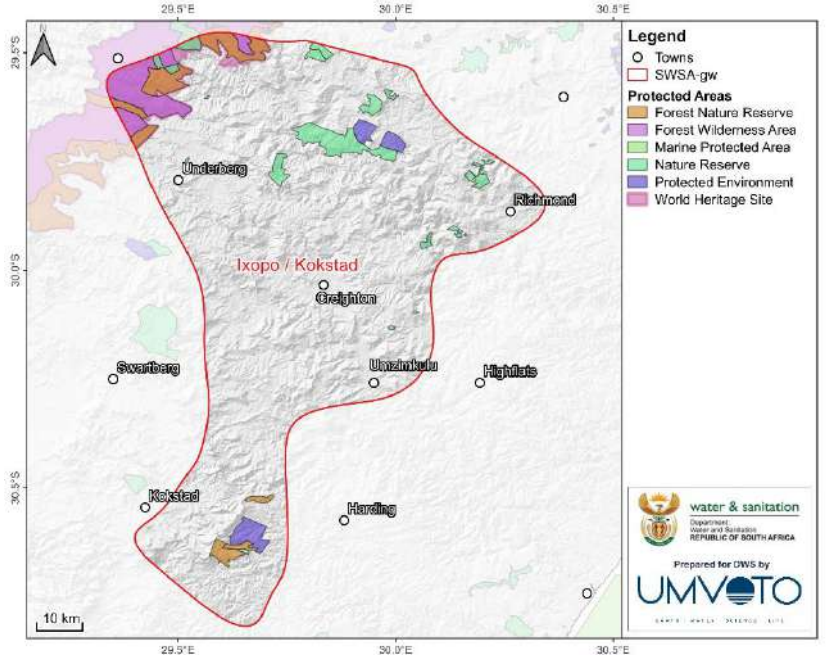
SWSA-gw Name:	Ixopo/Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Ixopo/Kokstad SWSA-gw has many protected areas, but because of the large size of the SWSA-gw, these areas make up a very small portion of the SWSA-gw.
The Ukhlamba Drakensberg Peak, a world heritage site (DFFE, 2024), partially falls within the SWSA-gw and extends northeast and southeast along the border of Lesotho. The Mzimkhulu Wilderness, Upper Mkhomazi Wilderness Area, and Mzimkulwana Nature Reserve all fall within this world heritage site and partially in the SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	• Ukhahlamba Drakensberg Peak • Ngele Nature Reserve • Upper Mkhomazi Wilderness Area • Mzimkulu Wilderness Area • Impendle Nature Reserve • Clairmont Nature Reserve • Mzimkulwana Nature Reserve • Mount Shannon Protected Environment • And various other small forest nature reserves, forest wilderness areas and nature reserves	1007.99	26
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Ixopo/Kokstad SWSA-gw that have protection status.

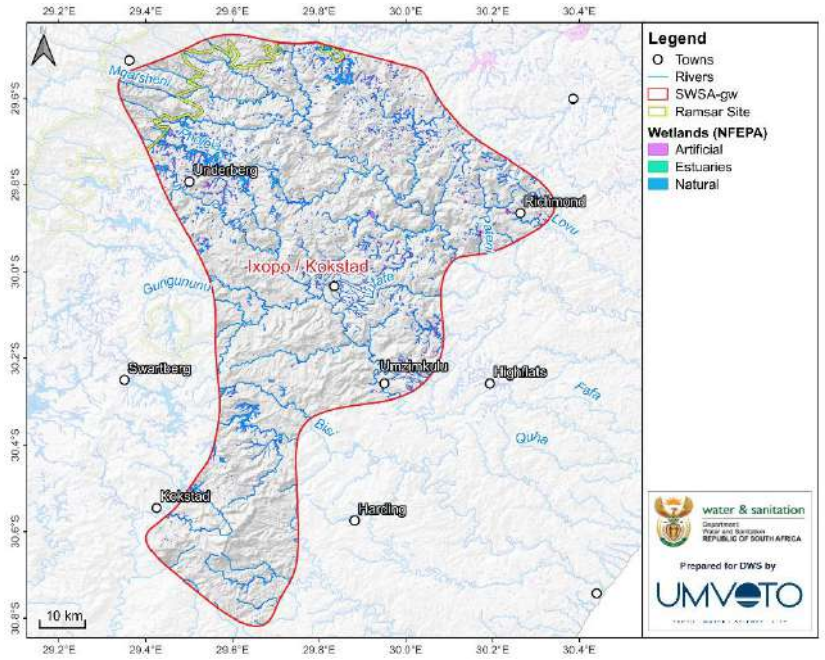
SWSA-gw Name:	Ixopo/Kokstad
Area:	7150 km^2
Elevation:	463 to 2430 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

There are two Ramsar-protected areas in the Ixopo/Kokstad SWSA-gw (DFFE, 2024). The Umgeni Vlei Nature Reserve is the smaller of the two, covering an area of 9.59 km^2, and is located on the northern edge of the SWSA-gw. The Natal Drakensberg Park is much larger and overlaps part of the SWSA-gw on the northwestern corner and is also a world heritage site and contains a few nature reserves and forest nature reserves. There are various small natural, artificial and estuary wetlands (CSIR, 2011) which cover approximately 3% of the SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	• Natal Drakensberg Park • Umgeni Vlei Nature Reserve	358.71	2
Wetlands	Various small natural, artificial and estuary wetlands	208	

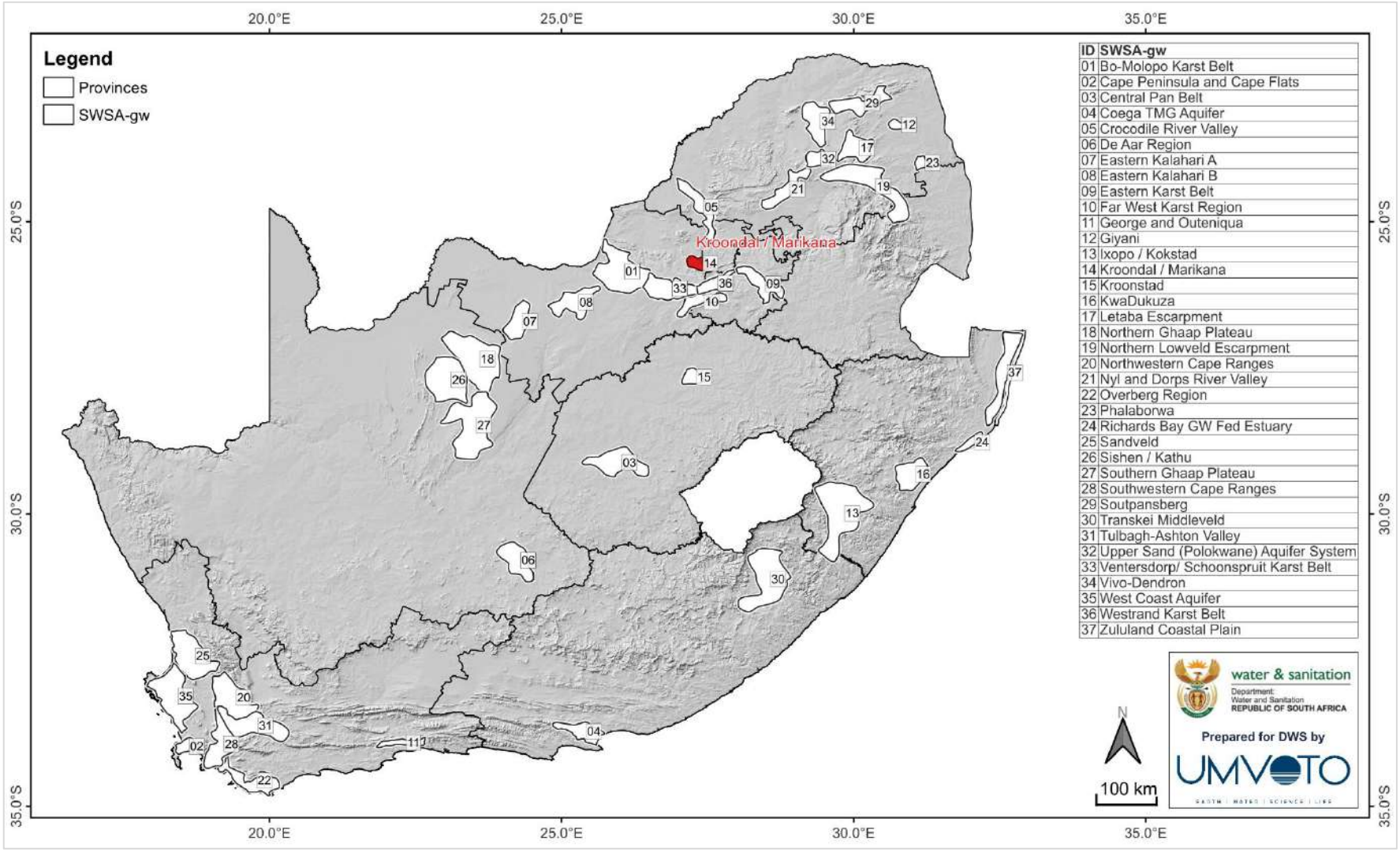


Map showing the major water bodies, Ramsar sites and GDEs in the Ixopo/Kokstad SWSA-gw.

APPENDIX 14

KROONDAL / MARIKANA SWSA SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE KROONDAL / MARIKANA SWSA-GW



14. Kroondal / Marikana

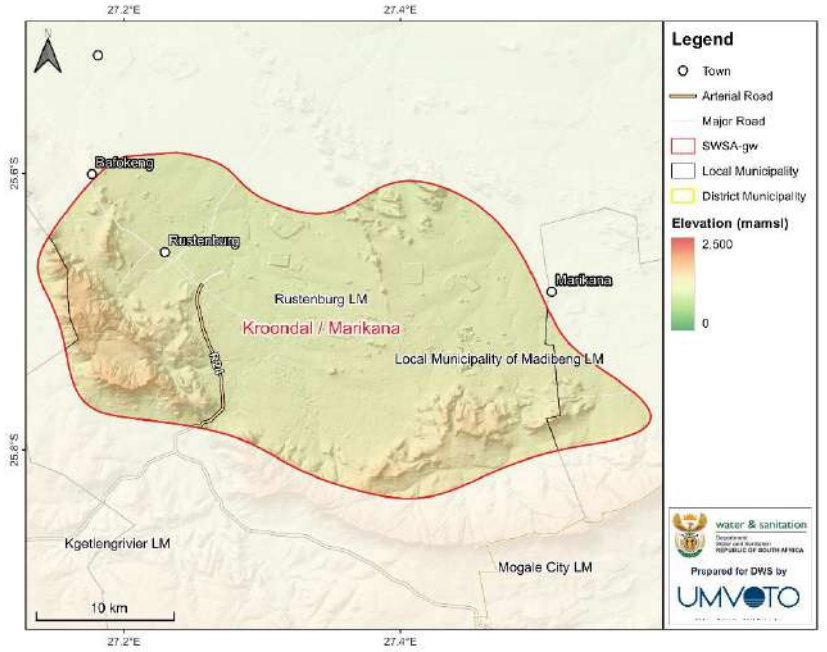
14.1. Description

SWSA-gw Name:	Kroondal/Marikana
Area:	795 km²
Elevation:	1092 to 1677 mamsl
Geospatial Context	

The topography of the Kroondal/Marikana SWSA-gw, as depicted in the map, is characterized by rugged terrain, rolling hills, and steep slopes, particularly near the Magaliesberg mountain range to the south. The Magaliesberg creates a distinct topographical feature, with rocky outcrops and sharp ridges cutting through the landscape. The area around Rustenburg and Marikana is more undulating, with gently sloping hills and some river valleys. Moving towards the Olifantsnek Dam and Buffelspoort Dam, the terrain becomes increasingly interrupted by hills and small ridges, with both dams situated in valleys surrounded by elevated terrain.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	North West
District Municipality	Bojanala
Local Municipality	Kgetlengrivier, Rustenburg and Madibeng
Towns	Rustenburg, Bafokeng, Kroondal, Marikana and Mooinooi
Major Roads	N4 and R104
Major Water Supply Networks	Magalies Water Rustenberg Scheme



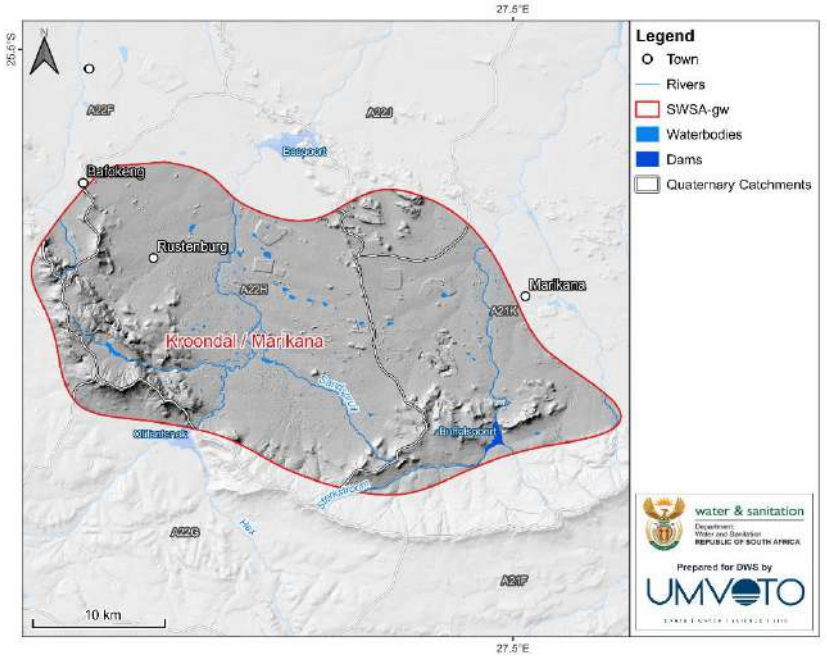
Locality map of Major Towns, District and Local Municipalities in the Kroondal/Marikana SWSA-gw.

SWSA-gw Name:	Kroondal/Marikana
Area:	795 km²
Elevation:	1092 to 1677 mamsl

Hydrology and Drainage

The Kroondal/Marikana SWSA-gw and surrounding areas include major surface water systems, which are summarised below and displayed on the map to the right. The Olifantsnek and Buffelspoort dams are located in the southern area, along with two perennial rivers, the Leragane and Maretlwana, both fed by the A2 catchment and flowing in a northerly direction.

Quaternary Catchments	A21K, A22C, A22F, A22G, A22H and A22J
Rivers	Perennial: Leragane, Maretlwana
	Ephemeral: Hex, Kleinwater, Sandspruit, Sterkstroom, Waterkloofspruit
Natural and manmade water bodies	
Major Dams:	Olifantsnek and Buffelspoort
Water Management Areas:	Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Kroondal/Marikana SWSA-gw

SWSA-gw Name:	Kroondal/Marikana
Area:	795 km²
Elevation:	1092 to 1677 mamsl
Geology	

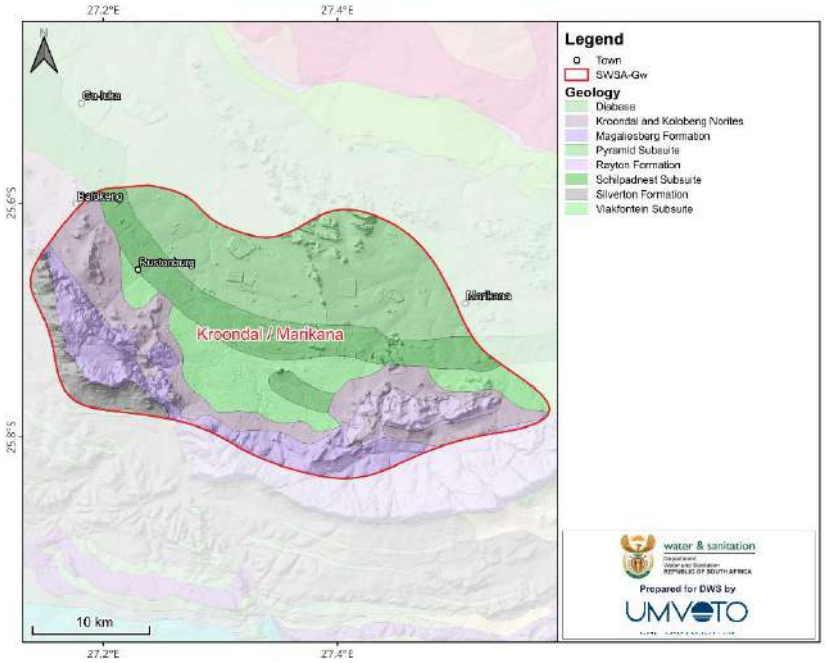
Geology

The northern half of the area is predominantly made up of the Rustenburg Layered Suite of the Bushveld Complex, featuring gabbro and norite with interlayered anorthosite, leuconorite, anorthosite, pyroxenite, chromitite, norite, and quartz norite.

The southern half of the area comprises the Pretoria Group of the Transvaal Supergroup, characterised by minor hornfels, quartzite with varying amounts of shale and sub-greywacke, shale with subordinate siltstone, as well as minor limestone or dolomite, basalt, and tuff.

Hydrostratigraphy

The Rustenburg Layered Suite forms a secondary, fractured rock aquifer system, while the Pretoria Group contributes to a mixed aquifer system, where quartzites and fractured shales support secondary permeability, while minor dolomitic units may contain localized intergranular-fractured aquifers.



Geology Map of the Kroondal/Marikana SWSA-gw region.

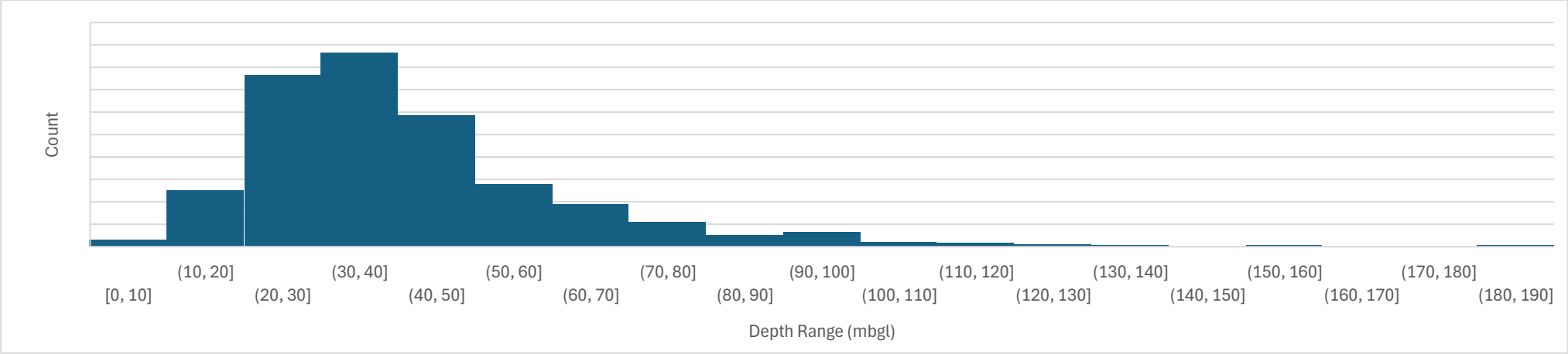
14.2. Current Status

SWSA-gw Name:	**Kroondal/Marikana**
Area:	**795 km²**
Elevation:	**1092 to 1677 mamsl**
Quantity & Quality	
Aquifer Classification	

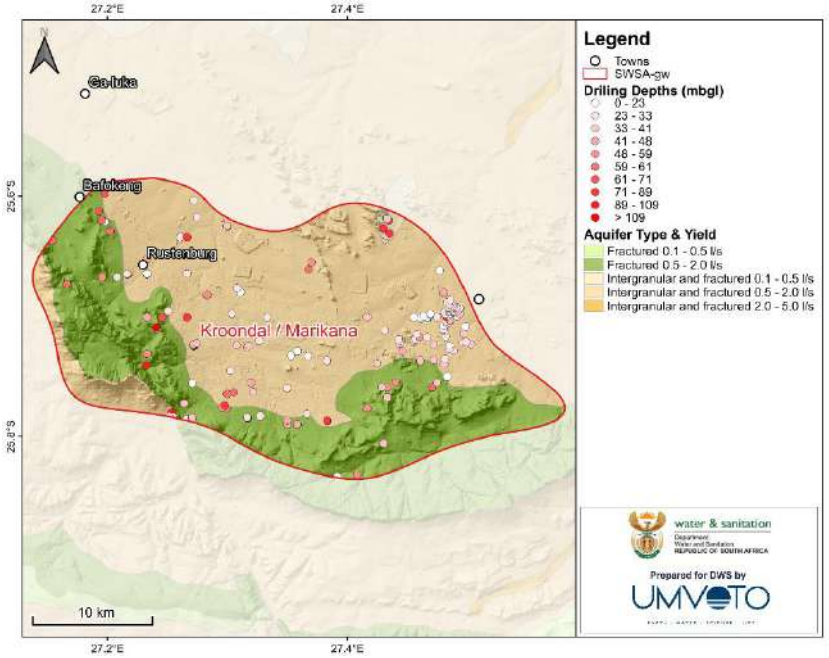
The aquifer systems within the Kroondal/Marikana SWSA-gw exhibit varying yields across fractured and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The majority of the SWSA-gw consists of a minor aquifer system, with a poor aquifer system in the central southern section. The major aquifer system has an average fractured and dual-porosity yield of 0.5 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 42 mbgl, and the most common depths are between 30 and 40 mbgl. The majority of the boreholes target the upper dual-porosity aquifer system. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 30 and 49 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 15 mbgl, with values ranging from 3 to 36 mbgl and a standard deviation of ~ 6 mbgl.

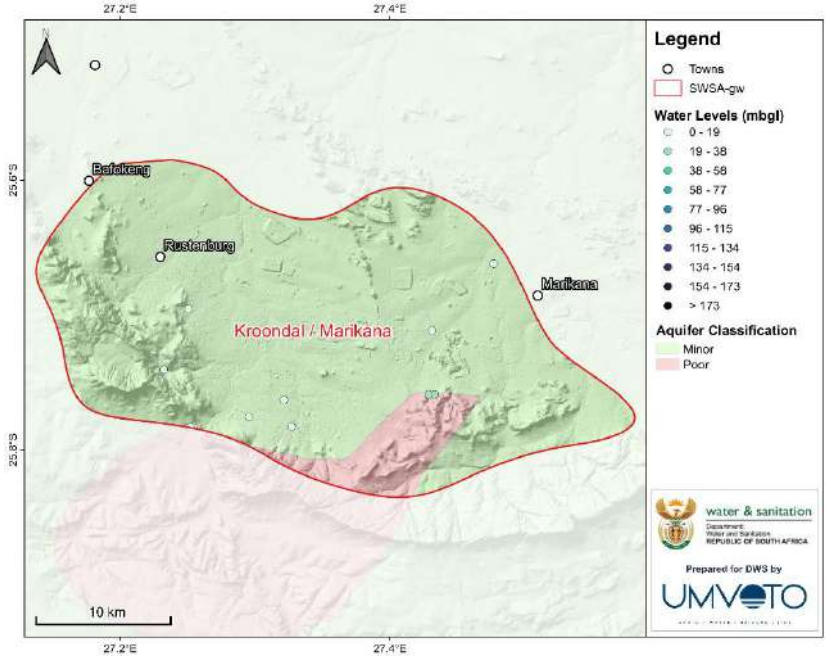
Graph of NGA drilling depths of the Kroondal/Marikana SWSA-gw region



SWSA-gw Name:	Kroondal/Marikana
Area:	795 km²
Elevation:	1092 to 1677 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Kroondal/Marikana SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Kroondal/Marikana SWSA-gw region.

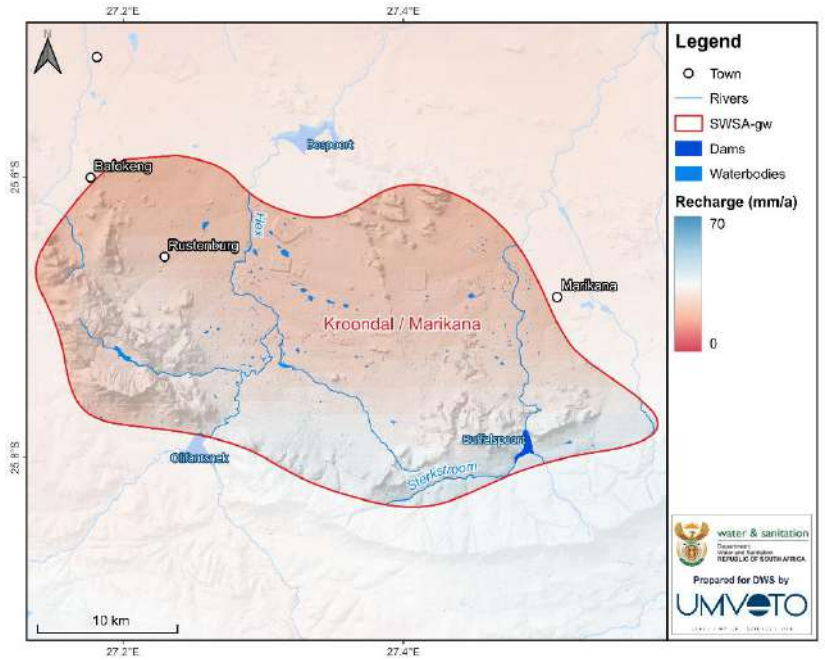
SWSA-gw Name:	**Kroondal/Marikana**
Area:	**795 km²**
Elevation:	**1092 to 1677 mamsl**

Quantity & Quality

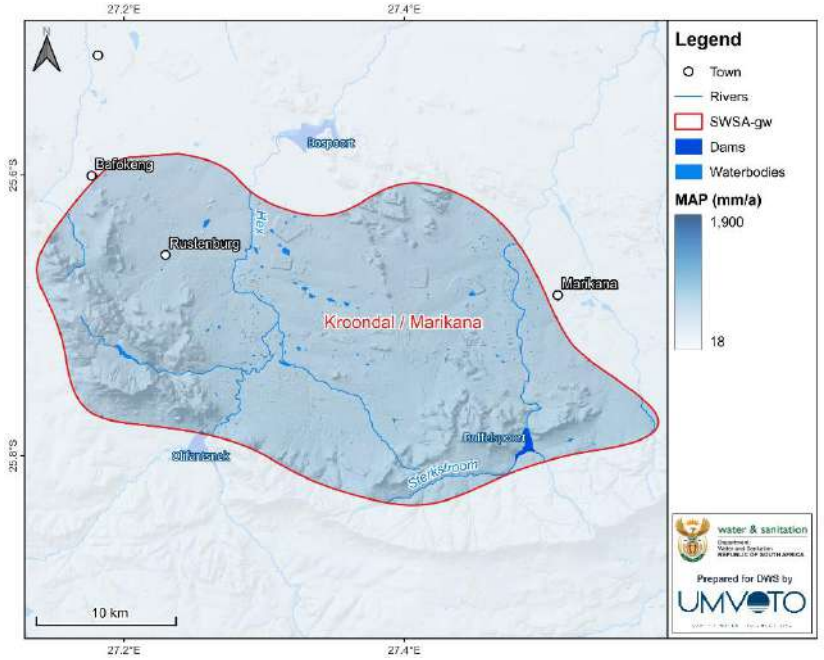
Groundwater Recharge

The Kroondal/ Marikana receives a total MAP volume of 511 Mm^3/a, with an average rainfall of 642 mm/a. However, only 22.7 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 4.4% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Kroondal / Marikana	511	642	22.7	28.6	4.4%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

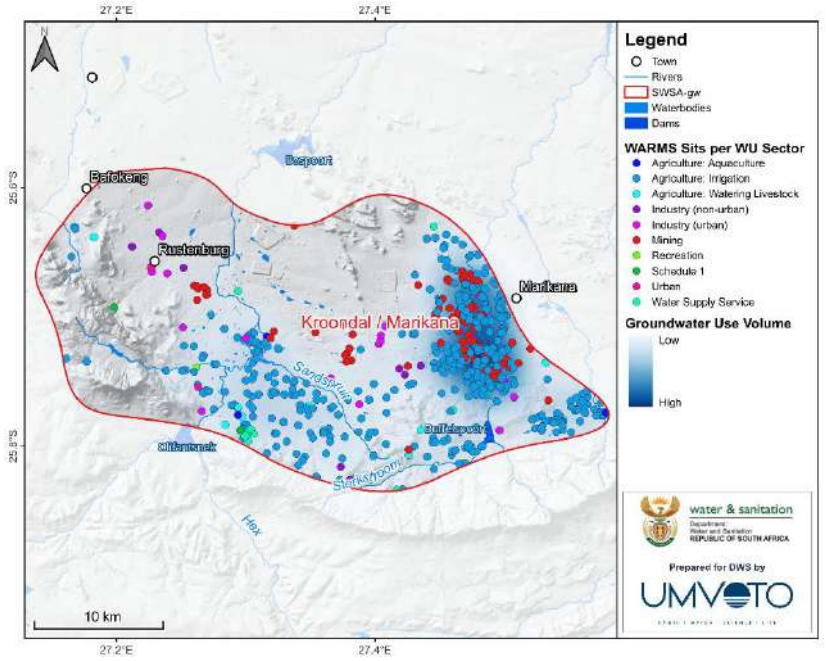
SWSA-gw Name:	Kroondal/Marikana
Area:	795 km²
Elevation:	1092 to 1677 mamsl
Quantity & Quality	
Groundwater Use	

The Kroondal Marikana SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. While no towns in this region rely primarily on groundwater for mining, industrial use, or agriculture (see Table below), an analysis of active groundwater use licenses from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Mining use is the largest, with 25.7 Mm^3/a allocated. Water is a vital resource in the mining process. Groundwater can offer a reliable water source in water-scarce or remote areas. The majority of the mining groundwater use occurs around Rustenburg and Marikana. Suggesting that a few mines are the biggest consumers of groundwater in the region.
- Agricultural irrigation use follows, with 10.5 Mm^3/a to sustain crop production. Despite having less volume than mining, the distribution of irrigation is more scattered throughout the region, however, use is predominantly in the southern parts of the region.
- Urban industrial follows, using 0.8 Mm^3/a allocated for manufacturing, processing, and other industrial activities in urban centers. Use is scattered around the map, close to the cities like Rustenburg and Marikana.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Marikana, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Aquaculture	0.2
	Agriculture: Irrigation	10.5
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	0.1
	Industry (Urban)	1.12
	Mining	25.7
	Urban (excluding industrial/domestic)	0.1
	Water Supply Service	0.8
	Total	**38.5**



Water use map for the Kroondal Marikana SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

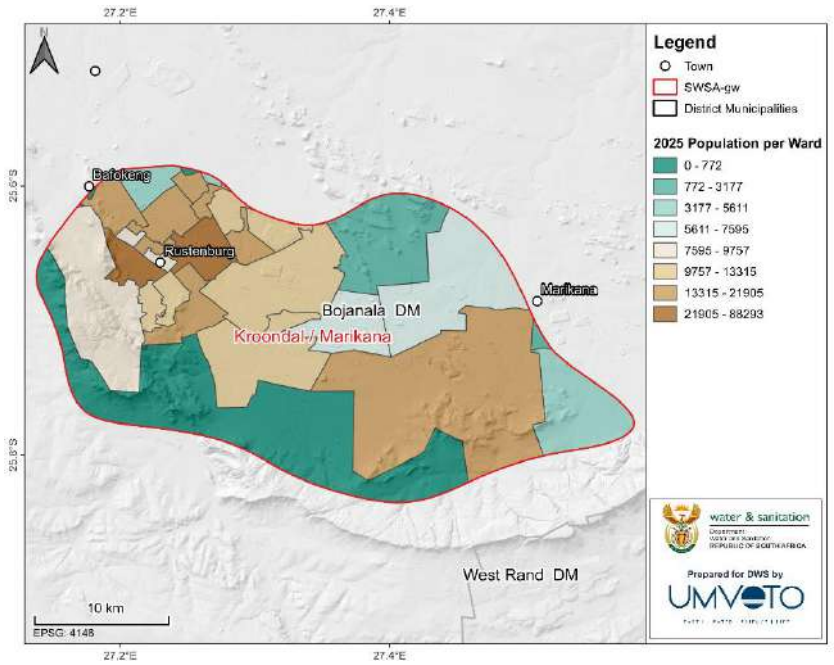
SWSA-gw Name:	Kroondal/Marikana
Area:	795 km²
Elevation:	1092 to 1677 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Kroondal/Marikana SWSA-gw is located within the Vaal-Orange Water Management Area (WMA, 2023). The groundwater resources within the Central Pan Belt SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction, while Magalies Water is the Bulk Water Service Provider (WSP) for some areas.

The estimated 2025 population within the Kroondal/Marikana SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of -0.87% per year, resulting in a projected population of approximately 273,386.

As shown in the map and table below, Rustenburg LM has the highest estimated population within the SWSA-gw, with approximately 268,614. Population concentrations within the SWSA-gw are highest in Rustenburg LM and the town of Bafokeng.



Projected population distribution in 2025 for the Kroondal/Marikana SWSA-gw.

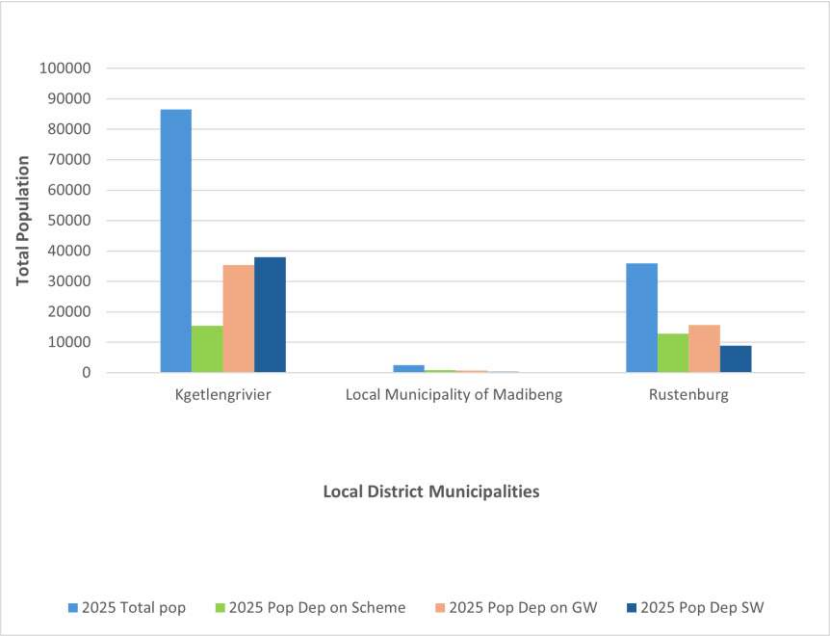
SWSA-gw Name:	Kroondal/Marikana
Area:	795 km²
Elevation:	1092 to 1677 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Kroondal/Marikana SWSA-gw, an estimated 41.4% of the population depends on groundwater sources (including boreholes and springs), 37.9% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 23.2% on the regional water supply scheme,

Among the LMs, the Rustenberg LM has the highest proportion of groundwater reliance, with approximately 43.7% of its population depending on groundwater and 24.9% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Kgetlengrivier	86,559	15,382	35,379	37,977
Local Municipality of Madibeng	2,494	833	700	383
Rustenburg	35,9001	12,767	15,692	8,950
Total	**124,954**	**28,982**	**51,771**	**47,310**



Projected population dependence on water sources in 2025.

SWSA-gw Name:	Kroondal/Marikana
Area:	795 km²
Elevation:	1092 to 1677 mamsl
Quantity & Quality	
Groundwater Quality	

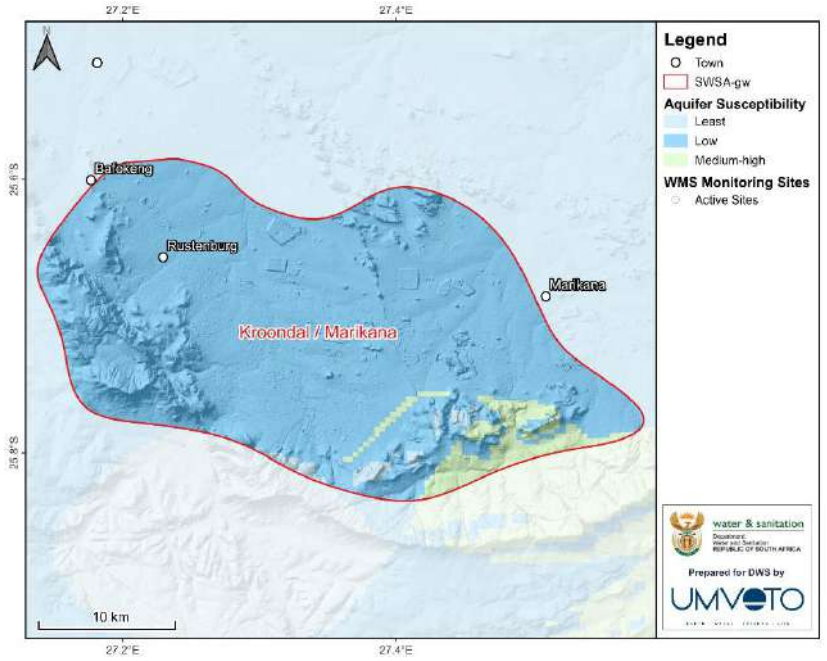
The Kroondal/Marikana SWSA-gw consists of Minor and Poor aquifer systems, classified based on their yield and water quality. The Minor aquifer system is moderately productive and has variable water quality. The Poor Aquifer system is a low to negligibly productive system and has moderate to poor water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 193.48 km^2, which is 24.33% of the Kroondal/Marikana SWSA-gw total area. Urban/Built-up areas cover 113.77 km^2 (14.31%), while mines and quarries account for 46.97 km^2 (5.91%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Poor aquifer system covers a small section on the southern edge of the Kroondal/Marikana SWSA-gw, and the minor aquifer system covers the rest of the aquifer.

The WMS database does not contain any actively monitored sites. The sites with water quality results were sampled between 20/03/1986 and 04/04/2008, so there is no recent data available.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 28.9 - 63.6 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.1 - 0.11 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 1 - 141.12 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 7.6 - 8.23 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 2 - 198.60 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Kroondal/Marikana**
Area:	**795 km²**
Elevation:	**1092 to 1677 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Kroondal/Marikana SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	N/A	N/A	2	41.03	mS/m	1986-2008 WMS data: 28.9 - 63.6 mS/m (Avg.: 41.03 mS/m). 2014-2024 GW Geosites: <70 mS/m. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <70 mS/m.	-
Fluoride	N/A	N/A	1	0.11	mg/L	1986-2005 WMS data: 0.1 - 0.11mg/L (Avg.: 0.11 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <0.5 mg/L.	-
Nitrate + Nitrite Nitrogen	N/A	N/A	2	47.76	mg/L	1986-2005 WMS data: 1 - 141.12 mg/L (Avg.: 47.76 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <11 mg/L.	-
pH	N/A	N/A	2	7.91	pH unit	1986-2005 WMS data: 7.6 - 8.23 (Avg.: 7.91). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: 7-9.	-
Sulphate	N/A	N/A	2	67.53	mg/L	1986-2005 WMS data: 2 - 198.60 mg/L (Avg.: 67.53 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <200 mg/L.	-

- *"Average" refers to the average concentrations for the Total Sites with WQ results of the Kroondal/Marikana SWSA-gw, taken from the WMS database from 1986-2008.*
- *"-" refers to no available data from the WMS database from 1986-2024 and the 2014-2024 GW Geosites.*
- *"N/A" refers to Not Applicable.*

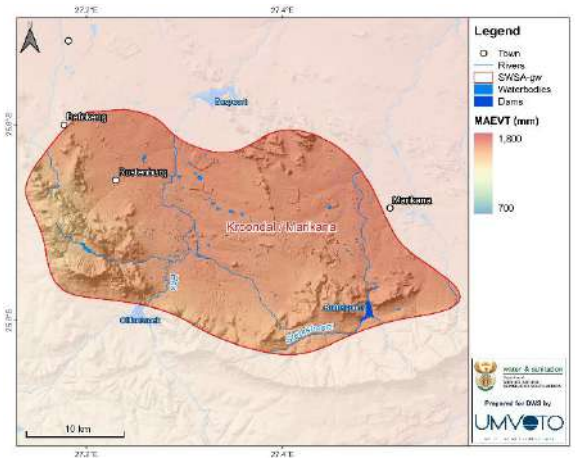
SWSA-gw Name:	**Kroondal/Marikana**
Area:	**795 km²**
Elevation:	**1092 to 1677 mamsl**

Threats & Risks

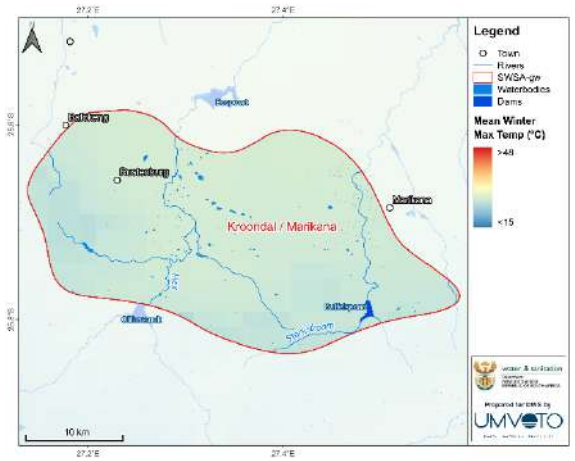
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Kroondal/Marikana SWSA-gw has a predominantly Cwa, humid subtropical climate characterized by hot and humid summers and dry, cool to mild winters. Towards the south, the climate shifts to a Cwb, a subtropical highland-type climate characterized by warm summers and dry winters and towards the north, a BSh, a hot semi-arid climate characterized by hot summers, warm to cool winters, and little to no precipitation. Temperatures in the SWSA-gw range from 0.1 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

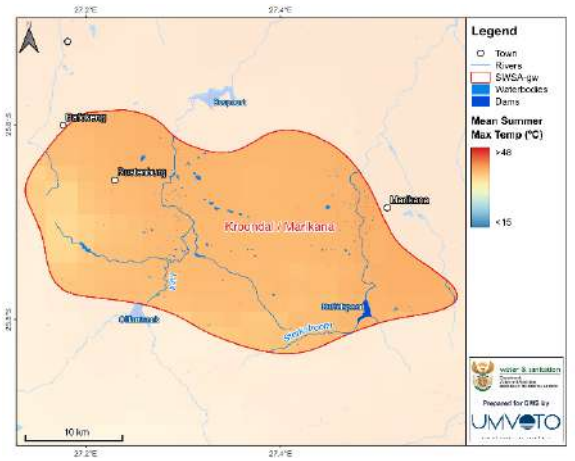
Temperature	Summer: 24.7 to 31 ºC, Winter: 0.1 to 4 °C
Evapotranspiration	Maximum value of 1661 mm/a with an average value of 1588 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, but an increase in recharge (ranging from ~ 16.6 to 23.6 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Kroondal/Marikana SWSA-gw region.



Mean winter temperatures of the Kroondal/Marikana SWSA-gw region.



Mean summer temperatures of the Kroondal/Marikana SWSA-gw region.

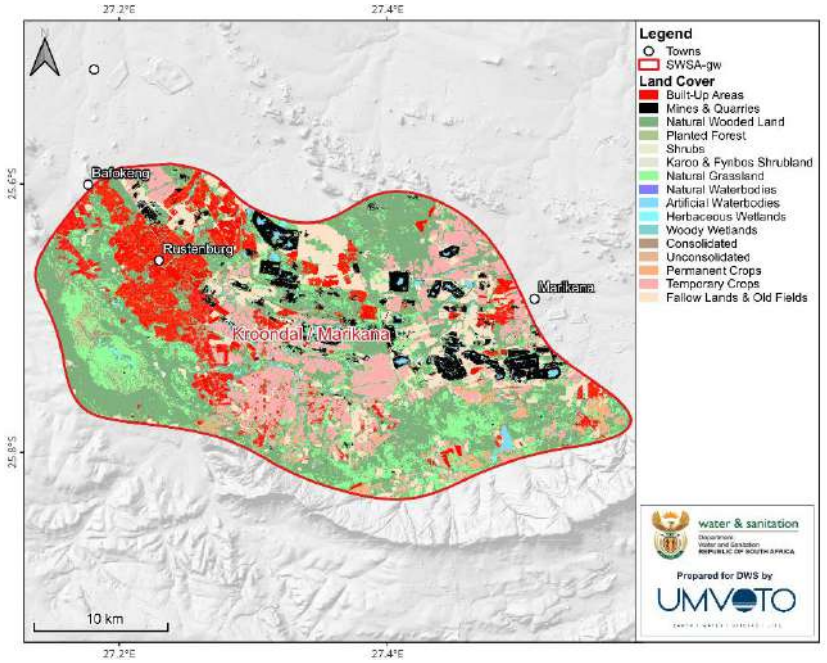
SWSA-gw Name:	Kroondal/Marikana
Area:	795 km^2
Elevation:	1092 to 1677 mamsl

Threats & Risks

Land Use

Forested land, which consists of natural wooded land and planted forest, is the dominant land cover type (DFFE, 2022) in the Kroondal/Marikana SWSA-gw, indicating a significant presence of forested or tree-covered areas that contribute to biodiversity and ecological stability. Grassland and cultivated land, which consists of temporary crops, permanent crops, fallow lands and old fields, suggest a mix of natural vegetation and agricultural activity. This supports both ecological functions and economic land use, as displayed on the map. Built-up areas, made up of residential, commercial and industrial areas, occupy a notable portion of the landscape and are concentrated in and around the town of Rustenburg. The presence of wetlands and waterbodies suggests minimal but crucial water resources. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, cover 6% of the area. Although it is relatively small, the impact can be quite significant.

Land Use Type	Area (km^2)	Area (%)
Barren Land	12	1.5
Built-Up	114	14.3
Cultivated	193	24.3
Forest Land	298	37.5
Grassland	115	14.5
Mines and quarries	47	5.9
Waterbodies	9	1.2
Wetlands	6	0.8



Land Cover 24-class map to show the types of land use and extent of each occurring in the Kroondal/Marikana SWSA-gw.

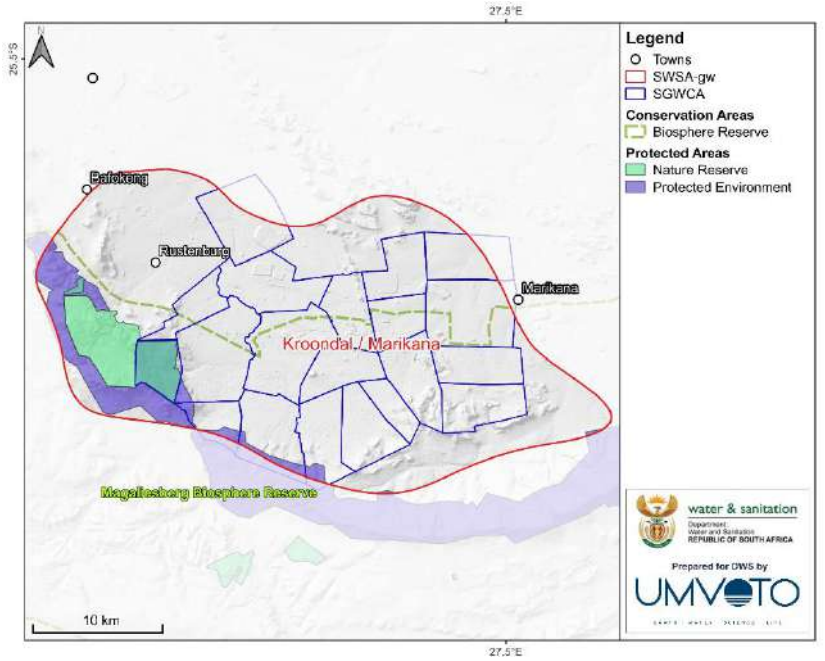
SWSA-gw Name:	Kroondal/Marikana
Area:	795 km²
Elevation:	1092 to 1677 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Magaliesberg Biosphere Reserve is the primary conservation area (DFFE, 2024) in the Kroondal/Marikana SWSA-gw, covering 471.34 km² of the southern half of the SWSA-gw. Protected areas include the Kgaswane Mountain Nature Reserve and the Magaliesberg Protected Natural Environment, which together span 105.70 km² (DFFE, 2024). The Kroondal Marikana subterranean government water control area (SGWCA) (CSIR, 1998) makes up 61% of the SWSA-gw and shows the area where the government had control over groundwater on private land under the Water Act No. 54 of 1956 (DWA, 2010).

Protection Status	Names	Area (km²)	Count
Conservation Areas	• Magaliesberg Biosphere Reserve	471.34	1
Protected Areas	• Kgaswane Mountain Nature Reserve • Magaliesberg Protected Natural Environment	105.70	2
SGWCA	• Kroondal Marikana	485.94	1
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Kroondal/Marikana SWSA-gw that have protection status.

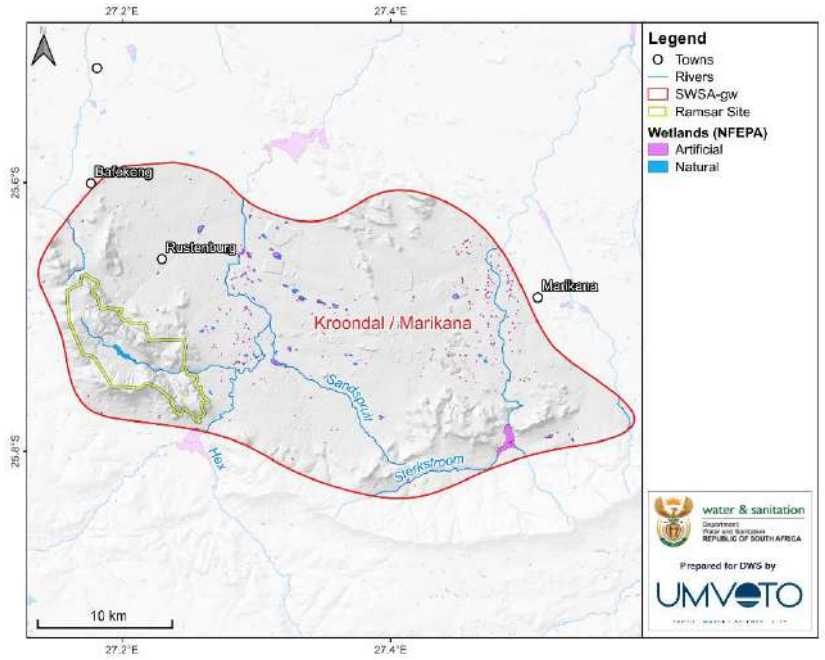
SWSA-gw Name:	Kroondal/Marikana
Area:	795 km^2
Elevation:	1092 to 1677 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Kgaswane Mountain Reserve is a Ramsar protected area (DFFE, 2024) that makes up approximately 6% of the SWSA-gw and is in the southwestern section of the SWSA-gw. The Buffelspoort Dam is the only major water body in the SWSA-gw, having the Sterkstroom and Kleinwater rivers running through it.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Buffelspoort Dam	1.30	1
Ramsar Sites	• Kgaswane Mountain Reserve	49.56	1
Wetlands	Various natural, artificial and estuary wetlands	6	

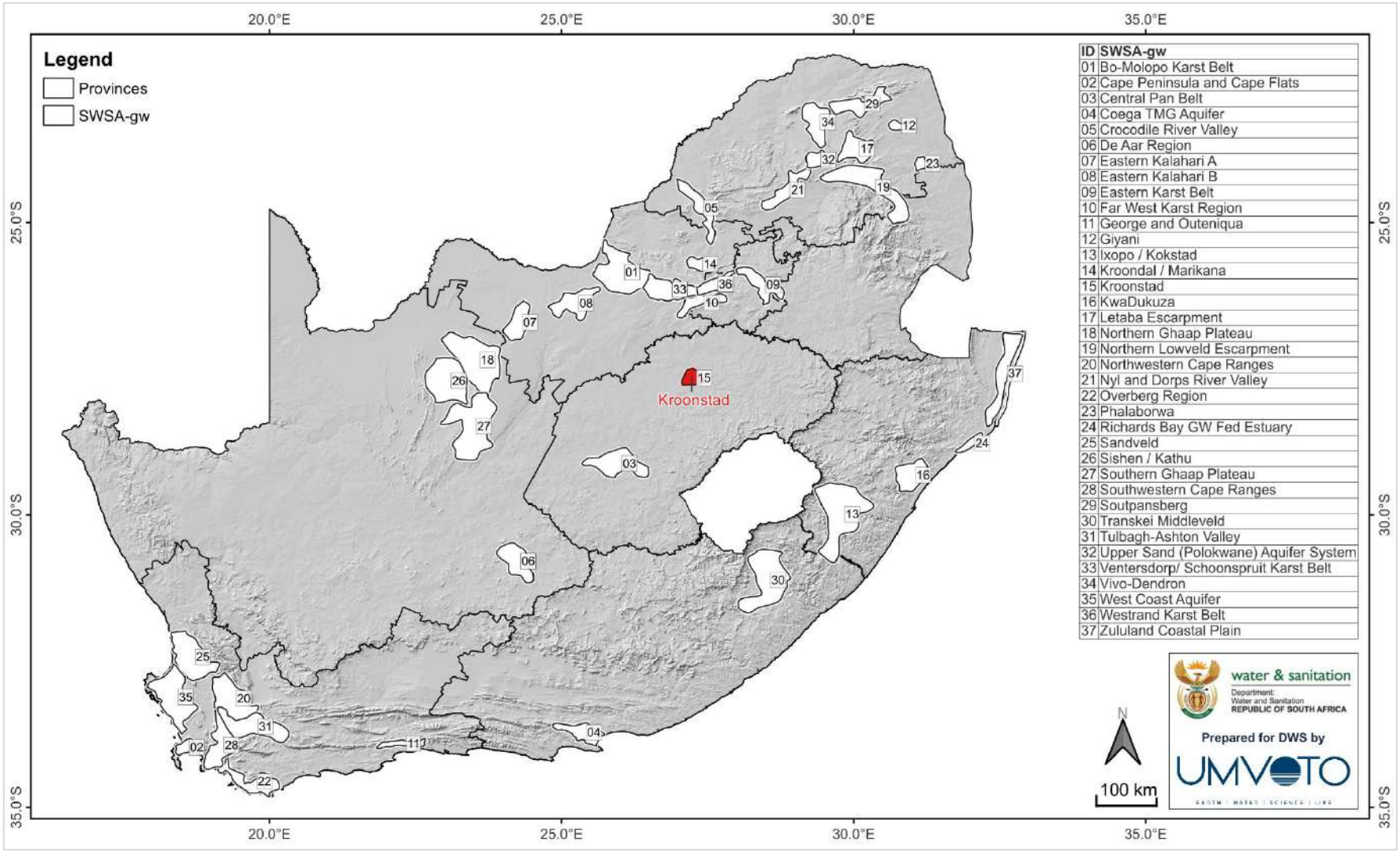


Map showing the major water bodies, Ramsar sites and GDEs in the Kroondal/Marikana SWSA-gw.

APPENDIX 15

KROONSTAD SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE KROONSTAD SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

15. Kroonstad

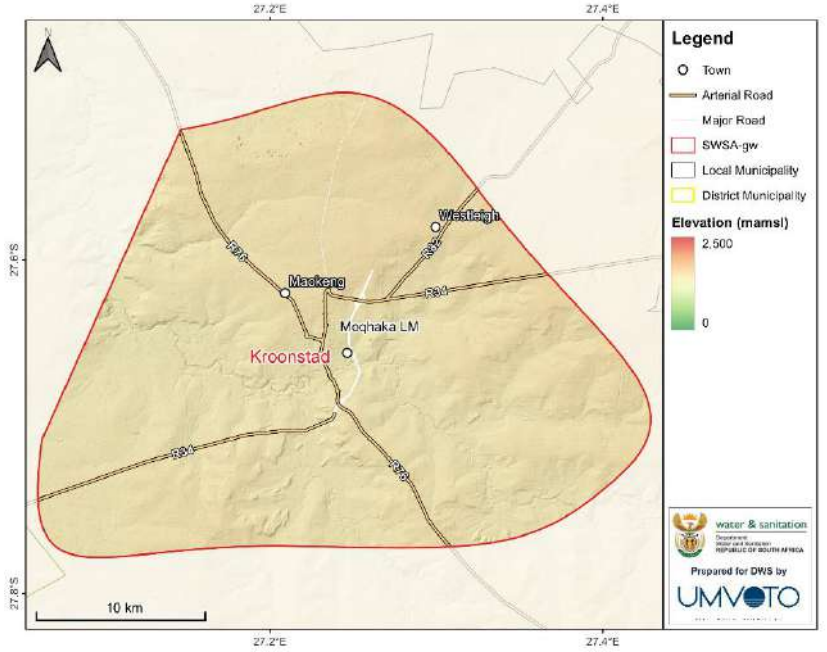
15.1. Description

SWSA-gw Name:	Kroonstad
Area:	799 km^2
Elevation:	1314 to 1475 mamsl
Geospatial Context	

The topography of the Kroonstad SWSA-gw, as depicted in the map, is characterized by a gently rolling to flat landscape, typical of the Highveld region. The terrain consists mostly of broad, open plains with low, undulating hills and occasional shallow valleys formed by river systems.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Free State
District Municipality	Fezile Dabi
Local Municipality	Moqhaka
Towns	Kroonstad
Major Roads	N1, R76, R34, R713, R721
Major Water Supply Networks	



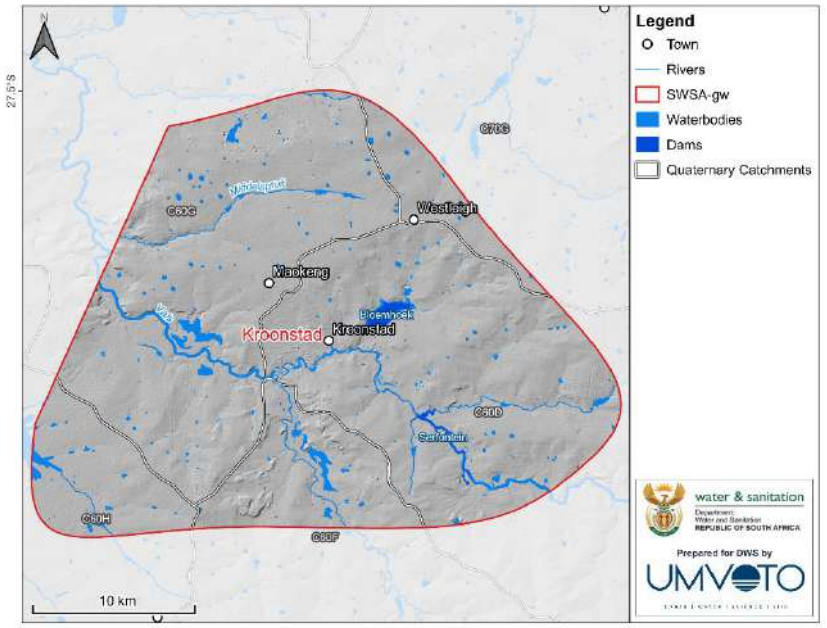
Locality map of Major Towns, District and Local Municipalities in the Kroonstad SWSA-gw.

SWSA-gw Name:	Kroonstad
Area:	799 km²
Elevation:	1314 to 1475 mamsl

Hydrology and Drainage

The Kroonstad SWSA-gw and surrounding areas include a few major surface water systems summarised below and displayed in the map on the right. The major surface water systems are the Bloemhoek and Serfontein dams, along with the Blomspruit and Vals perennial rivers, flowing in a north-westerly direction, are fed by the C6 catchment.

Quaternary Catchments	C60C, C60F, C60G, C60H and C70G
Rivers	Perennial: Blomspruit, Doringspruit, Vals
	Ephemeral: Middelspruit, Randjiespruit
Natural and manmade water bodies	
Major Dams:	Bloemhoek and Serfontein
Water Management Areas:	Vaal Orange



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Kroonstad SWSA-gw.

SWSA-gw Name:	Kroonstad
Area:	799 km^2
Elevation:	1314 to 1475 mamsl
Geology	

Geology

The Kroonstad area is largely covered by Quaternary deposits, consisting of aeolian sand and alluvium.

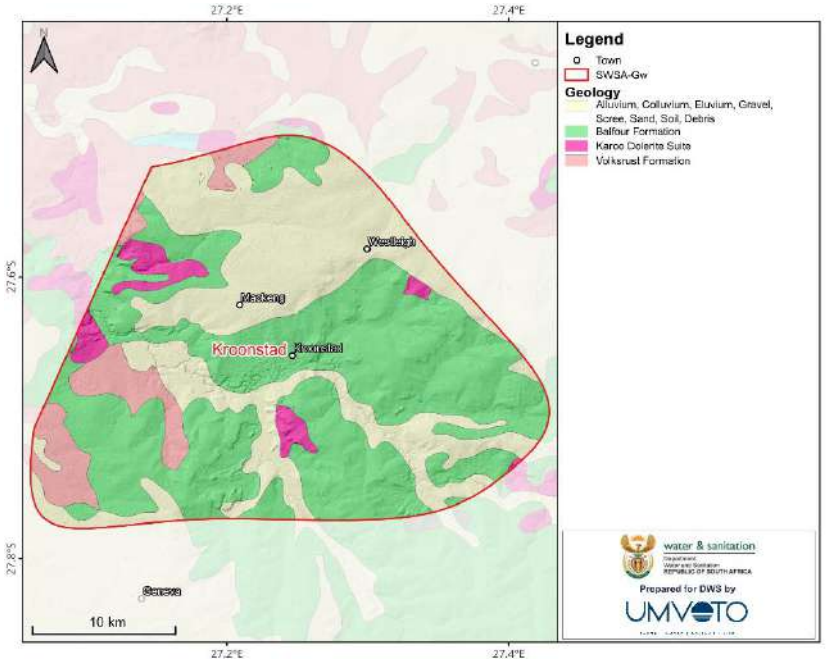
Intruding the underlying strata, the Karoo Dolerite Suite forms a network of dolerite sills, sheets, and dykes, predominantly associated with the Karoo Supergroup.

The Beaufort Group of the Karoo Supergroup dominates the lower half of the area, comprising green-grey mudstone, siltstone, grey shale rhythmites, and sandstone, with red mudstone occurring in the upper sections.

In the western part of the area, the Volksrust Formation of the Ecca Group (Karoo Supergroup) outcrops, characterised by mudrocks that reflect sedimentary conditions dominated by fine-grained clastics.

Hydrostratigraphy

The Kroonstad area hosts both primary and secondary aquifer systems. The Quaternary deposits, consisting of aeolian sand and alluvium, form shallow, unconfined primary intergranular aquifers. The underlying Beaufort Group and Volksrust Formation contribute to secondary, fractured rock aquifers. Dolerite intrusions associated with the Karoo Dolerite Suite further enhance secondary permeability, creating localized fractured aquifers.



Geology Map of the Kroonstad SWSA-gw region.

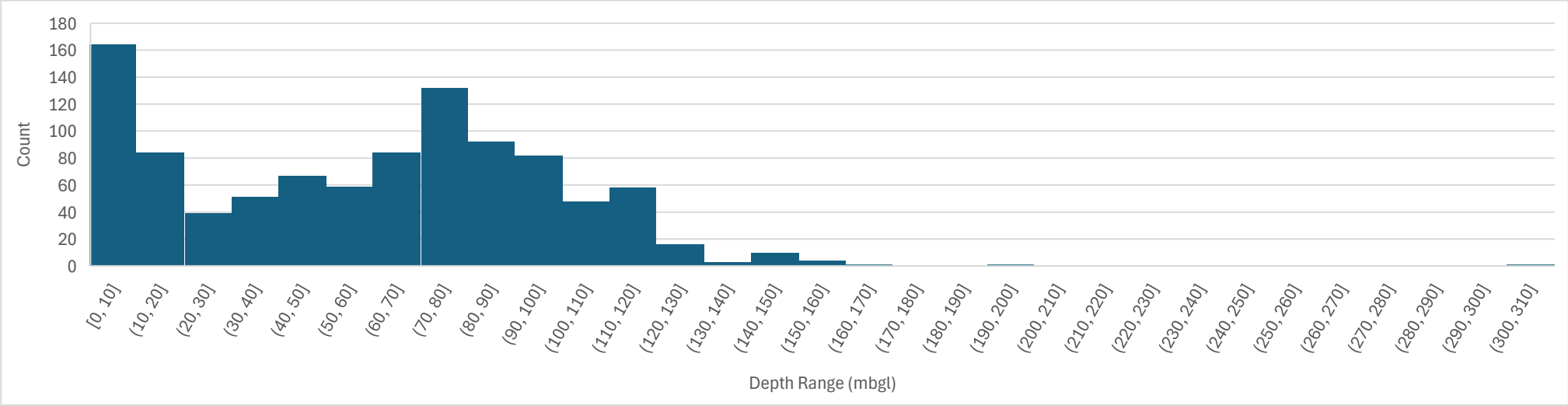
15.2. Current Status

SWSA-gw Name:	**Kroonstad**
Area:	**799 km²**
Elevation:	**1314 to 1475 mamsl**
Quantity & Quality	
Aquifer Classification	

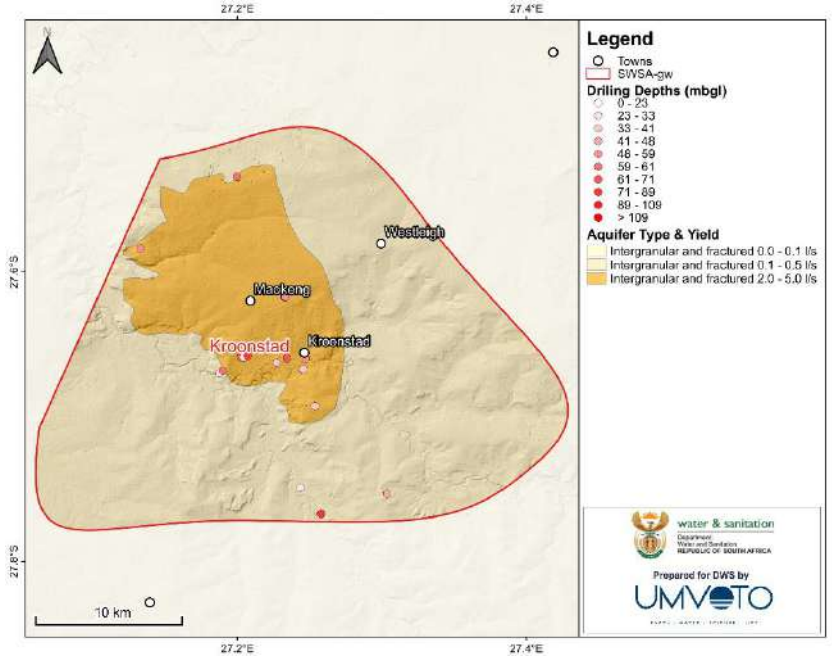
The aquifer systems within the Kroonstad SWSA-gw exhibit varying yields across fractured aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is a Minor aquifer system with an average dual-porosity yield ranging from 0.1 to 5.0 l/s.
Groundwater Targets	The average drilling depth is 67 mbgl, and the most common depths are around 30 and 60 mbgl, respectively, suggesting mixed targets in the dual-porosity aquifer system. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 21 and 88 mbgl. No NGA water level data for the past 25 years.

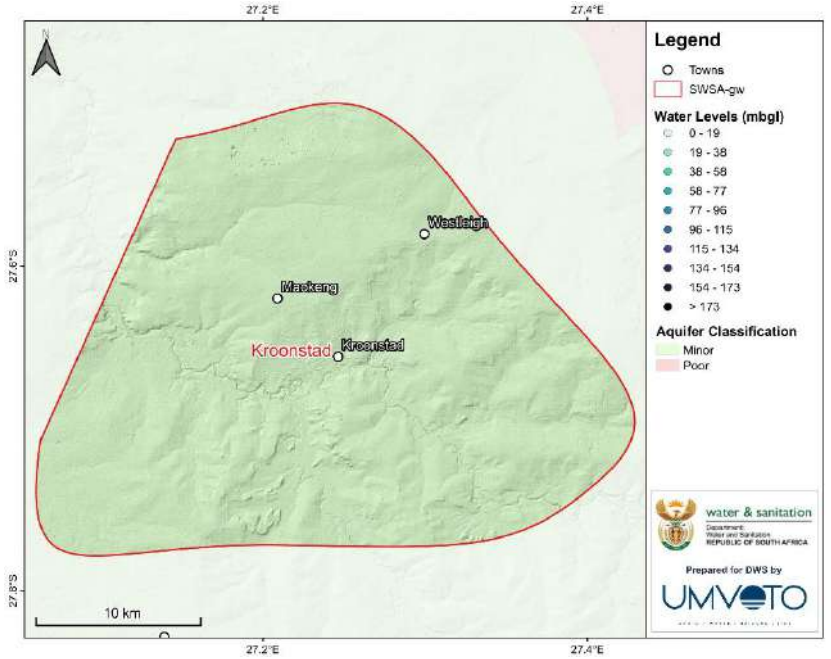
Graph of NGA drilling depths of the Kroonstad SWSA-gw region



SWSA-gw Name:	Kroonstad
Area:	799 km^2
Elevation:	1314 to 1475 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Kroonstad SWSA-gw region.



Map of the Aquifer Classification of the Kroonstad SWSA-gw region.

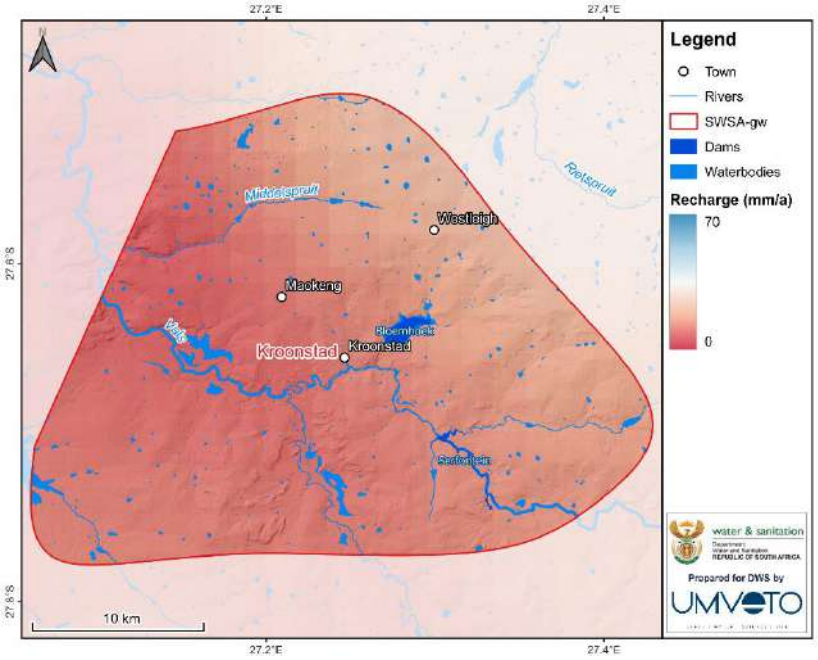
SWSA-gw Name:	**Kroonstad**
Area:	**799 km²**
Elevation:	**1314 to 1475 mamsl**

Quantity & Quality

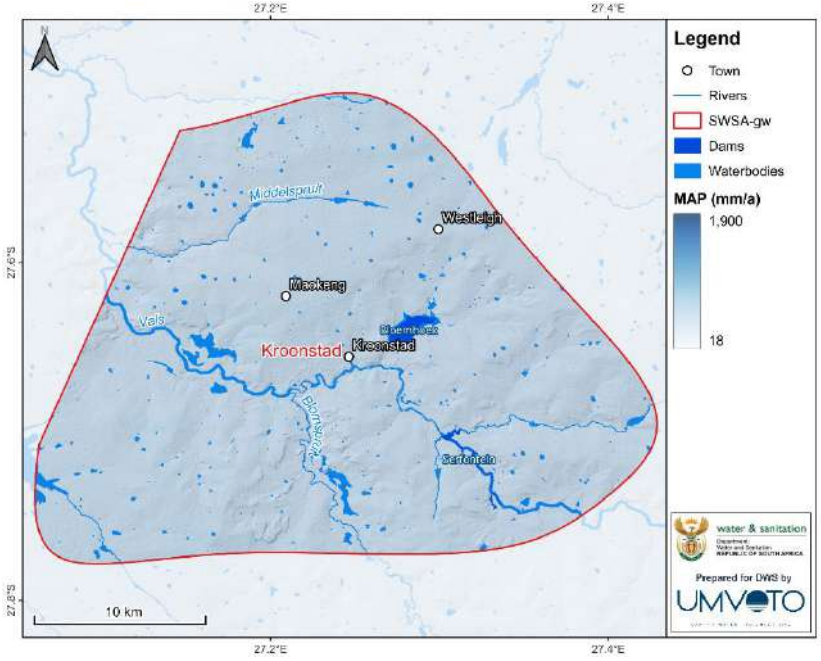
Groundwater Recharge

The Kroonstad receives a total MAP volume of 437 Mm^3/a, with an average rainfall of 548 mm/a. However, only 10.4 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 2.4% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Kroonstad	437	548	10.4	13.2	2.4%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

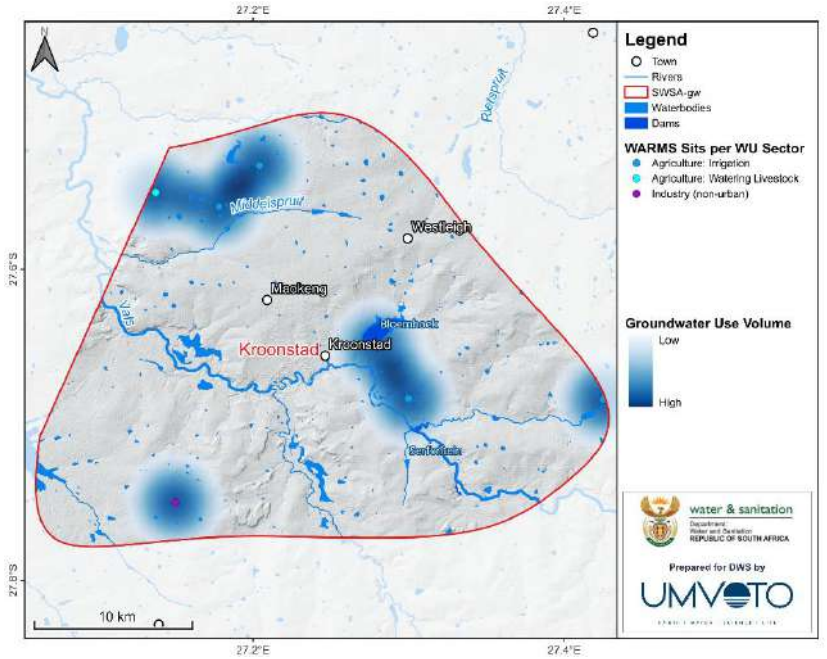
SWSA-gw Name:	Kroonstad
Area:	799 km^2
Elevation:	1314 to 1475 mamsl
Quantity & Quality	
Groundwater Use	

The Kroonstad SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Kroonstad (Conjunctive), who rely significantly on groundwater resources for industrial use and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 0.4 Mm^3/ a to sustain crop production. There are a few registered irrigation areas in the north of the region and south of Kroonstad. However, this region has less of a reliance on groundwater compared to the other 36.
- Agricultural livestock watering follows, using 0.1 Mm^3/a to provide water for livestock animals to drink and graze. Groundwater offers a reliable method for ensuring animals are hydrated, especially when water supply services are low. This is mainly in the northwest of the Kroonstad region.
- Non-urban industrial follows, using 0.03 Mm^3/a for manufacturing, processing, and other industrial activities outside urban centres. This sector is a major driver of groundwater demand, relying on the resource where alternative water supplies are limited. Use is primarily in the southwest of the region.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Kroonstad, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	0.4
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	0.03
	Total	**0.5**



Water use map for the Kroonstad SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

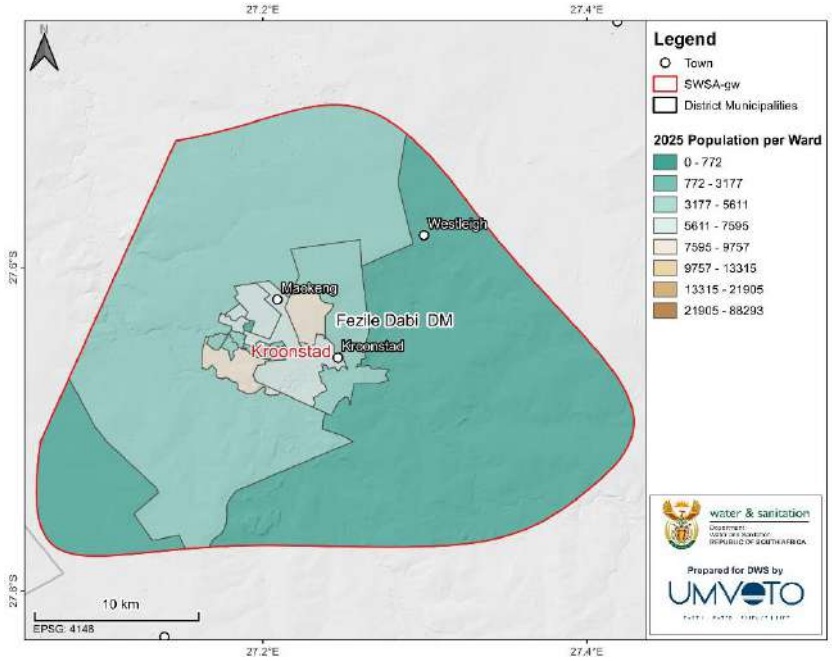
SWSA-gw Name:	Kroonstad
Area:	799 km^2
Elevation:	1314 to 1475 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Kroonstad SWSA-gw is located within the Vaal-Orange Water Management Area (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipality is the Water Service Authority (WSA) and Water Service Provider (WSP) for its jurisdiction.

The estimated 2025 population within the Kroonstad SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of -0.78% per year, resulting in a projected population of approximately 85,389.

As shown in the map and table below, Moqhaka LM has an estimated population of 85,389. Population concentrations within the SWSA-gw are highest in the town of Kroonstad.



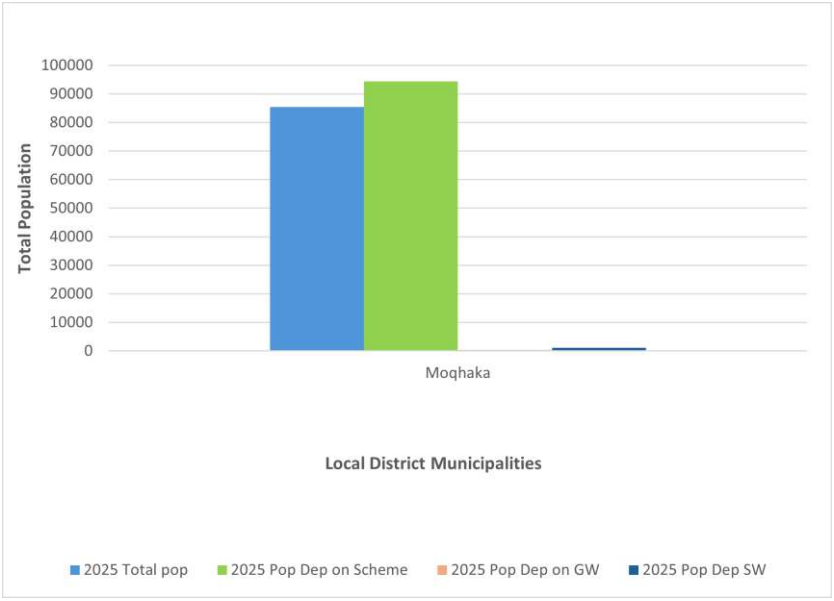
Projected population distribution in 2025 for the Kroonstad SWSA-gw.

SWSA-gw Name:	Kroonstad
Area:	799 km²
Elevation:	1314 to 1475 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Kroonstad SWSA-gw, Moqhaka LM is heavily dependent on the regional water scheme, with minimal reliance of 1.3% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 0.4% on groundwater sources (including boreholes and springs).

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Moqhaka	85,389	94,389	380	1,068
Total	**85,389**	**94,389**	**380**	**1,068**



Projected population dependence on water sources in 2025.

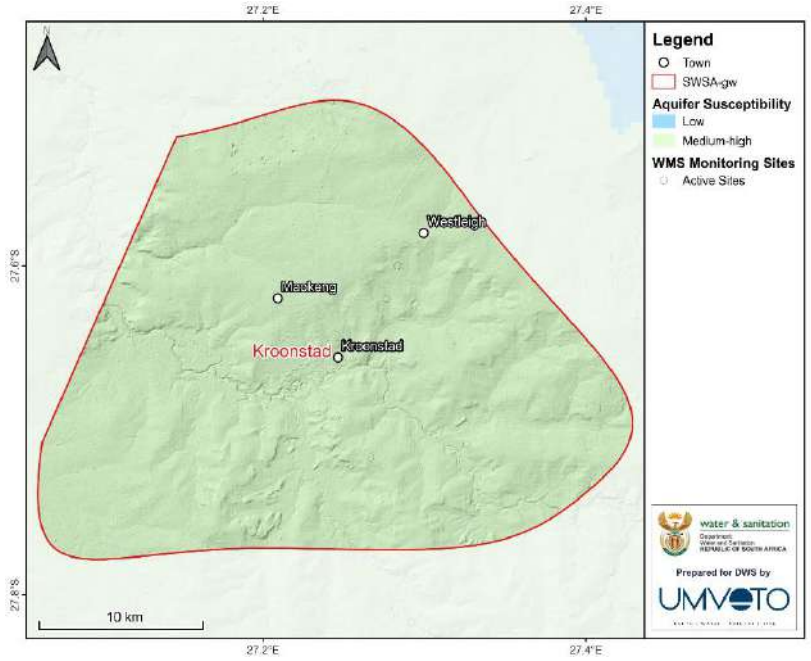
SWSA-gw Name:	Kroonstad
Area:	799 km^2
Elevation:	1314 to 1475 mamsl
Quantity & Quality	
Groundwater Quality	

The Kroonstad SWSA-gw consists of the Minor aquifer system, classified based on their yield and water quality. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 277.25 km^2, which is 34.68% of the Kroonstad SWSA-gw total area. Urban/Built-up areas cover 43.84 km^2 (5.48%), while mines and quarries account for 0.39 km^2 (0.05%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

PS. The WMS database does not contain any actively monitored sites. The sites with water quality results were sampled between 15/09/1972 and 15/10/1995, so there is no recent data available.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 66.7 – 152 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.1 - 0.43 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.13 - 20.33 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.8 to 8.26 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 31.7 – 790 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	Kroonstad
Area:	799 km²
Elevation:	1314 to 1475 mamsl
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Kroonstad Aquifer

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	N/A	N/A	4	104.82	mS/m	-	1972-1995 WMS data: 66.7 - 152 mS/m (Avg.: 212.96 mS/m). 2014-2024 GW Geosites: N/A.	-
Fluoride	N/A	N/A	4	0.27	mg/L	-	1972-1995 WMS data: 0.1 - 0.43 mg/L (Avg.: 0.85 mg/L). 2014-2024 GW Geosites: N/A.	-
Nitrate + Nitrite Nitrogen	N/A	N/A	4	8.55	mg/L	-	1972-1995 WMS data: 0.13 - 20.33 mg/L (Avg.: 8.55 mg/L). 2014-2024 GW Geosites: N/A.	-
pH	N/A	N/A	4	8.05	pH unit	-	1972-1995 WMS data: 6.8 - 8.26 (Avg.: 8.05). 2014-2024 GW Geosites: N/A.	-
Sulphate	N/A	N/A	3	294.70	mg/L	-	1972-1995 WMS data: 31.7 - 790 mg/L (Avg.: 294.70 mg/L). 2014-2024 GW Geosites: N/A.	-

- *"Average" refers to the average concentrations for the Total Sites with WQ results of the Kroonstad Aquifer SWSA-gw, taken from the WMS database from 1972-1995.*
- *"-" refers to no available data from the WMS database from 1972-2024 and the 2014-2024 GW Geosites.*
- *"N/A" refers to Not Applicable.*

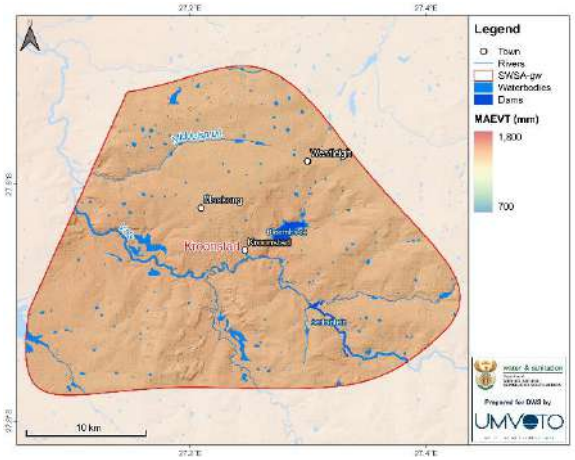
SWSA-gw Name:	**Kroonstad**
Area:	**799 km²**
Elevation:	**1314 to 1475 mamsl**

Threats & Risks

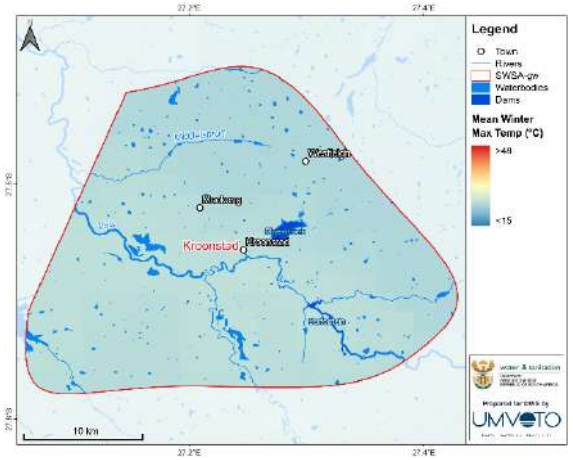
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Kroonstad SWSA-gw has a predominantly Cwa, humid subtropical, type climate characterised by hot summers and dry winters. Towards the east, the climate zone changes to a Cwb, a subtropical highland-type climate with wet summers and dry winters, towards the west the climate zone changes to BSk, cold semi-arid regions, type climate characterised by cold semi-arid regions. Temperatures in the SWSA-gw range from 1.9 – 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

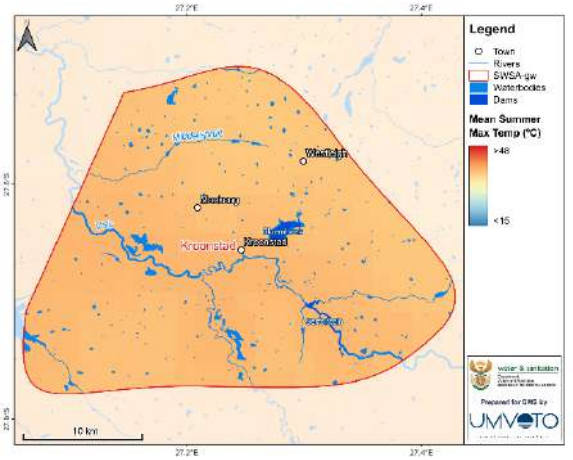
Temperature	Summer: 27 to 29.2 °C, Winter: -1.9 to 2 ºC
Evapotranspiration	Maximum value of 1543 mm/a with an average value of 1504 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, and an increase in recharge (ranging from ~ 6.2 to 11.3 mm/a). The DART Index indicates stable and some improving conditions.



Mean annual A-Pan evaporation of the Kroonstad SWSA-gw region.



Mean winter temperatures of the Kroonstad SWSA-gw region.



Mean summer temperatures of the Kroonstad SWSA-gw region.

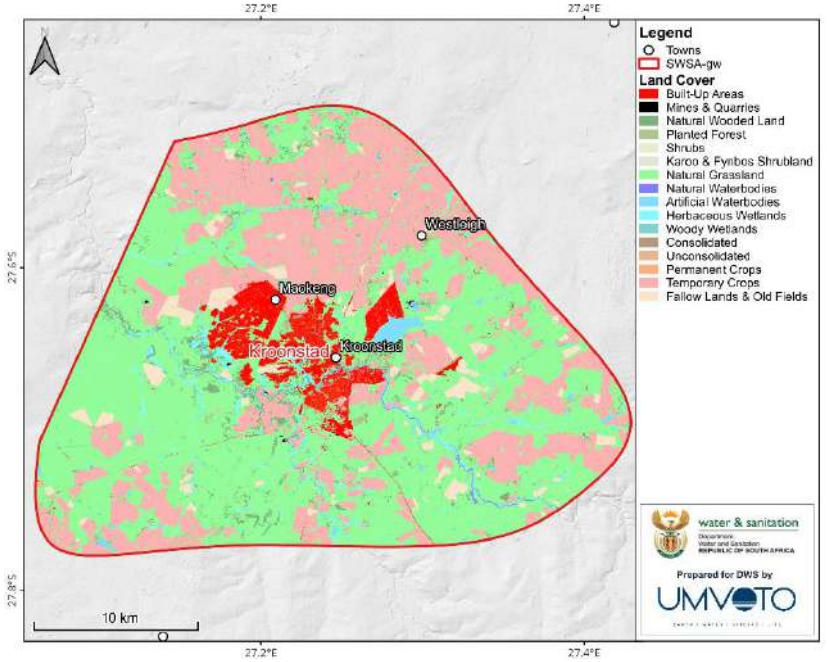
SWSA-gw Name:	Kroonstad
Area:	799 km²
Elevation:	1314 to 1475 mamsl

Threats & Risks

Land Use

Grassland is the dominant land cover in the Kroonstad SWSA-gw (DFFE, 2022), accounting for 51.7% of the area, which highlights its ecological significance. Cultivated land, which includes temporary crops, permanent crops, fallow land and old fields, covers 34.7% of the SWSA-gw, indicating a strong agricultural presence, particularly in the northern portion of the SWSA-gw. Built-up areas, made up of residential, commercial and industrial areas and smallholdings, are concentrated in and near the towns of Kroonstad and Maokeng, reflecting limited but notable human settlement within the landscape. Wetlands and waterbodies, both artificial and natural, play a crucial role in water retention and biodiversity, requiring careful management to preserve these valuable resources. Artificial waterbodies, such as the Serfontein dam on the Valsriver and the Bloemhoek dam near the town of Kroonstad supply water to the town of Kroonstad.

Land Use Type	Area (km²)	Area (%)
Barren Land	1	0.1
Built-Up	44	5.5
Cultivated	277	34.7
Forest Land	33	4.1
Grassland	414	51.7
Mines and quarries	0.4	0.05
Shrubland	1	0.1
Waterbodies	11	1.3
Wetlands	19	2.4



Land Cover 24-class map to show the types of land use and extent of each occurring in the Kroonstad SWSA-gw.

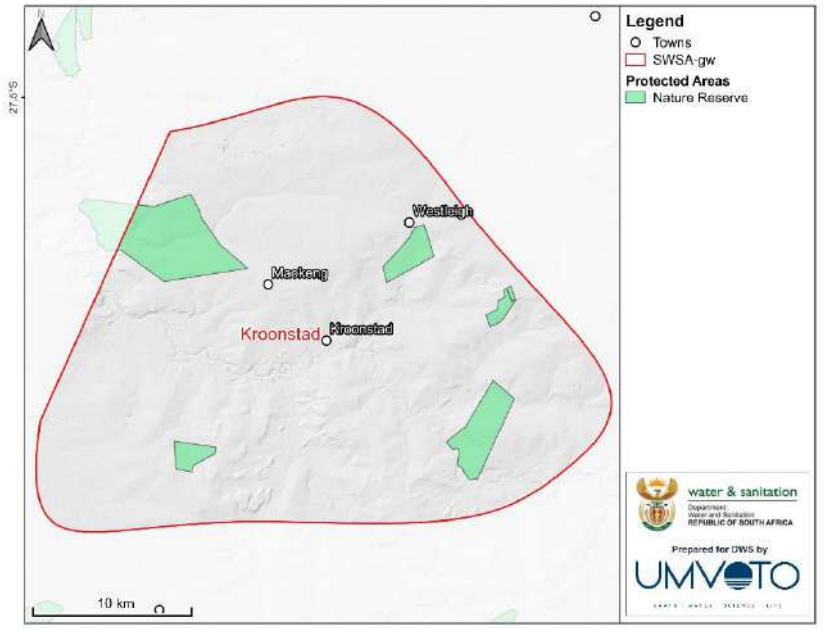
SWSA-gw Name:	Kroonstad
Area:	799 km^2
Elevation:	1314 to 1475 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Kroonstad SWSA-gw contains five nature reserves (DFFE, 2024), with the largest being the Free State Safaris, located towards the northwestern edge of the SWSA-gw, as displayed on the map.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		
Protected Areas	• Free State Safaris • Erfdeel Private Nature Reserve • Dalmanuthaa Game Reserve • Phatakalle Private Nature Reserve • Boslaagte Private Nature Reserve	53.90	5
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Kroonstad SWSA-gw that have protection status.

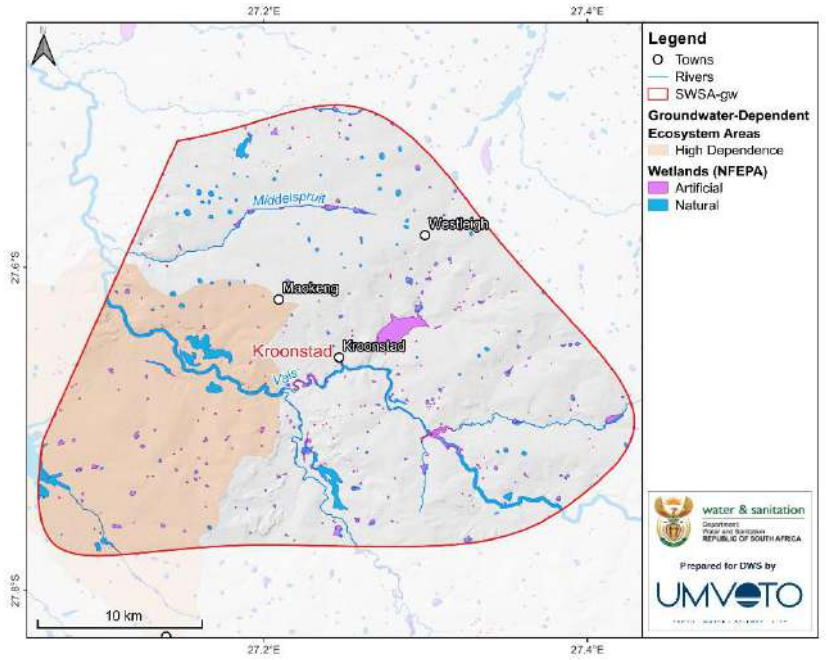
SWSA-gw Name:	Kroonstad
Area:	799 km^2
Elevation:	1314 to 1475 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Serfontein dam (DWS, 2011) lies on the main river, the Vals River, running through the Kroonstad SWSA-gw. The portion of the Vals River in the SWSA-gw comprises floodplain wetlands and channelled valley-bottom wetlands (CSIR, 2011). The Bloemhoek Dam is situated near the town of Kroonstad and functions as a water supply dam for the town. The wetlands in the southwestern part of the SWSA-gw are classified as potentially highly dependent on groundwater.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Serfontein Dam • Bloemhoek Dam	4.36	2
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	29	

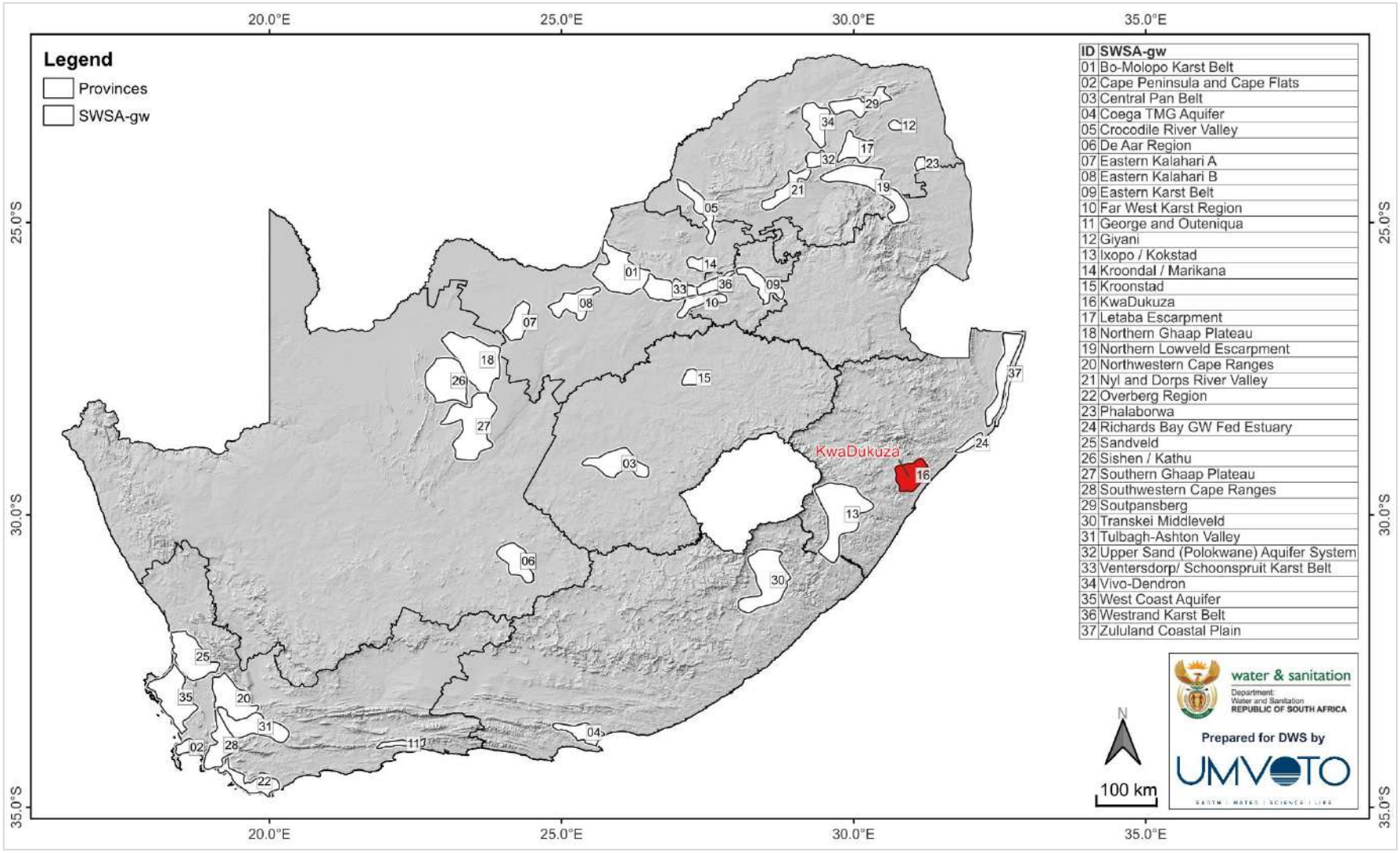


Map showing the major water bodies, Ramsar sites and GDEs in the Kroonstad SWSA-gw.

APPENDIX 16

KWADUKUZA SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE KWADUKUZA SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

16. KwaDukuza

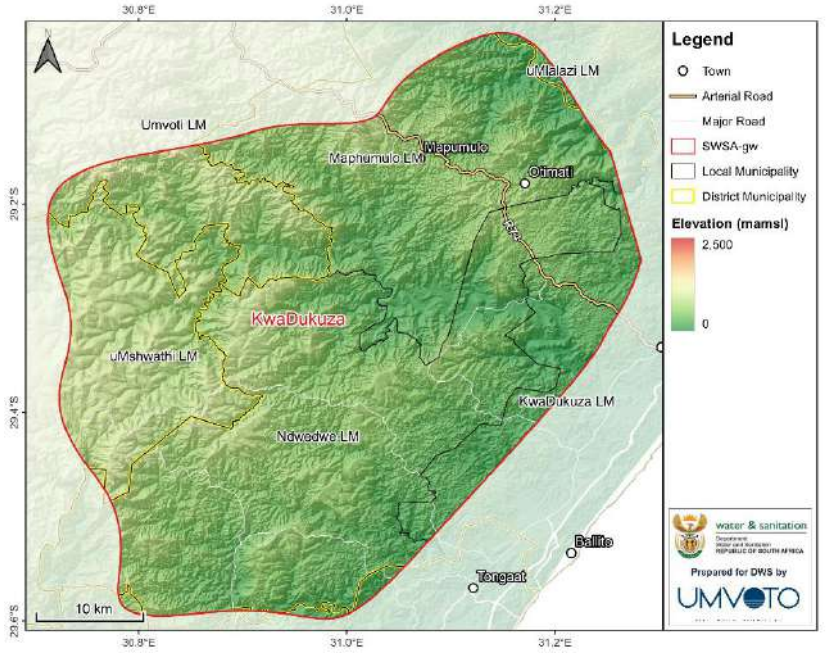
16.1. Description

SWSA-gw Name:	**KwaDukuza**
Area:	**2352 km^2**
Elevation:	**35 to 1153 mamsl**
Geospatial Context	

The topography of the KwaDukuza SWSA-gw, as depicted in the map, is characterized by numerous ridges and valleys. The elevation gradually decreases eastward towards the coastal plain near Stanger and Tongaat. The topography is shaped by river erosion, resulting in a network of deeply incised valleys that drain towards the Indian Ocean. This region transitions from the elevated interior to the coastal lowlands, where the terrain becomes less rugged.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	KwaZulu-Natal Province
Metropolitan Municipality	eThekwini
District Municipality	iLembe, Umgungundlovu, Umzinyathi, and Uthungulu.
Local Municipalities	uMshwathi, Ndwedwe, KwaDukuza, uMlalazi, Maphumulo, and Umvoti.
Towns	No major towns
Major Roads	R614, R74, P104
Major Water Supply Networks	iLembe



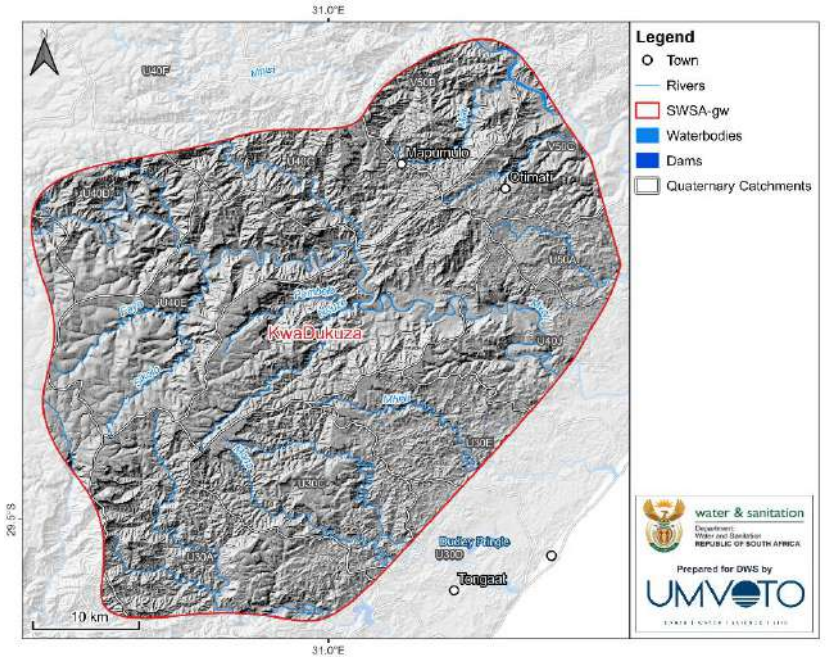
Locality map of Major Towns, District and Local Municipalities in the KwaDukuza SWSA-gw.

SWSA-gw Name:	KwaDukuza
Area:	2352 km^2
Elevation:	35 to 1153 mamsl

Hydrology and Drainage

The KwaDukuza SWSA-gw and surrounding areas include major surface water systems, summarised below and displayed in the map on the right. There are many perennial rivers in the area spread over multiple catchments (U5, U4, U3 and V5); the rivers predominantly flow east southeast.

Quaternary Catchments	U20L, U20K, U30A, U30D, U30C,U30E, U40C, U40D, U40G, U40H, U40J, U50A, V50B, and V50C.
Rivers	Perennial rivers: Hlimbitwa, Faye, Mdloti, Khamanzi, Mati, Mtize, Mqeku, Mhlali, Mona, Mvoti, Nonoti, Nsuze, Mwangala, Nsuze, Tongati, Pambela, Otimati, Thukela, Sikoto
Natural and manmade water bodies	
Major Dams:	No major dams
Water Management Areas:	Pongola Mtamvuna



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the KwaDukuza SWSA-gw.

SWSA-gw Name:	KwaDukuza
Area:	2352 km^2
Elevation:	35 to 1153 mamsl

Geology

Geology

Quaternary deposits, including scree, talus, and alluvium, sporadically outcrop across the KwaDukuza area.

The Karoo Dolerite Suite is characterised by a network of dolerite sills, sheets, and dykes, which predominantly intrude into the Karoo Supergroup.

The Karoo Supergroup consists of the Ecca and Dwyka Groups. The Pietermaritzburg Formation from the Ecca Group overlies the Dwyka Group with a sharp contact, consisting of shale with thin siltstone and sandstone layers in its uppermost part. The Dwyka Group is distinguished by diamictite (polymictic clasts in a poorly sorted, fine-grained matrix), varved shale, mudstone with dropstones, and fluvioglacial gravel.

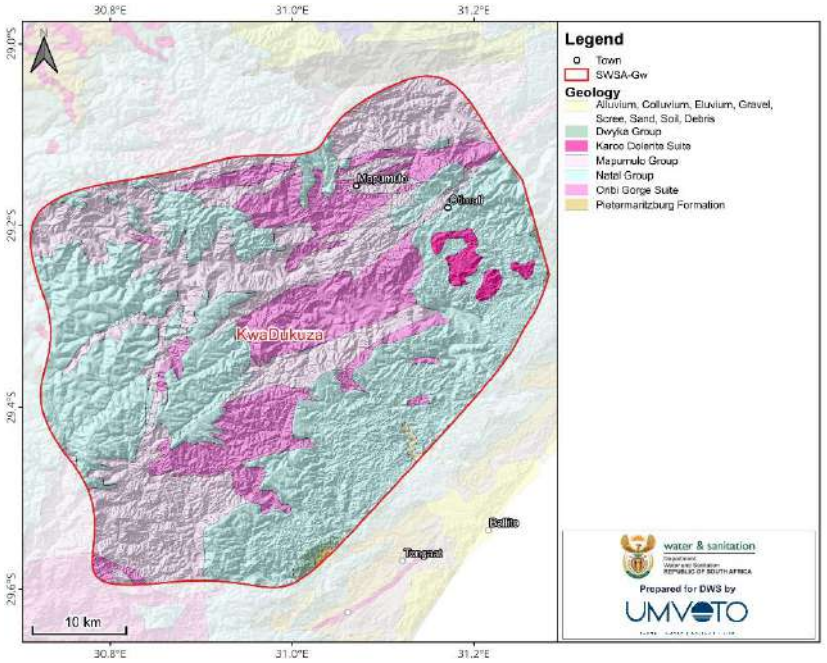
The Natal Group outcrops in the eastern and western sections of the area, composed generally of reddish, feldspathic, and micaceous sandstone with subordinate quartz arenite, mudrock, granulestone, and conglomerate.

Namibian-era deposits outcrop in the centre of the region from northeast to southwest, comprising various lithologies such as pink leucocratic gneiss, quartzite, sillimanite quartzite, amphibolite, megacrystic biotite granite, calc-silicate rocks, and mafic granulites (including diopsidic, hornblende-bearing, and garnetiferous types).

The Mapumulo Group of the Namaqua-Natal Province outcrops in the central and western parts of the area, characterised by heterogeneous layered paragneisses and migmatites with a wide compositional range.

Hydrostratigraphy

Quaternary deposits, including scree, talus, and alluvium, form shallow, unconfined primary intergranular aquifers. The Ecca and Dwyka Groups contribute to secondary, fractured rock aquifers, while the Karoo Dolerite Suite enhances secondary permeability, creating localized fractured aquifers.



Geology Map of the KwaDukuza SWSA-gw region.

16.2. Current Status

SWSA-gw Name:	**KwaDukuza**
Area:	**2352 km^2**
Elevation:	**35 to 1153 mamsl**

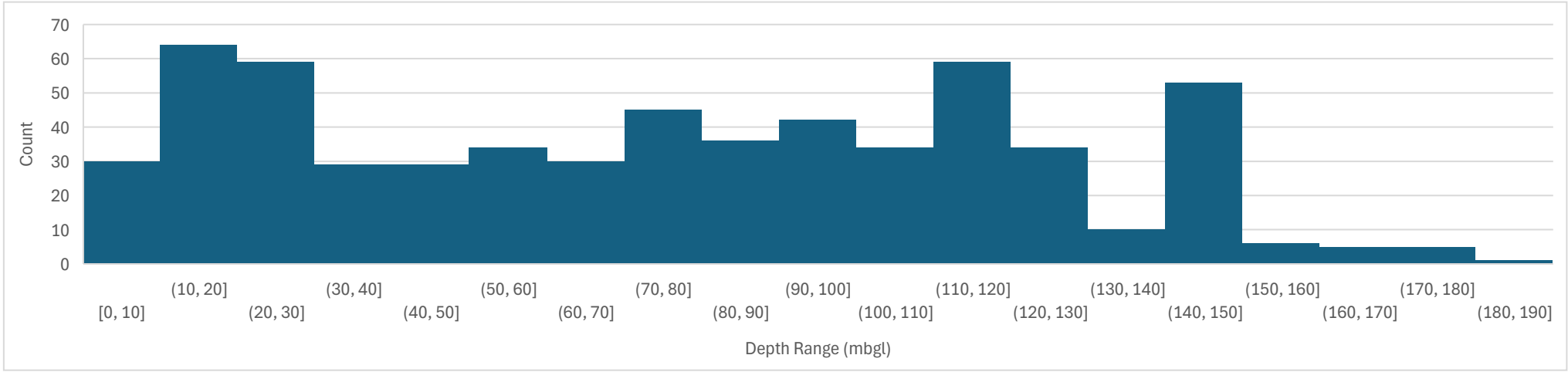
Quantity & Quality

Aquifer Classification

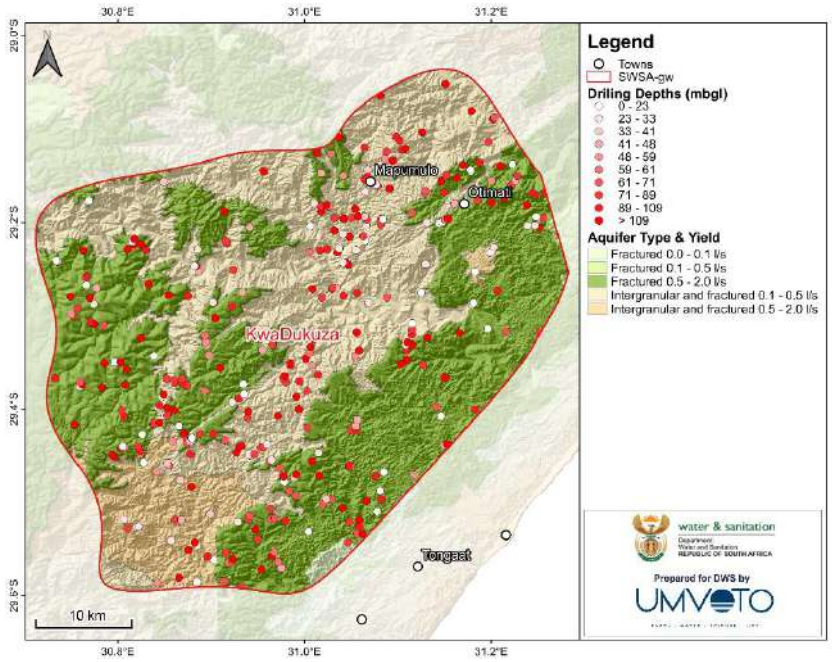
The aquifer systems within the George and Outeniqua & Outeniqua SWSA-gw exhibit varying yields across fractured and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is a minor aquifer system, with an average fractured yield ranging from 0.0 to 2.0 l/s and a dual-porosity yield ranging from 0.1 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 77 mbgl, and the most common depths are between 10 to 30 and 100 to 150 mbgl, suggesting mixed targets; the boreholes target both the dual-porosity aquifer and fractured aquifer systems. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 30 and 120 mbgl. Based on the past 25 years of NGA water level data, the average groundwater level in the region is ~ 60 mbgl, with values ranging from 0 to 136 mbgl and a standard deviation of ~ 43 mbgl.

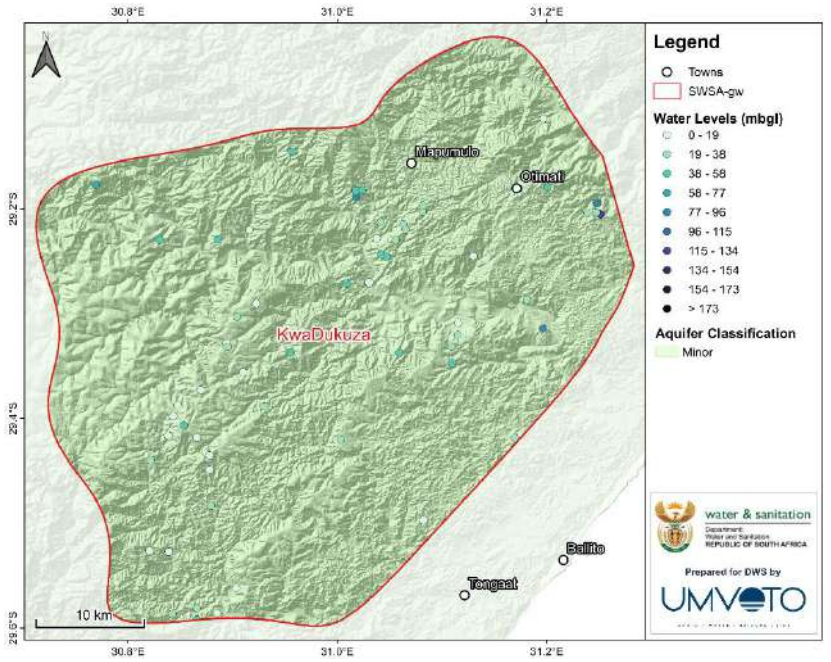
Graph of NGA drilling depths of the KwaDukuza SWSA-gw region



SWSA-gw Name:	KwaDukuza
Area:	2352 km^2
Elevation:	35 to 1153 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the KwaDukuza SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the KwaDukuza SWSA-gw region.

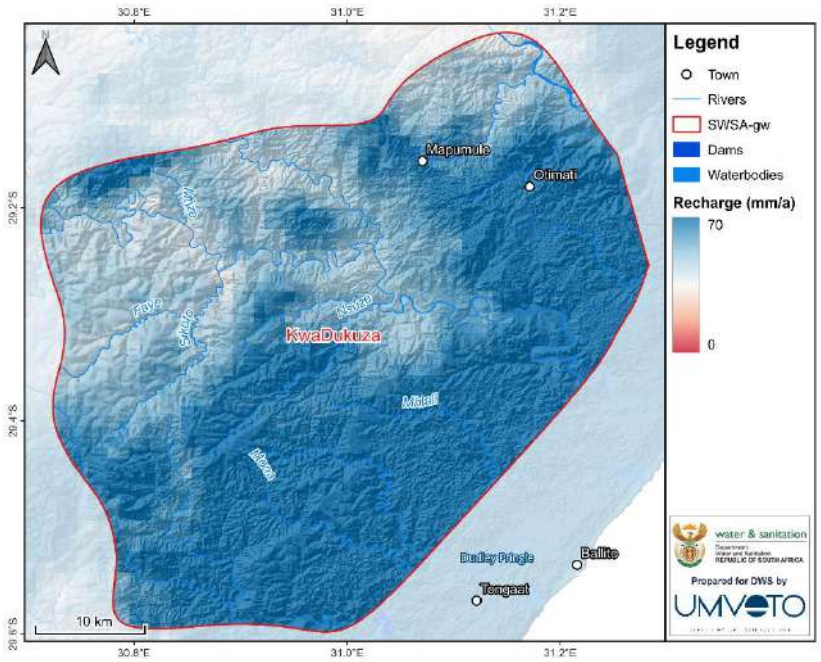
SWSA-gw Name:	**KwaDukuza**
Area:	**2352 km^2**
Elevation:	**35 to 1153 mamsl**

Quantity & Quality

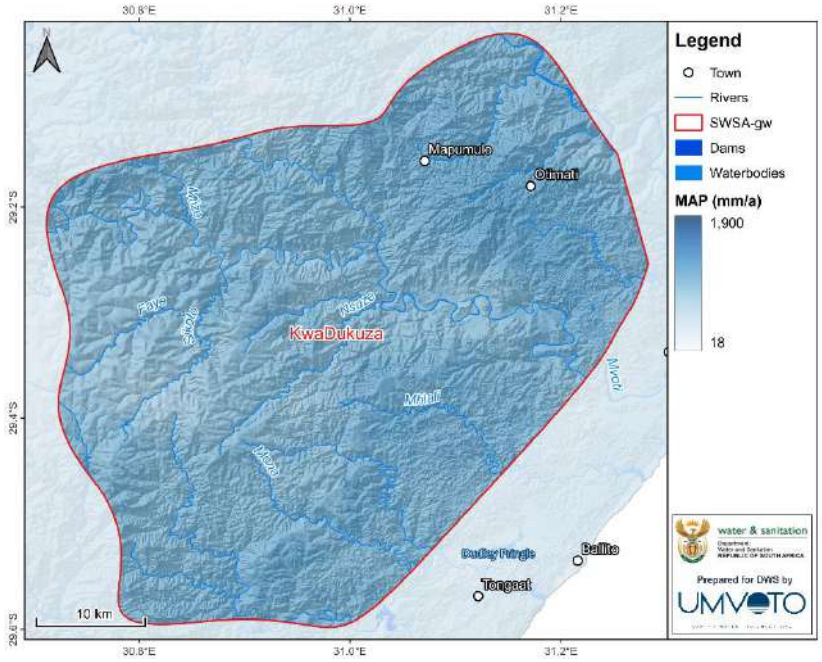
Groundwater Recharge

The KwaDukuza region receives a total MAP volume of 2185 Mm^3/a, with a significantly high average rainfall of 929 mm/a. However, only 156.1 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 7.1% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
KwaDukuza	2185	929	156.1	66.4	7.1%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

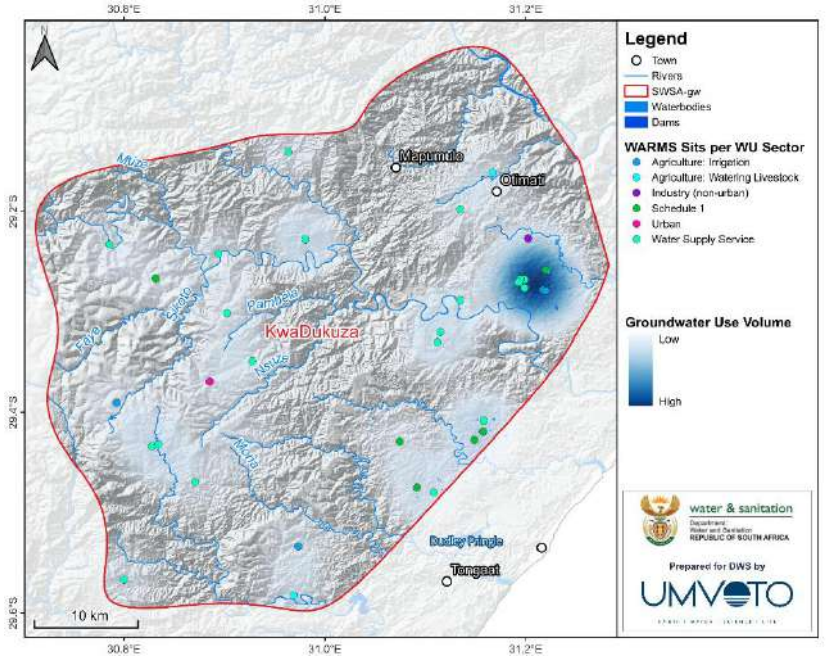
SWSA-gw Name:	KwaDukuza
Area:	2352 km^2
Elevation:	35 to 1153 mamsl
Quantity & Quality	
Groundwater Use	

The KwaDukuza SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Mapumulo (Conjunctive), who rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Municipal water supply services, at 1.1 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. The supply is scattered across the entire region with a clustering in the northeast of the area.
- Agricultural irrigation use, with 0.1 Mm^3/a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. The irrigation is mainly in the southern and western parts of the area.
- Agricultural livestock watering follows closely, using 0.01 Mm^3/a to provide water for livestock animals to drink and graze. This is predominantly in the northern and eastern parts of the region.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Mapumulo, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	0.1
	Agriculture: Watering Livestock	0.01
	Schedule 1	0.01
	Water Supply Service	1.1
	Total	**1.2**



Water use map for the KwaDukuza SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

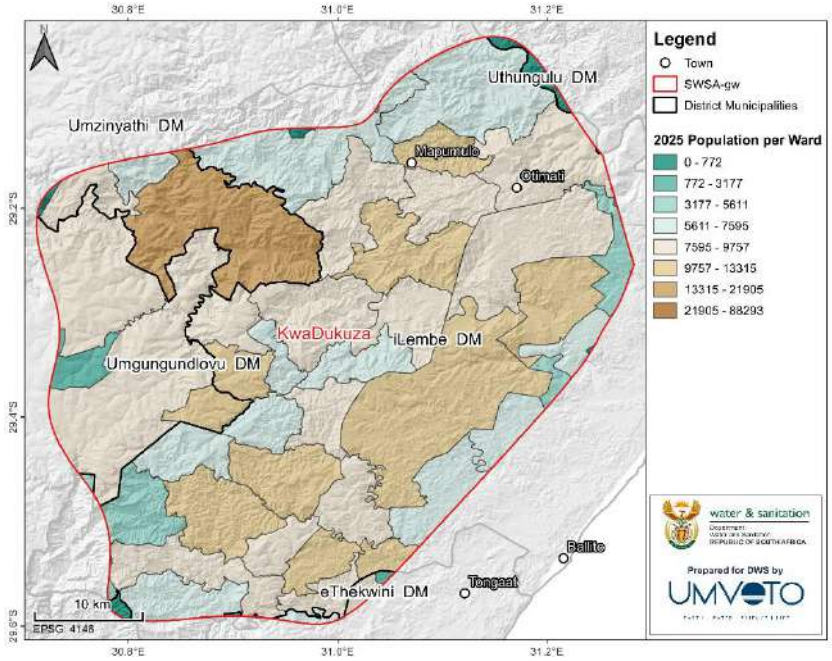
SWSA-gw Name:	KwaDukuza
Area:	2352 km^2
Elevation:	35 to 1153 mamsl
Quantity & Quality	
Socio Economic & Governance	

The KwaDukuza SWSA-gw is located within the Pongola-Mtamvuna Water Management Area (WMA, 2023). The groundwater resources within the Zululand Coastal Plain SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Pongola-Mtamvuna Catchment Management Agency (PUCMA), which was formed as part of a national restructuring process that consolidated CMAs. PUCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the PUCMA to manage water resources in the Pongola-Mtamvuna WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	PUCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Pongola-Mtamvuna WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The district municipalities are the relevant Water Service Authorities and Water Service Providers in the region.

The estimated 2025 population within the KwaDukuza SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 0.86% per year, resulting in a projected population of approximately 306,164.

As shown in the map and table below, Ndwedwe Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 133,245, followed by Maphumulo LM with 63,349.



Projected population distribution in 2025 for the KwaDukuza SWSA-gw.

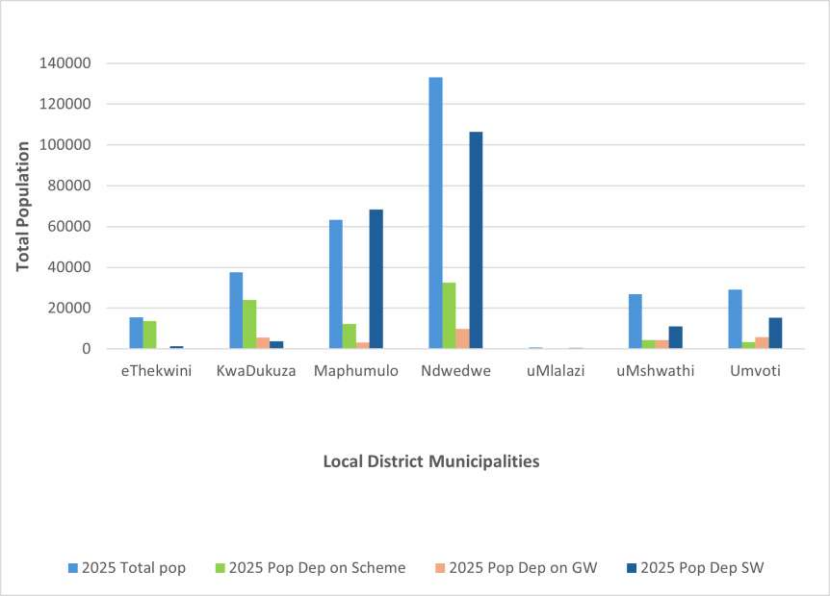
SWSA-gw Name:	KwaDukuza
Area:	2352 km^2
Elevation:	35 to 1153 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the KwaDukuza SWSA-gw, an estimated 67.4% of the population depends on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources), 29.5% on the regional water supply scheme and 9.6% on groundwater sources (including boreholes and springs).

Among the LMs, the Umvoti LM has the highest proportion of groundwater reliance, with approximately 19.9% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
eThekwini	15,497	13,602	342	1,293
KwaDukuza	37,521	24,050	5,694	3,730
Maphumulo	63,349	12,197	3,201	68,271
Ndwedwe	133,245	32,586	9,910	106,367
uMlalazi	645	92	67	451
uMshwathi	26,790	4,331	4,368	11,071
Umvoti	29,118	3,351	5,800	15,295
Total	**306,164**	**90,209**	**29,382**	**206,479**



Projected population dependence on water sources in 2025.

SWSA-gw Name:	KwaDukuza
Area:	2352 km^2
Elevation:	35 to 1153 mamsl
Quantity & Quality	
Groundwater Quality	

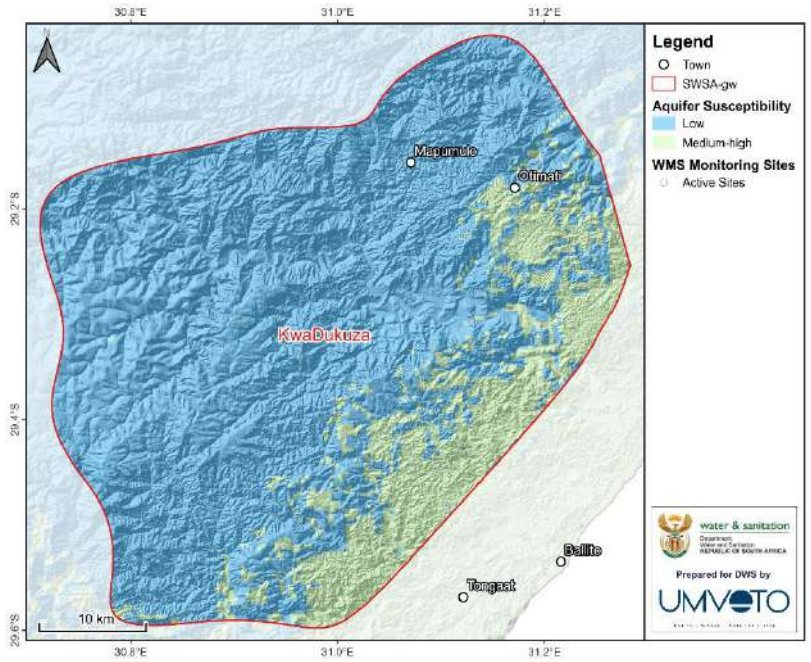
The KwaDukuza SWSA-gw consists of the Minor aquifer system, classified based on their yield and water quality. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 556.58 km^2, which is 23.66% of the KwaDukuza SWSA-gw total area. Urban/Built-up areas cover 505.20 km^2 (21.48%), while mines and quarries account for 0.25 km^2 (0.01%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The majority of the Minor aquifer system is characterized by areas that have the least vulnerability, while the moderately vulnerable areas are found in the eastern and southern parts of the aquifer.

The WMS database does not contain any actively monitored sites. The sites with water quality results were sampled between 16/02/1971 and 26/11/1993, so there is no recent data available.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 9.4 - 215 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.2 - 2.62 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.02 - 61.80 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 5.7 - 8.77 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 4.8 - 63.1 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**KwaDukuza**
Area:	**2352 km^2**
Elevation:	**35 to 1153 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the KwaDukuza SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	N/A	N/A	19	59.44	mS/m	1971-1993 WMS data: 9.4 - 215 mS/m (Avg.: 59.84 mS/m). 2014-2024 GW Geosites: N/A	1971-1993 WMS data: 14.7 - 134.9 mS/m (Avg.: 57.2 mS/m). 2014-2024 GW Geosites: N/A	-
Fluoride	N/A	N/A	19	0.95	mg/L	1971-1993 WMS data: 0.25 - 2.62 mg/L (Avg.: 0.95 mg/L). 2014-2024 GW Geosites: N/A	1971-1993 WMS data: 0.2 - 1.63 mg/L (Avg.: 0.75 mg/L). 2014-2024 GW Geosites: N/A	-
Nitrate + Nitrite Nitrogen	N/A	N/A	19	5.73	mg/L	1971-1993 WMS data: 0.02 - 61.80 mg/L (Avg.: 6.03 mg/L). 2014-2024 GW Geosites: N/A	1971-1993 WMS data: 0.02 - 10.64 mg/L (Avg.: 4.05 mg/L). 2014-2024 GW Geosites: N/A	-
pH	N/A	N/A	19	7.38	pH unit	1971-1993 WMS data: 5.7 - 8.77 (Avg.: 7.27). 2014-2024 GW Geosites: N/A	1971-1993 WMS data: 7.57 - 8.6 (Avg.: 7.98). 2014-2024 GW Geosites: N/A	-
Sulphate	N/A	N/A	18	21.88	mg/L	1971-1993 WMS data: 4.8 - 63.1 mg/L (Avg.: 23.34 mg/L). 2014-2024 GW Geosites: N/A	1971-1993 WMS data: 5.9 - 13 mg/L (Avg.: 9.45 mg/L). 2014-2024 GW Geosites: N/A.	-

- *"Average" refers to the average concentrations for the Total Sites with WQ results of the KwaDukuza SWSA-gw, taken from the WMS database from 1971-2024.*
- *"-" refers to no available data from the WMS database from 1971-2024 and the 2014-2024 GW Geosites.*
- *"N/A" refers to Not Applicable.*

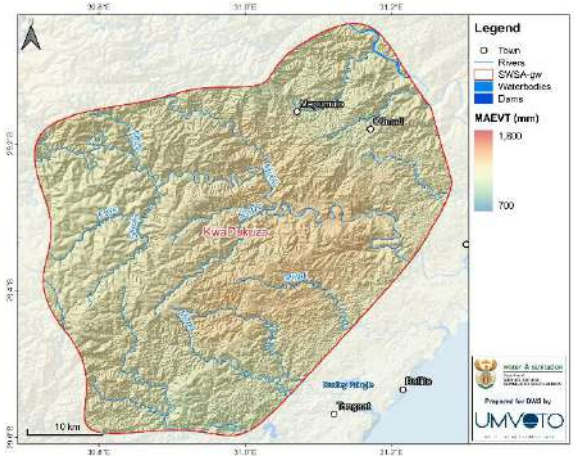
SWSA-gw Name:	**KwaDukuza**
Area:	**2352 km^2**
Elevation:	**35 to 1153 mamsl**

Threats & Risks

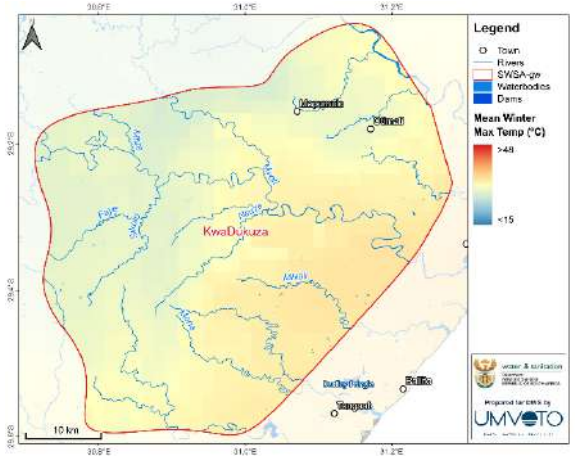
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the KwaDukuza SWSA-fw has a predominantly Cfa humid subtropical, type climate characterised by hot and humid summers and mild winters. The climate type changes to a Cwa humid subtropical climate type characterised by hot summers and cool winters and then into a Cwb subtropical highland type climate characterised by warm summers and dry winters towards the northwest. MAP increases towards the coast. Temperatures in the SWSA-gw range from 6.1 – 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

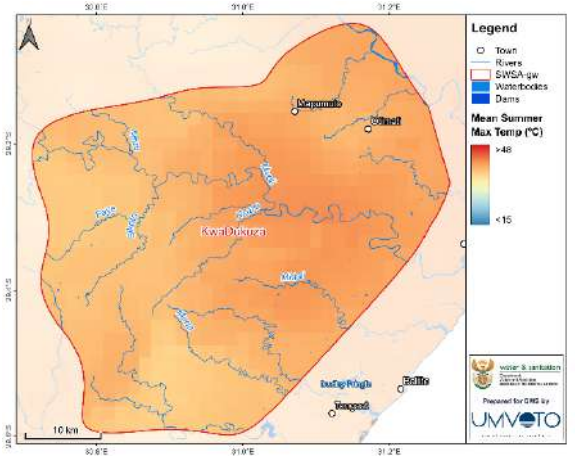
Temperature	Summer: 24.6 to 29.2 ºC, Winter: 6.1 to >8 °C
Evapotranspiration	Maximum value of 1437 mm/a with an average value of 1279 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, but an increase in recharge (ranging from ~ 6.2 to 16.6 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the KwaDukuza SWSA-gw region.



Mean winter temperatures of the KwaDukuza SWSA-gw region.



Mean summer temperatures of the KwaDukuza SWSA-gw region.

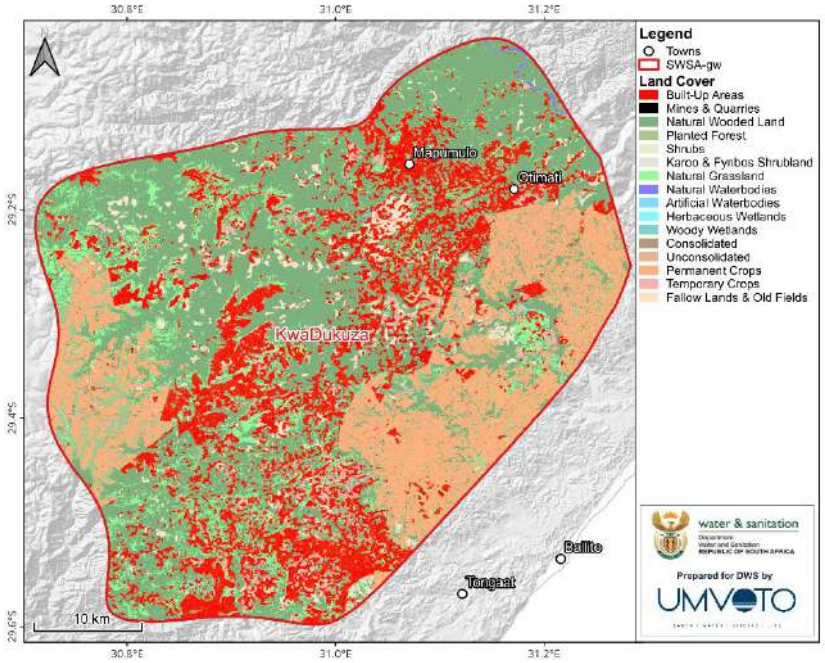
SWSA-gw Name:	KwaDukuza
Area:	2352 km^2
Elevation:	35 to 1153 mamsl

Threats & Risks

Land Use

Forest land, made up of natural wooded land and planted forest (DFFE, 2022), dominates the KwaDukuza SWSA-gw, covering 45.4% of the total area, indicating significant forested regions that contribute to biodiversity and ecosystem services. Built-up areas, consisting of residential, commercial and industrial areas, account for 21.5%, highlighting substantial human settlement and urban development. Cultivated land, which includes permanent crops, temporary crops, fallow lands and old fields, makes up 23.7%, suggesting a strong focus on long-term agricultural investments. Waterbodies and wetlands occupy minimal space, indicating limited sources of surface water in the SWSA-gw.

Land Use Type	Area (km^2)	Area (%)
Barren Land	10	0.4
Built-Up	505	21.5
Cultivated	557	23.7
Forest Land	1069	45.4
Grassland	203	8.6
Mines and quarries	0.25	0.01
Waterbodies	5	0.2
Wetlands	3	0.1



Land Cover 24-class map (DFFE, 2022) to show the types of land use and extent of each occurring in the KwaDukuza SWSA-gw.

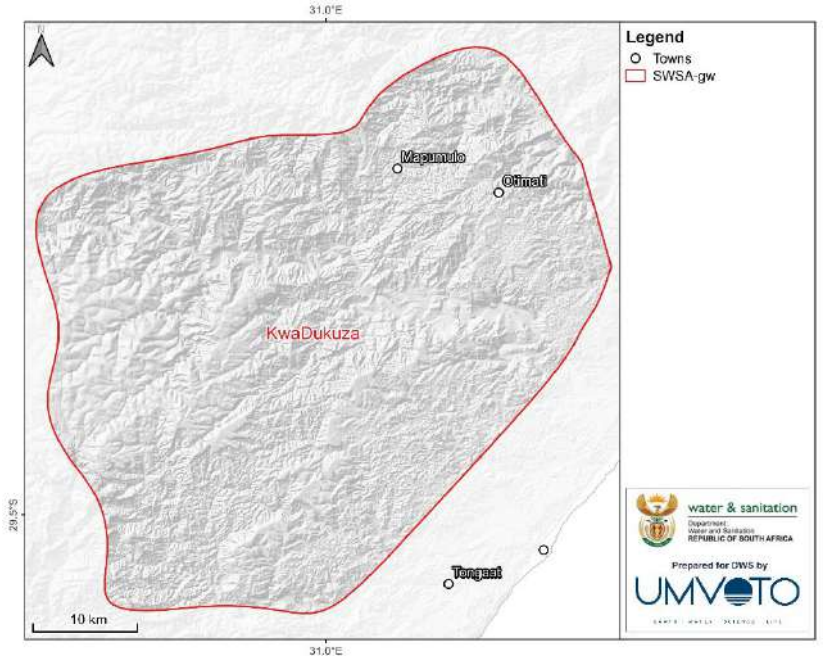
SWSA-gw Name:	KwaDukuza
Area:	2352 km^2
Elevation:	35 to 1153 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

There are no conservation and protected areas in the KwaDukuza SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	None		0
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the KwaDukuza SWSA-gw that have protection status.

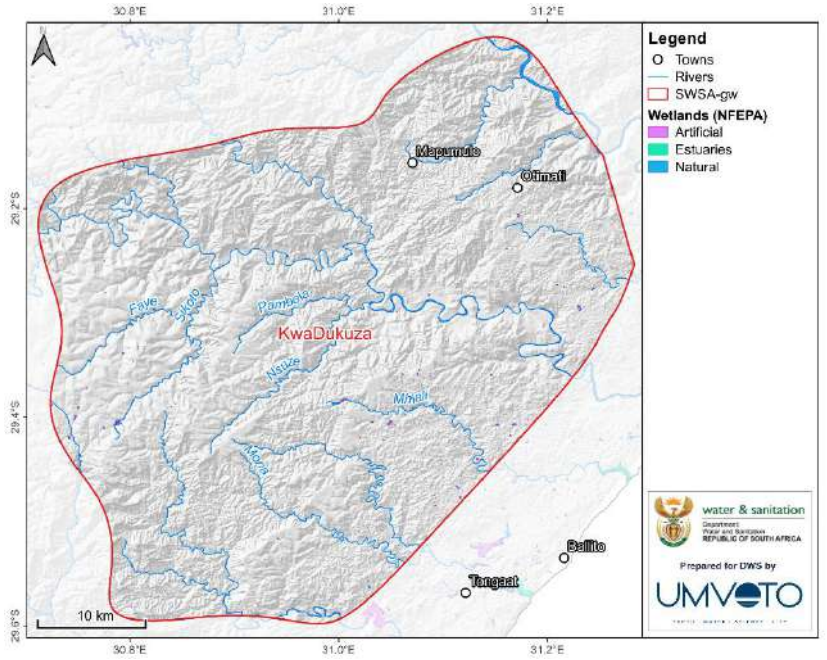
SWSA-gw Name:	KwaDukuza
Area:	2352 km^2
Elevation:	35 to 1153 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

Although there are several rivers in the KwaDukuza SWSA-gw, there are no major waterbodies, Ramsar sites nor groundwater-dependent ecosystems in the KwaDukuza SWSA-gw. There are, however, a few small wetlands scattered within the SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various small natural, artificial and estuary wetlands	9	0

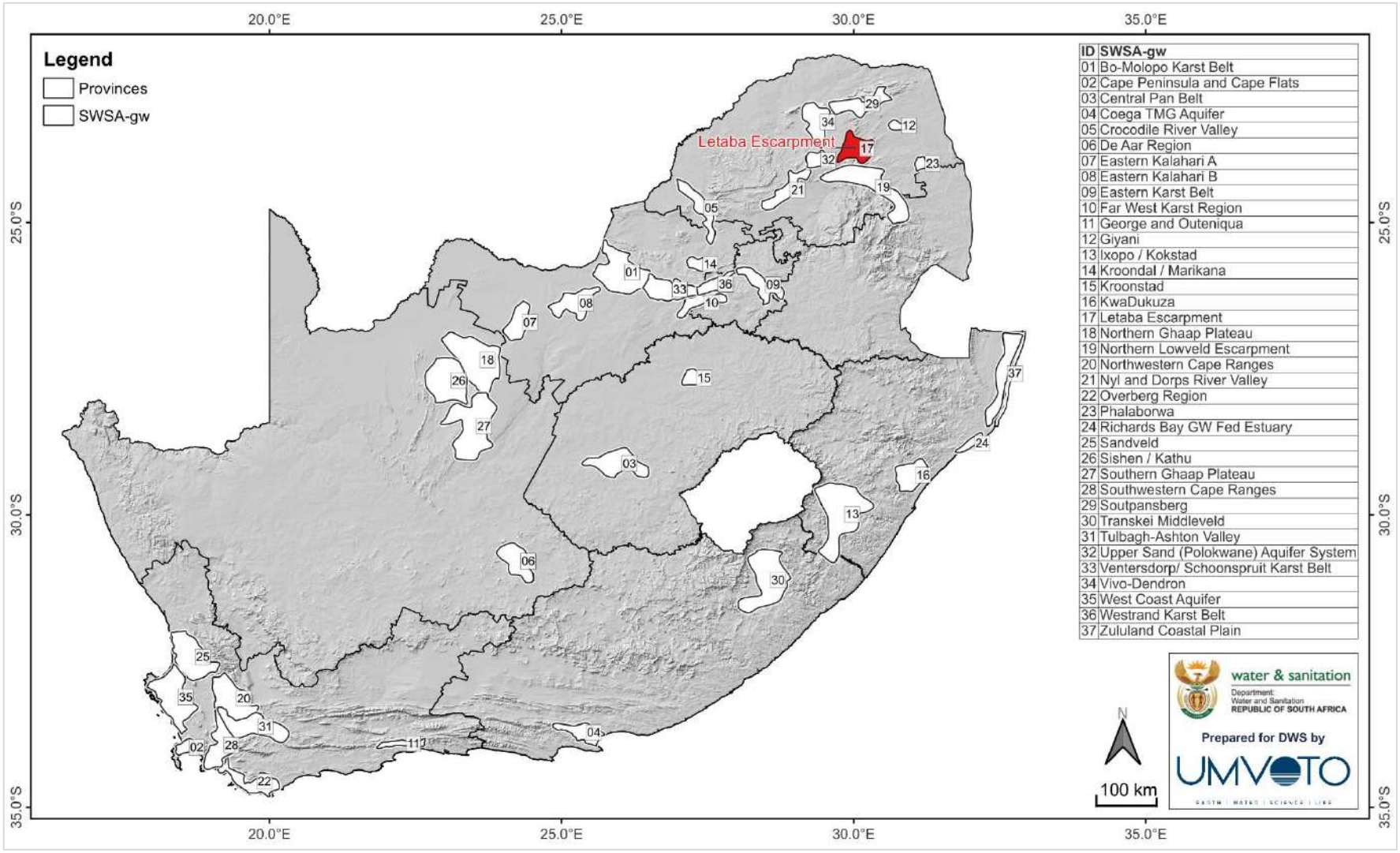


Map showing the major water bodies, Ramsar sites and GDEs in the KwaDukuza SWSA-gw.

APPENDIX 17

LETABA ESCARPMENT SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE LETABA ESCARPMENT SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

17. Letaba Escarpment

17.1. Description

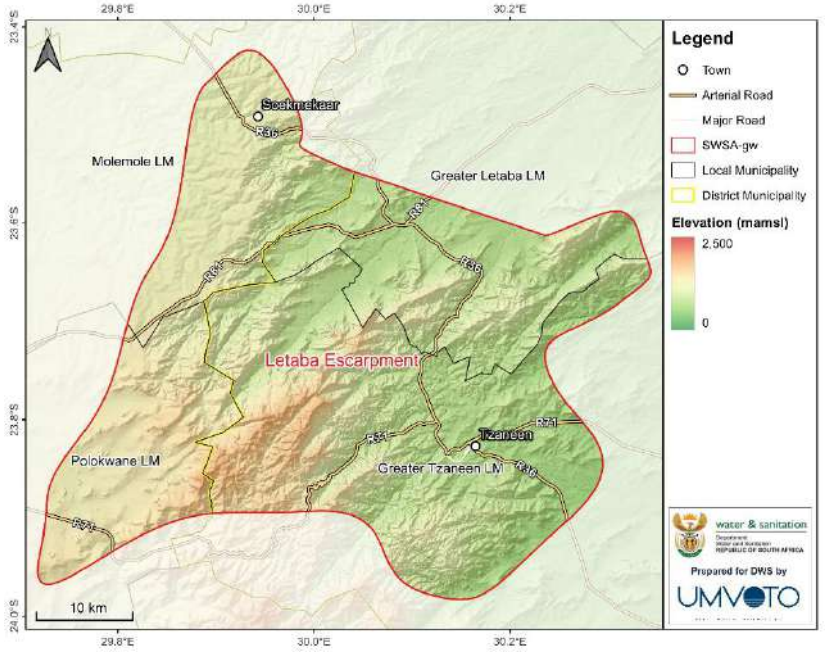
SWSA-gw Name:	**Letaba Escarpment**
Area:	**2151 km^2**
Elevation:	**541 to 1872 mamsl**

Geospatial Context

The topography of the Letaba Escarpment SWSA-gw, as depicted in the map, exhibits a diverse topography, with rugged mountainous terrain dominating the eastern and central regions, particularly around Mopani and Tzaneen. This area features steep slopes, deeply incised valleys, and a complex drainage network, indicative of highland landscapes. Moving westward towards Capricorn, the terrain transitions into lower-lying areas with more subdued relief, characterized by gentler slopes and broader valleys.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Limpopo
District Municipality	Capricorn and Mopani
Local Municipality	Molemole, Greater Letaba, Greater Tzaneen and Polokwane
Towns	Tzaneen
Major Roads	R81, R36 and R71
Major Water Supply Networks	



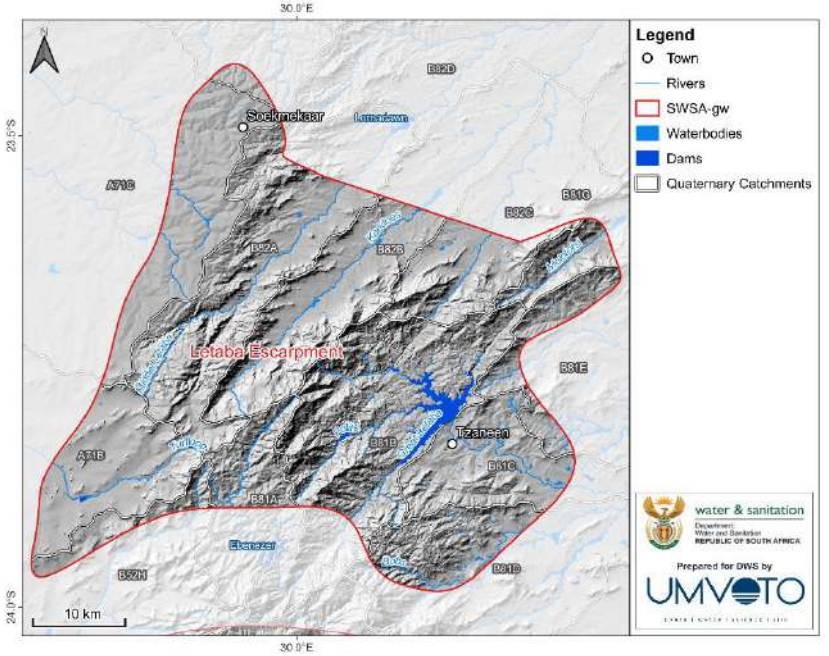
Locality map of Major Towns, District and Local Municipalities in the Letaba Escarpment SWSA-gw.

SWSA-gw Name:	Letaba Escarpment
Area:	2151 km^2
Elevation:	541 to 1872 mamsl

Hydrology and Drainage

The Letaba Escarpment SWSA-gw and surrounding areas include major surface water systems, summarised below and displayed in the map on the right. The main surface water systems are the Magoebaskloof, Hans Merensky and Tzaneen reservoirs fed by the B8 catchment, the Turfloop reservoirs fed by the A7 catchment and along with the many perennial rivers flowing in a variety of directions.

Quaternary Catchments	A71B, A71C, B52H, B81A, B81B, B81C, B81D, B81E, B81G, B82A, B82B, B82C and B82E
Rivers	Perennial: Bobs, Broederstroom, Dwars, Great Letaba, Koperspruit, Letsitele, Middel Letaba, Molototsi, Nwanedzi and Politsi
	Ephemeral: Brandboontjies, Koedoes, Mahitse, Morudi, Mothlaka-Semeetse and Turfloop
Natural and manmade water bodies	Turfloop, Magoebaskloof, Hans Merensky, Tzaneen reservoirs
Major Dams:	Turfloop, Magoebaskloof, Hans Merensky, Tzaneen
Water Management Areas:	Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Letaba Escarpment SWSA-gw.

SWSA-gw Name:	Letaba Escarpment
Area:	2151 km^2
Elevation:	541 to 1872 mamsl
Geology	

Geology

The Vaalian Era leucocratic biotite granite covers the majority of the eastern section of the Letaba Escarpment area. Diabase dykes are sporadically exposed throughout the region.

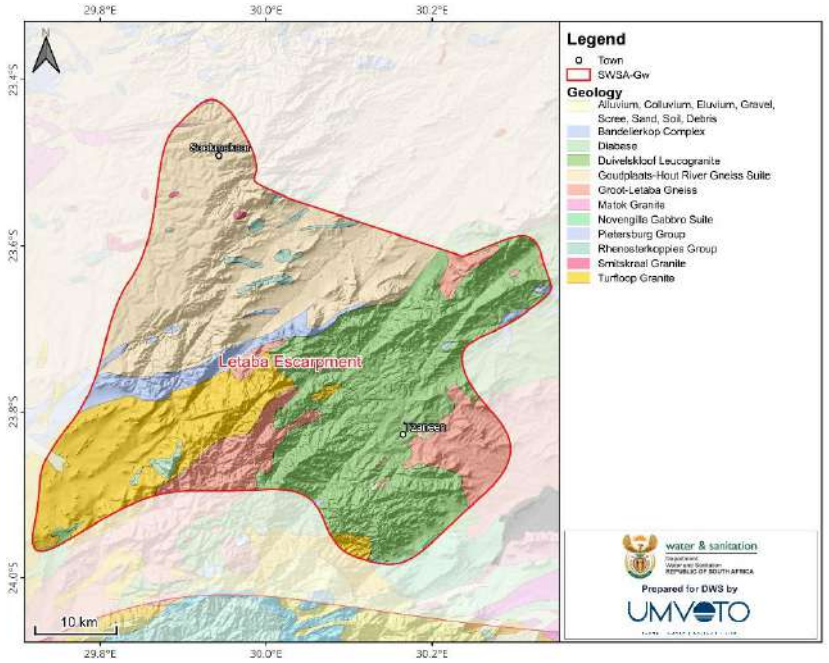
The Pietersburg Group outcrops are in the central-western section and periodically across the area, comprising formations such as the Eersteling Formation, characterised by amphibolite, metapyroxenite, and quartz-feldspar porphyry, and the Zandrivierspoort Formation, which includes amphibolites, schists, calc-silicate rocks, and magnetite quartzite. The Mothiba Formation contributes ultramafic volcanic rocks to the regional lithology.

The Turfloop Granite, found in the southwestern section, is composed of grey to pink, medium- to coarse-grained, adamellitic/granodioritic biotite granite.

The Archaean Goudplaats-Hout River Gneiss underlies the northern, central southern, and parts of the eastern sections, comprising leucocratic, migmatized biotite gneiss and greyish biotite gneiss, with minor leucogneiss.

Hydrostratigraphy

The Vaalian biotite granite and Archaean Goudplaats-Hout River Gneiss form secondary, fractured, and weathered aquifers. The Pietersburg Group consists of fractured aquifers. Dyke enhance secondary permeability. Primary, unconfined intergranular aquifers occur in the alluvial deposits along major river courses.



Geology Map of the Letaba Escarpment SWSA-gw region.

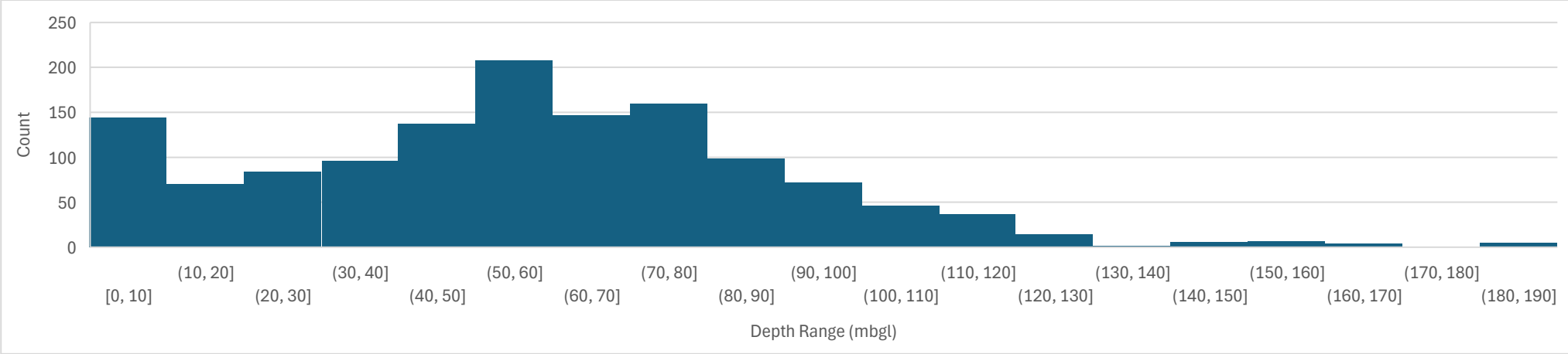
17.2. Current Status

SWSA-gw Name:	**Letaba Escarpment**
Area:	**2151 km²**
Elevation:	**541 to 1872 mamsl**
Quantity & Quality	
Aquifer Classification	

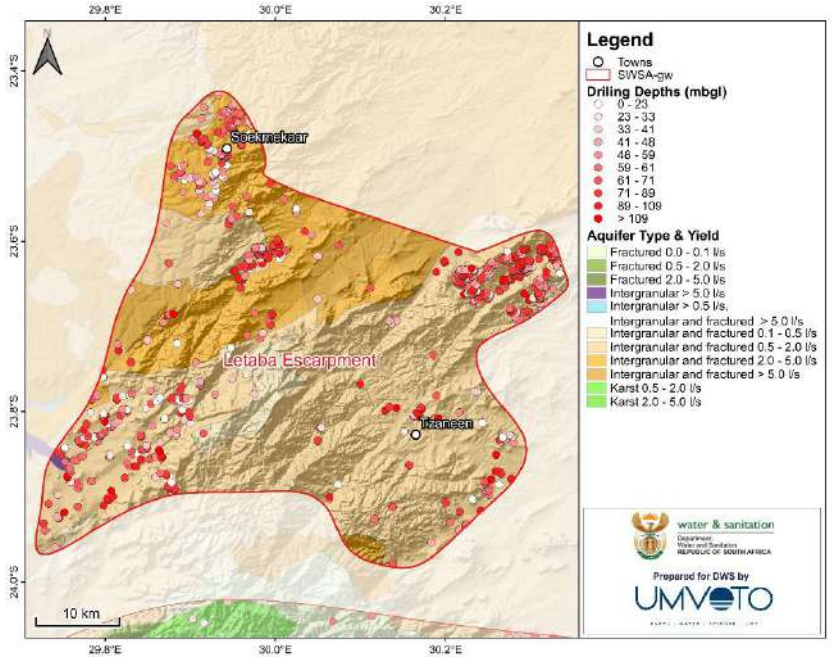
The aquifer systems within the Letaba Escarpment SWSA-gw exhibit varying yields across dual-porosity aquifers, as summarized in the table and maps below.

Aquifer Classification	The SWSA-gw is predominantly a minor aquifer system, with a major aquifer system on the western edge. The major aquifer system has an average dual-porosity yield ranging from 0.5 to over 5.0 l/s. The minor aquifer system has an average dual-porosity yield of 0.5, with occasional yields exceeding 5.0 l/s.
Groundwater Targets	The average drilling depth is 58 mbgl, and the most common depth is around 60 mbgl. This suggests the targeting of the shallow dual-porosity aquifer system, with minimal deeper drilling. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 35 and 78 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~10 mbgl, with values ranging from 0 to 44 mbgl and a standard deviation of ~ 9 mbgl. Statistical analysis of the available NGA data reveals a trend of dropping groundwater levels during this period.

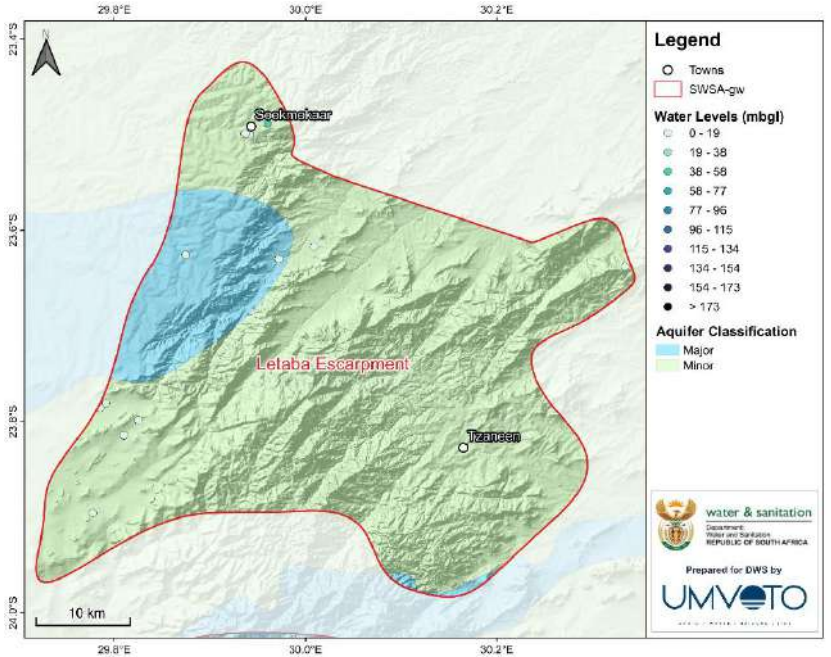
Graph of NGA drilling depths of the Letaba Escarpment SWSA-gw region



SWSA-gw Name:	Letaba Escarpment
Area:	2151 km^2
Elevation:	541 to 1872 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Letaba Escarpment SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Letaba Escarpment SWSA-gw region.

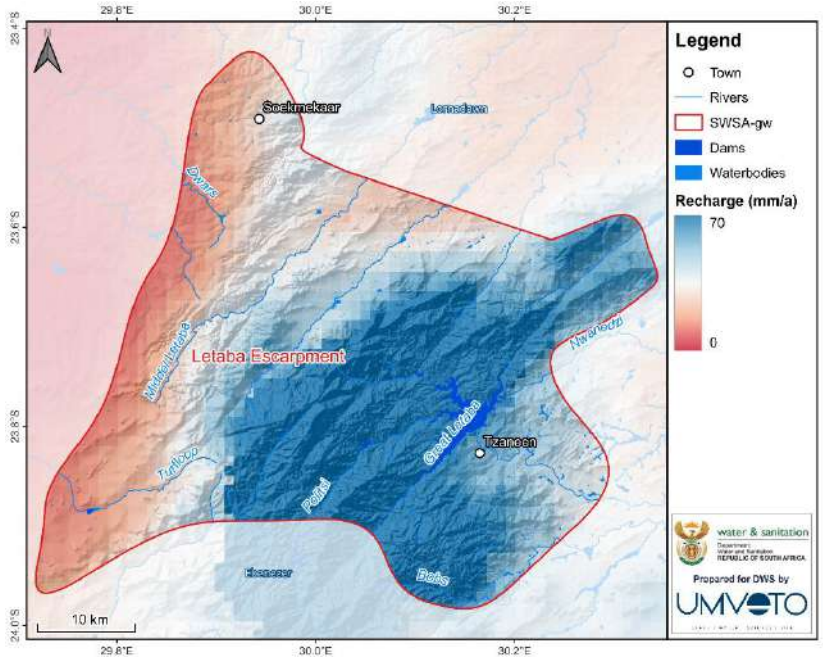
SWSA-gw Name:	**Letaba Escarpment**
Area:	**2151 km^2**
Elevation:	**541 to 1872 mamsl**

Quantity & Quality

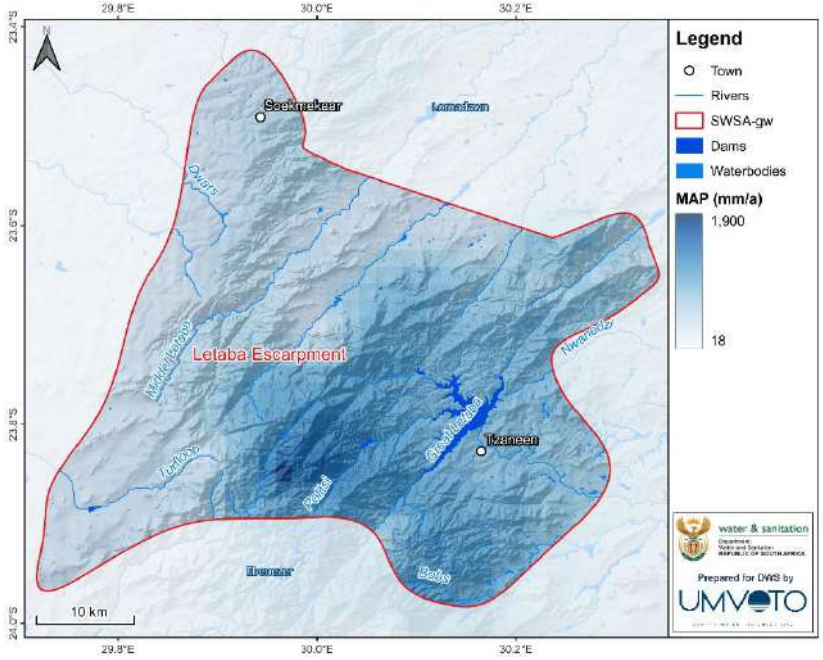
Groundwater Recharge

The Letaba Escarpment has a total MAP volume of 1814 Mm^3/a, with a relatively high average rainfall of 830mm/a. However, only 157.1 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 8.7% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Letaba Escarpment	1814	830	157.1	71.1	8.7%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Letaba Escarpment
Area:	2151 km^2
Elevation:	541 to 1872 mamsl

Quantity & Quality

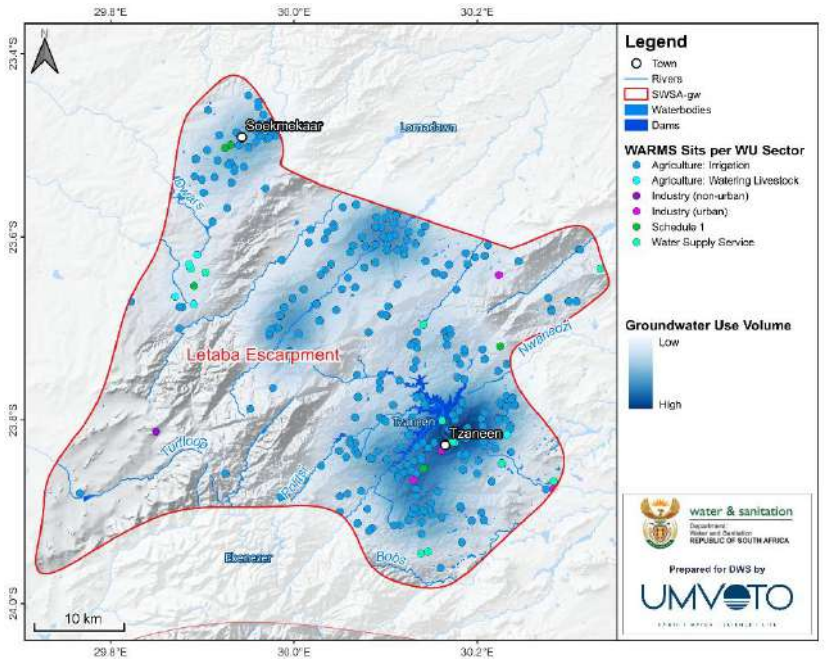
Groundwater Use

The Letaba Escarpment SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Mooketsi (Conjunctive), which relies significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 22.4 Mm^3/ a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. Use is scattered within the region but is denser in the northern and eastern parts of the region and around Tzaneen.
- Municipal water supply services, at 1 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. This is mostly in the area around Tzaneen.
- Non-Urban industrial follows, using 0.2 Mm^3/a, for manufacturing, processing, and other industrial activities outside urban centres. This sector is a major driver of groundwater demand, relying on the resource where alternative water supplies are limited. These areas are mostly located in the far west of the region.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Tzaneen, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	22.4
	Agriculture: Watering Livestock	0.02
	Industry (Non-urban)	0.2
	Industry (Urban)	0.04
	Schedule 1	0.03
	Water Supply Service	1
	Total	**23.7**



Water use map for the Letaba Escarpment SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

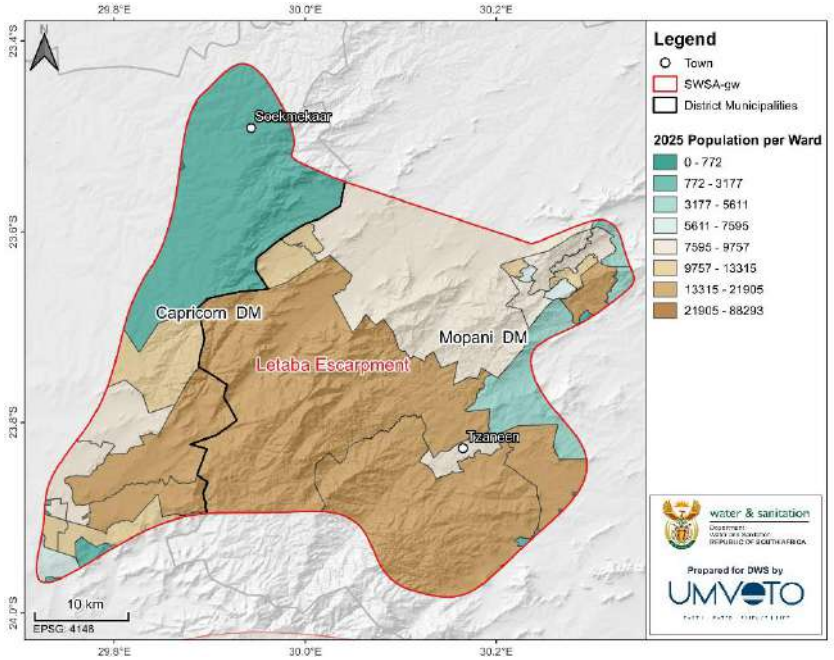
SWSA-gw Name:	Letaba Escarpment
Area:	2151 km^2
Elevation:	541 to 1872 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Letaba Escarpment SWSA-gw is located within the Limpopo-Olifants Water Management Areas (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. LOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the LOCMA to manage water resources in the Limpopo-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	LOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The district municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdictions.

The estimated 2025 population within the Letaba Escarpment SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 1.49% per year, resulting in a projected population of approximately 281,891.

As shown in the map and table below, Polokwane Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 110,960, followed by Greater Letaba LM with 90,201. Population concentrations within the SWSA-gw are highest in the Greater Tzaneen LM.



Projected 2025 population distribution per ward for the Letaba Escarpment SWSA-gw.

SWSA-gw Name:	Letaba Escarpment
Area:	2151 km^2
Elevation:	541 to 1872 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Letaba Escarpment SWSA-gw, an estimated 52.0% of the population depends on the regional water supply scheme, 34.0% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 16.2% on groundwater sources (including boreholes and springs).

Among the LMs, the Molemole LM has the highest proportion of groundwater reliance, with approximately 53.8% of its population depending on groundwater and 15.6% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Greater Letaba	90,201	36,981	20,356	27,855
Greater Tzaneen	78,593	32,460	14,814	29,751
Molemole	2,137	899	1,150	333
Polokwane	110,960	76,284	9,325	37,964
Total	**281,890**	**146,624**	**45,645**	**95,902**



Projected population dependence on water sources in 2025.

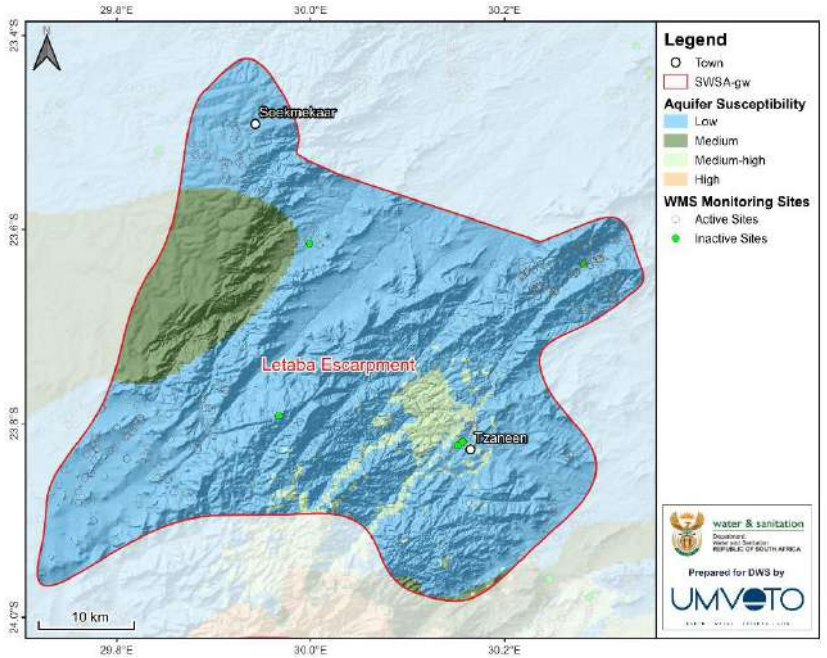
SWSA-gw Name:	Letaba Escarpment
Area:	2151 km^2
Elevation:	541 to 1872 mamsl
Quantity & Quality	
Groundwater Quality	

The Letaba Escarpment SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 451.18 km^2, which is 20.97% of the Letaba Escarpment SWSA-gw total area. Urban/Built-up areas cover 150.39 km^2 (6.99%), while mines and quarries account for 1.41 km^2 (0.07%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

WMS data is only available for the least vulnerable aquifer areas in the Minor Aquifer System.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 7.42 - 232.9 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 0.71 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.025 - 47.63 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 5.84 - 8.71 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0.3 - 90.7 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Letaba Escarpment**
Area:	**2151 km^2**
Elevation:	**541 to 1872 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Letaba Escarpment SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	4	1.91	209	40.74	mS/m	7.42 - 232.9 mS/m (Avg.: 40.74 mS/m). 2014-2024 GW Geosites: <70 - 370 mS/m. Mostly consistent with WMS (2000-2024).	2014-2024 GW Geosites: <70 - 370 mS/m.	-
Fluoride	4	1.93	207	0.21	mg/L	0.025 - 0.71 mg/L (Avg.: 0.21 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <0.5 - 1.5 mg/L.	-
Nitrate + Nitrite Nitrogen	4	1.92	208	6.14	mg/L	0.025 - 47.63 mg/L (Avg.: 6.14 mg/L). 2014-2024 GW Geosites: <11 - 50 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	2014-2024 GW Geosites: <11 - 50 mg/L.	-
pH	4	1.91	209	7.84	pH unit	5.84 - 8.71 (Avg.: 7.84). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: 7-9.	-
Sulphate	4	1.91	209	9.13	mg/L	0.3 - 90.7 mg/L (Avg.: 9.13 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <200 mg/L.	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Letaba Escarpment SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

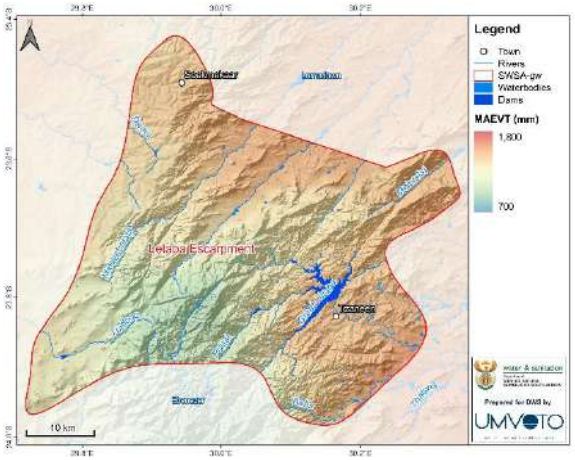
SWSA-gw Name:	**Letaba Escarpment**
Area:	**2151 km²**
Elevation:	**541 to 1872 mamsl**

Threats & Risks

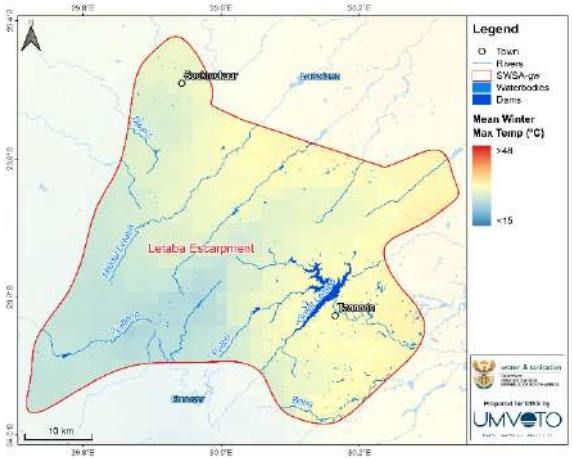
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Northern Ghaap Plateau SWSA-gw changes from a Cwa, humid subtropical, type climate characterised by hot and humid summers, and cool to mild winters, to a Cwb, subtropical highland, type climate characterized by warm summers and dry winters in the southwest. Temperatures in the SWSA-gw range from 4.1 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

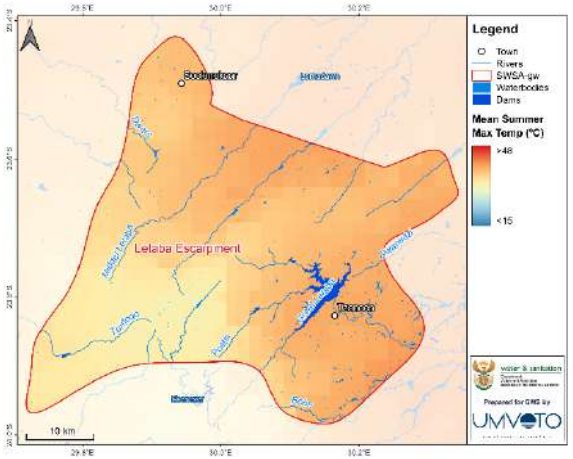
Temperature	Summer: 24.6 to 31 °C, Winter: 4.1 to >8 ºC
Evapotranspiration	Maximum value of 1597 mm/a with an average value of 1348 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, but an increase in recharge (ranging from ~ -4.1 to 2.5 mm/a). The DART Index indicates stable with some improving conditions.



Mean annual A-Pan evaporation of the Letaba Escarpment SWSA-gw region.



Mean winter temperatures of the Letaba Escarpment SWSA-gw region.



Mean summer temperatures of the Letaba Escarpment SWSA-gw region.

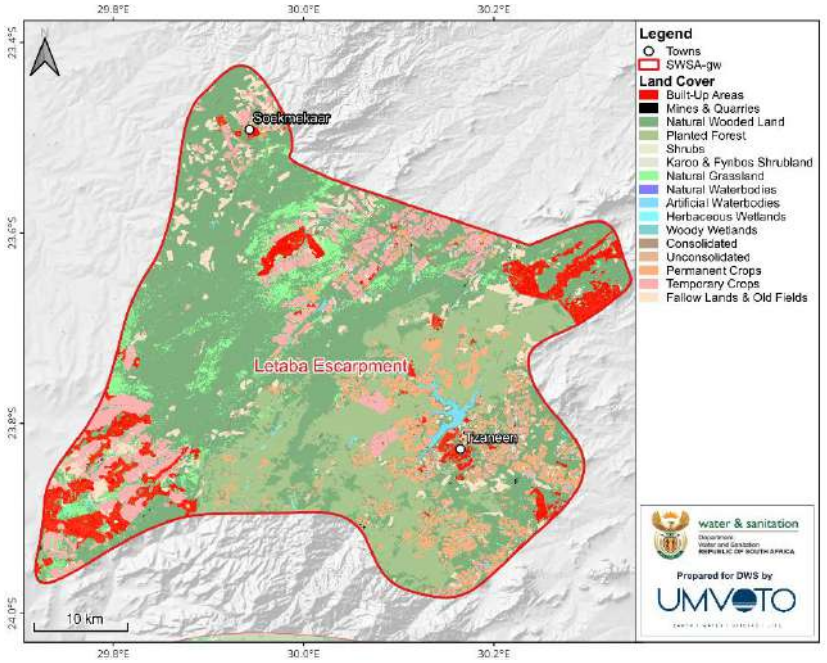
SWSA-gw Name:	Letaba Escarpment
Area:	2151 km^2
Elevation:	541 to 1872 mamsl

Threats & Risks

Land Use

Forest land, which is made up of natural wooded land and planted forest, is the dominant land cover (DFFE, 2022) in the Letaba Escarpment SWSA-gw, occupying 65.1% of the total area, which highlights the region's significant forested ecosystems. Agricultural use is evident with cultivated land, consisting of temporary crops, permanent crops, and fallow lands, indicating a mix of active and inactive cultivation areas. Built-up area, consisting of residential, commercial and industrial land covers, 7%, reflecting moderate human settlement and development within the region. Wetlands and waterbodies are minimal, underscoring the limited surface water availability.

Land Use Type	Area (km^2)	Area (%)
Barren Land	5	0.2
Built-Up	150	7.0
Cultivated	451	21.0
Forest Land	1401	65.1
Grassland	118	5.5
Mines and quarries	1	0.1
Shrubland	0	0.0
Waterbodies	16	0.7
Wetlands	8	0.4



Land Cover 24-class map to show the types of land use and extent of each occurring in the Letaba Escarpment SWSA-gw.

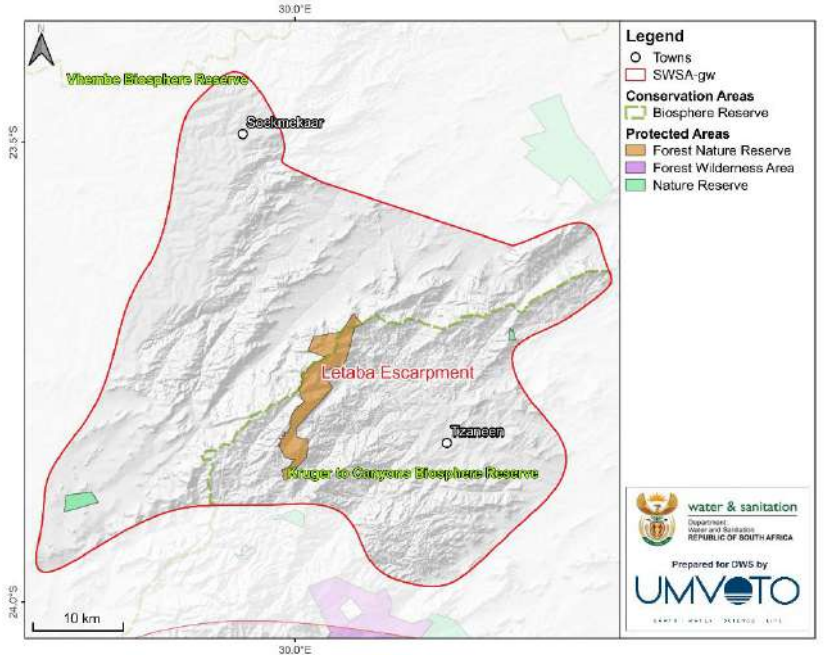
SWSA-gw Name:	Letaba Escarpment
Area:	2151 km^2
Elevation:	541 to 1872 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

A significant portion of the Letaba Escarpment SWSA-gw is covered by the Kruger to Canyons Biosphere Reserve (DFFE, 2024), as displayed on the map. The SWSA-gw also has one large forest nature reserve running through the centre, called the Grootbosch Nature Reserve (DFFE, 2024).

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Kruger to Canyons Biosphere Reserve	853.88	1
Protected Areas	• Grootbosch Nature Reserve • Turfloop Nature Reserve • Narina Nature Reserve	51.70	3
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Letaba Escarpment SWSA-gw that have protection status.

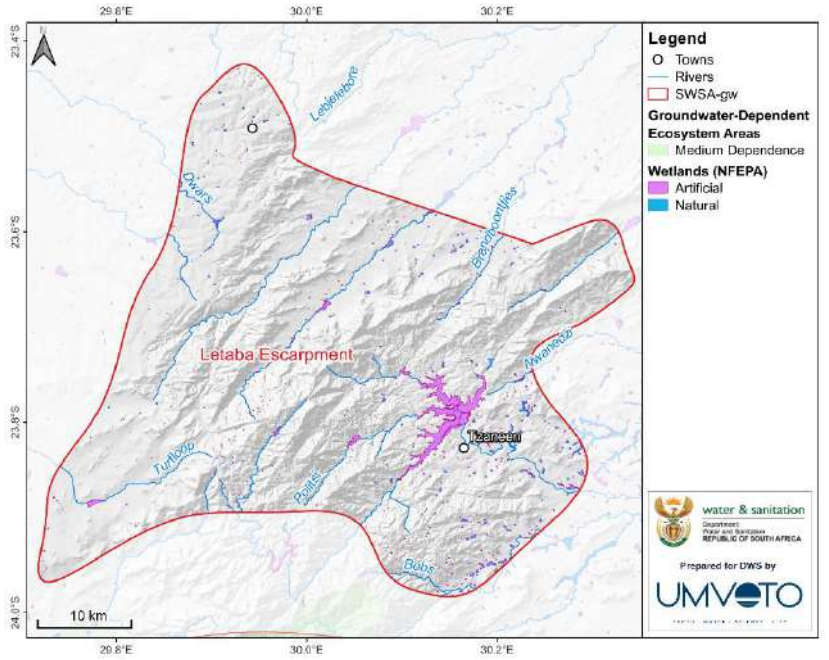
SWSA-gw Name:	Letaba Escarpment
Area:	2151 km^2
Elevation:	541 to 1872 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Tzaneen Dam (DWS, 2011) is a large water body in the Letaba Escarpment SWSA-gw that is fed by the Mahitse, Politsi and Great Letaba rivers.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Tzaneen Dam	18.95	1
Ramsar Sites	None		0
Wetlands	Various natural and artificial wetlands	34	0

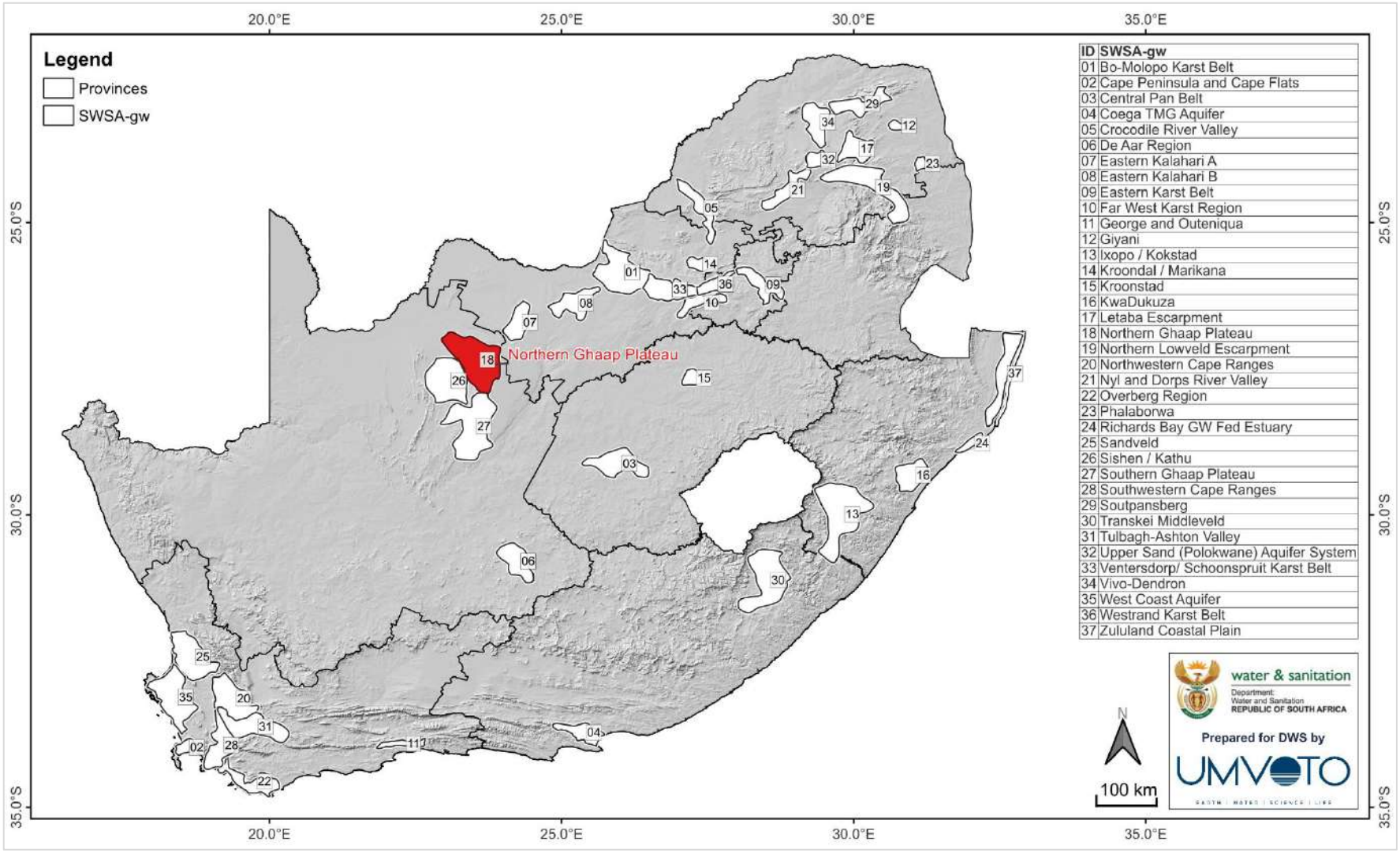


Map showing the major water bodies, Ramsar sites and GDEs in the Letaba Escarpment SWSA-gw.

APPENDIX 18

NORTHERN GHAAP PLATEAU SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE NORTHERN GHAAP PLATEAU SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

18. Northern Ghaap Plateau

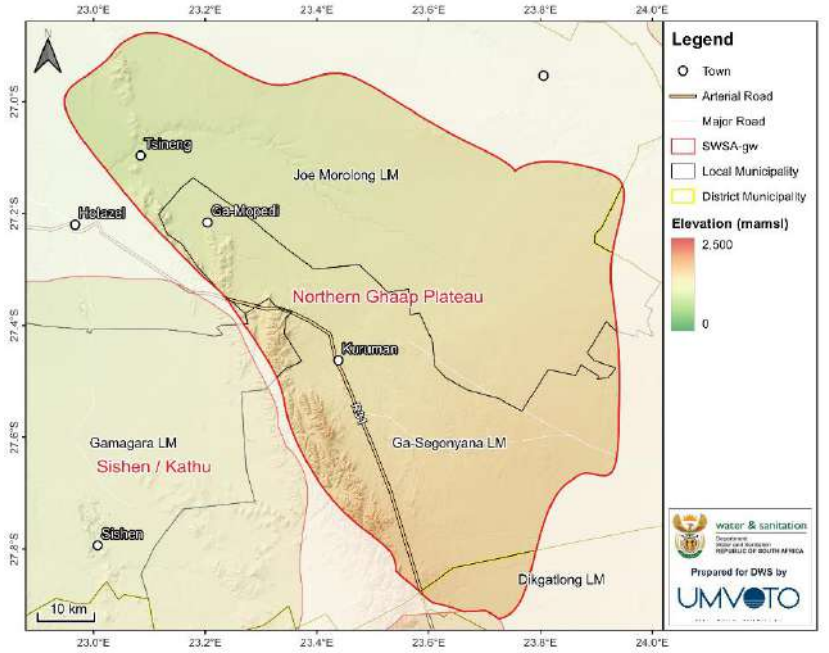
18.1. Description

SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795 mamsl
Geospatial Context	

The topography of the Northern Ghaap Plateau SWSA-gw, as depicted in the map, is characterized by a combination of flat to gently undulating plains, low hills, and sandy terrain, typical of the Kalahari Basin. Around Kuruman, the terrain features karst landscapes with sinkholes and dolomitic springs, such as the Eye of Kuruman, which influences local drainage. Ga-Motlhware lies in slightly more undulating terrain, with dry river valleys and isolated hills along the western edge breaking the otherwise open landscape.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Northern Cape and North West
District Municipality	John Taolo Gaetsewe, Dr Ruth Segomotsi Mompati, ZF Mgcawu, Frances Baard
Local Municipality	Morolong, Gamagara, Ga-Segonyana, Greater Taung, Dikgatlong
Towns	Ga-Motlhware, Mothibi and Kuruman
Major Roads	N14, R31 and R372
Major Water Supply Networks	



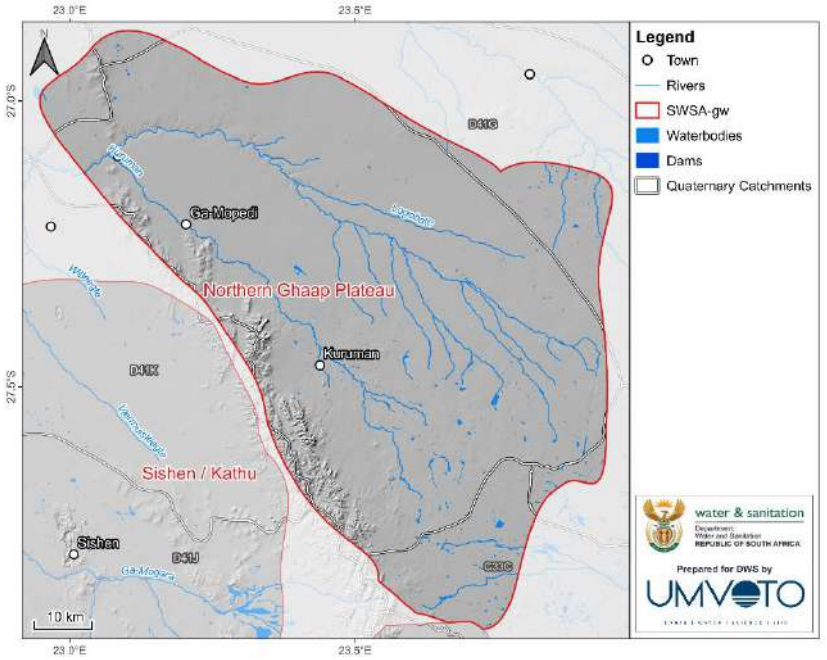
Locality map of Major Towns, District and Local Municipalities in the Northern Ghaap Plateau SWSA-gw.

SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795 mamsl

Hydrology and Drainage

The Northern Ghaap Plateau SWSA-gw and surrounding areas include one major surface water system, summarised below and displayed in the map on the right. The surface water system is the Kuruman River, which flows in a north-westerly direction and is fed by the D4 catchment.

Quaternary Catchments	C33C, D41G, D41K, D41L, D41M and a small section of D41J
Rivers	Perennial: Kuruman
	Ephemeral: Ga-Masepa, Klein-Boetsap, Logobate, Manyeding, Matlhotshaneng, Matlhwaring, Moshaweng
Natural and manmade water bodies	
Major Dams:	No major dams
Water Management Areas:	Vaal Orange



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Northern Ghaap Plateau SWSA-gw.

SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795 mamsl
Geology	

Geology

Sporadic Quaternary deposits of superficial cover sand, rubble, and soil are scattered across the Northern Ghaap Plateau area.

Tertiary deposits, including calcrete, calcified pan dunes, and surface limestone, outcrop near the center of the region.

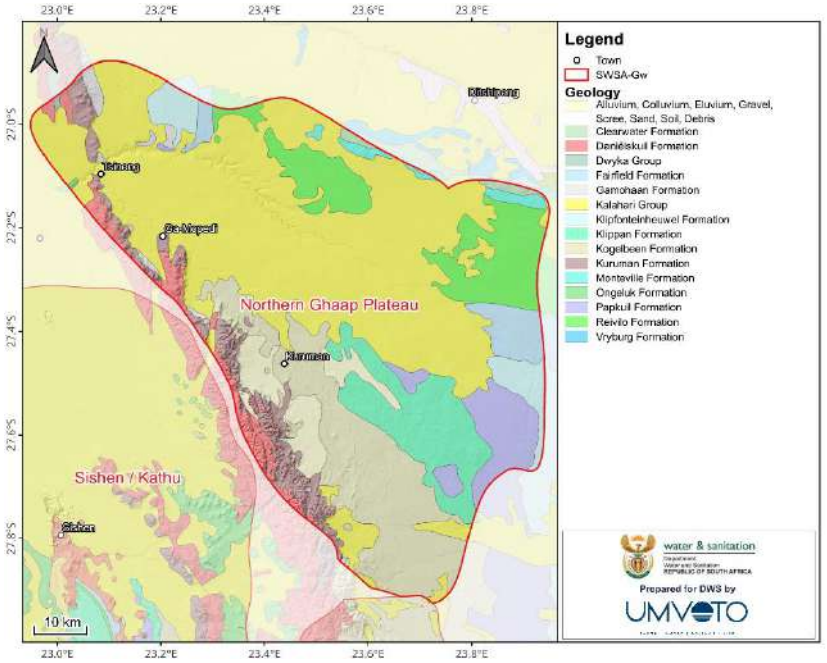
The Kalahari Group dominates much of the northeastern section, with formations such as the Mokalanen Formation, characterised by gravel, limestone, and calcrete breccia, and the Gordonia Formation, dominated by aeolian sands and dunes.

The geology of the area is primarily influenced by the Transvaal Supergroup, which predominantly outcrops in the eastern section and is represented by the Ghaap Group. This group includes various formations and subgroups, such as the Campbell Rand Subgroup, composed of stromatolitic dolomite and chert, brown dolomite, fine-grained stromatolitic limestone, and coarse-grained dolomite. The Schmidtsdrif Subgroup adds to the geological diversity with the Clearwater Formation, comprising conglomerate, chert, and dolomite, and the Boomplaas Formation, featuring dolomite, limestone, and mudrock.

Along the western border of the area, the Asbestos Hills Subgroup is characterised by banded iron formations, chert, and amphibolite, with iron-rich jaspilite and mudrock contributing to its composition.

Hydrostratigraphy

The Quaternary and Kalahari deposits form a primary intergranular aquifer with generally low yields. The Ghaap Plateau dolomites create a secondary karstic-fractured aquifer.



Geology Map of the Northern Ghaap Plateau SWSA-gw region.

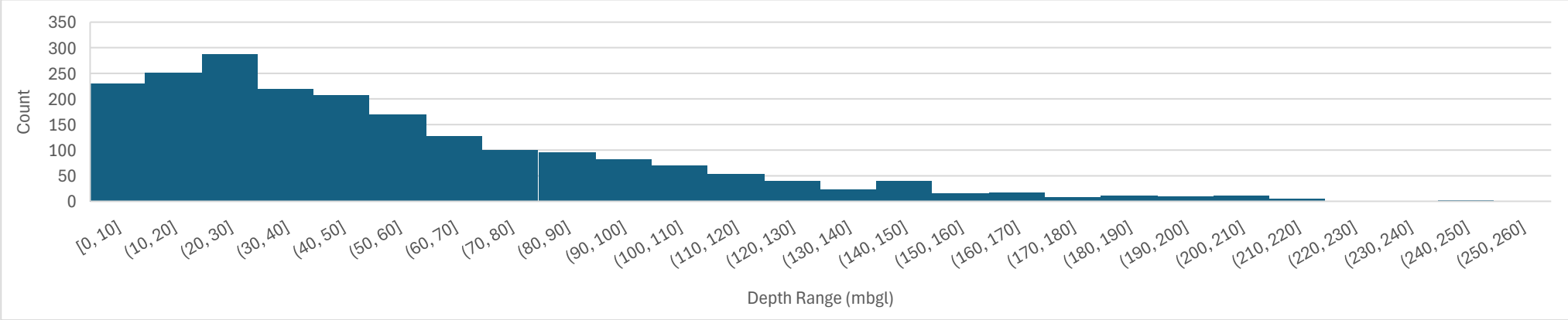
18.2. Current Status

SWSA-gw Name:	**Northern Ghaap Plateau**
Area:	**6274 km²**
Elevation:	**1026 to 1795 mamsl**
Quantity & Quality	
Aquifer Classification	

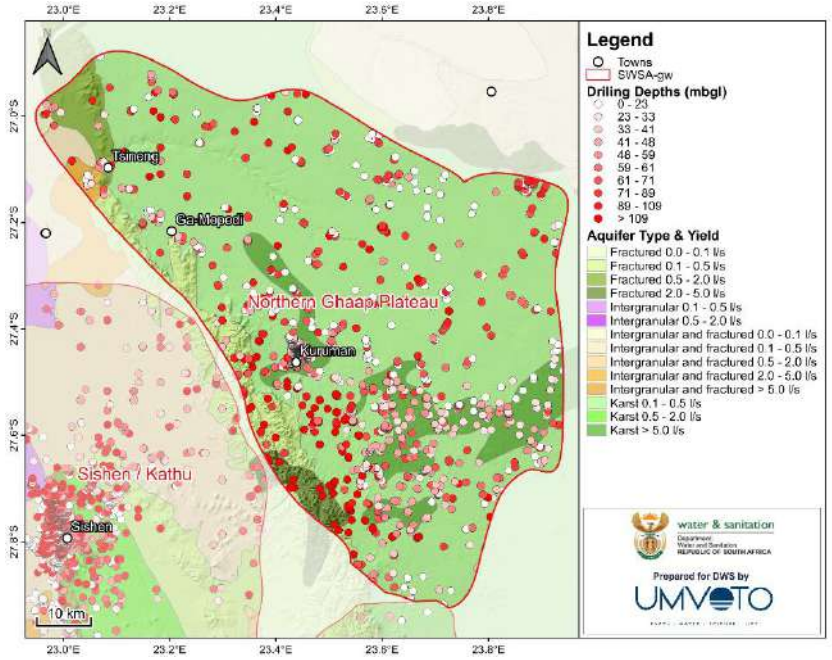
The aquifer systems within the Northern Ghaap Plateau SWSA-gw exhibit varying yields across karst aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw predominantly comprises major and minor aquifer systems, with the major aquifer system located in the eastern section and a small, poor aquifer system along the western edge. The major aquifer system has an average karst yield ranging from 0.1 to over 0.5 l/s. The minor aquifer system has an average karst yield of 0.1 to 0.5 l/s, with occasional fractured yields ranging from 0.5 to 5.0 l/s.
Groundwater Targets	The average drilling depth is 58 mbgl, and the most common depths are between 10 to 20 mbgl. The majority of the boreholes target the shallow karst aquifer, with minimal deeper drilling (> 200mbgl) into the fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 22 and 77 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 34 mbgl, with values ranging from 0 to 144 mbgl and a standard deviation of ~ 37 mbgl.

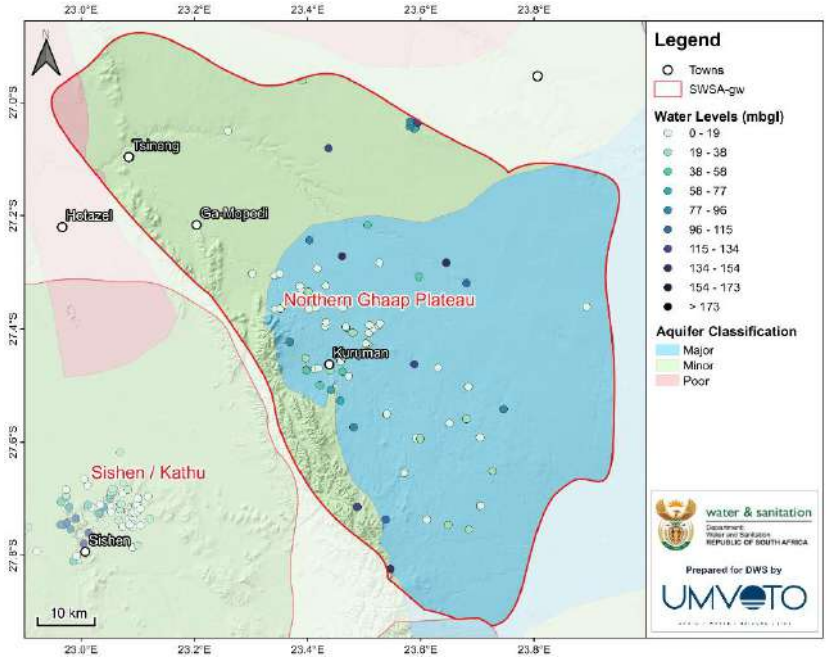
Graph of NGA drilling depths of the Northern Ghaap Plateau SWSA-gw region



SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Northern Ghaap Plateau SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Northern Ghaap Plateau SWSA-gw region.

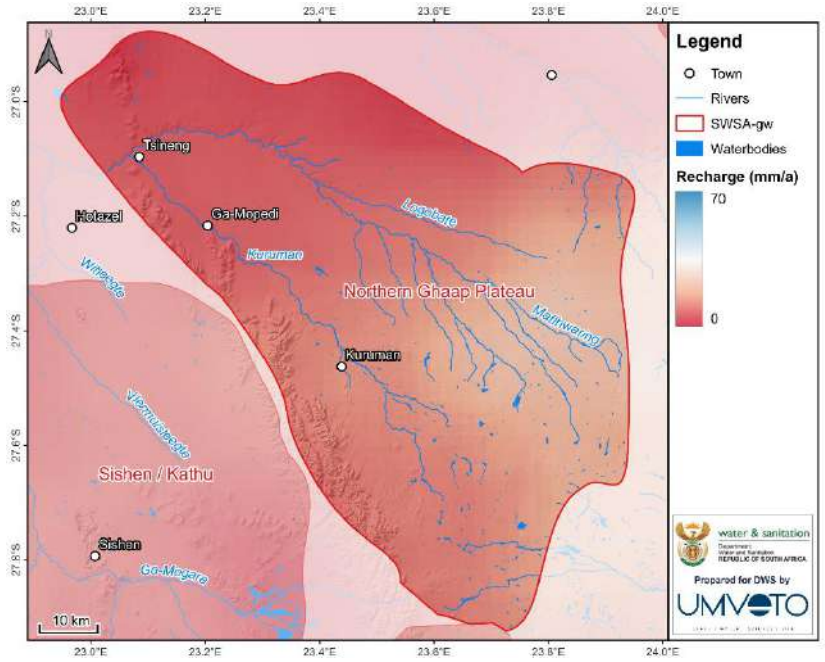
SWSA-gw Name:	**Northern Ghaap Plateau**
Area:	**6274 km²**
Elevation:	**1026 to 1795 mamsl**

Quantity & Quality

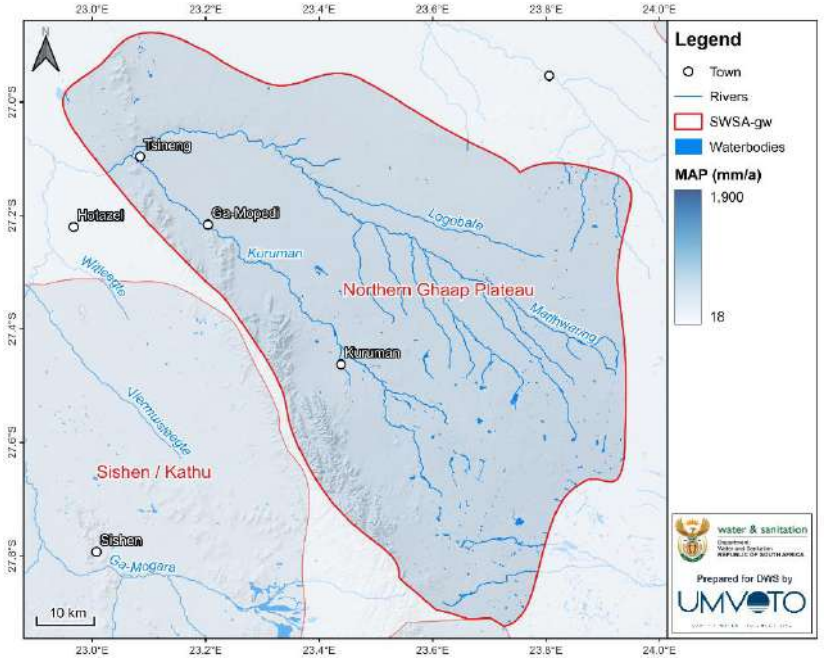
Groundwater Recharge

The Northern Ghaap Plateau receives a total MAP volume of 2339 Mm^3/a, with an average rainfall of 372 mm/a. However, only 74.5 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 3.2% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Northern Ghaap Plateau	2339	372	74.5	11.8	3.2%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795 mamsl

Quantity & Quality

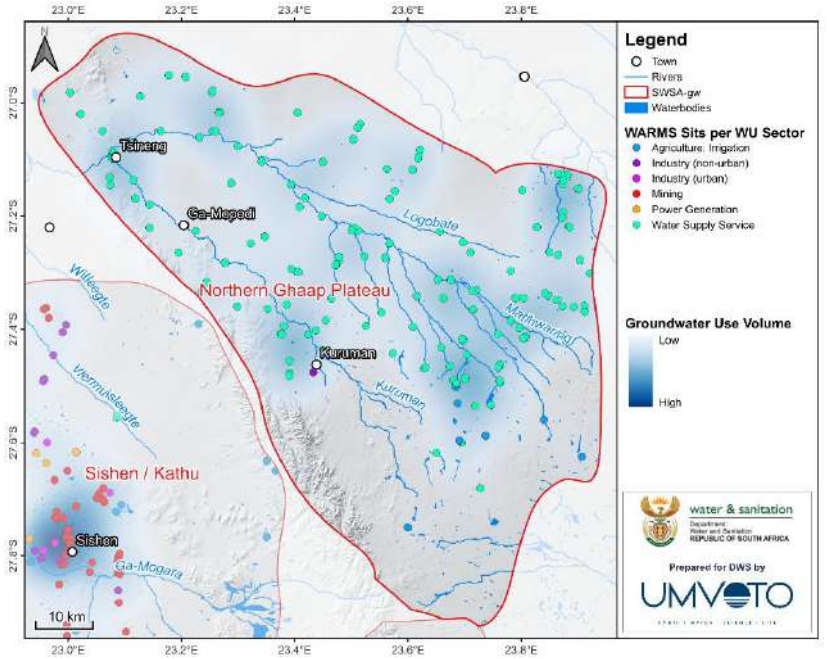
Groundwater Use

The Northern Ghaap Plateau SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Kuruman (Groundwater), which relies significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Municipal water supply services, at 17.9 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. The Northern Ghaap Plateau has a large proportion that relies on municipal groundwater supply. This can be seen by how a lot of the region, particularly in the north, uses it. This makes groundwater a crucial resource in this area.
- Agricultural irrigation use, with 1.2 Mm^3/a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. While groundwater is used significantly less for irrigation, a lot of crop production, like in the south, depends on it.
- Non-urban industrial follows, using 0.01 Mm^3/a for manufacturing, processing, and other industrial activities outside urban centres. This sector's usage is mainly seen near Kuruman in this region.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Kuruman and Mothibi, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	1.2
	Industry (Non-urban)	0.01
	Water Supply Service	17.9
	Total	**19.1**



Water use map for the Northern Ghaap Plateau SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

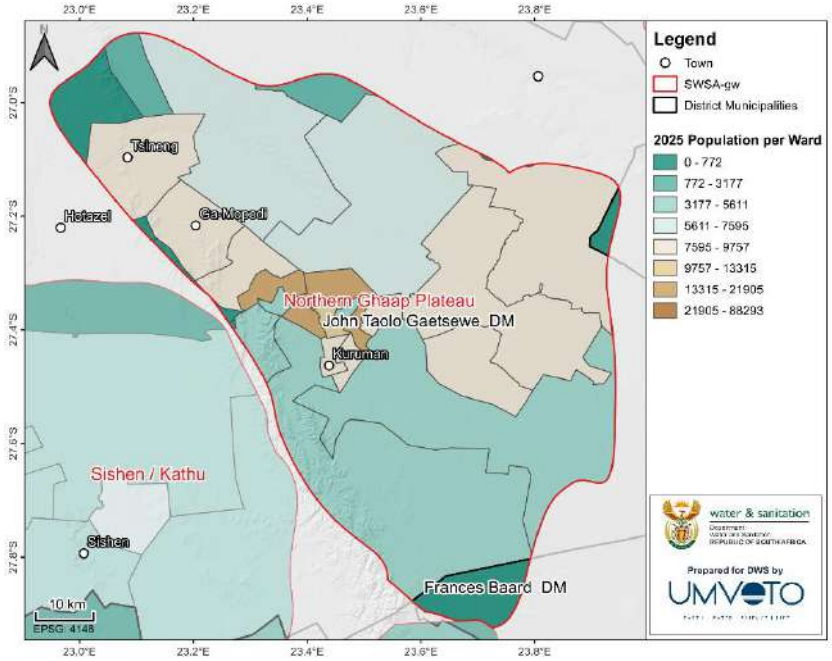
SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Northern Ghaap Plateau SWSA-gw is located within the Vaal-Orange Water Management Area (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities within the Northern Cape Province are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdictions, while the Dr Ruth Segomotsi Mompati DM is the WSA and WSP in its jurisdiction.

The estimated 2025 population within the Northern Ghaap Plateau SWSA-gw was calculated using Census 2011 2011 and 2022 data to determine a population growth rate of 0.27% per year, resulting in a projected population of approximately 152,469.

As shown in the map and table below, Ga-Segonyana Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 105,946. Population concentrations within the SWSA-gw are highest in the Ga-Segonyana and Joe Morolong LMs.



Projected population distribution in 2025 for the Northern Ghaap Plateau SWSA-gw.

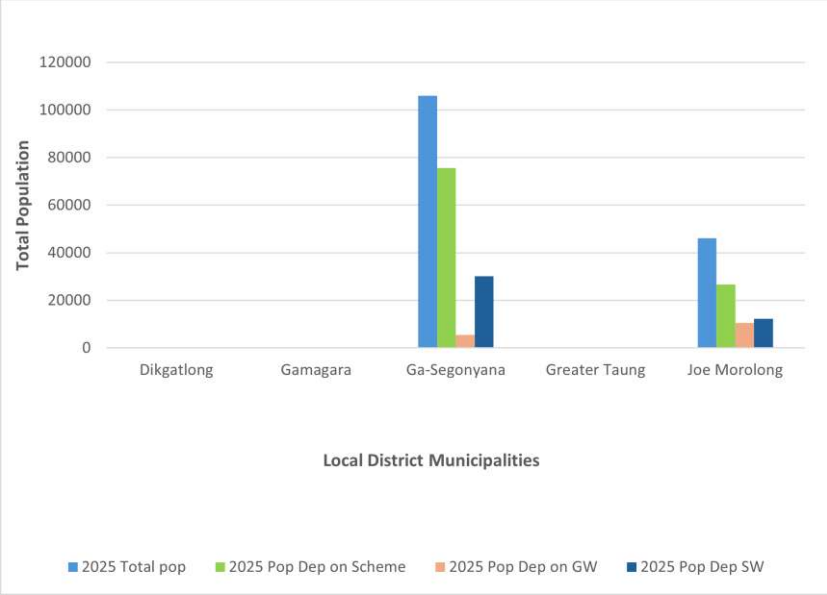
SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Northern Ghaap Plateau SWSA-gw, an estimated 67.4% of the population depends on the regional water supply scheme, 27.8% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 10.5% on groundwater sources (including boreholes and springs).

Among the LMs, the Greater Taung LM has the highest proportion of groundwater reliance, with approximately 64.5% of its population depending on groundwater and 12.2% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Dikgatlong	152	113	9	54
Gamagara	245	221	24	7
Ga-Segonyana	105,946	75,656	5,443	30,073
Greater Taung	73	35	47	9
Joe Morolong	46,053	26,712	10,522	12,223
Total	**152,469**	**102,737**	**16,044**	**42,365**



Projected population dependence on water sources in 2025.

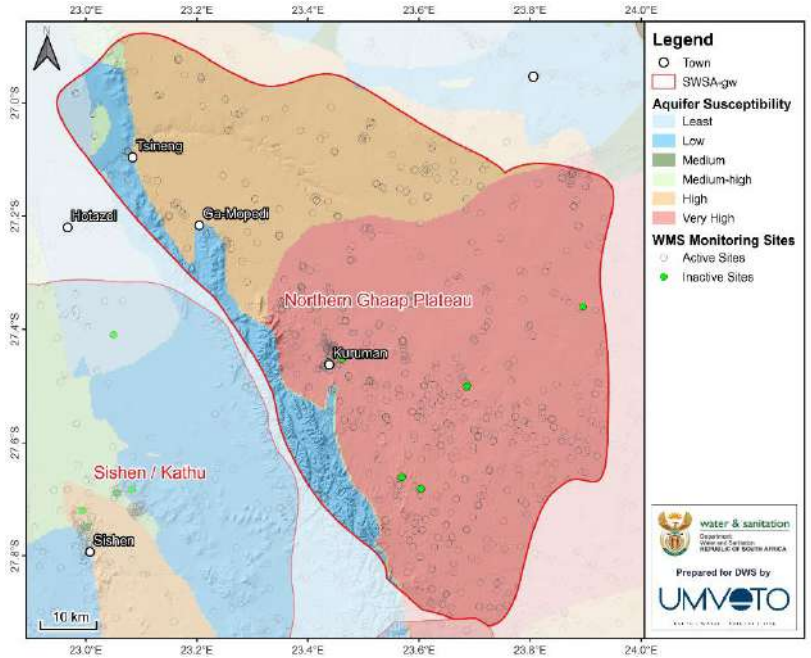
SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795 mamsl
Quantity & Quality	
Groundwater Quality	

The Northern Ghaap Plateau SWSA-gw consists of Minor and Poor aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), Urban/Built-up areas cover a total of 174.13 km^2, which is 2.78% of the Northern Ghaap Plateau SWSA-gw total area. Cultivated areas cover 68.88 km^2 (1.10%), while mines and quarries account for 3.74 km^2 (0.06%) of the total area. These land uses contribute to diffuse contamination sources, with urban areas being the primary concern. Urban areas tend to include informal settlements and townships, and this places the groundwater source under a high risk of contamination (Le Maitre et al., 2018). Several water quality indicators help assess aquifer vulnerability and contamination risks:

WMS data is only available for the most vulnerable aquifer areas in the Minor Aquifer System.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 20.6 - 89.2 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 0.87 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.04 - 14.94 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 7.2 - 8.89 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 1.48 - 32.44 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Northern Ghaap Plateau**
Area:	**6274 km^2**
Elevation:	**1026 to 1795 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Northern Ghaap Plateau SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	7	26.92	26	50.54	mS/m	2014-2024 GW Geosites: <70 - 150 mS/m.	2014-2024 GW Geosites: N/A	20.6 - 89.2 mS/m (Avg.: 50.54 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Mostly consistent with WMS (2000-2024).
Fluoride	7	28.00	25	0.16	mg/L	2014-2024 GW Geosites: <0.5 mg/L.	2014-2024 GW Geosites: N/A	0.025 - 0.87 mg/L (Avg.: 0.16 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	7	28.00	25	2.53	mg/L	2014-2024 GW Geosites: <11 mg/L.	2014-2024 GW Geosites: N/A	0.04 - 14.94 mg/L (Avg.: 2.53 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	7	26.92	26	8.23	pH unit	2014-2024 GW Geosites: 7-9.	2014-2024 GW Geosites: N/A	7.2 - 8.89 (Avg.: 8.23). 2014-2024 GW Geosites: 5.7-9. Consistent with WMS (2000-2024).
Sulphate	7	26.92	26	6.65	mg/L	2014-2024 GW Geosites: <200 mg/L.	2014-2024 GW Geosites: N/A	1.48 - 32.44 mg/L (Avg.: 6.65 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the Northern Ghaap Plateau SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*
- *"N/A" refers to Not Applicable.*

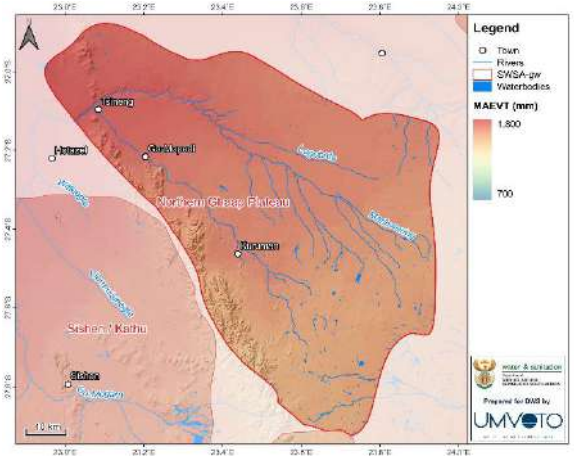
SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795 mamsl

Threats & Risks

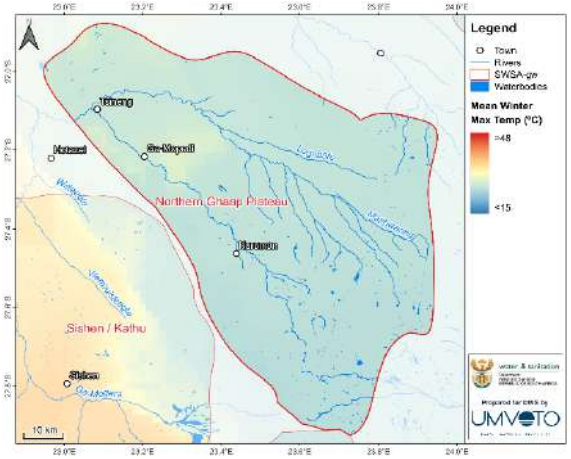
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Northern Ghaap Plateau SWSA-gw changes from a BWh, hot desert, type climate characterised by high temperatures, intense sunshine, and little rain in the northwest section, to a BSh, hot semi-arid, type climate characterised by hot summers, warm to cool winters, and little to no precipitation in the central section and a BSk, cold semi-arid, type climate characterised by hot, dry summers and cold winters in the southeastern section. Temperatures in the SWSA-gw range from -1.9 – >31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

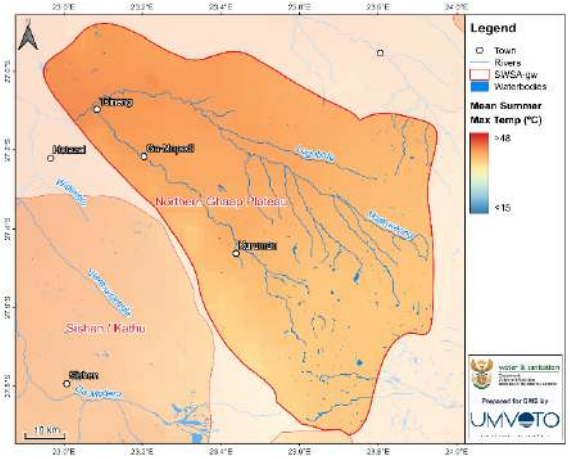
Temperature	Summer: 27 to >31 °C, Winter: -1.9 to 4 ºC
Evapotranspiration	Maximum value of 1803 mm/a with an average value of 1646 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, and a small reduction in recharge (ranging from ~ -6 to 0.8 mm/a). The DART Index indicates stable with some improving conditions.



Mean annual A-Pan evaporation of the Northern Ghaap Plateau SWSA-gw region.



Mean winter temperatures of the Northern Ghaap Plateau SWSA-gw region.



Mean summer temperatures of the Northern Ghaap Plateau SWSA-gw region.

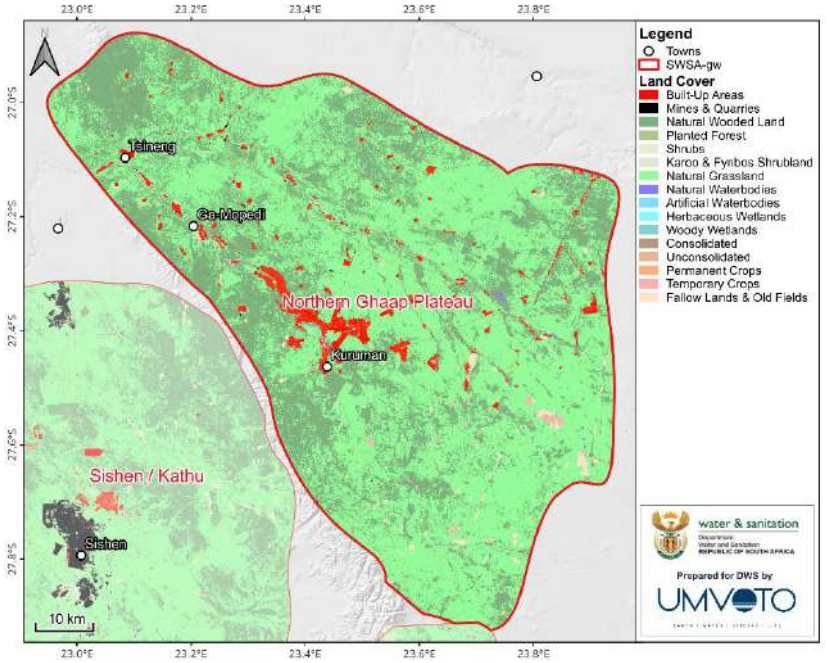
SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795 mamsl

Threats & Risks

Land Use

The Northern Ghaap Plateau SWSA-gw is dominated by vegetation land cover (DFFE, 2022). Grassland and forest land, which consists of natural wooded land and planted forest, cover approximately 96% of the SWSA-gw. Built-up areas, which consist of residential, industrial and commercial areas, cover a small portion of the SWSA-gw and are concentrated near the town of Kuruman and towards the town of Ga-Mopedi. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.1% of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	21	0.3
Built-Up	174	2.8
Cultivated	69	1.1
Forest Land	2138	34.1
Grassland	3839	61.2
Mines and quarries	4	0.1
Shrubland	20	0.3
Waterbodies	8	0.1
Wetlands	0.03	0.0



Land Cover 24-class map to show the types of land use and extent of each occurring in the Northern Ghaap Plateau SWSA-gw.

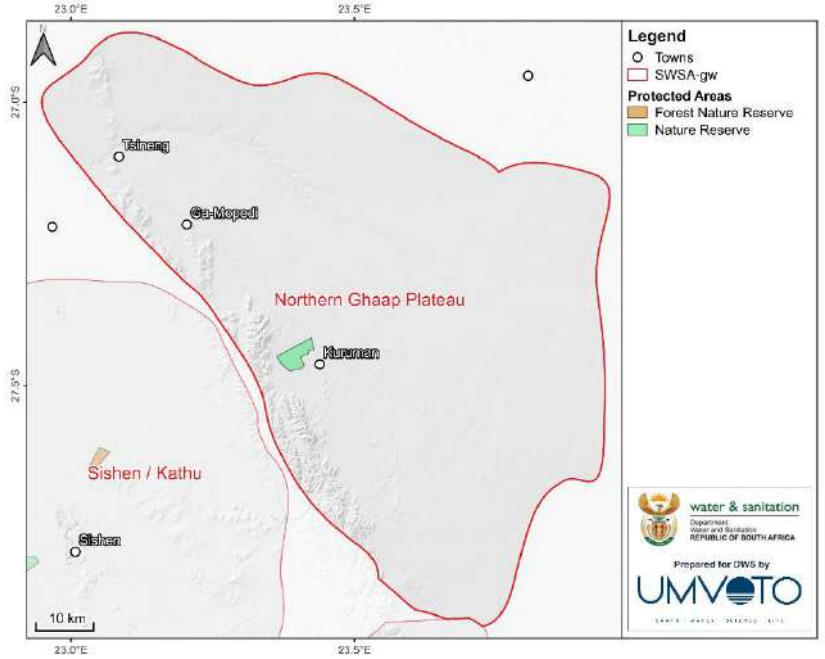
SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795

Protection Status and Ecosystems

Biodiversity and Conservation

The Northern Ghaap Plateau SWSA-gw contains only one nature reserve (DFFE, 2024) near the town of Kuruman, as displayed on the map.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	Billy Duvenhage Nature Reserve		1
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Northern Ghaap Plateau SWSA-gw that have protection status.

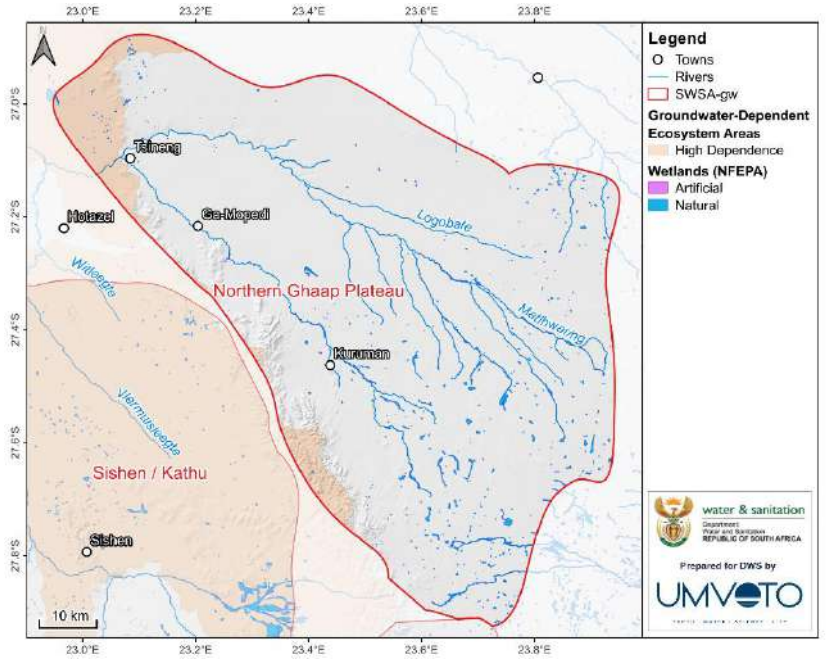
SWSA-gw Name:	Northern Ghaap Plateau
Area:	6274 km^2
Elevation:	1026 to 1795

Protection Status and Ecosystems

Biodiversity and Conservation

The Northern Ghaap Plateau SWSA-gw contains few wetlands (CSIR, 2011) on the south-western and western edges with Camel Thorn vegetation that is potentially highly dependent on groundwater (DWA, 2010).

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural and artificial wetlands	50	5

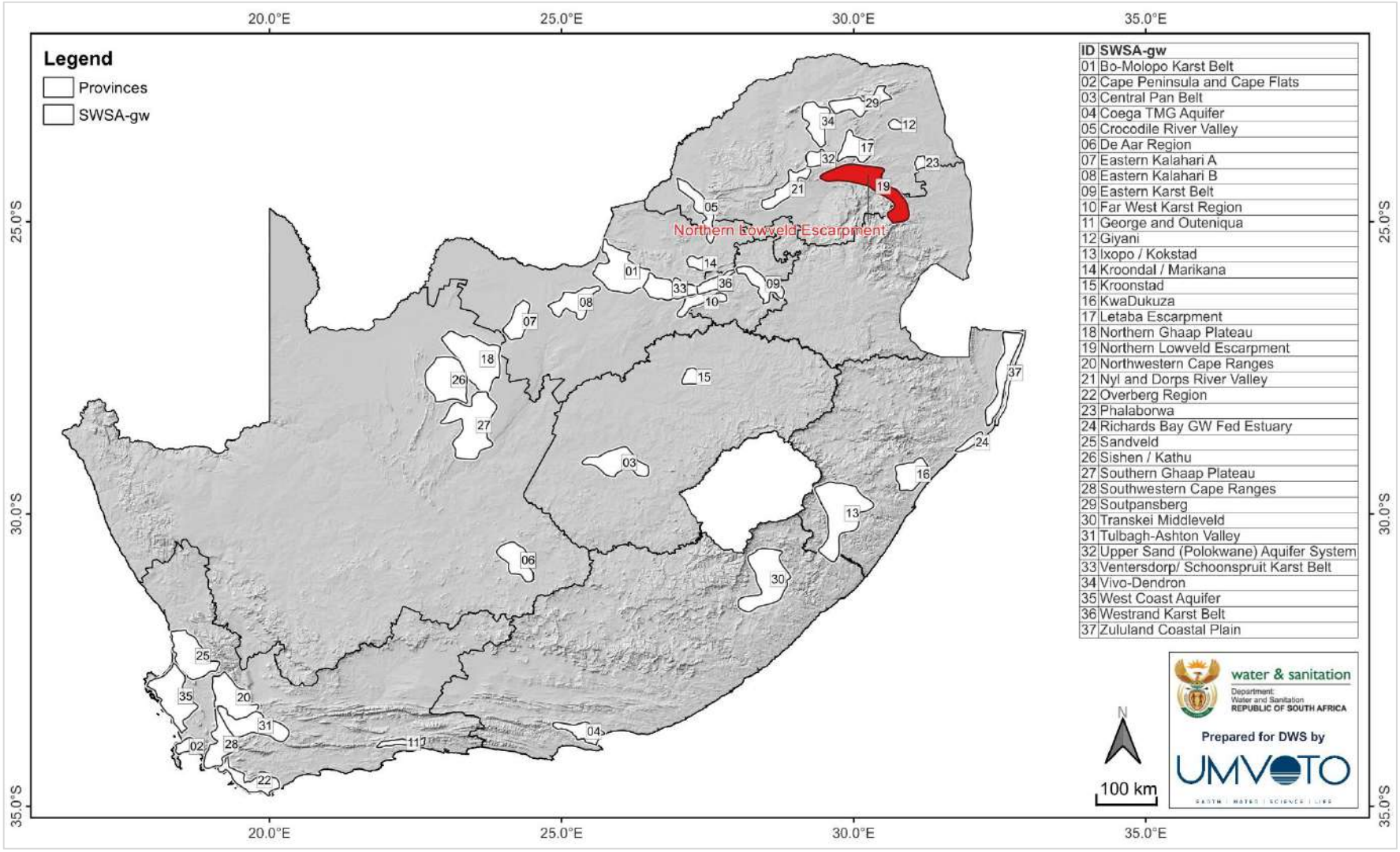


Map showing the major water bodies, Ramsar sites and GDEs in the Northern Ghaap Plateau SWSA-gw.

APPENDIX 19

NORTHERN LOWVELD ESCARPMENT SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE NORTHERN LOWVELD ESCARPMENT SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

19. Northern Lowveld Escarpment

19.1. Description

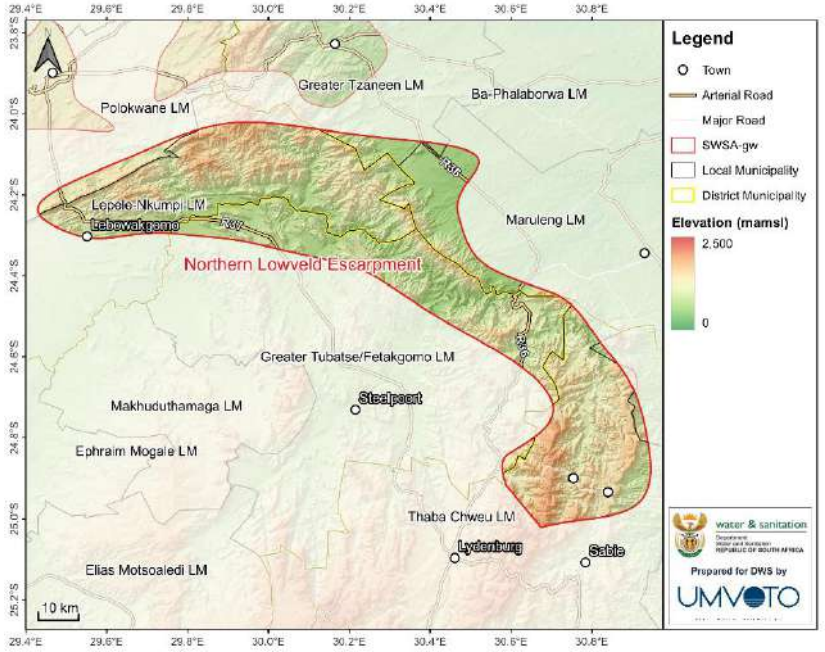
SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km^2
Elevation:	484 to 2044 mamsl

Geospatial Context

The topography of the Northern Lowveld Escarpment SWSA-gw, as depicted in the map, exhibits a predominantly rugged and mountainous landscape, particularly in the northern and central regions near Penge and Madeira. These highlands are characterized by steep slopes, deeply incised valleys, and complex drainage patterns indicative of significant elevation changes. The terrain gradually transitions southward into rolling hills and lower-lying areas around Burgersfort and Steelpoort, where the slopes become gentler.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Limpopo and Mpumalanga
District Municipality	Mopani, Capricorn, Sekhukhune and Ehlanzeni
Local Municipality	Greater Tzaneen, Maruleng, Lepele-Nkumpi, Thaba Chweu, Bushbuckridge, Polokwane and Greater Tubatse/Fetakgomo
Towns	Apara, Boromatshini, Didimala, Dipping, Ga-Mamatlhola, Ga-Monlala, Graskop, Kanana, Khutsong, Lebowakgomo, Leroro, Madeira, Mahudua, Makgaung, Malala, Mapalagela, Mashelebeng, Morolaneng, Ngwetsintshage, Penge, Tshabelang, Tshirelang and Tswafeng
Major Roads	R37, R36, R532, R533
Major Water Supply Networks	



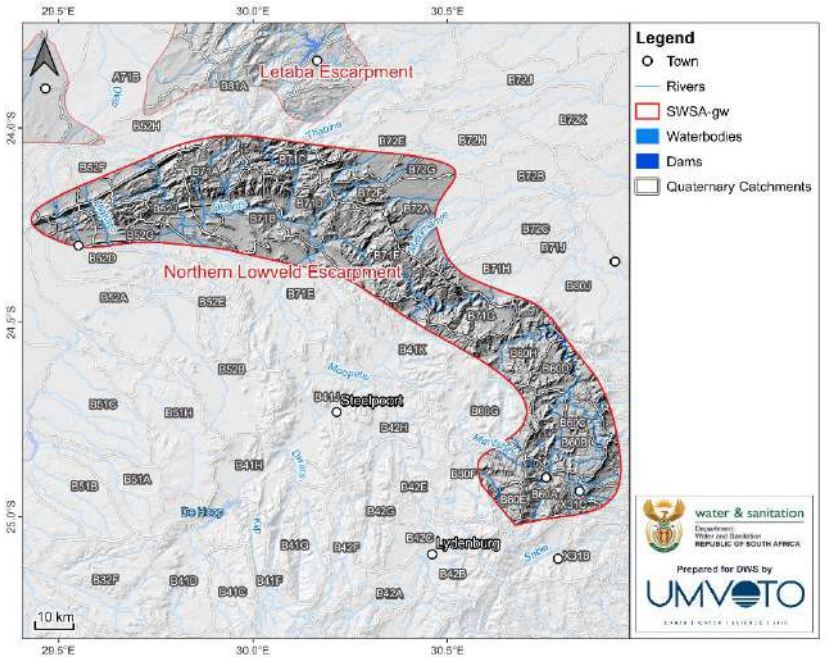
Locality map of Major Towns, District and Local Municipalities in the Northern Lowveld Escarpment SWSA-gw.

SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km^2
Elevation:	484 to 2044 mamsl

Hydrology and Drainage

The Northern Lowveld Escarpment SWSA-gw and surrounding areas include major surface water systems, summarised below and displayed in the map on the right. The surface water systems are the Mabeleni, Nqadu and Umtata reservoirs along with the many perennial rivers, flowing in a variety of directions. The area is fed by the T1, T2 and T3 catchments.

Quaternary Catchments	B41K, B51G, B52A, B52C, B52D, B52F, B52G, B52H, B52J, B60A, B60B, B60C, B60D, B60E, B60F, B60G, B60H, B60J, B71A, B71B, B71C, B71D, B71E, B71F, B71G, B71H, B72A, B72E, B72F, B72G, B72H, B81D, X31A, X31C, X31E, X31F, X32A, X32D and a small section of B72C
Rivers	Perennial: Blyde, Hlakaro, Klein Sabie, Lisbon, Mac-Mac, Mantshibi, Marite, Mohlapitse, Motitsi, Motse, Mphogodima, Mutlumuvi, Ohrigstad, Olifants, Steelpoort, Tongwane, Vyehoek
	Ephemeral: Chunies, Ga-Selati, Mabogwane, Makhutswi, Malomanye, Masokuditsi, Molomahlapi, Monametsi, Moungwane, Ngwabitsi, Paardevlei, Thabina, Thlabasane, Tlulandziteka
Natural and manmade water bodies	Chuniespoort, Blyderivierspoort and Ohrigstad Reservoirs
Major Dams:	Chuniespoort, Blyderivierspoort and Ohrigstad
Water Management Areas:	Limpopo Olifants and Inkomati Usuthu



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Northern Lowveld Escarpment SWSA-gw.

SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km^2
Elevation:	484 to 2044 mamsl

Geology

Geology

The Northern Lowveld Escarpment area features scattered outcroppings of Quaternary deposits.

In the western section, the Rustenburg Layered Suite of the Bushveld Complex outcrops, comprising gabbro, norite, anorthosite, pyroxenite, chromitite, and harzburgite.

The Chuniespoort Group of the Transvaal Supergroup dominates the central region, consisting of dolomite, subordinate chert, minor carbonaceous shale, limestone, and quartzite. To the east of the Chuniespoort Group, the Black Reef Formation outcrops, characterised by quartzite, subordinate conglomerate, and shale. On the western side, the Pretoria Group outcrops are comprised of mudrock, quartzite, and minor diamictite.

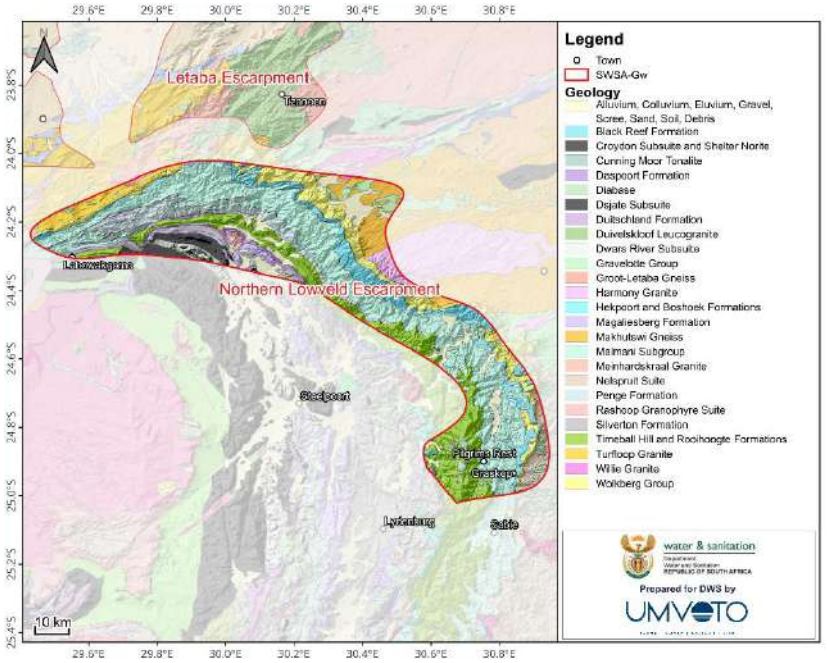
The Wolkberg Group outcrops are in the southeastern section, featuring shale and fine- to medium-grained quartzite.

In the eastern section, Archaean granitoid intrusions are prominent. The Harmony Granite is a light grey, coarse-grained (porphyritic in places), tonalitic, and biotite-muscovite granite. The Makhutswi Gneiss is a homogeneous, light grey (leucocratic), medium-grained granodioritic/tonalitic and biotite gneiss.

In the southeasternmost section, the Nelspruit Suite outcrops, comprising white to pale brown, medium- to coarse-grained porphyritic biotite granite and granodiorite.

Hydrostratigraphy

The Quaternary and alluvial deposits form a primary intergranular aquifer. The Chuniespoort Group dolomites create a secondary karstic-fractured aquifer. The Bushveld Complex and granitoid intrusions host secondary, fractured aquifers, with groundwater occurring in weathered and structurally controlled zones.



Geology Map of the Northern Lowveld Escarpment SWSA-gw region.

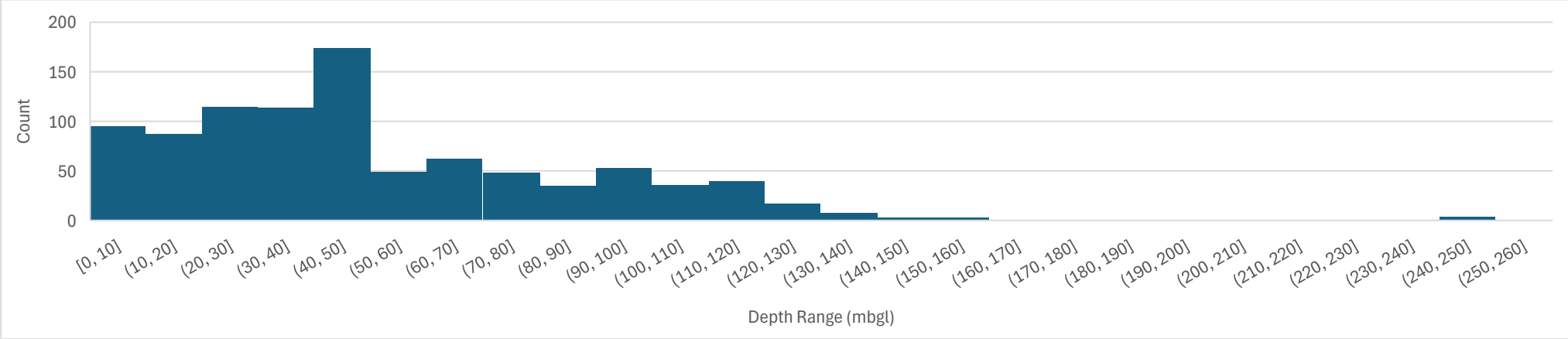
19.2. Current Status

SWSA-gw Name:	**Northern Lowveld Escarpment**
Area:	**5168 km²**
Elevation:	**484 to 2044 mamsl**
Quantity & Quality	
Aquifer Classification	

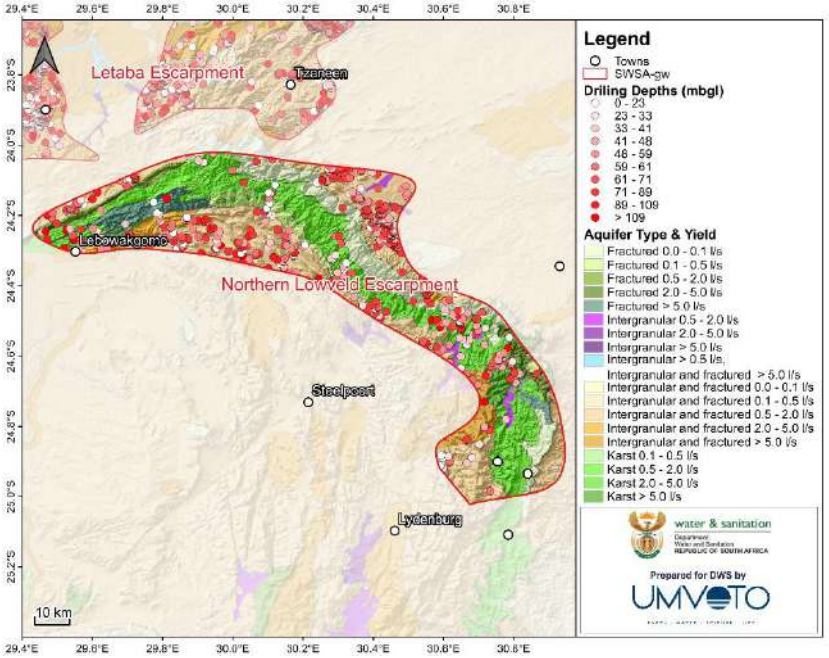
The aquifer systems within the Northern Lowveld Escarpment SWSA-gw exhibit varying yields across dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw consists of a combination of Major and Minor aquifer systems. The Major aquifer system has an average karst yield of 2.0 to over 5.0 l/s and an average fractured yield ranging from 0.0 to over 5.0 l/s. The Minor aquifer system has an average dual-porosity yield of 0.5 to 5.0 l/s, with occasional fractured yields ranging from 0.1 to over 5.0 l/s.
Groundwater Targets	The average drilling depth is 57 mbgl, and the most common depth is around 40 mbgl, suggesting predominantly shallow targets. Boreholes are drilled in both the karst aquifer system and the dual-porosity aquifer system. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 27 and 72 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is 22 mbgl, with values ranging from 0 to 73 mbgl and a standard deviation of~ 14 mbgl.

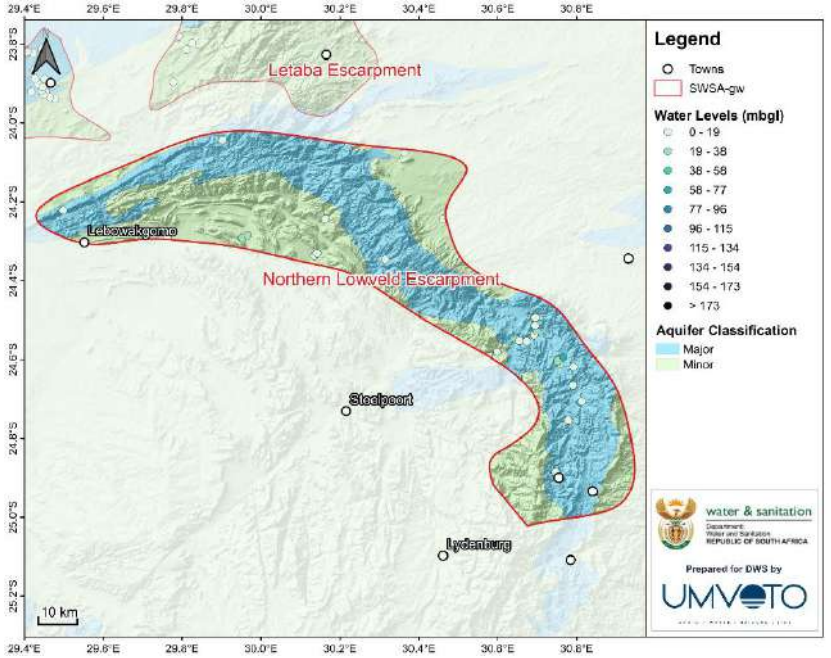
Graph of NGA drilling depths of Northern Lowveld Escarpment SWSA-gw region



SWSA-gw Name:	**Northern Lowveld Escarpment**
Area:	**5168 km²**
Elevation:	**484 to 2044 mamsl**
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and Nga drilling depths of the Northern Lowveld Escarpment SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Northern Lowveld Escarpment SWSA-gw region.

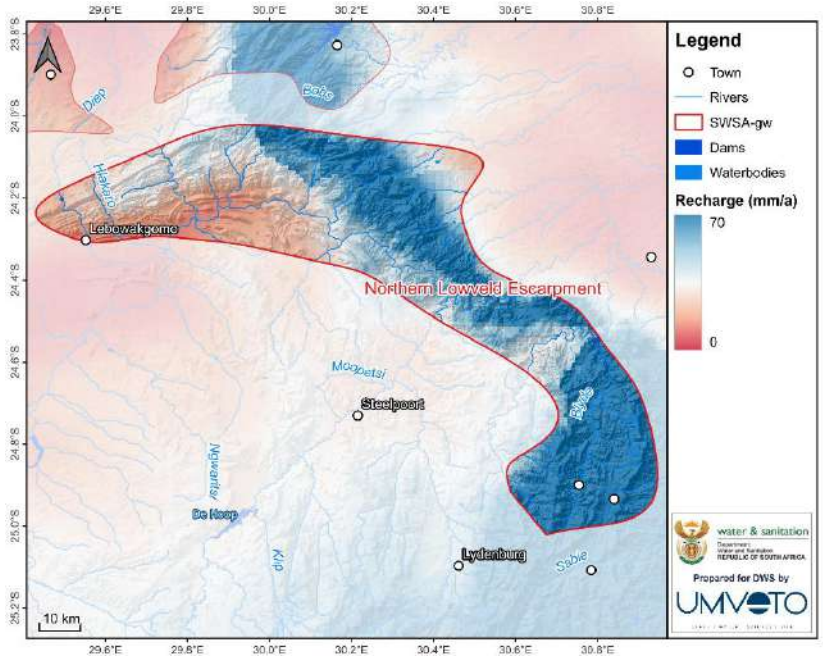
SWSA-gw Name:	**Northern Lowveld Escarpment**
Area:	**5168 km^2**
Elevation:	**484 to 2044 mamsl**

Quantity & Quality

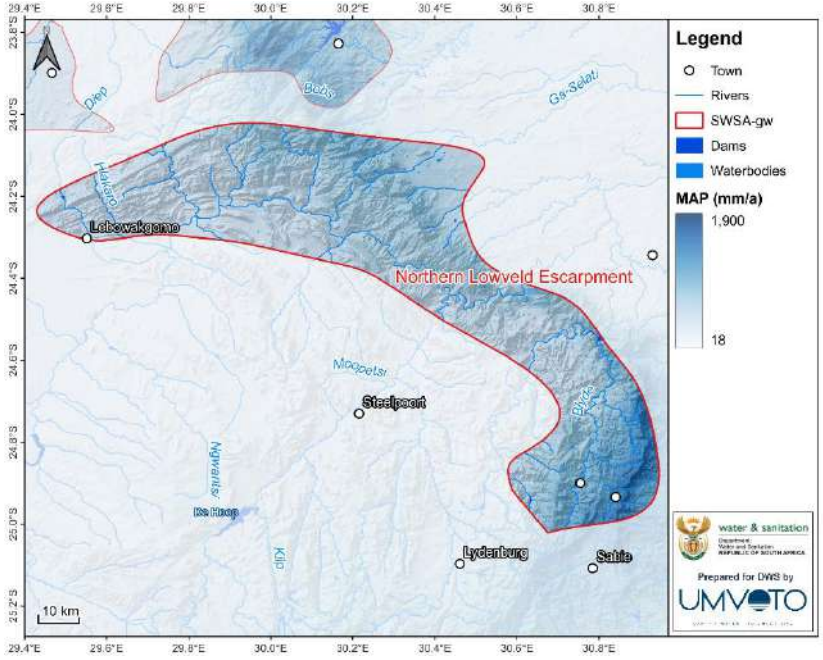
Groundwater Recharge

The Northern Lowveld Escarpment receives a total MAP volume of 3697 Mm^3/a, with a significantly high average rainfall of 718 mm/a. Despite this, only 427.1 Mm^3/a contributes to groundwater recharge, resulting in a moderate recharge of 11.6% of MAP. This suggests that while the area experiences relatively high rainfall, a substantial portion is still lost to runoff, evaporation, or surface water flow, though recharge efficiency is better compared to drier regions.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Northern Lowveld Escarpment	3697	718	427.1	82.5	11.6%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km^2
Elevation:	484 to 2044 mamsl

Quantity & Quality

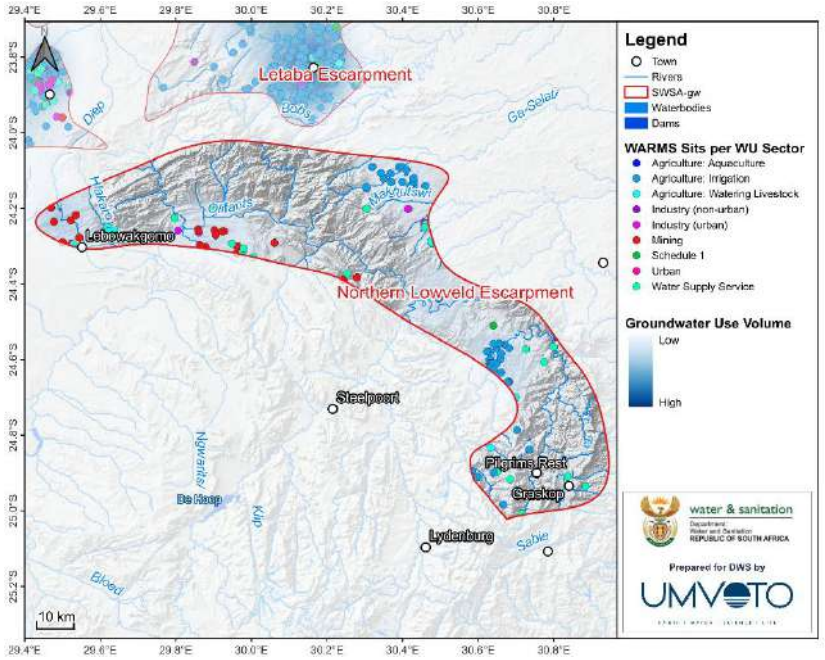
Groundwater Use

The Northern Lowveld Escarpment SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Penge (Groundwater), which relies significantly on groundwater resources for municipal supply, mining, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Mining use has 10.6 Mm^3/a allocated. Water is a vital resource in the mining process. Groundwater can offer a reliable water source in water-scarce or remote areas. Most of the mining is registered in the north of the region indicating that that is where it is most needed.
- Agricultural irrigation use follows closely, with 8.2 Mm^3/a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. Most of the irrigation is clustered west of Apara and north of Madeira.
- Municipal water supply services, at 3.2 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. Interestingly most of the municipal water supply is in the same region as the mining in the north. Indicating that the north relies heavily on water both for mining and water supply to households. There are a few areas which rely on municipal water supply, like Penge, Madeira and Graskop.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Apara, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	8.2
	Industry (Urban)	0.04
	Mining	10.6
	Schedule 1	0.02
	Water Supply Service	3.2
	Total	**22.1**



Water use map for the Northern Lowveld Escarpment SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

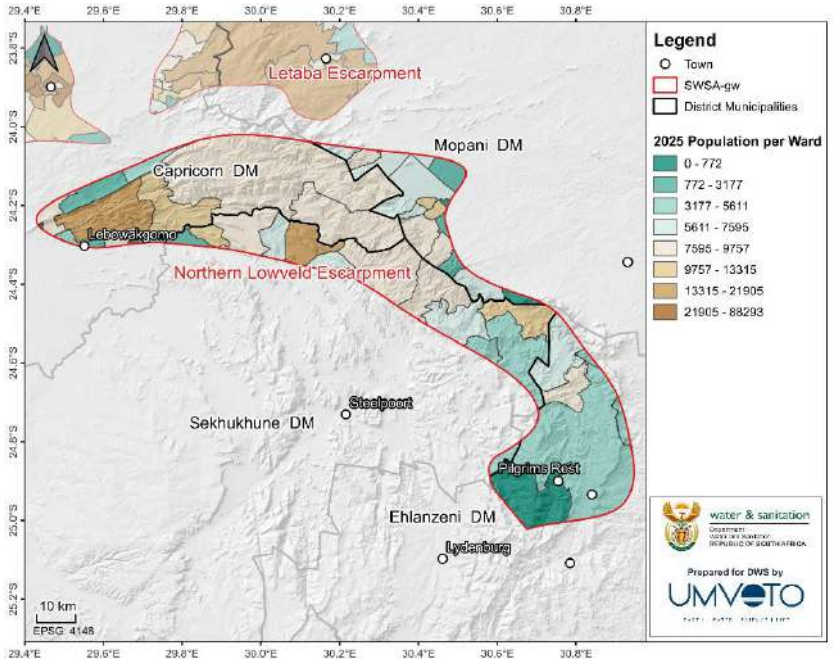
SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km^2
Elevation:	484 to 2044 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Northern Lowveld Escarpment SWSA-gw is located within the Limpopo-Olifants Water Management Areas (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. LOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the LOCMA to manage water resources in the Limpopo-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	LOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	Lebalelo WUA is a local water management group that assists the CMA with allocation decisions among water users and oversees groundwater infrastructure and monitoring within the SWSA-gw.
WSA & WSP	The district municipalities in Limpopo are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdictions, while the local municipalities within Mpumalanga are the WSAs and WSPs

The estimated 2025 population within the Northern Lowveld Escarpment SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 1.73% per year, resulting in a projected population of approximately 276,431.

As shown in the map and table below, Greater Tubatse/ Fetakgomo Tubatse Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 90,007, followed by Maruleng LM with 66,734.



Projected population distribution in 2025 for the Northern Lowveld Escarpment SWSA-gw.

SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km^2
Elevation:	484 to 2044 mamsl

Quantity & Quality

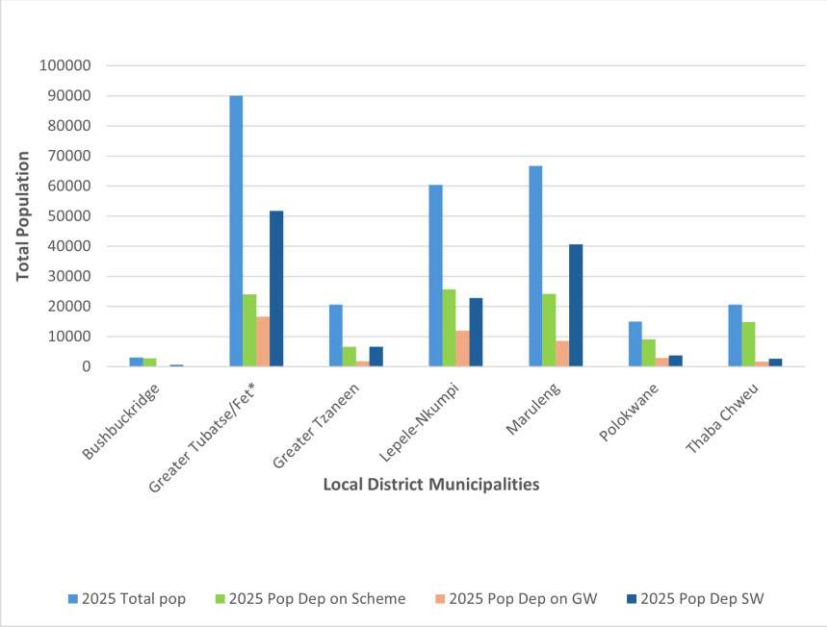
Socio Economic & Governance

In terms of water reliance within the Northern Lowveld Escarpment SWSA-gw, an estimated 46.6% of the population depends on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources), 38.8% on the regional water supply scheme and 15.8% on groundwater sources (including boreholes and springs).

Among the LMs, the Lepele-Nkumpi LM has the highest proportion of groundwater reliance, with approximately 19.9% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Bushbuckridge	3,075	2,731	142	574
Greater Tubatse/Fet*	90,007	23,997	16,688	51,733
Greater Tzaneen	20,569	6,651	1,826	6,686
Lepele-Nkumpi	60,443	25,717	12,012	22,837
Maruleng	66,734	24,148	8,494	40,716
Polokwane	14,948	9,141	2,951	3,695
Thaba Chweu	20,655	14,890	1,661	2,662
Total	**276,431**	**107,275**	**43,774**	**128,901**



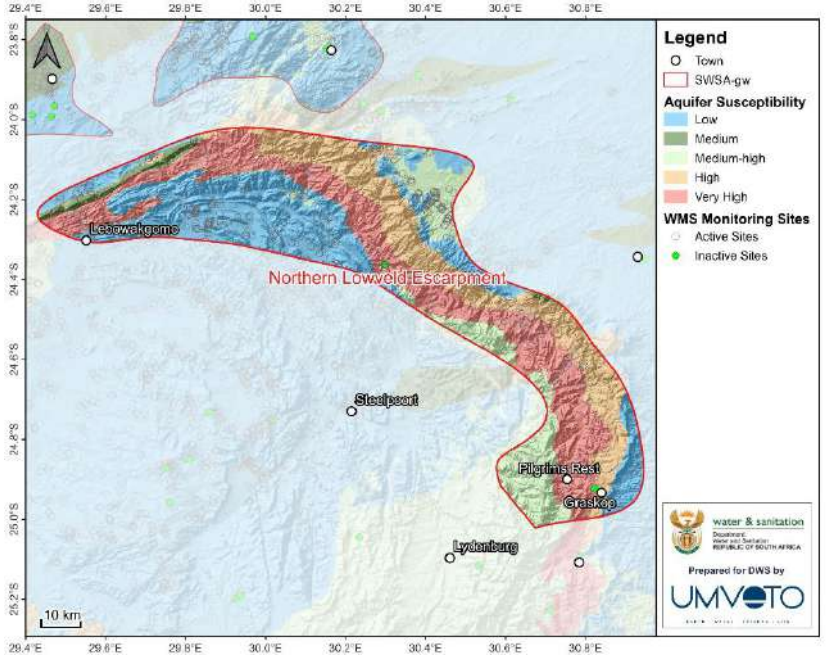
Projected population dependence on water sources in 2025.

SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km^2
Elevation:	484 to 2044 mamsl
Quantity & Quality	
Groundwater Quality	

The Northern Lowveld Escarpment SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 345.16 km^2, which is 6.68% of the Northern Lowveld Escarpment SWSA-gw total area. Urban/Built-up areas cover 210.33 km^2 (4.07%), while mines and quarries account for 12.76 km^2 (0.25%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 5.52 - 106.2 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 0.68 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.025 - 6.43 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.15 - 8.77 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0.3 - 93.79 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Northern Lowveld Escarpment**
Area:	**5168 km^2**
Elevation:	**484 to 2044 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Northern Lowveld Escarpment SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	2	0.76	264	43.96	mS/m	2014-2024 GW Geosites: <70 - 370 mS/m.	2014-2024 GW Geosites: <70 - 370 mS/m.	5.52 - 106.2 mS/m (Avg.: 43.96 mS/m). 2014-2024 GW Geosites: <70 - 370 mS/m. Mostly consistent with WMS (2000-2024).
Fluoride	2	0.85	234	0.22	mg/L	2014-2024 GW Geosites: <0.5 - 5.0 mg/L.	2014-2024 GW Geosites: <0.5 - 1.5 mg/L.	0.025 - 0.68 mg/L (Avg.: 0.22 mg/L). 2014-2024 GW Geosites: <0.5 - 5.0 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	2	0.80	251	1.02	mg/L	2014-2024 GW Geosites: <11 - 50 mg/L	2014-2024 GW Geosites: <11 - 50 mg/L.	0.025 - 6.43 mg/L (Avg.: 1.02 mg/L). 2014-2024 GW Geosites: <11 - 50 mg/L. Mostly consistent with WMS NO_3+NO_2 (2000-2024).
pH	2	0.76	264	7.87	pH unit	2014-2024 GW Geosites: 7 - 9.	2014-2024 GW Geosites: 7-9.	6.15 - 8.77 (Avg.: 7.87). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	2	0.76	264	28.48	mg/L	2014-2024 GW Geosites: <200 mg/L.	2014-2024 GW Geosites: <200 mg/L.	0.3 - 93.79 mg/L (Avg.: 24.48 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the Northern Lowveld Escarpment SWSA-gw, taken from the WMS database from 2000-2024.*

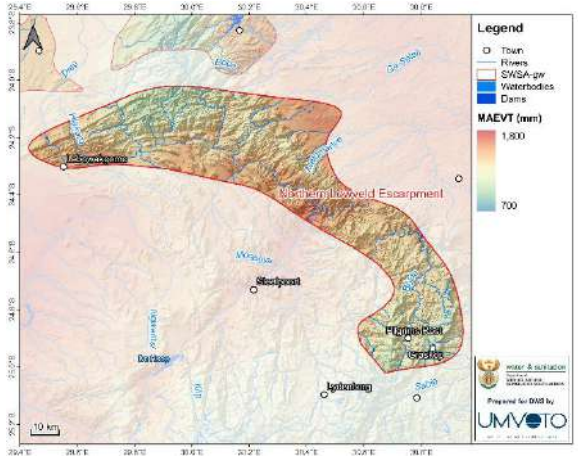
SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km²
Elevation:	484 to 2044 mamsl

Threats & Risks

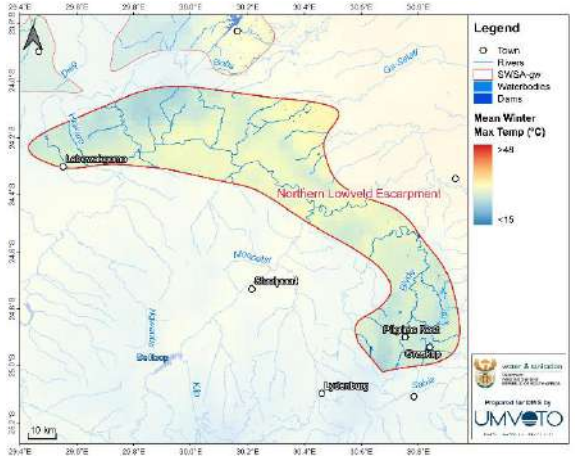
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Northern Lowveld Escarpment SWSA-gw is predominantly a combination of Cwa, humid subtropical, type climate with hot and humid summers and cool to mild winters and Cwb, subtropical highland, type climate with warm summers and dry winters. The eastern and western outskirts of the area have a BSh, hot semi-arid, climate with hot summers, warm to cool winters, and little precipitation. Temperatures in the SWSA-gw range from 6.1 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

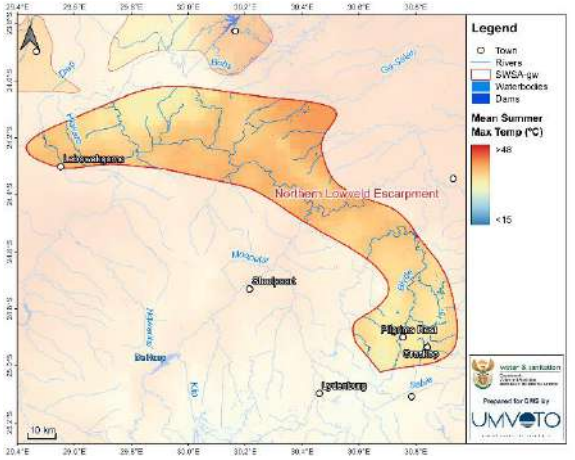
Temperature	Summer: 24.6 to 31 °C, Winter: 6.1 to >8 ºC
Evapotranspiration	Maximum value of 1654 mm/a with an average value of 1381 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, but an increase in recharge (ranging from ~ 2.5 to 7.8 mm/a). The DART Index indicates mostly stable conditions.



Mean annual A-Pan evaporation of the Northern Lowveld Escarpment SWSA-gw region.



Mean winter temperatures of the Northern Lowveld Escarpment SWSA-gw region.



Mean summer temperatures of the Northern Lowveld Escarpment SWSA-gw region.

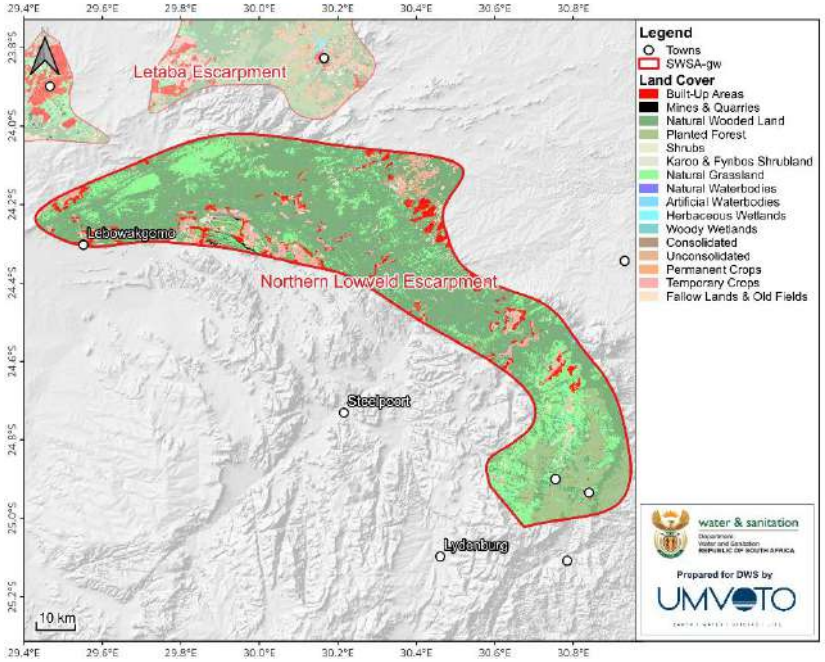
SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km^2
Elevation:	484 to 2044 mamsl

Threats & Risks

Land Use

Forest land, which includes natural wooded land and planted forest, and grassland dominate the Northern Lowveld Escarpment (DFFE, 2022), covering 87% of the total area, highlighting the ecological significance of the SWSA-gw. Cultivated land, made up of temporary crops, permanent crops, fallow land and old fields, indicates moderate agricultural, contributing to land use diversity. Built-up areas, consisting of residential, commercial and industrial areas, account for smaller portions, suggesting limited urban development. The presence of wetlands and waterbodies is minimal, indicating that the presence of surface water is limited in the SWSA-gw. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.2% of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	57	1.1
Built-Up	210	4.1
Cultivated	345	6.7
Forest Land	3531	68.3
Grassland	963	18.6
Mines and quarries	13	0.2
Shrubland	0.02	0.0
Waterbodies	15	0.3
Wetlands	33	0.6



Land Cover 24-class map to show the types of land use and extent of each occurring in the Northern Lowveld Escarpment SWSA-gw.

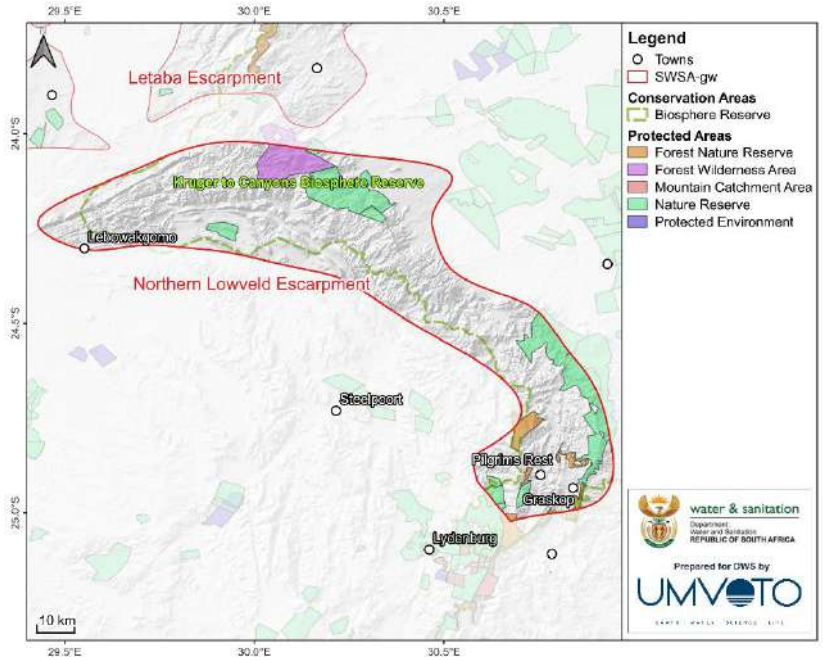
SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km^2
Elevation:	484 to 2044 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The majority of the Northern Lowveld SWSA-gw is within the large Kruger to Canyons Biosphere Reserve (DFFE, 2024), as can be seen on the map. The SWSA-gw further contains multiple forest nature reserves, forest wilderness areas and nature reserves (DFFE, 2024). The Wolkberg Wilderness is a large forest wilderness area situated on the northern edge of the SWSA-gw adjacent to the large Nature Reserve: Co-operation and Development

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Kruger to Canyons Biosphere Reserve	4250.58	1
Protected Areas	• Morgenzon Reserve • Wolkberg Wilderness Area • Nature Reserve: Cooperation and Development • Potlake Nature Reserve • Blyderivierspoort Nature Reserve • And various other small nature reserves and forest nature reserves	767.55	15
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Northern Lowveld Escarpment SWSA-gw that have protection status.

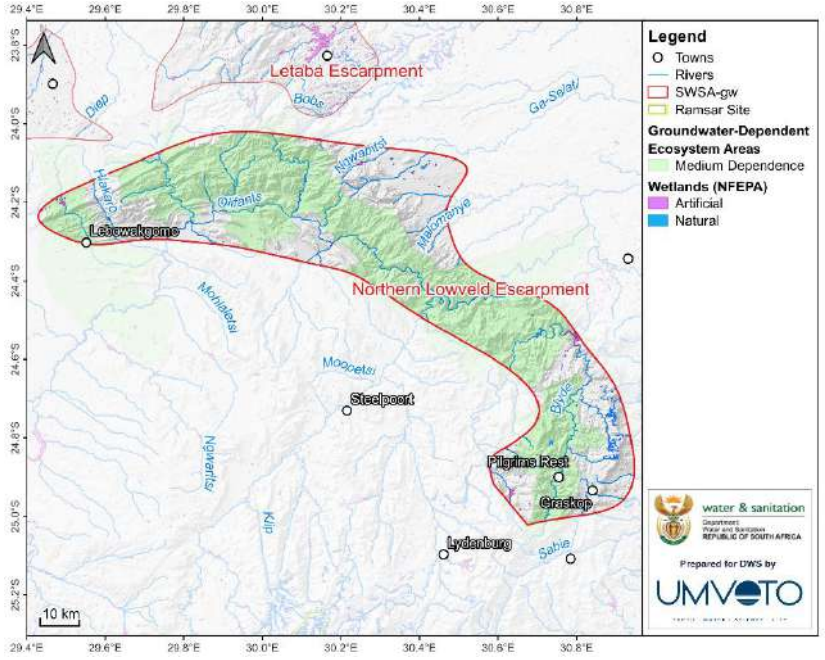
SWSA-gw Name:	Northern Lowveld Escarpment
Area:	5168 km^2
Elevation:	484 to 2044 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Northern Lowveld Escarpment SWSA-gw has Dolomite vegetation wetlands with a potentially medium dependency on groundwater (DWA, 2010).

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural and artificial wetlands	29	

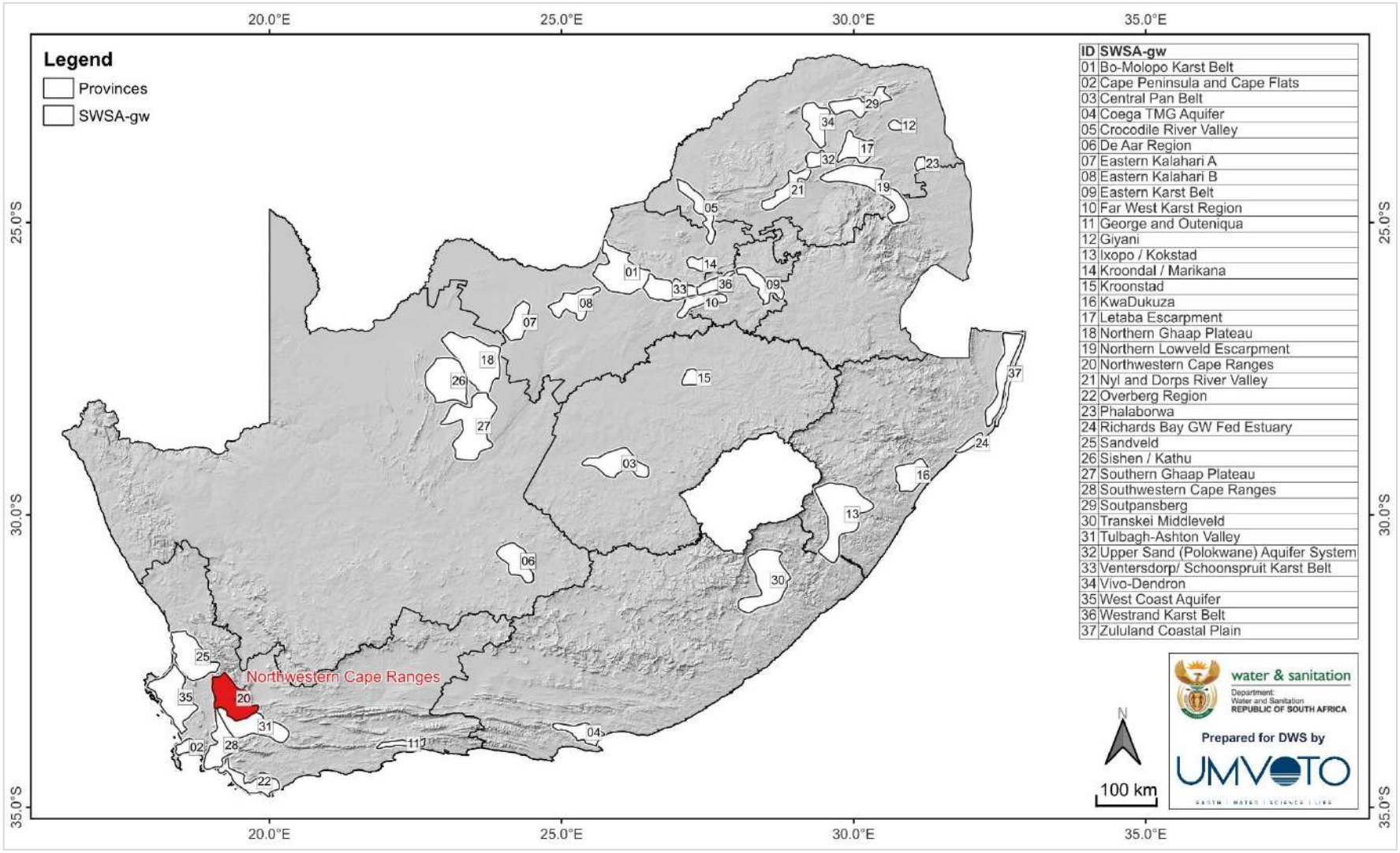


Map showing the major water bodies, Ramsar sites and GDEs in the Northern Lowveld Escarpment SWSA-gw.

APPENDIX 20

NORTHWESTERN CAPE RANGES SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE NORTHWESTERN CAPE RANGES SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

20. Northwestern Cape Ranges

20.1. Description

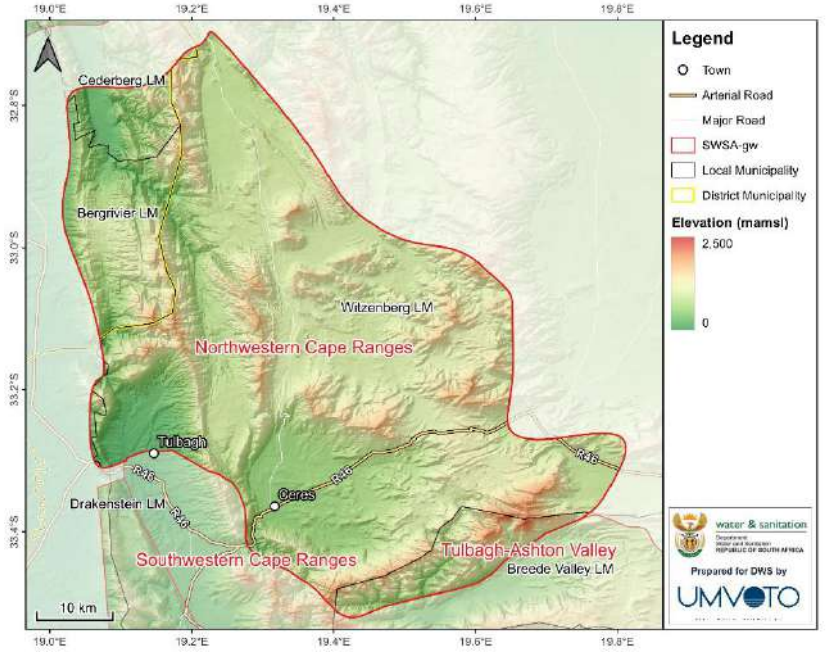
SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km²
Elevation:	78 to 2226 mamsl

Geospatial Context

The topography of the Northwestern Cape Ranges SWSA-gw, as depicted in the map, is dominated by the rugged mountainous terrain of the Cape Fold Belt, with prominent ranges such as the Witzenberg and surrounding mountains. The western portion, near Porterville and Saron, transitions from lower-lying areas into the more dramatic relief of the mountain ranges. The central and eastern sections, including Ceres, Tulbagh, and Op die Berg, are characterized by deep valleys, elevated plateaus, and steep ridges. Further southeast, towards De Doorns and the Cape Winelands, the landscape remains mountainous but interspersed with valleys.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Western Cape Province
District Municipality	West Coast and Cape Winelands
Local Municipality	Cederberg, Bergrivier, Witzenberg, Drakenstein and Breede Valley
Towns	Bella Vista, Ceres, De Doorns, Nduli, Op die Berg, Porterville, Saron and Tulbagh.
Major Roads	R303 and R46
Major Water Supply Networks	



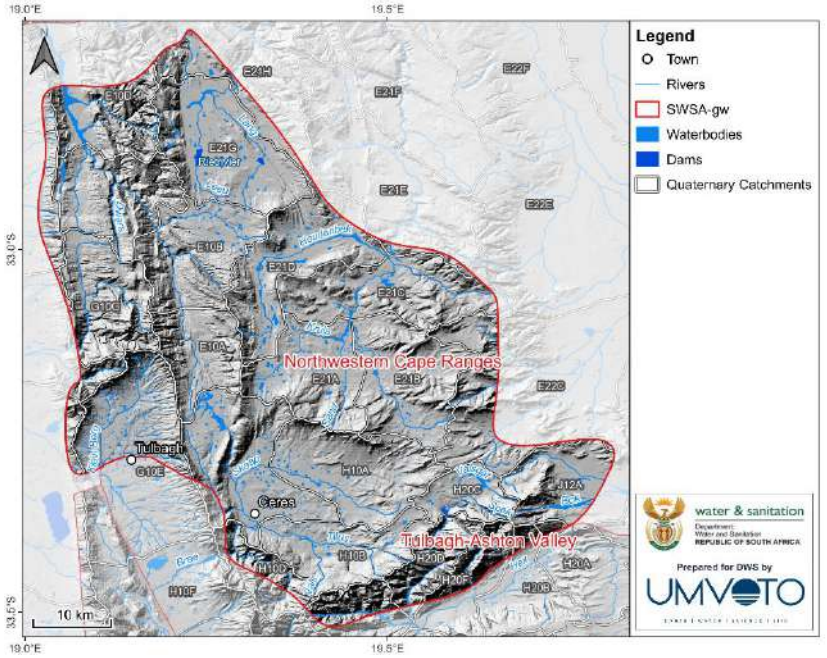
Locality map of Major Towns, District and Local Municipalities in the Northwestern Cape Ranges SWSA-gw.

SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km²
Elevation:	78 to 2226 mamsl

Hydrology and Drainage

The Northwestern Cape Ranges SWSA-gw and surrounding areas include a few large surface water systems, along with several unnamed seeps and floodplains, which are summarised below and displayed on the map to the right. The primary surface water features include the Rietrivier and Demeul reservoirs, both fed by the E2 catchment, as well as the Lakenvallei and Roode Els reservoirs, which are fed by the H2 catchment. Several perennial and ephemeral rivers flow through the area, with varying flow directions.

Quaternary Catchments	E10A, E10B, E10C, E10D, E21A, E21B, E21C, E21D, E21G, E22C, G10E, G10G, H10A, H10B, H10C, H20C, H20F and J12A as well as a small section of E21E, E21H, E22E, G10H, G10F, G10J, G30B, H10D, H20A, H20B, H20D and H20E.
Rivers	Perennial: Amandel, Bok, Bree, Dwars, Houdenbek, Klein Berg, Koekedou, Kruis, Middeldeur, Modder, Olifants, Pyls, Ratel, Riet, Rooi-Elskloof, Smalblaar, Smits, Spek, Titus, Vals, Valsgat, Vier-en-Twintig and Witels
	Ephemeral: Assegaaibosspruit, Driedam se, Groot Kliphuis, Klein Kliphuis, Lang, Leeu, Sand, Skaap, Soutkloof and Welgemoed
Natural and manmade water bodies	Seeps and floodplains
Major Dams:	Roode Els, Rietrivier, Demeul and Lakenvallei
Water Management Areas:	Breede Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Northwestern Cape Ranges SWSA-gw.

SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km²
Elevation:	78 to 2226 mamsl
Geology	

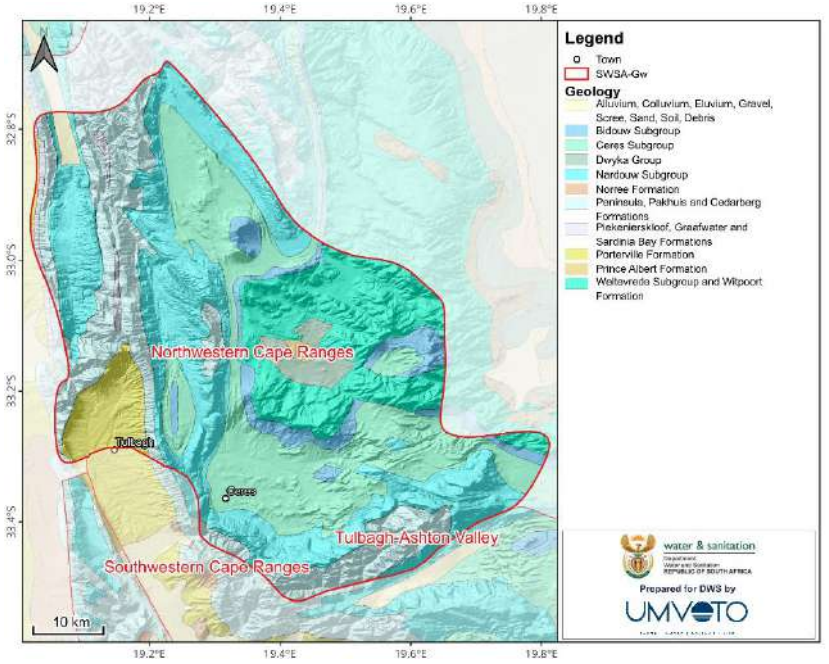
Geology

Quaternary deposits are present in the western section of the area and include alluvium, colluvium, eluvium, sandy soils, scree, talus, Piedmont gravel, and Tertiary river-terrace gravel. Sedimentary rocks of the Table Mountain Group are found in the eastern, northwestern, and southernmost sections of the area. These formations consist of quarzitic sandstone, siltstone, mudstone, conglomerates, and shale.

The Bokkeveld Group covers the central and western sections, comprising sandstone, mudstone, feldspathic arenite, and wacke. The Worcester Fault cuts across the westernmost corner of the area.

Hydrostratigraphy

The Table Mountain Group forms a regional fractured-rock aquifer system where quartzitic sandstones have negligible primary porosity but significant secondary permeability due to fracturing. The Peninsula and Nardouw Aquifers are the main water-bearing units, with permeability controlled by faulting and bedding-plane fractures, while the Pakhuis-Cederberg Formation acts as an aquitard, restricting vertical flow.



Geology Map of the Northwestern Cape Ranges SWSA-gw region.

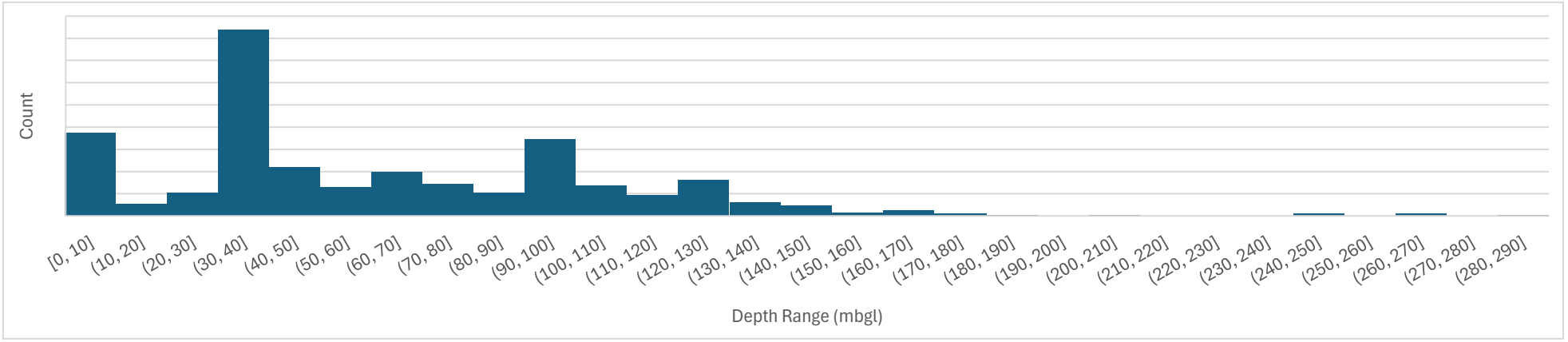
20.2. Current Status

SWSA-gw Name:	**Northwestern Cape Ranges**
Area:	**3638 km²**
Elevation:	**78 to 2226 mamsl**
Quantity & Quality	
Aquifer Classification	

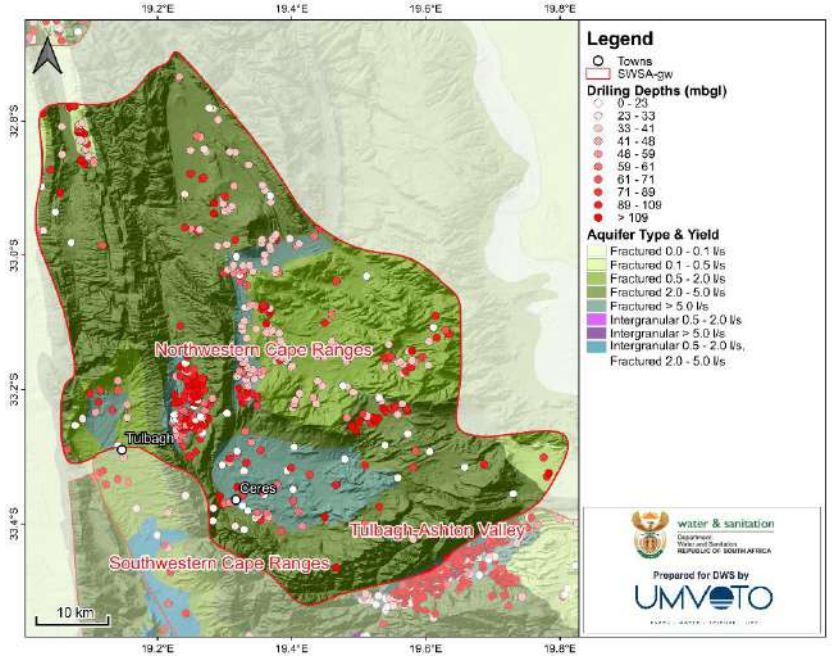
The aquifer systems within the Northwestern Cape Ranges SWSA-gw exhibit varying yields across fractured aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is predominantly a major aquifer system, with a small minor aquifer system along the western edge. The major aquifer system has an average fractured yield ranging from 0.1 l/s to over 5.0 l/s.
Groundwater Targets	The average drilling depth is 63 mbgl, and the most common depth is around 40 mbgl, with the majority of boreholes targeting the higher-yielding fractured aquifer system. The presence of boreholes >200 mbgl suggests a secondary target within the underlying fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 35 and 97 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 7 mbgl, with values ranging from 0 to 69 mbgl and a standard deviation of ~ 8 mbgl.

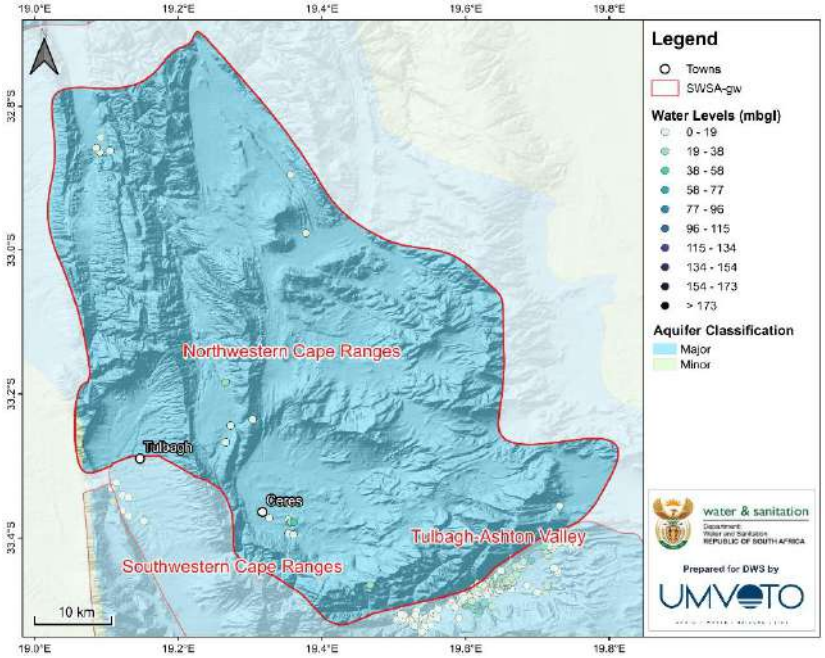
Graph of NGA drilling depths of the Northwestern Cape Ranges SWSA-gw region



SWSA-gw Name:	**Northwestern Cape Ranges**
Area:	**3638 km²**
Elevation:	**78 to 2226 mamsl**
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Northwestern Cape Ranges SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Northwestern Cape Ranges SWSA-gw region.

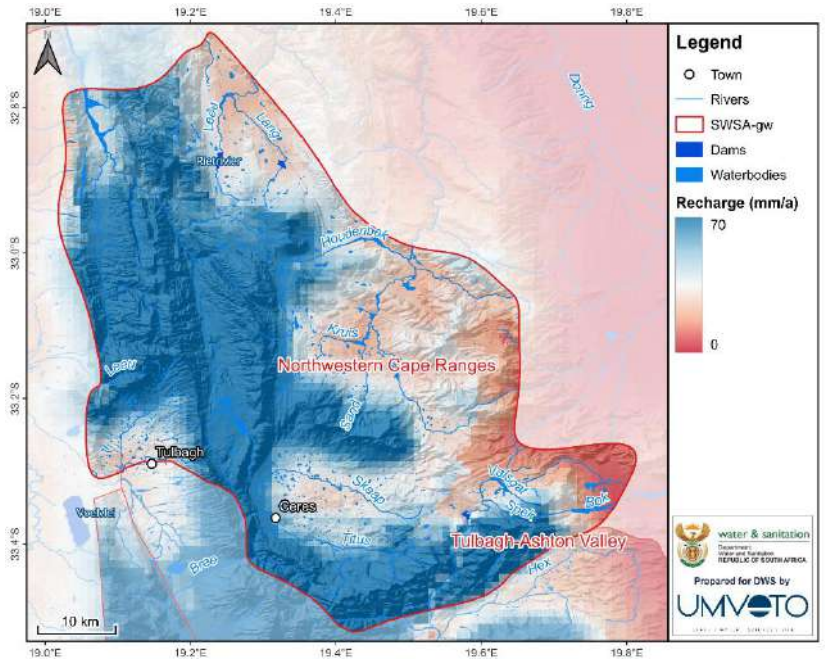
SWSA-gw Name:	**Northwestern Cape Ranges**
Area:	**3638 km²**
Elevation:	**78 to 2226 mamsl**

Quantity & Quality

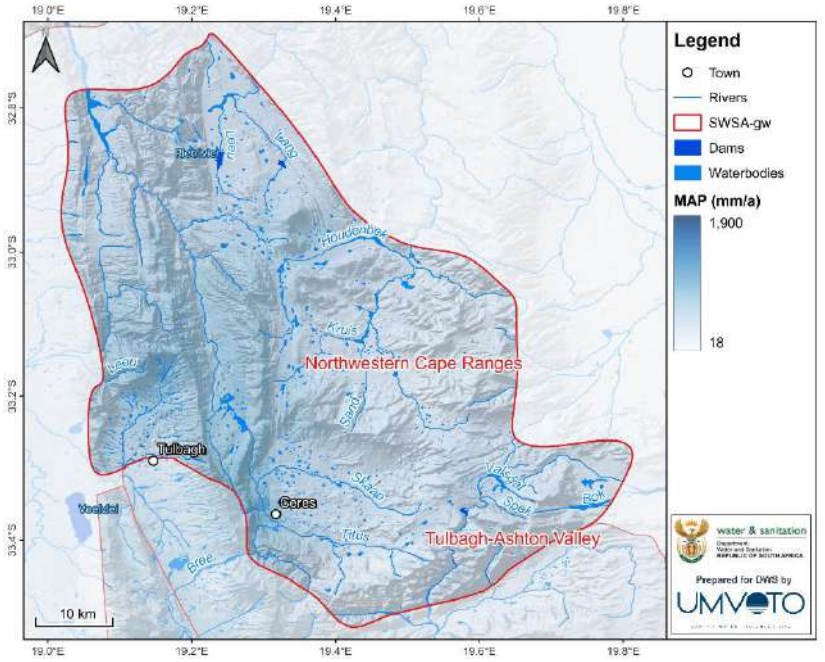
Groundwater Recharge

The Northwestern Cape Ranges receive a total MAP volume of 1,865 Mm^3/a, with an average rainfall of 508 mm/a. Out of this, 241.1 Mm^3/a infiltrates to recharge the aquifer, resulting in a recharge of 12.9% of MAP, which is relatively high compared to other regions. This suggests that the area's geology and soil conditions may support better infiltration, allowing for a greater proportion of rainfall to replenish groundwater, though surface runoff and evaporation still account for significant losses.

SWSA-gw	Sum of MAP Volume Mm Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Northwestern Cape Ranges	1865	508	241.1	65.8	12.9%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

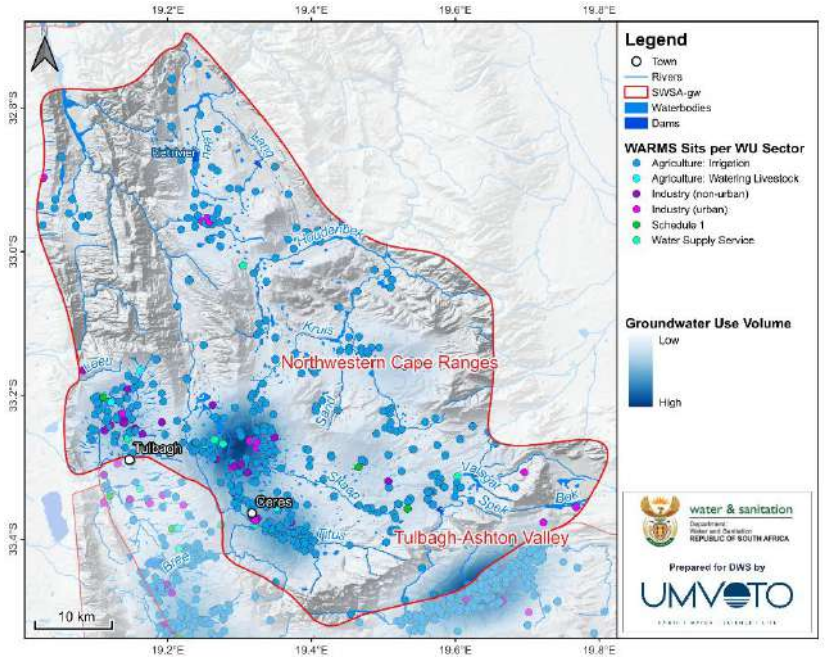
SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km²
Elevation:	78 to 2226 mamsl
Quantity & Quality	
Groundwater Use	

The Northwestern Cape Ranges SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. While no towns in this region rely primarily on groundwater for municipal supply, industrial use, or agriculture (see Table below), an analysis of active groundwater use licenses from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is significantly the largest, with 75.4 Mm^3/a. The area relies on groundwater for food production and the local economy. The use is concentrated mostly in the southwest of the map around Bella Vista, Nduli and Ceres. As well as in the north around Op die Berg.
- Urban industrial follows, using 1.7 Mm^3/a allocated for manufacturing, processing, and other industrial activities in urban centres. Unlike agricultural irrigation groundwater use, which is more scattered across the area, urban industrial use is concentrated in the southern parts of the map around Bella Vista and Tulbagh.
- Non-urban industrial use is the third highest use, with 0.6 Mm^3/a, although it is significantly less than the first two. Interestingly, non-urban industrial use is also concentrated around Tulbagh, Bell Vista and Ceres like the first two. This indicates that these towns rely heavily on groundwater for a variety of sectors.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Bella Vista and Nduli, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	75.4
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	0.6
	Industry (Urban)	1.7
	Schedule 1	0.04
	Water Supply Service	0.3
	Total	**78.1**



Water use map for the Northwestern Cape Ranges SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

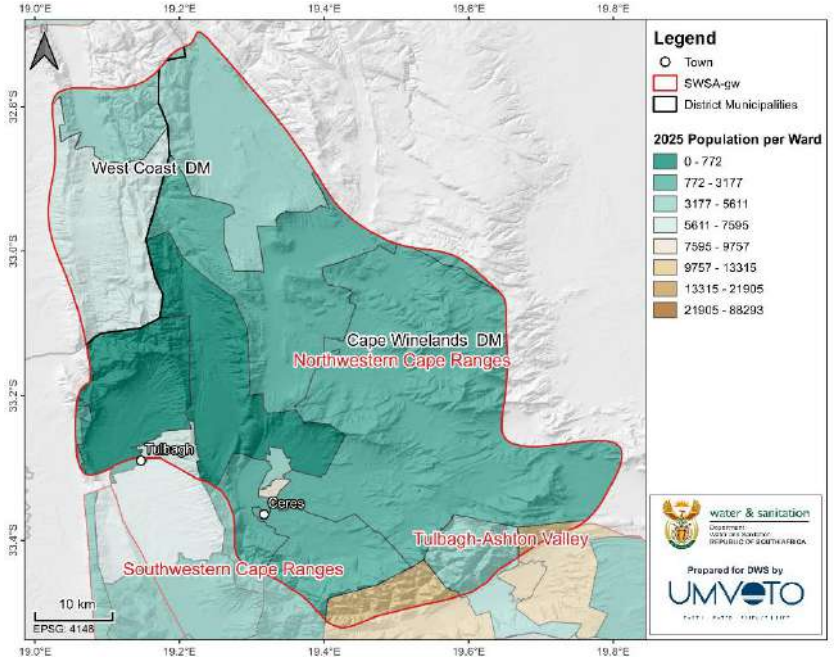
SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km²
Elevation:	78 to 2226 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Northwestern Cape Ranges SWSA-gw is located within the Breede-Olifants Water Management Area (WMA, 2023). The groundwater resources within the Northwestern Cape Ranges SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Breede-Olifants Catchment Management Agency (BOCMA), which was formed as part of a national restructuring process that consolidated CMAs. BOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the BOCMA to manage water resources in the Breede-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	BOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Breede-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	Local municipalities are the Water Service Authorities (WSA), while the West Coast DM is the Bulk Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Northwestern Cape Ranges SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of -0.01% per year, resulting in a projected population of approximately 71,648.

As shown in the map and table below, Witzenberg Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 52,122.



Projected population distribution in 2025 for the Northwestern Cape Ranges SWSA-gw.

SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km²
Elevation:	78 to 2226 mamsl

Quantity & Quality

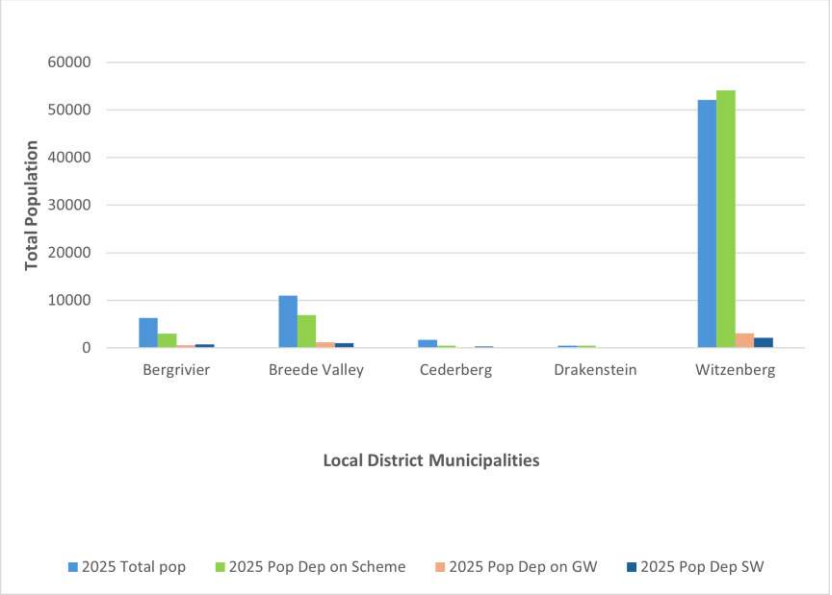
Socio Economic & Governance

In terms of water reliance within the Northwestern Cape Ranges SWSA-gw, an estimated 90.8% of the population depends on the regional water supply scheme, 7.1% on groundwater sources (including boreholes and springs), and 5.9% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources).

Among the LMs, the Breede Valley LM has the highest proportion of groundwater reliance, with approximately 11.2% of its population depending on groundwater and 9.3% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Bergrivier	6,320	3,004	564	719
Breede Valley	10,985	6,908	1,226	1,023
Cederberg	1,748	519	152	314
Drakenstein	473	459	7	17
Witzenberg	52,122	54,160	3,108	2,152
Total	**71,648**	**65,050**	**5,057**	**4,225**



Projected population dependence on water sources in 2025.

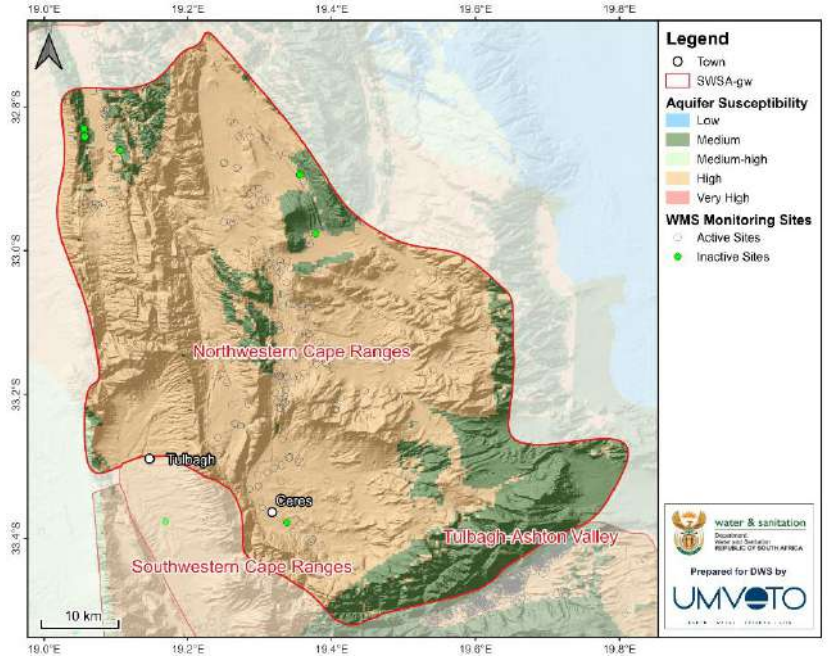
SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km²
Elevation:	78 to 2226 mamsl
Quantity & Quality	
Groundwater Quality	

The Northwestern Cape Ranges SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 702.13 km^2, which is 19.30% of the Northwestern Cape Ranges SWSA-gw total area. Urban/Built-up areas cover 24.43 km^2 (0.67%), while mines and quarries account for 2.52 km^2 (0.07%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major aquifer consists of areas with moderate and most aquifer vulnerability. The majority of the Major Aquifer is characterized by areas that have the most vulnerability, while moderate vulnerability areas are found in the E-SE, N, Central and NW parts of the aquifer.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. EC ranges from 5.25 - 135.9 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 0.7 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate and nitrite concentrations range from 0.005 – 10.07 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 4.6 - 8.44 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0.6 - 39.14 mg/L in the Major aquifer system



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Northwestern Cape Ranges**
Area:	**3638 km²**
Elevation:	**78 to 2226 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Northwestern Cape Ranges SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	7	35.00	20	29.27	mS/m	-	5.25 - 12.1 mS/m (Avg.: 8.15 mS/m). 2014-2024 GW Geosites: <70 mS/m. Consistent with WMS (2000-2024).	5.61 - 135.9 mS/m (Avg.: 49.89 mS/m). 2014-2024 GW Geosites: <70 mS/m. Mostly consistent with WMS (2000-2024).
Fluoride	7	46.67	15	0.14	mg/L	-	0.025 - 0.315 mg/L (Avg.: 0.10 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).	0.025 - 0.7 mg/L (Avg.: 0.18 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	7	46.67	15	1.14	mg/L	-	0.05 - 10.07 mg/L (Avg.: 1.66 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO3+NO2 (2000-2024).	0.005 - 4.41 mg/L (Avg.: 0.61 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO3+NO2 (2000-2024).
pH	7	35.00	20	6.89	pH unit	-	4.6 - 7.89 (Avg.: 6.18). 2014-2024 GW Geosites: <5.7, some 7 - 9. Mostly consistent with WMS (2000-2024).	5.034 - 8.44 (Avg.: 7.61). 2014-2024 GW Geosites: <5.7 - 9. Mostly consistent with WMS (2000-2024).
Sulphate	7	46.67	15	12.32	mg/L	-	0.6 - 15.27 mg/L (Avg.: 3.77 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	2 - 39.14 mg/L (Avg.: 21.08 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the Northwestern Cape Ranges SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

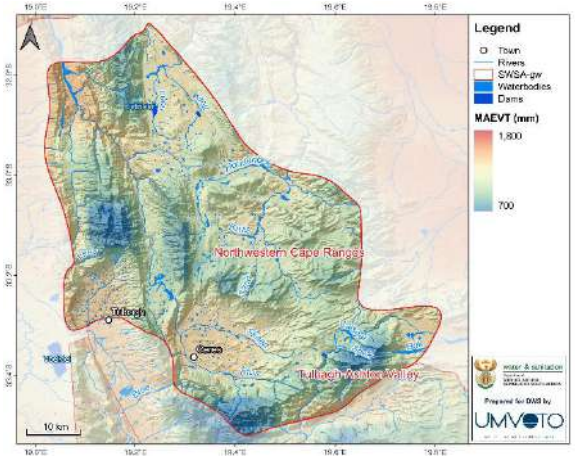
SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km²
Elevation:	78 to 2226 mamsl

Threats & Risks

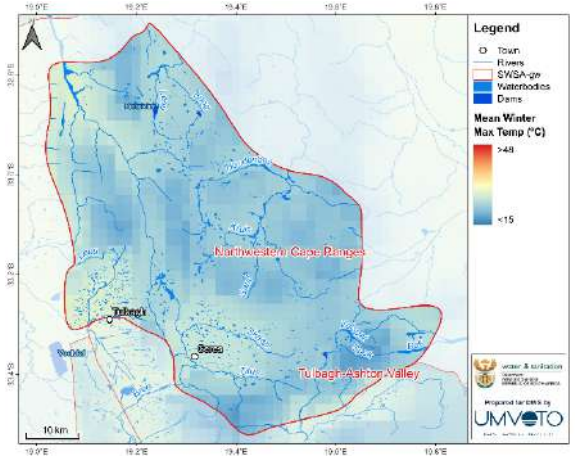
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Northwestern Cape Ranges SWSA-gw have predominantly Csb and Csa, mediterranean and semi-arid type climates characterised by dry and hot summers and a BSk type climate in the eastern section characterised by hot dry summers, but with colder winters. Temperatures in the SWSA-gw range from 0.1 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

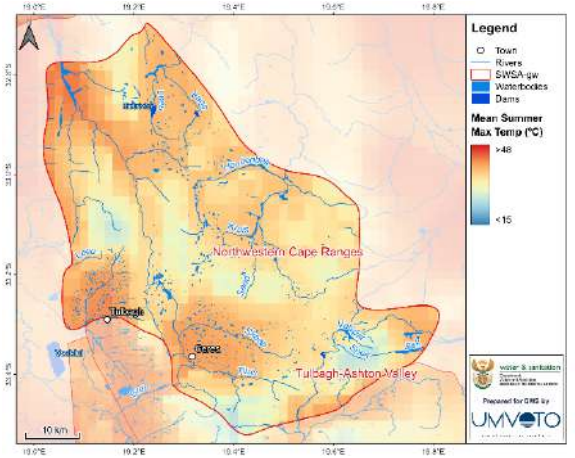
Temperature	Summer: 24.7 to 31 °C, Winter: 0.1 to 6 ºC
Evapotranspiration	Maximum value of 1477 mm/a to average value of 1145 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall and a decline in recharge (ranging from ~2.3 to 4..3 mm/a). The DART Index indicates overall stable conditions.



Mean annual A-Pan evaporation of the Northwestern Cape Ranges SWSA-gw region.



Mean winter temperatures of the Northwestern Cape Ranges SWSA-gw region.



Mean summer temperatures of the Northwestern Cape Ranges SWSA-gw region.

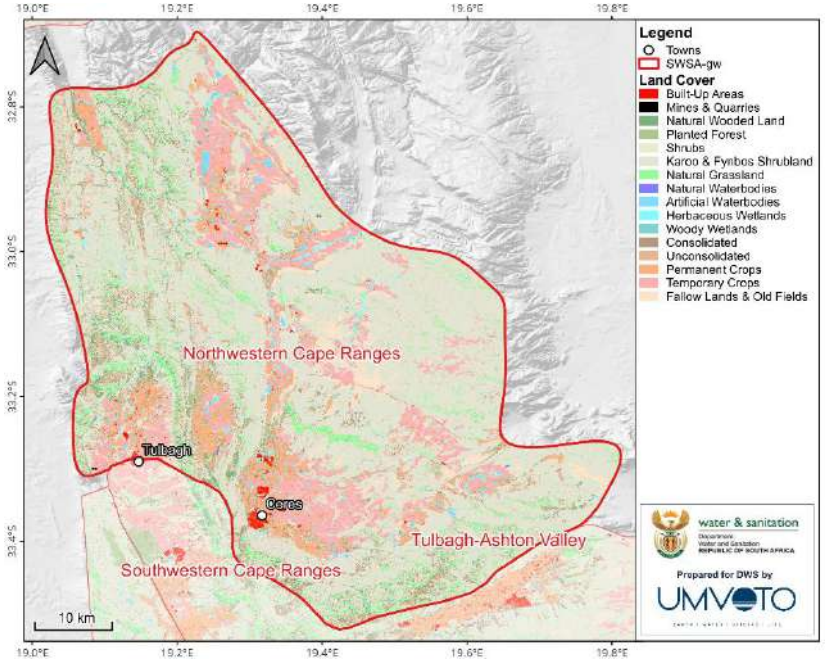
SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km^2
Elevation:	78 to 2226 mamsl

Threats & Risks

Land Use

The Northwestern Cape Ranges SWSA-gw is predominantly covered by Shrubland, consisting of Karoo and Fynbos Shrubland (DFFE, 2022), which accounts for 61.2% of the total area, highlighting its natural and ecologically significant landscape. Cultivated areas are also prominent, with temporary and permanent crops covering 19.3% of the SWSA-gw, indicating a reliance on farming in certain parts of the region. Despite the presence of wetlands and waterbodies, water resources remain limited. Built-up areas, consisting of residential, commercial and industrial areas, cover a small portion of the SWSA-gw, showing minimal urban development, and are concentrated in the towns of Ceres and Tulbagh. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.1% of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	264	7.2
Built-Up	24	0.7
Cultivated	702	19.3
Forest Land	145	4.0
Grassland	194	5.3
Mines and quarries	3	0.1
Shrubland	2227	61.2
Waterbodies	38	1.0
Wetlands	41	1.1



Land Cover 24-class map to show the types of land use and extent of each occurring in the Northwestern Cape Ranges SWSA-gw.

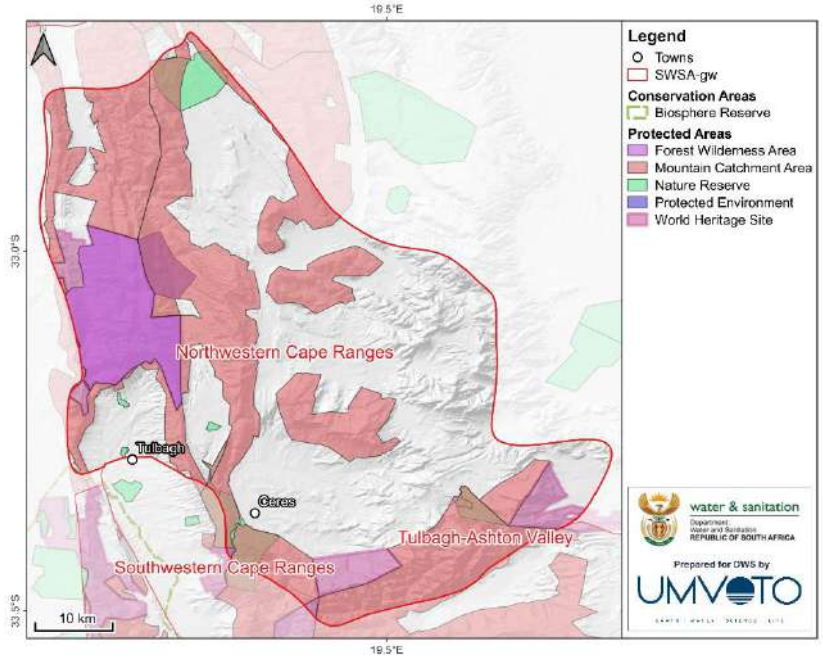
SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km^2
Elevation:	78 to 2226 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Northwestern Cape Ranges SWSA-gw includes significant protected areas, covering 58.4% across 14 designated sites (DFFE, 2024), ensuring the conservation of critical ecosystems and biodiversity. The Cape Winelands Biosphere Reserve, although small at 0.18 km², provides additional ecological protection within the region (DFFE, 2024). The Koue Bokkeveld Mountain Catchment Area runs predominantly through the middle of the SWSA-gw, while the Winterhoek Mountain Catchment Area sits on the western edge and the Matroosberg Mountain Catchment Area on the southern edge of the SWSA-gw. A key protected area is the Cape Floral Region Protected Areas, a world heritage site, located on the western edge of the SWSAgw, known for its rich plant diversity.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Cape Winelands Biosphere Reserve	0.18	1
Protected Areas	• Cape Floral Region Protected Areas • Groot-Winterhoek Wilderness Area • Winterhoek Mountain Catchment Area • Koue Bokkeveld Mountain Catchment Area • Matroosberg Mountain Catchment Area • Grootwinterhoek Protected Environment • Ceres Bergfynbos Reserve • Wagenboom Nature Reserve • Matroosberg Private Nature Reserve • And various other small nature reserves	2126.03	14
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Northwestern Cape Ranges SWSA-gw that have protection status.

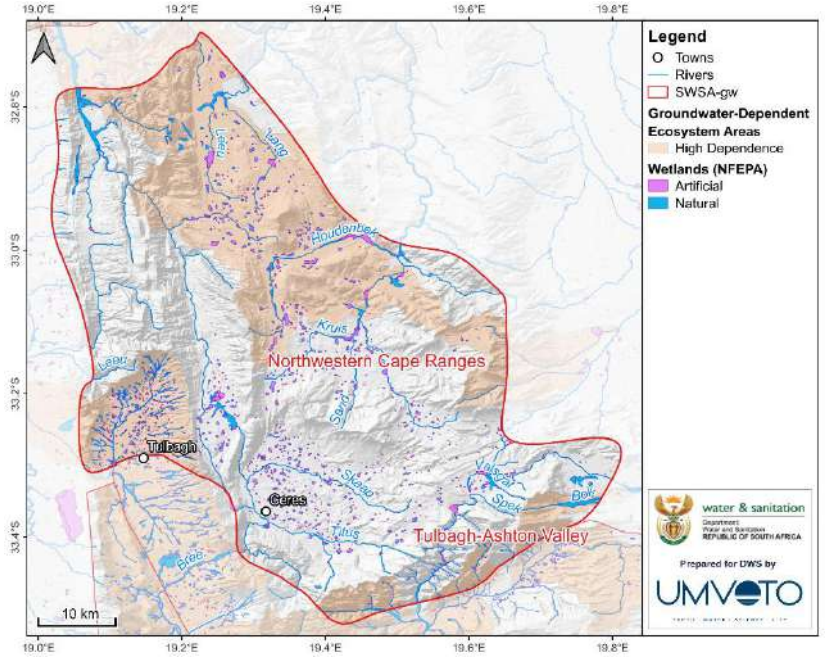
SWSA-gw Name:	Northwestern Cape Ranges
Area:	3638 km^2
Elevation:	78 to 2226 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The northern portion of the Northwestern Cape Ranges SWSA-gw is covered by wetlands (CSIR, 2011) with vegetation that is highly dependent on groundwater (DWA, 2010), as displayed in the map.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	124	

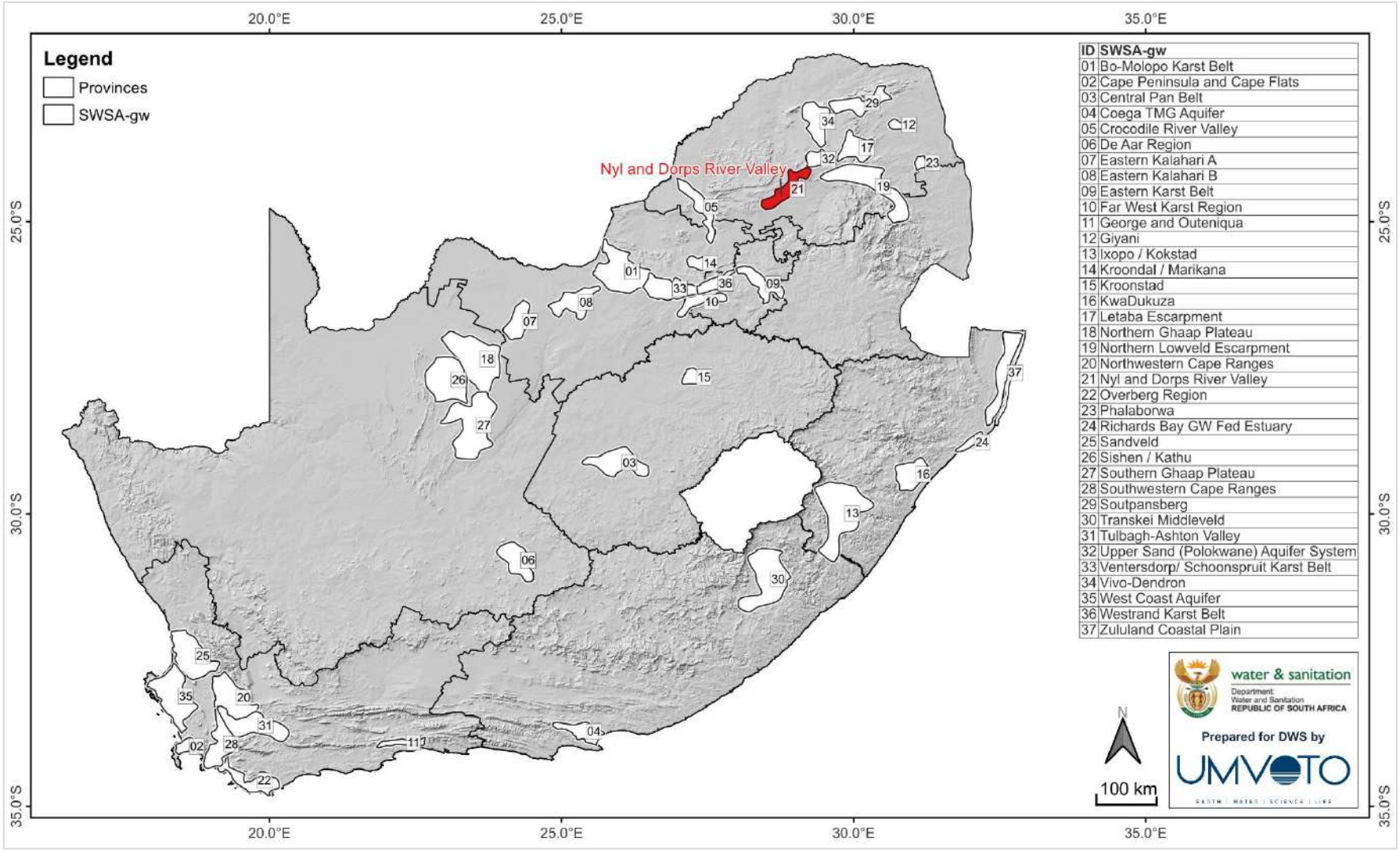


Map showing the major water bodies, Ramsar sites and GDEs in the Northwestern Cape Ranges SWSA-gw.

APPENDIX 21

NYL AND DORPS RIVER VALLEY SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE NYL AND DORPS RIVER VALLEY SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

21. Nyl and Dorps River Valley

21.1. Description

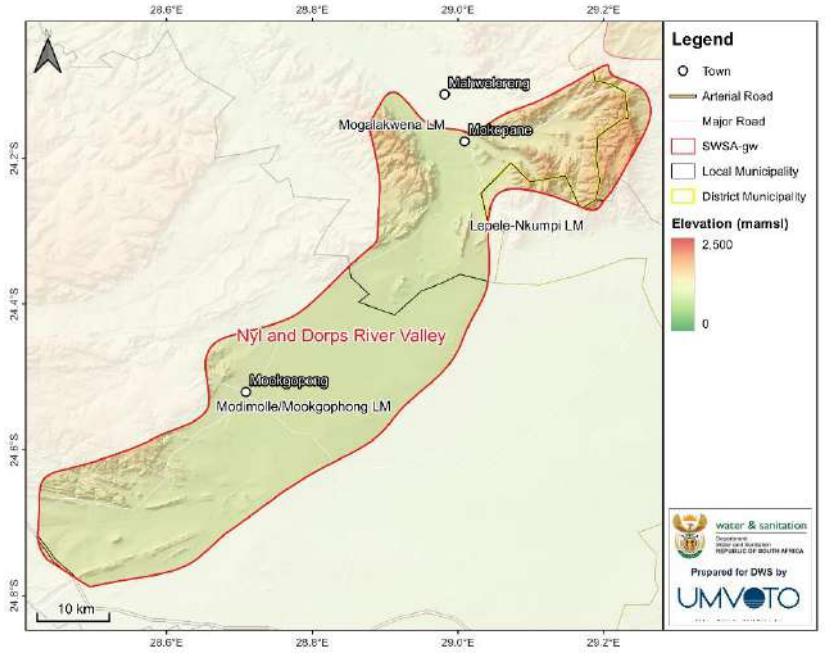
SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031-1949 mamsl

Geospatial Context

The topography of the Nyl and Dorps River Valley SWSA-gw, as depicted in the map, is characterized by a mix of gently rolling hills, undulating plains, and rugged terrain. The region lies on the eastern edge of the Bushveld and is influenced by the Waterberg Plateau to the north. The landscape is dominated by rolling hills and small valleys, with the Waterberg Mountains creating a more rugged, elevated topography to the north of Mokopane and Modimolle. The area around Mookgophong features gently sloping terrain with river valleys and rocky outcrops scattered across the landscape.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Limpopo
District Municipality	Waterberg and Capricorn
Local Municipality	Lepele-Nkumpi, Modimolle/Mookgophong, Mogalakwena and Polokwane
Towns	Modimolle, Mookgophong, Sekgakgapeng and Mokopane
Major Roads	N1, R101 and R518
Major Water Supply Networks	



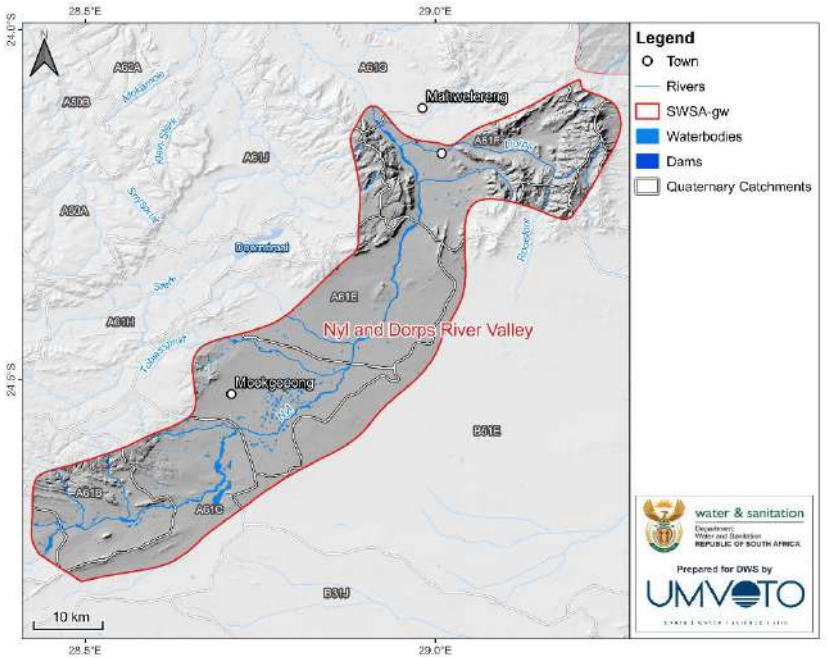
Locality map of Major Towns, District and Local Municipalities in the Nyl and Dorps River Valley SWSA-gw.

SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031-1949 mamsl

Hydrology and Drainage

The Nyl and Dorps River Valley SWSA-gw and surrounding areas include a few major surface water systems, which are summarised below and displayed on the map to the right. The majority of the perennial rivers are fed by the A6 catchment, with the Rooisloot and Mogoto rivers being fed by the B5 catchment and the Sand River being fed by the A7 catchment.

Quaternary Catchments	A61B, A61C, A61D, A61E, A61F, A61J, B51E and A61A, A61G, A71A, B51G, B51F
Rivers	Perennial: Andriesspruit, Badseloop, Great Nyl, Little Nyl, Mogalakwena, Mogoto, Nyl, Sand, Tobiasspruit
	Ephemeral: Dorps, Middelfonteinspruit, Olifantspruit, Rooisloot
Natural and manmade water bodies	Nylsvlei floodplain
Major Dams:	Gert Combrink
Water Management Areas:	Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Nyl and Dorps River Valley SWSA-gw.

SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031-1949 mamsl
Geology	

Geology

The study area features Quaternary alluvium distributed centrally. In the southern section, there are intrusions of Karoo dolerite dykes, while in the northern section, diabase dyke intrusions are present.

The Lebombo Group and Clarens Formation of the Karoo Supergroup, located in the central section, consist of basic volcanic rocks, including tholeiites, picrite basalts, and nephelinites, as well as fine-grained sandstone and siltstone.

The Waterberg Group, found in the southeastern section, includes medium- to coarse-grained sandstone (pebbly in places), conglomerate, trachytic lava, quartz porphyry, feldspathic sandstone, and subordinate conglomerate and mudrock (mainly siltstone).

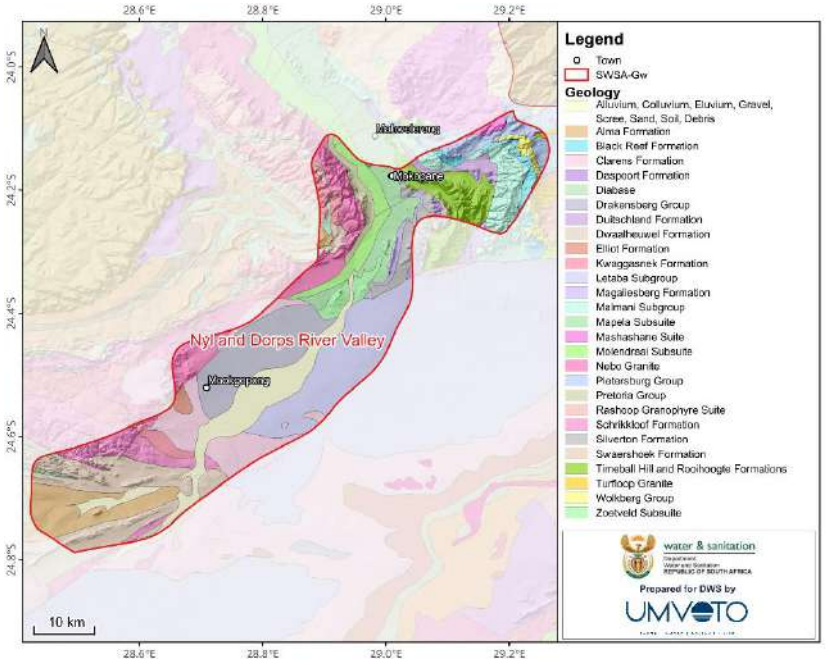
The Rooiberg Group of the Transvaal Supergroup, also in the eastern section, comprises fine-grained, flow-banded, porphyritic, and spherulitic felsite, as well as massive red porphyritic felsite, minor pyroclastic rocks, and sandstone/quartzite. The Pretoria Group, located in the northern section, features minor hornfels, quartzite, shale with subordinate limestone/dolomite, basalt, and tuff, as well as sub-greywacke.

The Rustenburg Layered Suite of the Bushveld Complex, also in the northern section, includes pyroxenite, harzburgite, chromitite, gabbro, norite, magnetite gabbro with magnetitite layers, and the coarse-grained granite of the Lebowa Granite Suite.

The Zebediela Fault cuts across the central section of the area.

Hydrostratigraphy

The Quaternary alluvium forms a primary intergranular aquifer. The Bushveld Complex, Rooiberg Group, and Waterberg Group host secondary fractured aquifers, with groundwater occurring in weathered zones, fault zones, and along dolerite and granite contacts. Dolerite and diabase dykes create localized secondary, fractured aquifers with high permeability along their margins.



Geology Map of the Nyl and Dorps River Valley SWSA-gw region.

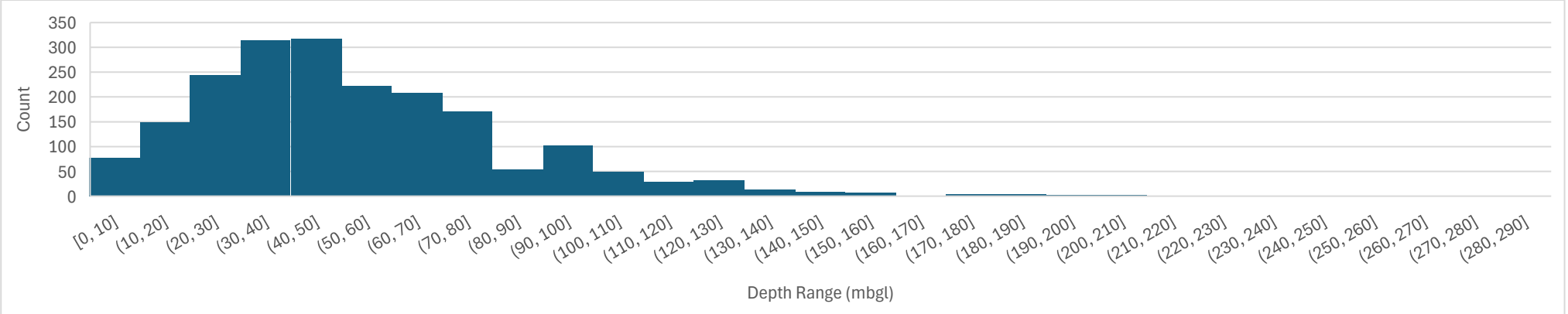
21.2. Current Status

SWSA-gw Name:	**Nyl and Dorps River Valley**
Area:	**2036 km²**
Elevation:	**1031-1949 mamsl**
Quantity & Quality	
Aquifer Classification	

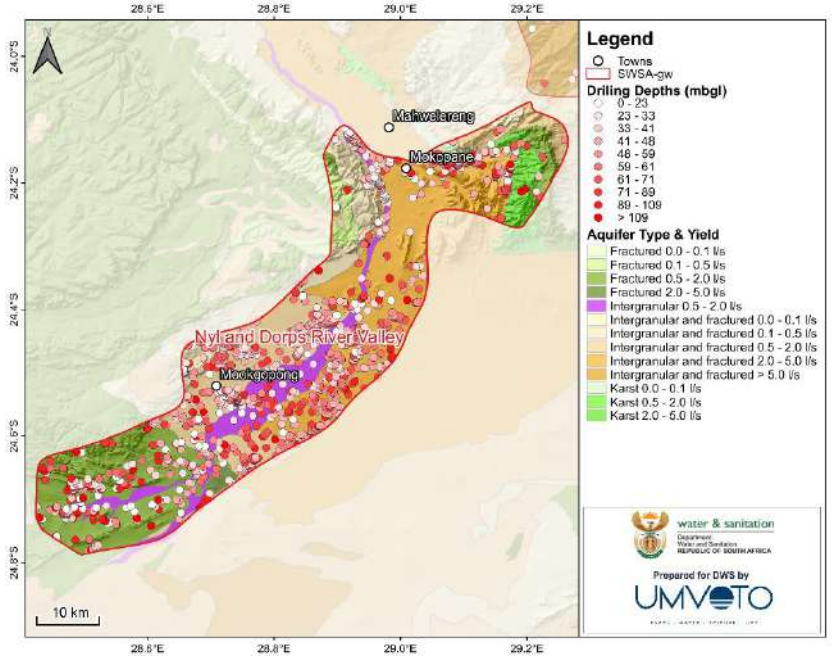
The aquifer systems within the George and Nyl and Dorps River Valley SWSA-gw exhibit varying yields across fractured, karst and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The eastern half of the SWSA-gw is a major aquifer system, while the western half is a minor aquifer system. The major aquifer system has an average dual-porosity yield of 0.5 to 5.0 l/s, with a section having an average karst yield of 2.0 to 5.0 l/s. The minor aquifer system has an average fractured and dual-porosity yield of 0.5 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 54 mbgl, and the most common depths are between 40 and 60 mbgl, suggesting mixed targets; boreholes target the dual-porosity, fractured and karst aquifer systems. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 31 and 69 mbgl. Based on the past 25 years of NGA water level data, the average groundwater level in the region is ~ 11 mbgl, with values ranging from 0 to 45 mbgl and a standard deviation of ~7 mbgl.

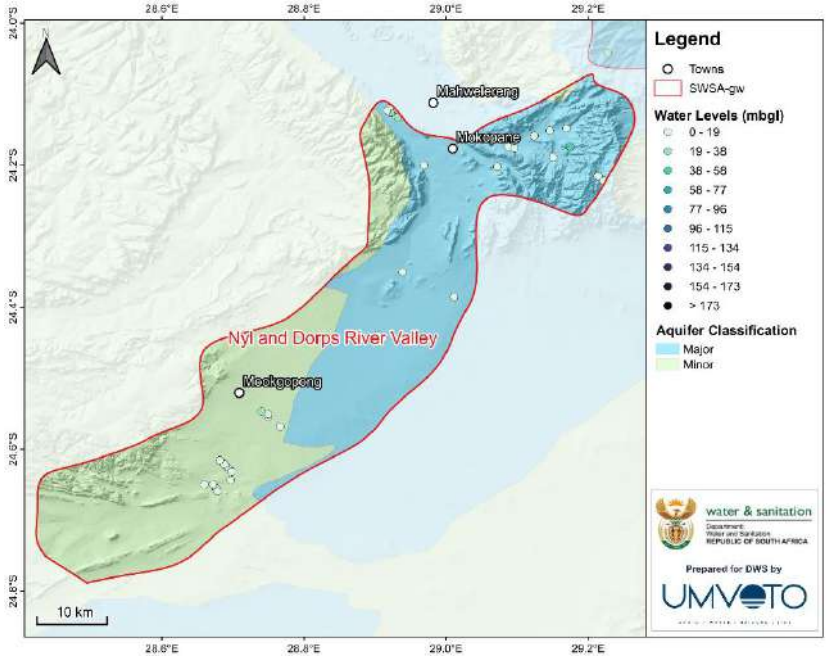
Graph of NGA drilling depths of the Nyl and Dorps River Valley SWSA-gw region



SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031-1949 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Nyl and Dorps River Valley SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Nyl and Dorps River Valley SWSA-gw region.

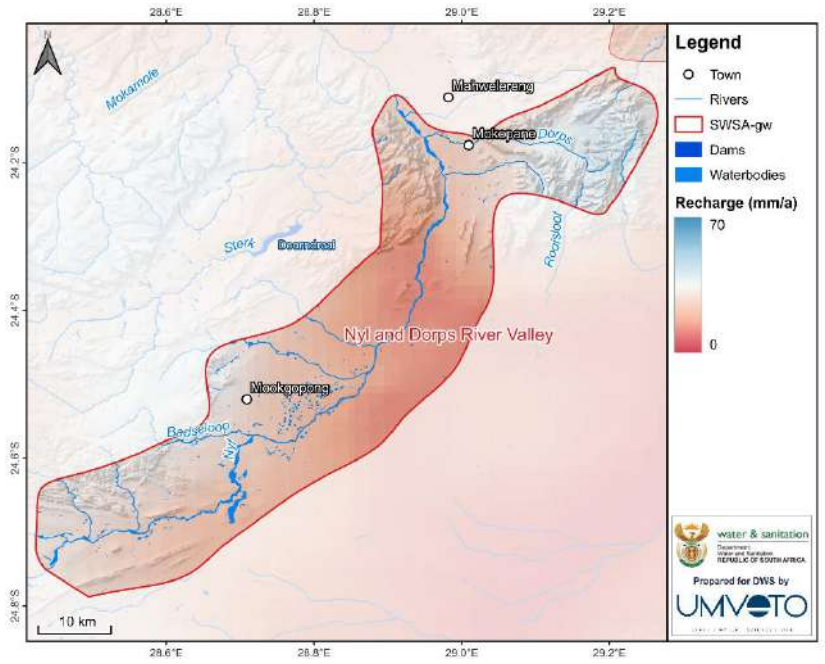
SWSA-gw Name:	**Nyl and Dorps River Valley**
Area:	**2036 km²**
Elevation:	**1031-1949 mamsl**

Quantity & Quality

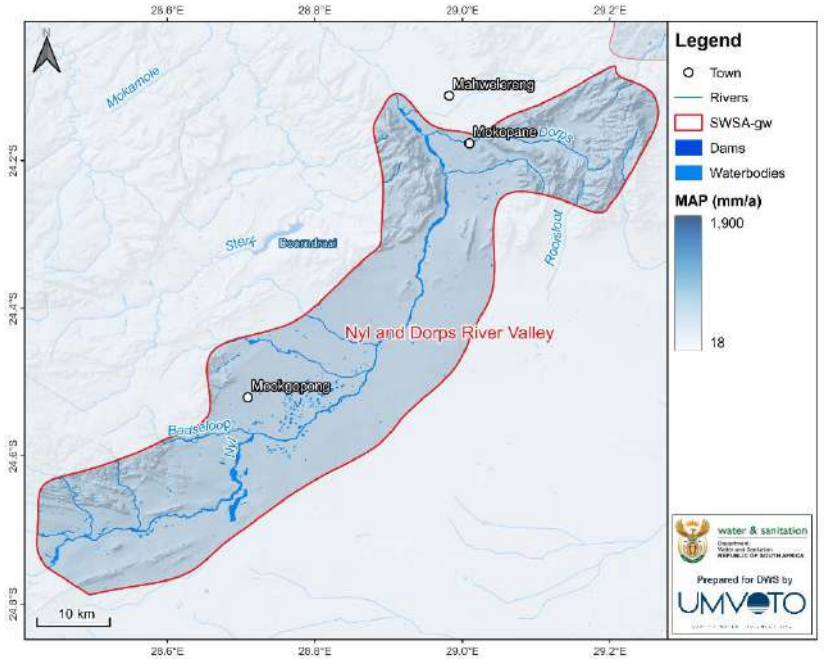
Groundwater Recharge

The Nyl and Dorps River Valley receives a total MAP volume of 1128 Mm^3/a, with an average rainfall of 553 mm/a. However, only 51.3 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 4.6% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Nyl and Dorps River Valley	1128	553	51.3	25.3	4.6%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031-1949 mamsl

Quantity & Quality

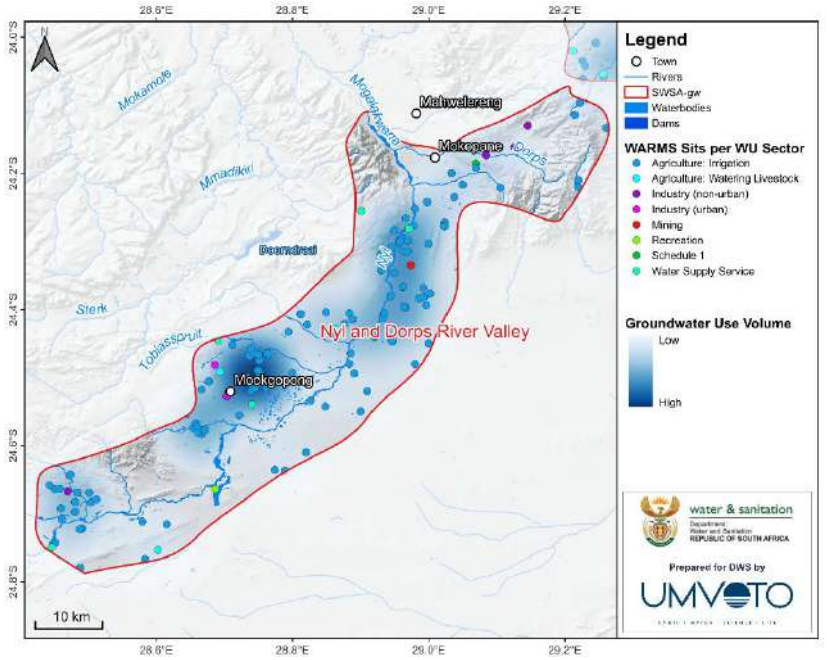
Groundwater Use

The Nyl and Dorps River Valley SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Mokopane (Groundwater) and Mookgophong (Conjunctive), which rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 17.6 Mm^3/a to sustain crop production. Registered irrigation use is scattered around the region, but there are clusters in the central parts of the region from Mokopane to Mookgophong and in the southernmost region next to Modimolle.
- Municipal water supply services, at 2.5 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. The use is mainly around the cities like Mookgophong, Mokopane and Sekgakgapeng.
- Non-Urban industrial follows, using 0.8 Mm^3/a allocated for manufacturing, processing, and other industrial activities outside urban centres. This sector is significantly less than the first two, use is mostly in the north and south.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Mokopane and Mookgophong, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	17.6
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	0.8
	Industry (Urban)	0.02
	Mining	0.2
	Water Supply Service	2.5
	Total	**21.1**



Water use map for the Nyl and Dorps River Valley SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

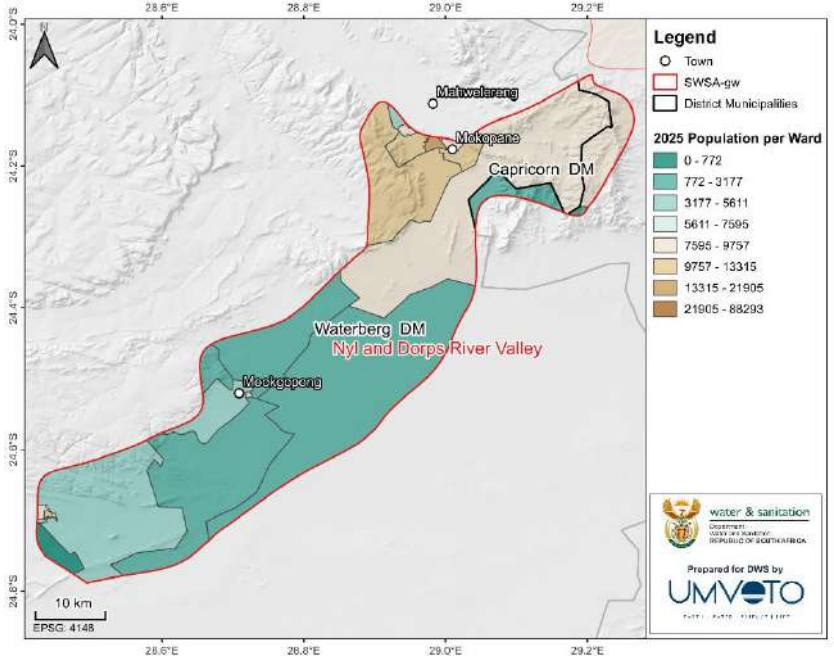
SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031-1949 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Nyl and Dorps River Valley SWSA-gw is located within the Limpopo-Olifants Water Management Areas (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. LOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the LOCMA to manage water resources in the Limpopo-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	LOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities within Waterberg DM (Modimolle/Mookgophong and Mogalakwena) are the Water Service Authorities (WSA) and Water Service Providers (WSP) in their jurisdiction, while Polokwane LM and Capricorn District Municipality are the respective WSA and WSP for their jurisdictions.

The estimated population within the Nyl and Dorps River Valley SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 1.60% per year, resulting in a projected population of approximately 113,501.

As shown in the map and table below, Mogalakwena Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 66,322, followed by Modimolle/Mookgophong LM with 44,365.



Projected population distribution in 2025 for the Nyl and Dorps River Valley SWSA-gw.

SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031-1949 mamsl

Quantity & Quality

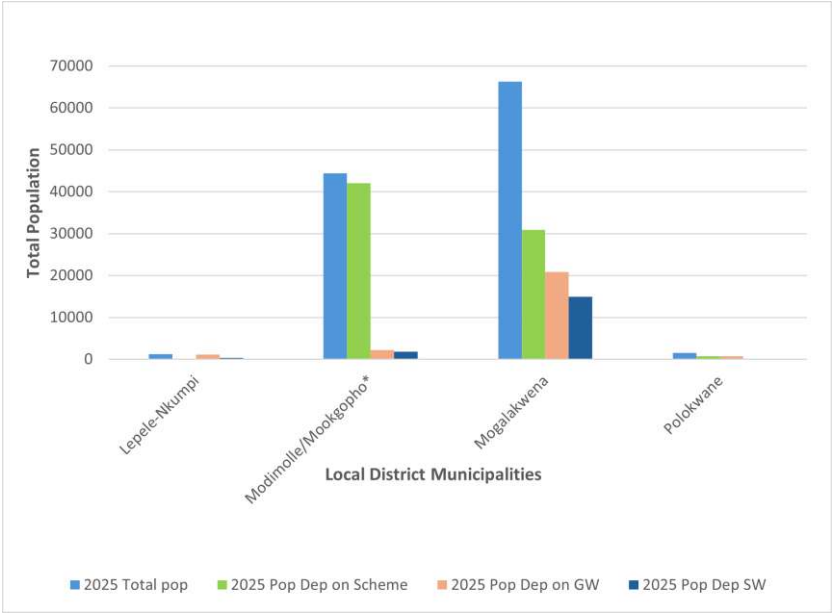
Socio Economic & Governance

In terms of water reliance within the Nyl and Dorps River Valley SWSA-gw, an estimated 64.9% of the population depends on the regional water supply scheme, 21.9% on groundwater sources (including boreholes and springs), and 15.2% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources).

Among the LMs, the Lepele-Nkumpi LM has the highest proportion of groundwater reliance, with approximately 87.3% of its population depending on groundwater and 26.5% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Lepele-Nkumpi	1,251	33	1,093	331
Modimolle/Mookgophong	44,365	42,000	2,200	1,850
Mogalakwena	66,322	30,872	20,818	14,921
Polokwane	1,563	763	701	145
Total	**113,501**	**73,668**	**24,812**	**17,248**



Projected population dependence on water sources in 2025.

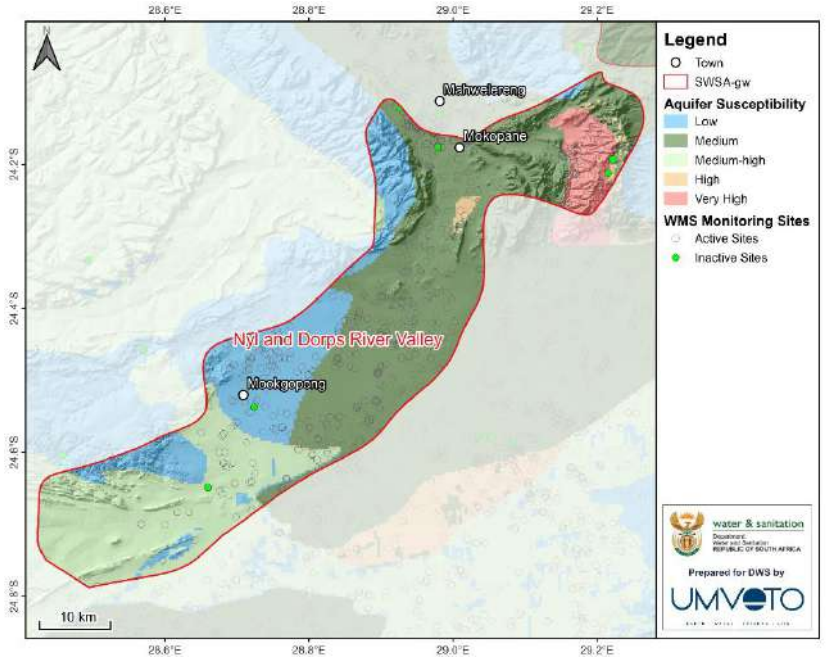
SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031-1949 mamsl
Quantity & Quality	
Groundwater Quality	

The Nyl and Dorps River Valley SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 573.39 km^2, which is 28.16% of the Nyl and Dorps River Valley SWSA-gw total area. Urban/Built-up areas cover 85.43 km^2 (4.20%), while mines and quarries account for 3.61 km^2 (0.18%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major aquifer consists of areas with moderate and most aquifer vulnerability. The majority of the Major Aquifer is characterized by areas that have moderate vulnerability, while the most vulnerable areas are found in the Northeastern parts of the aquifer.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 5.2 - 172.6 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 1.04mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.025 - 43.62 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.03 – 9.17 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0.6 - 116 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Nyl and Dorps River Valley**
Area:	**2036 km²**
Elevation:	**1031-1949 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Nyl and Dorps River Valley SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	4	7.02	57	55.46	mS/m	57.2 - 59.1 mS/m (Avg.: 58.15 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024).	5.2 - 172.6 mS/m (Avg.: 58.16 mS/m). 2014-2024 GW Geosites: <70 - 370 mS/m. Consistent with WMS (2000-2024).	24.7 - 101.1 mS/m (Avg.: 52.32 mS/m). 2014-2024 GW Geosites: 70 - 150 mS/m. Consistent with WMS (2000-2024).
Fluoride	4	7.02	57	0.24	mg/L	0.5 - 0.568 mg/L (Avg.: 0.53 mg/L). 2014-2024 GW Geosites: <0.5 mg/L, >1.5-5.0 mg/L. Consistent with WMS (2000-2024).	0.025 - 1.04 mg/L (Avg.: 0.25 mg/L). 2014-2024 GW Geosites: <0.5 mg/L, >1.5-5.0 mg/L. Consistent with WMS (2000-2024).	0.025 - 0.67 mg/L (Avg.: 0.21 mg/L). 2014-2024 GW Geosites: <0.5 mg/L, >1.5-5.0 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	4	7.02	57	6.10	mg/L	7.46 - 10.95 mg/L (Avg.: 9.20 mg/L). 2014-2024 GW Geosites: <11-20 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	0.025 - 43.62 mg/L (Avg.: 10.41 mg/L). 2014-2024 GW Geosites: <11-50 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	0.025 - 26.05 mg/L (Avg.: 1.36 mg/L). 2014-2024 GW Geosites: <11-20 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	4	7.02	57	7.97	pH unit	7.83 - 8.16 (Avg.: 7.99). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	6.03 - 9.17 (Avg.: 7.74). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	7 - 8.9 (Avg.: 8.22). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	4	7.02	57	18.88	mg/L	2 - 5.06 mg/L (Avg.: 3.53 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	0.6 - 116 mg/L (Avg.: 25.99 mg/L). 2014-2024 GW Geosites: <200-500 mg/L. Mostly consistent with WMS (2000-2024).	2 - 66.85 mg/L (Avg.: 11.64 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the Nyl and Dorps River Valley SWSA-gw, taken from the WMS database from 2000-2024.*

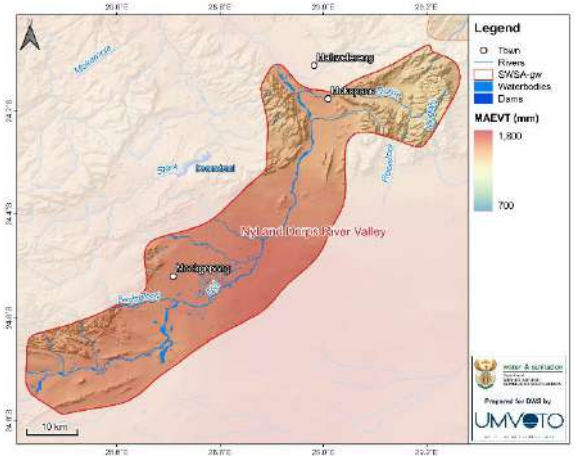
SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031-1949 mamsl

Threats & Risks

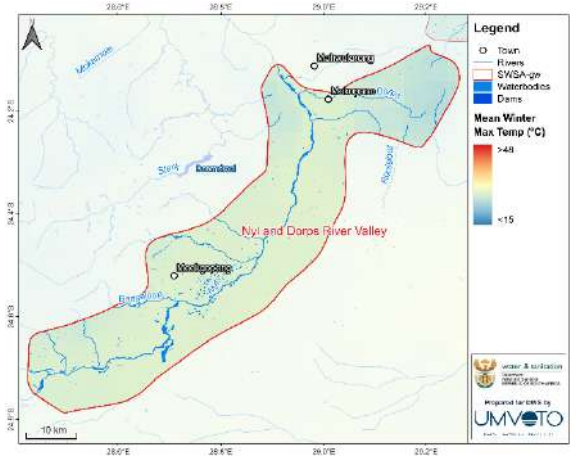
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Nyl and Dorps River Valley SWSA-gw primarily experiences a BSh, hot semi-arid, type climate characterized by hot summers, warm to cool winters, and minimal precipitation. Some areas also fall within the BSk, cold semi-arid, type climate characterized by cold winters and hot, dry summers. Additionally, Cwa and Cwb, subtropical climates, are present along the western and northern edges, bringing warm summers and dry winters. Temperatures in the SWSA-gw range from 2.1 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

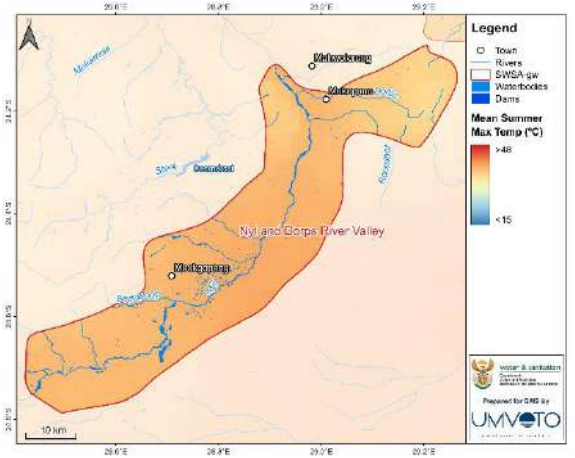
Temperature	Summer: 24.6 to 31 ºC, Winter: 2.1 to 6.1 °C
Evapotranspiration	Maximum value of 1724 mm/a with an average value of 1583 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, but an increase in recharge (ranging from ~ 18.2 to 26.3 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Nyl and Dorps River Valley SWSA-gw region.



Mean winter temperatures of the Nyl and Dorps River Valley SWSA-gw region.



Mean summer temperatures of the Nyl and Dorps River Valley SWSA-gw region.

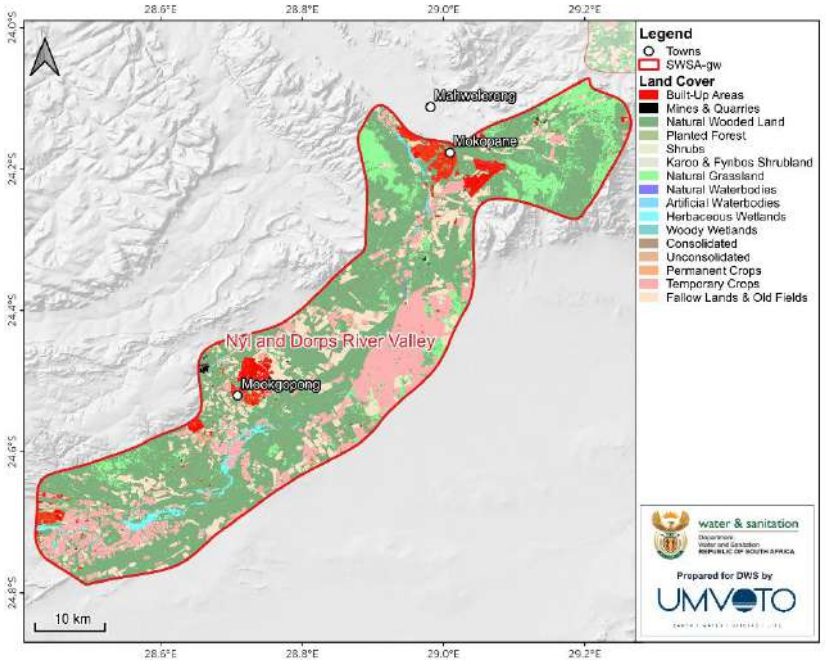
SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km^2
Elevation:	1031 to 1949 mamsl

Threats & Risks

Land Use

Forested land, which includes natural wooded land and planted forests, and grassland covers 65.6% of the Nyl and Dorps River Valley SWSA-gw (DFFE, 2022), indicating that the majority of the area consists of vegetation, showing the ecological importance of the SWSA-gw. A significant portion of land is dedicated to cultivated land, made up of permanent crops, temporary crops, fallow lands and old fields, with a large portion concentrated to the central eastern edge of the SWSA-gw. Built-up areas, which consist of residential, commercial. Industrial areas and smallholdings make up relatively small portions of the SWSA-gw. They are concentrated in and near the towns of Mokopane, Mookgopong and Modimolle, indicating minimal urban development. Wetlands and waterbodies represent a minor portion of the landscape, suggesting limited water-based habitats in the region. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.2% of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	3	0.2
Built-Up	85	4.2
Cultivated	573	28.2
Forest Land	1132	55.6
Grassland	203	10
Mines and quarries	4	0.2
Waterbodies	9	0.4
Wetlands	27	1.3



Land Cover 24-class map to show the types of land use and extent of each occurring in the Nyl and Dorps River Valley SWSA-gw.

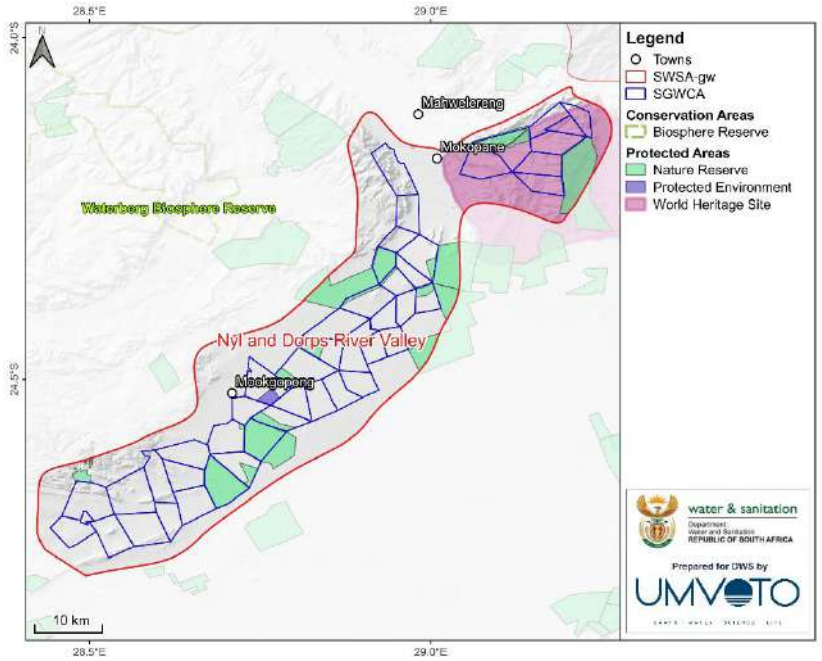
SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031 to 1949 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

A large world heritage site, Fossil Hominid Sites of SA (DFFE, 2024), is partially located within the Nyl & Dorps River Valley SWSA-gw on the northern section. Throughout the SWSA-gw, there are many small nature reserves and a protected environment, the Grootvalley Protected Environment (DFFE, 2024).

Protection Status	Names	Area (km²)	Count
Conservation Areas	None		0
Protected Areas	• Fossil Hominid Sites of SA • Grootvalley Protected Environment • Nylsvley Private Nature Reserve • Mosdene Private Nature Reserve • Naboom Private Nature Reserve • Palmer Private Nature Reserve • Mogoto Private Nature Reserve • And various other small nature reserves	561.87	15
SGWCA	• Dorpsrivier • Nyl River Valley	980.26	2
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Nyl and Dorps River Valley SWSA-gw that have protection status.

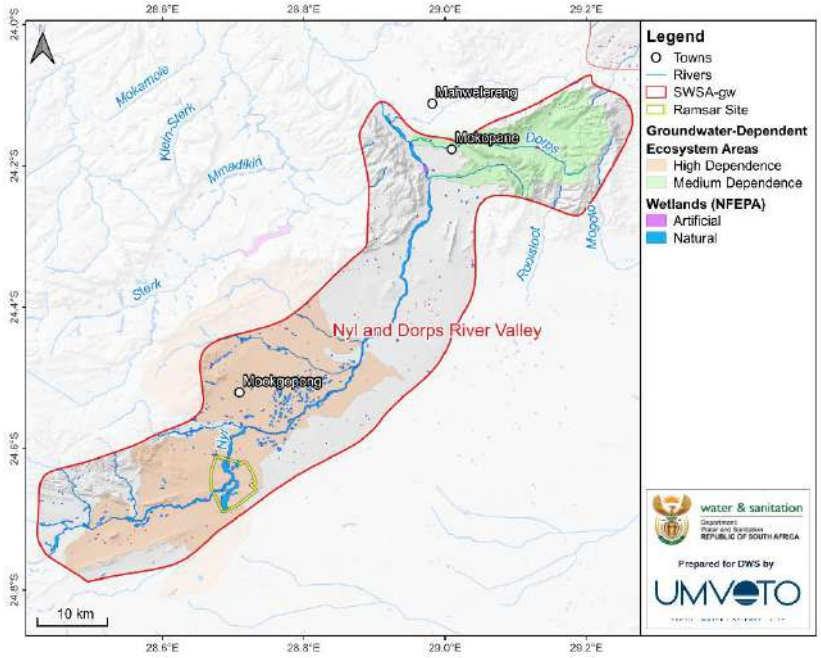
SWSA-gw Name:	Nyl and Dorps River Valley
Area:	2036 km²
Elevation:	1031 to 1949 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Nyl and Dorps River Valley SWSA-gw has wetlands of Alluvial vegetation with a potentially high dependence on groundwater (DWA, 2010) concentrated mainly towards the middle to southwestern end of the SWSA-gw. Wetlands with Dolomite vegetation and a potentially medium dependence on groundwater are found on the northeastern portion. The Nyl River, which runs through most of the SWSA-gw, mostly consists of floodplain wetlands and runs through the Ramsar-protected Nylsvley Nature Reserve.

Protection Status	Names	Area (km²)	Count
Major Waterbodies	None		0
Ramsar Sites	• Nylsvley Nature Reserve	39.23	1
Wetlands	Various natural, artificial and estuary wetlands	52	

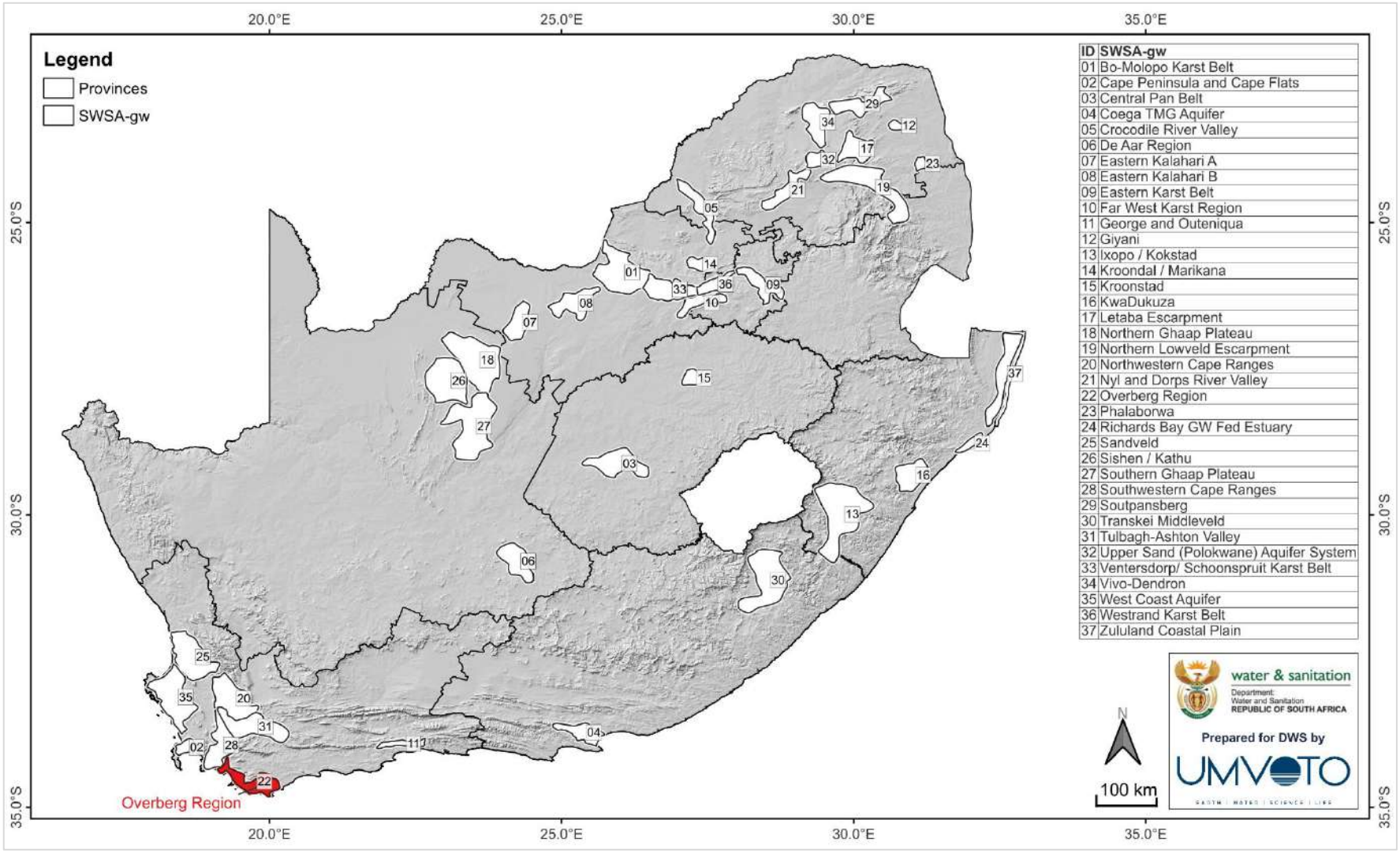


Map showing the major water bodies, Ramsar sites and GDEs in the Nyl and Dorps River Valley SWSA-gw.

APPENDIX 22

OVERBERG REGION SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE OVERBERG REGION SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

22. Overberg Region

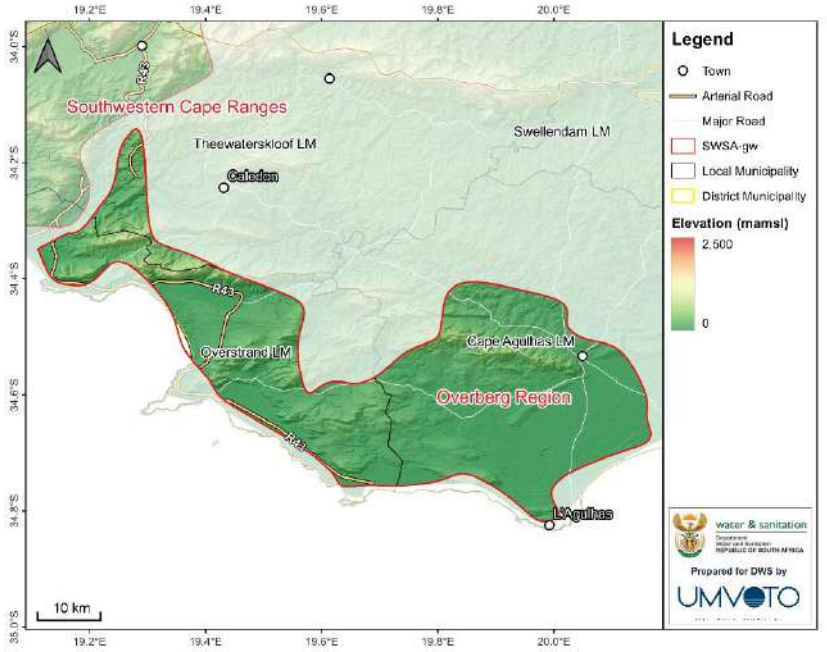
22.1. Description

SWSA-gw Name:	**Overberg Region**
Area:	**2261 km²**
Elevation:	**45 to 957 mamsl**
Geospatial Context	

The topography of the Overberg Region SWSA-gw, as depicted in the map, features a predominantly low-relief coastal plain along the southern and southwestern coastline, particularly near Gansbaai, Hermanus, L'Agulhas, and Struisbaai, where elevations remain relatively close to sea level. Moving inland, the terrain gradually rises towards the Overberg region, where rolling hills and valleys are interspersed with more rugged features. The northwestern portion, near Botrivier and Caledon, transitions into higher elevations associated with the Cape Fold Belt, characterized by steep ridges and mountainous terrain. The Napier and Bredasdorp areas also exhibit gentle undulations, shaped by river systems and geological formations.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Western Cape
District Municipality	Overberg
Local Municipality	Cape Agulhas, Overstrand and Theewaterskloof
Towns	L'Agulhas, Struisbaai, Gansbaai, Bredasdorp, Napier, Stanford, Hermanus and Botrivier
Major Roads	N2, R43, R316, R317, R319, R320 and R326
Major Water Supply Networks	Ruensveld West Rural water supply scheme



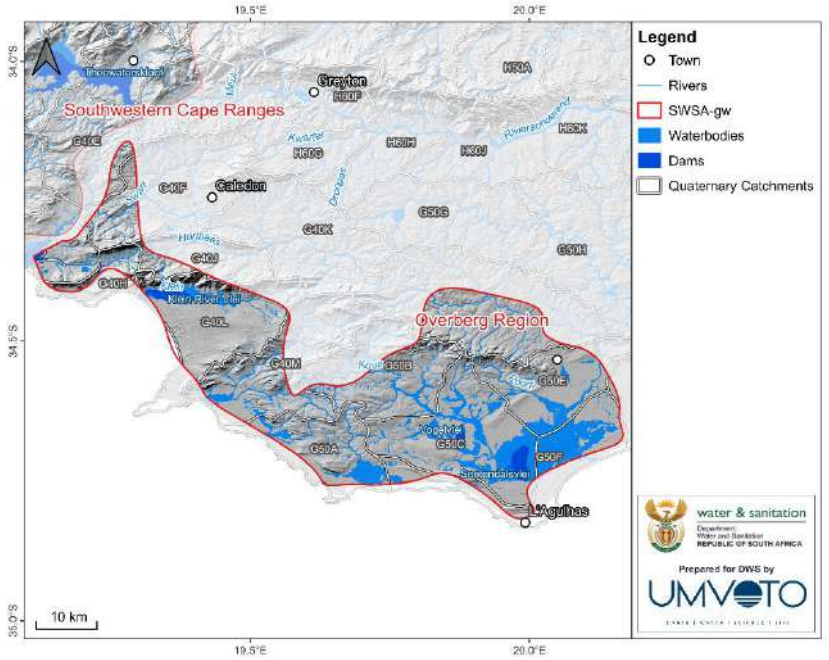
Locality map of Major Towns, District and Local Municipalities in the Overberg Region SWSA-gw.

SWSA-gw Name:	Overberg Region
Area:	2261 km²
Elevation:	45 to 957 mamsl

Hydrology and Drainage

The Overberg Region SWSA-gw and surrounding areas include a few large surface water systems, along with several unnamed seeps and floodplains, which are summarised below and displayed on the map to the right. The primary surface water features include Bot River Vlei, Klein River Vlei, De Bos Reservoir, Bot/Kleinmond Estuary, Klein Estuary, and Uilkraals Estuary, all fed by the G4 catchment. Additionally, Vogelvlei, Soetendalsvlei, and Heuningnes Estuary are fed by the G5 catchment. The area contains several perennial rivers and one ephemeral river with varying flow directions.

Quaternary Catchments	G40E, G40F, G40G, G40H, G40J, G40L, G40M, G50A, G50B, G50C, G50D, G50E, G50F and as well as a small section of G40E and G50J
Rivers	Perennial: Afdaks, Boesmans, Bot, Groot Sand, Haelkraal, Hartbees, Jan Swartskraal, Kars, Klein, Klein Sand, Koue, Nuwejaar, Onrus, Poort, Ratel, Swart and Uilkraal
	Ephemeral: Klein-Sout
Natural and manmade water bodies	Bot River Vlei, Klein River Vlei, Vogelvlei, Soetendalsvlei, De Bos reservoir, Uilkraals, Estuary, Bot/Kleinmond Estuary, Klein Estuary and Heuningnes Estuary
Major Dams:	De Bos, Vogelvlei and Soetendalsvlei
Water Management Areas:	Breede Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Overberg Region SWSA-gw.

SWSA-gw Name:	Overberg Region
Area:	2261 km²
Elevation:	45 to 957 mamsl

Hydrology and Drainage

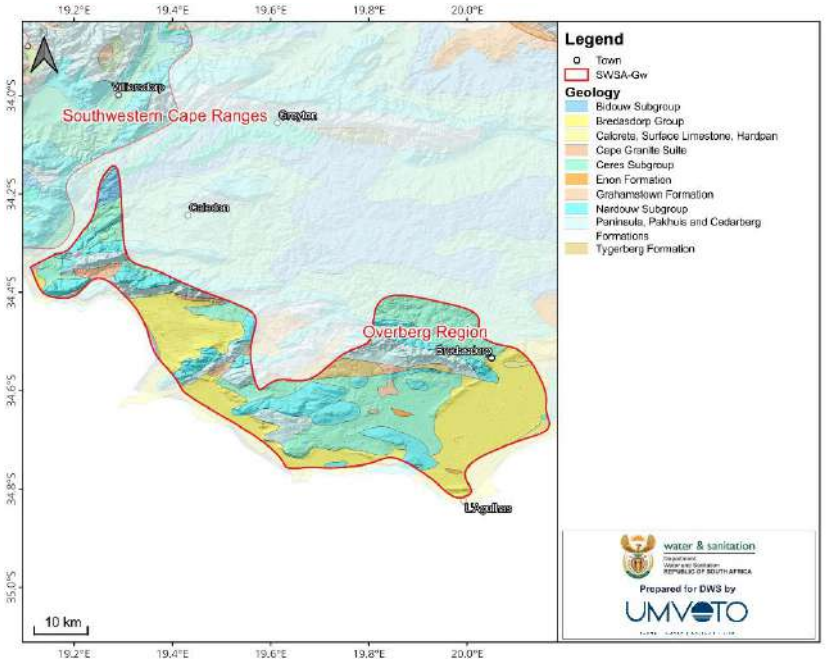
Geology

In the eastern and western sections of the area, there are outcrops of Quaternary deposits and the Bredasdorp Group comprising alluvium, aeolianite, sandy and loamy soils, scree, gravel, sandstone, conglomerate, calcrete, calcarenite and calcareous soils.

The majority of the area is covered by the Cape Supergroup, including the Bokkeveld and Table Mountain Groups. The Bokkeveld Group is characterised by mudrock, siltstone, sandstone, quartz wacke, and micaceous sandstone. The Table Mountain Group, dominated by quarzitic and feldspathic sandstone, mudstone, minor conglomerate, and scattered coarse clasts.

Hydrostratigraphy

Shallow, unconfined aquifers occur in alluvial and regolith deposits. The TMG forms a regional secondary fractured aquifer system, with groundwater movement controlled by faults and fractures. The Peninsula Aquifer is the primary deep confined aquifer, while the Nardouw Aquifer is semi-confined to unconfined, depending on local geology. The Pakhuis-Cedarberg aquitard restricts vertical flow.



Geology Map of the Overberg Region SWSA-gw region.

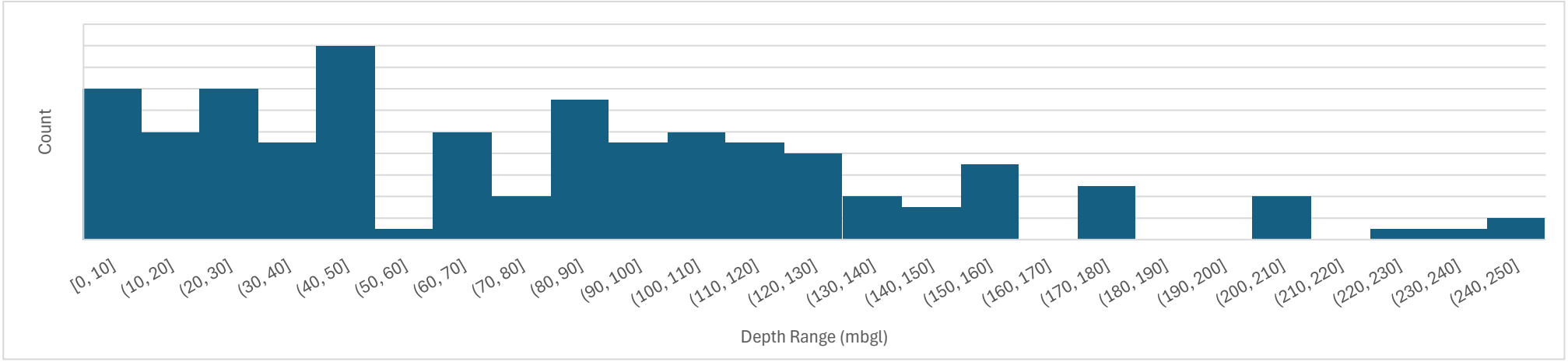
22.2. Current Status

SWSA-gw Name:	**Overberg Region**
Area:	**2261 km²**
Elevation:	**45 to 957 mamsl**
Quantity & Quality	
Aquifer Classification	

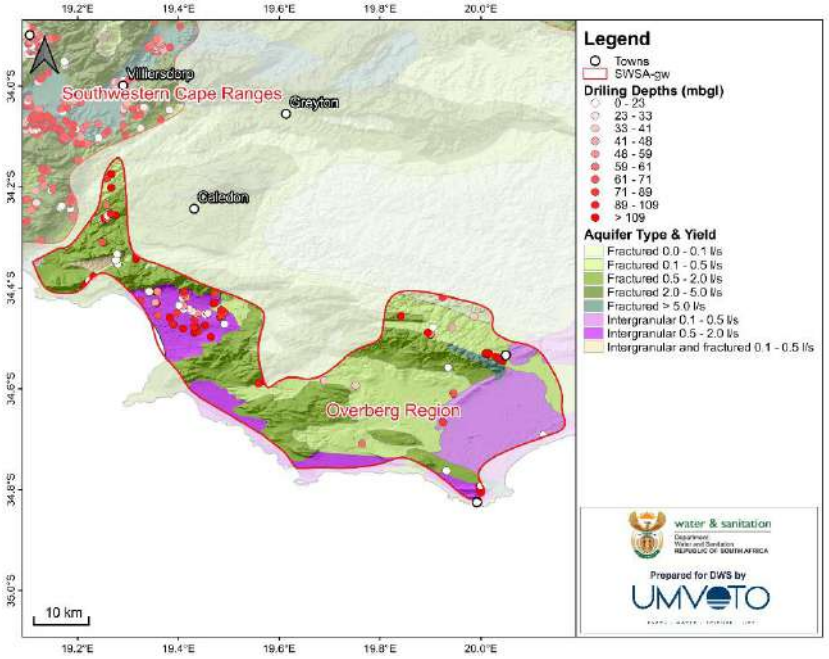
The aquifer systems within the Overberg Region SWSA-gw exhibit varying yields across dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is predominantly a Major aquifer system, with a Minor aquifer system along the eastern edge. The Major aquifer system has an average fractured yield of 0.1 to 5.0 l/s and an average intergranular yield of 0.5 to 2.0 l/s. The Minor aquifer system has an intergranular yield averaging between 0.1 and 0.5 l/s.
Groundwater Targets	The average drilling depth is 81 mbgl, and the most common depths are 50 and 90 mbgl. The presence of deep boreholes (>200 mbgl), particularly near the northeastern border, suggests a secondary target within the underlying fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 31 and 120 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 30 mbgl, with values ranging from 1 to 92 mbgl and a standard deviation of ~ 31 mbgl.

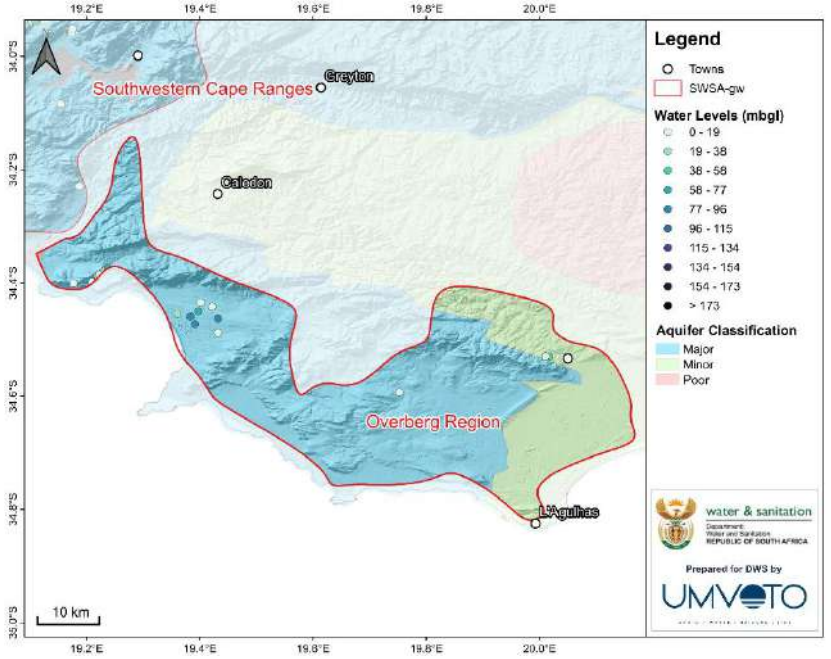
Graph of NGA drilling depths of the Overberg Region SWSA-gw region



SWSA-gw Name:	Overberg Region
Area:	2261 km²
Elevation:	45 to 957 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Overberg Region SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Overberg Region SWSA-gw region.

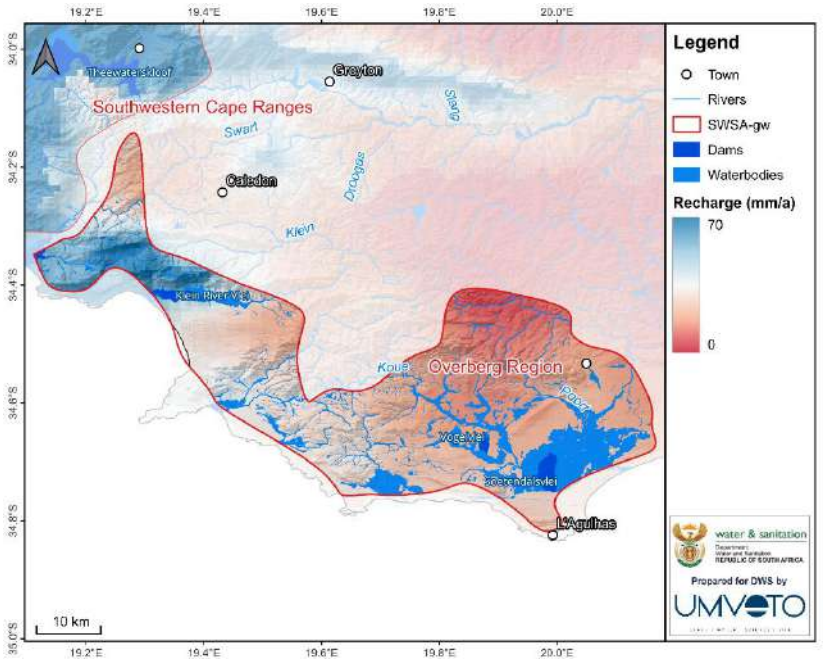
SWSA-gw Name:	Overberg Region
Area:	2261 km²
Elevation:	45 to 957 mamsl

Quantity & Quality

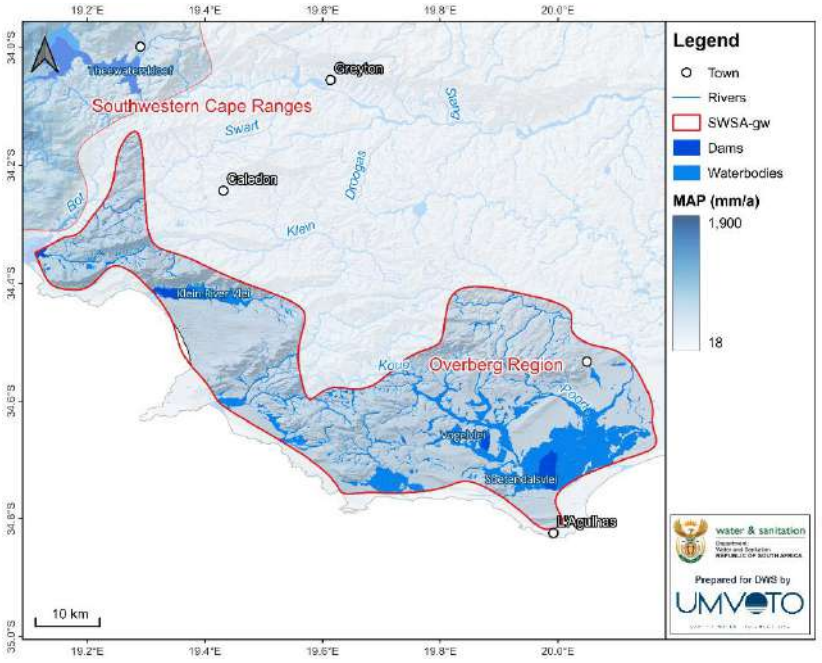
Groundwater Recharge

The Overberg Region receives a total MAP volume of 1125 Mm^3/a, with an average rainfall of 497 mm/a. However, only 59 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 5.3% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Overberg Region	1125	497	59	26.4	5.3%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Overberg Region
Area:	2261 km²
Elevation:	45 to 957 mamsl

Quantity & Quality

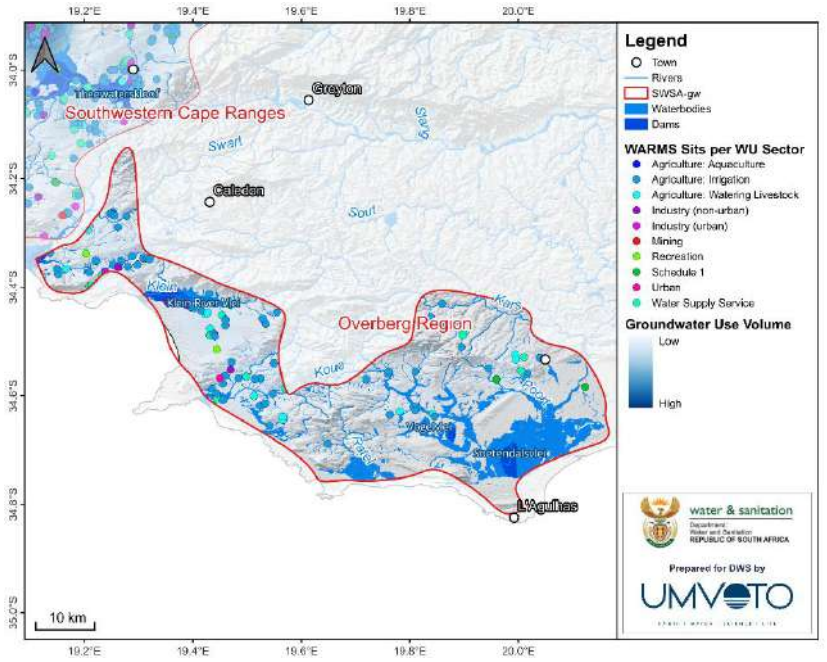
Groundwater Use

The Overberg Region SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Stanford (Groundwater) and Bredasdorp (Conjunctive), which rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 5.7 Mm^3/a to sustain crop production. There is scattered use of agricultural irrigation throughout the area, however, the western side of the map relies on it more heavily than the east. In the east, use is mostly around the Bredasdorp area, whereas in the west, use is around the Stanford area.
- Municipal water supply services, at 2.8 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. Water supply is predominantly needed in towns like Stanford, Napier and Bredasdorp, This is because, generally, more people will be living in the towns compared to the other areas, which increases demand in those areas.
- Agricultural livestock watering accounts for 0.2 Mm^3/a, which is used to provide water for livestock animals to drink and graze. A similar trend to the first two is seen with livestock watering occurring mainly in the areas around Stanford and Bredasdorp.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Stanford and Bredasdorp, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	5.7
	Agriculture: Watering Livestock	0.2
	Industry (Non-urban)	0.1
	Recreation	0.1
	Schedule 1	0.04
	Water Supply Service	2.8
	Total	**9**



Water use map for the Overberg Region SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

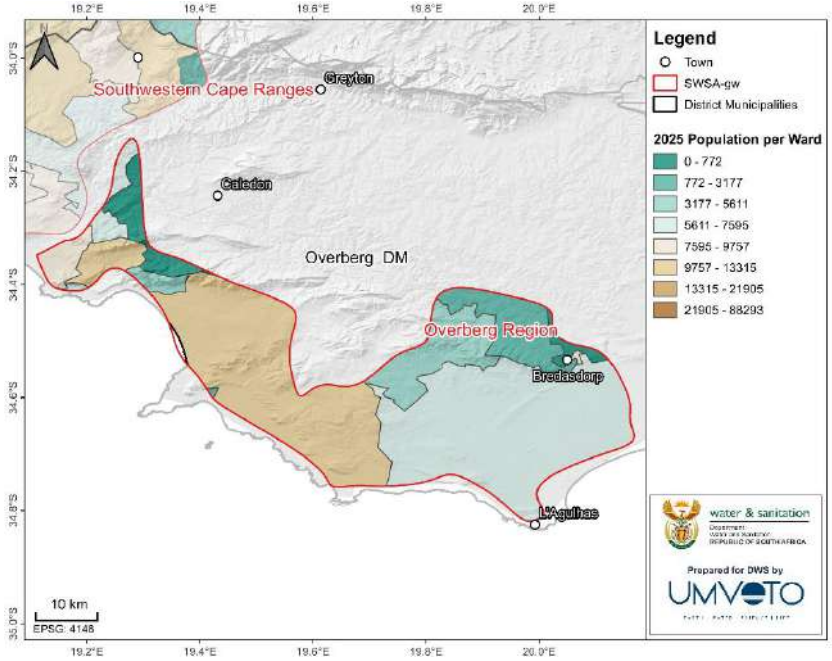
SWSA-gw Name:	Overberg Region
Area:	2261 km²
Elevation:	45 to 957 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Overberg Region is located within the Breede-Olifants Water Management Area (WMA, 2023). The groundwater resources within the Overberg Region SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Breede-Olifants Catchment Management Agency (BOCMA), which was formed as part of a national restructuring process that consolidated CMAs. BOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established BOCMA to manage water resources in the Breede-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	BOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Breede-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	The Onrus WUA is a local water management group that potentially assists the CMA with allocation decisions and water resource management among water users within the SWSA-gw. However, this WUA is currently inactive.
WSA & WSP	Local municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Overberg Region SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 1.91% per year, resulting in a projected population of approximately 56,207.

As shown in the map and table below, Overstrand Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 33,578, followed by Cape Agulhas LM with 20,026.



Projected population distribution in 2025 for the Overberg Region SWSA-gw.

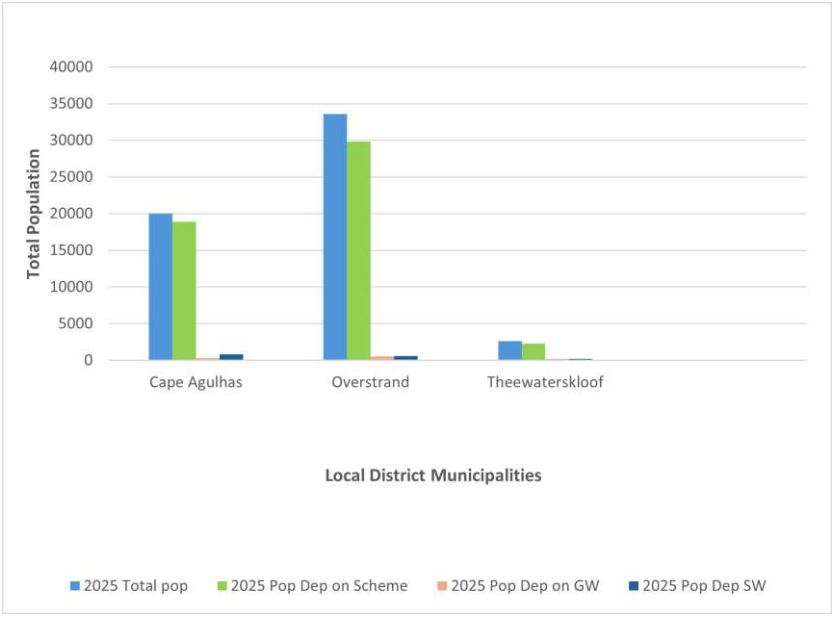
SWSA-gw Name:	Overberg Region
Area:	2261 km²
Elevation:	45 to 957 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Overberg Region SWSA-gw, an estimated 90.8% of the population depends on the regional water supply scheme, 2.9% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 1.8% on groundwater sources (including boreholes and springs).

Among the LMs, the Theewaterskloof LM has the highest proportion of groundwater reliance, with approximately 7.0% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Cape Agulhas	20,026	18,919	316	813
Overstrand	33,578	29,817	529	614
Theewaterskloof	2,603	2,285	181	183
Total	**56,207**	**51,020**	**1,027**	**1,611**



Projected population dependence on water sources in 2025.

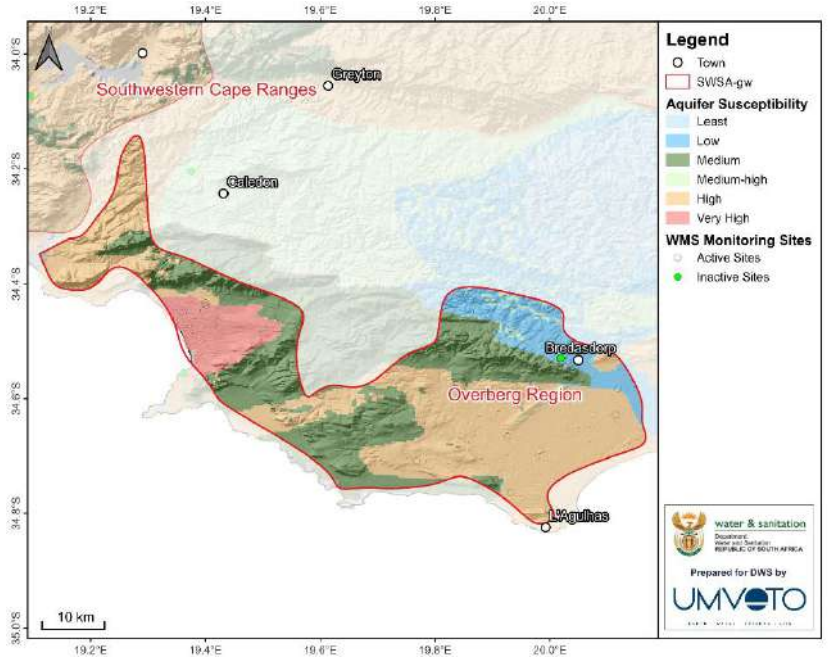
SWSA-gw Name:	Overberg Region
Area:	2261 km²
Elevation:	45 to 957 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Overberg Region SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 751.86 km^2, which is 33.25% of the Overberg Region SWSA-gw total area. Urban/Built-up areas cover 21.90 km^2 (0.97%), while mines and quarries account for 3.02 km^2 (0.13%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major aquifer consists of areas with moderate and most aquifer vulnerability. Areas of most aquifer vulnerability account for the majority of the Major Aquifer, with areas of moderate vulnerability covering the E-SE, N, Central and NW parts of the aquifer. However, WMS data is unavailable for both the moderately and highly vulnerable aquifer areas in the Major aquifer system. Data is available for the Minor Aquifer System for the areas with the least aquifer vulnerability.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 46.2 – 78 mS/m in the Minor aquifer system. Coastal aquifers typically show an EC gradient, with higher values near the coastline due to seawater intrusion or marine aerosol deposition.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.05 - 0.22 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.005 - 0.41 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 3.9 - 7.18 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 15.57 – 125 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Overberg Region**
Area:	**2261 km²**
Elevation:	**45 to 957 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Overberg Region SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	1	25.00	4	55.10	mS/m	46.2 - 78 mS/m (Avg.: 55.10 mS/m). 2014-2024 GW Geosites: <70 mS/m. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <70 - 150 mS/m.	2014-2024 GW Geosites: <70 - 150 mS/m.
Fluoride	1	50.00	2	0.11	mg/L	0.05 - 0.22 mg/L (Avg.: 0.11 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <0.5 mg/L.	2014-2024 GW Geosites: <0.5 mg/L.
Nitrate + Nitrite Nitrogen	1	50.00	2	0.07	mg/L	0.005 - 0.41 mg/L (Avg.: 0.074 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	2014-2024 GW Geosites: <11 mg/L.	2014-2024 GW Geosites: <11 mg/L.
pH	1	25.00	4	5.99	pH unit	3.9 - 7.18 (Avg.: 5.99). 2014-2024 GW Geosites: 5.7 - 7. Mostly consistent with WMS (2000-2024).	2014-2024 GW Geosites: 5.7 - 9.	2014-2024 GW Geosites: 5.7 - 9.
Sulphate	1	50.00	2	26.58	mg/L	15.57 - 125 mg/L (Avg.: 26.58 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	2014-2024 GW Geosites: <200 mg/L.	2014-2024 GW Geosites: <200 mg/L.

- *"Average" refers to the average concentrations for the Total Active Sites of the Overberg Region SWSA-gw, taken from the WMS database from 2000-2024.*

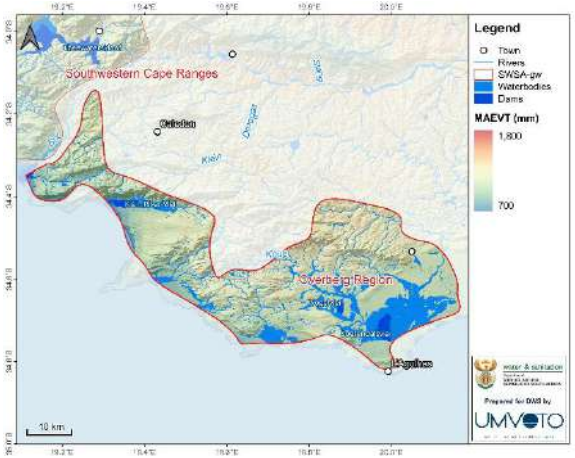
SWSA-gw Name:	**Overberg Region**
Area:	**2261 km²**
Elevation:	**45 to 957 mamsl**

Threats & Risks

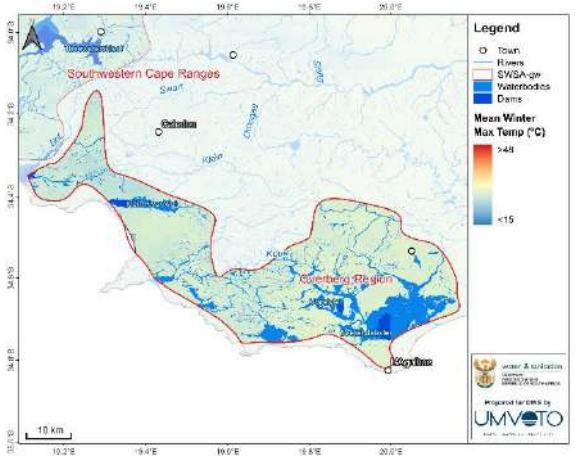
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Coega TMG Aquifer & Tsitsikamma SWSA-gw has a combination of Csb and Bsk, mediterranean and semi-arid type climates characterized by mild to hot summers and mild to cool winters in the northwestern section of the area and cold winters, large temperature swings, as well as hot, dry summers towards the southeastern section of the area. Temperatures in the SWSA-gw range from 4.1 – 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

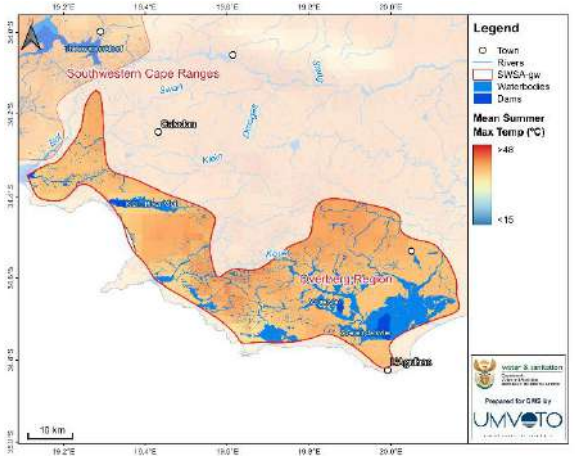
Temperature	Summer: 24.6 to 26.9 °C, Winter: 4.1 to 8 ºC
Evapotranspiration	Maximum value of 1341 mm/a with an average value of 1113 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns and a decline in recharge (ranging from ~ 0.9 to 7.8 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Overberg Region SWSA-gw region.



Mean winter temperatures of the Overberg Region SWSA-gw region.



Mean summer temperatures of the Overberg Region SWSA-gw region.

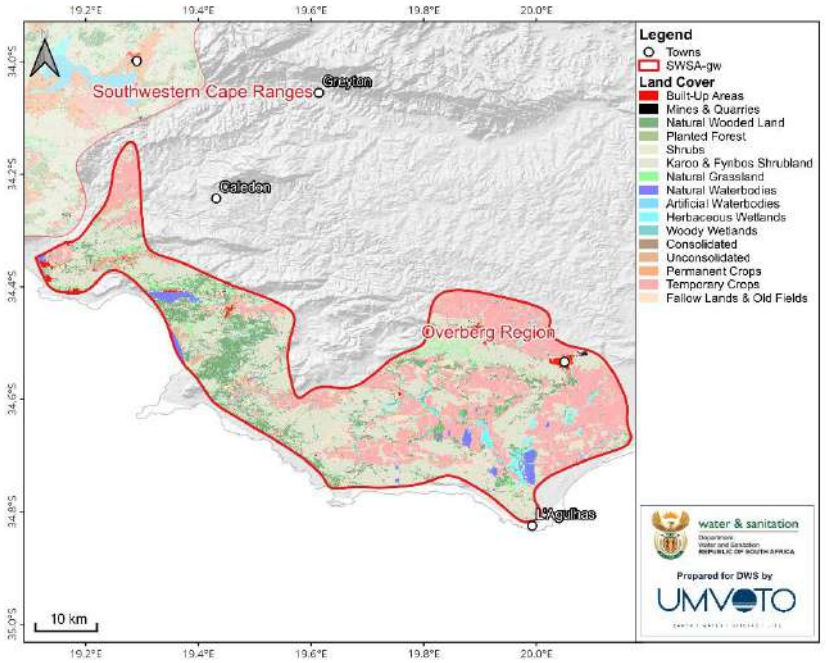
SWSA-gw Name:	Overberg Region
Area:	2261 km^2
Elevation:	45 to 957 mamsl

Threats & Risks

Land Use

Shrublands, specifically Karoo & Fynbos Shrubland, is the predominant land cover (DFFE, 2022) in the Overberg Region SWSA-gw, occupying 45.3% of the area, which highlights the region's natural vegetation and ecological significance. Cultivated land, which includes permanent and temporary crops and fallow lands and old fields, makes up a substantial portion of the landscape, indicating a strong agricultural presence. Forested land which contains natural wooded vegetation contributes about 13.3%. Wetlands and grasslands cover 2.3% and 2.1%, respectively, playing a crucial role in biodiversity and water retention. Built-up areas, which include residential, commercial and industrial areas, are minimal, suggesting limited urban development within the region. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.1% of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	15	0.7
Built-Up	22	1.0
Cultivated	752	33.3
Forest Land	301	13.3
Grassland	47	2.1
Mines and quarries	3	0.1
Shrubland	1025	45.3
Waterbodies	43	1.9
Wetlands	53	2.3



Land Cover 24-class map to show the types of land use and extent of each occurring in the Overberg Region SWSA-gw.

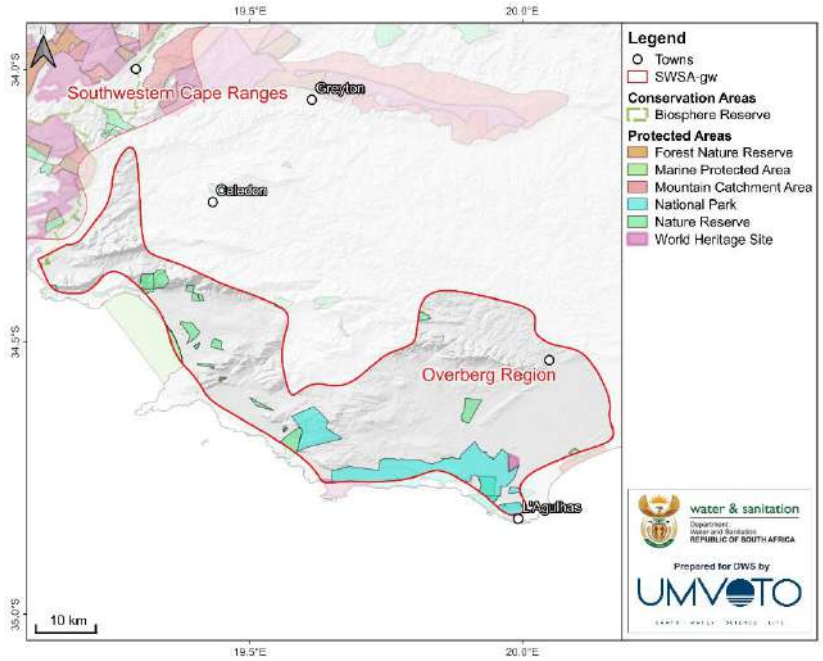
SWSA-gw Name:	Overberg Region
Area:	2261 km²
Elevation:	45 to 957 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Overberg Region SWSA-gw features the Kogelberg Biosphere Reserve, covering a small area of 2.24 km² (DFFE, 2024), highlighting its role in conservation. Protected areas, including the Cape Floral Region Protected Areas and various nature reserves, span 81.07 km² across 21 sites (DFFE, 2024), contributing to biodiversity preservation. Agulhas National Park, the largest protected area in the region at 179.06 km², plays a crucial role in safeguarding ecosystems.

Protection Status	Names	Area (km²)	Count
Conservation Areas	• Kogelberg Biosphere Reserve	2.24	1
Protected Areas	• Cape Floral Region Protected Areas • Platbos Forest Nature Reserve • Walker Bay Whale Sanctuary Marine Protected Area • Bosbokstrand Private Nature Reserve • Rhenosterkop Private Nature Reserve • Groot Hagelkraal Private Nature Reserve • Maanschynkop Nature Reserve • Vogelgat Private Nature Reserve • Kleinrivier Private Nature Reserve • And various other small nature reserves	81.07	21
SGWCA	None		0
National Parks	• Agulhas National Park	179.06	1

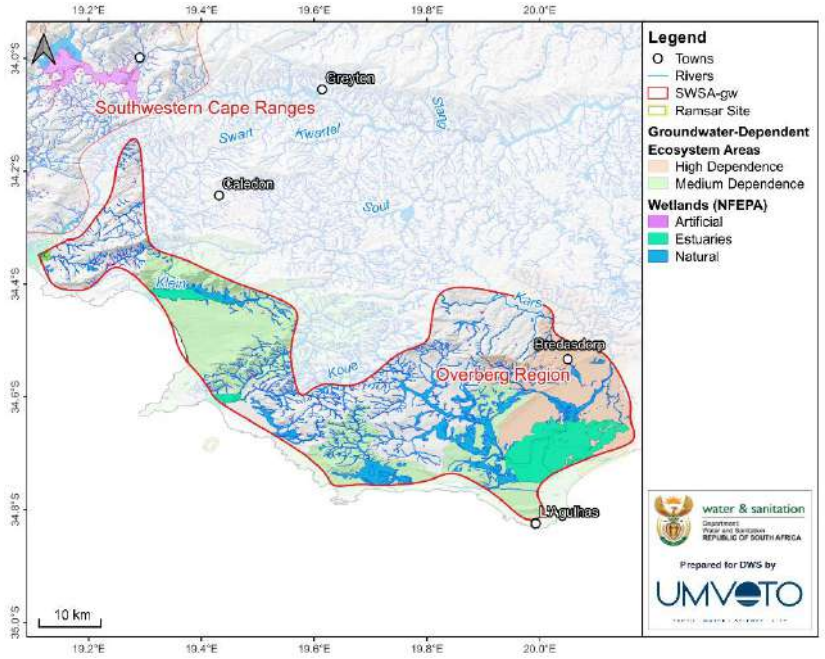


Biospheres, Protected Areas and SGWCAs to show the portions of the Overberg Region SWSA-gw that have protection status.

SWSA-gw Name:	Overberg Region
Area:	2261 km²
Elevation:	45 to 957 mamsl
Quantity & Quality	
Biodiversity and Conservation	

The region contains five major waterbodies, including the Klein River Vlei Dam (DWS, 2011) and Heuningnes Estuary (CSIR, 2011), covering a total area of 180.92 km², which play a vital role in local hydrology and biodiversity. A small portion of the Bot-Kleinmond Estuarine System, designated as a Ramsar site at 1.89 km² (DFFE, 2024), is within the SWSA-gw and highlights the area's international importance for wetland conservation. A significant portion of the SWSA-gw is also covered by wetlands (CSIR, 2018) with vegetation that is dependent on groundwater (55.3%)(DWA, 2010), indicating reliance on groundwater resources for ecological sustainability.

Protection Status	Names	Area (km²)	Count
Major Waterbodies	• Klein River Vlei Dam • Vogelvlei Dam • Soetendalsvlei Dam • Klein Estuary • Heuningnes Estuary	180.92	5
Ramsar Sites	• Bot-Kleinmond Estuarine System	1.89	1
Wetlands	Various natural, artificial and estuary wetlands	414	

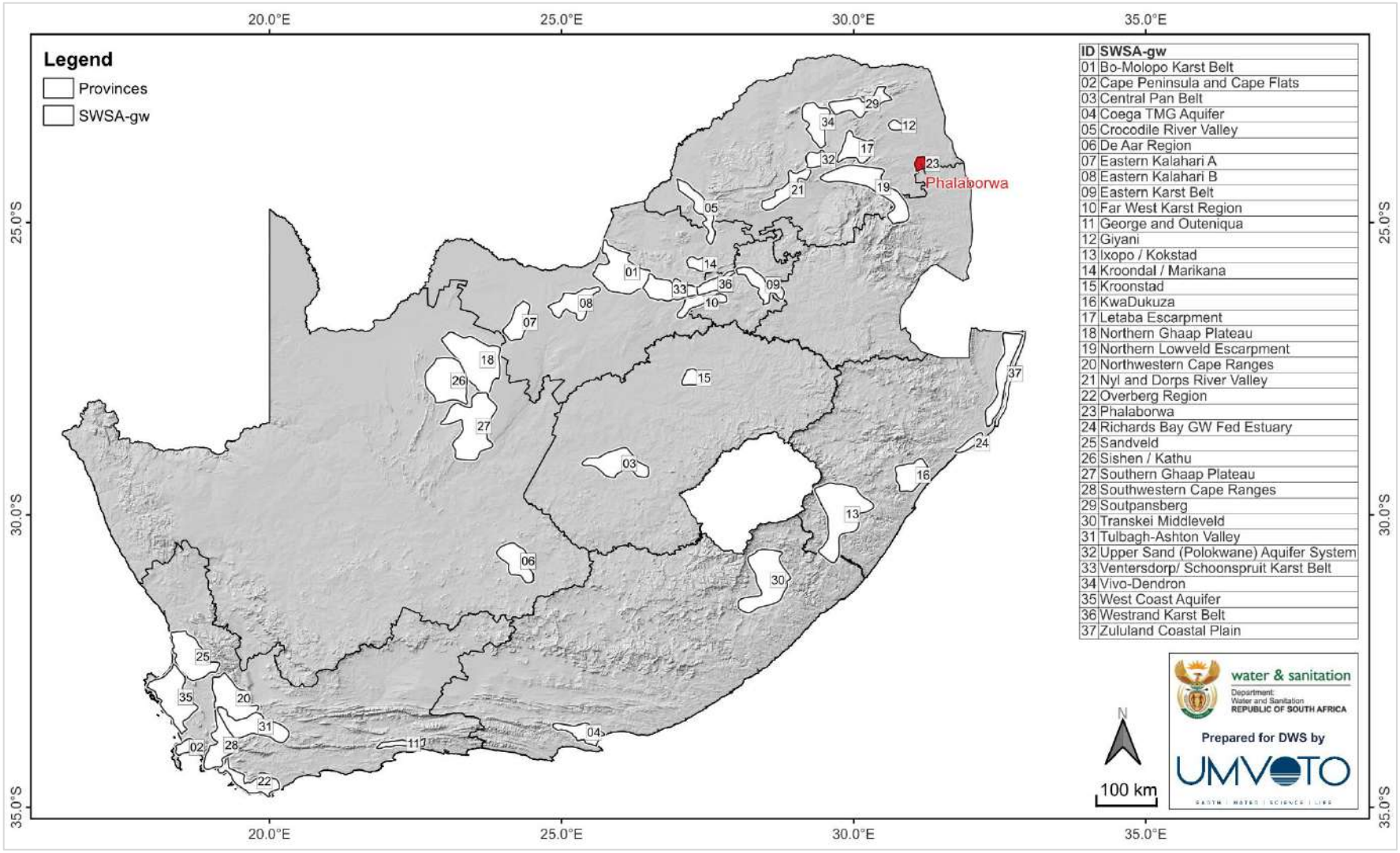


Map showing the major water bodies, Ramsar sites and GDEs in the Overberg Region SWSA-gw.

APPENDIX 23

PHALABORWA SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE PHALABORWA SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

23. Phalaborwa

23.1. Description

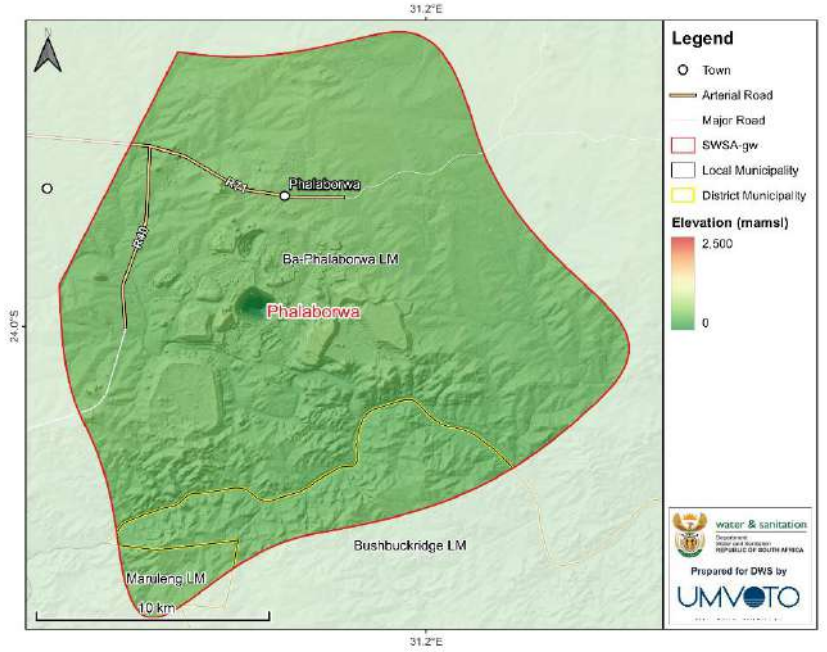
SWSA-gw Name:	Phalaborwa
Area:	433 km^2
Elevation:	179 to 519 mamsl

Geospatial Context

The topography of the Phalaborwa SWSA-gw, as depicted in the map, is characterized by a relatively flat to gently undulating landscape. The terrain features broad plains with occasional low hills and rocky outcrops, particularly near old geological formations associated with the Phalaborwa Igneous Complex. The presence of the Olifants River contributes to shallow valleys and seasonal drainage lines, shaping the local landscape. The region's topography has also been influenced by mining activity, particularly copper and phosphate extraction, which has altered parts of the natural terrain.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Limpopo and Mpumalanga
District Municipality	Mopani and Ehlanzeni
Local Municipality	Ba-Phalaborwa, Maruleng and Bushbuckridge
Towns	Phalaborwa and Lulekani
Major Roads	R71, R40 and R71
Major Water Supply Networks	Palabora reservoir and Phalaborwa Barrage



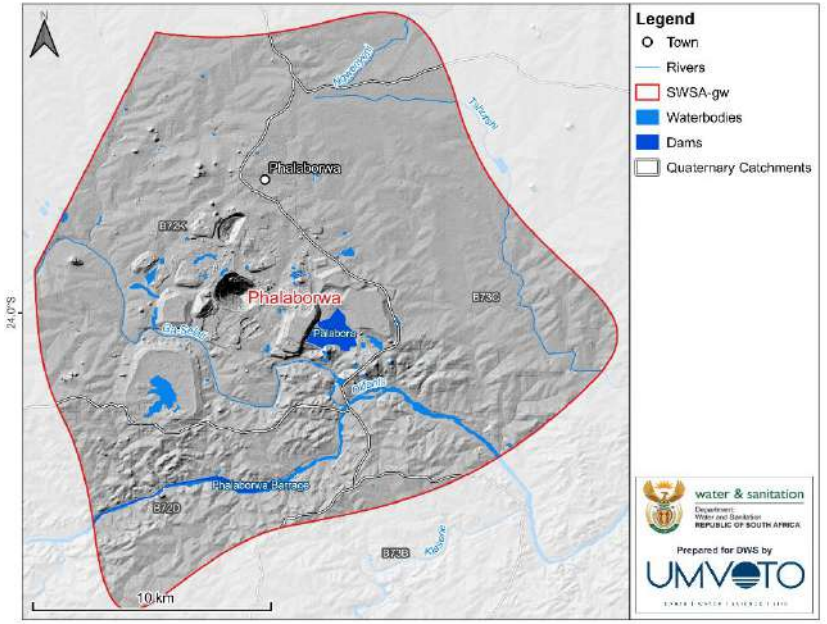
Locality map of Major Towns, District and Local Municipalities in the Phalaborwa SWSA-gw.

SWSA-gw Name:	Phalaborwa
Area:	433 km²
Elevation:	179 to 519 mamsl

Hydrology and Drainage

The Phalaborwa SWSA-gw and surrounding areas include a few major surface water systems summarised below and displayed in the map on the right. The two perennial rivers, the Ga-Selati and Olifants rivers, are fed by the B7 catchment and are flowing in a easterly direction.

Quaternary Catchments	B72D, B72K, B73B, B73C and B83A
Rivers	Perennial: Ga-Selati, Olifants
	Ephemeral: Ngwenyeni, Tshutshi
Natural and manmade water bodies	
Major Dams:	Palabora and Phalaborwa Barrage
Water Management Areas:	Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Phalaborwa SWSA-gw.

SWSA-gw Name:	Phalaborwa
Area:	433 km²
Elevation:	179 to 519 mamsl
Geology	

Geology

The southern half of the Phalaborwa area is dominated by the Gravelotte Group, comprising diverse volcanic and sedimentary rocks, including mafic lavas, chlorite schists, quartzites, conglomerates, "grits," porphyritic tuffs, banded iron formation (BIF), and ultramafic lavas.

A Karoo dolerite dyke intrudes the southern section of the area, while a diabase dyke outcrops in the northern section.

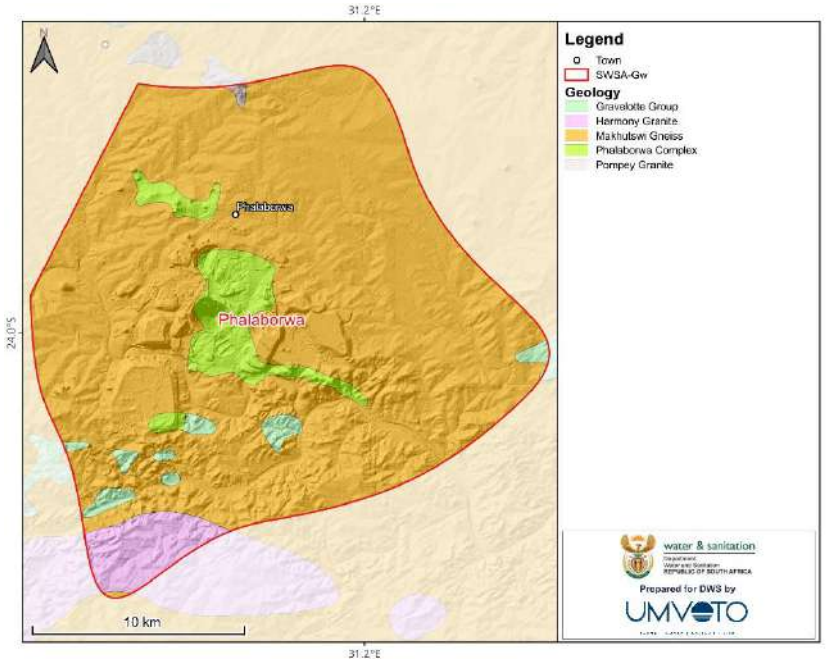
Beneath the Gravelotte Group, the Makhutswi Gneiss extends across most of the area. This homogeneous, light grey granodioritic/tonalitic biotite gneiss reflects high-grade metamorphism.

The Harmony Granite, located in the southern section, is a light grey, coarse-grained, and occasionally porphyritic tonalitic biotite-muscovite granite.

Centrally located, the Phalaborwa Complex features specialised high-temperature rock types, including syenite, phlogopite pyroxenite, feldspathic pyroxenite, and fenite, indicative of unique magmatic processes.

Hydrostratigraphy

The Quaternary alluvial deposits form a primary intergranular aquifer. The Gravelotte Group, Makhutswi Gneiss, and Harmony Granite host secondary, fractured and weathered aquifers, with groundwater occurring in structurally controlled zones. The Phalaborwa Complex contributes to localized, fractured aquifers with unique hydrothermal influences. Dolerite and diabase dykes create secondary, fractured aquifers.



Geology Map of the Phalaborwa SWSA-gw region.

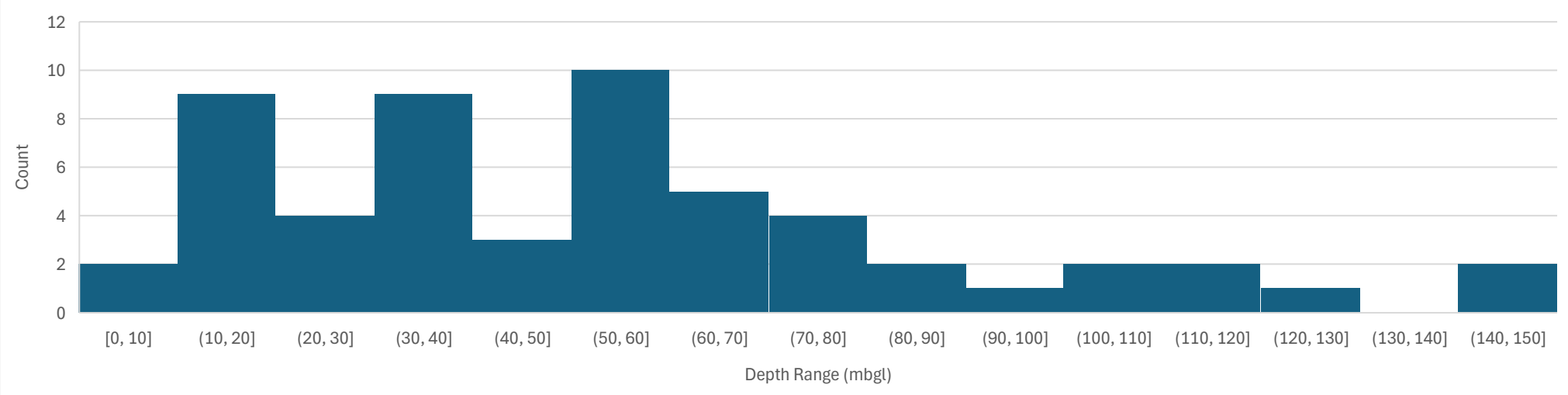
23.2. Current Status

SWSA-gw Name:	**Phalaborwa**
Area:	**433 km²**
Elevation:	**179 to 519 mamsl**
Quantity & Quality	
Aquifer Classification	

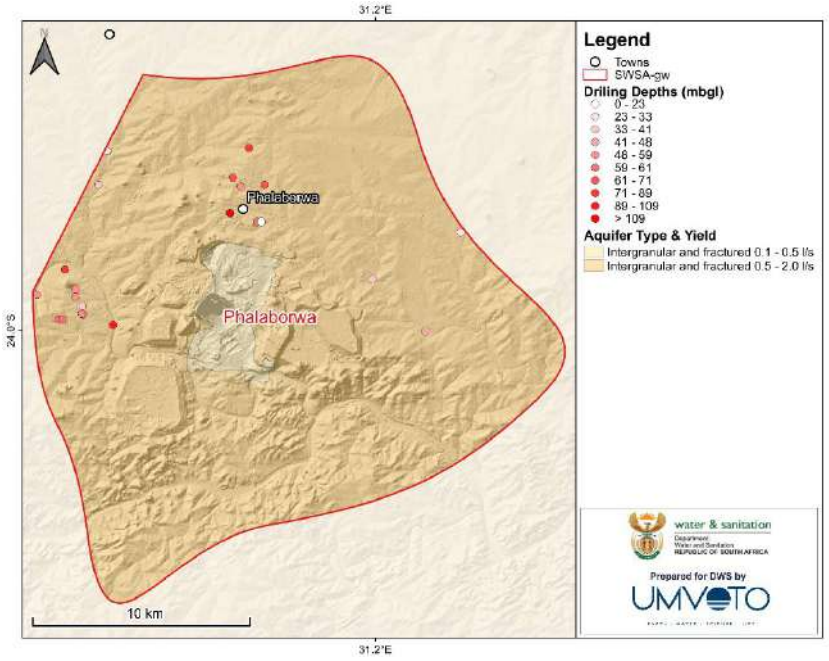
The aquifer systems within the Phalaborwa SWSA-gw exhibit varying yields across fractured aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is a minor aquifer system with an average dual-porosity yield ranging from 0.1 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 54 mbgl and the most common depths are around 20, 60 and 40 mbgl, respectively, suggesting mixed targets in the dual-porosity aquifers systems. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 28 and 68 mbgl. No NGA water level data available for the last 25 years.

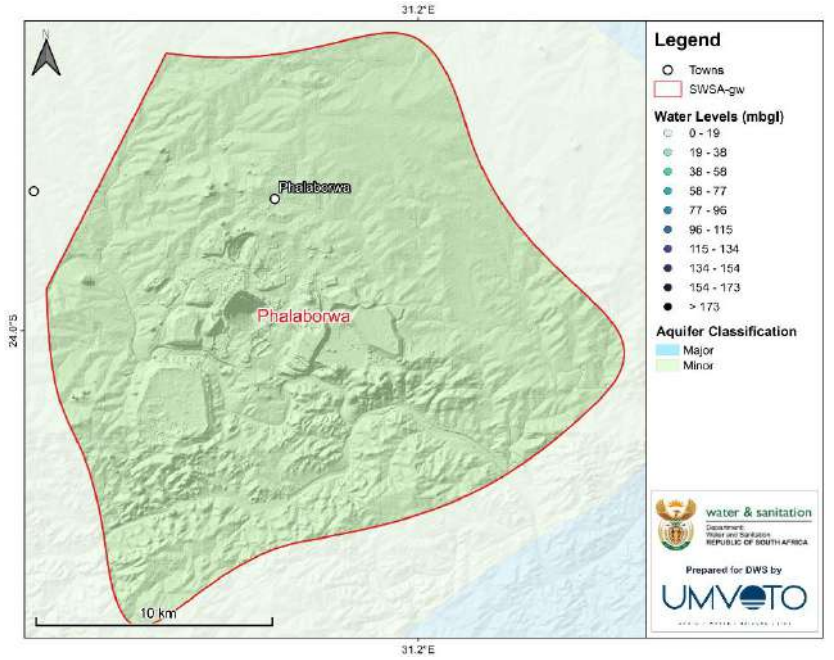
Graph of NGA drilling depths (after DWS, n.d.) of the Phalaborwa SWSA-gw region



SWSA-gw Name:	Phalaborwa
Area:	433 km²
Elevation:	179 to 519 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Phalaborwa SWSA-gw region.



Map of the Aquifer Classification of the Phalaborwa SWSA-gw region.

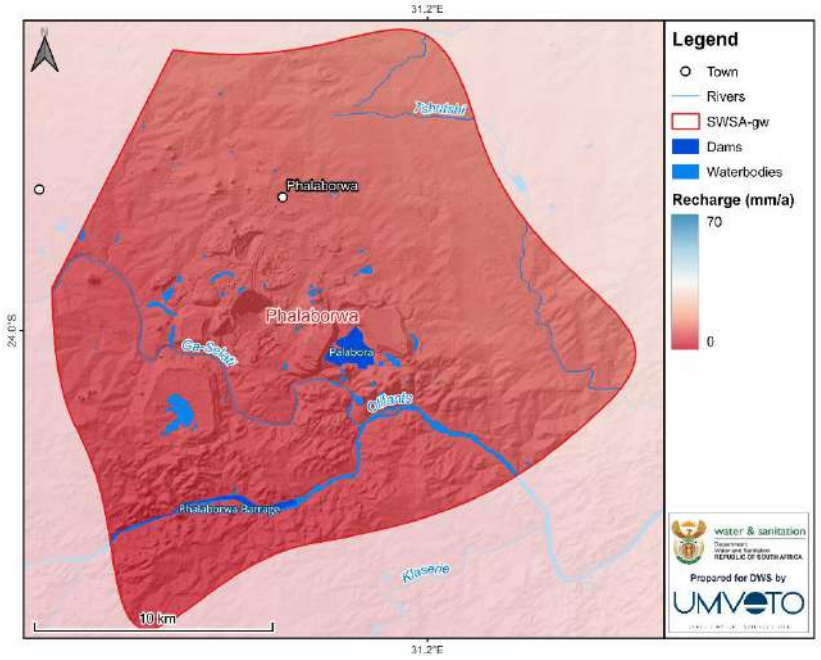
SWSA-gw Name:	**Phalaborwa**
Area:	**433 km²**
Elevation:	**179 to 519 mamsl**

Quantity & Quality

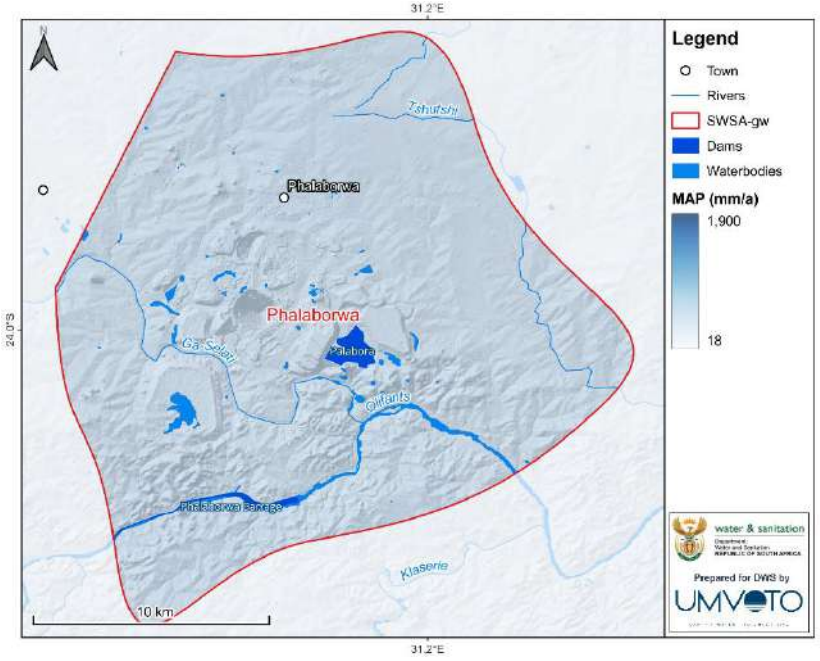
Groundwater Recharge

The Phalaborwa receives a total MAP volume of 198 Mm^3/a, with an average rainfall of 458 mm/a. However, only 3.4 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in an extremely low recharge of 1.7% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Phalaborwa	198	458	3.4	8	1.7%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Phalaborwa
Area:	433 km²
Elevation:	179 to 519 mamsl

Quantity & Quality

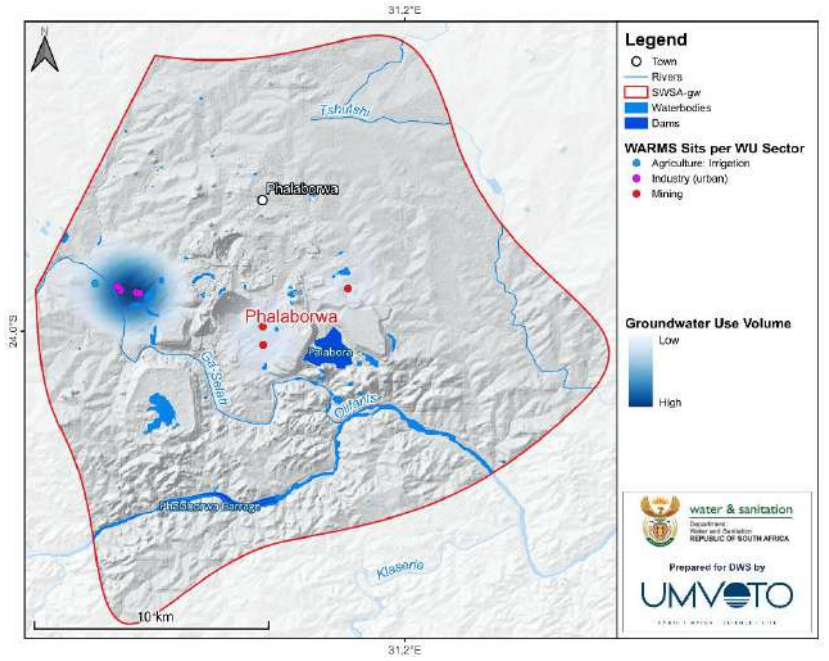
Groundwater Use

The Phalaborwa SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is BaPhalaborwa (Conjunctive), who rely significantly on groundwater resources for mining, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Mining use is the largest, with 3.1 Mm³/a allocated. Water is a vital resource in the mining process. Despite Phalaborwa being a relatively small region, a significant proportion of groundwater use is mining, and this is primarily in the centre of the region, south of Phalaborwa.
- Urban industrial, using 0.1 Mm³/a for manufacturing, processing, and other industrial activities in urban centres. This sector is clustered in the west of the region.
- Agricultural irrigation follows closely, with 0.1 Mm³/a to sustain crop production. The irrigation is also in the western region of the area, west of the urban industry.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Phalaborwa, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm³/a)
Active Groundwater Use Licences	Agriculture: Irrigation	0.1
	Industry (Urban)	0.1
	Mining	3.1
	Total	**3.2**



Water use map for the Phalaborwa SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

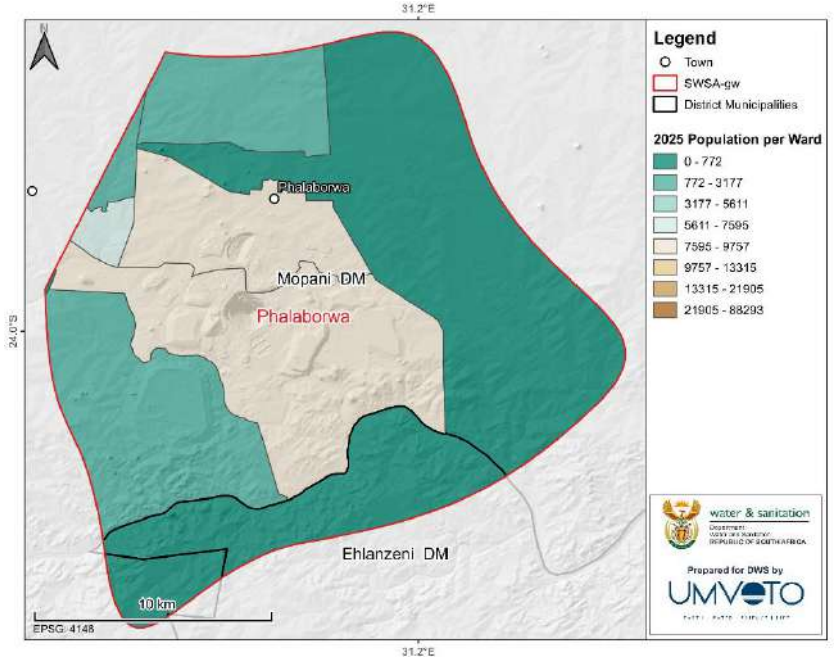
SWSA-gw Name:	Phalaborwa
Area:	433 km²
Elevation:	179 to 519 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Phalaborwa SWSA-gw is located within the Limpopo-Olifants Water Management Areas (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. LOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	LOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Limpopo-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The Mopani district municipality is the Water Service Authority (WSA) and Water Service Provider (WSP) in Limpopo, while Bushbuckridge LM is the WQSA and WSP for their respective jurisdictions.

The estimated 2025 population within the Phalaborwa SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 2.05% per year, resulting in a projected population of approximately 26,243.

As shown in the map and table below, Ba-Phalaborwa Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 25,977. Population concentrations within the SWSA-gw are highest around the Ba-Phalaborwa LM and the town of Phalaborwa.



Projected population distribution in 2025 for the Phalaborwa SWSA-gw.

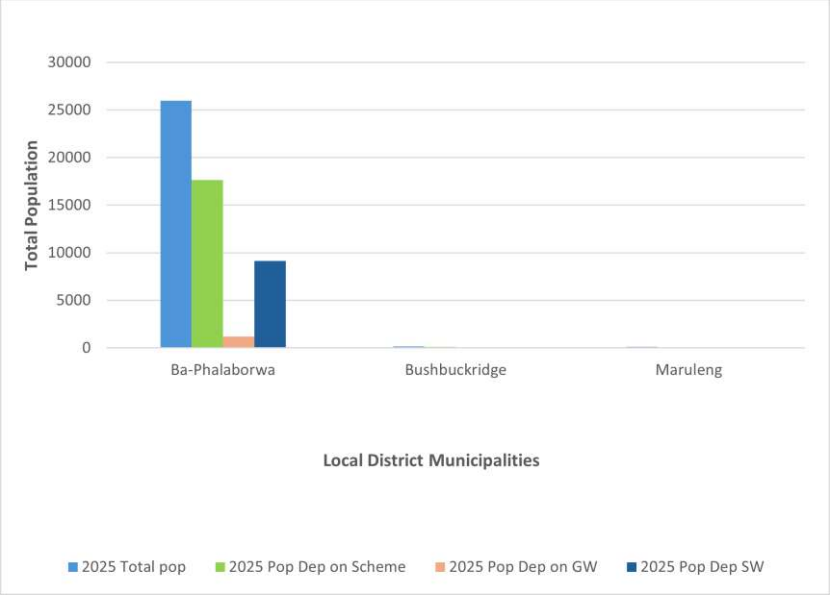
SWSA-gw Name:	Phalaborwa
Area:	433 km²
Elevation:	179 to 519 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Phalaborwa SWSA-gw, an estimated 67.7% of the population depends on the regional water supply scheme, 35.0% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 5.0% on groundwater sources (including boreholes and springs).

Among the LMs, the Maruleng LM has the highest proportion of groundwater reliance, with approximately 43.1% of its population depending on groundwater and 24.9% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Ba-Phalaborwa	25,977	17,655	1,215	9,157
Bushbuckridge	165	113	54	14
Maruleng	101	11	44	25
Total	**26,243**	**17,779**	**1,313**	**9,196**



Projected population dependence on water sources in 2025.

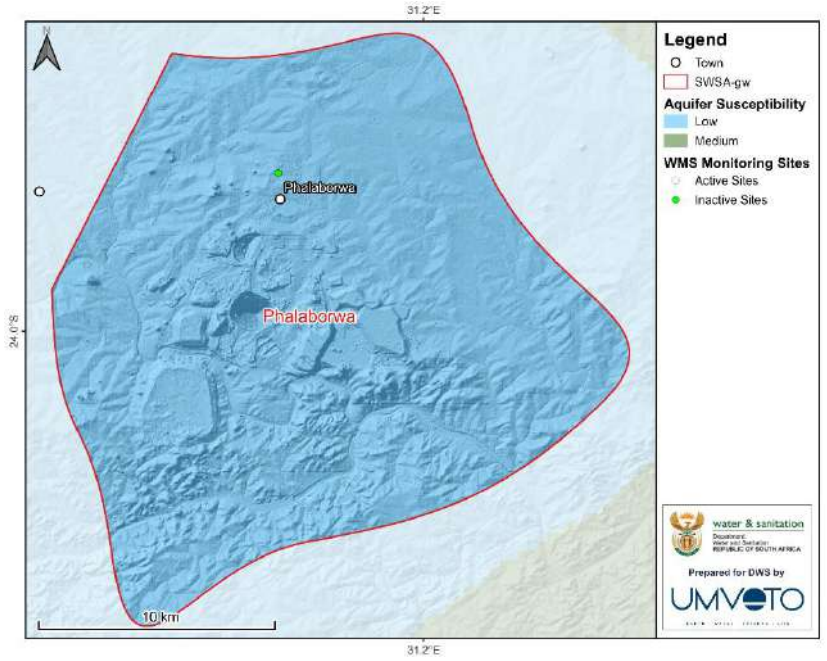
SWSA-gw Name:	Phalaborwa
Area:	433 km^2
Elevation:	179 to 519 mamsl
Quantity & Quality	
Groundwater Quality	

The Phalaborwa SWSA-gw consists of the Minor aquifer system, classified based on their yield and water quality. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), mines and quarries cover a total of 32.73 km^2, which is 7.56% of the Phalaborwa SWSA-gw total area. Urban/Built-up areas cover 14.98 km^2 (3.46%), while cultivated areas account for 5.85 km^2 (1.35%) of the total area. These land uses contribute to diffuse contamination sources, with mining being the primary concern. Mining has significant impacts on water quality through unmanaged point discharges (e.g. from tailings dams) and groundwater impacts, particularly the generation of acid mine drainage (AMD). The acidity in the AMD increases the solubility of aluminium and heavy metals, and this polluted water may decant to, or is discharged into, surface waters where it can have significant impacts on human and aquatic ecosystem health (Le Maitre et al., 2018). Several water quality indicators help assess aquifer vulnerability and contamination risks:

PS. The actively monitored site (Monitoring Point ID: 89694) in the WMS database was last sampled on 11/05/1999. Hence, no latest data is available.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 2.7 - 260 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.79 - 0.93 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 1.25 - 2.06 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.8 to 8.78 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 101.2 – 118 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	Phalaborwa
Area:	433 km²
Elevation:	179 to 519 mamsl
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Phalaborwa SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	1	5.88	17	212.96	mS/m	1981-2005 WMS data: 2.7 - 260 mS/m (Avg.: 212.96 mS/m). 2014-2024 GW Geosites: N/A	-	-
Fluoride	1	5.88	17	0.85	mg/L	1981-2005 WMS data: 0.79 - 0.93 mg/L (Avg.: 0.85 mg/L). 2014-2024 GW Geosites: N/A.	-	-
Nitrate + Nitrite Nitrogen	1	8.33	12	1.56	mg/L	1981-2005 WMS data: 1.25 - 2.06 mg/L (Avg.: 1.56 mg/L). 2014-2024 GW Geosites: N/A.	-	-
pH	1	5.88	17	7.55	pH unit	1981-2005 WMS data: 6.8 - 8.78 (Avg.: 7.55). 2014-2024 GW Geosites: N/A.	-	-
Sulphate	1	5.88	17	107.91	mg/L	1981-2005 WMS data: 101.2 - 118 mg/L (Avg.: 107.91 mg/L). 2014-2024 GW Geosites: N/A.	-	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Phalaborwa SWSA-gw, taken from the WMS database from 1981-2005.*
- *"-" refers to no available data from the WMS database from 1981-2024 and the 2014-2024 GW Geosites.*

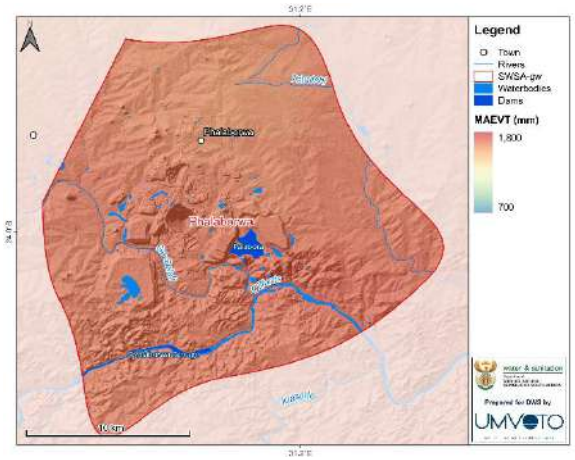
SWSA-gw Name:	Phalaborwa
Area:	433 km²
Elevation:	179 to 519 mamsl

Threats & Risks

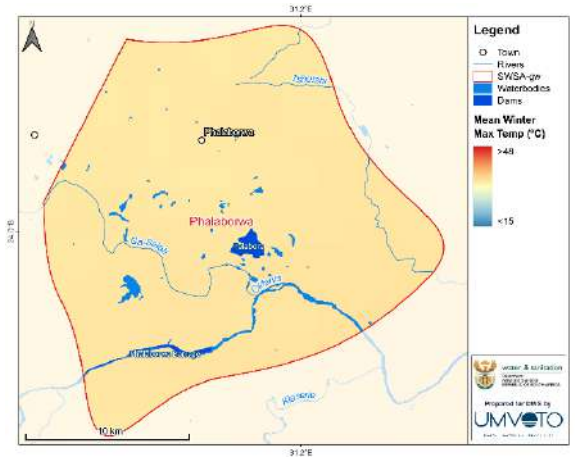
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Phalaborwa SWSA-gw has a BSh, hot semi-arid, type climate, characterized by hot summers, warm to cool winters, and little to no precipitation. Temperatures in the SWSA-gw range from 6.1 – > 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

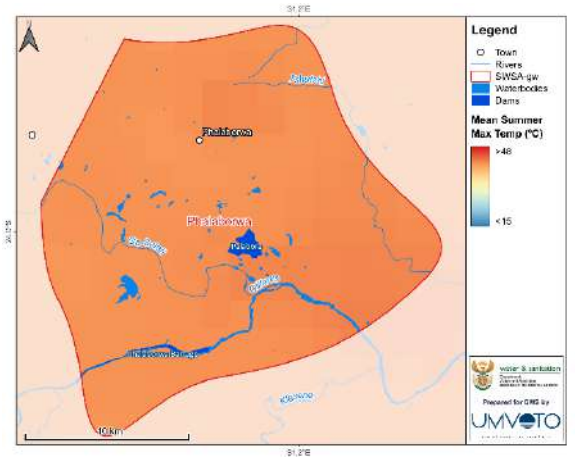
Temperature	Summer: 29.3 to >31 ºC, Winter: 6.1 to >8 ºC
Evapotranspiration	Maximum value of 1692 mm/a with an average value of 1649 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, but a small increase in recharge (ranging from ~ 6.2 to 13.1 mm/a). The DART Index indicates mostly stable conditions.



Mean annual A-Pan evaporation of the Phalaborwa SWSA-gw region.



Mean winter temperatures of the Phalaborwa SWSA-gw region.



Mean summer temperatures of the Phalaborwa SWSA-gw region.

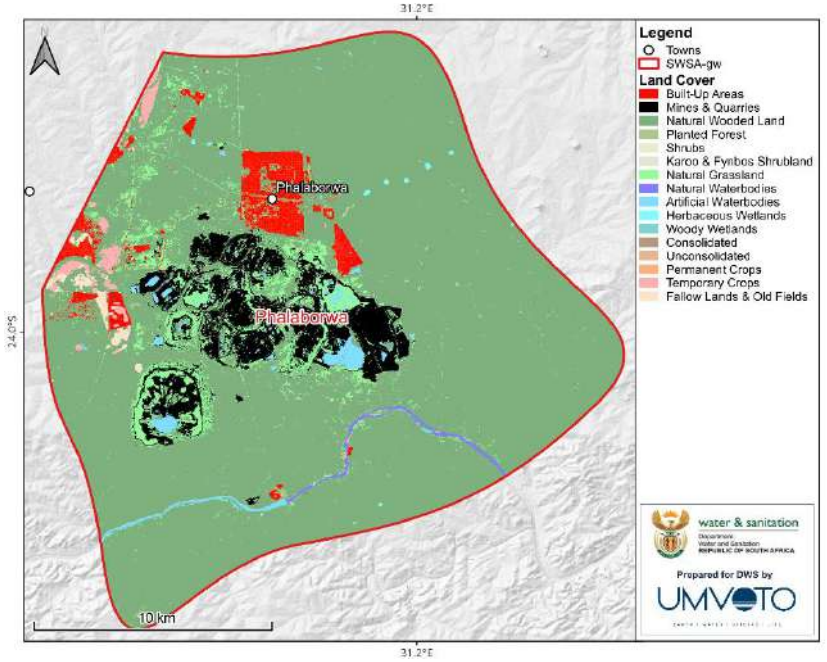
SWSA-gw Name:	Phalaborwa
Area:	433 km²
Elevation:	179 to 519 mamsl

Threats & Risks

Land Use

Forest land, which is made up of natural wooded land and planted forest, dominates the Phalaborwa SWSA-gw, covering 79.4% of the total area (DFFE, 2022), indicating a landscape largely characterized by dense vegetation. Grassland provides additional ecological value, though it is significantly less extensive. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, highlight human-induced land modifications linked to industrial or mining activities. These are situated just outside of the town of Phalaborwa. Built-up areas, consisting of residential, commercial and industrial areas, are concentrated in the town of Phalaborwa (as displayed on the map) and are limited, suggesting minimal urban development within the SWSA-gw. Water-related land uses, including waterbodies, natural and artificial, and wetlands, account for a small but essential portion of the landscape, contributing to local biodiversity and hydrology.

Land Use Type	Area (km²)	Area (%)
Barren Land	1	0.2
Built-Up	15	3.5
Cultivated	6	1.4
Forest Land	344	79.4
Grassland	27	6.3
Mines and quarries	33	7.6
Waterbodies	7	1.6
Wetlands	0	0.1



Land Cover 24-class map to show the types of land use and extent of each occurring in the Phalaborwa SWSA-gw.

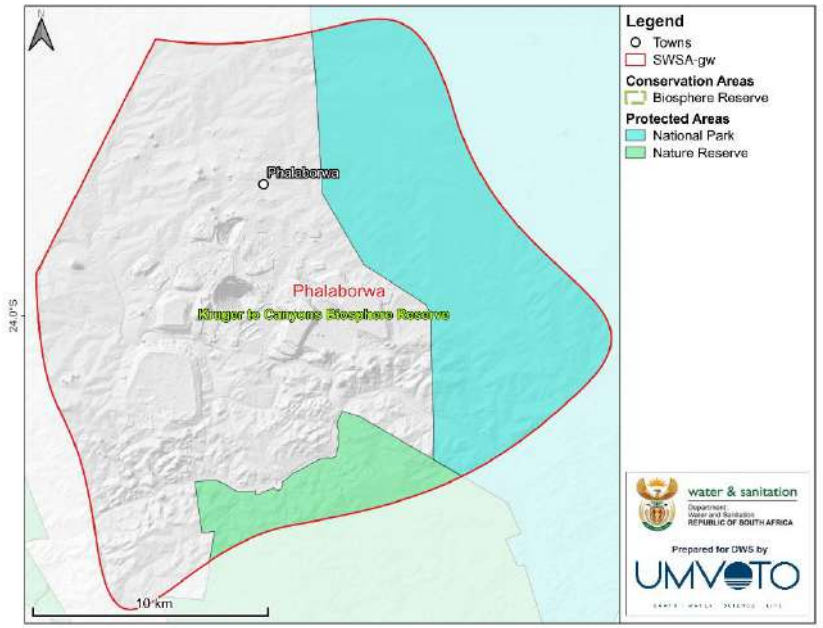
SWSA-gw Name:	Phalaborwa
Area:	433 km²
Elevation:	179 to 519 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The entire Phalaborwa SWSA-gw falls within the Kruger to Canyons Biosphere Reserve (DFFE, 2024). This is a large biosphere reserve covering roughly two-thirds of the Kruger National Park, borders Mozambique and then extends to the west to the town of Lebowakgomo. A small portion of the Kruger National Park (DFFE, 2024) falls within the Phalaborwa SWSA-gw.

Protection Status	Names	Area (km²)	Count
Conservation Areas	• Kruger to Canyons Biosphere Reserve	432.89	1
Protected Areas	• Klaserie Private Nature Reserve	29.15	1
SGWCA	None		0
National Parks	• Kruger National Park	129.75	1



Biospheres, Protected Areas and SGWCAs to show the portions of Phalaborwa SWSA-gw that have protection status.

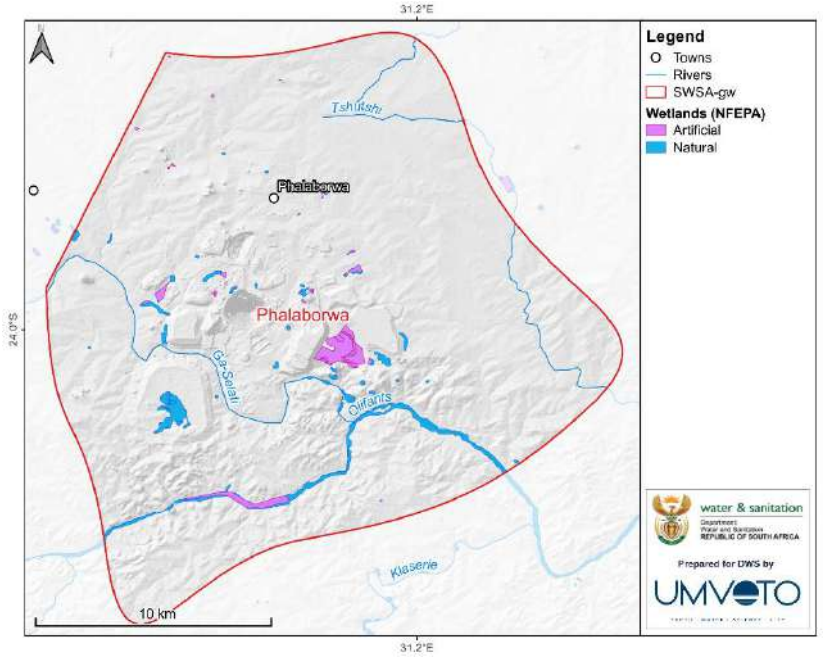
SWSA-gw Name:	Phalaborwa
Area:	433 km^2
Elevation:	179 to 519 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

There are two notable water bodies in the Phalaborwa SWSA-gw, one of which is a dam (DWS, 2011) on the Olifants River towards the southwestern end of the SWSA-gw, and the other in the centre of the SWSA-gw, as displayed in the map. The Palabora Dam is surrounded by mining activities, as displayed in the land cover map above.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Palabora Dam • Phalaborwa Barrage	3.30	1
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	10	

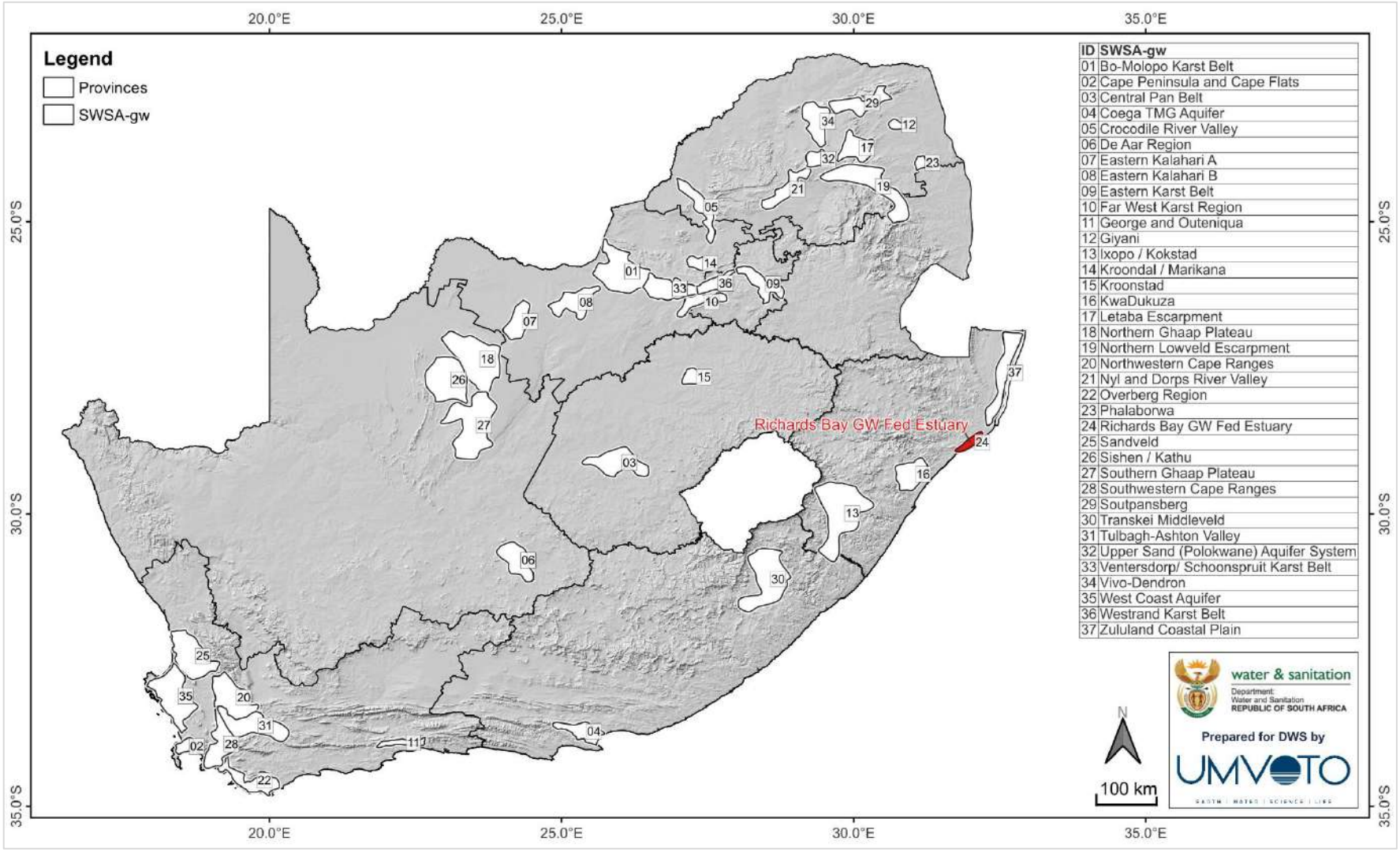


Map showing the major water bodies, Ramsar sites and GDEs in the Phalaborwa SWSA-gw.

APPENDIX 24

RICHARDS BAY GW FED ESTUARY SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE RICHARDS BAY GW FED ESTUARY SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

24. Richards Bay GW Fed Estuary

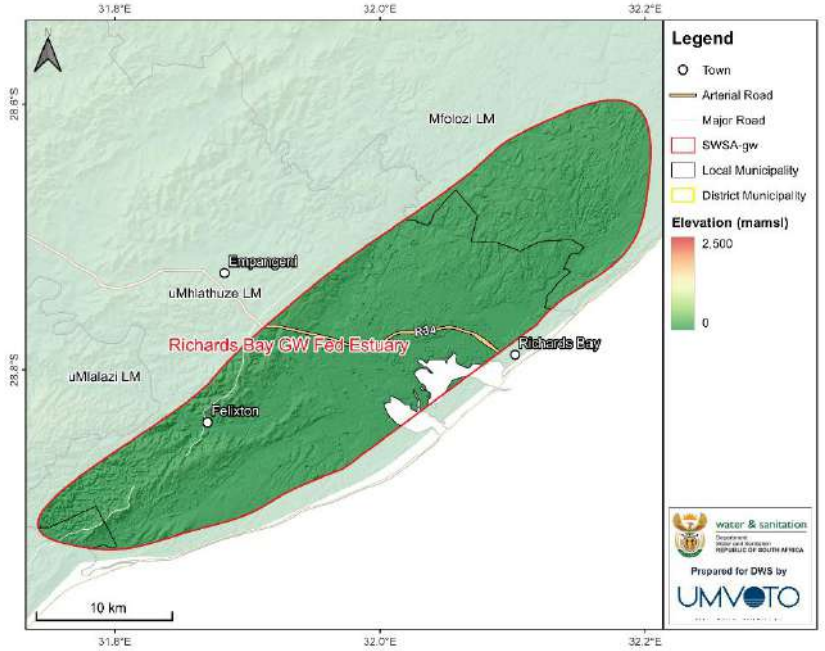
24.1. Description

SWSA-gw Name:	**Richards Bay GW Fed Estuary**
Area:	**606 km²**
Elevation:	**29 to 129 mamsl**
Geospatial Context	

The topography of the Richards Bay GW Fed Estuary SWSA-gw, as depicted in the map, features a relatively lower relief compared to more mountainous inland areas, transitioning from coastal plains to slightly undulating terrain. The eastern section, near Richards Bay, consists of flat coastal lowlands, likely with sandy soils and wetlands, given the proximity to the Indian Ocean. Moving inland toward Empangeni, the topography becomes more varied and rolling hills.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	KwaZulu-Natal Province
District Municipality	Uthungulu
Local Municipalities	uMalazi, uMhlathuze, and Mfolozi.
Towns	Empangeni and Richards Bay
Major Roads	N2 and R34
Major Water Supply Networks	Uthungulu



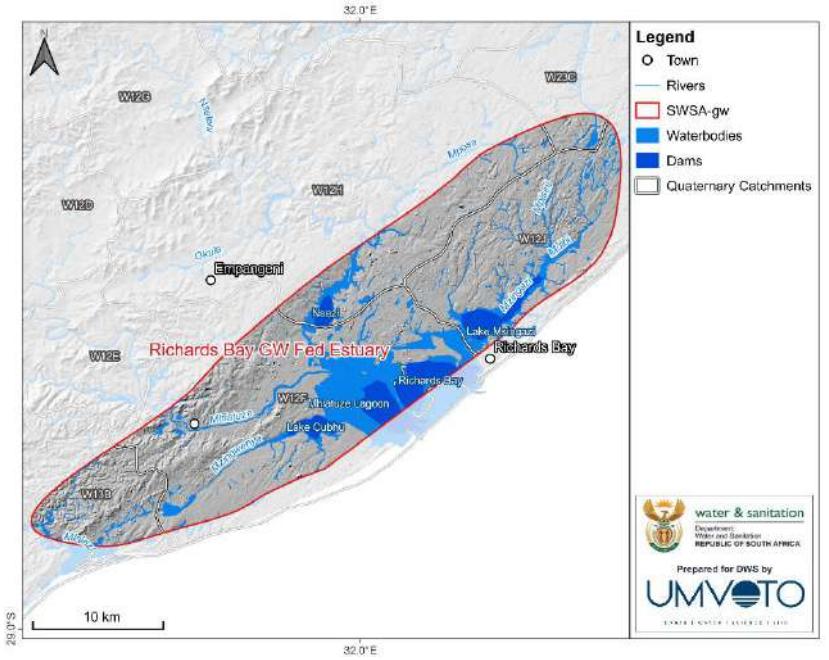
Locality map of Major Towns, District and Local Municipalities in the Richards Bay GW Fed Estuary SWSA-gw.

SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km^2
Elevation:	29 to 129 mamsl

Hydrology and Drainage

The Richards Bay GW Fed Estuary SWSA-gw and surrounding areas include major surface water systems summarised below and displayed in the map on the right. There are multiple natural water bodies in the area: the Lake Cubhu, Nsezi, Lake Msingazi as well as the Richards Bay estuary and Mhlatuze lagoon fed by the W1 catchment. There are many perennial rivers in the area flowing southwest.

Quaternary Catchments	W12F, W12H, W12J, W13B, and W23C
Rivers	Perennial: Mpisini, Mdibi, Nseleni, Mhlatuze, Mzingwenya, Mlalazi, Mhlabane, Mposa Mbabe, KwaGugushe, Kondweni, Nundwane, Mavuya
Natural and manmade water bodies	Nsezi, Lake Msingazi, Richards Bay, Mhlatuze Lagoon, Lake Cubhu, Estuary, as well as unnamed seeps and floodplains
Major Dams:	-
Water Management Areas:	Pongola Mtamvuna



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Richards Bay GW Fed Estuary SWSA-gw.

SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km^2
Elevation:	29 to 129 mamsl
Geology	

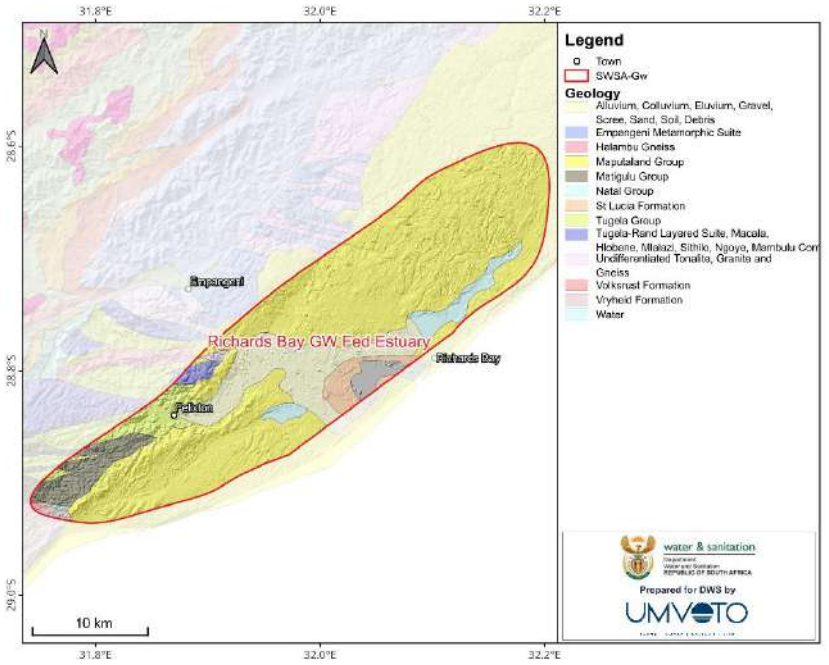
Geology:

Quaternary alluvium deposits and yellowish redistributed sand cover the majority of the area.

In the western section, Cenozoic-era Berea deposits, consisting of red decalcified sand in inland dune cordons, are present. The Matigulu Group of the Nanaqua-Natal Province outcrops in the westernmost section and includes sillimanite-garnet-biotite and quartz-biotite-garnet gneiss. Additionally, the intrusive granitoid Buhleni Gneiss outcrops in the western section, along with biotite-granite gneiss of the Ngoye Complex.

Hydrostratigraphy:

The Quaternary deposits constitute a primary, intergranular aquifer system, while the Cenozoic deposits constitute a dual-porosity, intergranular-fractured aquifer system.



Geology Map of the Richards Bay GW Fed Estuary SWSA-gw region.

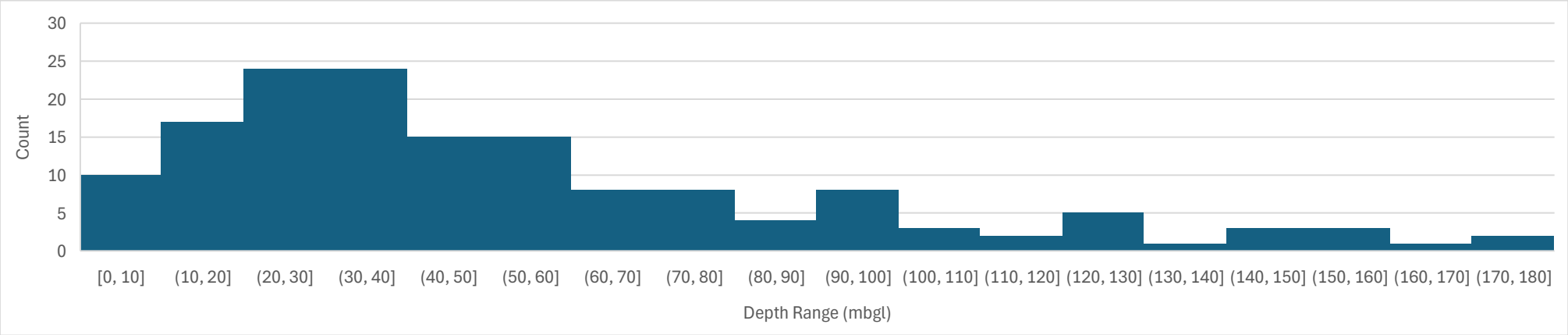
24.2. Current Status

SWSA-gw Name:	**Richards Bay GW Fed Estuary**
Area:	**606 km^2**
Elevation:	**29 to 129 mamsl**
Quantity & Quality	
Aquifer Classification	

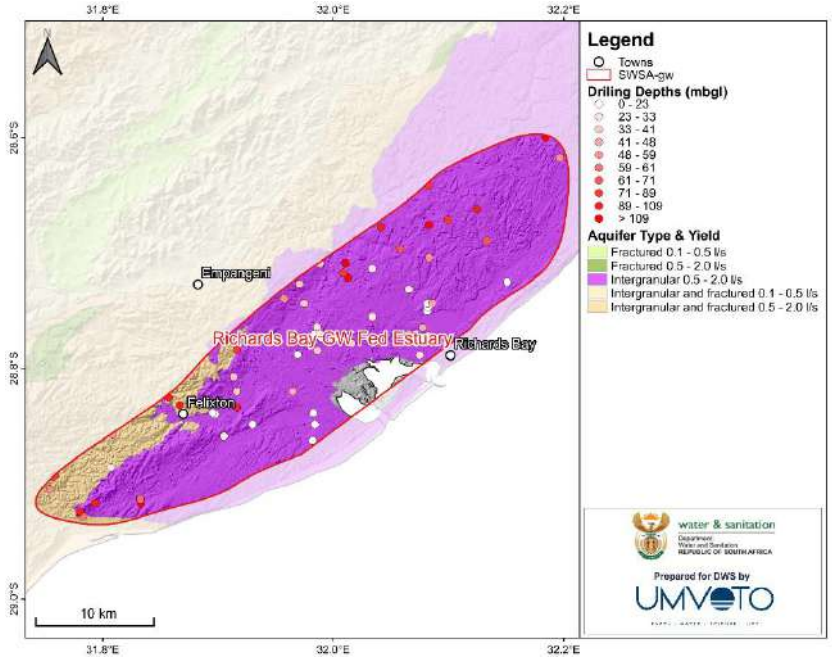
The aquifer systems within the Richards Bay GW Fed Estuary SWSA-gw exhibit varying yields across intergranular and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The Northwestern half of the SWSA-gw is a minor aquifer system, while the southeastern half is a major aquifer system. The major aquifer system has an average intergranular yield of 0.5 to 2.0 l/s. The minor aquifer system has a dual-porosity yield ranging from 0.5 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 55 mbgl, and the most common depths are between 30 to 40 mbgl. The majority of the boreholes target the shallow intergranular aquifer system. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 27 and 73 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 6 mbgl, with water levels ranging from 0 to 24 mbgl and a standard deviation of ~ 4 mbgl.

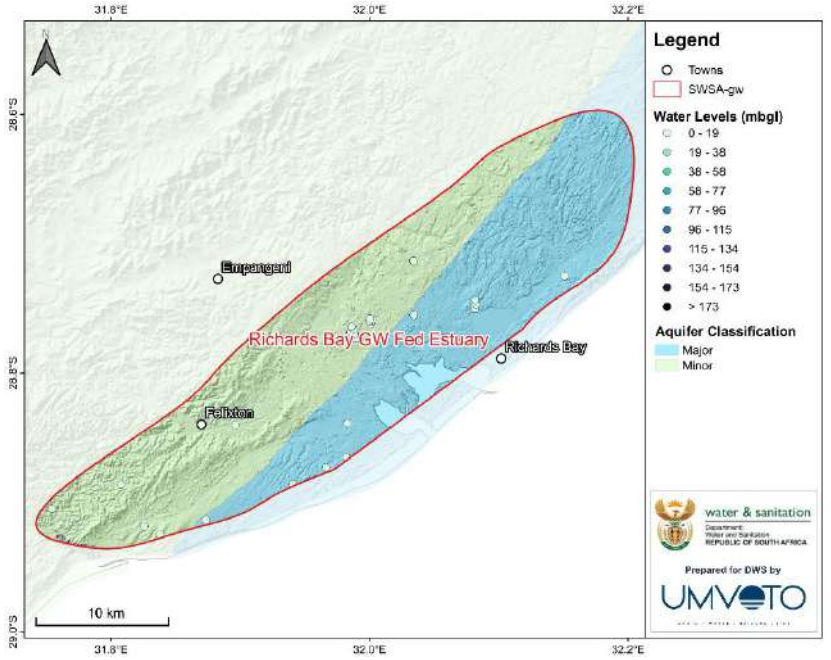
Graph of NGA drilling depths of the Richards Bay GW Fed Estuary SWSA-gw region



SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km^2
Elevation:	29 to 129 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Richards Bay GW Fed Estuary SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Richards Bay GW Fed Estuary SWSA-gw region.

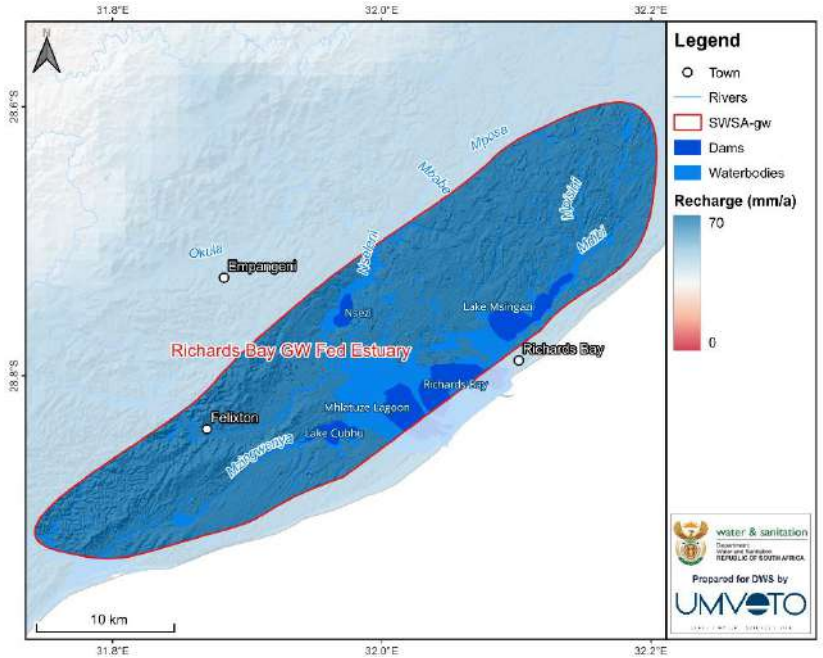
SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km^2
Elevation:	29 to 129 mamsl

Quantity & Quality

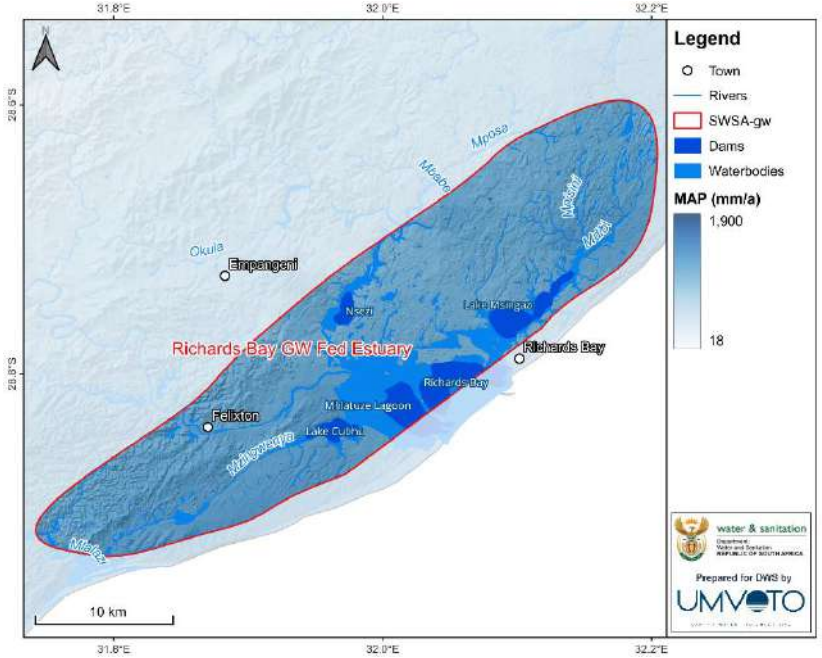
Groundwater Recharge

The Richards Bay GW Fed Estuary receives a total MAP volume of 728 Mm^3/a, with a significantly high average rainfall of 1200 mm/a. Despite this, only 82.5 Mm^3/a contributes to groundwater recharge, resulting in a moderate recharge of 11.3% of MAP. This suggests that while the area experiences relatively high rainfall, a substantial portion is still lost to runoff, evaporation, or surface water flow, though recharge efficiency is better compared to drier regions.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Richards Bay GW Fed Estuary	728	1200	82.5	135.6	11.3%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

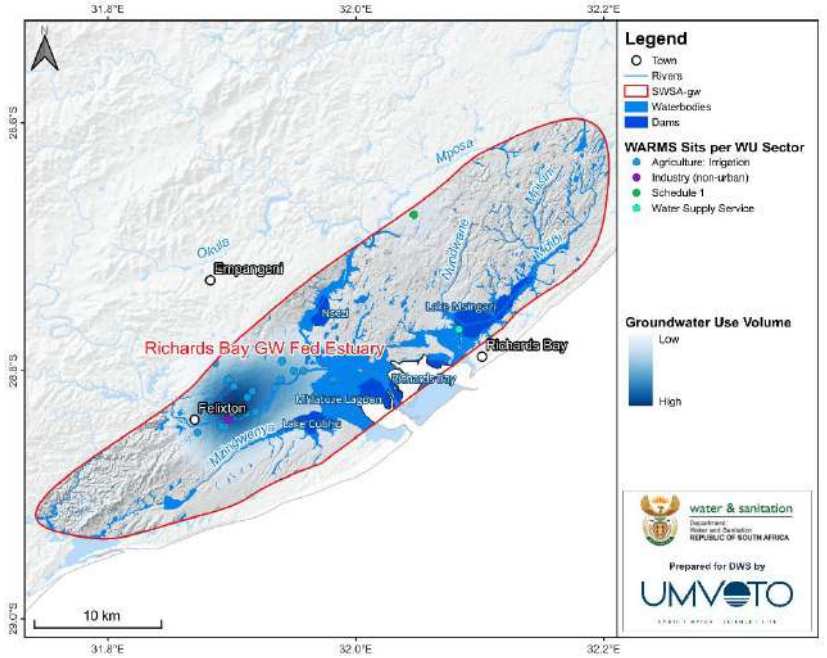
SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km^2
Elevation:	29 to 129 mamsl
Quantity & Quality	
Groundwater Use	

The Richards Bay GW Fes Estuary SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater use within this region includes agricultural activities and domestic self-supply (see Table below). Analysis of active groundwater use licences from WARMS reveals that two sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 0.2 Mm^3/ a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. However, there are not many areas with high reliance on groundwater.
- Schedule 1 follows, using 0.02 Mm^3/a, used by households for domestic use. Domestic demand for groundwater is an important source, especially in places with water restrictions, poor water quality or remote areas.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located south of Empangeni, where groundwater use is highest due to industrial, municipal, and agricultural activities.

Active Groundwater Use Licences	Water User Sector	Registered Volume (Mm^3/a)
	Agriculture: Irrigation	0.2
	Schedule 1	0.02
	Total	**0.2**



Water use map for the Richards Bay GW Fed Estuary SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

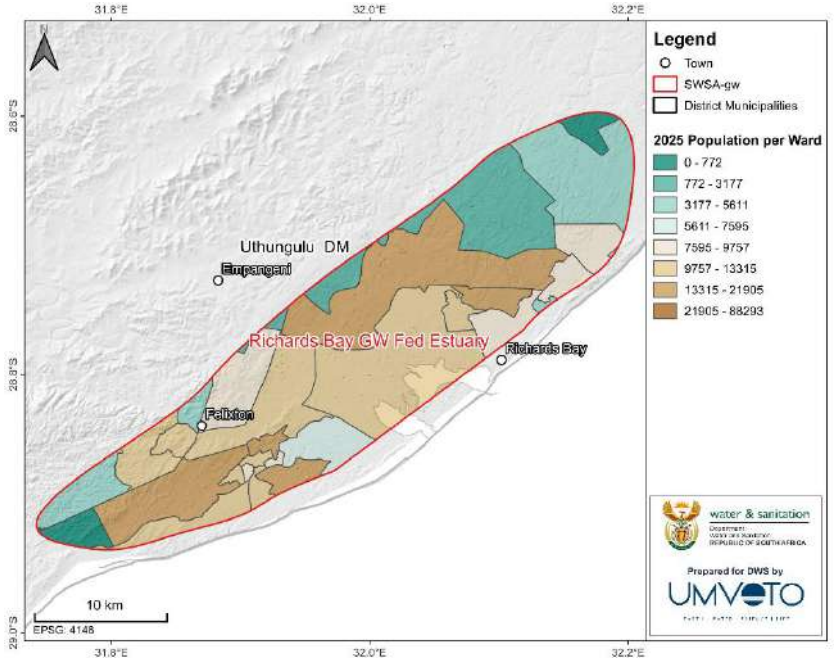
SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km^2
Elevation:	29 to 129 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Richards Bay GW Fed Estuary SWSA-gw is located within the Pongola-Mtamvuna Water Management Area (WMA, 2023). The groundwater resources within the Zululand Coastal Plain SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Pongola-Mtamvuna Catchment Management Agency (PUCMA), which was formed as part of a national restructuring process that consolidated CMAs. PUCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the PUCMA to manage water resources in the Pongola-Mtamvuna WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	PUCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Pongola-Mtamvuna WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA/WSP	The district municipality and the City of uMhlathuze are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Richards Bay GW Fed Estuary SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 1.06% per year, resulting in a projected population of approximately 256,214.

As shown in the map and table below, uMhlathuze Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 227,178.



Projected population distribution in 2025 for the Richards Bay GW Fed Estuary SWSA-gw.

SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km^2
Elevation:	29 to 129 mamsl

Quantity & Quality

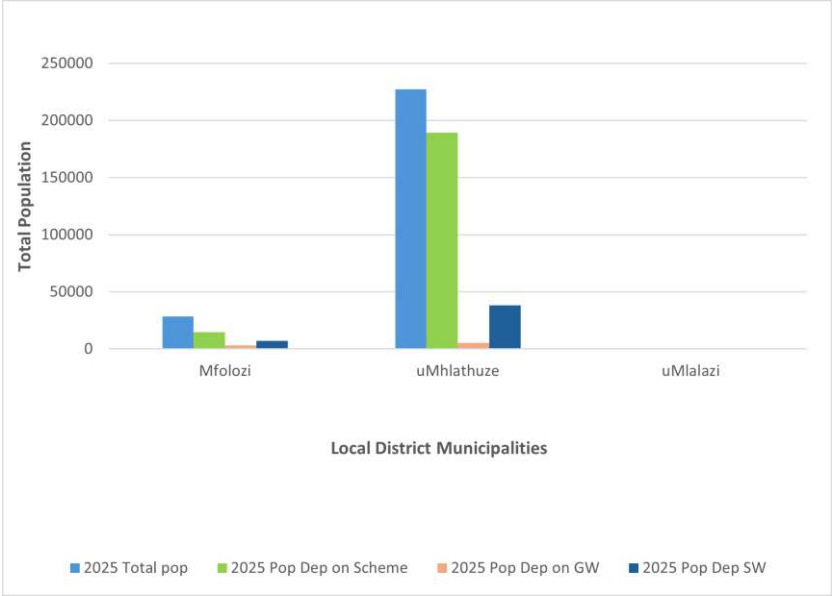
Socio Economic & Governance

In terms of water reliance within the Richards Bay GW Fed Estuary SWSA-gw, an estimated 79.7% of the population depends on the regional water supply scheme, 17.8% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 3.3% on groundwater sources (including boreholes and springs).

Among the LMs, the uMlalazi LM has the highest proportion of groundwater reliance, with approximately 21.9% of its population depending on groundwater and 43.8% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Mfolozi	28,551	14,754	2,974	7,212
uMhlathuze	227,178	189,327	5,329	38,124
uMlalazi	484	218	106	212
Total	**256,214**	**204,299**	**8,409**	**45,547**



Projected population dependence on water sources in 2025.

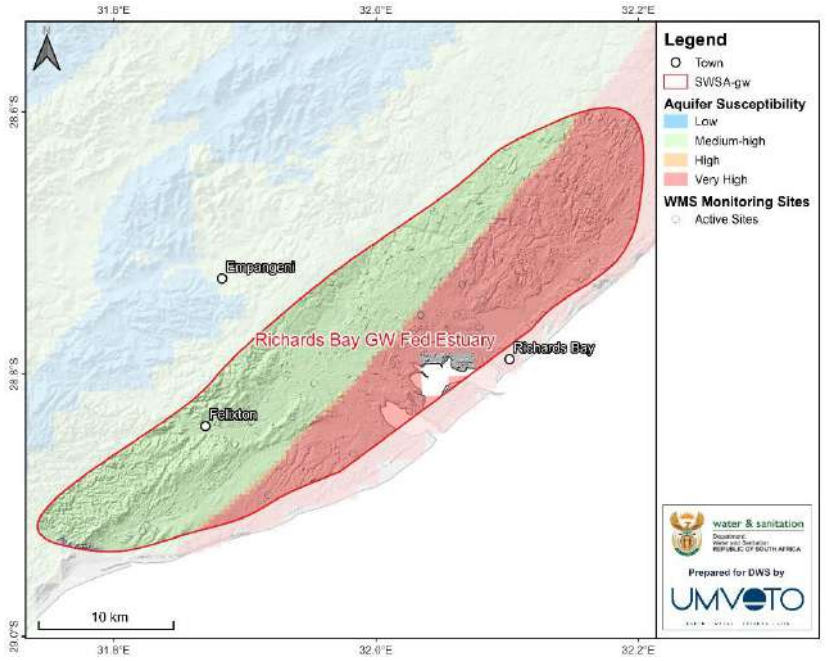
SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km^2
Elevation:	29 to 129 mamsl
Quantity & Quality	
Groundwater Quality	

The Richards Bay GW Fed Estuary SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), Urban/Built-up areas cover a total of 119.93 km^2, which is 19.80% of the Richards Bay GW Fed Estuary SWSA-gw total area. Cultivated areas cover 80.24 km^2 (13.25%), while mines and quarries account for 6.34 km^2 (1.05%) of the total area. These land uses contribute to diffuse contamination sources, with urban areas being the primary concern. Urban areas tend to include informal settlements and townships, and this places the groundwater source under a high risk of contamination (Le Maitre et al., 2018). Several water quality indicators help assess aquifer vulnerability and contamination risks:

PS. The WMS database does not contain any actively monitored sites. The sites with water quality results were sampled between 13/07/1971 and 16/11/2017, with no recent data being available. One monitoring point, Monitoring Point ID 172911 (WINDY RIDGE), does not fall under any of the aquifer vulnerability areas.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 12.4 - 203 mS/m in the Major aquifer system. Coastal aquifers typically show an EC gradient, with higher values near the coastline due to seawater intrusion or marine aerosol deposition.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.05 - 3.74 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.02 - 7.6 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.36 - 8.4 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 1.5 - 164.89 mg/L in the Major aquifer system



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Richards Bay GW Fed Estuary**
Area:	**606 km²**
Elevation:	**29 to 129 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Richards Bay GW Fed Estuary SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	N/A	N/A	42	84.09	mS/m	-	1971-2017 WMS data: 24.6 - 1098.4 mS/m (Avg.: 144.03 mS/m). 2014-2024 GW Geosites: <70 mS/m. Inconsistent with WMS (1971-2017).	1971-2017 WMS data: 12.4 - 203 mS/m (Avg.: 58.63 mS/m). 2014-2024 GW Geosites: <70 mS/m. Inconsistent with WMS (1971-2017).
Fluoride	N/A	N/A	42	0.45	mg/L	-	1971-2017 WMS data: 0.13-2.02 mg/L (Avg.: 0.49 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (1971-2017).	1971-2017 WMS data: 0.05 - 3.74 mg/L (Avg.: 0.44 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (1971-2017).
Nitrate + Nitrite Nitrogen	N/A	N/A	42	1.44	mg/L	-	1971-2017 WMS data: 0.02 - 15.66 mg/L (Avg.: 2.94 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (1971-2017).	1971-2017 WMS data: 0.02 - 7.6 mg/L (Avg.: 0.59 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (1971-2017).
pH	N/A	N/A	42	7.65	pH unit	-	1971-2017 WMS data: 6.7 - 8.96 (Avg.: 7.71). 2014-2024 GW Geosites: 7-9. Consistent with WMS (1971-2017).	1971-2017 WMS data: 6.36 - 8.4 (Avg.: 7.63). 2014-2024 GW Geosites: 7-9. Consistent with WMS (1971-2017).
Sulphate	N/A	N/A	40	17.99	mg/L	-	1971-2017 WMS data: 1.5 - 54.2 mg/L (Avg.: 16.3 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (1971-2017).	1971-2017 WMS data: 1.5 - 164.89 mg/L (Avg.: 18.90 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (1971-2017).

- *"Average" refers to the average concentrations for the Total Sites with WQ results of the Richards Bay GW Fed Estuary SWSA-gw, taken from the WMS database from 1971-2024.*
- *"-" refers to no available data from the WMS database from 1971-2024 and the 2014-2024 GW Geosites.*
- *"N/A" refers to Not Applicable.*

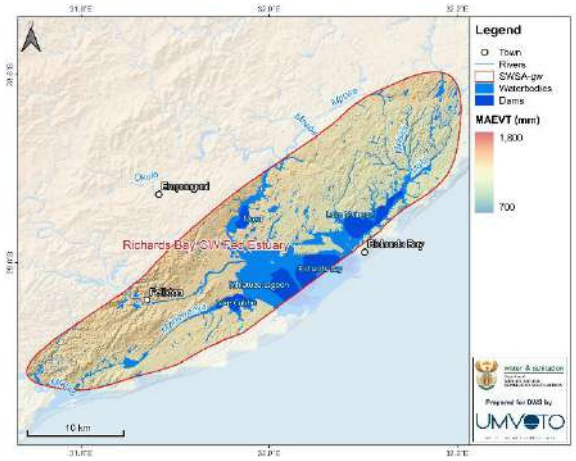
SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km^2
Elevation:	29 to 129 mamsl

Threats & Risks

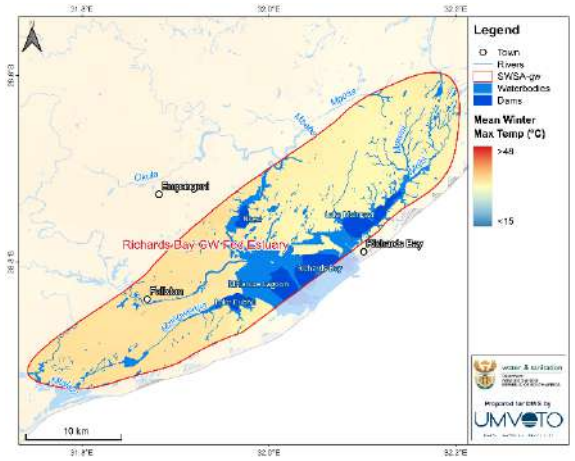
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Richards Bay GW Fed Estuary SWSA-gw has a Cfa, humid subtropical, type climate characterised by hot and humid summers and mild winters. Temperatures in the SWSA-gw range from >8– 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

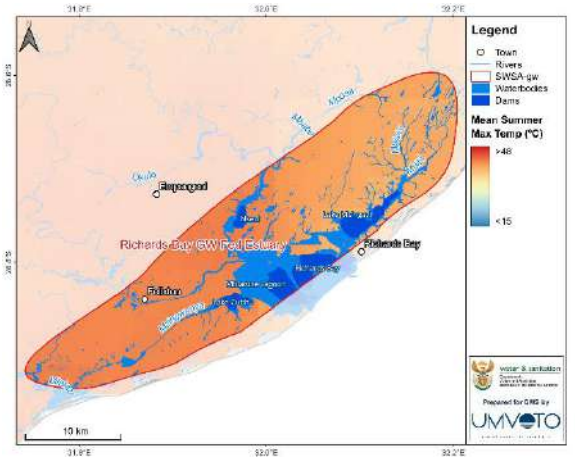
Temperature	Summer: 24.7 to 29.2 ºC, Winter: > 8 °C
Evapotranspiration	Maximum value of 1401 mm/a with an average value of 1276 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, but an increase in recharge (ranging from ~ 13.2 to 26.3 mm/a). The DART Index indicates mostly stable conditions.



Mean annual A-Pan evaporation of the Richards Bay GW Fed Estuary SWSA-gw region.



Mean winter temperatures of the Richards Bay GW Fed Estuary SWSA-gw region.



Mean summer temperatures of the Richards Bay GW Fed Estuary SWSA-gw region.

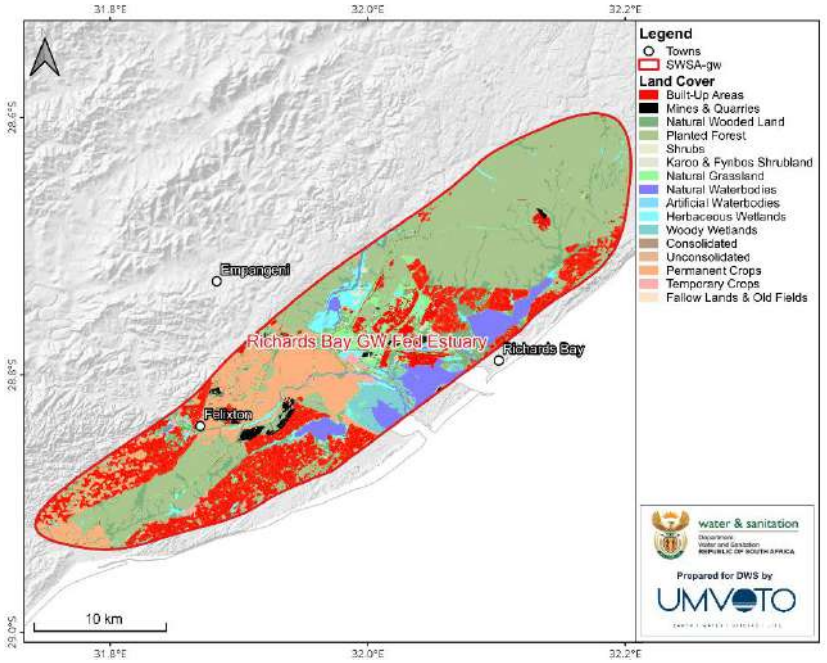
SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km^2
Elevation:	29 to 129 mamsl

Threats & Risks

Land Use

Forest land, which is made up of planted forest and natural wooded land, dominates the Richards Bay GW Fed Estuary SWSA-gw, covering 48.9% of the area (DFFE, 2022), indicating significant forestry activity and managed vegetation, particularly in the northern half of the SWSA-gw. Built-up areas, which include residential, industrial and commercial areas, represent a notable portion of land use, suggesting moderate urban development. Cultivated land, consisting of permanent crops, temporary crops, fallow lands and old fields, contributes to agricultural productivity and is particularly concentrated northeast of the town of Felixton. Natural and artificial waterbodies and wetlands, which are concentrated to the east edge of the SWSA-gw and lead out to the coast, cover 11% of the SWSA-gw and provide ecological diversity along with the natural grassland. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 1% of the area, located predominantly in the northwest of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	4	0.7
Built-Up	120	19.8
Cultivated	80	13.2
Forest Land	296	48.9
Grassland	33	5.5
Mines and quarries	6	1.0
Waterbodies	33	5.5
Wetlands	33	5.4



Land Cover 24-class map to show the types of land use and extent of each occurring in the Richards Bay GW Fed Estuary SWSA-gw.

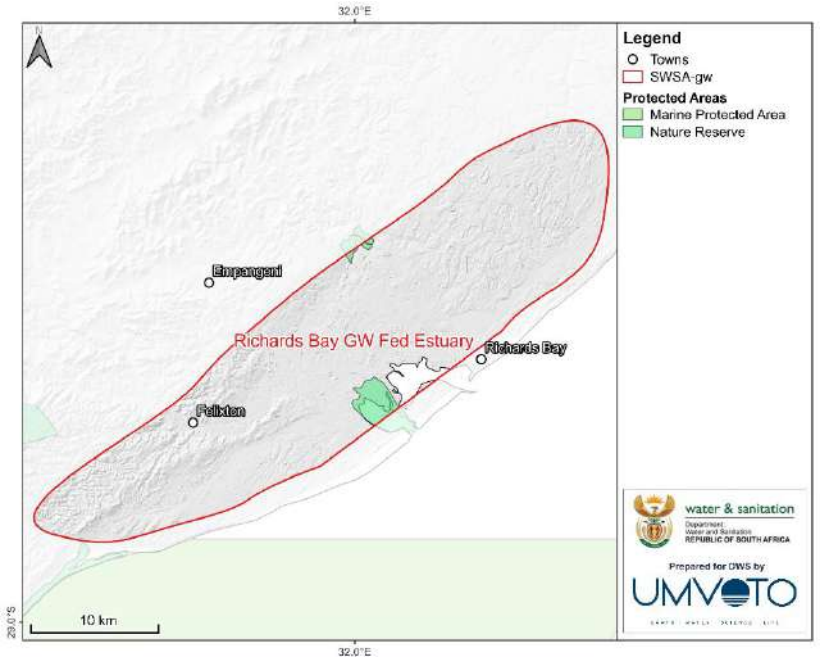
SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km²
Elevation:	29 to 129 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Richards Bay GW Fed Estuary & Zuland Coast SWSA-gw contains two nature reserves (DFFE, 2024), with the largest of the two being the Richards Bay Game Reserve on the southeastern edge of the SWSA-gw.

Protection Status	Names	Area (km²)	Count
Conservation Areas	None		0
Protected Areas	• Richards Bay Game Reserve • Enseleni Nature Reserve	10.36	2
Subterranean Government Water Control Areas	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Richards Bay GW Fed Estuary SWSA-gw that have protection status.

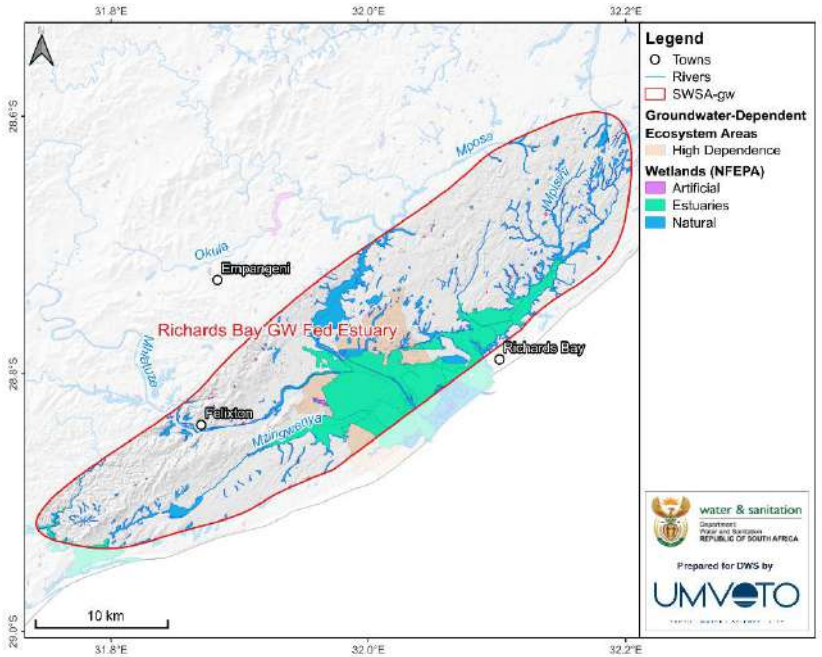
SWSA-gw Name:	Richards Bay GW Fed Estuary
Area:	606 km²
Elevation:	29 to 129 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Mhlatuze Floodplain is a wetland (CSIR, 2011) that is fed by the Mhlatuze River, and that then leads to the estuary. The estuary lies within an area of potentially highly groundwater-dependent wetlands (DWA, 2010).

Protection Status	Names	Area (km²)	Count
Major Waterbodies	• Mhlatuze Floodplain • Estuary	95.94	2
Ramsar Sites	None		0
Wetlands	Various small natural, artificial and estuary wetlands	120	1

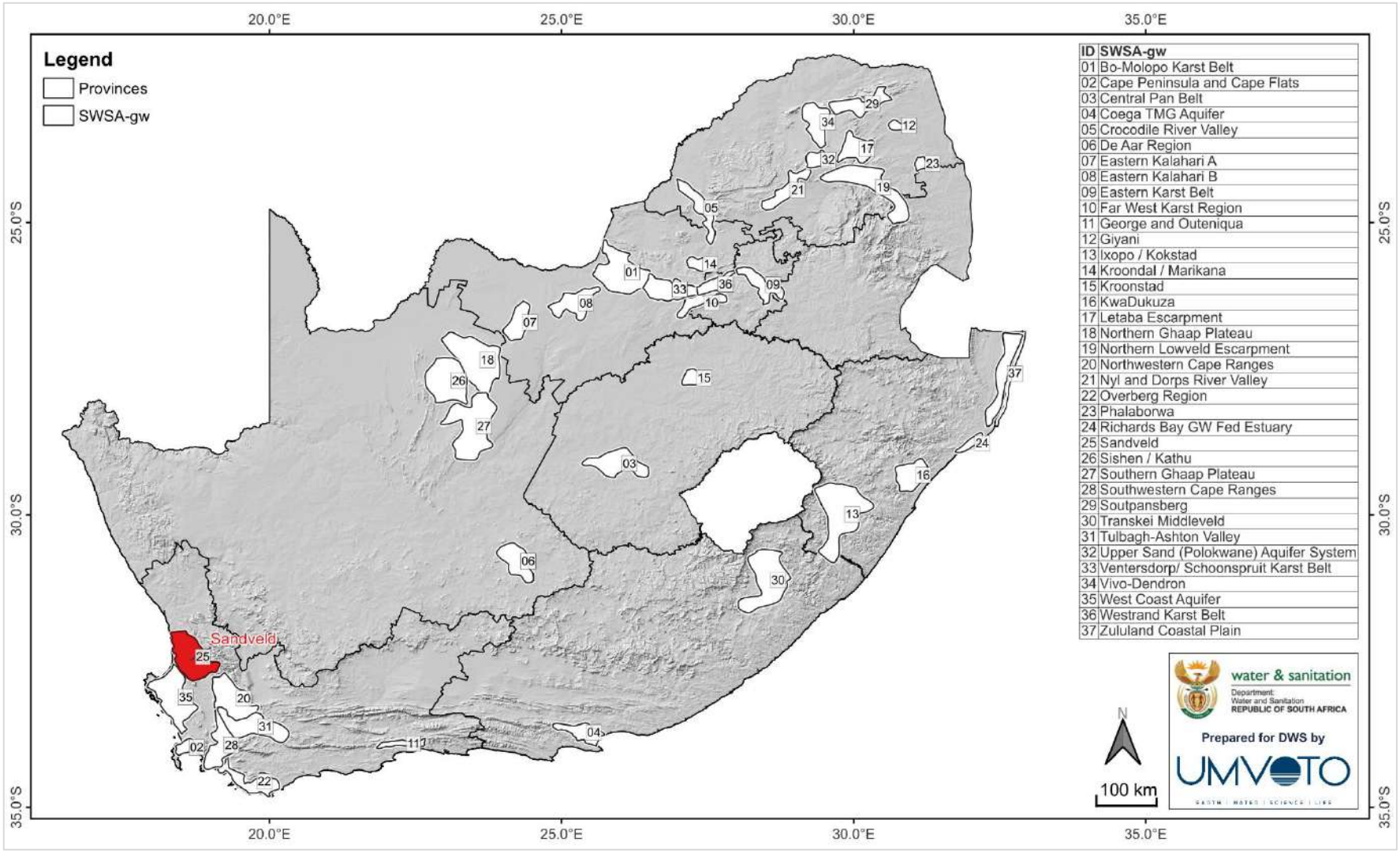


Map showing the major water bodies, Ramsar sites and GDEs in the Richards Bay GW Fed Estuary SWSA-gw.

APPENDIX 25

SANDVELD SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE SANDVELD SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

25. Sandveld

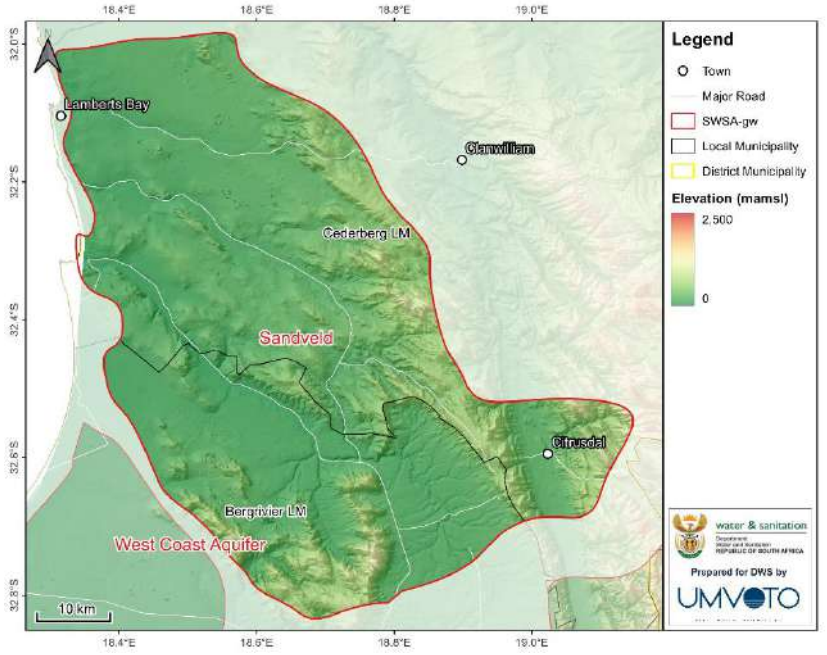
25.1. Description

SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl
Geospatial Context	

The topography of the Sandveld SWSA-gw, as depicted in the map, showcases a distinct transition from a low-relief coastal plain along the western edge to increasingly rugged terrain towards the east. The coastal plain, encompassing areas such as Lambert's Bay and Elandsbaai, is characterized by relatively flat topography with low elevations near sea level. Moving inland, the landscape begins to rise, particularly east of towns like Redelinghuys and Graafwater, where the terrain becomes more undulating. Further east, towards Citrusdal, the topography becomes more rugged and mountainous.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Western Cape Province
District Municipality	West Coast
Local Municipalities	Cederberg and Bergriver
Towns	Aurora, Citrusdal, Eendekuil, Elands Bay, Goedverwag, Graafwater, Heerenlogement, Het Kruis, Lamberts Bay, Leipoldtville, Noordkuil, Paleisheuwel, Pools, Ratelfontein, Redelinghuys, Sandberg, Sauer, Wolfhuis
Major Roads	N7
Major Water Supply Networks	Elands Bay and Lamberts Bay pipeline



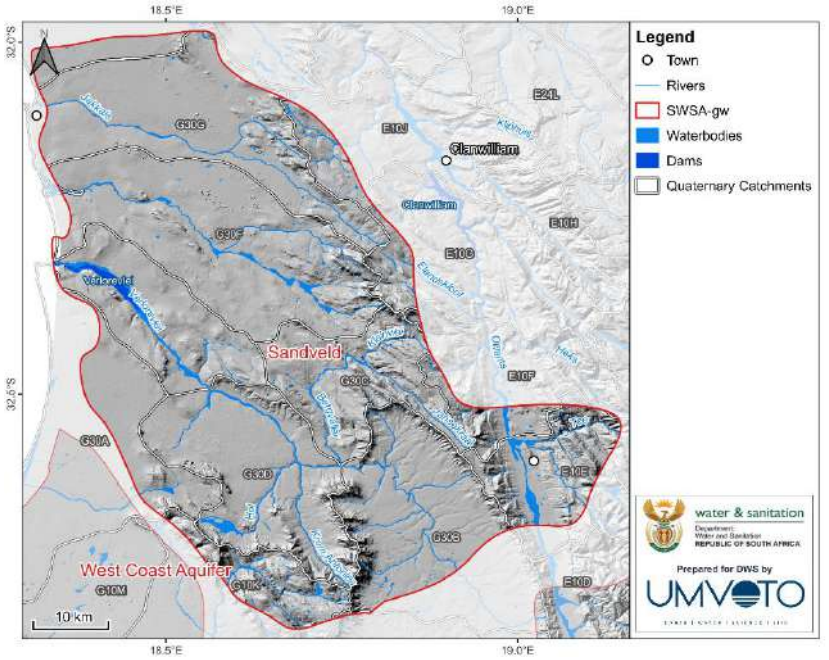
Locality map of Major Towns, District and Local Municipalities in the Sandveld SWSA-gw.

SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl

Hydrology and Drainage

The Sandveld SWSA-gw and surrounding areas include major surface water systems, along with several unnamed seeps and floodplains, which are summarised below and displayed on the map to the right. The primary surface water features include the Wadrift and Jakkals Estuaries, as well as Verlorevlei, all of which are fed by the G3 catchment. Several perennial rivers flow through the area, predominantly flowing northwest.

Quaternary Catchments	E10A, E10B, E10C, E10D, E21A, E21B, E21C, E21D, E21G, E22C, G10E, G10G, H10A, H10B, H10C, H20C, H20F and J12A as well as a small section of E21E, E21H, E22E, G10H, G10F, G10J, G30B, H10D, H20A, H20B, H20D and H20E
Rivers	Perennial: Bergvallei, Boesmans, Boontjies, Elandskloof, Hol, Jakkals, Jansekraal, Kleinvlei, Krom Antonies, Kruismans, Lambertshoek, Langvlei, Olifants, Papkuil, Platkloof, Tee and Verlorevlei
	Ephemeral: Huis, Seekoevlei and Soutkloof
Natural and manmade water bodies	Wadrift and Jakkals Estuaries, Verlorevlei Estuary, as well as several seeps and floodplains
Major Dams:	-
Water Management Areas:	Breede Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Sandveld SWSA-gw.

SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl
Geology	

Geology

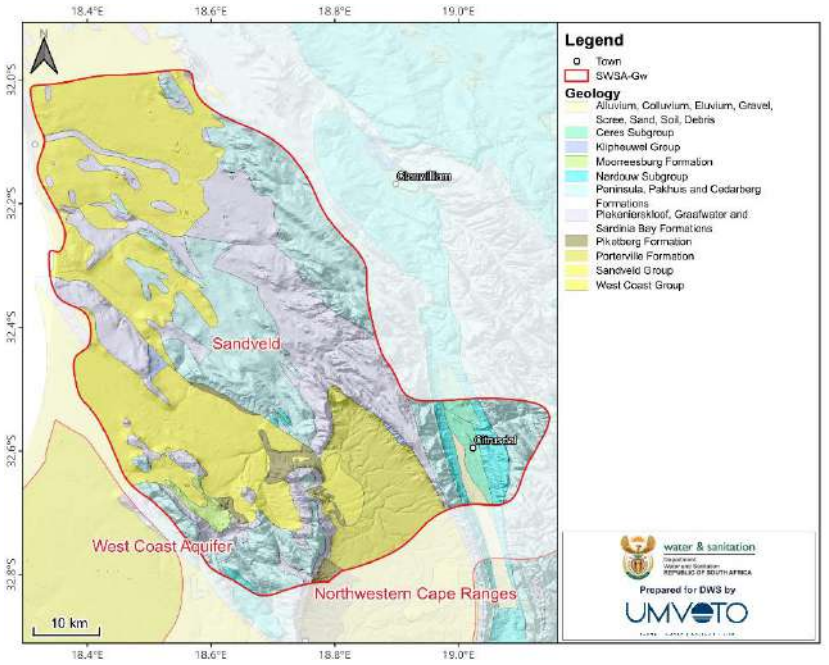
The Sandveld Group, including the Witzand Formation and Quaternary deposits such as alluvium, colluvium, and eluvium, are found along the western section of the Sandveld. These deposits consist of quartzose sand, carbonaceous clay, peat, and calcareous and gypsiferous dune sand. The Varswater Formation, part of the Cenozoic sediments in this region, includes gravel, sandy silt, and phosphorite deposits.

In the central, eastern, and southern sections of the area, sedimentary rocks of the Table Mountain Group (~480–390 Ma) outcrop extensively. These formations are characterised by shale, siltstone, sandstone, and conglomerates.

The Malmesbury Group, dating back to the Precambrian, is represented by the Piketberg and Porterville Formations, which outcrop in the southern parts of the area. These formations predominantly comprise phyllitic shale, greywacke, limestone, arenite, and greenstone, with dolomite and chert lenses.

Hydrostratigraphy

The Sandveld Group sediments constitute a primary intergranular aquifer system, while the Table Mountain Group sandstones and Malmesbury Group metamorphic rocks constitute fractured-rock and weathered (intergranular-fractured) aquifer systems.



Geology Map of the Sandveld SWSA-gw region.

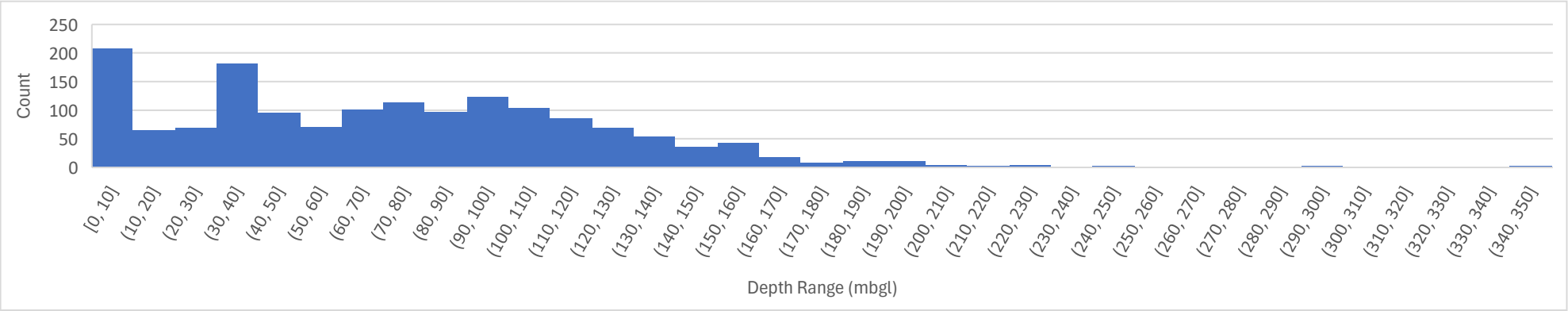
25.2. Current Status

SWSA-gw Name:	**Sandveld**
Area:	**4010 km²**
Elevation:	**19 to 1387 mamsl**
Quantity & Quality	
Aquifer Classification	

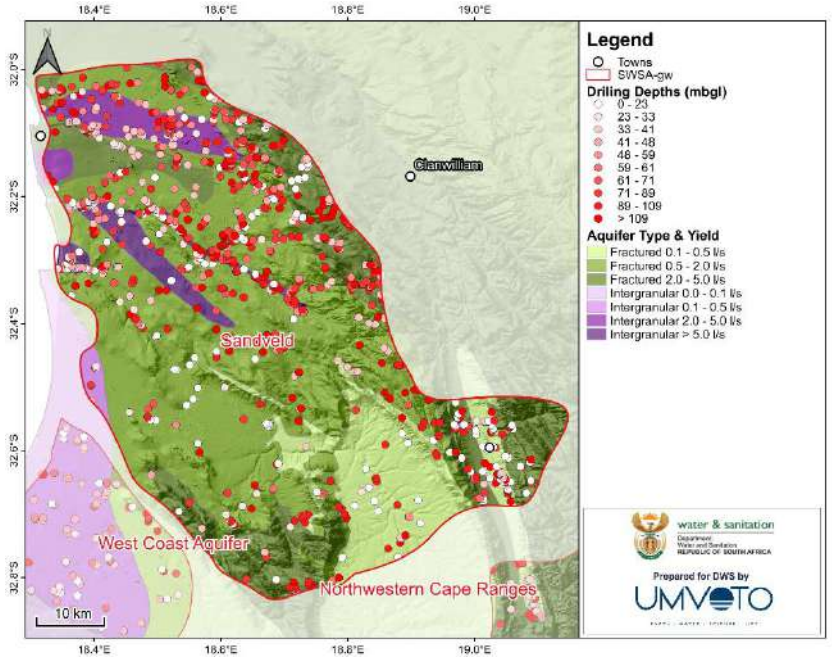
The aquifer systems within the Sandveld SWSA-gw exhibit varying yields across fractured and intergranular aquifers, as summarised in the table and maps below.

Aquifer Classification	The majority of the SWSA-gw consists of a combination of major and minor aquifer systems, with a poor aquifer system in the northernmost section. The major aquifer predominantly has a fractured yield, averaging between 0.1 and 5.0 l/s, while its intergranular yield ranges from 2.0 to over 5.0 l/s. The minor aquifer has a fractured yield averaging between 0.5 and 5.0 l/s, with an intergranular yield of 0.1 to 0.5 l/s.
Groundwater Targets	The average drilling depth is 75 mbgl, with the most common depths around 10 and 40 mbgl, suggesting that boreholes predominantly target the upper aquifer system. While the majority of boreholes target the shallow intergranular and fractured aquifer, a small number exceed 200 mbgl, likely tapping the deeper fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 35 and 108 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 8 mbgl, with values ranging from 0 to 139 mbgl and a standard deviation of ~ 10 mbgl.

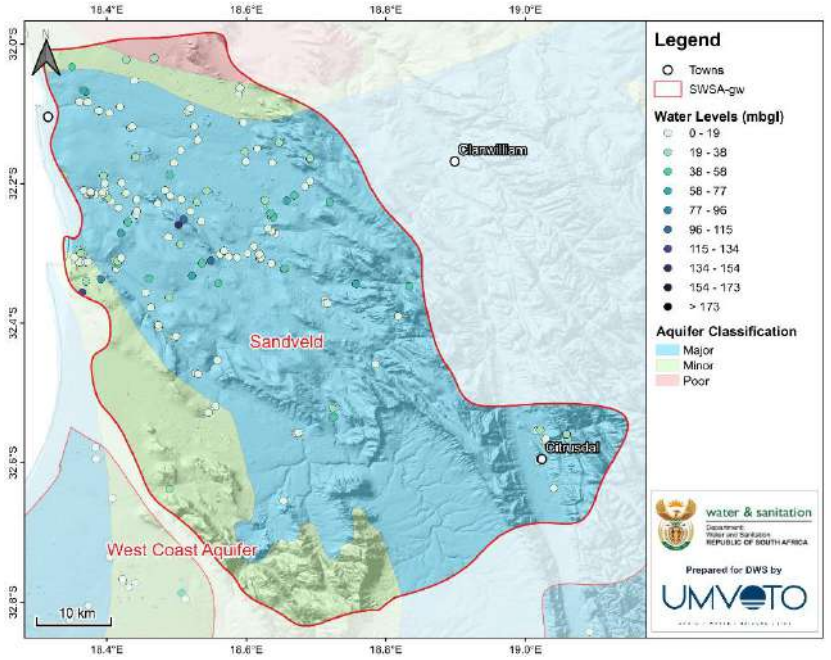
Graph of NGA drilling depths of the Sandveld SWSA-gw region



SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Sandveld SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Sandveld SWSA-gw region.

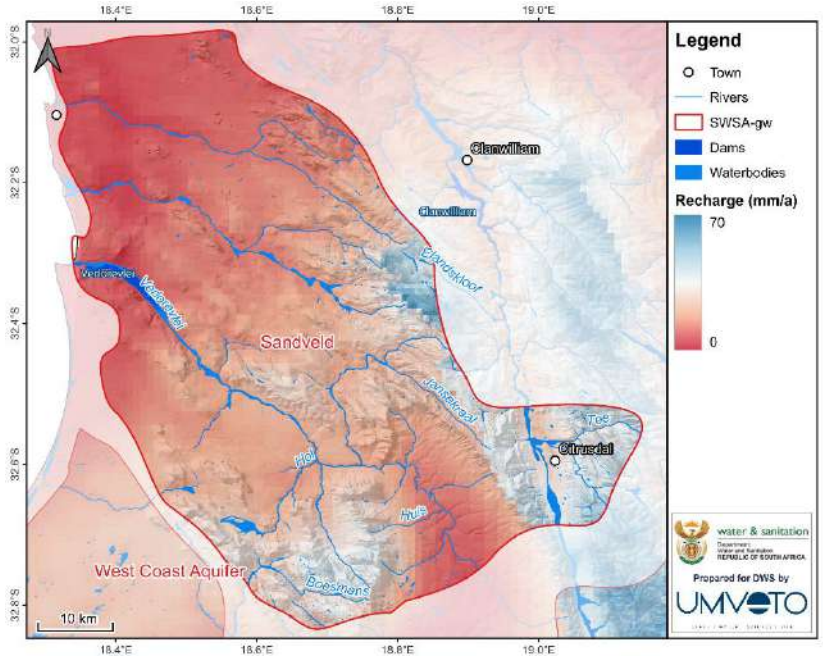
SWSA-gw Name:	**Sandveld**
Area:	**4010 km²**
Elevation:	**19 to 1387 mamsl**

Quantity & Quality

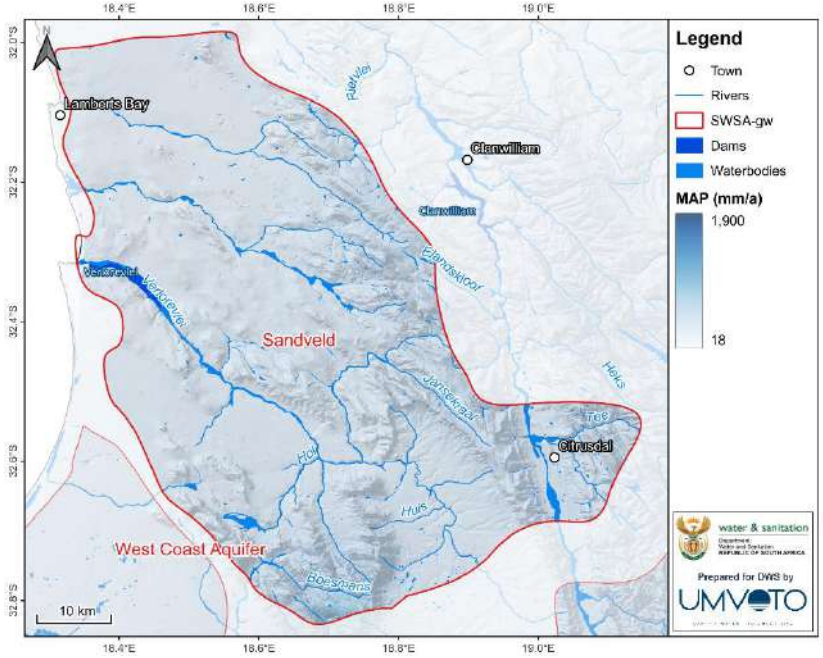
Groundwater Recharge

The Sandveld & Winterhoek region receives a total Mean Annual Precipitation (MAP) volume of 1294 Mm^3/a, with an average rainfall of 323 mm/a. However, only 18.7 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 5.8% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of map mm/a	Sum of Recharge Vol Mm^3/a	Average of recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Sandveld	1294	323	74.4	18.7	5.8%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

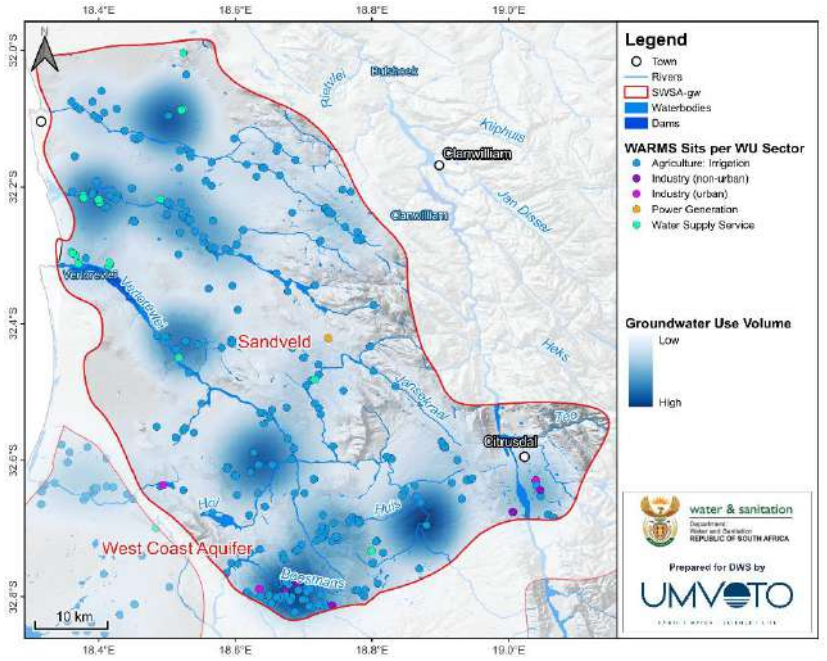
SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl
Quantity & Quality	
Groundwatere	

The Sandveld Aquifer SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Elandsbaai (Groundwater) and Citrusdal (Conjunctive), which rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation is the predominant groundwater use, accounting for 93.93% of groundwater licenses, with an annual extraction of 58.2 Mm^3/a. Major extraction hotspots in Elandsbaai, Redelinghuys, Graafwater, and Citrusdal, where low rainfall and limited surface water make groundwater essential for farming.
- Municipal water supply services, at 3.6 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. Elandsbaai shows particularly dense usage, indicating a heavy reliance on groundwater compared to other settlements.
- Urban industrial use is the third-highest category, with 0.1 Mm^3/a allocated for manufacturing, processing, and industrial activities in urban centres. Unlike agricultural groundwater use, which is widespread across the region, urban industrial extraction is concentrated in the southern part. Other areas within Sandveld SWSA-gw depend almost entirely on groundwater for agriculture and municipal supply, highlighting the region's sector-specific water dependencies.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Graafwater. Elandsbaai and Redlinghuys, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	58.2
	Industry (Non-urban)	0.1
	Industry (Urban)	0.1
	Water Supply Service	3.6
	Total	**62**



Water use map for the Sandveld SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

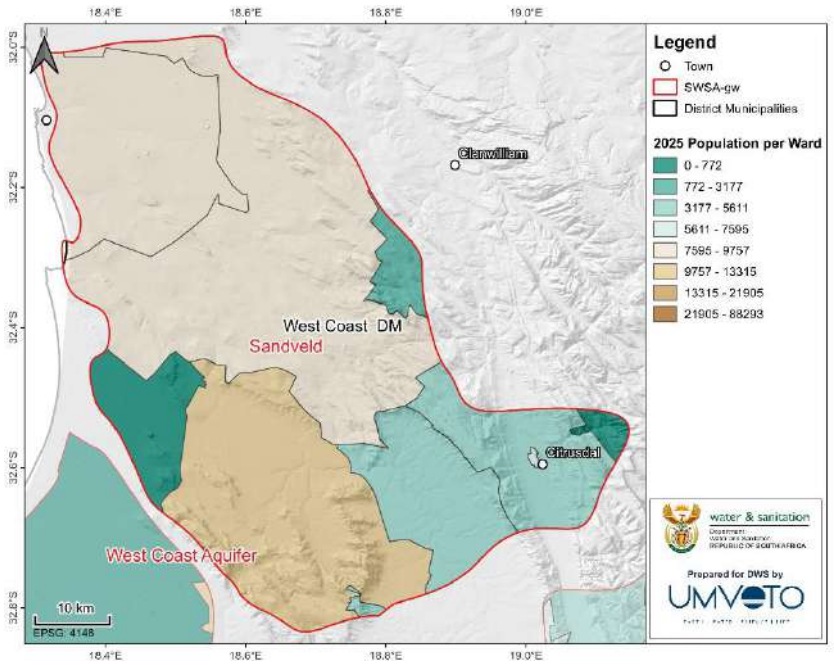
SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Sandveld SWSA-gw is located within the Breede-Olifants Water Management Area (WMA, 2023). The groundwater resources within the Sandveld SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Breede-Olifants Catchment Management Agency (BOCMA), which was formed as part of a national restructuring process that consolidated CMAs. BOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (NWA, Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the BOCMA to manage water resources in the Breede-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	BOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Breede-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	Local municipalities are the Water Service Authorities (WSA), while West Coast DM is the Bulk Water Service Provider (WSP) for their jurisdiction.

The estimated 2025 population within the Sandveld SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 0.74% per year, resulting in a projected population of approximately 45,888.

As shown in the map and table below, Cederberg Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 29,312. Population concentrations within the SWSA-gw are highest in the Bergrivier and Cederberg LMs.



Projected population distribution in 2025 for the Sandveld SWSA-gw.

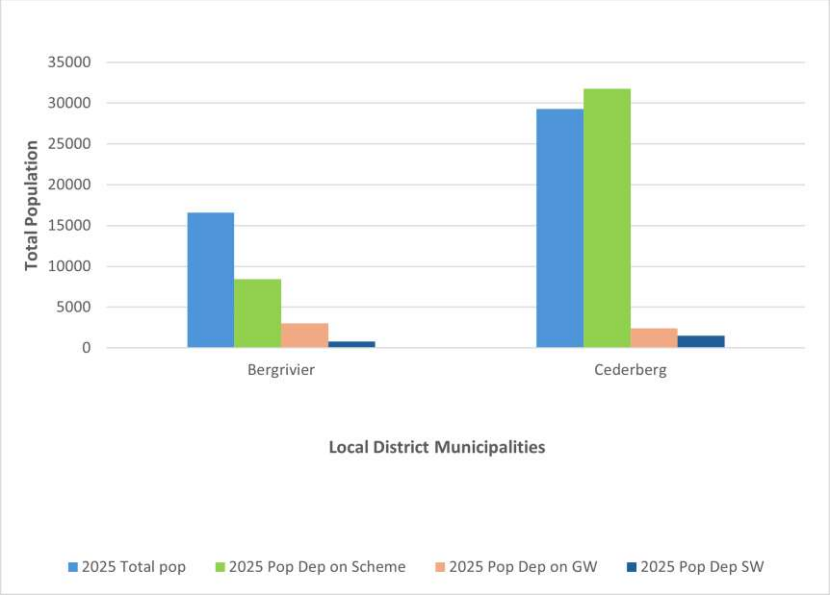
SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Sandveld SWSA-gw, an estimated 87.7% of the population depends on the regional water supply scheme, 11.8% on groundwater sources (including boreholes and springs), and 5.0% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources).

Among the LMs, the Bergrivier LM has the highest proportion of groundwater reliance, with approximately 18.1% of its population depending on groundwater and 4.8% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Bergrivier	16,576	8,430	3,007	792
Cederberg	29,312	31,794	2,414	1,489
Total	**45,888**	**40,225**	**5,421**	**2,282**



Projected population dependence on water sources in 2025.

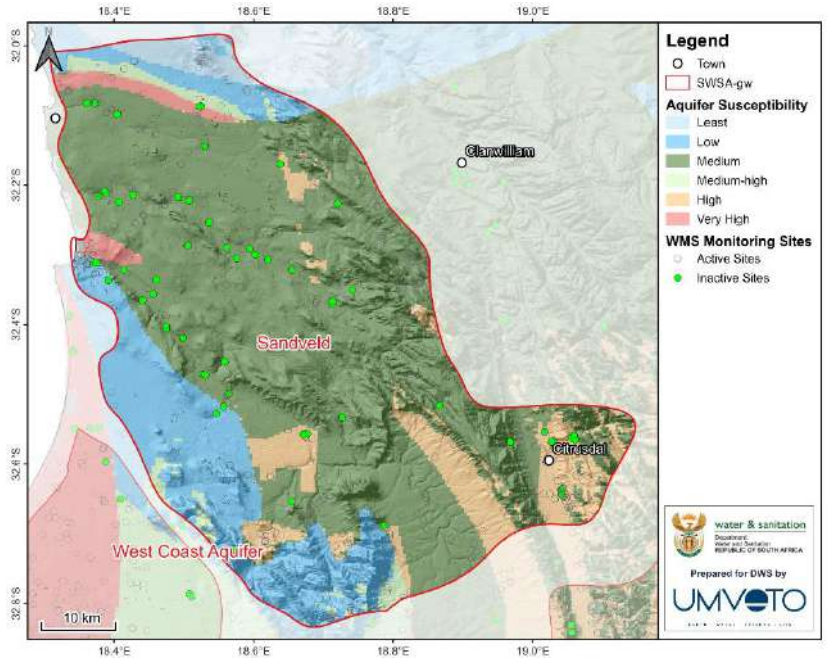
SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl
Quantity & Quality	
Groundwater Quality	

The Sandveld SWSA-gw consists of Poor, Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 1633.85 km^2, which is 40.75% of the Sandveld SWSA-gw total area. Urban/Built-up areas cover 25.55 km^2 (0.64%), while mines and quarries account for 3.15 km^2 (0.08%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major aquifer consists of areas with moderate and most aquifer vulnerability. The majority of the Major Aquifer is characterized by areas that have moderate vulnerability, while the most vulnerable areas are found in the W, N, Central, S and SE parts of the aquifer.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. In the Sandveld SWSA-gw, EC ranges from 3.01 – 939 mS/m in the Major aquifer system. Coastal aquifers typically show an EC gradient, with higher values near the coastline due to seawater intrusion or marine aerosol deposition.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. In the Sandveld SWSA-gw, fluoride levels range from 0.025 – 1.75 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. In the Sandveld SWSA-gw, concentrations range from 0.005 - 36.10 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. In the Sandveld SWSA-gw, pH ranges from 4.16 - 8.66 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. In the Sandveld SWSA-gw, sulphate levels range from 0.6 - 321.20 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Sandveld SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	67	42.95	156	95.19	mS/m	6.59 - 286 mS/m (Avg.: 93.87 mS/m). 2014-2024 GW Geosites: 0 - 370 mS/m, some >500 mS/m. Consistent with WMS (2000-2024).	3.01 - 939 mS/m (Avg.: 109.80 mS/m). 2014-2024 GW Geosites: 0 - 370 mS/m. Consistent with WMS (2000-2024). The upper limit of 939 mS/m may be an outlier.	5.42 - 175 mS/m (Avg.: 49.56 mS/m). 2014-2024 GW Geosites: 0 - 370 mS/m, some >500 mS/m. Mostly consistent with WMS (2000-2024), except for values above the upper limit.
Fluoride	67	43.23	155	0.14	mg/L	0.025 - 0.50 mg/L (Avg.: 0.14 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	0.025 - 1.75 mg/L (Avg.: 0.14 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	0.025 - 0.50 mg/L (Avg.: 0.12 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	67	43.23	155	3.95	mg/L	0.025 - 10.43 mg/L (Avg.: 1.88 mg/L). 2014-2024 GW Geosites:0 - 11 mg/L, some 20 - 50 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	0.005 - 36.10 mg/L (Avg.: 5.14 mg/L). 2014-2024 GW Geosites: 0 - 11 mg/L, some 20 - 50 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	0.005 - 5.81 mg/L (Avg.: 0.77mg/L). 2014-2024 GW Geosites: 0 - 11 mg/L, some 20 - 50 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	67	42.95	156	6.57	pH unit	4.42 - 8.15 (Avg.: 6.41). 2014-2024 GW Geosites: 5.7 - 9. Consistent with WMS (2000-2024).	4.16 - 8.66 (Avg.: 6.57). 2014-2024 GW Geosites: 5.7 - 9. Consistent with WMS (2000-2024).	4.33 - 8.10 (Avg.: 6.63). 2014-2024 GW Geosites: 5.7 - 9. Mostly consistent with WMS (2000-2024), except some WMS values >9.
Sulphate	67	42.95	156	33.03	mg/L	0.6 - 125.47 mg/L (Avg.: 31.32 mg/L). 2014-2024 GW Geosites: 0 - 800 mg/L. Consistent with WMS, except for values above the upper limit.	0.6 - 321.20 mg/L (Avg.: 39.12 mg/L). 2014-2024 GW Geosites: 0 - 800 mg/L. Mostly consistent with WMS (2000-2024).	0.6 - 96.42 mg/L (Avg.: 14.14 mg/L). 2014-2024 GW Geosites: 0 - 200 mg/L, some 500 - 800 mg/L. Mostly consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the Sandveld SWSA-gw, taken from the WMS database from 2000-2024.*

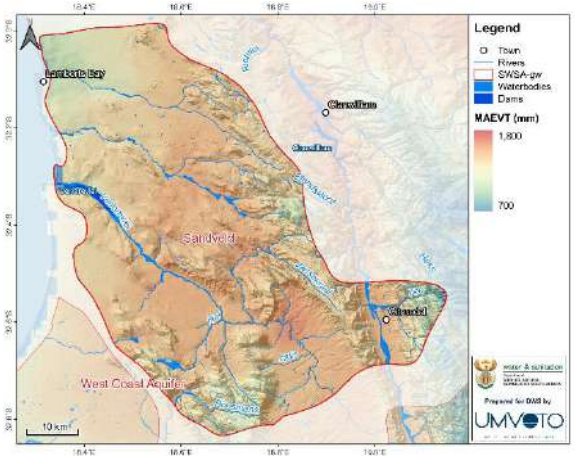
SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl

Threats & Risks

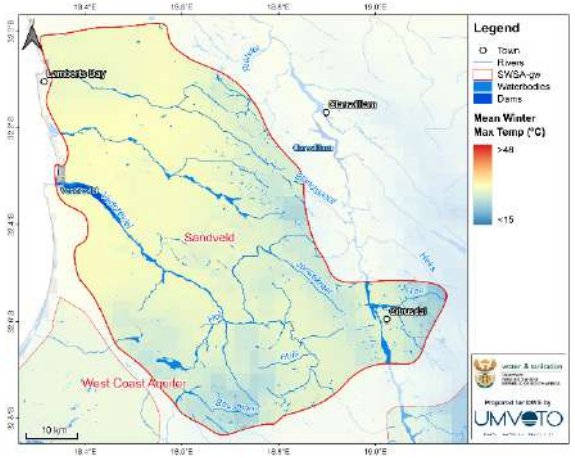
Climate

According to the Köppen-Geiger Climate Classification (Beck et al., 2018), the Sandveld SWSA-gw predominantly have a BSk and BSh, semi-arid, climate type characterised characterised by hot, dry summers, though BSk areas experience colder winters. Towards the southeastern side, the climate transitions into the Csa type, which features dry, hot summers. Temperatures in the SWSA-gw range from 2 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

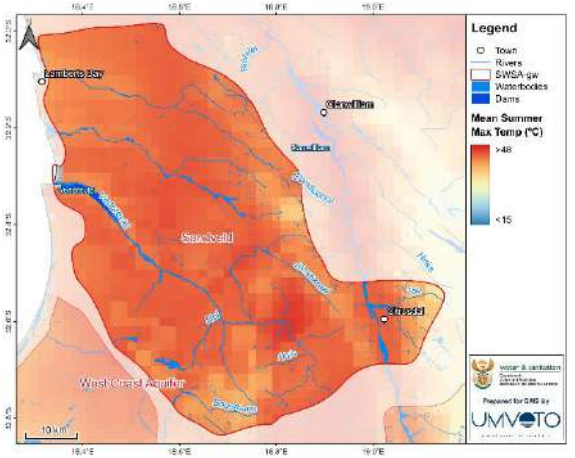
Temperature	Summer: 25 to 31 ºC, Winter: 2 to 8°C
Evapotranspiration	Maximum of 1628 mm/a with an average value of 1409 mm/a
Climate Change Prediction	Increased temperatures, reduced rainfall, and a small decline in recharge (ranging from ~-6 to -2.4 mm/a). The DART Index indicates an overall worsening of drought conditions.



Mean annual A-Pan evaporation of the Sandveld SWSA-gw region.



Mean winter temperatures of the Sandveld SWSA-gw region.



Mean summer temperatures of the Sandveld SWSA-gw region.

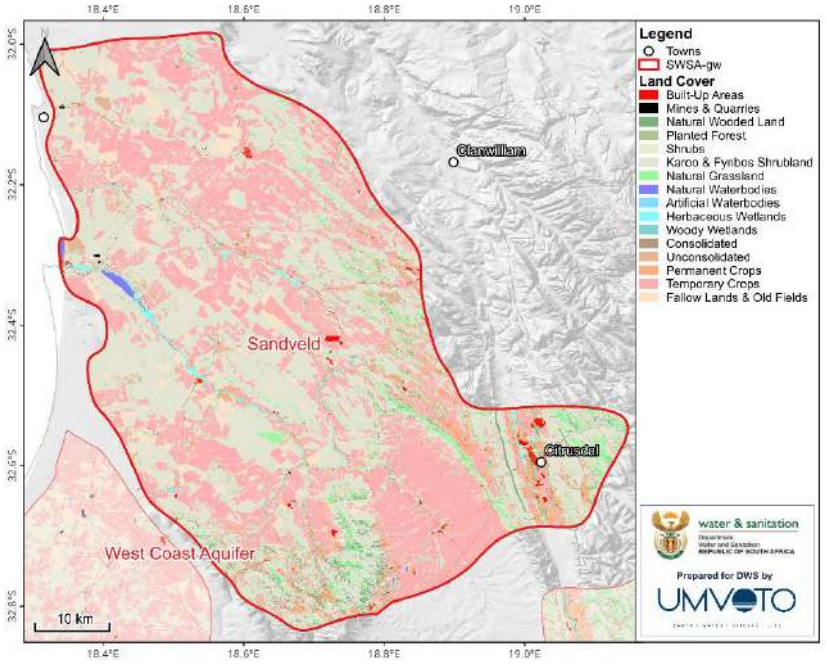
SWSA-gw Name:	Sandveld
Area:	4010 km^2
Elevation:	19 to 1387 mamsl

Threats & Risks

Land Use

Shrubland, consisting of Karoo and Fynbos, is the dominant land cover (DFFE, 2022), occupying 48.9% of the Sandveld SWSA-gw, highlighting the region's natural vegetation and ecological significance. Cultivated lands occupy 40.7%. This is made up of both temporary and permanent crops, indicating a strong agricultural presence and reliance on cultivated land as well as fallow lands and old fields. Barren land, which is made up of consolidated and unconsolidated lands, along with grassland and forested land, contributes to the region's diverse terrain. Wetlands and water bodies occupy a small but essential portion of the landscape, playing a crucial role in water retention and biodiversity conservation. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.1% of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	159	4.0
Built-Up	26	0.6
Cultivated	1634	40.7
Forest Land	85	2.1
Grassland	99	2.5
Mines and quarries	3	0.1
Shrubland	1959	48.9
Waterbodies	13	0.3
Wetlands	33	0.8



Land Cover 24-class map to show the types of land use and extent of each occurring in the Sandveld SWSA-gw.

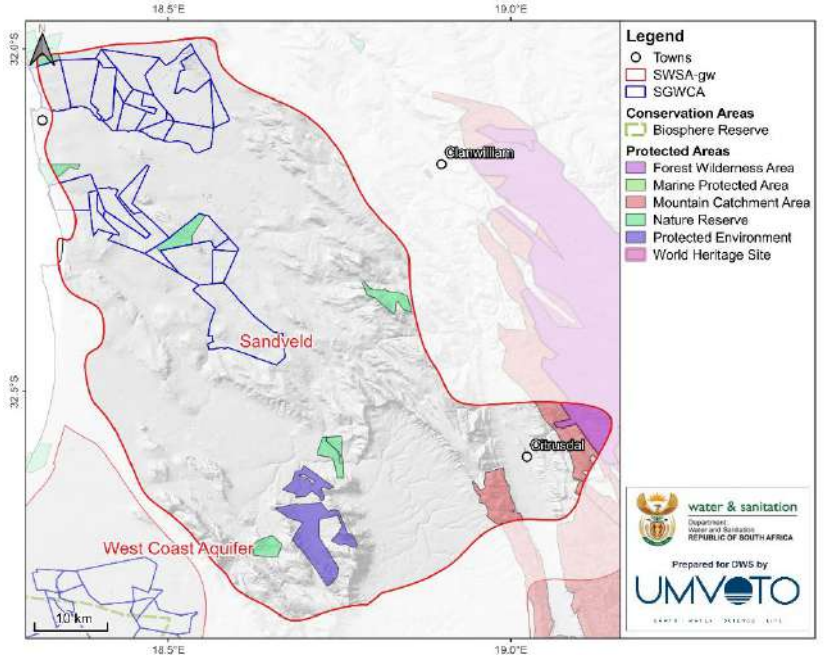
SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Sandveld SWSA-gw has a total of 266.17 km² designated as protected areas (DFFE, 2024), including significant sites like the Sederberg and Winterhoek Mountain Catchment Areas along the southeastern section of the SWSA-gw near the town of Citrusdal, as well as various private and smaller nature reserves. The region also includes the subterranean groundwater control areas (SGWCA) (CSIR, 1998) of Graafwater and Wadrif, covering approximately 13% of the SWSA-gw, as indicated on the map. This shows areas where the government had control over groundwater on private land under the Water Act No. 54 of 1956 (DWA, 2010). However, there are no national parks or designated conservation areas within the region, meaning that large-scale ecological protection is limited. The Cape Floral Region Protected Area, which covers a small portion of the SWSA-gw, is a world heritage site which contributes to biodiversity conservation, especially in mountain and nature reserve zones.

Protection Status	Names	Area (km²)	Count
Conservation Areas	None		0
Protected Areas	• Sederberg Mountain Catchment Area • Winterhoek Mountain Catchment Area • Mountshoek Protected Environment • Banghoek Private Nature Reserve • Cape Floral Region Protected Areas • And various other small nature reserves	266.17	10
SGWCA	• Graafwater • Wadrif	549.03	2
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Sandveld SWSA-gw that have protection status.

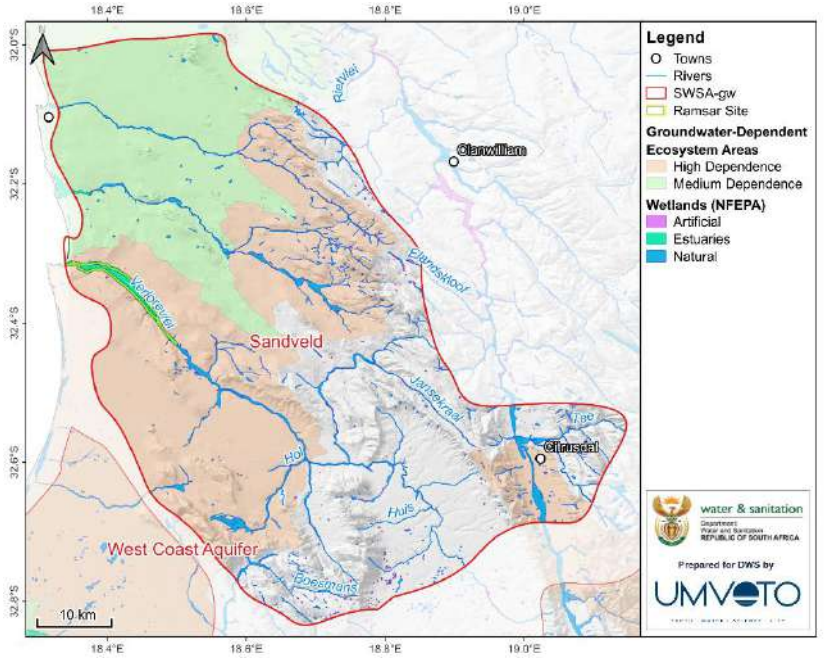
SWSA-gw Name:	Sandveld
Area:	4010 km²
Elevation:	19 to 1387 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Sandveld SWSA-gw contains a significant area of wetlands (CSIR, 2018) that consist of groundwater-dependent ecosystems (GDEs)(DWA, 2010), with a total area of 2,551 km², categorized into high and medium dependence zones. High-dependence GDEs, such as alluvial and dune fynbos systems, are primarily concentrated along major river courses and near Citrusdal, while medium-dependence dune strandveld areas are more prevalent in the western coastal zones. The Verlorenvlei Estuary (CSIR, 2011), which runs along the Verlorevlei River and extends to the river mouth, is a crucial waterbody and a designated Ramsar site (DFFE, 2024), emphasising its international importance for wetland conservation. The presence of natural, estuarine, and artificial wetlands further highlights the region's ecological diversity and reliance on groundwater resources.

Protection Status	Names	Area (km²)	Count
Major Waterbodies	• Verlorenvlei Estuary	14.45	1
Ramsar Sites	• Verlorenvlei	14.45	1
Wetlands	Various natural, artificial and estuary wetlands	135	

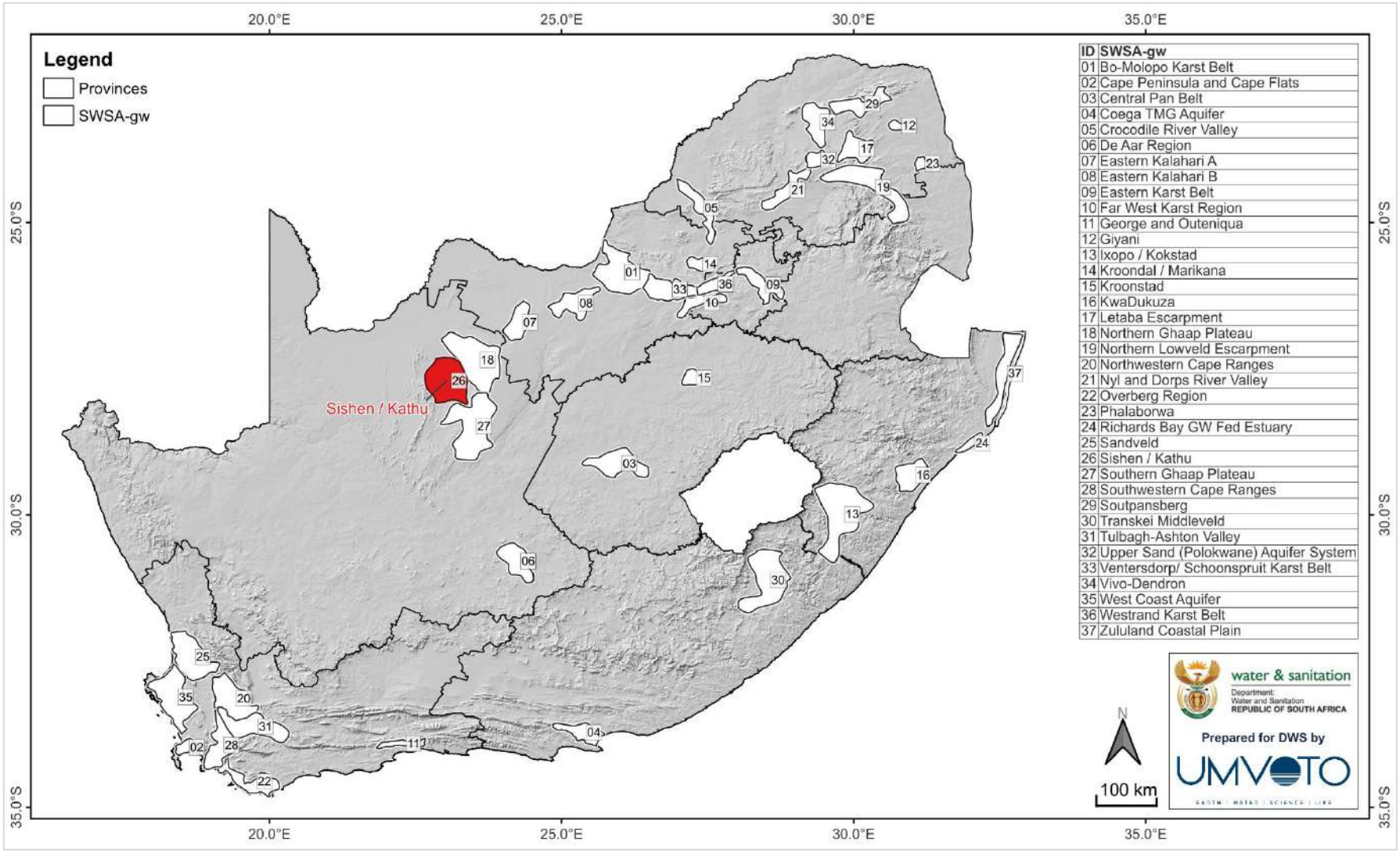


Map showing the major water bodies, Ramsar sites and GDEs in the Sandveld SWSA-gw.

APPENDIX 26

SISHEN/KATHU SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE SISHEN / KATHU SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

26. Sishen/Kathu

26.1. Description

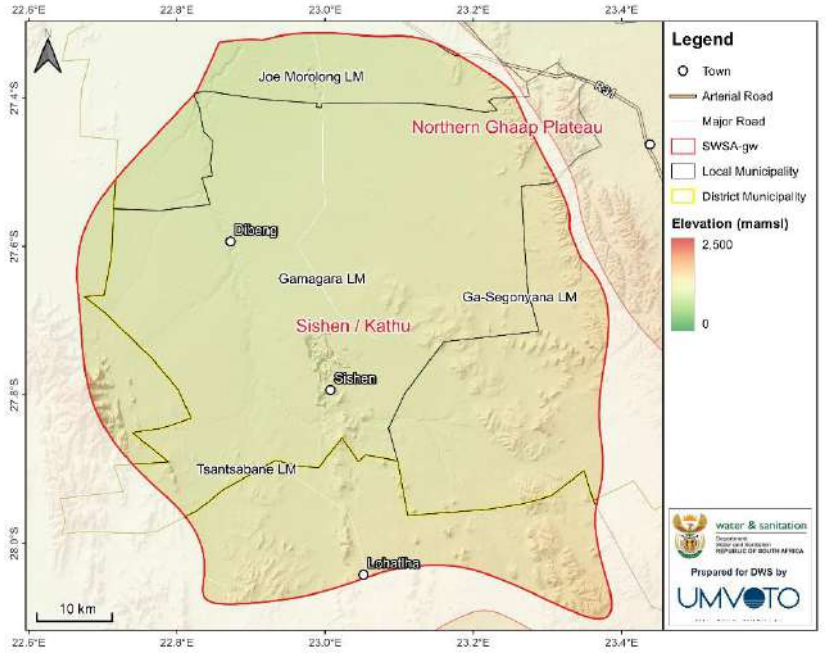
SWSA-gw Name:	Sishen/Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl

Geospatial Context

The topography of the Sishen/Kathu SWSA-gw, as depicted in the map, is characterized by a relatively flat to gently undulating topography, typical of the Kalahari Basin. The landscape consists mostly of sandy plains and low-relief terrain, with occasional dunes and isolated hills.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Northern Cape
District Municipality	John Taolo Gaetsewe, Z F Mgcawu
Local Municipality	Joe Morolong Gamagara, Tsantsabane, Ga-Segonyana and Kgatelopele
Towns	Kathu
Major Roads	N14
Major Water Supply Networks	



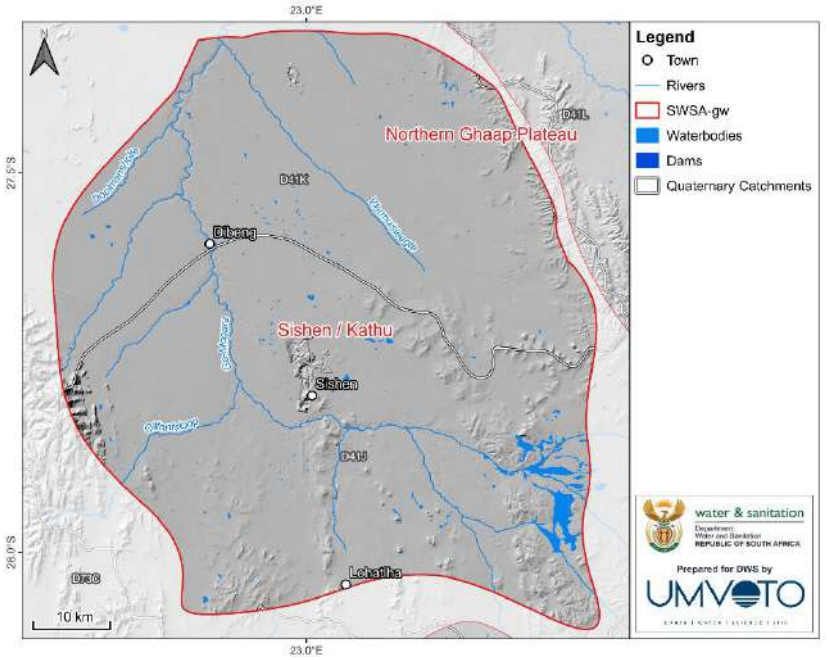
Locality map of Major Towns, districts and Local Municipalities in the Sishen/Kathu SWSA-gw.

SWSA-gw Name:	Sishen/Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl

Hydrology and Drainage

The Sishen/Kathu SWSA-gw and surrounding areas include a few surface water systems, summarised below and displayed in the map on the right. All the rivers in the area are ephemeral fed by the D4 catchment and flowing towards the north.

Quaternary Catchments	D41J, D41K and a small section of D73A, D41L
Rivers	Perennial: None
	Ephemeral: Dooimansholte, Ga-Mmatshephe, Ga-Mogara, Olifantsloop, Vlermuisleegte, Witleegte
Natural and manmade water bodies	
Major Dams:	No major dams
Water Management Areas:	Vaal Orange



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Sishen/Kathu SWSA-gw.

SWSA-gw Name:	Sishen/Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl
Geology	

Geology

Tertiary deposits, comprising calcrete, calcified pan dunes, and surface limestone, are present in the central Sishen/Kathu area, along with Quaternary deposits of superficial cover sand, rubble, and soil along the eastern edge. The Gordonia Formation of the Kalahari Group covers the majority of the area.

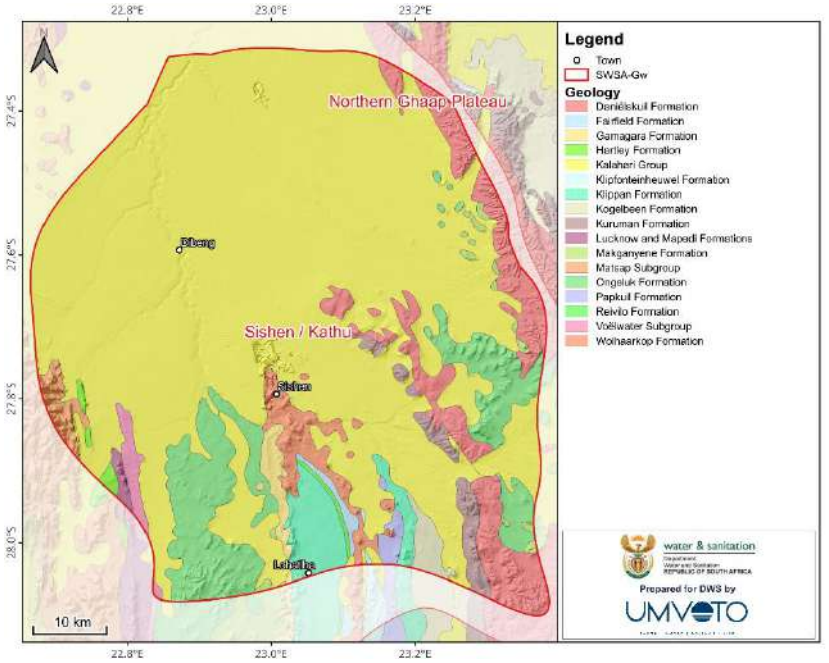
The Olifantshoek Supergroup outcrops west of the Transvaal Supergroup and includes coarse-grained, reddish-brown quartzite, minor conglomerate, basalt/basaltic andesite, tuff, quartzite, flagstone, shale, and dolomitic limestone, with aeolian sands, including cover sands and dunes, also present in this region.

The Transvaal Supergroup dominates the geology of the area, with significant representation by the Ghaap Group in the central southern section. The Ghaap Group is characterised by iron-formation ("jaspilite"), mudrock, and minor minerals such as crocidolite, riebeckite, and minnesotaite. The Asbestos Hills Subgroup outcrops are in the southeastern section, featuring ferruginized brecciated banded ironstone.

The Postmasburg Group of the Transvaal Supergroup outcrops in the southwestern and southeastern sections of the area. Its formations include the Makganyene Formation, consisting of diamictite, subordinate sandstone, carbonate rock, jaspilite, mudrock, chert, and conglomerate; the Ongeluk Formation, dominated by andesitic and basaltic lava with rich pillow structures and minor jasper; and the Volwater Subgroup, characterised by dolomite, jasper, iron-formation, chert, and minor lava.

Hydrostratigraphy

The Tertiary and Quaternary deposits of the Kalahari Group form a primary, intergranular aquifer system. The Ghaap Plateau Dolomites create a secondary karstic aquifer system. The Olifantshoek and Postmasburg Groups host secondary fractured aquifer systems, where groundwater occurs within weathered rock and fracture networks. The Lower Vaal Aquifer consists of chert-rich dolomites forming a secondary karstic-fractured aquifer system.



Geology Map of the Sishen/Kathu SWSA-gw region.

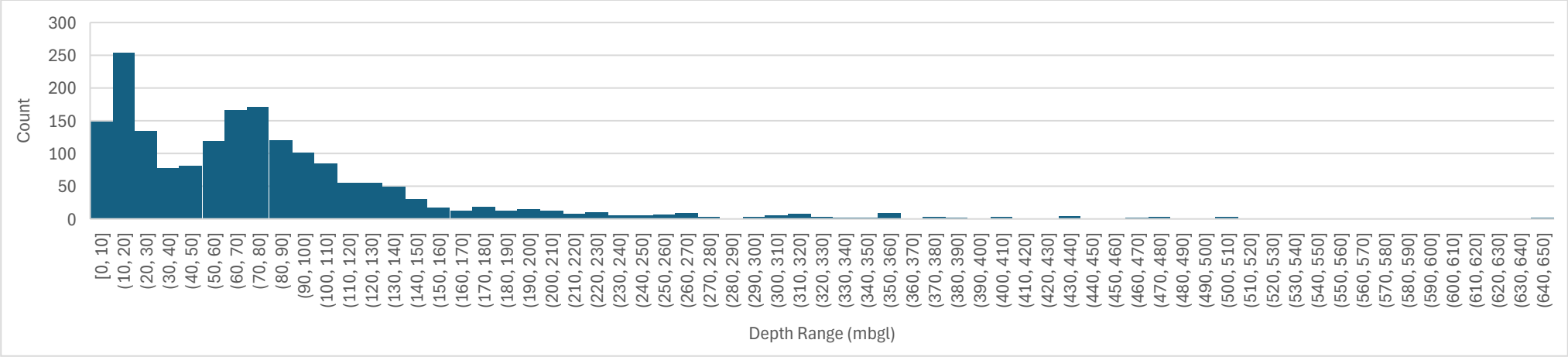
26.2. Current Status

SWSA-gw Name:	**Sishen / Kathu**
Area:	**4827 km²**
Elevation:	**1025 to 1762 mamsl**
Quantity & Quality	
Aquifer Classification	

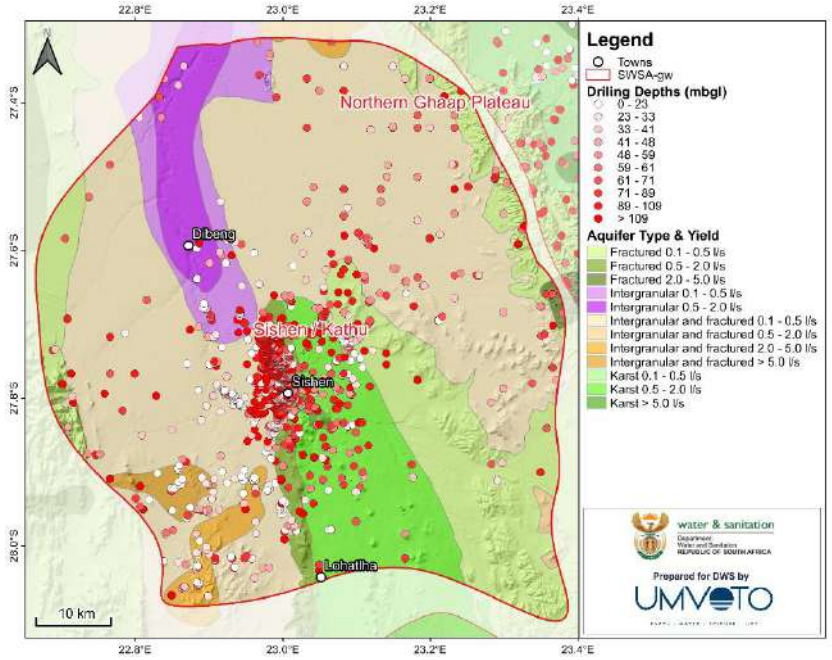
The aquifer systems within the Sishen / Kathu SWSA-gw exhibit varying yields across intergranular, karst and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The majority of the SWSA-gw consists of a minor aquifer system, with a poor aquifer system in the northern section. The minor aquifer system has an average dual-porosity yield ranging from 0.1 to over 0.5 l/s, with an average karst yield of 0.5 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 83 mbgl, and the most common depths are between 40 to 60 mbgl, suggesting mixed targets. The majority of the boreholes target the karst and the dual-porosity aquifer system, with minimal deeper drilling (> 200mbgl) into the fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 24 and 102 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 36 mbgl, with values ranging from 1 to 188 mbgl and a standard deviation of ~ 31 mbgl.

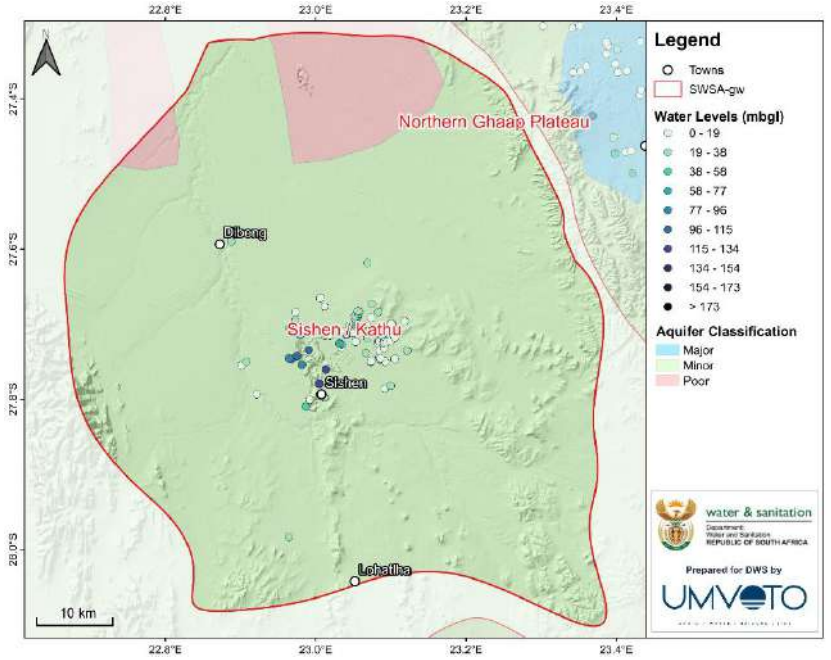
Graph of NGA drilling depths of the Sishen / Kathu SWSA-gw region



SWSA-gw Name:	Sishen / Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield of the Sishen / Kathu SWSA-gw region.



Map of the Aquifer Classification of the Sishen / Kathu SWSA-gw region.

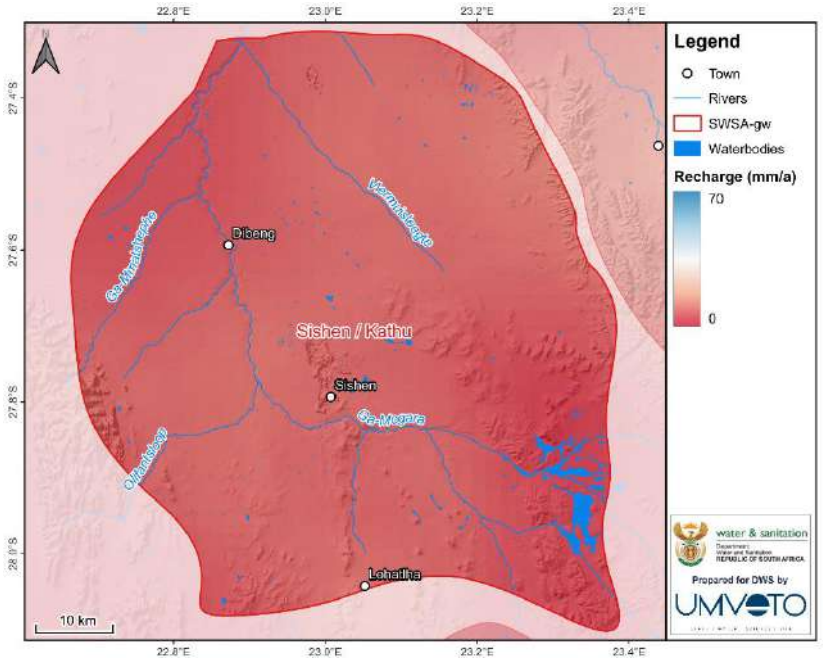
SWSA-gw Name:	**Sishen / Kathu**
Area:	**4827 km²**
Elevation:	**1025 to 1762 mamsl**

Quantity & Quality

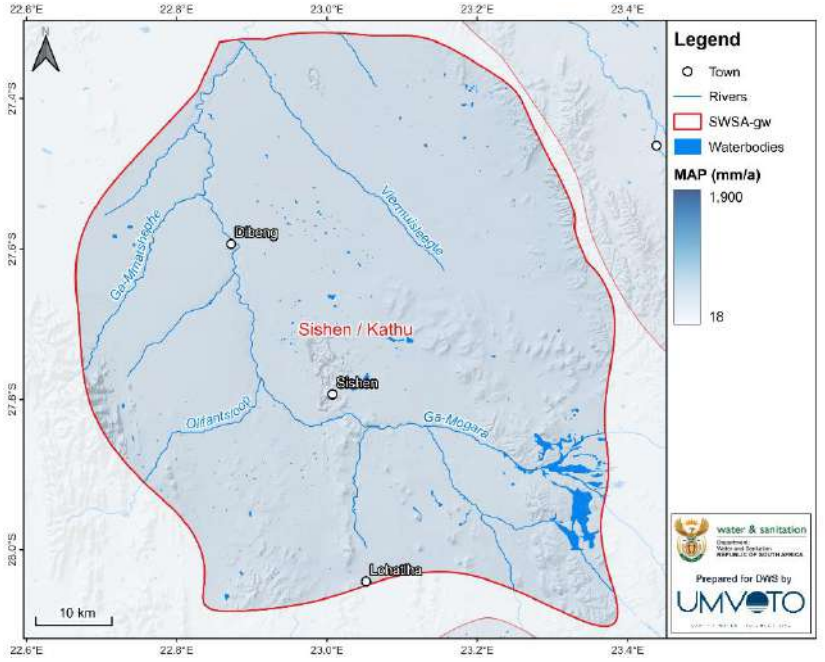
Groundwater Recharge

The Sishen Kathu receives a total MAP volume of 1634 Mm³/a, with an average rainfall of 339 mm/a. However, only 36.3 Mm³/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 2.2% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm³/a	Average of MAP mm/a	Sum of Recharge Vol Mm³/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm³/a)
Sishen / Kathu	1634	339	36.3	7.5	2.2%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

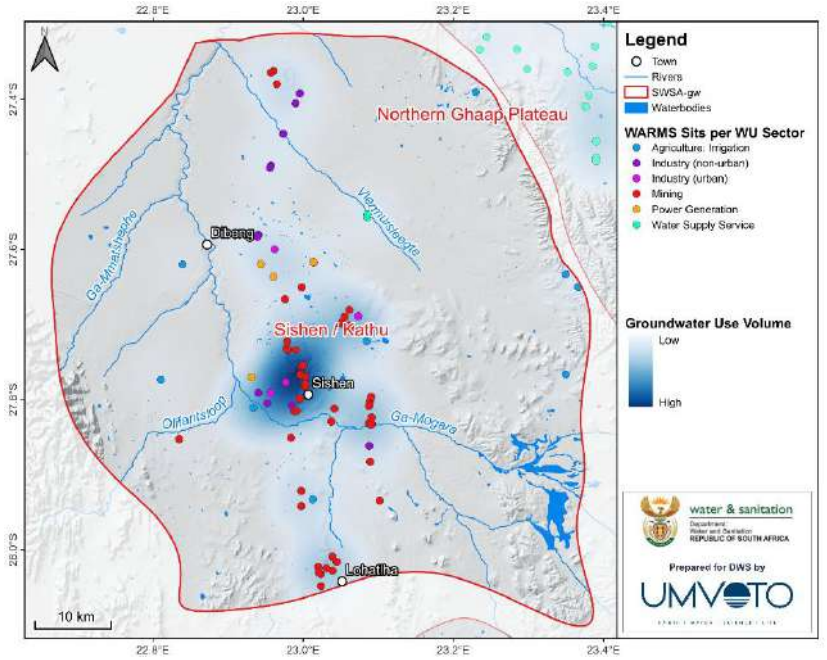
SWSA-gw Name:	Sishen / Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl
Quantity & Quality	
Groundwater Use	

The Sishen Kathu SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Kathu (Conjunctive), which relies significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Mining use has 14.1Mm^3/a allocated to it. Water is a vital resource in the mining process. Groundwater can offer a reliable water source in water-scarce or remote areas. Most of the mining use in near Kathu and in the southern parts of the region.
- Urban industrial follows, using 2.6 Mm^3/a for manufacturing, processing, and other industrial activities in urban centres. This sector is a major driver of groundwater demand, relying on the resource where alternative water supplies are limited. Urban industrial use is scattered across the region; there are a few areas south of Kathu, but it is mostly in the northern parts of the area.
- Agricultural irrigation use, with 0.6 Mm^3/a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. This reliance highlights the need for careful management to prevent over-extraction. This use is the least abundant but is more evenly distributed.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Kathu, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	0.6
	Industry (Non-urban)	0.1
	Industry (Urban)	2.6
	Mining	14.1
	Power Generation	0.04
	Water Supply Service	0.03
	Total	**17.5**



Water use map for the Sishen Kathu SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

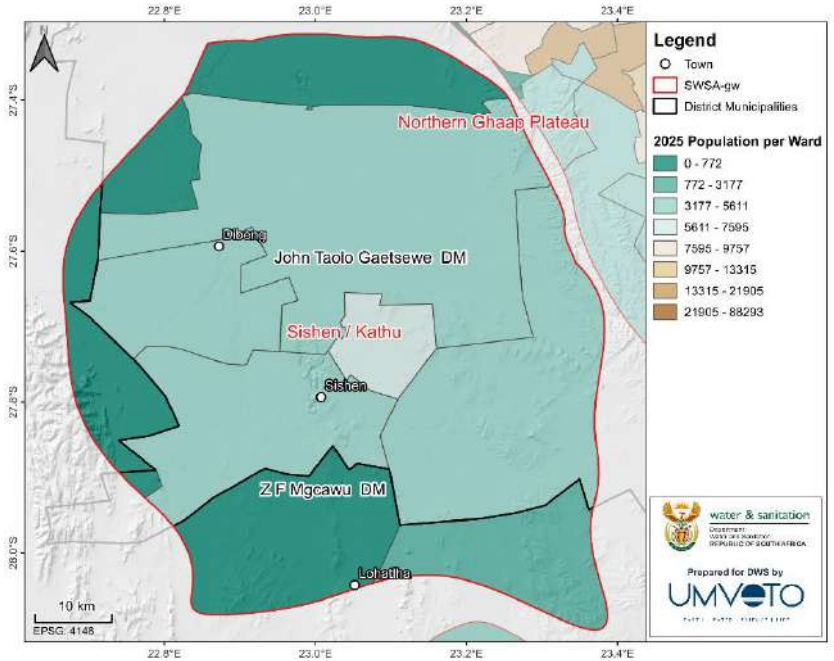
SWSA-gw Name:	Sishen / Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Sishen / Kathu SWSA-gw is located within the Vaal-Orange Water Management Area (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Sishen / Kathu SWSA-gw was calculated using Census 2011 2011 and 2022 data to determine a population growth rate of -0.62% per year, resulting in a projected population of approximately 24,256.

As shown in the map and table below, Gamagara Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 18,802. Population concentrations within the SWSA-gw are highest in the Gamagara LM.



Projected population distribution in 2025 for the Sishen / Kathu SWSA-gw.

SWSA-gw Name:	Sishen / Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl

Quantity & Quality

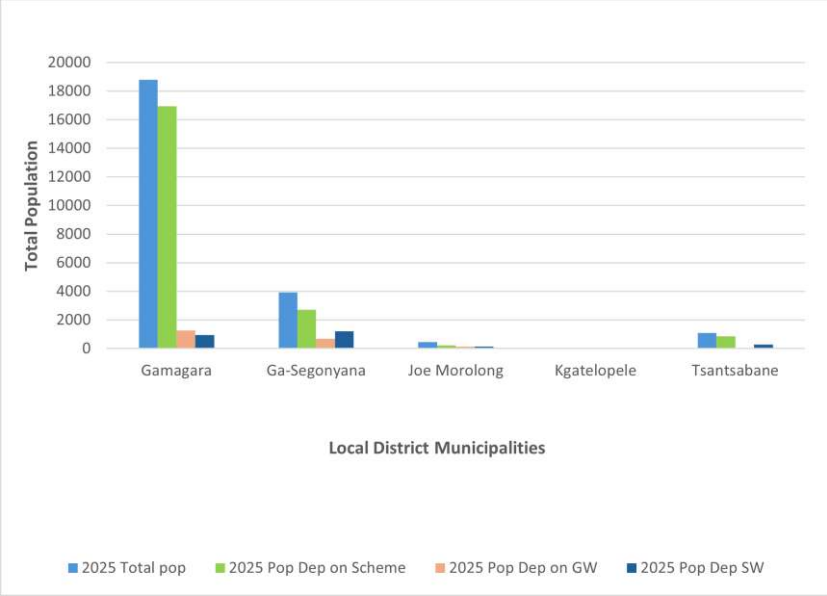
Socio Economic & Governance

In terms of water reliance within the Sishen / Kathu SWSA-gw, an estimated 85.4% of the population depends on the regional water supply scheme, 10.6% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 8.8% on groundwater sources (including boreholes and springs).

Among the LMs, the Joe Morolong LM has the highest proportion of groundwater reliance, with approximately 30.3% of its population depending on groundwater and 29.3% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Gamagara	18,802	16,929	1,253	943
Ga-Segonyana	3,933	2,699	689	1,217
Joe Morolong	441	219	134	129
Kgatelopele	0	0	0	0
Tsantsabane	1,079	861	56	280
Total	**24,256**	**20,709**	**2,131**	**2,569**



Projected population dependence on water sources in 2025.

SWSA-gw Name:	Sishen / Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl

Quantity & Quality

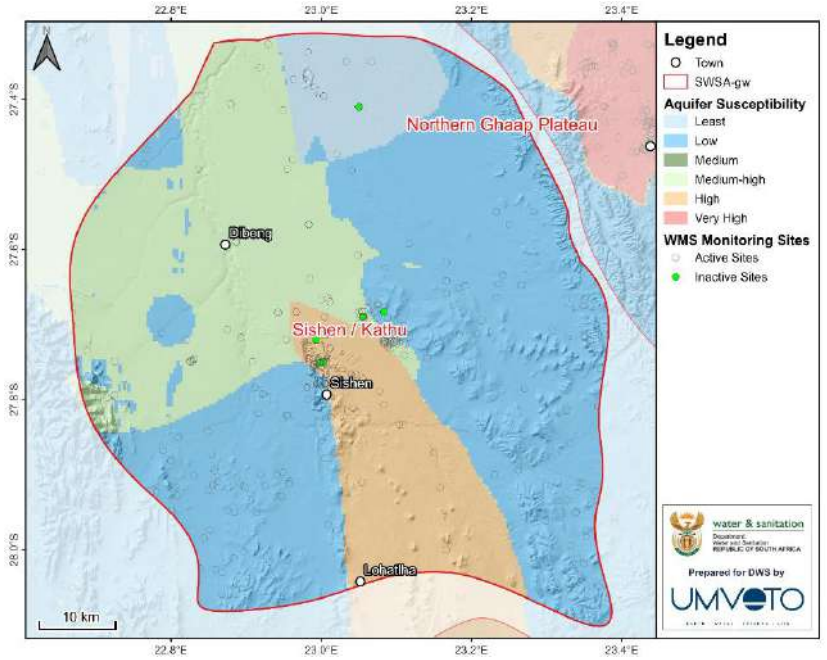
Groundwater Quality

The Sishen / Kathu SWSA-gw consists of Minor and Poor aquifer systems, classified based on their yield and water quality. The Minor Aquifer System is moderately productive and has variable water quality, while the Poor Aquifer System is a low to negligibly productive system and has moderate to poor water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), mines and quarries cover a total of 113.15 km^2, which is 2.34% of the Sishen / Kathu SWSA-gw total area. Urban/Built-up areas cover 35.34 km^2 (0.73%), while cultivated areas account for 35.15 km^2 (0.73%) of the total area. These land uses contribute to diffuse contamination sources, with mining being the primary concern. Mining has significant impacts on water quality through unmanaged point discharges (e.g. from tailings dams) and groundwater impacts, particularly the generation of acid mine drainage (AMD). The acidity in the AMD increases the solubility of aluminium and heavy metals, and this polluted water may decant to, or is discharged into, surface waters where it can have significant impacts on human and aquatic ecosystem health (Le Maitre et al., 2018). Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Poor aquifer system covers two small sections in the Northern edges of the Sishen/Kathu SWSA-gw, the Minor aquifer system covers the rest of the aquifer. WMS data is available for the least, moderate and most vulnerable aquifer areas in the Minor aquifer system.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 54.7- 94.78 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 1.07 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 1.49 - 19.54 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.78 - 8.68 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 12.18 – 86.11 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Sishen / Kathu**
Area:	**4827 km^2**
Elevation:	**1025 to 1762 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Sishen / Kathu SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	5	23.81	21	75.77	mS/m	54.7- 94.78 mS/m (Avg.: 80.86 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Mostly consistent with WMS (2000-2024).	64.6 - 88.3 mS/m (Avg.: 78.59 mS/m). 2014-2024 GW Geosites: N/A	64.7 - 78.2 mS/m (Avg.: 70.51 mS/m). 2014-2024 GW Geosites: N/A
Fluoride	5	23.81	21	0.23	mg/L	0.025 - 1.07 mg/L (Avg.: 0.19 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).	0.1 - 0.28 mg/L (Avg.: 0.17 mg/L). 2014-2024 GW Geosites: N/A	0.15 - 0.61 mg/L (Avg.: 0.29 mg/L). 2014-2024 GW Geosites: N/A
Nitrate + Nitrite Nitrogen	5	23.81	21	3.45	mg/L	1.73 - 19.54 mg/L (Avg.: 2.78 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	1.49 - 2.37 mg/L (Avg.: 1.90 mg/L). 2014-2024 GW Geosites: N/A	1.61 - 10.48 mg/L (Avg.: 4.52 mg/L). 2014-2024 GW Geosites: N/A
pH	5	23.81	21	7.98	pH unit	6.78 - 8.68 (Avg.: 8.08). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	7.43 - 7.99 (Avg.: 7.81). 2014-2024 GW Geosites: N/A	7.67 - 8.17 (Avg.: 7.94). 2014-2024 GW Geosites: N/A
Sulphate	5	23.81	21	24.44	mg/L	18.76 - 39.7 mg/L (Avg.: 27.73 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	14.77 - 33.62 mg/L (Avg.: 23.17 mg/L). 2014-2024 GW Geosites: N/A	12.18 - 86.11 mg/L (Avg.: 22.08 mg/L). 2014-2024 GW Geosites: N/A

- *"Average" refers to the average concentrations for the Total Active Sites of the Sishen / Kathu SWSA-gw, taken from the WMS database from 2000-2024.*
- *"N/A" refers to Not Applicable*

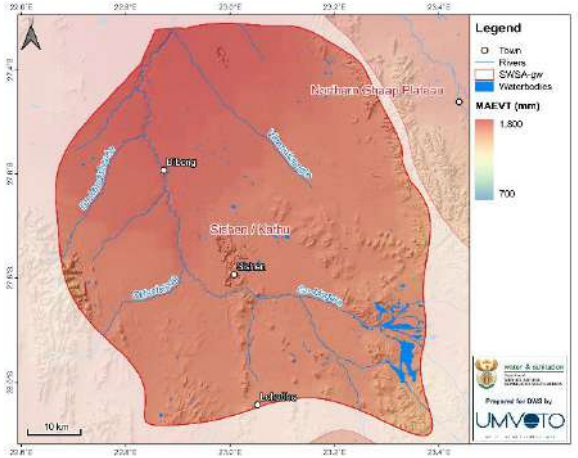
SWSA-gw Name:	**Sishen / Kathu**
Area:	**4827 km²**
Elevation:	**1025 to 1762 mamsl**

Threats & Risks

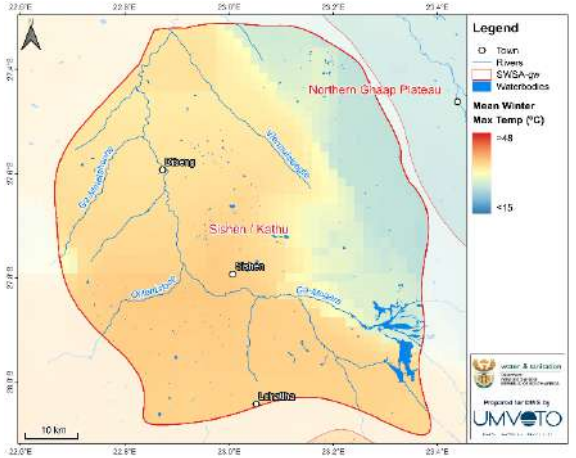
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Sishen / Kathu SWSA-gw changes from a BSh hot semi-arid, type climate characterised by hot summers, warm to cool winters, and little precipitation, in the northwest to a BSk, cold semi-arid, type climate characterised by hot, dry summers and cold winters in the southeast. Temperatures in the SWSA-gw range from 0.1 – >31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

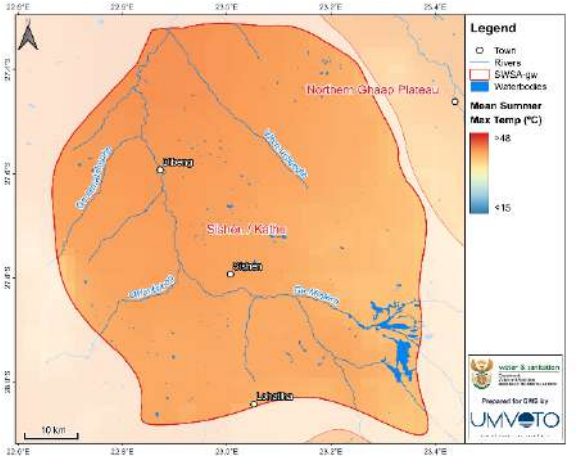
Temperature	Summer: 27 to >31 °C, Winter: 0.1 to 4 ºC
Evapotranspiration	Maximum value of 1778 mm/a with an average value of 1676 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, and a small decline in recharge (ranging from ~ -6 to -2.4 mm/a). The DART Index indicates mostly stable conditions.



Mean annual A-Pan evaporation of the Sishen / Kathu SWSA-gw region.



Mean winter temperatures of the Sishen / Kathu SWSA-gw region.



Mean summer temperatures of the Sishen / Kathu SWSA-gw region.

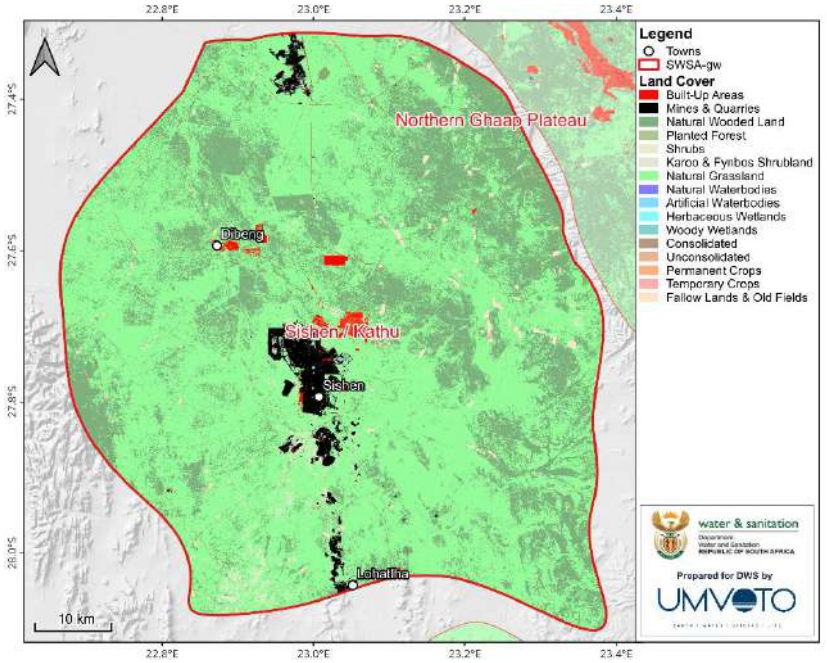
SWSA-gw Name:	Sishen / Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl

Threats & Risks

Land Use

There is minimal development in the Sishen/Kathu SWSA-gw, with grassland and forest land, which consists of natural wooded land and planted forest, covering approximately 94% (DFFE, 2022) of the SWSA-gw. Towards the centre and at the northern edge of the SWSA-gw are mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, and just north of it is a relatively small built-up area made up of residential, commercial and industrial areas.

Land Use Type	Area (km^2)	Area (%)
Barren Land	8	0.2
Built-Up	35	0.7
Cultivated	35	0.7
Forest Land	1399	29.0
Grassland	3156	65.4
Mines and quarries	113	2.3
Shrubland	78	1.6
Waterbodies	2	0.04
Wetlands	0	0.0



Land Cover 24-class map to show the types of land use and extent of each occurring in the Sishen/Kathu SWSA-gw.

SWSA-gw Name:	Sishen/Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl

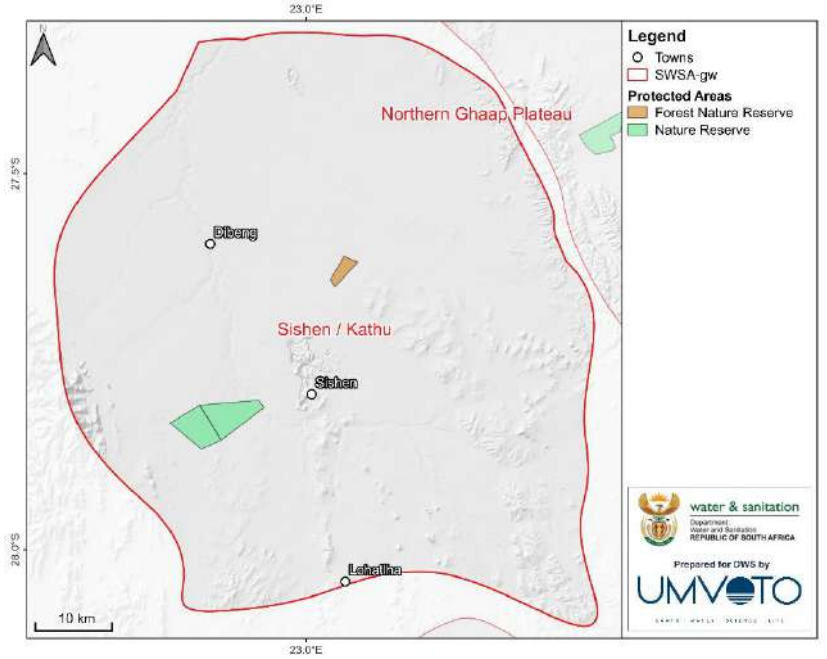
Protection Status and Ecosystems

Biodiversity and Conservation

There are two nature reserves and one forest nature reserve (DFFE, 2024) located within the Sishen/Kathu SWSA-gw.

The nature reserves, which are adjacent to each other, are located just west of the town Sishen, and the forest nature reserve is located north of Sishen, as displayed in the map.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	• Bredenkamp Nature Reserve • Brooks Nature Reserve • Khathu Forest Nature Reserve	53.69	3
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Sishen/Kathu SWSA-gw that have protection status.

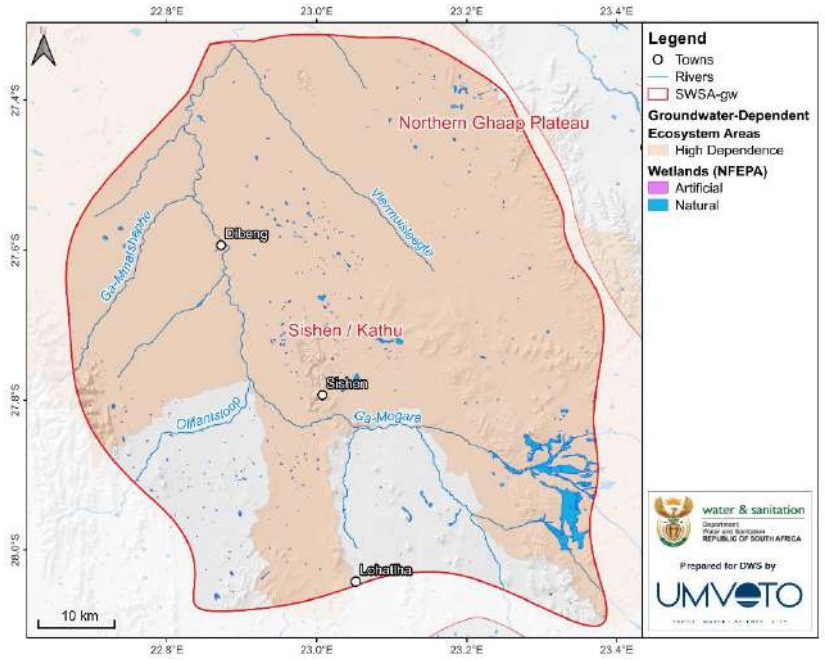
SWSA-gw Name:	Sishen/Kathu
Area:	4827 km^2
Elevation:	1025 to 1762 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Sishen/Kathu SWSA-gw is mostly by Camel Thorn vegetation with wetlands (CSIR, 2011) that are classified as potentially highly dependent on groundwater (DWA, 2010). The nature reserves fall within the area of those wetlands.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural and artificial wetlands	58	

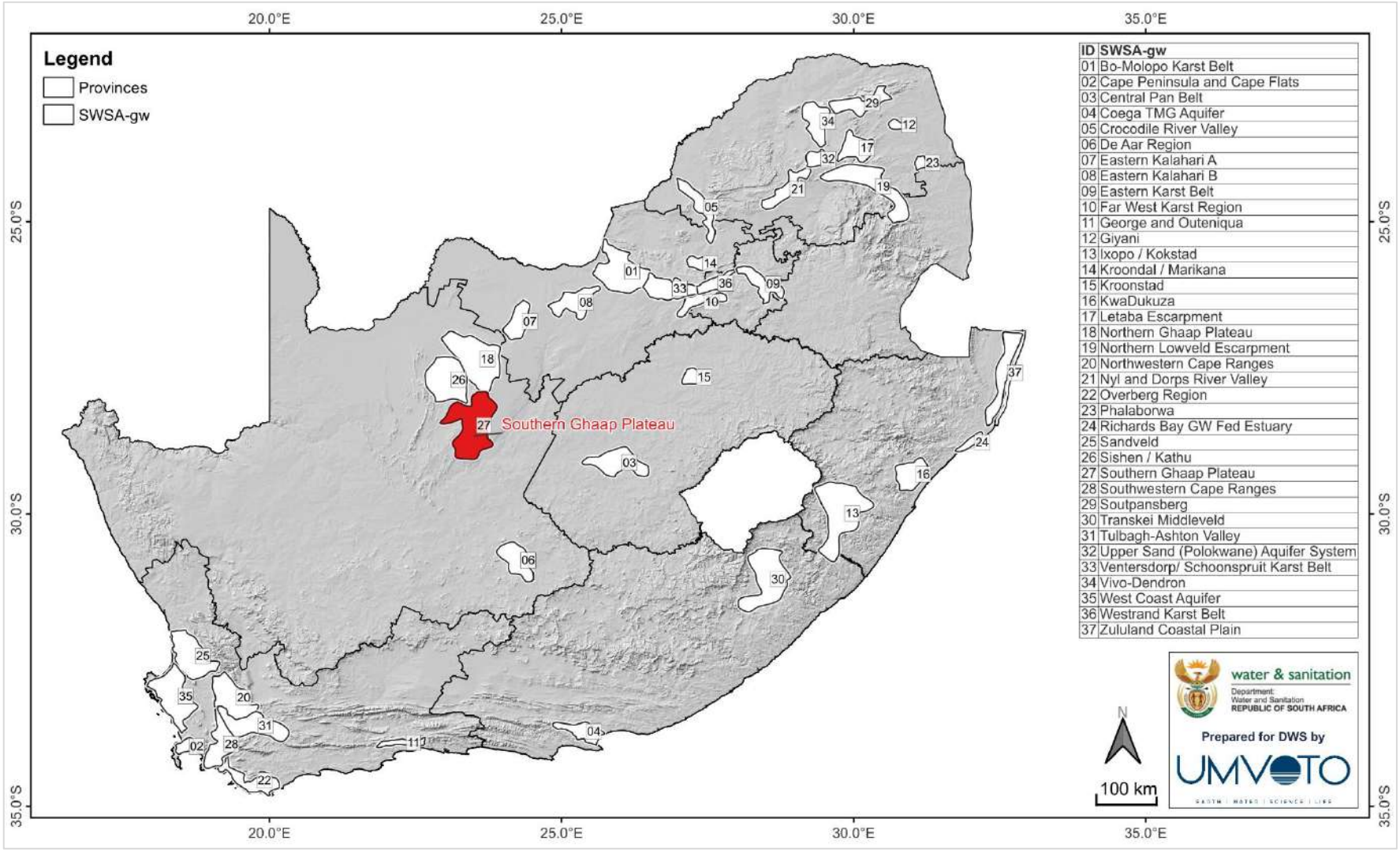


Map showing the major water bodies, Ramsar sites and GDEs in the Sishen/Kathu SWSA-gw.

APPENDIX 27

SOUTHERN GHAAP PLATEAU SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE SOUTHERN GHAAP PLATEAU SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

27. Southern Ghaap Plateau

27.1. Description

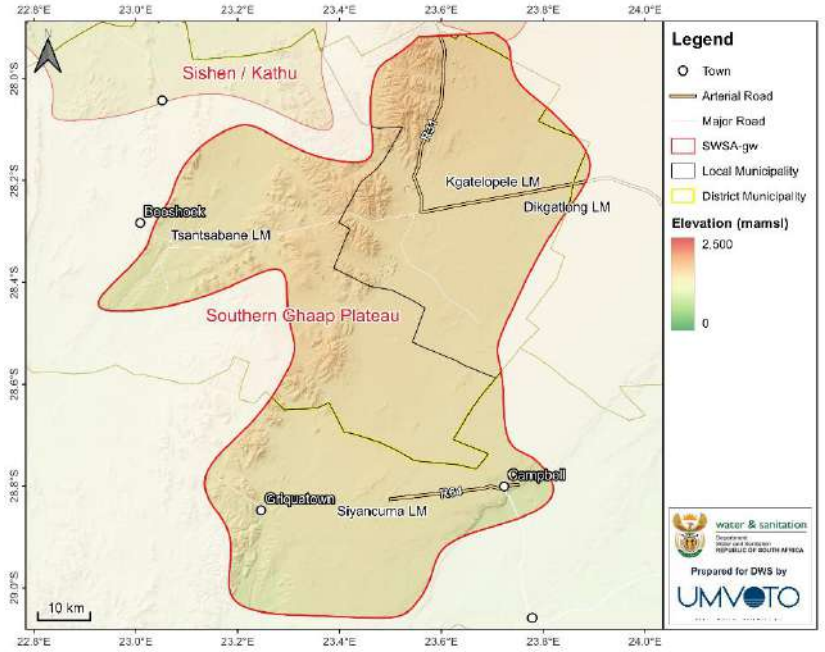
SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km²
Elevation:	1118 to 1787 mamsl

Geospatial Context

The topography of the Southern Ghaap Plateau SWSA-gw, as depicted in the map, is characterized by a predominantly low-relief landscape with vast, flat plains and gently undulating terrain. As the landscape transitions towards the west, near areas like Postmasburg, Beeshoek, and Daniëlskuil, the topography becomes slightly more rugged, with scattered rocky outcrops and elevated ridges, offering a more varied terrain.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Northern Cape
District Municipality	Z F Mgcawu, Frances Baard and Pixley ka Seme
Local Municipality	Tsantsabane, Kgatelopele, Dikgatlong and Siyancuma
Towns	Beeshoek, Daniëlskuil, Griekwastad, Lime Acres, Norfin and Postmasburg
Major Roads	N8, R31, R385
Major Water Supply Networks	



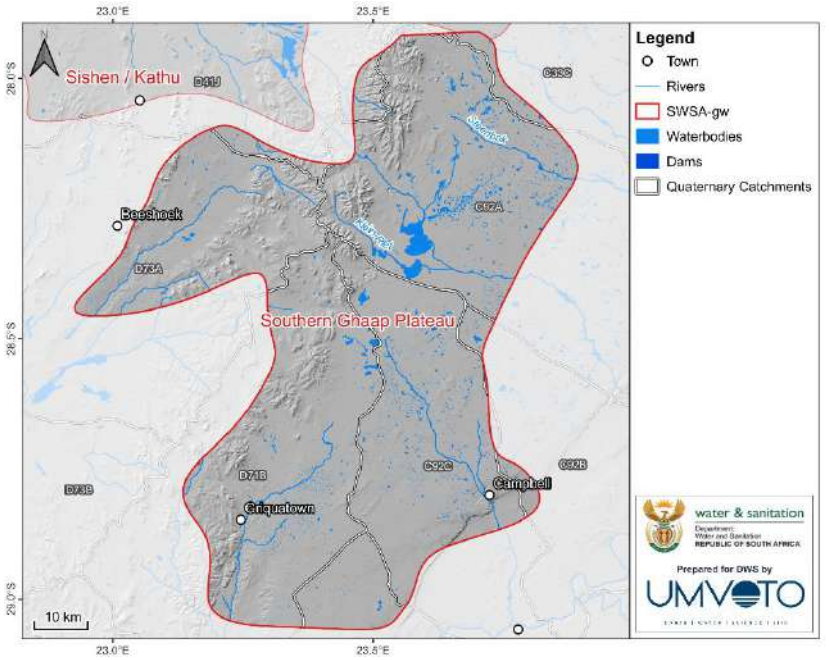
Locality map of Major Towns, District and Local Municipalities in the Southern Ghaap Plateau SWSA-gw.

SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km²
Elevation:	1118 to 1787 mamsl

Hydrology and Drainage

The Southern Ghaap Plateau SWSA-gw and surrounding areas include no major surface water systems, only a few ephemeral rivers, which are summarised below and displayed on the map to the right. The rivers flowing in a southwesterly direction are fed by the D7 catchment, while those flowing in a southeasterly direction are fed by the C9 catchment.

Quaternary Catchments	C92A, C92C, D71A, D71B, D73A and small sections of C33C, C92B, D41J
Rivers	Perennial: None
	Ephemeral: Danielskuil, Groenwaterspruit, Klein-Riet and Steenbok
Natural and manmade water bodies	
Major Dams:	No major dams
Water Management Areas:	Vaal Orange



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Southern Ghaap Plateau SWSA-gw.

SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km²
Elevation:	1118 to 1787 mamsl
Geology	

Geology

Quaternary and Tertiary deposits can be found across the southern and western sections of the area, as well as in the easternmost tip. These deposits include alluvium, river terrace gravel, scree, surface rubble, and sand, along with calcrete, calcified pan dunes, and surface limestone.

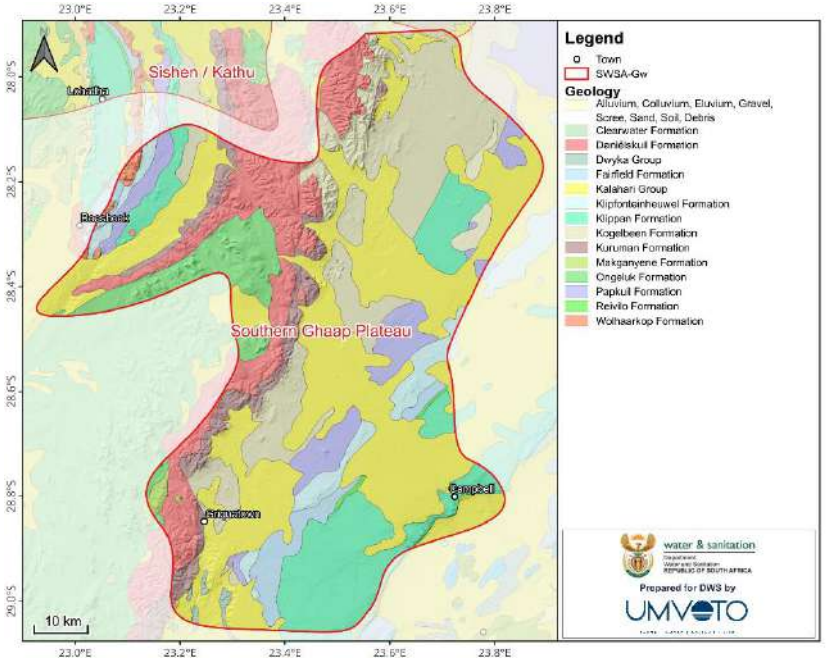
The aeolian sands, including dunes and cover sands, of the Kalahari Group are widespread across the western section of the area.

Outcroppings of the Ghaap and Postmasburg Groups of the Transvaal Supergroup can be found throughout the area. The Ghaap Group comprises chert, chert breccia, dolomite/limestone, banded iron-formation, quartzite, shale, jaspilite, and interbedded chert and limestone. The Postmasburg Group outcrops are in the westernmost section and consist of andesitic and basaltic lava with abundant pillows, minor jasper, as well as diabase, subordinate sandstone, carbonate rock, jaspilite, mudrock, chert, and conglomerate.

Faults are observed in the western corner of the area.

Hydrostratigraphy

The Quaternary and Tertiary deposits form a primary, intergranular aquifer system. The aeolian sands of the Kalahari Group constitute a primary intergranular aquifer with low yields. The dolomites of the Ghaap Group form a secondary karstic aquifer system. The Postmasburg Group, comprising andesitic and basaltic lava, chert, and mudrock, forms a secondary, fractured aquifer system.



Geology Map of the Southern Ghaap Plateau SWSA-gw region.

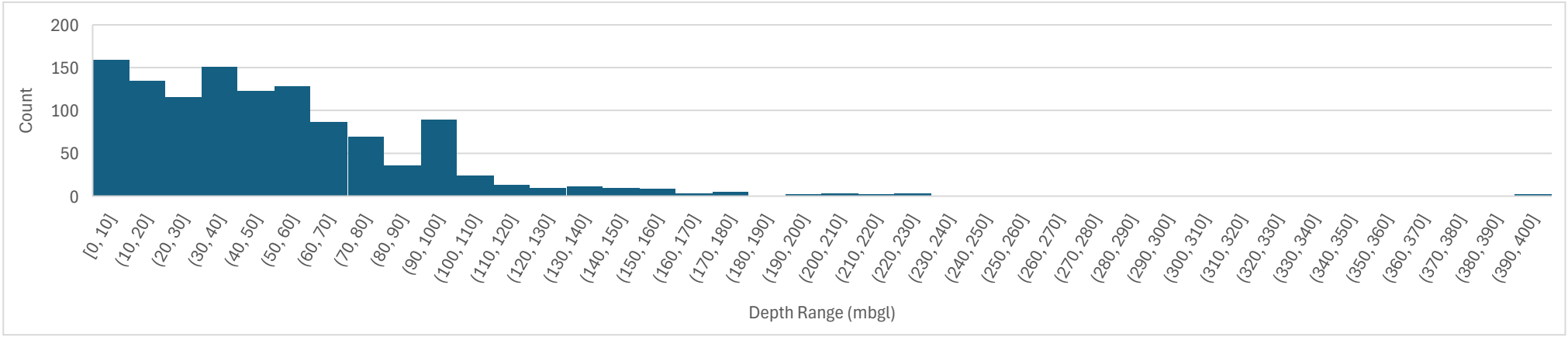
27.2. Current Status

SWSA-gw Name:	**Southern Ghaap Plateau**
Area:	**6542 km²**
Elevation:	**1118 to 1787 mamsl**
Quantity & Quality	
Aquifer Classification	

The aquifer systems within the Southern Ghaap Plateau SWSA-gw exhibit varying yields across karst and occasional fractured aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is predominantly a Minor aquifer system, with major aquifer systems in the north and south. The major aquifer systems have an average karst yield ranging from 0.1 to over 5.0 l/s, while the minor aquifer system has an average karst yield of 0.1 to 2.0 l/s, with occasional fractured yields ranging from 0.1 to over 5.0 l/s.
Groundwater Targets	The average drilling depth is 51 mbgl, and the most common depths are around 10 and 30 mbgl, suggesting mixed targets. Most boreholes target the high-yielding karst aquifer, with some deeper boreholes (>150 mbgl) suggesting a secondary target in the fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 21 and 70 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~13 mbgl, with values ranging from 0 to 68 mbgl with a standard deviation of ~ 11 mbgl.

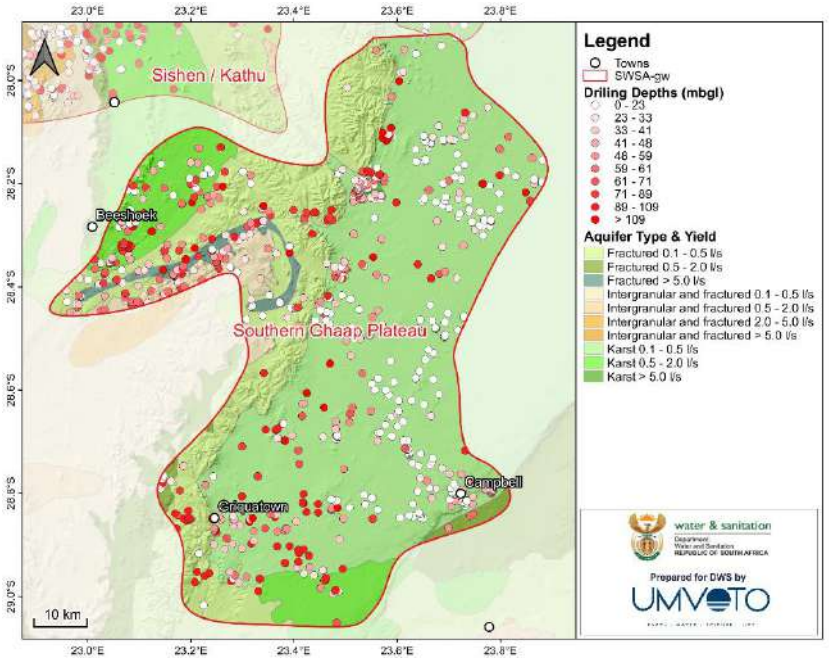
Graph of NGA drilling depths of the Southern Ghaap Plateau SWSA-gw region



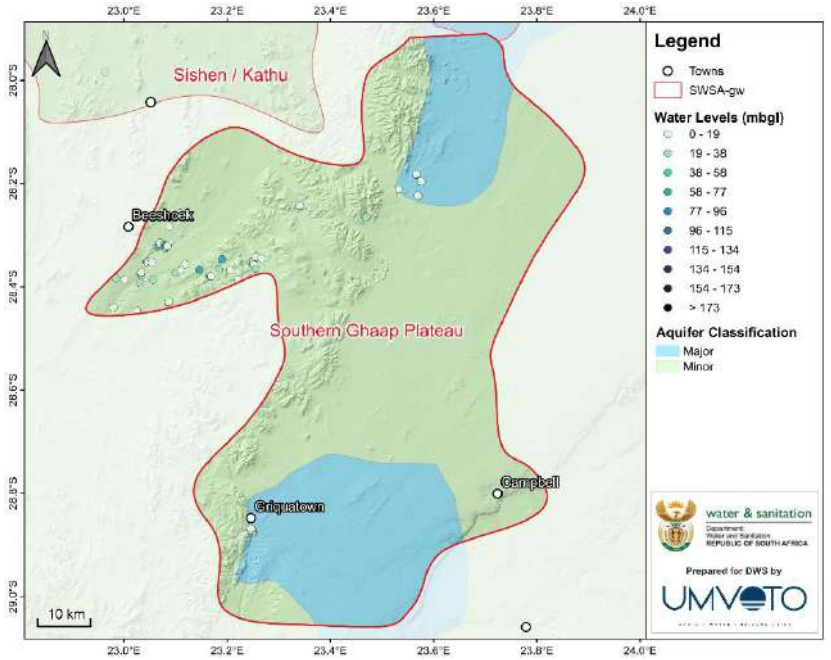
SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km²
Elevation:	1118 to 1787 mamsl

Quantity & Quality

Aquifer Classification



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Southern Ghaap Plateau SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Southern Ghaap Plateau SWSA-gw region.

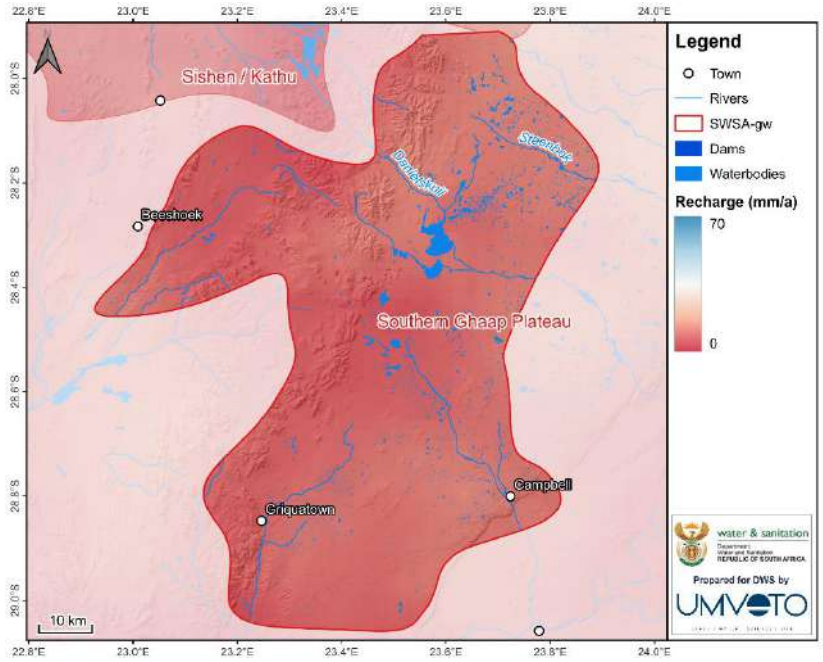
SWSA-gw Name:	**Southern Ghaap Plateau**
Area:	**6542 km²**
Elevation:	**1118 to 1787 mamsl**

Quantity & Quality

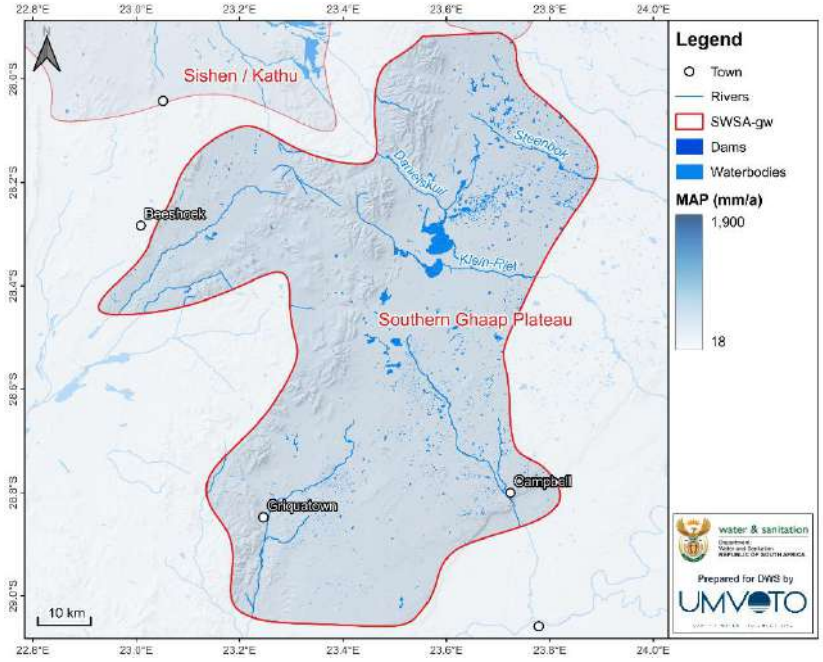
Groundwater Recharge

The Southern Ghaap Plateau receives a total MAP volume of 2166 Mm^3/a, with an average rainfall of 331 mm/a. However, only 59.8 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a very low recharge of 2.8% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Southern Ghaap Plateau	2166	331	59.8	9.1	2.8%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km²
Elevation:	1118 to 1787 mamsl

Quantity & Quality

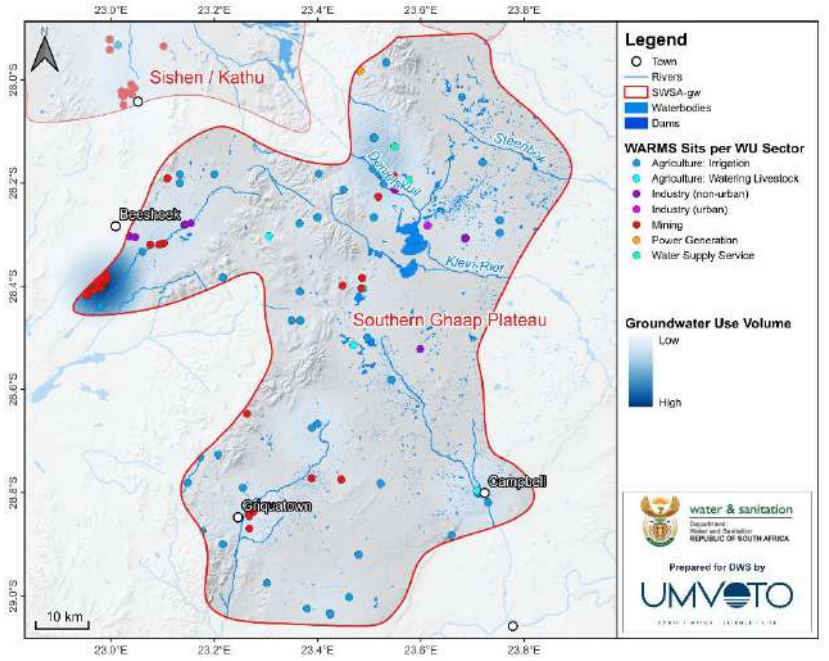
Groundwater Use

The Southern Ghaap Plateau SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Danielskuil (Groundwater), Postmasburg (Conjunctive), and Griekwastad (Groundwater), which rely significantly on groundwater resources for mining, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Mining use has 48.4 Mm^3/a allocated which is a significant proportion of the groundwater used in this region. The most consumption tends to be located near the towns like Postmasburg, Norfin, Lime Acres and Griekwastad. This is interesting because there are relatively few mining spots, which are not scattered throughout the area. Despite this, these spots are the major consumers of groundwater in this region.
- Urban industrial follows, using 5.3 Mm^3/a for manufacturing, processing, and other industrial activities in urban centers. Again, this is not evenly distributed across the region, instead, it is concentrated just south of Danielskuil. This makes sense as Danielskuil is a groundwater-dependent town, so the industry in that area would also depend on groundwater.
- Agricultural irrigation use is last, with 2.8 Mm^3/a to sustain crop production. Unlike the first two sectors, agricultural irrigation is more scattered across the region. However, there are a few clusters near the cities, like Danielskuil and Postmasburg.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Danielskuil and Postmasburg, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	2.8
	Agriculture: Watering Livestock	0.02
	Industry (Non-urban)	0.4
	Industry (Urban)	5.3
	Mining	48.4
	Power Generation	0.01
	Water Supply Service	0.8
	Total	**57.8**



Water use map for the Southern Ghaap Plateau SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km²
Elevation:	1118 to 1787 mamsl

Quantity & Quality

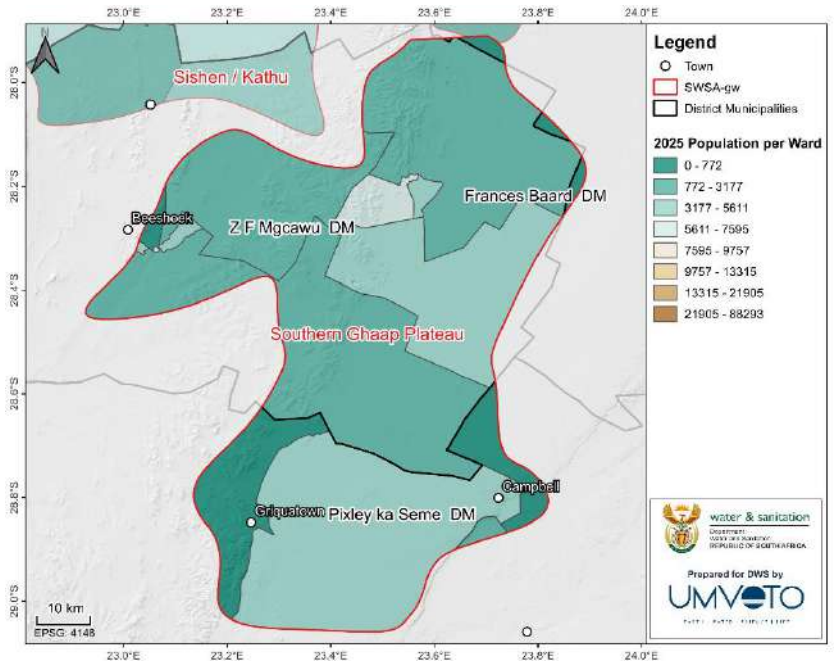
Socio Economic & Governance

The Southern Ghaap Plateau SWSA-gw is located within the Vaal-Orange Water Management Area (WMA), which was established through the merger of the former Vaal WMA and Orange WMA. The groundwater resources within the Southern Ghaap Plateau SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	Local municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Southern Ghaap Plateau SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 0.12% per year, resulting in a projected population of approximately 38,533.

As shown in the map and table below, Kgatelopele Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 16,937, followed by Tsantsabane LM with 14,681. Population concentrations within the SWSA-gw are highest around the Kgatelopele and Siyancuma LMs.



Projected population distribution in 2025 for the Southern Ghaap Plateau SWSA-gw.

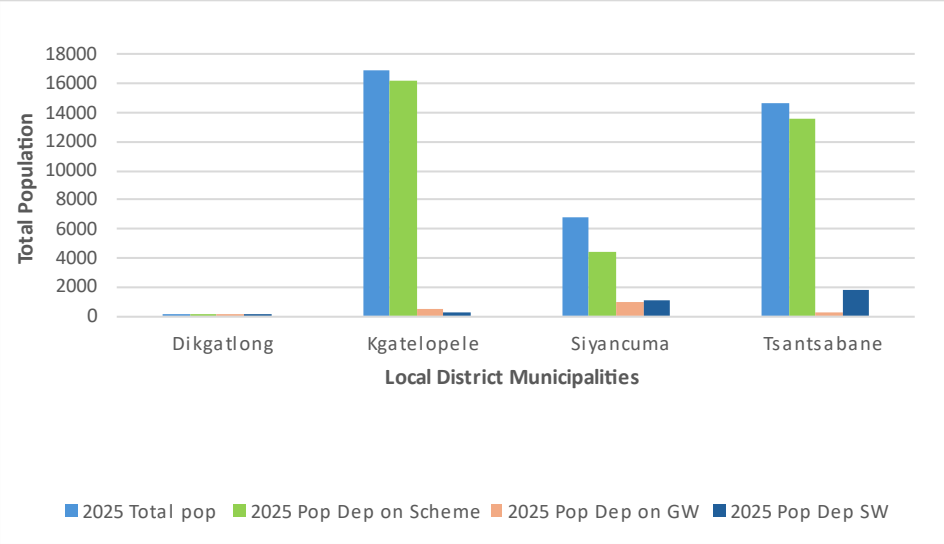
SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km²
Elevation:	1118 to 1787 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Southern Ghaap Plateau SWSA-gw, an estimated 89.1% of the population depends on the regional water supply scheme, while 8.4% relies on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources), and 4.5% on groundwater sources (including boreholes and springs).

Among the LMs, Siyancuma LM has the highest proportion of groundwater dependence, with approximately 14.7% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Dikgatlong	54	40	3	19
Kgatelopele	16,937	16,257	528	313
Siyancuma	6,861	4,462	1,008	1,137
Tsantsabane	14,681	13,563	211	1,766
Total	**38,533**	**34,322**	1,749	3,236



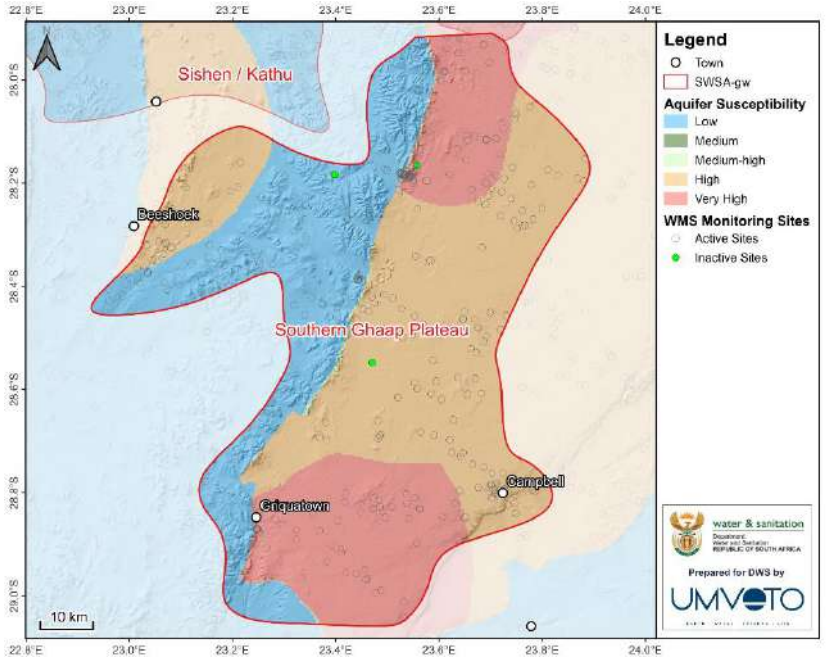
Projected population dependence on water sources in 2025.

SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km²
Elevation:	1118 to 1787 mamsl
Quantity & Quality	
Groundwater Quality	

The Southern Ghaap Plateau SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), Urban/Built-up areas cover a total of 38.27 km^2, which is 0.59% of the Southern Ghaap Plateau SWSA-gw total area. Mine and quarry areas cover 37.71 km^2 (0.58%), while cultivated areas account for 23.19 km^2 (0.35%) of the total area. These land uses contribute to diffuse contamination sources, with urban areas being the primary concern. Urban areas tend to include informal settlements and townships, and this places the groundwater source under a high risk of contamination (Le Maitre et al., 2018). Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 24 – 36 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 0.53 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.02 - 1.15 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 7.64 - 8.60 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 2 - 12.1 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Southern Ghaap Plateau**
Area:	**6542 km²**
Elevation:	**1118 to 1787 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Southern Ghaap Plateau SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	1	4.35	23	31.70	mS/m	2014-2024 GW Geosites: <70 mS/m.	-	24 - 36 mS/m (Avg.: 31.70 mS/m). 2014-2024 GW Geosites: <70 mS/m. Consistent with WMS (2000-2024).
Fluoride	1	4.35	23	0.13	mg/L	2014-2024 GW Geosites: <0.5 mg/L.	-	0.025 - 0.53 mg/L (Avg.: 0.13 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	1	4.35	23	0.47	mg/L	2014-2024 GW Geosites: <11 mg/L.	-	0.02 - 1.15 mg/L (Avg.: 0.47 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	1	4.35	23	8.23	pH unit	2014-2024 GW Geosites: 7-9.	-	7.64 - 8.60 (Avg.: 8.23). 2014-2024 GW Geosites: 7-9. Mostly consistent with WMS (2000-2024).
Sulphate	1	4.35	23	7.87	mg/L	2014-2024 GW Geosites: <200 mg/L.	-	2 - 12.1 mg/L (Avg.: 7.87 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the Southern Ghaap Plateau SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

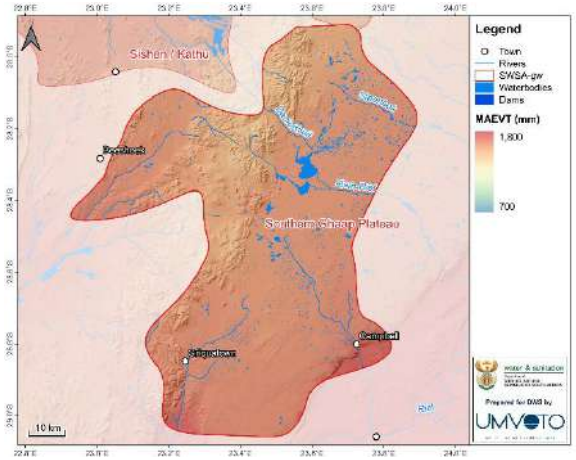
SWSA-gw Name:	**Southern Ghaap Plateau**
Area:	**6542 km²**
Elevation:	**1118 to 1787 mamsl**

Threats & Risks

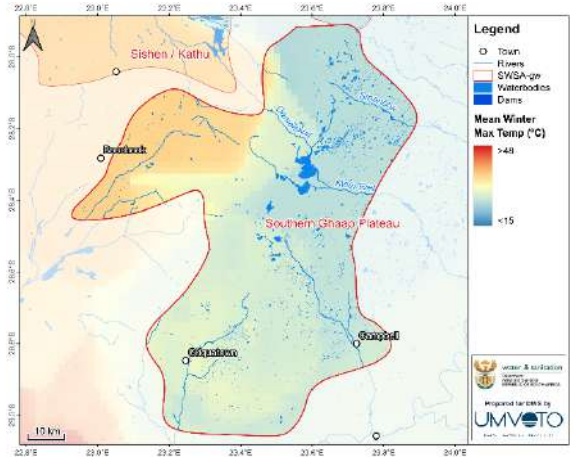
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Southern Ghaap Plateau SWSA-gw has a BSk, cold semi-arid, type climate characterized by cold winters, large temperature swings, and hot, dry summers. Temperatures in the SWSA-gw range from -1.9 – 27 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

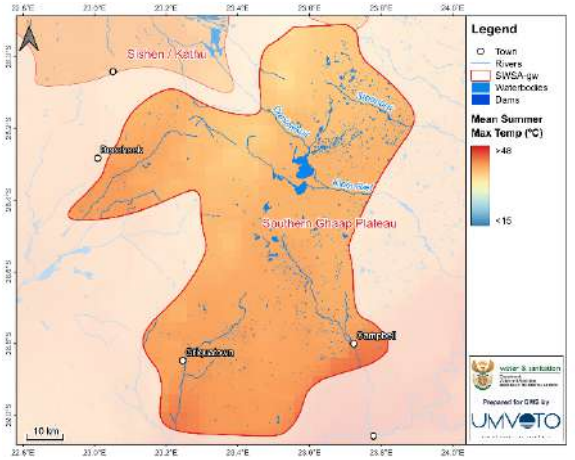
Temperature	Summer: 21 to 27 ºC, Winter: -1.9 to 4 °C
Evapotranspiration	Maximum value of 1762 mm/a with an average value of 1608 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, but a small increase in recharge (ranging from ~ 6.2 to 13.1mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Southern Ghaap Plateau SWSA-gw region.



Mean winter temperatures of the Southern Ghaap Plateau SWSA-gw region.



Mean summer temperatures of the Southern Ghaap Plateau SWSA-gw region.

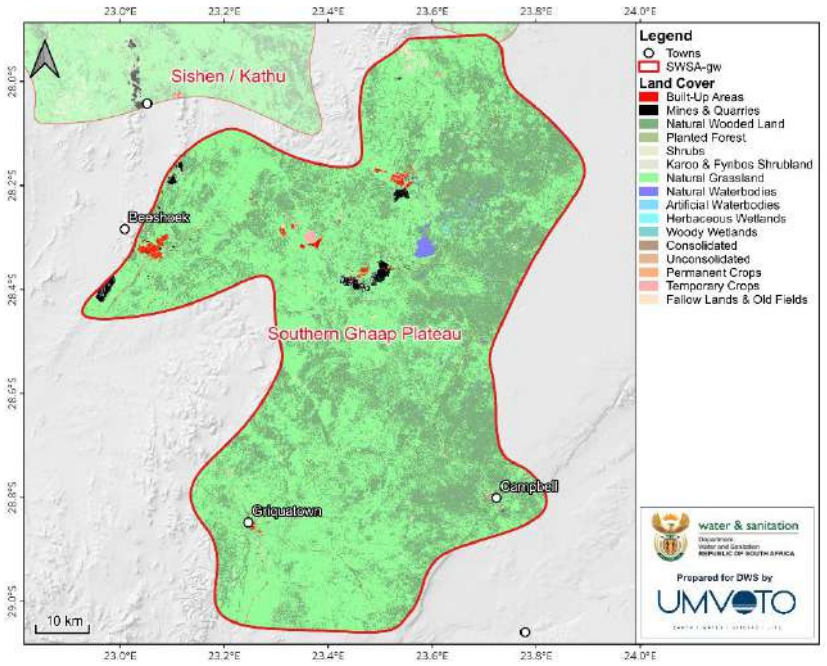
SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km²
Elevation:	1118 to 1787 mamsl

Threats & Risks

Land Use

The Southern Ghaap Plateau SWSA-gw is predominantly covered by grassland and forested land, which includes natural wooded land and planted forests (DFFE, 2022), covering 97% of the SWSA-gw and indicating a largely undeveloped and ecologically significant area. Shrublands, waterbodies, and wetlands occupy minimal space, collectively making up less than 1.5% of the total area. Built-up areas, which include residential, commercial and industrial areas, and mines and quarries, which include extraction sites and waste/resource dumps, are very limited, each covering less than 1% of the land. Built-up areas are mainly concentrated in the towns of Griquatown, Campbell, southeast of Beeshoek and nearby mines. This suggests that human impact is relatively low, with the region maintaining a primarily natural land cover.

Land Use Type	Area (km²)	Area (%)
Barren Land	14	0.2
Built-Up	38	0.6
Cultivated	23	0.4
Forest Land	2533	38.7
Grassland	3808	58.2
Mines and quarries	38	0.6
Shrubland	50	0.8
Waterbodies	37	0.6
Wetlands	0.003	0



Land Cover 24-class map to show the types of land use and extent of each occurring in the Southern Ghaap Plateau SWSA-gw.

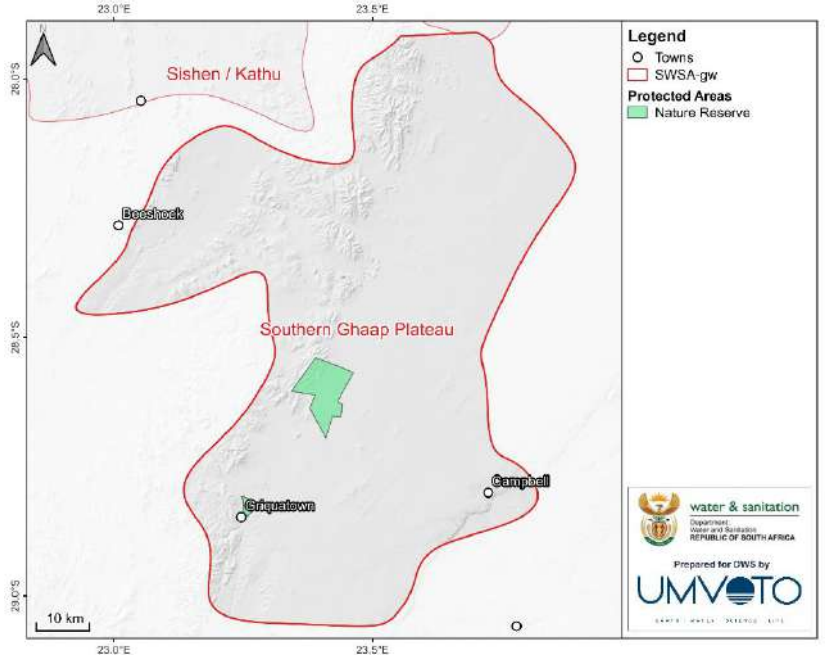
SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km²
Elevation:	1118 to 1787 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Southern Ghaap Plateau SWSA-gw has limited formal protection, with only two designated protected areas (DFFE, 2024)—Rockwood Nature Reserve and Klaarwater Nature Reserve—covering a total of 99.79 km². There are no conservation areas, SGWCA, or national parks within the area. This suggests a relatively low level of formal biodiversity protection.

Protection Status	Names	Area (km²)	Count
Conservation Areas	None		0
Protected Areas	• Rockwood Nature Reserve • Klaarwater Nature Reserve	99.79	2
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Southern Ghaap Plateau SWSA-gw that have protection status.

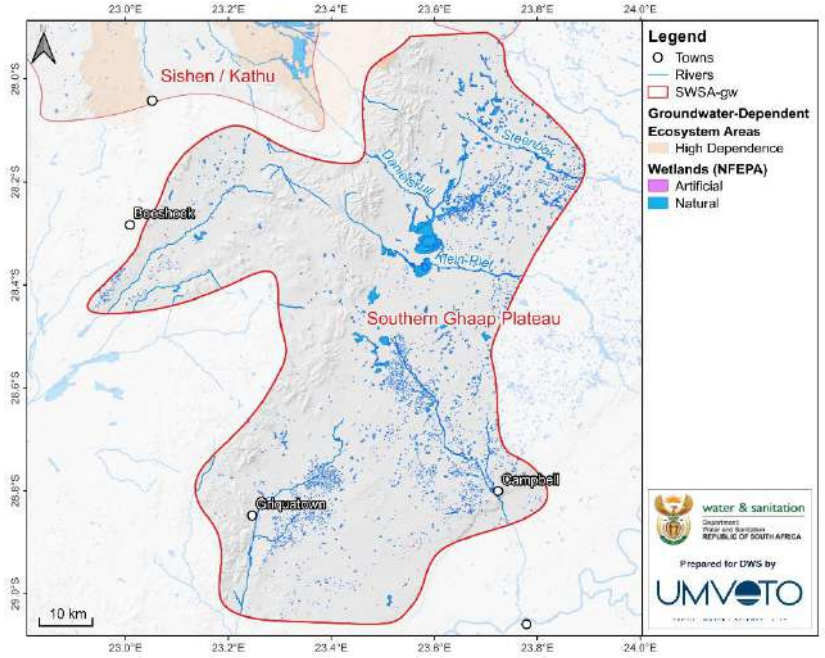
SWSA-gw Name:	Southern Ghaap Plateau
Area:	6542 km^2
Elevation:	1118 to 1787 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Southern Ghaap Plateau SWSA-gw has no major waterbodies or designated Ramsar sites. However, there is one small portion of wetlands (CSIR, 2018) with potentially high-dependence groundwater-dependent ecosystem (GDE) (DWA, 2010) covering 8.26 km^2. Most other wetlands are not considered groundwater dependent,

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands		184	

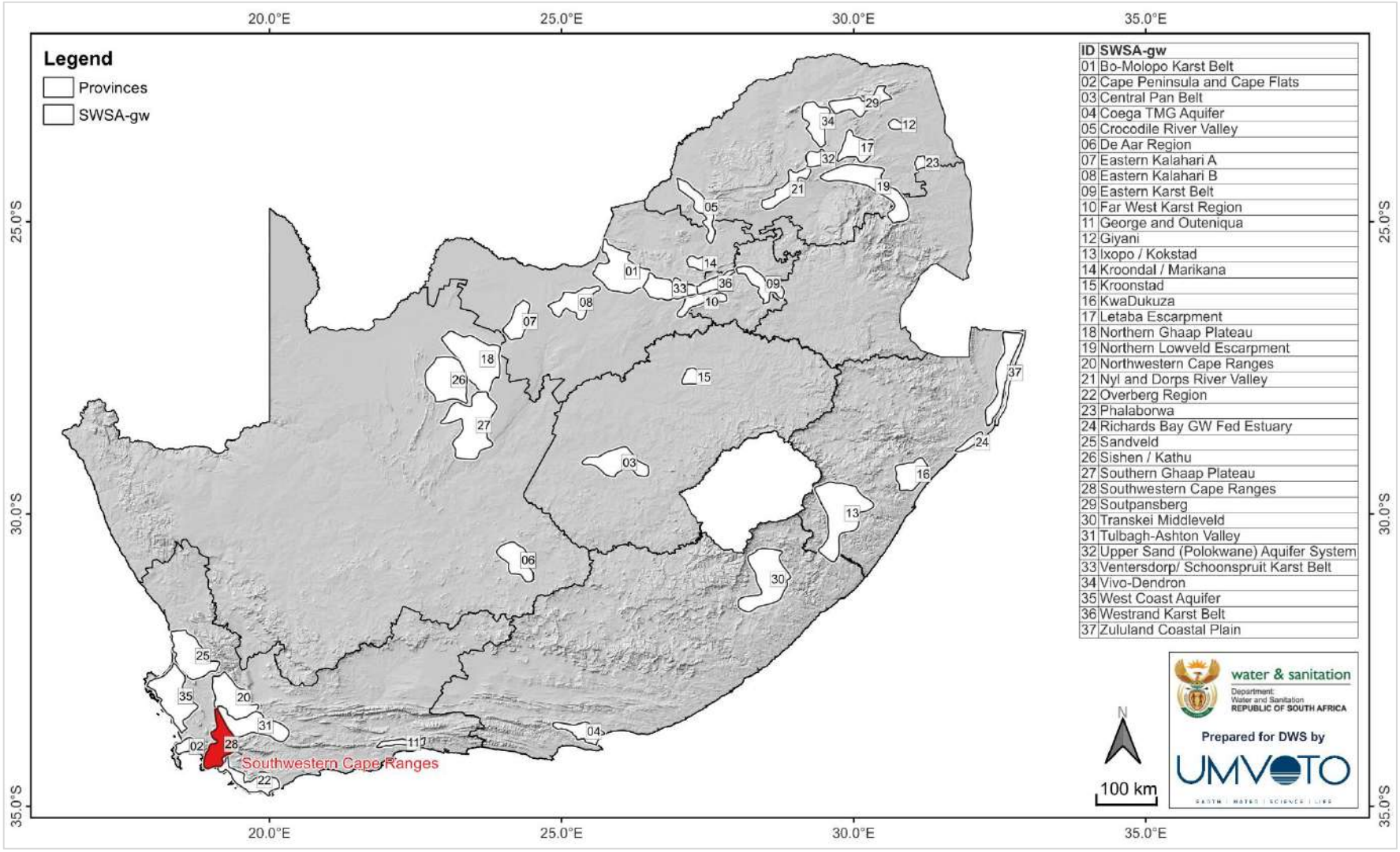


Map showing the major water bodies, Ramsar sites and GDEs in the Southern Ghaap Plateau SWSA-gw.

APPENDIX 28

SOUTHWESTERN CAPE RANGES SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE SOUTHWESTERN CAPE RANGES SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

28. Southwestern Cape Ranges

28.1. Description

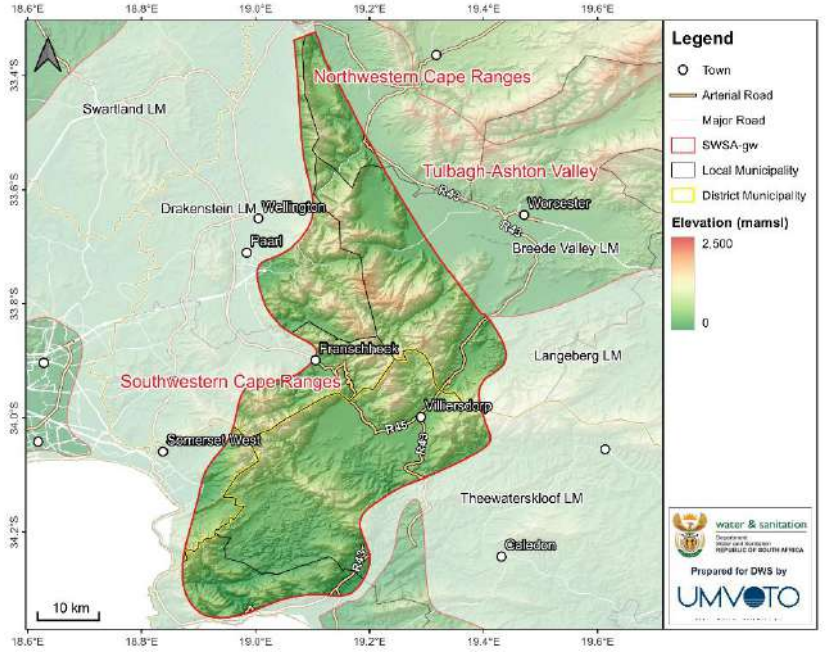
SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl

Geospatial Context

The topography of the Southwestern Cape Ranges SWSA-gw, as depicted in the map, is characterised by rugged mountain ranges interspersed with fertile valleys. The terrain is dominated by the Cape Fold Belt, which creates dramatic ridges and steep slopes, particularly around Paarl, Wellington, and Rawsonville. These mountains gradually transition into the rolling hills and agricultural plains of Stellenbosch and Somerset West. To the south, near Grabouw and Botrivier, the landscape remains mountainous before descending towards the coastal lowlands of Betty's Bay and Kleinmond.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Western Cape Province
District Municipality	Overberg, Cape Winelands and City of Cape Town
Local Municipalities	City of Cape Town, Overstrand, Stellenbosch, Theewaterskloof, Drakenstein, Breede Valley, and Witzenberg.
Towns	Botrivier, Grabouw, Villiersdorp, Goudini, Betty's Bay, Kleinmond, Botha, De Nova, Rawsonville, and Paarl.
Major Roads	N2, R321, R45, N1, and R42
Major Water Supply Networks	City of Cape Town



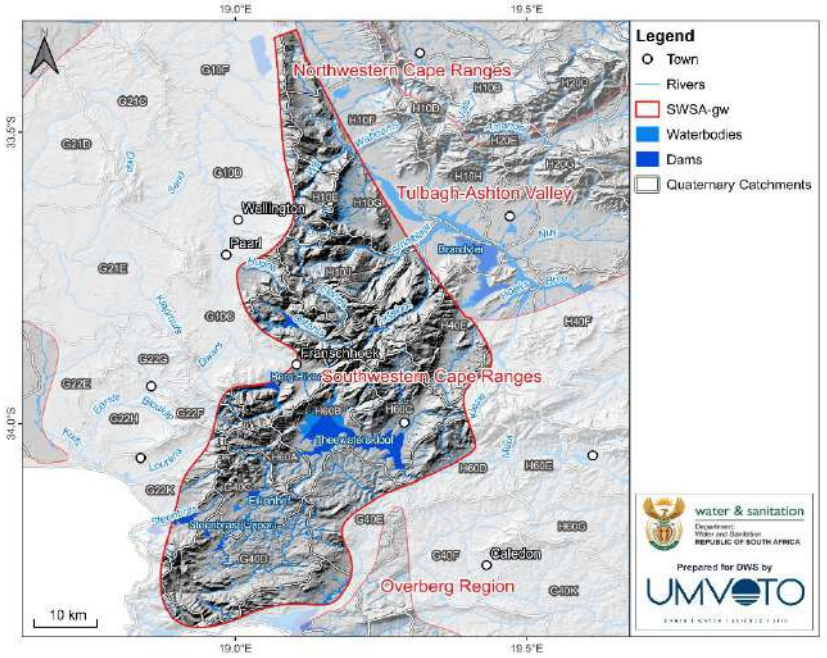
Locality map of Major Towns, District and Local Municipalities in the Southwestern Cape Ranges SWSA-gw.

SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl

Hydrology and Drainage

The Southwestern Cape Ranges SWSA-gw and surrounding areas include major surface water systems, summarised below and displayed in the map on the right. There are multiple reservoirs in the area (see table below). There are many perennial rivers in the area spread over the catchments. The rivers flow in multiple directions.

Quaternary Catchments	G10A, G10B, G10C, G10D, G10E, G10F, G22F, G22J, G22K, G40A, G40B, G40C, G40D, G40E, G40G, H10E, H10F, H10G, H10J, H10K, H10L, H40D, H40E, H60A, H60B, H60C, H60D
Rivers	Perennial: Palmiet, Bot, Swart, Wolwekloof, Hugos, Berg, Bakkerskloof, Riviersonderend, Elands, Spreeudrifspruit, Holsloot, Du Toits, Tierstel, Bree, Rooiels, Lourens, Steenbras, Ribbok, Jakkals, Waterkloof, Elands, Dwars, Zachariashoek, Kasteelskloof, Franschhoek, Drakenstein, Olifants, Wemmershoek, Hoeks, Wit, Kompanjies, Molenaars, Slanghoek, Wabooms, Krom
	Ephemeral rivers: Swartboschkloof, Sir Lowrys Pass, Jonkershoek, Lang, Tierkloof, Krom, Knolvlei, Watervals
Natural and manmade water bodies	Theewaterskloof, Eikenhof, Wemmershoek, Berg River, Elandskloof, Stettynskloof, Nuwerberg, Zwiegelaars, Steenbras, Grootvlei G, Rockview, Fortuin083, Applethwaite, Arieskraal, Bot river vlei, Voelvlei, Kleinplaasas and several unnamed floodplains and seeps.
Major Dams:	Applethwaite, Arieskraal, Berg River, Eikenhof, Elandskloof, Fortuin083, Grootvlei G, Kogelberg, Nuweberg, Rockview, Steenbras (Lower), Steenbras (Upper), Stettynskloof, Theewaterskloof, Wemmershoek and Zwiegelaars
Water Management Areas:	Breede Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Southwestern Cape Ranges SWSA-gw.

SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl
Geology	

Geology

Quaternary alluvial deposits, colluvium, coastal sands, coastal dunes, and estuarine deposits sporadically cover the Southwestern Cape Ranges and Boland area.

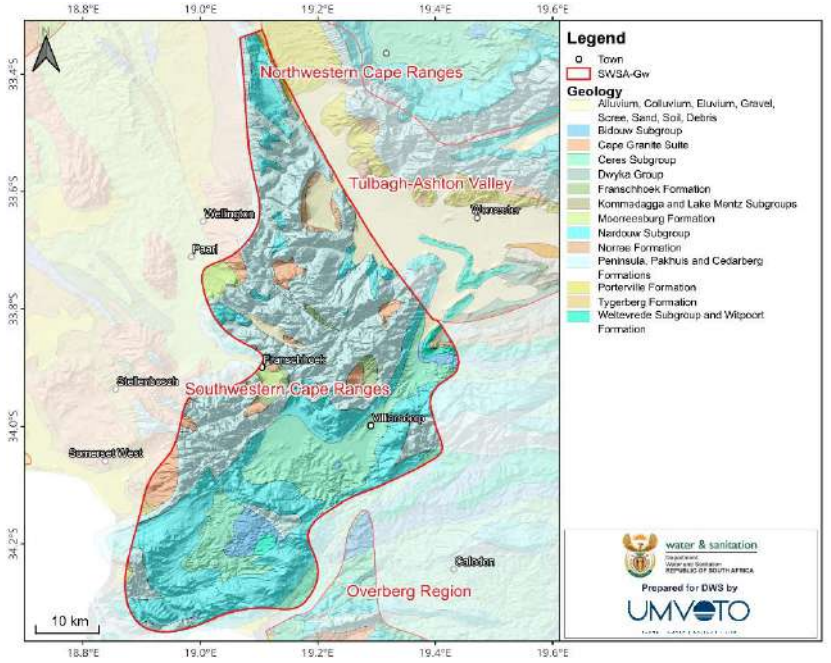
The Table Mountain Group of the Cape Supergroup dominates much of the region and is composed of white, siliceous, feldspathic sandstone, mudrock, thick-bedded, medium- to coarse-grained cross-bedded quartzitic sandstone, shale, siltstone, minor conglomerates, cobbles, boulders, and diamictite.

Central to the area are outcroppings of the Wellington Pluton of the Cape Granite.

In the southern central section, the Bokkeveld Group of the Cape Supergroup outcrops, comprising fine-grained quartz wacke sandstone, siltstone, and mudrock, as well as feldspathic arenite, wacke, and mudrock.

Hydrostratigraphy

The Quaternary alluvial deposits, colluvium, and coastal sands form a primary intergranular aquifer system. The Table Mountain Group sandstones, having undergone metamorphism, constitute a secondary, fractured aquifer system. The Bokkeveld Group forms a secondary, fractured aquifer. The Cape Granite outcrops represent a secondary, fractured aquifer system, with groundwater stored in weathered zones and fractures.



Geology Map of the Southwestern Cape Ranges SWSA-gw region.

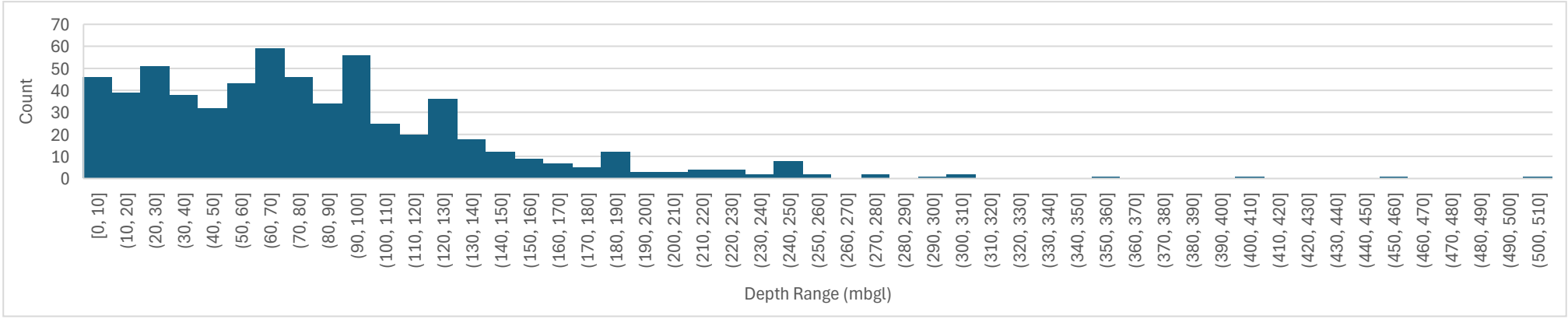
28.2. Current Status

SWSA-gw Name:	**Southwestern Cape Ranges**
Area:	**2749 km^2**
Elevation:	**3 to 1770 mamsl**
Quantity & Quality	
Aquifer Classification	

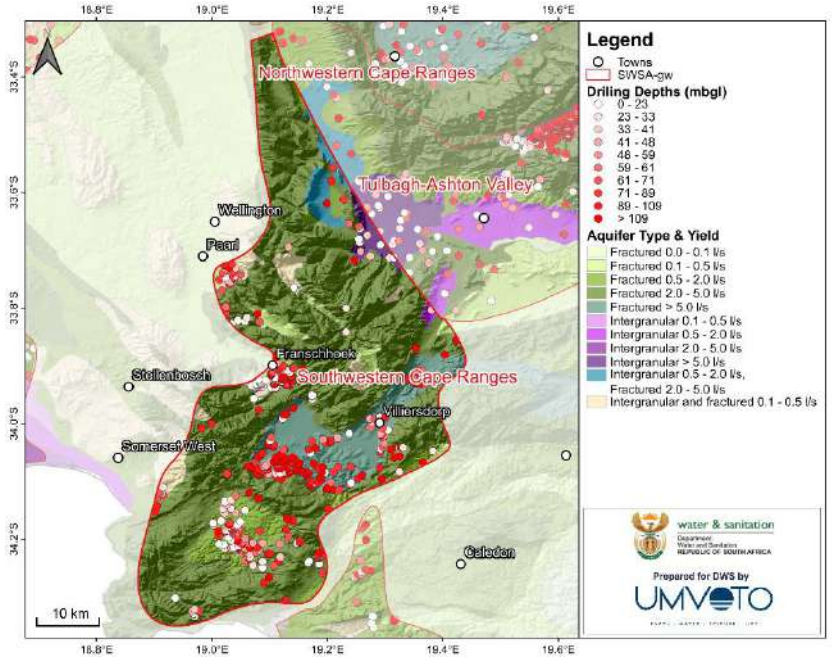
The aquifer systems within the Southwestern Cape Ranges SWSA-gw exhibit varying yields across fractured, intergranular and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is predominantly a major aquifer system, with minor aquifer systems occurring along the western edge and centre. The major aquifer system has an average fractured yield of 0.1 to over 5.0 l/s and an intergranular yield of 0.5 to over 5.0 l/s. The minor aquifer system has a fractured yield ranging from 0.1 to 0.5 l/s and an average fractured and dual-porosity yield of 0.1 to 0.5 l/s.
Groundwater Targets	The average drilling depth is 82 mbgl, and the most common depths are between 60 and 90 mbgl, suggesting a mixed aquifer system. The majority of the boreholes target the fractured aquifer system. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 27 and 110 mbgl. Limited deep boreholes (> 250 mbgl) may indicate drilling into the fractured basement aquifer. Based on the past 25 years of NGA water level data, the average groundwater level in the region is ~ 7 mbgl, with values ranging from 0 to 71 mbgl and a standard deviation of ~ 9 mbgl.

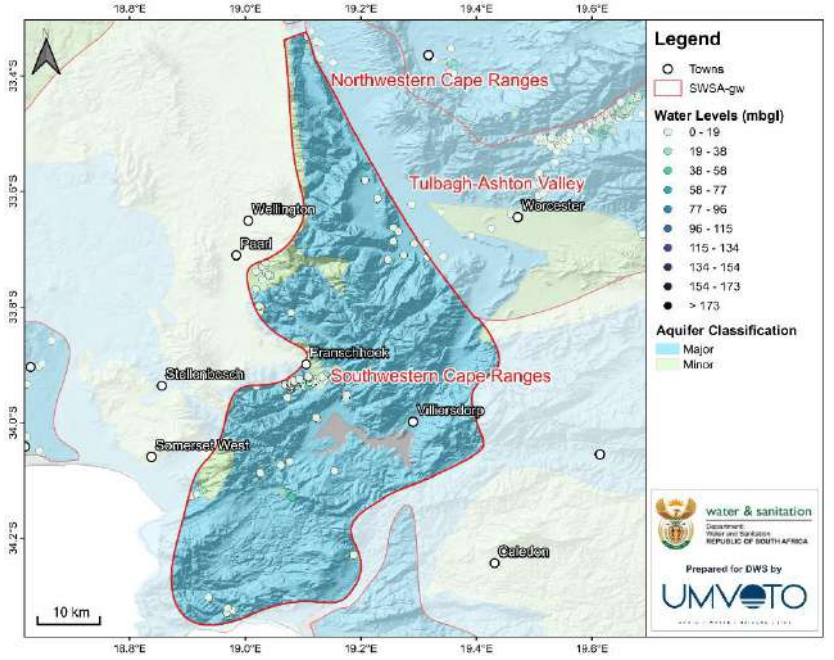
Graph of NGA drilling depths of the Southwestern Cape Ranges SWSA-gw region



SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Southwestern Cape Ranges SWSA-gw region.



Map of the Aquifer Classification of the Southwestern Cape Ranges SWSA-gw region.

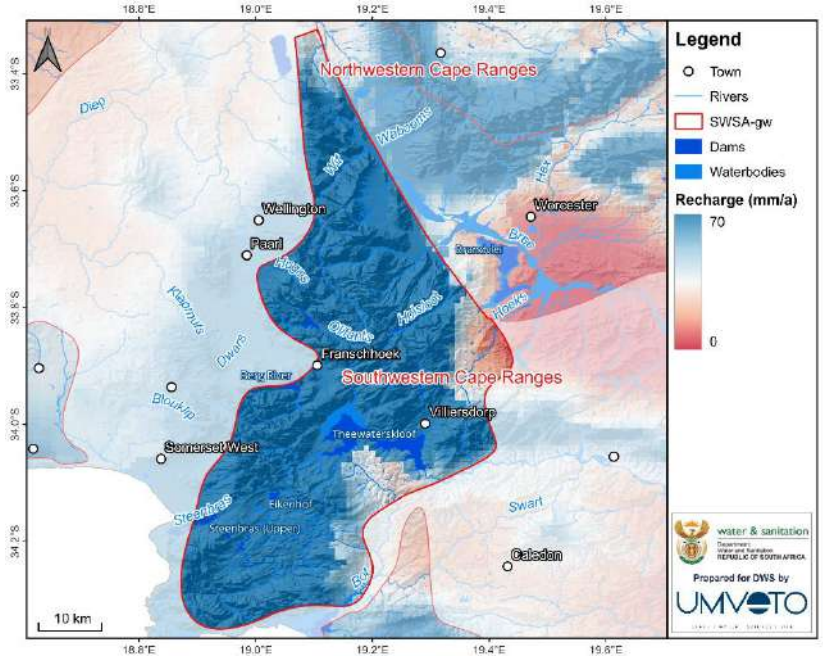
SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl

Quantity & Quality

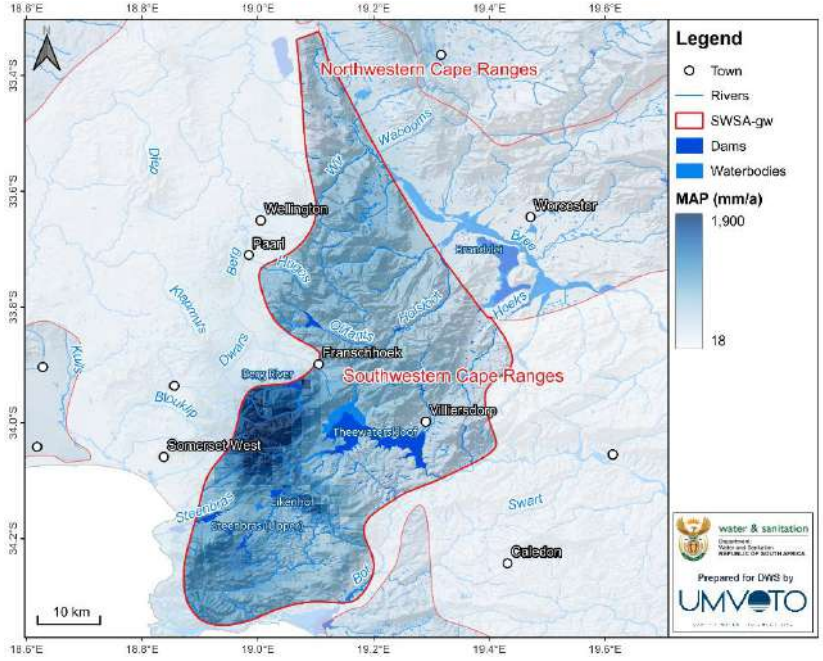
Groundwater Recharge

The Southwestern Cape Ranges receive a total Mean Annual Precipitation (MAP) Volume of 2,419 Mm^3/a, with an average rainfall of 866 mm/a, one of the highest in the regions considered. 509.7 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a recharge of 21.1% of MAP. This high recharge rate indicates that a significant portion of rainfall is efficiently infiltrating and replenishing the groundwater, likely due to favorable conditions such as higher rainfall, permeable soil, and appropriate land use, suggesting a more sustainable aquifer.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Southwestern Cape Ranges	2419	866	509.7	181.1	21.1%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl

Quantity & Quality

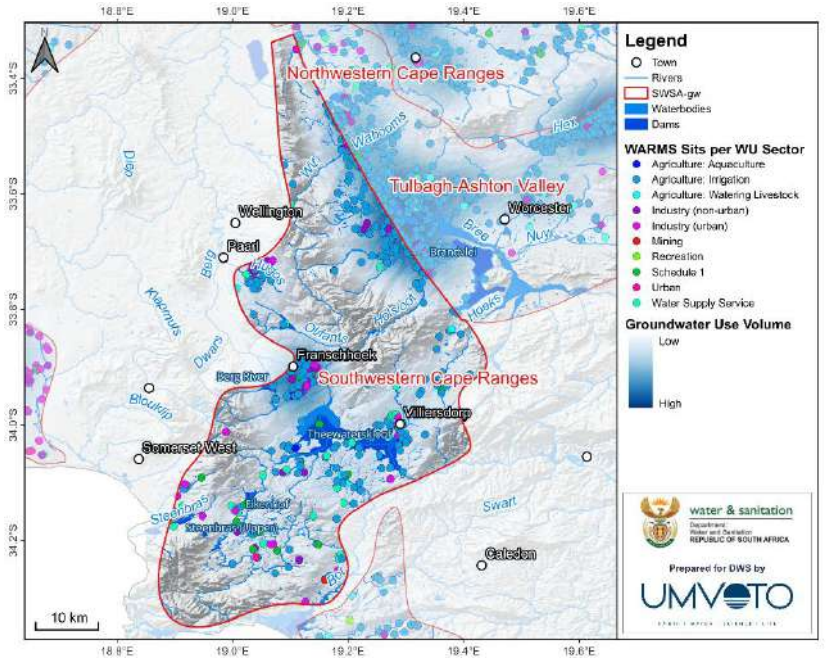
Groundwater Use

The Southwestern Cape Ranges SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Villiersdorp (Conjunctive), who rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licenses from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Municipal water supply services, at 30.3 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. This is mainly in the southern parts of the regions around Villersdopr, Grabouq and Botrivier.
- Agricultural irrigation use, with 21.8 Mm^3/a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. The irrigation is mainly clustered in the northern parts of the map, like northwest of Villersdorp and surrounding Goudini. Water usage for irrigation in these areas is densely packed, indicating a strong reliance on groundwater for crop production.
- Non-urban industrial follows, using 0.7 Mm^3/a for manufacturing, processing, and other industrial activities outside urban centers. The non-urban industry has a more scattered distribution, primarily around Grabouw and Botrivier.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Villiersdorp, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Aquaculture	0.3
	Agriculture: Irrigation	21.8
	Agriculture: Watering Livestock	0.02
	Industry (Non-urban)	0.7
	Industry (Urban)	0.7
	Mining	0.04
	Schedule 1	0.1
	Water Supply Service	30.3
	Total	**53.9**



Water use map for the Southwestern Cape Ranges SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

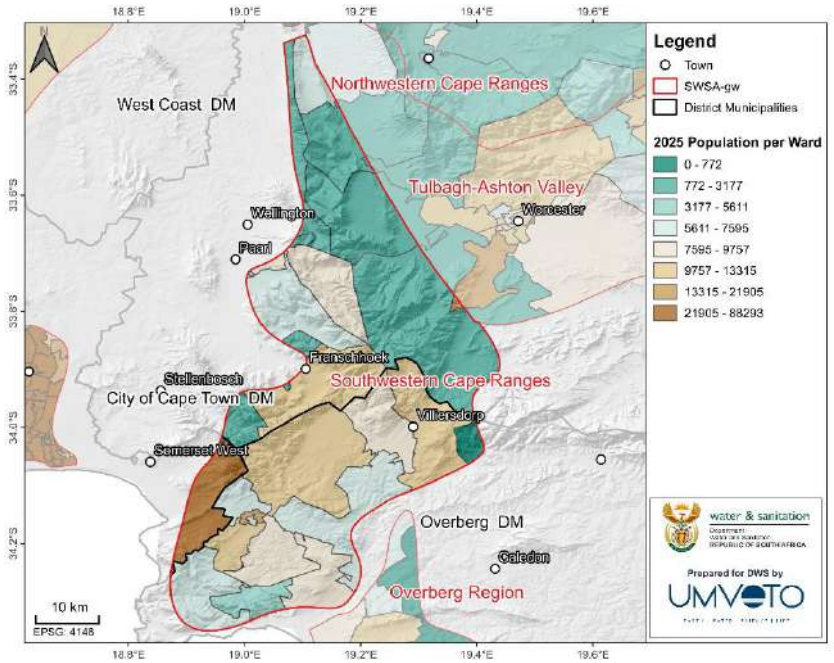
SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Southwestern Cape Ranges SWSA-gw is located within the Breede-Olifants Water Management Area (WMA, 2023). The groundwater resources within the Cape Peninsula and Cape Flats & Table Mountain SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Breede-Olifants Catchment Management Agency (BOCMA), which was formed as part of a national restructuring process that consolidated CMAs. BOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the BOCMA to manage water resources in the Breede-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	BOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Breede-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	Groenland Water Users Association is located around the town of Grabouw, and farmers around the Theewaterskloof Dam belong to the Vyeboom Irrigation Board.
WSA/WSP	The local municipalities are the Water Service Authorities and Water Service Providers in the region, except for the are falling under the jurisdiction of the City of Cape Town, which is both WSA and WSP.

The estimated 2025 population within the Southwestern Cape Ranges SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 0.57% per year, resulting in a projected population of approximately 183,174.

As shown in the map and table below, Theewaterskloof Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 81,124, followed by the City of Cape Town LM with 30,531.



Projected population distribution in 2025 for the Southwestern Cape Ranges SWSA-gw.

SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl

Quantity & Quality

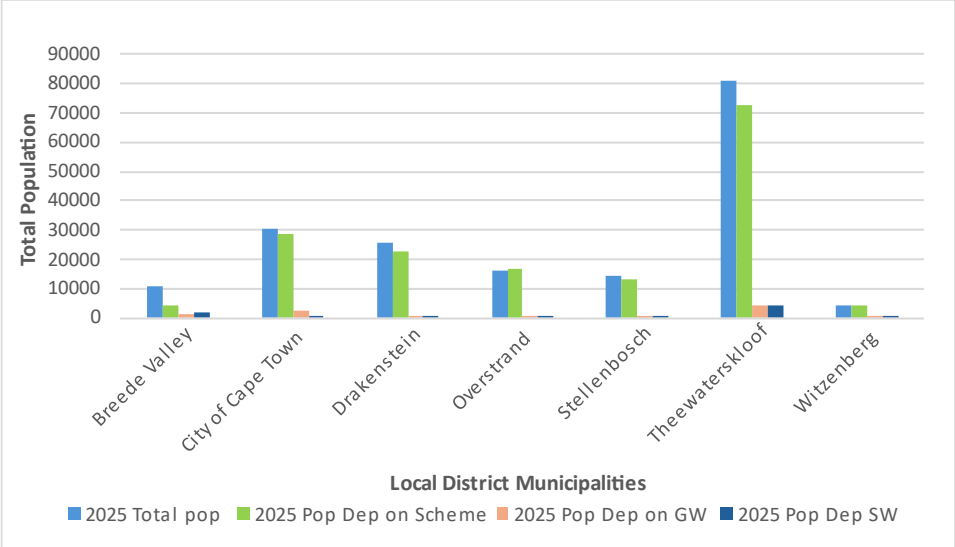
Socio Economic & Governance

In terms of water reliance within the Southwestern Cape Ranges SWSA-gw, an estimated 88.8% of the population depends on the regional water scheme, 5.2% on groundwater (including boreholes and springs) and 4.7% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources).

Among the LMs, Breede Valley LM has the highest proportion of groundwater reliance, with approximately 12.8 % of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Breede Valley	10,942	4,310	1,396	1,991
City of Cape Town	30,531	28,733	2,286	666
Drakenstein	25,804	22,532	742	591
Overstrand	16,142	16,964	51	88
Stellenbosch	14,222	13,144	393	898
Theewaterskloof	81,124	72,731	4,285	4,269
Witzenberg	4,409	4,336	281	175
Total	**183,174**	**162,750**	9,434	8,678



Projected population dependence on water sources in 2025.

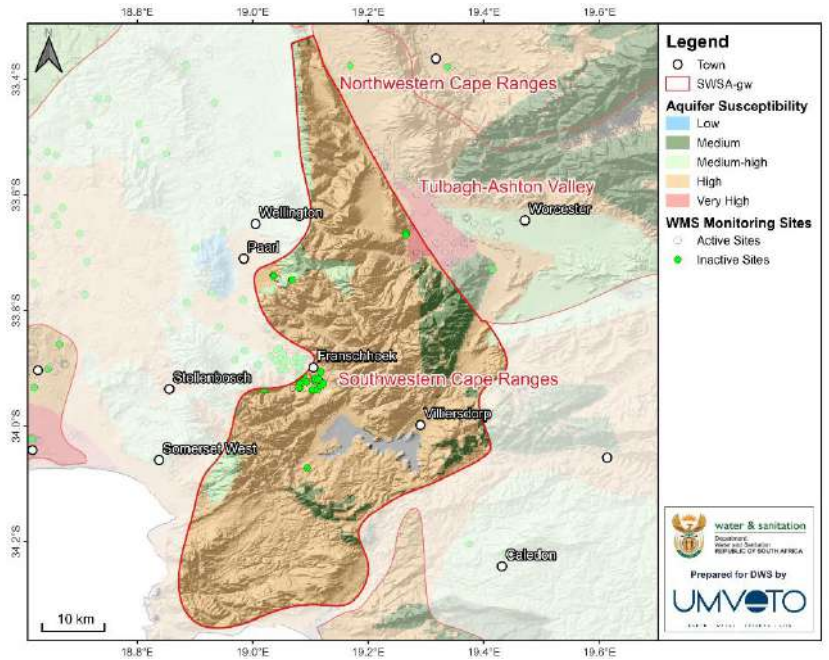
SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl
Quantity & Quality	
Groundwater Quality	

The Southwestern Cape Ranges SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 391.32 km^2, which is 14.23% of the Southwestern Cape Ranges SWSA-gw total area. Urban/Built-up areas cover 33.87 km^2 (1.23%), while mines and quarries account for 1.69 km^2 (0.06%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major aquifer consists of areas with moderate and most aquifer vulnerability. The majority of the Major aquifer system is characterized by areas that have the most vulnerability, while the moderately vulnerable areas are found in the eastern and southeastern parts of the aquifer.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 3.23 - 70.7 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 1.56 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.005 - 7.60 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 3.61 - 9.83 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0 - 64.36 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Southwestern Cape Ranges**
Area:	**2749 km^2**
Elevation:	**3 to 1770 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Southwestern Cape Ranges SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	21	53.85	39	19.45	mS/m	-	4.56 - 13 mS/m (Avg.: 6.28 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024).	3.23 - 70.7 mS/m (Avg.: 20.42 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024).
Fluoride	20	74.07	27	0.39	mg/L	-	0.025 - 0.63 mg/L (Avg.: 0.15 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	0.025 - 1.56 mg/L (Avg.: 0.41 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	21	75.00	28	0.63	mg/L	-	0.005 - 0.23 mg/L (Avg.: 0.098 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	0.005 - 7.60 mg/L (Avg.: 0.66 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	21	53.85	39	7.32	pH unit	-	6.71 - 7.83 (Avg.: 7.20). 2014-2024 GW Geosites: 5.7-9. Consistent with WMS (2000-2024).	3.61 - 9.83 (Avg.: 7.33). 2014-2024 GW Geosites: 5.7-9. Consistent with WMS (2000-2024).
Sulphate	21	75.00	28	4.35	mg/L	-	0.6 - 9.51 mg/L (Avg.: 3.14 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).	0 - 64.36 mg/L (Avg.: 4.43 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the Southwestern Cape Ranges SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

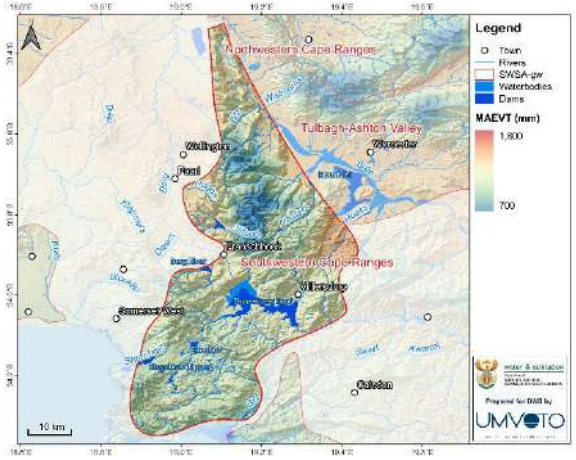
SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl

Threats & Risks

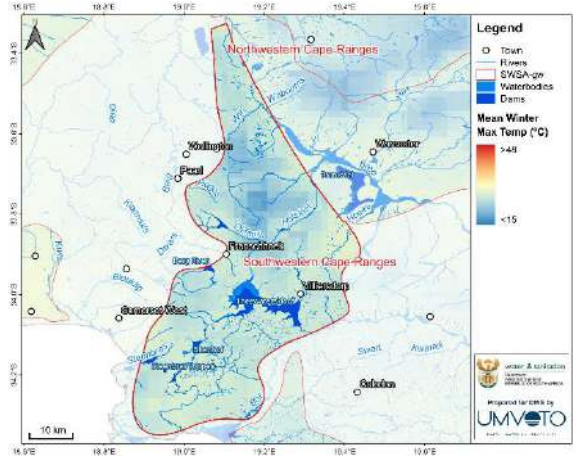
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Southwestern Cape Ranges SWSA-gw has a Csb, Cool-summer Mediterranean, climate characterized by mild, wet winters and warm, dry summers. Temperatures in the SWSA-gw range from 2.1 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

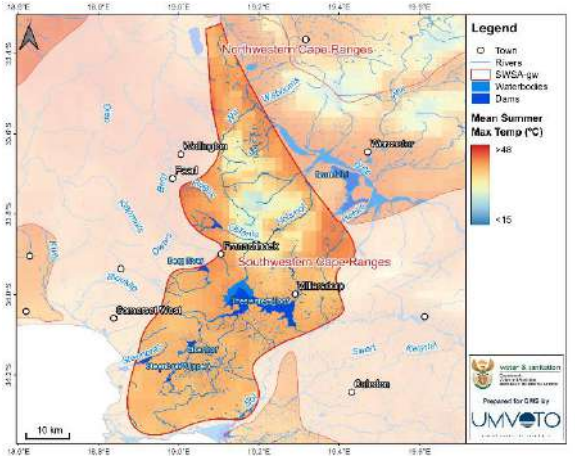
Temperature	Summer: 24.6 to 31 ºC, Winter: 2.1 to 8 °C
Evapotranspiration	Maximum value of 1551 mm/a with an average value of 1154 mm/a
Climate Change Predictions	Increased temperatures disrupted rainfall patterns, but a decline in recharge (ranging from ~ 9.6 to 19.9 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Southwestern Cape Ranges SWSA-gw region.



Mean winter temperatures of the Southwestern Cape Ranges SWSA-gw region.



Mean summer temperatures of the Southwestern Cape Ranges SWSA-gw region.

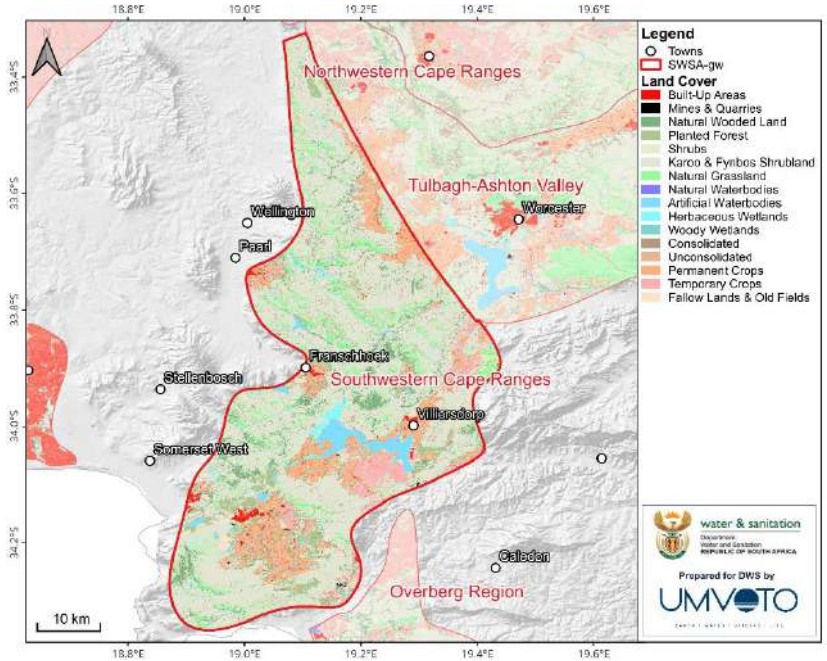
SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl

Threats & Risks

Land Use

Shrubland, specifically Karoo & Fynbos shrubland, is the dominant land cover (DFFE, 2022), occupying 59.6% of the Southwestern Cape Ranges SWSA-gw, highlighting the region's predominantly natural and ecologically significant vegetation. Cultivated land, consisting of permanent crops, temporary crops, fallow lands and old fields, cover 14.2% of the SWSA-gw, indicating agricultural activity with a focus on both long-term and seasonal cultivation. Grassland and forested land, which includes natural wooded land and planted forest, cover 4% of the SWSA-gw and contribute to the area's biodiversity and support ecosystems. Wetlands, natural and artificial waterbodies occupy a small portion of the landscape but play a crucial role in water retention and ecological balance, particularly within and around the Theewaterskloof dam towards the centre of the SWSA-gw. Built-up areas, consisting of residential, commercial and industrial areas, are minimal, suggesting limited urban development within this largely natural and agricultural region. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.1% of the area, located predominantly in the northwest of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	62	2.3
Built-Up	34	1.2
Cultivated	391	14.2
Forest Land	289	10.5
Grassland	218	7.9
Mines and quarries	2	0.1
Shrubland	1638	59.6
Waterbodies	71	2.6
Wetlands	45	1.6



Land Cover 24-class map to show the types of land use and extent of each occurring in the Southwestern Cape Ranges SWSA-gw.

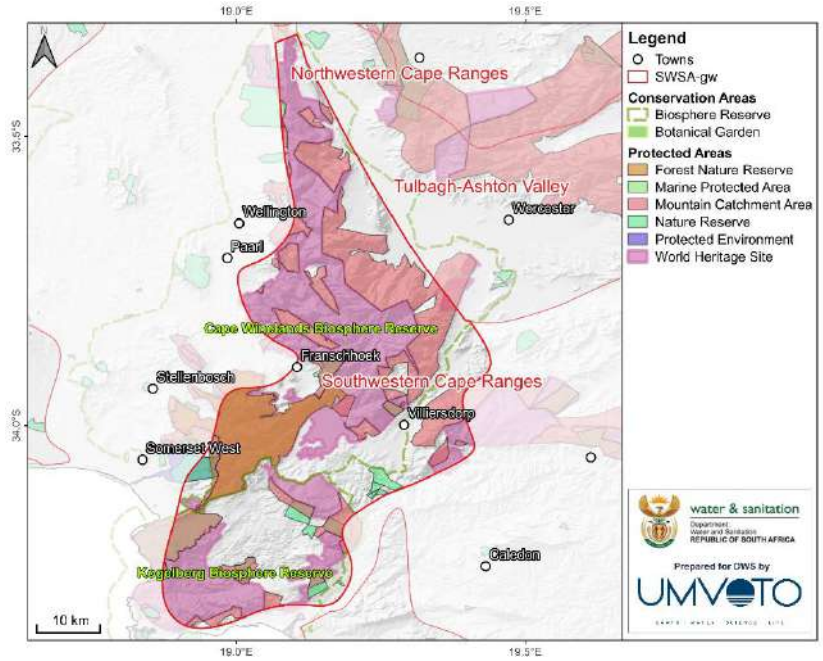
SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Southwestern Cape Ranges SWSA-gw is highly concentrated with conservation and protected areas (DFFE, 2024). The Cape Winelands Biosphere Reserve covers a significant portion of the SWSA-gw, more than half. The Kogelberg Biosphere Reserve covers the southern section of the SWSA-gw. The Hawequas Mountain Catchment Area, Hottentots-Holland Mountain Catchment Area, Hottentotsholland Nature Reserve and the Cape Floral Region Protected Areas world heritage site cover the bulk of the SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Cape Winelands Biosphere Reserve • Kogelberg Biosphere Reserve	2414.83	2
Protected Areas	• Cape Floral Region Protected Areas • Hottentotsholland Nature Reserve • Hawequas Mountain Catchment Area • Riviersonderend Mountain Catchment Area • Hottentots-Holland Mountain Catchment Area • Lourens River Protected Natural Environment • Steenbras Nature Reserve • Vergelegen Nature Reserve • Mont Rochelle Nature Reserve • And various other small nature reserves	2118.32	21
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Southwestern Cape Ranges SWSA-gw that have protection status.

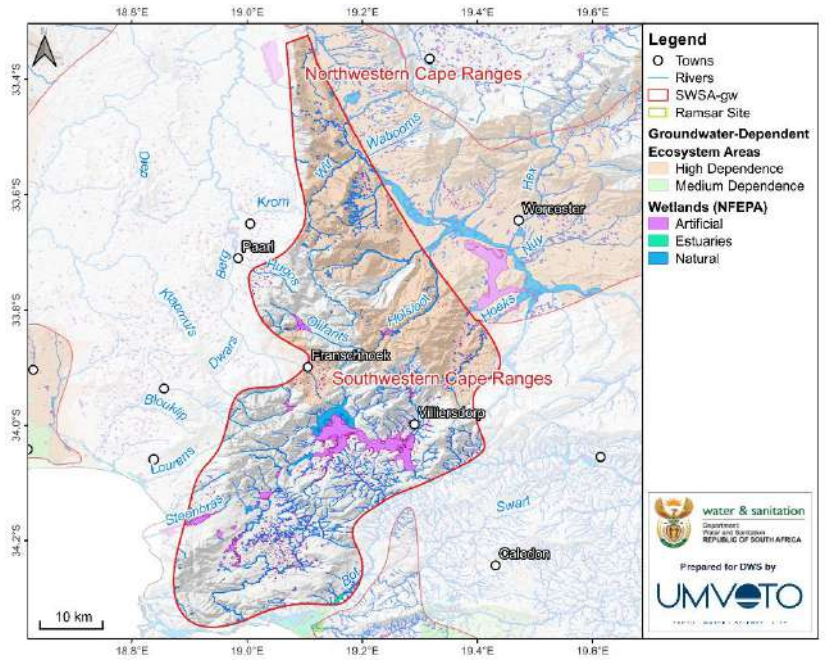
SWSA-gw Name:	Southwestern Cape Ranges
Area:	2749 km^2
Elevation:	3 to 1770 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Theewaterskloof Dam (DWS, 2012) is the largest dam and water body in the Southwestern Cape Ranges SWSA-gw, located around the centre of the SWSA-gw, as displayed on the map. North and northeast of the Theewaterskloof Dam are several wetlands that are potentially highly dependent on groundwater (DWA, 2010).

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Theewaterskloof Dam • Steenbras (Upper) Dam • Berg River Dam • Wemmershoek Dam • Eikenhof Dam	54.76	5
Ramsar Sites	None		0
Wetlands	Various small natural, artificial and estuary wetlands	195	

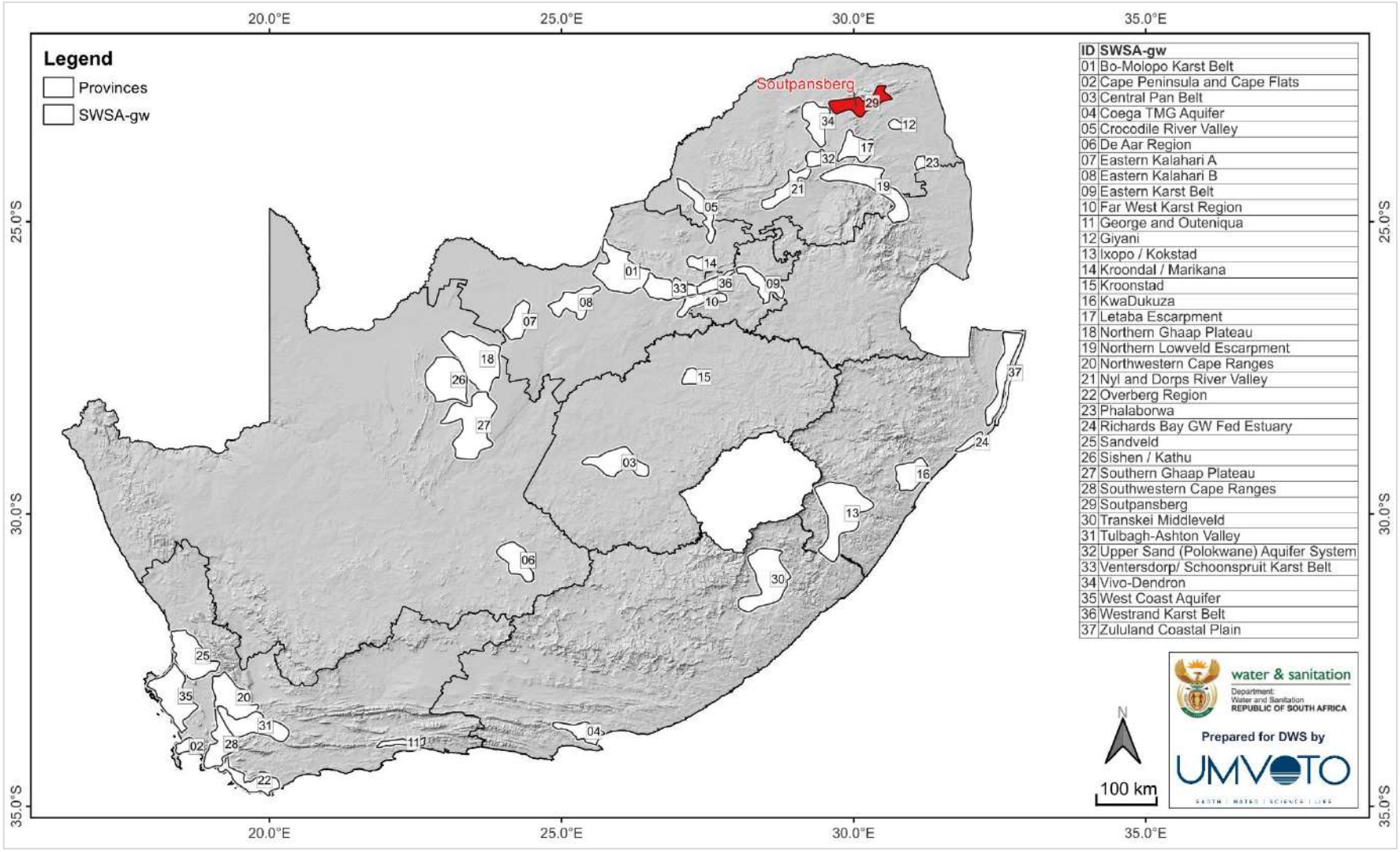


Map showing the major water bodies, Ramsar sites and GDEs in the Southwestern Cape Ranges SWSA-gw.

APPENDIX 29

SOUTPANSBERG SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE SOUTPANSBERG SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

29. Soutpansberg

29.1. Description

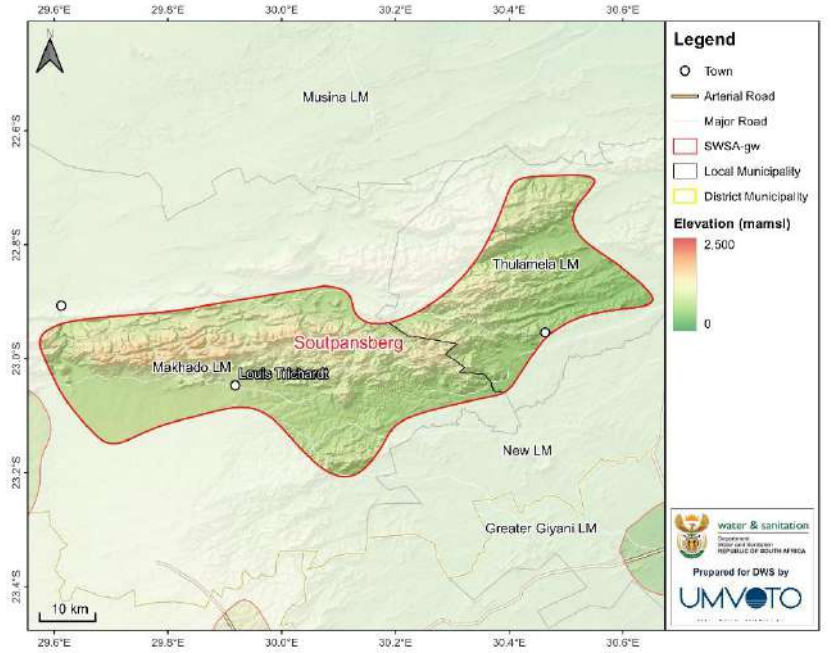
SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681 mamsl

Geospatial Context

The topography of the Soutpansberg SWSA-gw, as depicted in the map, is characterized by a rugged, mountainous landscape with prominent ridges running in a northeast-southwest direction. The terrain is particularly steep and elevated in the central and northern portions, near Tshiulungoma and Vhembe, where the mountains appear to be deeply dissected by valleys. Towards the south, near Louis Trichardt and Elim, the elevation gradually decreases, transitioning into lower-lying areas with gentler slopes.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Limpopo
District Municipality	Vhembe
Local Municipality	Makhado and Thulamela
Towns	Louis Trichardt Elim and Tshiulungoma
Major Roads	N1, R523, R524
Major Water Supply Networks	



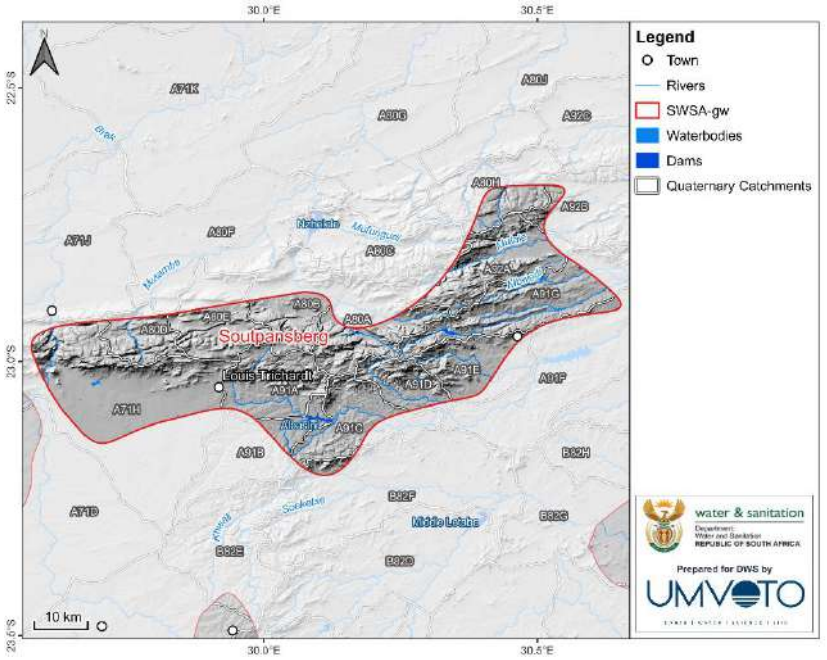
Locality map of Major Towns, District and Local Municipalities in the Soutpansberg SWSA-gw.

SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681 mamsl

Hydrology and Drainage

The area features major surface water systems, summarised below and displayed in the map on the right. The main surface water systems are the Albasini and Vondo reservoirs fed by the A9 catchment, the Mutshedzi reservoirs fed by the A8 catchment and along with the many perennial rivers flowing in a variety of directions.

Quaternary Catchments	A71H, A80A, A80B, A80D, A80E, A80F, A80H, A91A, A91B, A91C, A91D, A91E, A91G, A92A, A92B, B82F and small sections of A80C, A91F
Rivers	Perennial: Luvuvhu, Mutale, Mutamba, Mutshedzi, Mutshindudi and Sand
	Ephemeral: Doringspruit, Dzindi, Latonyanda, Luphephe, Mbwedi, Mudzwiriti, Nwanedi, Nzhelele, Phangani, Tshiluvhadi and Tshinane
Natural and manmade water bodies	
Major Dams:	Albasini, Mutshedzi and Vondo
Water Management Areas:	Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Northwestern Cape Ranges & Groot Winterhoek & Boland SWSA-gw.

SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681 mamsl

Geology

Geology

Quaternary deposits are prominent in the western section of the area, where sandy soils are prevalent, while sporadic aeolian sands occur in the northern section. Small outcroppings of metapelite from the Bandelierkop Formation are found in the southern section.

The geology of the area is dominated by the Soutpansberg Group, which occupies the northern section and includes formations such as the Fundudzi Formation, characterised by basalts, quartzitic sandstones, conglomerates, tuffs, shales, and siltstones, and the Musekwa Basalt, comprising basaltic, andesitic, and trachytic lavas interbedded with tuff, ignimbrite, sandstone, shale, and chert. Other significant formations within this group include the Nzhelele Formation, composed of quartzitic sandstones, red shales, tuffs, and lavas, and the Sibasa Formation, which features basaltic and andesitic lavas, pyroclastic rocks, and quartzites. The Tshifhefhe Formation consists of conglomerates, quartzitic sandstones, greywacke, and shales.

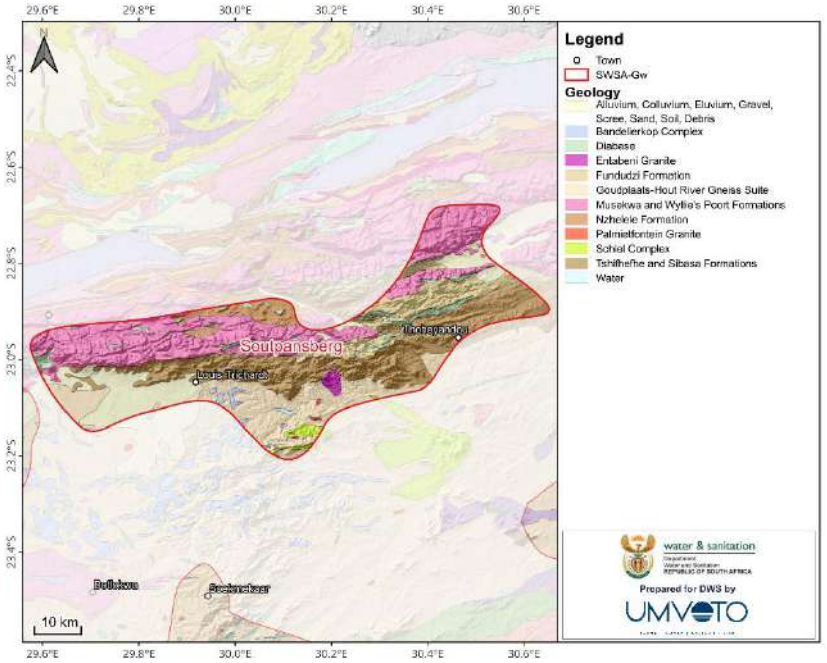
Plutonic units in the area include the Lunkslip Granite, a pink, medium- to coarse-grained granite, and the Palmietfontein Granite, a light grey to brown muscovite granite.

Diabase of Mokolian age outcrops sporadically across the northern section of the area.

The southern section is underlain by the Archaean Goudplaats-Hout River Gneiss, which is composed of leucocratic, strongly migmatized biotite gneiss and greyish, weakly migmatized biotite gneiss, with minor leucogneiss and dark grey biotite gneiss.

Hydrostratigraphy

The Quaternary deposits form a primary, intergranular aquifer system. The Soutpansberg Group forms a secondary, fractured aquifer system. The Archaean Goudplaats-Hout River Gneiss and Mokolian granites create secondary, fractured-rock aquifers. Alluvial deposits along major drainage courses act as high-yield, intergranular aquifers. Karoo sediments and lavas contribute to mixed intergranular-fractured aquifers.



Geology Map of the West Coast Aquifer SWSA-gw region.

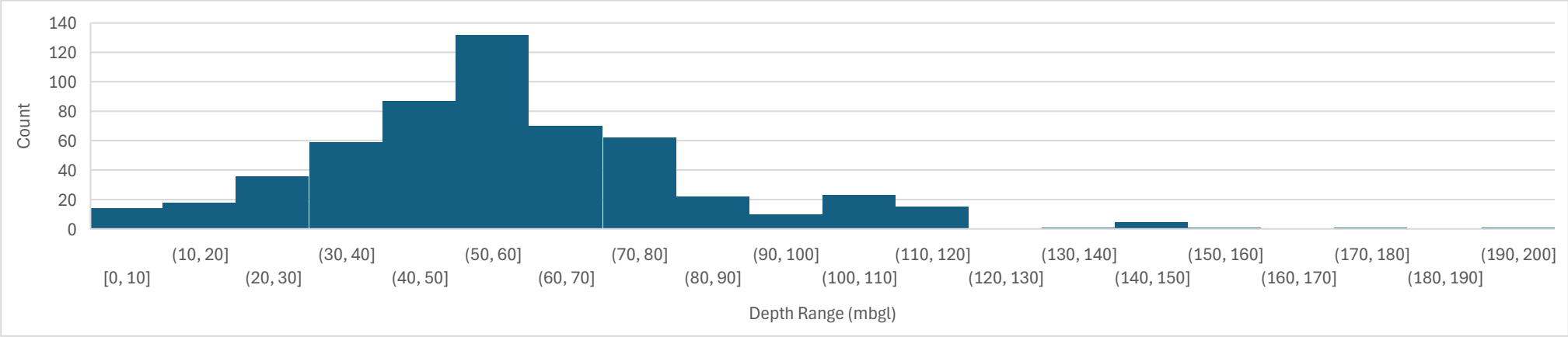
29.2. Current Status

SWSA-gw Name:	**Soutpansberg**
Area:	**2573 km²**
Elevation:	**485 to 1681 mamsl**
Quantity & Quality	
Aquifer Classification	

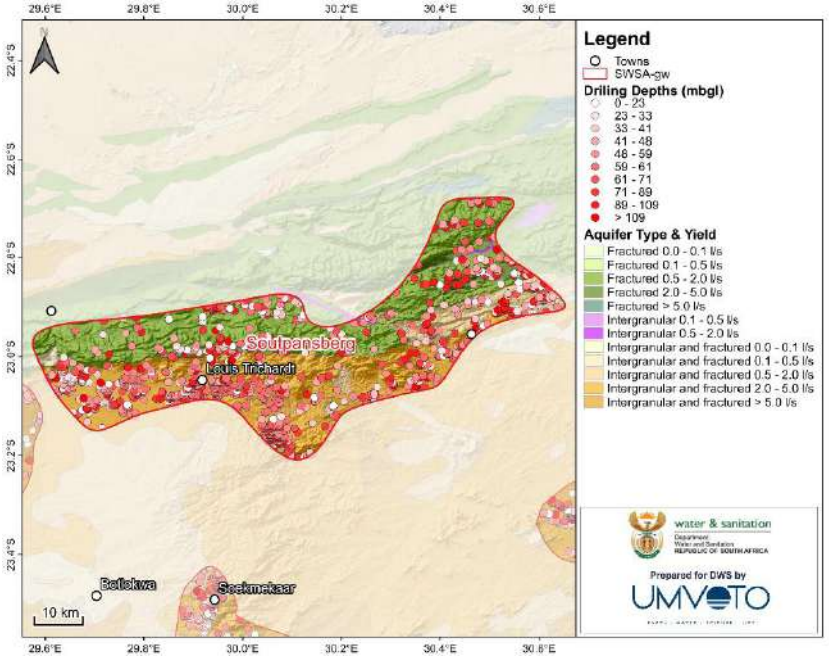
The aquifer systems within the Soutpansberg SWSA-gw exhibit varying yields across dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw consists of a major aquifer system in the south, a minor aquifer system in the middle, and a poor aquifer system in the north. The major aquifer system has an average dual-porosity yield ranging from 0.1 to over 5.0 l/s. The minor aquifer system has a fractured yield of 0.5 to 2.0 l/s and a dual-porosity yield of 0.5 to 5.0 l/s.
Groundwater Targets	The average drilling depth is 59 mbgl, and the most common depth is around 60 mbgl. This suggests the targeting of a shallow aquifer system, with the majority of the boreholes targeting the dual-porosity aquifer in the southern section of the SWSA-gw. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 42 and 70 mbgl. Based on the past 25 years of NGA water level data, the average groundwater level in the region is ~7 mbgl, with values ranging from 0 to 62 mbgl and a standard deviation of ~ 8 mbgl.

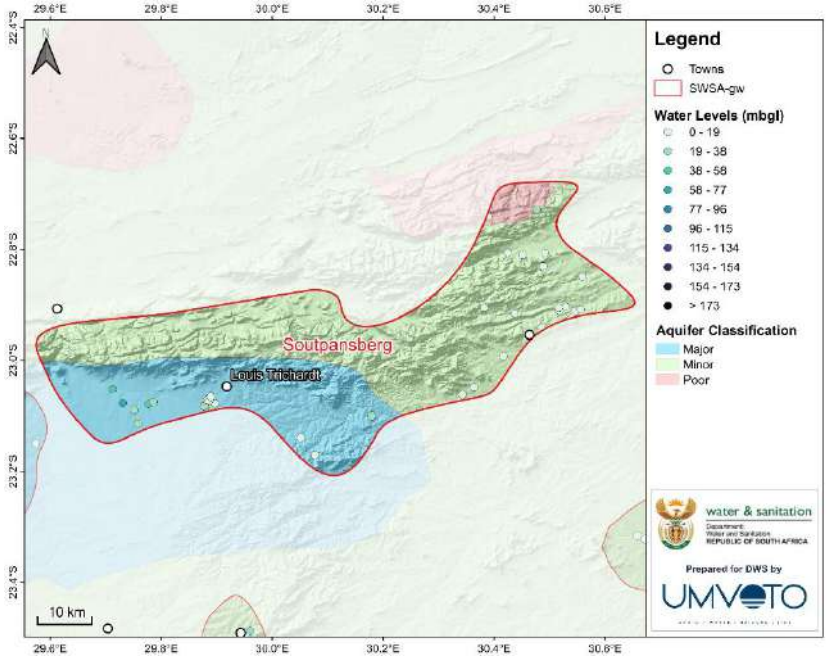
Graph of NGA drilling depths of the Soutpansberg SWSA-gw region



SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Classification, Aquifer Type and Associated Yield and NGA drilling depths of the Soutpansberg SWSA-gw region.



Map of the Aquifer Classification, Aquifer Type and Associated Yield and NGA water levels of the Soutpansberg SWSA-gw region.

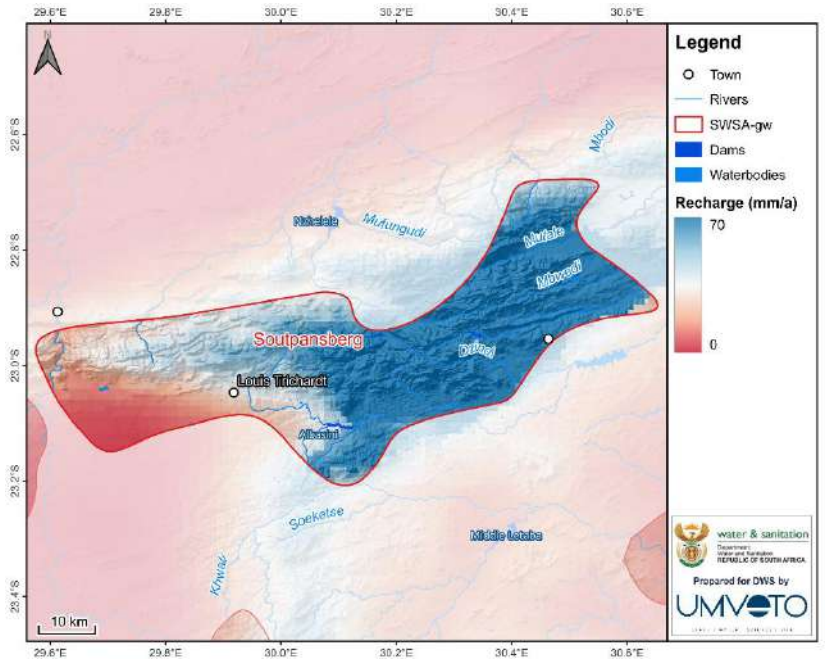
SWSA-gw Name:	**Soutpansberg**
Area:	**2573 km^2**
Elevation:	**485 to 1681 mamsl**

Quantity & Quality

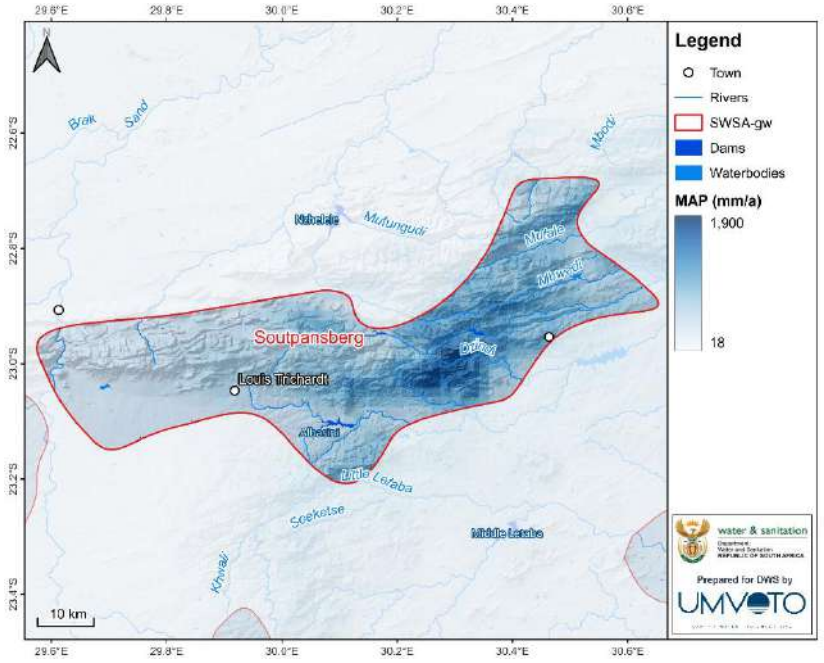
Groundwater Recharge

The Soutpansberg receives a total MAP volume of 2082 Mm^3/a, with a significantly high average rainfall of 797 mm/a. Despite this, only 228 Mm^3/a contributes to groundwater recharge, resulting in a moderate recharge of 11% of MAP. This suggests that while the area experiences relatively high rainfall, a substantial portion is still lost to runoff, evaporation, or surface water flow, though recharge efficiency is better compared to drier regions.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Soutpansberg	2082	797	228	86	11%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681 mamsl

Quantity & Quality

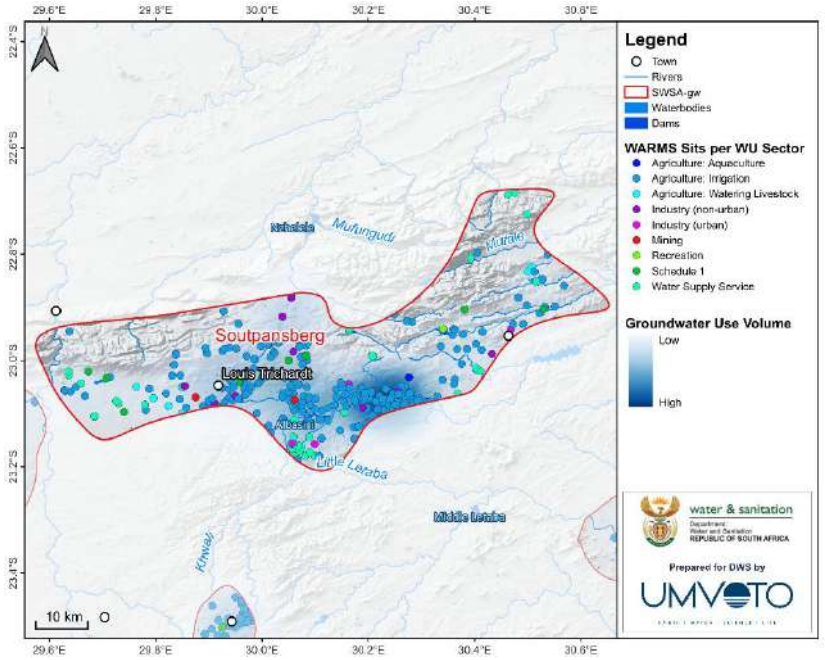
Groundwater Use

The Soutpansberg SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Lous Trichardt (Conjunctive) and Levubu (Conjunctive), which rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 36.8 Mm^3/ a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. While the use is scattered across the region, there are dense clusters around Louis Trichardt and Elim, particularly on the east of Elim. This reliance highlights the need for careful management to prevent over-extraction.
- Municipal water supply services, at 3 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. Supply is highest around Elim, there is also quite a bit of use scattered on the western side of the region.
- Non-urban industrial follows, using 0.4 Mm^3/a for manufacturing, processing, and other industrial activities outside urban centres. This sector is a major driver of groundwater demand, relying on the resource where alternative water supplies are limited. This is mostly around Louis Trichardt and to the east of Elim.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Lous Trichardt, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	36.8
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	0.4
	Industry (Urban)	0.1
	Mining	0.01
	Schedule 1	0.1
	Water Supply Service	3
	Total	**40.5**



Water use map for the Soutpansberg SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

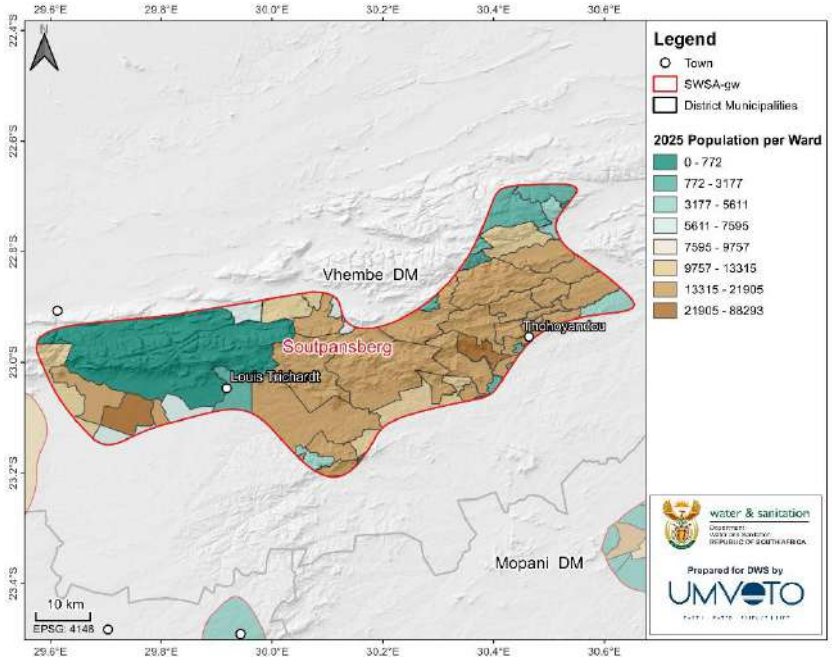
SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Soutpansberg SWSA-gw is located within the Limpopo-Olifants Water Management Areas (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. LOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the LOCMA to manage water resources in the Limpopo-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	LOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The Vhembe district municipality is the Water Service Authority (WSA) and Water Service Provider (WSP) for its jurisdiction.

The estimated 2025 population within the Soutpansberg SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 2.25% per year, resulting in a projected population of approximately 568,158.

As shown in the map and table below, Thulamela Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 309,466, followed by Makhado LM with 258,692. Population concentrations within the SWSA-gw are highest in the Thulamela LM and around the town of Thohoyandou.



Projected 2025 population distribution per ward for the Soutpansberg SWSA-gw.

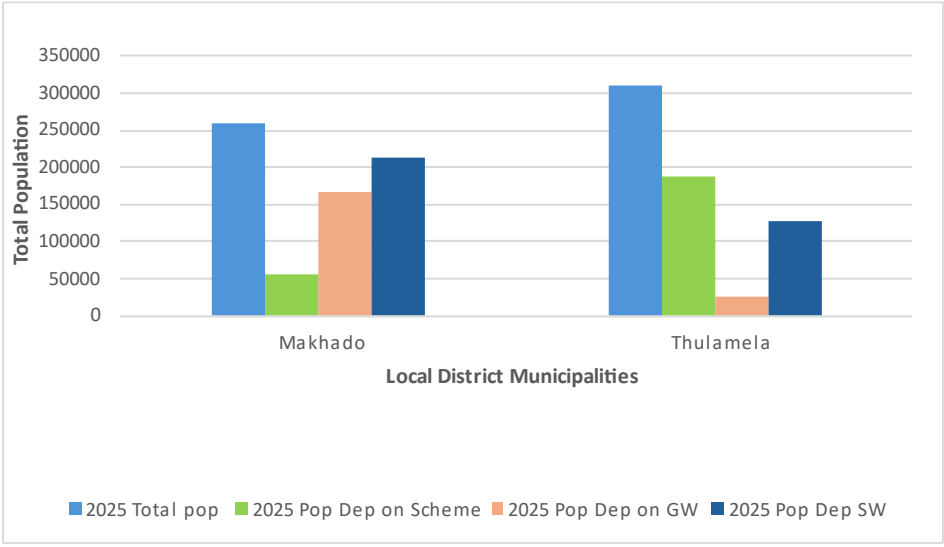
SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Soutpansberg SWSA-gw, an estimated 59.9% of the population depends on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources), 42.9% on the regional water supply schemes and 33.9% on groundwater sources (including boreholes and springs).

Among the LMs, the Makhado LM has the highest proportion of groundwater reliance, with approximately 64.7% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Makhado	258,692	55,406	167,368	212,764
Thulamela	309,466	188,346	25,187	127,281
Total	**568,158**	**243,751**	192,555	340,045



Projected population dependence on water sources in 2025.

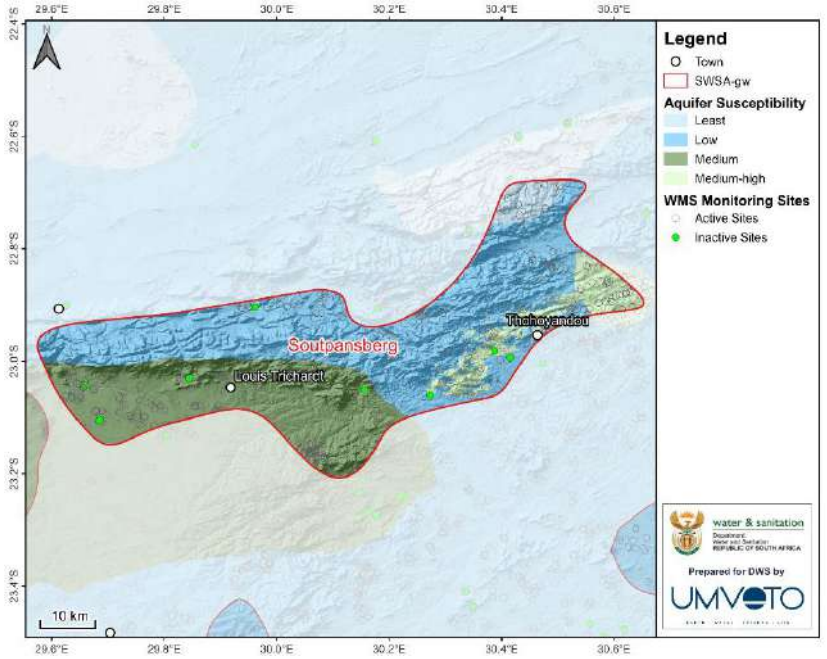
SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681 mamsl
Quantity & Quality	
Groundwater Quality	

The Soutpansberg SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 448.09 km^2, which is 17.42% of the Soutpansberg SWSA-gw total area. Urban/Built-up areas cover 352.42 km^2 (13.70%), while mines and quarries account for 0.64 km^2 (0.02%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major aquifer consists of areas with moderate aquifer vulnerability.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 14.6 - 227.6 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 2.57 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.025 - 34.90 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.06 - 8.8 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0.6 - 86.63 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681 mamsl
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Soutpansberg SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	8	2.40	334	68.55	mS/m	14.11 - 314.1 mS/m (Avg.: 54.83 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Mostly consistent with WMS (2000-2024), except for values above the upper limit.	14.6 - 227.6 mS/m (Avg.: 71.35 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Mostly consistent with WMS (2000-2024), except for values above the upper limit.	-
Fluoride	8	2.79	287	0.30	mg/L	0.025 - 0.79 mg/L (Avg.: 0.26 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	0.025 - 2.57 mg/L (Avg.: 0.31 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).	-
Nitrate + Nitrite Nitrogen	8	2.51	319	6.49	mg/L	0.05 - 14.79 mg/L (Avg.: 3.26 mg/L). 2014-2024 GW Geosites: <11 mg/L. Mostly consistent with WMS NO_3+NO_2 (2000-2024).	0.025 - 34.90 mg/L (Avg.: 7.16 mg/L). 2014-2024 GW Geosites: <11 - 20 mg/L. Mostly consistent with WMS NO_3+NO_2 (2000-2024).	-
pH	8	2.40	334	8.03	pH unit	7 - 8.75 (Avg.: 8.17). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	6.06 - 8.8 (Avg.: 8.00). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	-
Sulphate	8	2.40	334	16.84	mg/L	0.6 - 60.50 mg/L (Avg.: 12.08 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	0.6 - 86.63 mg/L (Avg.: 17.87 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Soutpansberg SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

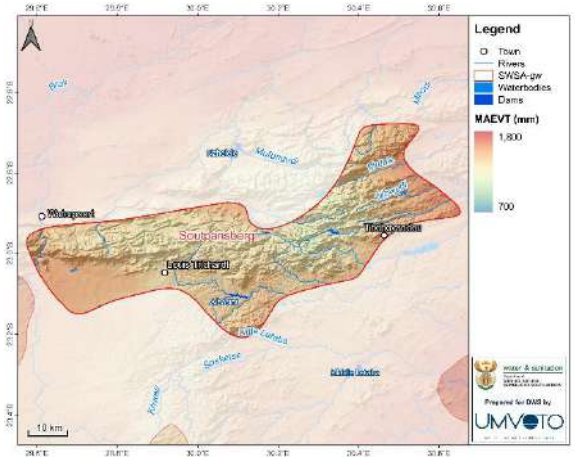
SWSA-gw Name:	**Soutpansberg**
Area:	**2573 km²**
Elevation:	**485 to 1681 mamsl**

Threats & Risks

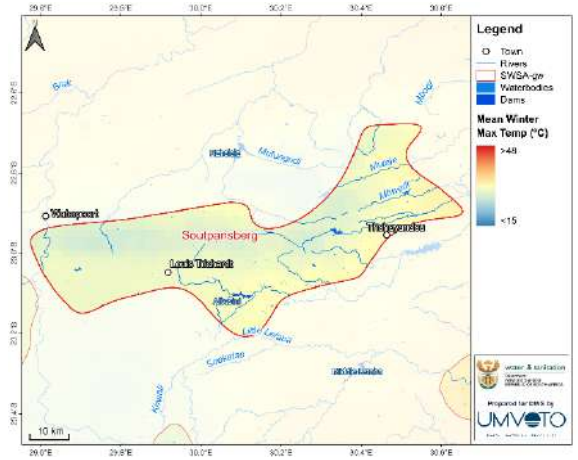
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Soutpansberg SWSA-gw is predominantly a combination of Cwa, humid subtropical, type climate characterised by hot and humid summers and cool to mild winters and a Cwb, subtropical highland, type climate with warm summers and dry winters. Towards the west is a BSk, hot semi-arid, type climate with hot summers, warm to cool winters, and little to no precipitation. Temperatures in the SWSA-gw range from 6.1 – >31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

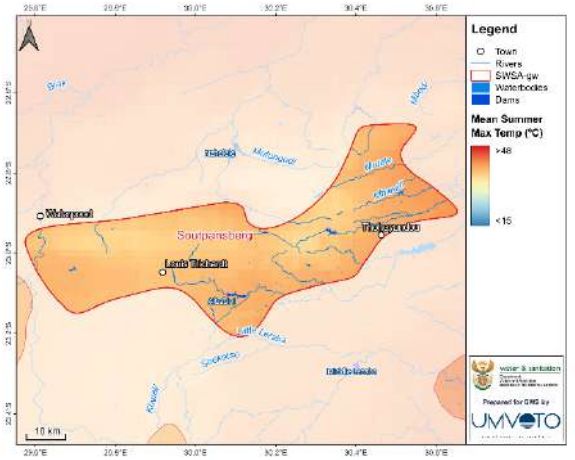
Temperature	Summer: 24.6 to >31 °C, Winter: 6.1 to >8 ºC
Evapotranspiration	Maximum value of 1636 mm/a with an average value of 1411 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, and a small decline in recharge (ranging from ~ -2.3 to 4.4 mm/a). The DART Index indicates mostly stable conditions.



Mean annual A-Pan evaporation of the Soutpansberg SWSA-gw region.



Mean winter temperatures of the Soutpansberg SWSA-gw region.



Mean summer temperatures of the Soutpansberg SWSA-gw region.

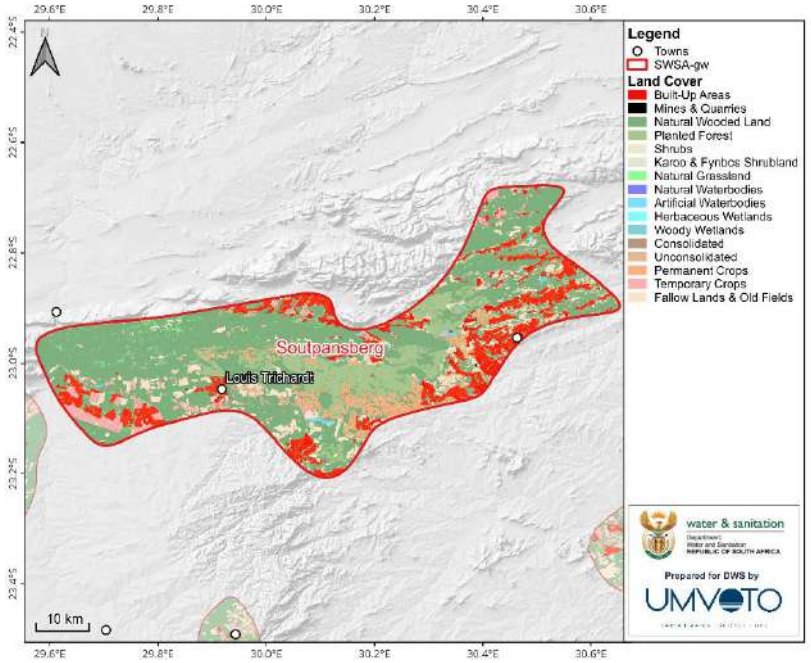
SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681 mamsl

Threats & Risks

Land Use

Forest land, which consists of natural wooded land and planted forest, is the dominant land cover (DFFE, 2022), occupying 56.19% of the Soutpansberg SWSA-gw, highlighting the region's extensive forested landscape and ecological importance. Built-up areas, which include, residential, commercial and industrial areas, make up a significant portion, indicating notable urban and settlement development. Cultivated land, which includes permanent crops, temporary crops, fallow land and old fields, reflect a strong presence of managed agricultural activities. Wetlands and waterbodies occupy a minimal area and indicate the limited supply of surface water in the SWSA-gw.

Land Use Type	Area (km^2)	Area (%)
Barren Land	1	0.1
Built-Up	352	13.7
Cultivated	448	17.4
Forest Land	1728	67.2
Grassland	28	1.1
Mines and quarries	1	0.02
Shrubland	0.001	0.0
Waterbodies	10	0.4
Wetlands	5	0.2



Land Cover 24-class map to show the types of land use and extent of each occurring in the Soutpansberg SWSA-gw.

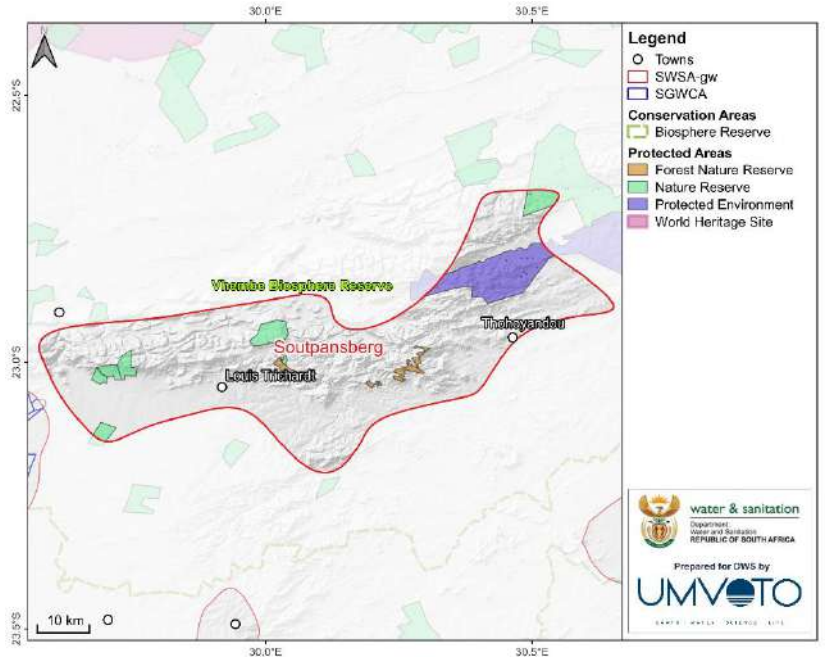
SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681

Protection Status and Ecosystems

Biodiversity and Conservation

The Soutpansberg SWSA-gw falls entirely within the large Vhembe Biosphere Reserve (DFFE, 2024) in the north of the Limpopo Province. Also within the SWSA-gw lies a portion of the large Mphaphuli Protected Environment, a protected environment (DFFE, 2024) which extends east until the borders of the Kruger National Park.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Vhembe Biosphere Reserve	2572.51	1
Protected Areas	• Mphaphuli Protected Environment • Entabeni Nature Reserve • Studholme Nature Reserve • Thengwe Nature Reserve • Happy Rest Nature Reserve • And various other small nature reserves and forest nature reserves	229.27	9
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of Soutpansberg SWSA-gw that have protection status.

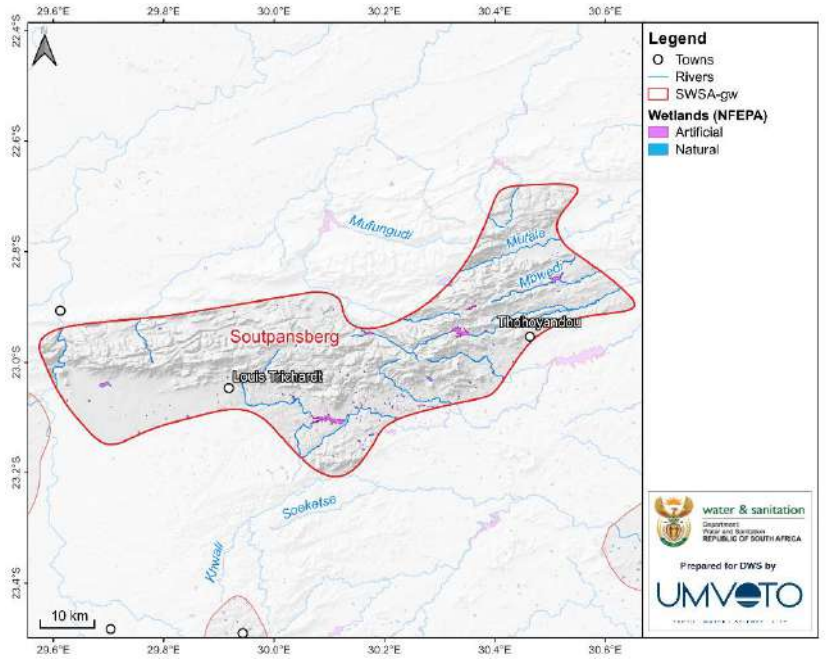
SWSA-gw Name:	Soutpansberg
Area:	2573 km^2
Elevation:	485 to 1681

Protection Status and Ecosystems

Biodiversity and Conservation

There are two dams (DWS, 2011) in the Soutpansberg SWSA-gw, making up a small portion of the SWSA-gw. The Vondo Dam lies along the Mutshindudi River, while the Albasini Dam is fed by the Luvuvhu and Doringspruit rivers.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Vondo Dam • Albasini Dam	4.78	2
Ramsar Sites	None		0
Wetlands	Various natural and artificial wetlands	16	0

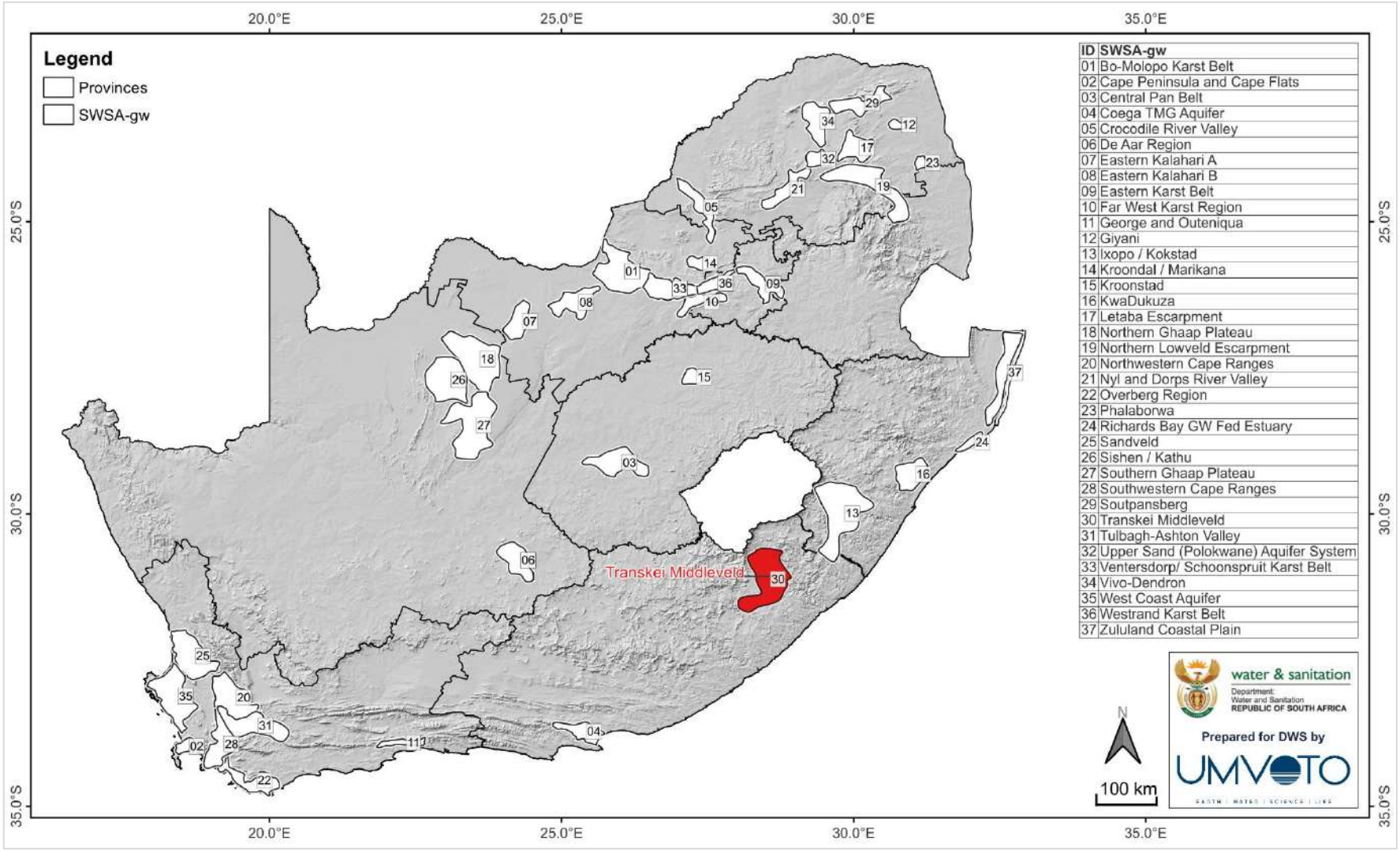


Map showing the major water bodies, Ramsar sites and GDEs in the Soutpansberg SWSA-gw.

APPENDIX 30

TRANSKEI MIDDLEVELD SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE TRANSKEI MIDDLEVELD SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

30. Transkei Middleveld

30.1. Description

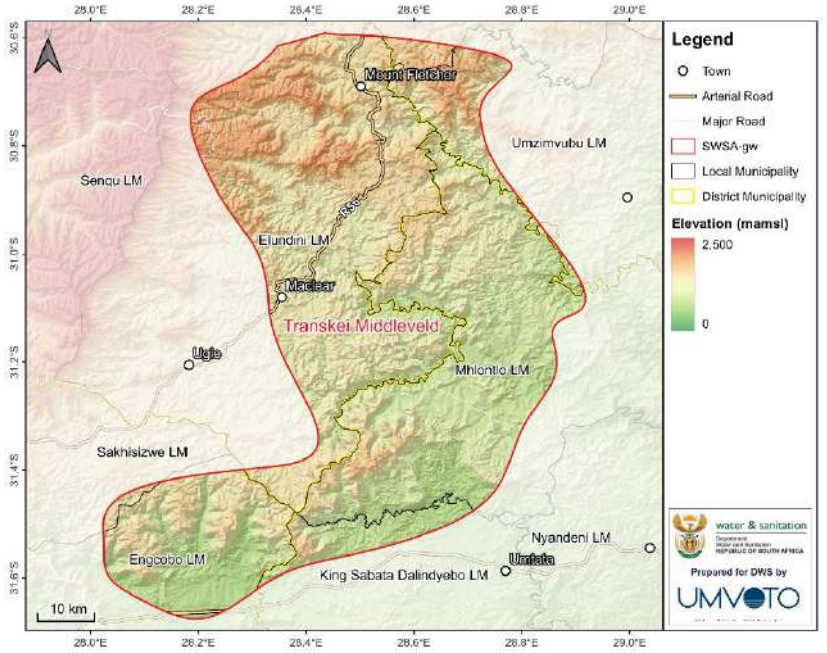
SWSA-gw Name:	**Transkei Middleveld**
Area:	**5607 km²**
Elevation:	**675 to 2106 mamsl**

Geospatial Context

The topography of the Transkei Middleveld SWSA-gw, as depicted in the map, exhibits a predominantly rugged and elevated terrain, with higher elevations concentrated in the central and northern areas around Mount Fletcher, Maclear, and Ugie. This area is characterized by dissected highlands, steep slopes, and deeply incised river valleys. In contrast, the southeastern portion, including O.R. Tambo and Mthatha, transitions into lower-lying terrain with gentler slopes. The elevation gradually decreases towards the west, where the landscape becomes less rugged. The overall topography suggests a mix of mountainous highlands and river-carved valleys, shaping the region's drainage patterns and settlement distribution.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Eastern Cape
District Municipality	Alfred Nzo, Chris Hani, Joe Gqabi and O.R.Tambo
Local Municipality	Elundini, Engcobo, King Sabata Dalindyebo, Matatiele, Mhlontlo, Sakhisizwe and Umzimvubu
Towns	Mount Fletcher, Maclear and Tsolo
Major Roads	R396, R412, R56 and N2
Major Water Supply Networks	



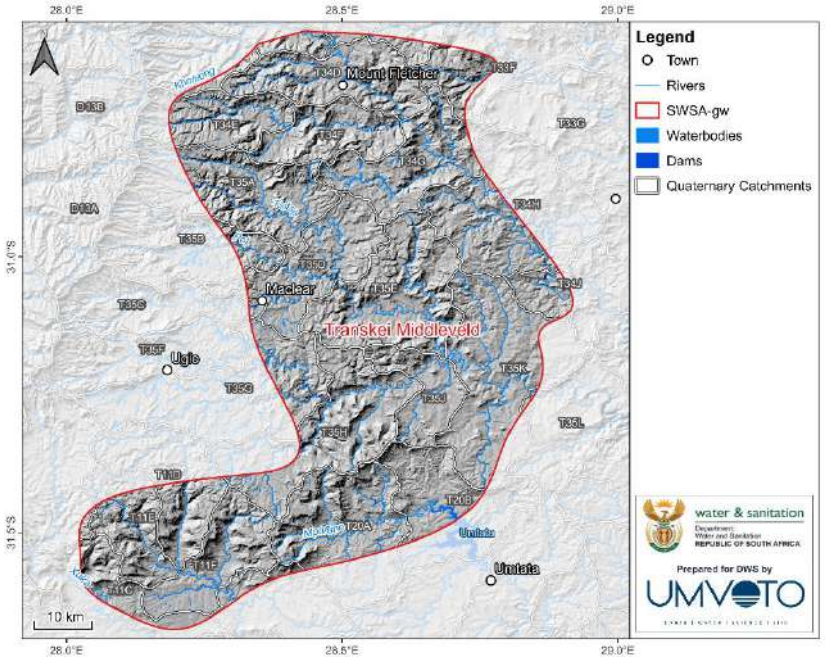
Locality map of Major Towns, District and Local Municipalities in the Transkei Middleveld SWSA-gw.

SWSA-gw Name:	Transkei Middleveld
Area:	5607 km^2
Elevation:	675 to 2106 mamsl

Hydrology and Drainage

The Transkei Middleveld SWSA-gw and surrounding areas include major surface water systems, summarised below and displayed in the map on the right. The surface water systems are the Mabeleni, Nqadu and Umtata reservoirs along with the many perennial rivers, flowing in a variety of directions. The area is fed by the T1, T2 and T3 catchments.

Quaternary Catchments	T11C, T11D, T11E, T11F, T11G, T20A, T20B, T33E, T33F, T34A, T34B, T34C, T34D, T34E, T34F, T34G, T34H, T34J, T35A, T35B, T35C, T35D, T35E, T35G, T35H, T35J, T35K and small areas of T11B, T35L
Rivers	Perennial: Bradgate se Loop, Culunca, Gatberg, Gqaqala, Gqobonco, Gqukunqa, Hlankomo, Inxu, iTsitsa, Khalatsu, Khohlong, Luzi, Mbhashe, Mhlahlane, Mnyolo, Mooi, Mpafane, Mthatha, Ncolosi, Ncome, Ngcibira, Ngcothi, Ngqunge, Nqancule, Nxaxa, Pot, Qelana, Qhanqu, Qwakele, Qwidlana, Somabadi, Tabase, Thina, Tinana, Tokwana, Tsilithwa, Tsitsa, Tsitsana, Tyira, Umnga, Xokonxa, Xuka
	Ephemeral: none
Natural and manmade water bodies	
Major Dams:	Mabeleni, Nqadu and Umtata
Water Management Areas:	Mzimvubu Tsitsikamma



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Transkei Middleveld SWSA-gw.

SWSA-gw Name:	Transkei Middleveld
Area:	5607 km^2
Elevation:	675 to 2106 mamsl

Geology

Geology

The Transkei Middleveld area is primarily covered by the Karoo Supergroup.

A complex network of dolerite sills, sheets, and dykes from the Karoo Dolerite Suite is scattered throughout the region.

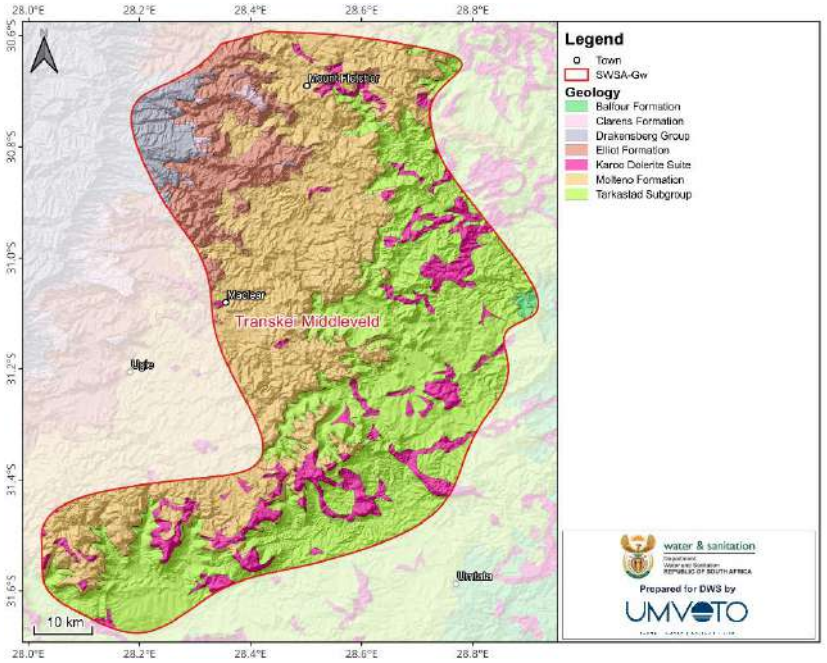
The youngest geological unit, the Drakensberg Group, outcrops in the northwestern section and is dominated by extensive basaltic lava flows with minor sandstones, tuffs, and agglomerates.

In the western section, the Molteno Formation outcrops, characterised by alternating sandstones, olive mudstones, dark grey shales with coal seams, and plant fossils. To the north, the Elliot and Clarens Formations outcrop. The Elliot Formation is composed of red and greenish-grey mudstones with subordinate sandstones, while the Clarens Formation consists of fine-grained sandstones and siltstones, evidenced by aeolian dune deposits from an arid phase.

In the southern and eastern sections, the Beaufort Group outcrops, comprising red and greenish-grey mudstones and fine- to medium-grained sandstones.

Hydrostratigraphy

The Karoo Supergroup forms a two-layered aquifer system. The upper weathered-jointed layer acts as a secondary, intergranular-fractured aquifer, while the lower fractured layer functions as a secondary, fractured-rock aquifer. The Ecca Group and Clarens Formation contribute to secondary, intergranular-fractured aquifers. The Drakensberg Group basalts form a secondary, fractured aquifer with limited groundwater potential.



Geology Map of the Transkei Middleveld SWSA-gw region.

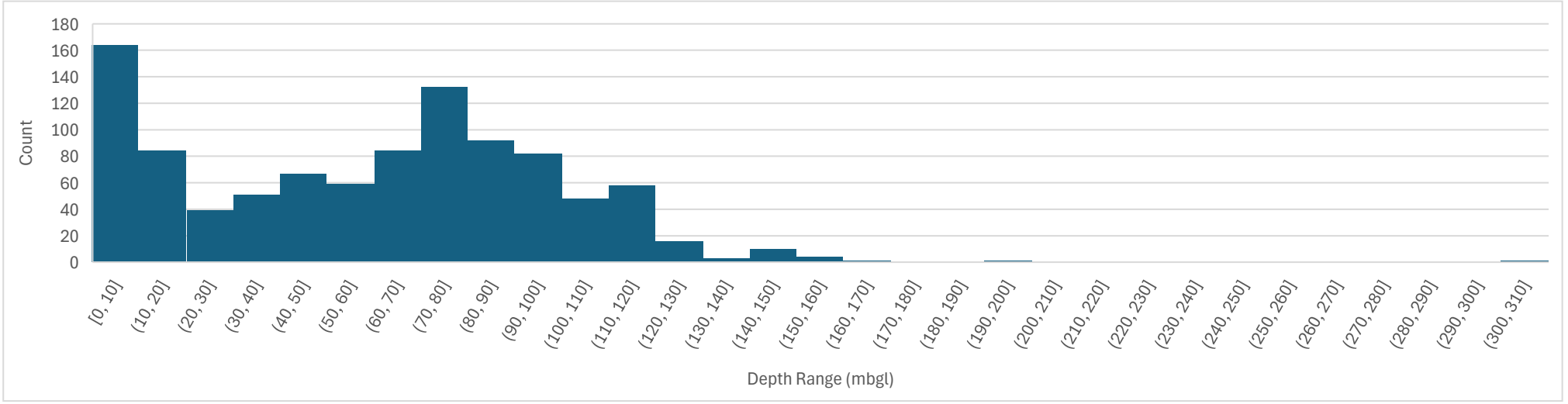
30.2. Current Status

SWSA-gw Name:	**Transkei Middleveld**
Area:	**5607 km²**
Elevation:	**675 to 2106 mamsl**
Quantity & Quality	
Aquifer Classification	

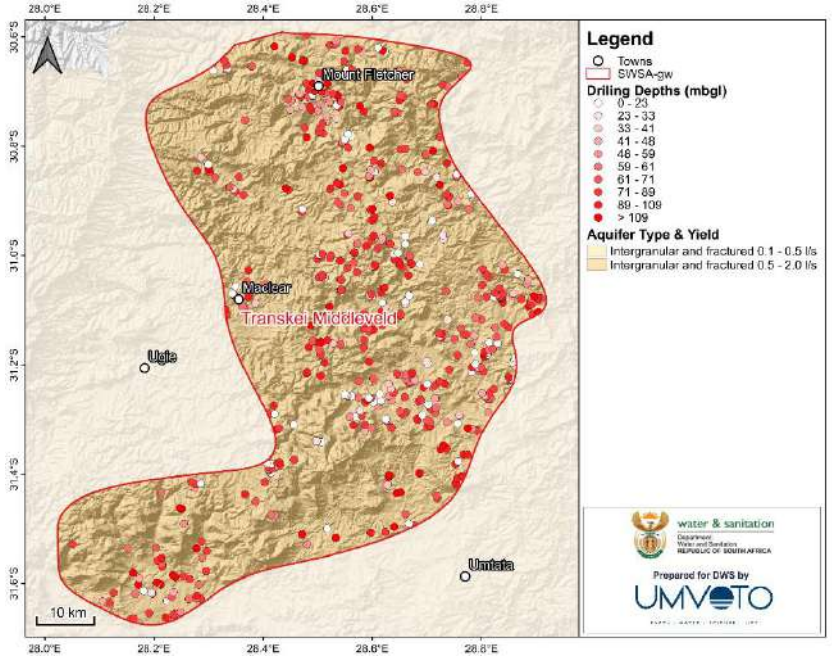
The aquifer systems within the Transkei Middleveld SWSA-gw exhibit varying yields across dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is a Minor aquifer system with an average dual-porosity yield ranging from 0.5 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 60 mbgl, and the most common depths are around 10 and 80 mbgl, respectively, suggesting mixed targets in the dual-porosity aquifer systems. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 17 and 90 mbgl. Based on the last 25 years of NGA water level data, the average groundwater water level in the region is 28 mbgl, with values ranging from 0 to 90 mbgl and a standard deviation of 20 mbgl.

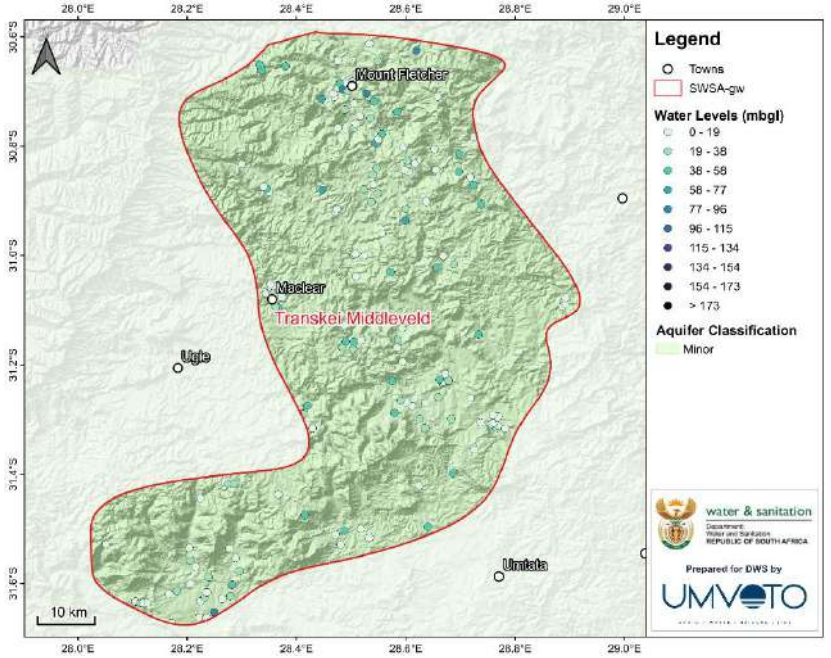
Graph of NGA drilling depths of the Transkei Middleveld SWSA-gw region



SWSA-gw Name:	Transkei Middleveld
Area:	5607 km^2
Elevation:	675 to 2106 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Transkei Middleveld SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Transkei Middleveld SWSA-gw region.

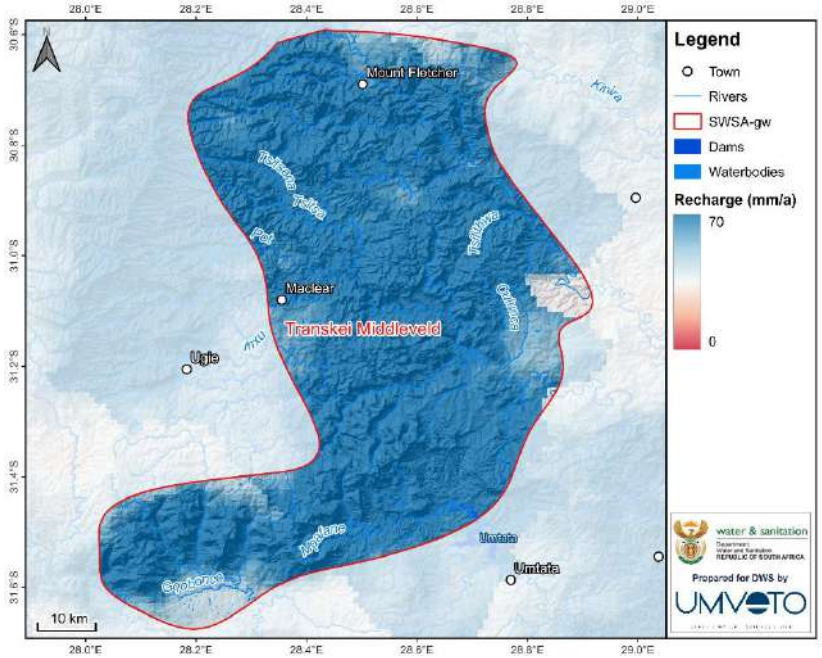
SWSA-gw Name:	**Transkei Middleveld**
Area:	**5607 km²**
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Quantity & Quality

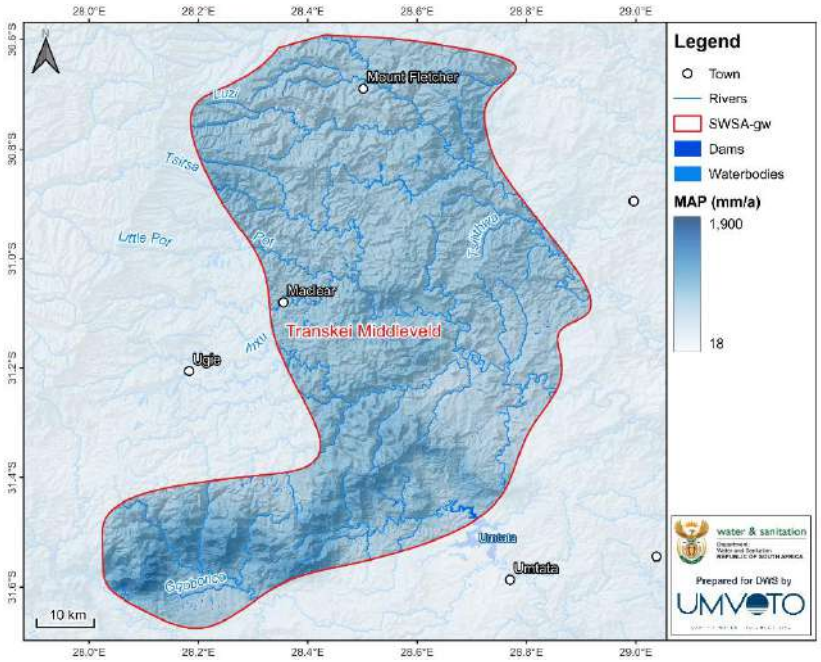
Groundwater Recharge

The Transkei Middleveld receives a total MAP volume of 4638 Mm³/a, with a significantly high average rainfall of 825 mm/a. Despite this, only 475.6 Mm³/a contributes to groundwater recharge, resulting in a moderate recharge of 10.3% of MAP. This suggests that while the area experiences relatively high rainfall, a substantial portion is still lost to runoff, evaporation, or surface water flow, though recharge efficiency is better compared to drier regions.

SWSA-gw	Sum of MAP Volume Mm³/a	Average of MAP mm/a	Sum of Recharge Vol Mm³/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm³/a)
Transkei Middleveld	4638	825	475.6	84.1	10.3%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

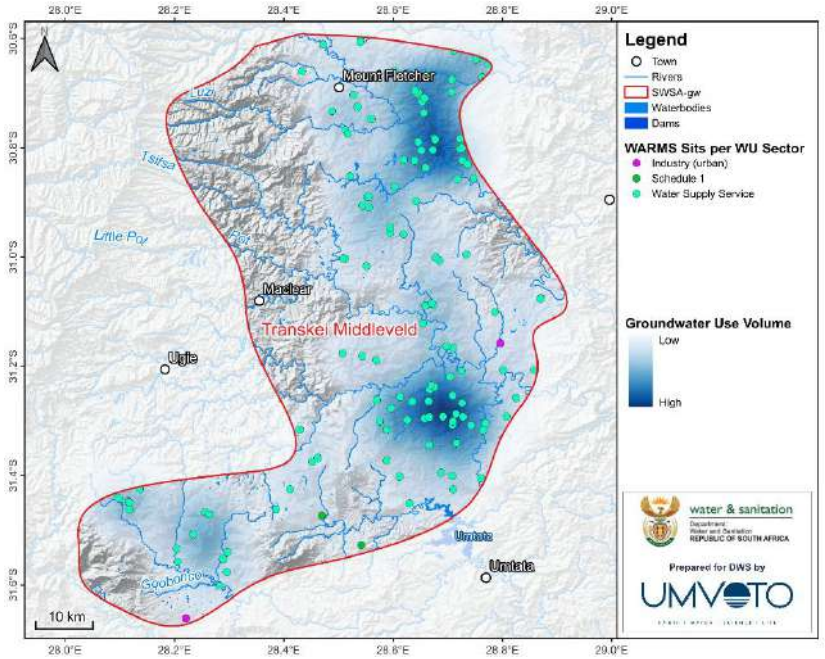
SWSA-gw Name:	Transkei Middleveld
Area:	5607 km^2
Elevation:	675 to 2106 mamsl
Quantity & Quality	
Groundwater Use	

The Transkei Middleveld SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Tsolo (Conjunctive), which relies significantly on groundwater resources for municipal supply, industrial use, and schedule 1 (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Municipal water supply services, at 2.2 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. Municipal water use is quite scattered throughout the region, particularly on the eastern sides and around Tsolo and Mount Fletcher. A large proportion of this region depends on groundwater.
- Urban industrial follows, using 0.02 Mm^3/a for manufacturing, processing, and other industrial activities in urban centres. This is mainly located north of Tsolo.
- Schedule 1 follows, using 0.01 Mm^3/a, used by households for domestic use. Domestic demand for groundwater is important, especially in places with water restrictions, poor water quality or remote areas. Schedule 1 water is distributed to the south of Tsolo.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Tsolo, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Industry (Urban)	0.02
	Schedule 1	0.01
	Water Supply Service	2.2
	Total	**2.3**



Water use map for the Transkei Middleveld SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

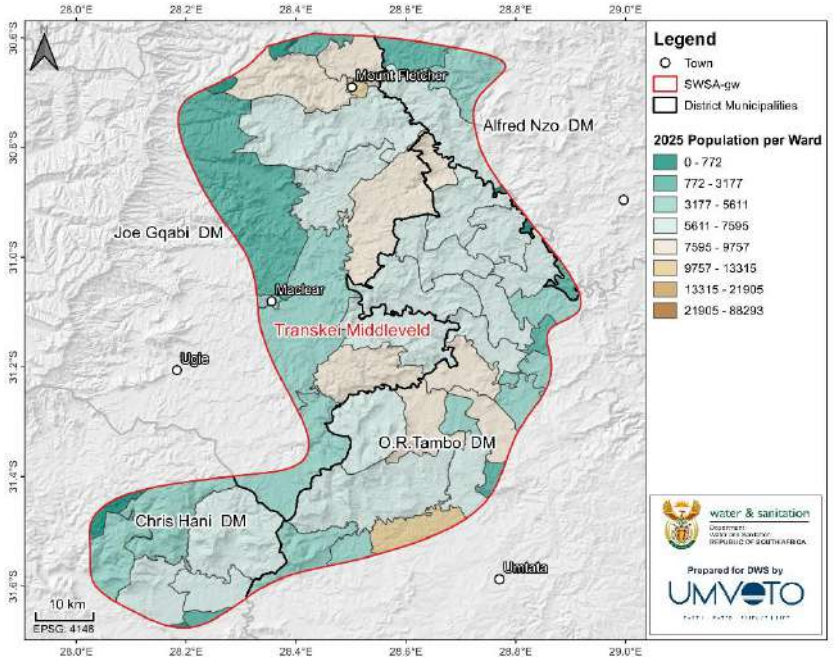
SWSA-gw Name:	Transkei Middleveld
Area:	5607 km^2
Elevation:	675 to 2106 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Transkei Middleveld SWSA-gw is located within the Mzimvubu-Tsitsikamma Water Management Area (WMA, 2023). The groundwater resources within the Northwestern Cape Ranges SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Mzimvubu-Tsitsikamma Catchment Management Agency (MTCMA), which was formed as part of a national restructuring process that consolidated CMAs. MTCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the MTCMA to manage water resources in the Mzimvubu-Tsitsikamma WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	MTCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Mzimvubu-Tsitsikamma WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The district municipalities (Joe Gqabi DM, Alfred Nzo DM, O.R. Tambo DM and Chris Hani DM) are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdictions.

The estimated 2025 population within the Transkei Middleveld SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of -1.83% per year, resulting in a projected population of approximately 188,438.

As shown in the map and table below, Mhlontlo Local Municipality (LM) has the highest estimated population within the SWSA-gw with 84,442, followed by Elundini LM with 60,212. Population concentrations within the SWSA-gw are highest in the Mhlontlo, King Sabata Dalindyebo and Engcobo LMs and around the town of Mount Fletcher.



Projected population distribution in 2025 for the Transkei Middleveld SWSA-gw.

SWSA-gw Name:	Transkei Middleveld
Area:	5607 km^2
Elevation:	675 to 2106 mamsl

Quantity & Quality

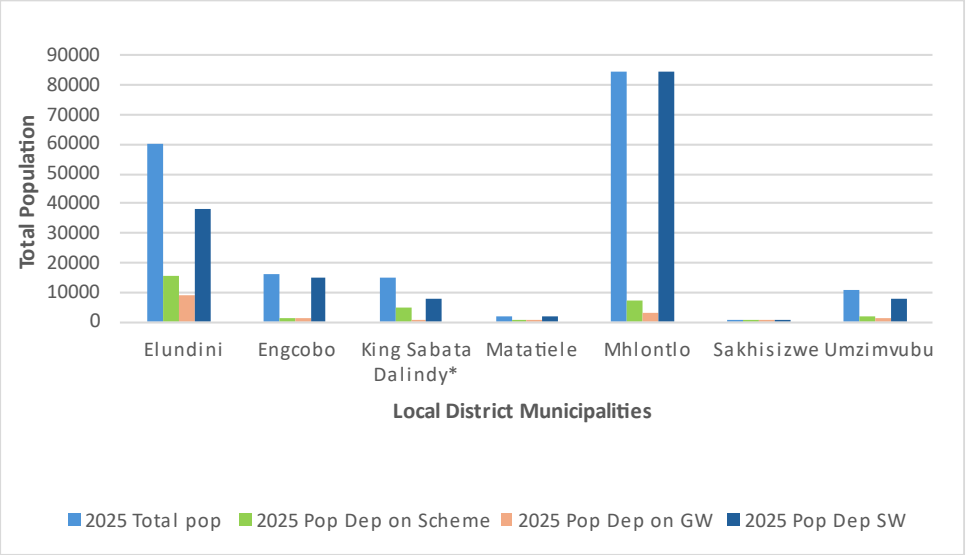
Socio Economic & Governance

In terms of water reliance within the Transkei Middleveld SWSA-gw, an estimated 82.6% of the population depends on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources), 16.4% depend on regional water supply schemes and 8.2% on groundwater (including boreholes and springs).

Among the LMs, the Matatiele LM has the highest proportion of groundwater reliance, with approximately 20.6% of the population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Elundini	60,212	15,849	8,906	38,200
Engcobo	16,111	1,055	1,022	14,823
King Sabata Dalindy*	14,752	4,736	628	8,087
Matatiele	2,148	21	443	1,594
Mhlontlo	84,442	7,398	3,258	84,715
Sakhisizwe	194	153	7	88
Umzimvubu	10,578	1,728	1,130	8,125
Total	**188,438**	**30,940**	15,393	155,633



Projected population dependence on water sources in 2025.

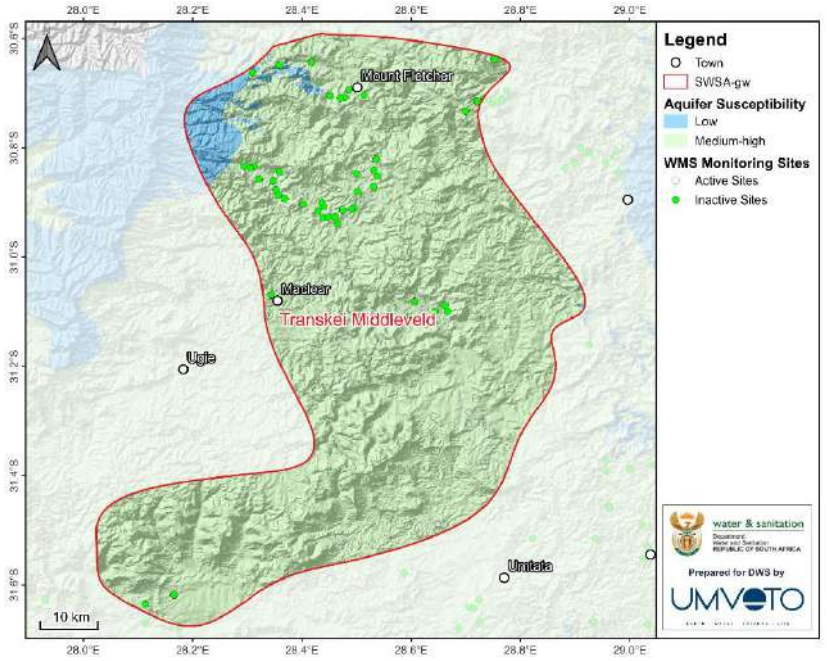
SWSA-gw Name:	Transkei Middleveld
Area:	5607 km^2
Elevation:	675 to 2106
Quantity & Quality	
Groundwater Quality	

The Transkei Middleveld SWSA-gw consists of the Minor aquifer system, classified based on their yield and water quality. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 1078.07 km^2, which is 19.23% of the Transkei Middleveld SWSA-gw total area. Urban/Built-up areas cover 518.84 km^2 (9.25%), while mines and quarries account for 5.80 km^2 (0.10%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Minor aquifer consists of areas with moderate and least aquifer vulnerability. The majority of the Minor aquifer is characterized by areas that have moderate vulnerability, while the least vulnerable areas are found in the Northwestern parts of the aquifer.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 3.9 – 55 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 12.3 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.005 - 8.3 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 5.3 to 9.07 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0.5 - 24.8 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Transkei Middleveld**
Area:	**5607 km^2**
Elevation:	**675 to 2106**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Transkei Middleveld SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	40	95.24	42	27.12	mS/m	17.5 mS/m. 2014-2024 GW Geosites: N/A	3.9 - 55 mS/m (Avg.: 27.24 mS/m). 2014-2024 GW Geosites: <70 mS/m. Mostly consistent with WMS (2000-2024), except for values above the upper limit.	-
Fluoride	50	96.15	52	0.27	mg/L	0.025 mg/L. 2014-2024 GW Geosites: N/A	0.025 - 12.3 mg/L (Avg.: 0.28 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Mostly consistent with WMS (2000-2024).	-
Nitrate + Nitrite Nitrogen	37	94.87	39	1.46	mg/L	0.39 mg/L. 2014-2024 GW Geosites: N/A	0.005 - 8.3 mg/L (Avg.: 1.47 mg/L). 2014-2024 GW Geosites: <11 mg/L. Mostly consistent with WMS NO_3+NO_2 (2000-2024).	-
pH	40	95.24	42	7.18	pH unit	7.32. 2014-2024 GW Geosites: N/A	5.3 - 9.07 (Avg.: 7.18). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	-
Sulphate	43	95.56	45	6.59	mg/L	6 mg/L. 2014-2024 GW Geosites: N/A	0.5 - 24.8 mg/L (Avg.: 6.60 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Transkei Middleveld SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*
- *"N/A" refers to Not Applicable.*

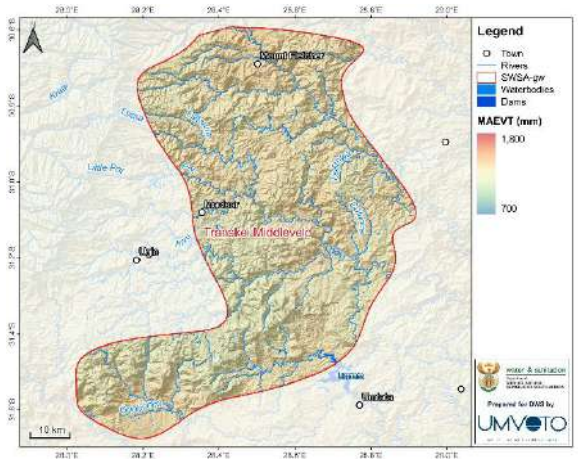
SWSA-gw Name:	Transkei Middleveld
Area:	5607 km²
Elevation:	675 to 2106 mamsl

Threats & Risks

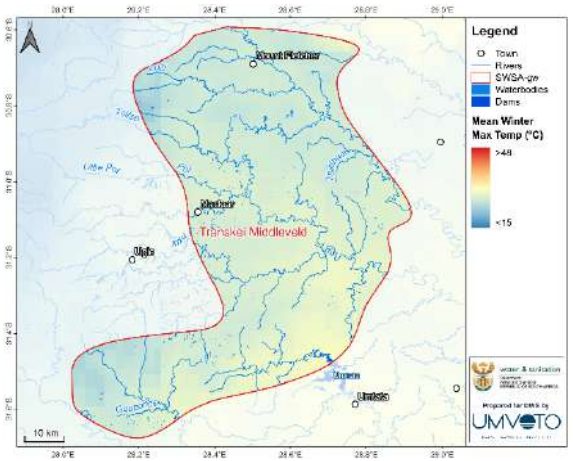
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Transkei Middleveld SWSA-gw has a combination of a Cwb, subtropical highland, type climate characterized by warm summers and dry winters and a Cfb, humid marine, type climate with short, dry summers and mild winters. Temperatures in the SWSA-gw range from -1.9 – 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

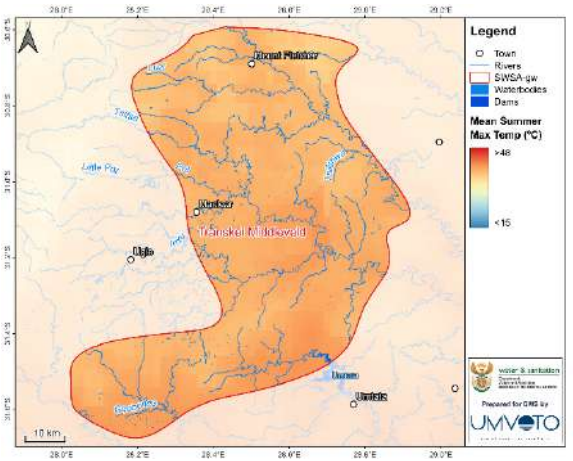
Temperature	Summer: 24.7 to 29.2 °C, Winter: -1.9 to 8 ºC
Evapotranspiration	Maximum value of 1383 mm/a with an average value of 1310 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, but an increase in recharge (ranging from ~ 4.4 to 9.6 mm/a). The DART Index indicates stable and some improving conditions.



Mean annual A-Pan evaporation of the Transkei Middleveld SWSA-gw region.



Mean winter temperatures of the Transkei Middleveld SWSA-gw region.



Mean summer temperatures of the Transkei Middleveld SWSA-gw region.

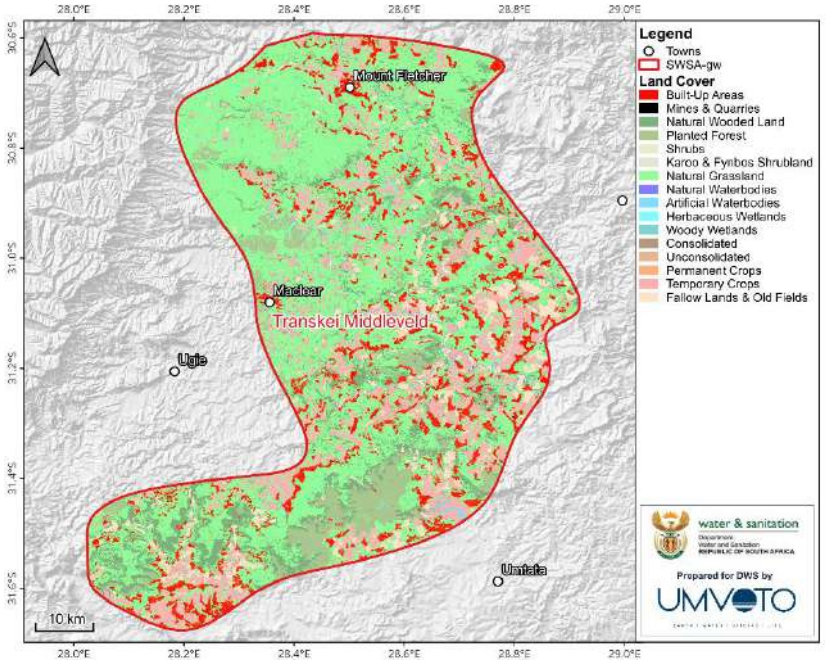
SWSA-gw Name:	Transkei Middleveld
Area:	5607 km^2
Elevation:	675 to 2106 mamsl

Threats & Risks

Land Use

Grassland is the predominant land cover (DFFE, 2022), occupying 50.6% of the Transkei Middleveld, highlighting the region's extensive open landscapes and natural vegetation. Cultivated land, which includes temporary crops, permanent crops, fallow land and old fields, represents a significant portion, indicating active agricultural use and reliance on seasonal cultivation. Forest land, made up of natural wooded land and planted forests, contributes to the region's forestry resources, balancing both natural and managed vegetation. Built-up areas, consisting of residential, commercial and industrial areas, are scattered throughout the SWSA-gw and show moderate urban development, suggesting a mix of rural and urban land use. Wetlands and water bodies cover a small but essential portion, playing a crucial role in maintaining biodiversity and water resource sustainability.

Land Use Type	Area (km^2)	Area (%)
Barren Land	72	1.3
Built-Up	519	9.3
Cultivated	1078	19.2
Forest Land	1007	18.0
Grassland	2839	50.6
Mines and quarries	6	0.1
Waterbodies	25	0.4
Wetlands	61	1.1



Land Cover 24-class map to show the types of land use and extent of each occurring in the Transkei Middleveld SWSA-gw.

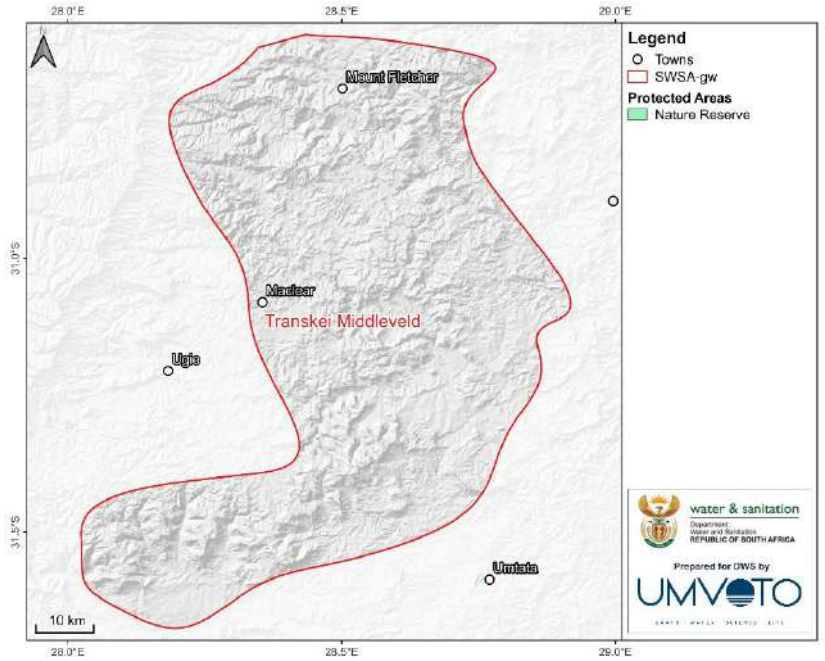
SWSA-gw Name:	Transkei Middleveld
Area:	5607 km^2
Elevation:	675 to 2106

Protection Status and Ecosystems

Biodiversity and Conservation

The Transkei Middleveld SWSA-gw does not contain any conservation areas or protected areas.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	None		0
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Transkei Middleveld SWSA-gw that have protection status.

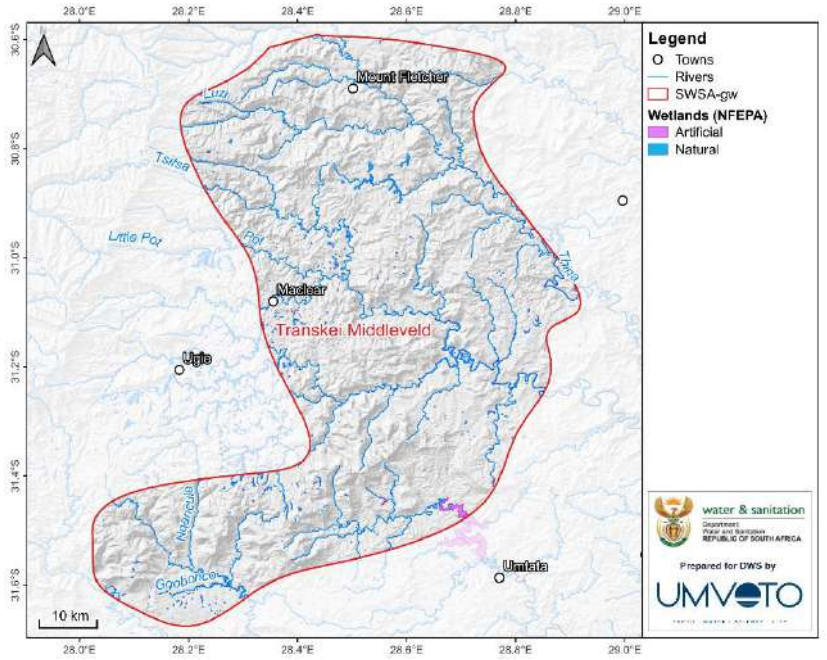
SWSA-gw Name:	Transkei Middleveld
Area:	5607 km^2
Elevation:	675 to 2106

Protection Status and Ecosystems

Biodiversity and Conservation

The Umtata Dam (DWS, 2011) is a major water body that only partly falls within the Transkei Middleveld SWSA-gw towards its southeastern edge. There are various small natural and artificial wetlands (CSIR, 2011) covering an area of 62 km^2 of the SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Umtata Dam	1.66	1
Ramsar Sites	None		0
Wetlands	Various natural and artificial wetlands	62	

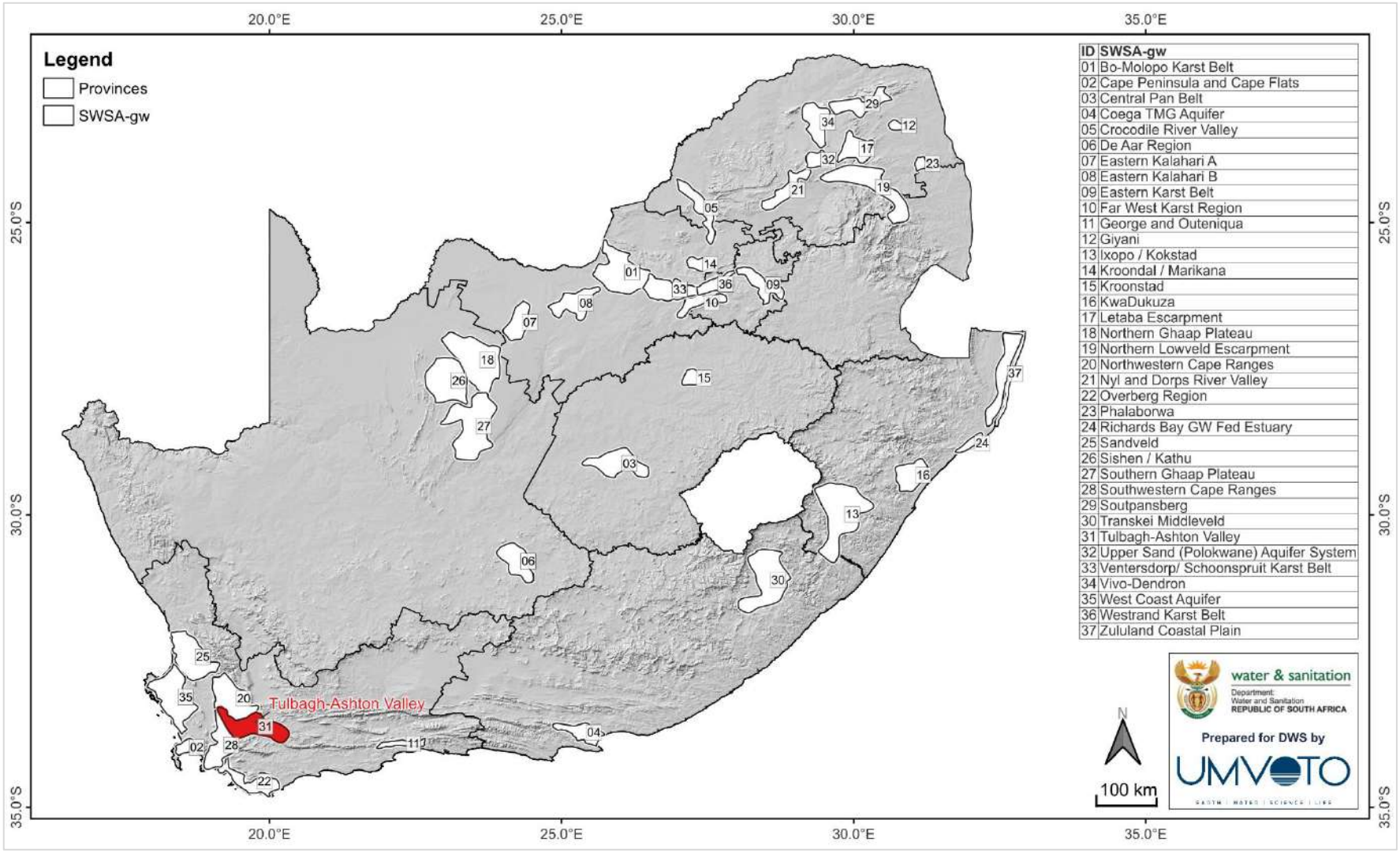


Map showing the major water bodies, Ramsar sites and GDEs in the Transkei Middleveld SWSA-gw.

APPENDIX 31

TULBAGH-ASHTON VALLEY SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE TULBAGH-ASHTON VALLEY SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

31. Tulbagh-Ashton Valley

31.1. Description

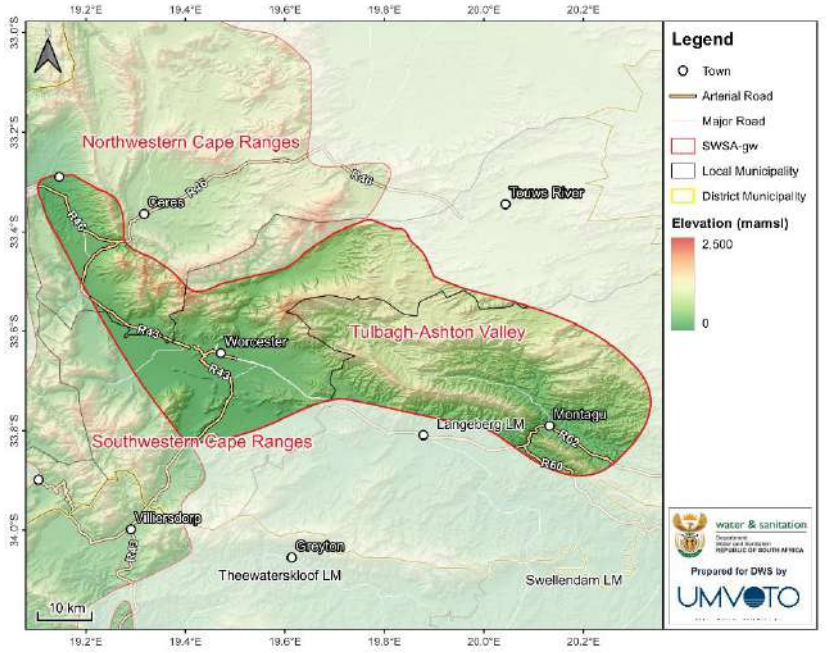
SWSA-gw Name:	Tulbagh-Ashton Valley
Area:	3560 km^2
Elevation:	103 to 2029 mamsl

Geospatial Context

The topography of the Tulbagh-Ashton Valley SWSA-gw, as depicted in the map, is dominated by rugged mountain ranges and valleys. The western and central portions, including Worcester, De Doorns, and Goudini, are characterized by steep, elevated terrain associated with the Cape Fold Belt, with prominent ridges and deep valleys. Moving southeast towards Robertson, Montagu, and Ashton, the terrain gradually transitions into rolling hills and lower-lying valleys, providing a mix of rugged and more gently undulating landscapes.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Western Cape
District Municipality	Cape Winelands
Local Municipality	Witzenberg, Breede Valley and Langeberg
Towns	Ashton, Bergsig, Botha, Brandvlei, Ceres, De Doorns, De Nova, Goudini, Montagu, Rawsonville, Robertson, Tulbagh and Worcester
Major Roads	N1, R43, R46, R60, R62, R101 and R318
Major Water Supply Networks	



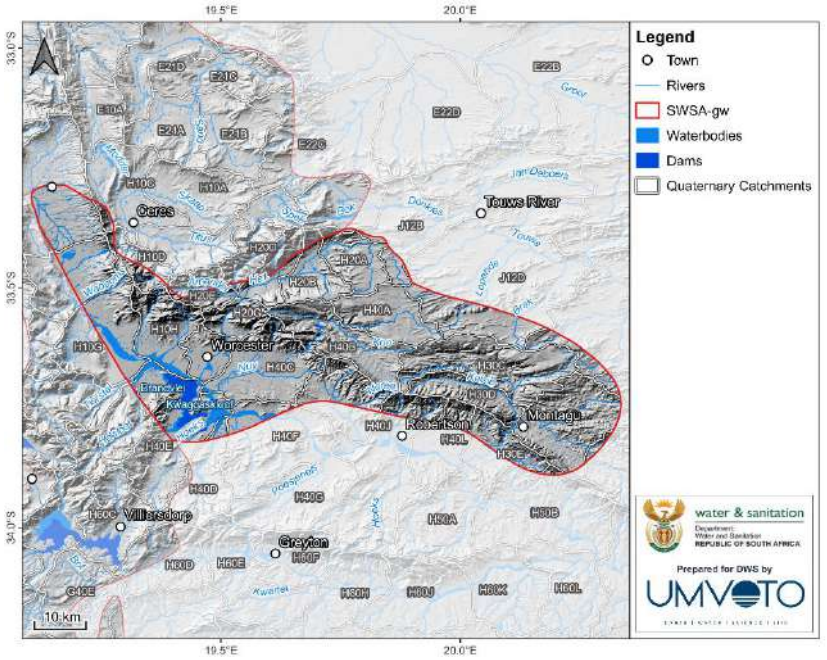
Locality map of Major Towns, District and Local Municipalities in the Tulbagh-Ashton Valley SWSA-gw.

SWSA-gw Name:	Tulbagh-Ashton Valley
Area:	3560 km^2
Elevation:	103 to 2029 mamsl

Hydrology and Drainage

The Tulbagh-Ashton Valley SWSA-gw and surrounding areas include major surface water systems, summarised below and displayed in the map on the right. The main surface water systems are the Brandvlei reservoir, fed by the H1 catchment; the Kwaggaskloof, Moordkuil, and Keerom reservoirs, fed by the H4 catchment; and the Pietersfontein reservoirs, fed by the H3 catchment, along with the many perennial rivers flowing in diverse directions.

Quaternary Catchments	G10E, H10C, H10D, H10F, H10G, H10H, H10J, H10L, H20A, H20B, H20E, H20F, H20G, H20H, H30A, H30B, H30C, H30D, H30E, H40A, H40B, H40C, H40D, H40E, H40F, H40H, H40J, H40L, J12B, J12D, J12F, J12J and a small section of H10K, H50B, J12A, H20D
Rivers	Perennial: Amandel, Boontjies, Bothaspruit, Bree, Doring, Dwarriega, Groot, Hartbees, Hex, Hoeks, Holsloot, Hoops, Keisie, Keurboskloof, Kiesie, Kingna, Koekedou, Kogmanskloof, Koo, Nonna, Noree, Nuy, Raaswater, Rooi-Elskloof, Slanghoek, Smalblaar, Spek, Vink, Wabooms, Willem Nels, Witels
	Ephemeral: Brak, Brakkloof, Die Brak, Dikkopskraal, Gatskraal se, Knolvlei, Kruis, Langkloofspruit, Lopende, Pietersfontein, Toontjies, Watervals
Natural and manmade water bodies	Brandvlei, Kwaggaskloof, Moordkuil, Keerom, Pietersfontein reservoirs
Major Dams:	Brandvlei, Kwaggaskloof, Moordkuil, Keerom, Pietersfontein
Water Management Areas:	Breede Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Tulbagh-Ashton Valley SWSA-gw.

SWSA-gw Name:	Tulbagh-Ashton Valley
Area:	3560 km^2
Elevation:	103 to 2029 mamsl
Geology	

Geology

The western side of the Tulbagh-Ashton Valley area is characterised by Quaternary deposits, including loamy soils, alluvium, scree, and river terrace gravels.

The Karoo Supergroup is represented by the Dwyka and Ecca Groups. The Dwyka Group comprises diamictite interbedded with varved shale and mudstone, while the Ecca Group includes the Prince Albert Formation, characterised by dark-grey mudrock, and the Whitehill Formation, featuring carbonaceous shale.

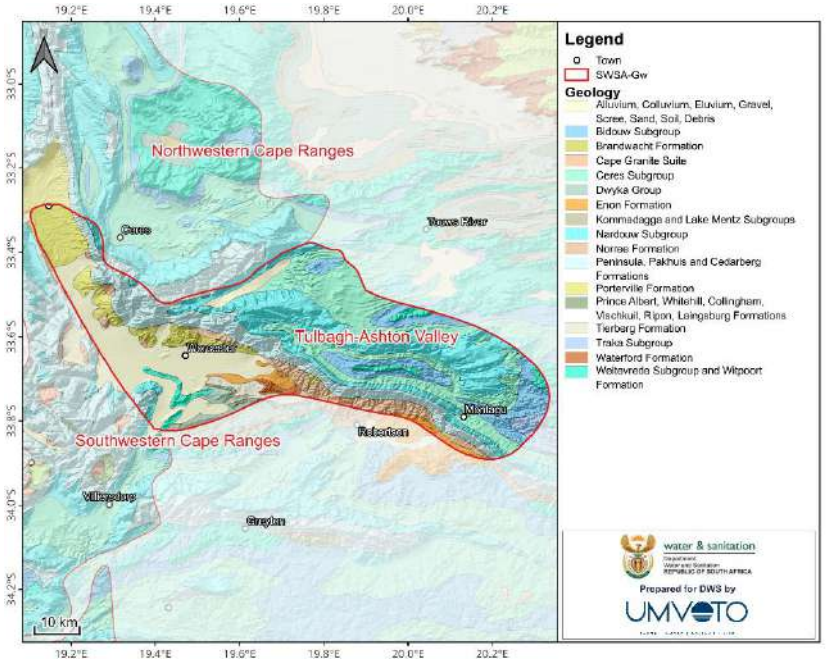
The Cape Supergroup outcrops are in the eastern section, with the Table Mountain Group dominated by quartzitic sandstone and minor shale and conglomerate, particularly in the Peninsula Formation, and subordinate shale and sandstone in the Pakhuis Formation. The Bokkeveld Group, represented by the Ceres Subgroup, includes mudstone, siltstone, and sandstone. The Witteberg Group is characterised by quartzitic sandstone and shale.

The western section features the Malmesbury Group, which includes greywacke, phyllite, and pelitic rocks.

The Worcester Fault traverses the area, running from the western section through to the lower eastern section.

Hydrostratigraphy

The Table Mountain Group forms a regional fractured-rock aquifer system where quartzitic sandstones have negligible primary porosity but significant secondary permeability due to fracturing. The Peninsula and Nardouw Aquifers are the main water-bearing units, with permeability controlled by faulting and bedding-plane fractures, while the Pakhuis-Cederberg Formation acts as an aquitard, restricting vertical flow.



Geology Map of the Tulbagh-Ashton Valley SWSA-gw region.

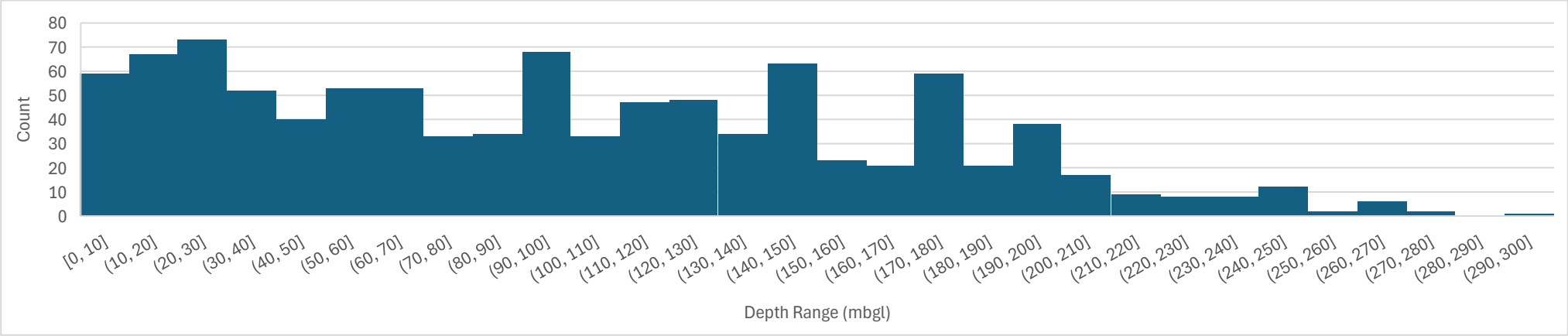
31.2. Current Status

SWSA-gw Name:	**Tulbagh-Ashton Valley**
Area:	**3560 km²**
Elevation:	**103 to 2029 mamsl**
Quantity & Quality	
Aquifer Classification	

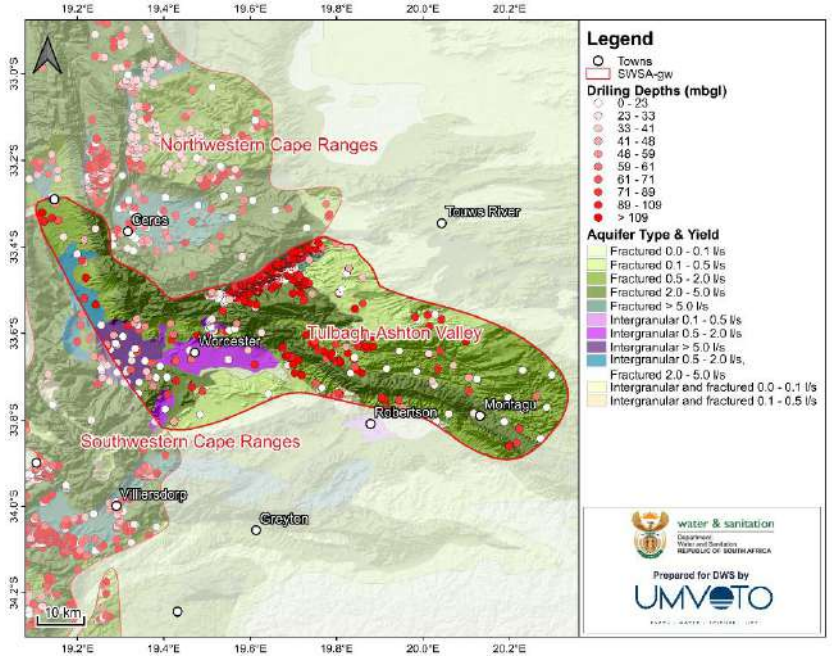
The aquifer systems within the Tulbagh-Ashton Valley SWSA-gw exhibit varying yields across fractured aquifers and an occasional intergranular, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is predominantly a major aquifer system, with some minor aquifer systems in the eastern and southern sections. The major aquifer system has an average fractured yield ranging from 0.1 to over 5.0 l/s and an occasional intergranular yield of 0.5 to over 5.0 l/s. The Minor aquifer systems have an average fractured yield of 0.1 to 0.5 l/s and an intergranular yield of 0.1 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 106 mbgl, and the most common depths are between 10 to 20 and 150 to 180 mbgl, respectively, suggesting mixed targets. Some deeper boreholes (> 250) are likely tapping into the fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 40 and 150 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 15 mbgl, with values ranging from 0 to 87 mbgl and a standard deviation of ~ 15 mbgl.

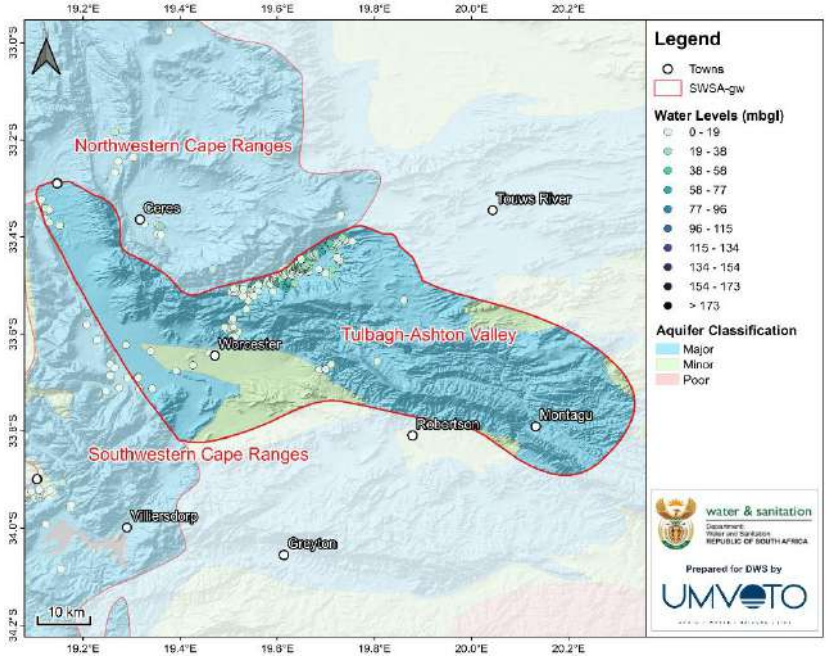
Graph of NGA drilling depths of the Tulbagh-Ashton Valley SWSA-gw region



SWSA-gw Name:	Tulbagh-Ashton Valley
Area:	3560 km^2
Elevation:	103 to 2029 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Tulbagh-Ashton Valley SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Tulbagh-Ashton Valley SWSA-gw region.

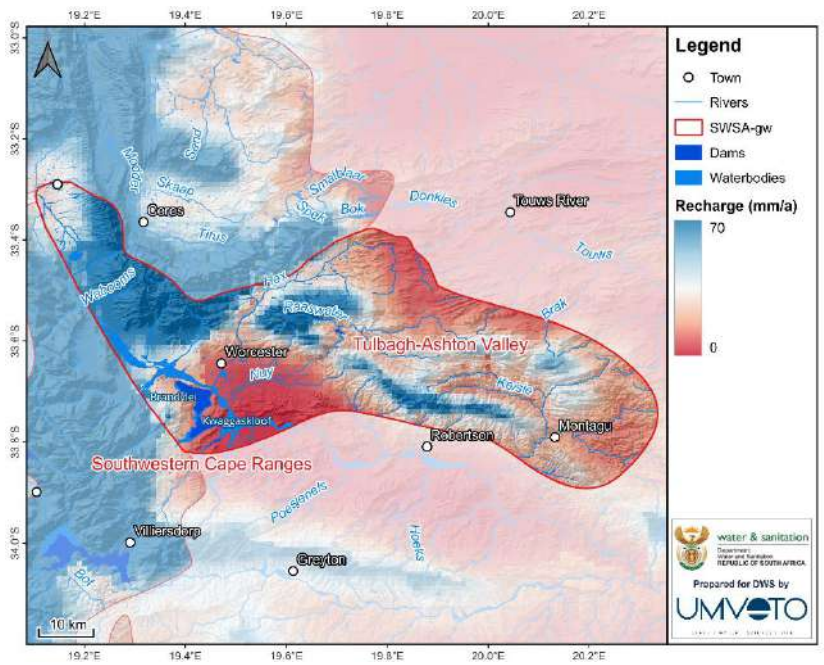
SWSA-gw Name:	**Tulbagh-Ashton Valley**
Area:	**3560 km²**
Elevation:	**103 to 2029 mamsl**

Quantity & Quality

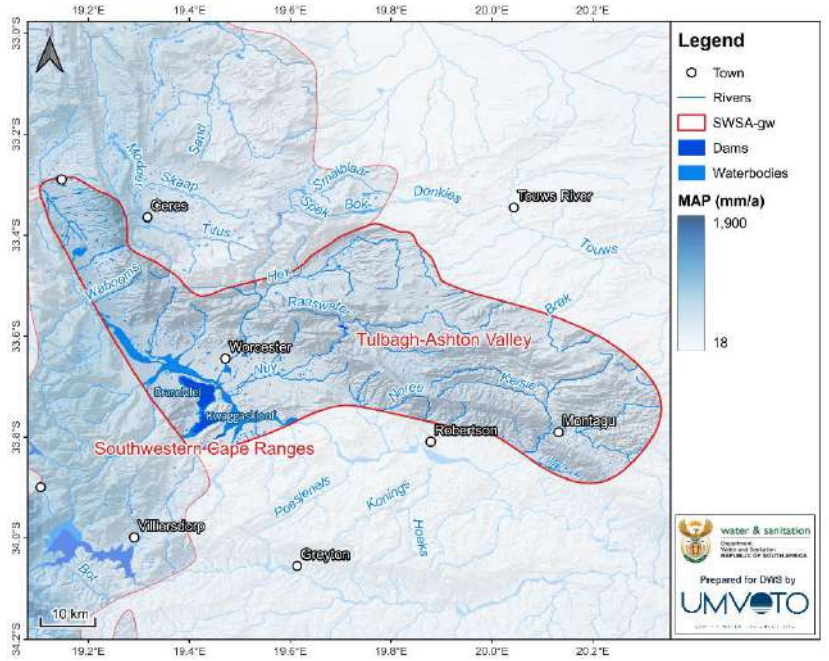
Groundwater Recharge

The Tulbagh-Ashton Valley receives a total MAP volume of 1242 Mm^3/a, with an average rainfall of 353 mm/a. Despite this, only 150.1 Mm^3/a contributes to groundwater recharge, resulting in a moderate recharge of 12.1% of MAP. This suggests that while the area experiences relatively high rainfall, a substantial portion is still lost to runoff, evaporation, or surface water flow, though recharge efficiency is better compared to drier regions.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Tulbagh-Ashton Valley	1242	353	150.1	42.2	12.1%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Tulbagh-Ashton Valley
Area:	3560 km^2
Elevation:	103 to 2029 mamsl

Quantity & Quality

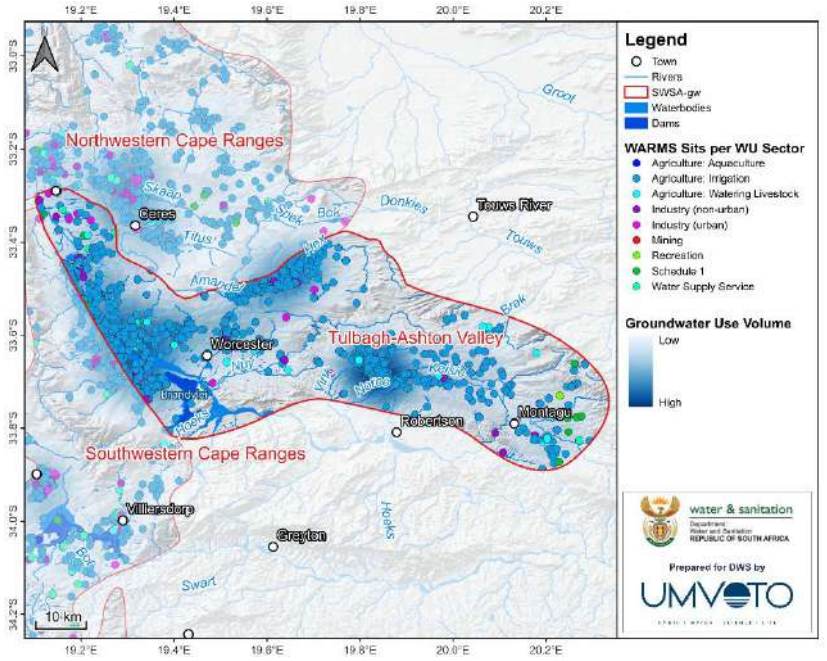
Groundwater Use

The Tulbagh-Ashton Valley SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent town within this region is Tulbagh (Conjunctive), which relies significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 74.8 Mm^3/ a to sustain crop production. Given the arid conditions of the West Coast, groundwater is essential for farming, supporting food production and local economies. There are distinct clusters of groundwater used for irrigation around the towns like Botha, De Doorns, Worcester and Ashton. It appears that agriculture relies heavily on groundwater in these areas.
- Municipal water supply services, at 0.7 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. This is primarily near Tulbagh, which makes sense as Tulbagh relies significantly on groundwater use.
- Urban industrial follows, using 0.6 Mm^3/a allocated for manufacturing, processing, and other industrial activities in urban centres. These can be seen near the towns Botha, Worcester and De Doorns.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Tulbagh, Botha and De Doorns, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	74.8
	Agriculture: Watering Livestock	0.2
	Industry (Non-urban)	0.5
	Industry (Urban)	0.6
	Mining	0.02
	Recreation	0.3
	Schedule 1	0.1
	Water Supply Service	0.7
	Total	**77.2**



Water use map for the Tulbagh-Ashton Valley SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

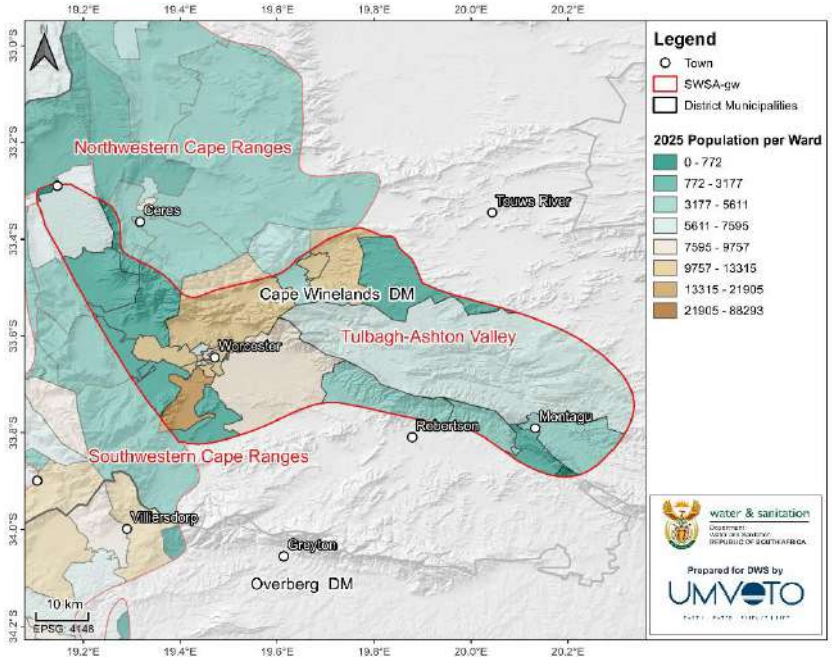
SWSA-gw Name:	Tulbagh-Ashton Valley
Area:	3560 km^2
Elevation:	103 to 2029 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Tulbagh-Ashton Valley SWSA-gw is located within the Breede-Olifants Water Management Area (WMA, 2023). The groundwater resources within the Sandveld SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Breede-Olifants Catchment Management Agency (BOCMA), which was formed as part of a national restructuring process that consolidated CMAs. BOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (NWA, Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the BOCMA to manage water resources in the Breede-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	BOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Breede-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	Brandvlei WUA is the local water management group that assists the CMA with allocation decisions among water users and oversees groundwater infrastructure and monitoring within the SWSA-gw.
WSA & WSP	The local municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Tulbagh-Ashton Valley SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of -0.89% per year, resulting in a projected population of approximately 186,229.

As shown in the map and table below, Breede Valley Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 147,318, followed by Langeberg LM with 24,538. Population concentrations within the SWSA-gw are highest around the town of Worcester and Breede Valley LM.



Projected population distribution in 2025 for the Tulbagh-Ashton Valley SWSA-gw.

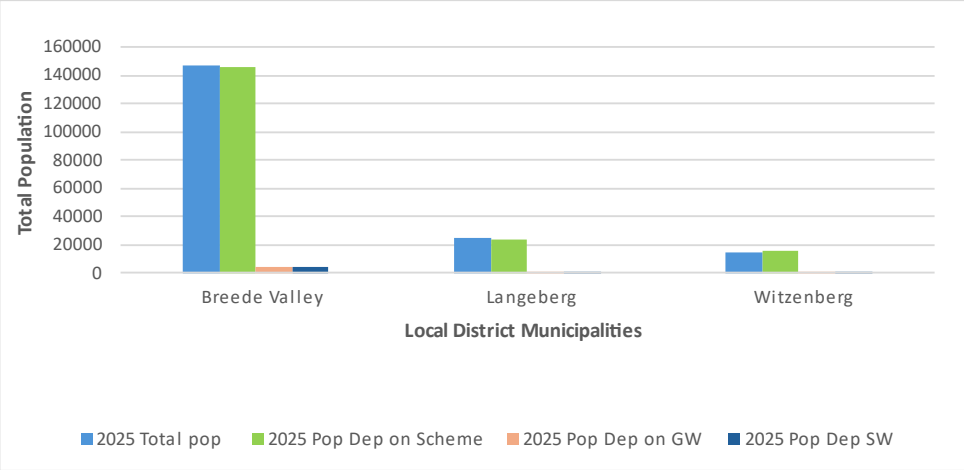
SWSA-gw Name:	Tulbagh-Ashton Valley
Area:	3560 km^2
Elevation:	103 to 2029 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Tulbagh-Ashton Valley SWSA-gw, an estimated 99.5% of the population depends on the regional water scheme, the remainder uses groundwater and surface water. The regional water scheme supply is the most used water source.

Among the LMs, Witzenberg has the highest proportion of groundwater reliance, with approximately 5.4% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Breede Valley	147,318	146,270	4,264	4,792
Langeberg	24,538	23,781	1,254	1,040
Witzenberg	14,373	15,299	770	573
Total	**186,229**	**185,350**	6,289	6,405



Projected population dependence on water sources in 2025.

SWSA-gw Name:	Tulbagh-Ashton Valley
Area:	3560 km^2
Elevation:	103 to 2029 mamsl

Quantity & Quality

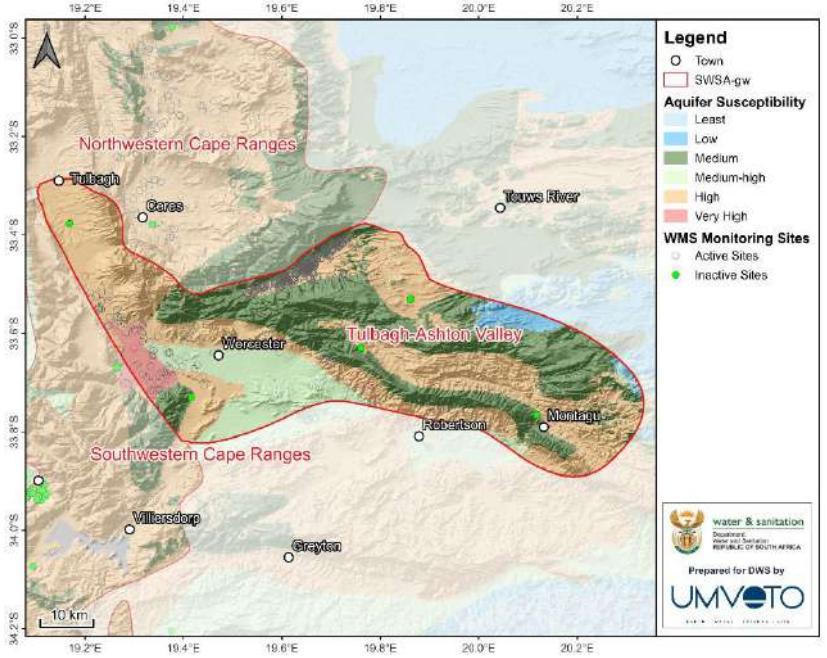
Groundwater Quality

The Tulbagh-Ashton Valley SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 630.16 km^2, which is 17.70% of the Tulbagh-Ashton Valley SWSA-gw total area. Urban/Built-up areas cover 68.66 km^2 (1.93%), while mines and quarries account for 4.13 km^2 (0.12%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major aquifer consists of areas with moderate and most aquifer vulnerability. The majority of the Major aquifer is characterized by areas that have the most vulnerability, while the moderately vulnerable areas are found mainly in the central to eastern parts of the aquifer.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 7.65 – 177 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 – 1.06 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.005 - 21.23 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 5.8 - 8.60 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0.6 - 506.59 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Tulbagh-Ashton Valley**
Area:	**3560 km^2**
Elevation:	**103 to 2029 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Tulbagh-Ashton Valley SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	5	23.81	21	40.55	mS/m	-	7.65 - 24.4 mS/m (Avg.: 13.05 mS/m). 2014-2024 GW Geosites: <70 - 370 mS/m. Mostly consistent with WMS (2000-2024)	60.6 - 177 mS/m (Avg.: 107.22 mS/m). 2014-2024 GW Geosites: <70 - 370 mS/m. Mostly consistent with WMS (2000-2024).
Fluoride	5	100.00	5	0.24	mg/L	-	0.025 - 0.96 mg/L (Avg.: 0.19 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).	0.1- 1.06 mg/L (Avg.: 0.39 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	5	100.00	5	1.5	mg/L	-	0.025 - 0.84 mg/L (Avg.: 0.16 mg/L). 2014-2024 GW Geosites: <11 mg/L. Mostly consistent with WMS NO_3+NO_2 (2000-2024).	0.005 - 21.23 mg/L (Avg.: 4.84 mg/L). 2014-2024 GW Geosites: <11 mg/L. Mostly consistent with WMS NO_3+NO_2 (2000-2024).
pH	5	23.81	21	7.62	pH unit	-	5.8 - 8.39 (Avg.: 7.49). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	6.6 - 8.60 (Avg.: 7.94). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	5	100.00	5	55.55	mg/L	-	0.6 - 23.31 mg/L (Avg.: 3.73 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	3 - 506.59 mg/L (Avg.: 189.27 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024), except for values above the upper limit.

- *"Average" refers to the average concentrations for the Total Active Sites of the Tulbagh-Ashton Valley SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

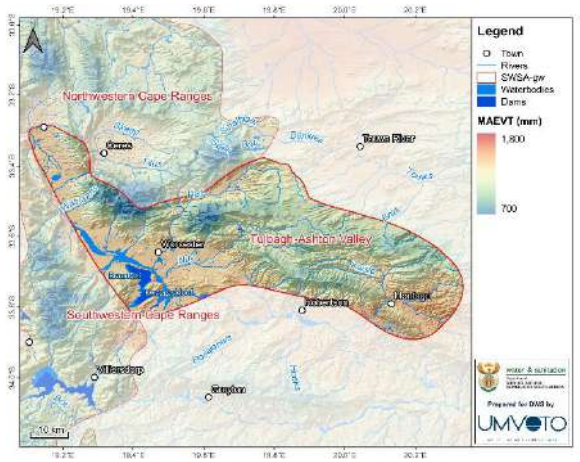
SWSA-gw Name:	**Tulbagh-Ashton Valley**
Area:	**3560 km²**
Elevation:	**103 to 2029 mamsl**

Threats & Risks

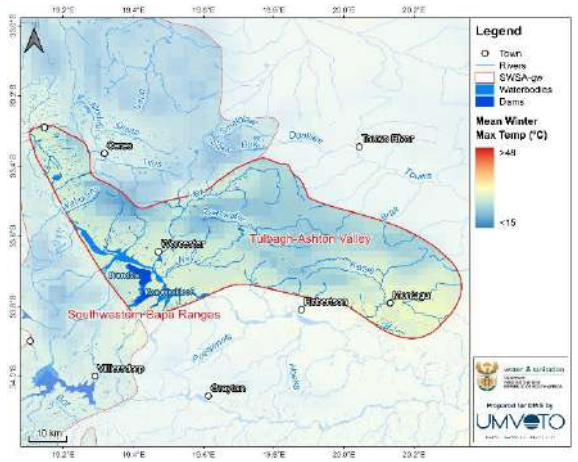
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Tulbagh-Ashton Valley SWSA-gw is a predominantly a combination of Cwa, humid subtropical, type climate characterised by hot with humid summers, and cool to mild winters and Cwb, subtropical highland, type climate, characterized by warm summers and dry winters. Towards the eastern is a BSk, cold semi-arid, type climate with hot, dry summers and cold winters and BWk which is a cold desert climate. For more details, see the table and maps below.

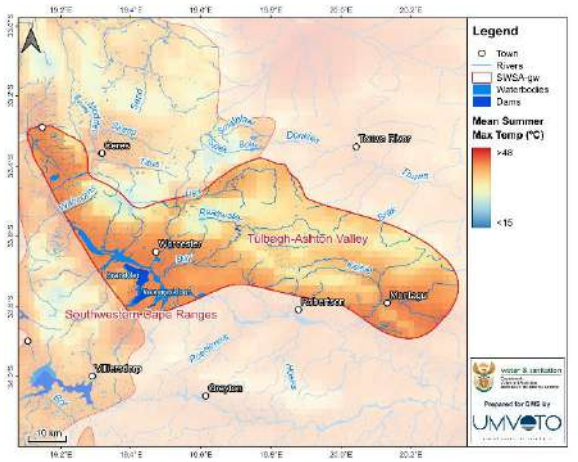
Temperature	Summer: 24.7 to 31 °C, Winter: 2.1 to 6 ºC
Evapotranspiration	Maximum value of 1237 mm/a with an average value of 1524 mm/a
Climate Change Predictions	Increased temperatures disrupted rainfall patterns and caused a decline in recharge (ranging from ~ 0.9 to 6.1 mm/a). The DART Index indicates mostly stable conditions.



Mean annual A-Pan evaporation of the Tulbagh-Ashton Valley SWSA-gw region.



Mean winter temperatures of the Tulbagh-Ashton Valley SWSA-gw region.



Mean summer temperatures of the Tulbagh-Ashton Valley SWSA-gw region.

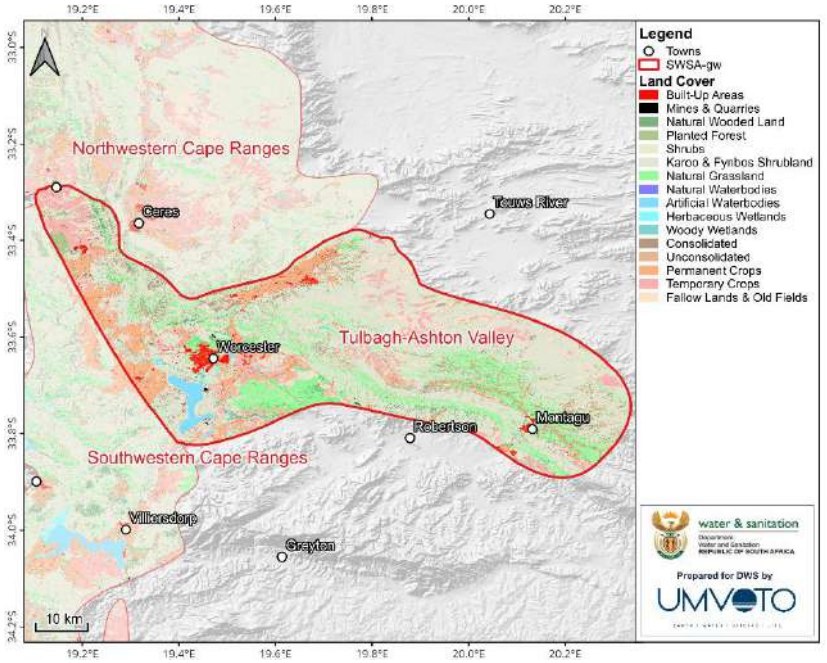
SWSA-gw Name:	Tulbagh-Ashton Valley
Area:	3560 km^2
Elevation:	103 to 2029 mamsl

Threats & Risks

Land Use

Shrubland, specifically Karoo & Fynbos Shrubland, make up more than half the coverage of the Tulbagh-Ashton Valley SWSA-gw, while cultivated land, which consists of temporary crops, permanent crops, fallow lands and old fields, and grassland cover approximately 31.1% of the SWSA-gw (DFFE, 2022). With a significant portion of the SWSA-gw covered by mountain ranges, there is minimal development in the SWSA-gw. Built-up areas, made up of residential, commercial and industrial areas, are concentrated in the main towns of Worcester and Montagu and within larger areas of agriculture. Two dams are located just south of the town of Worcester, as can be seen on the land cover map and the map in the Biodiversity and Conservation section below. There is a small proportion of mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps.

Land Use Type	Area (km^2)	Area (%)
Barren Land	244	6.9
Built-Up	69	1.9
Cultivated	630	17.7
Forest Land	142	4.0
Grassland	477	13.4
Mines and quarries	4	0.1
Shrubland	1907	53.6
Waterbodies	54	1.5
Wetlands	32	0.9



Land Cover 24-class map to show the types of land use and extent of each occurring in the Soutpansberg SWSA-gw.

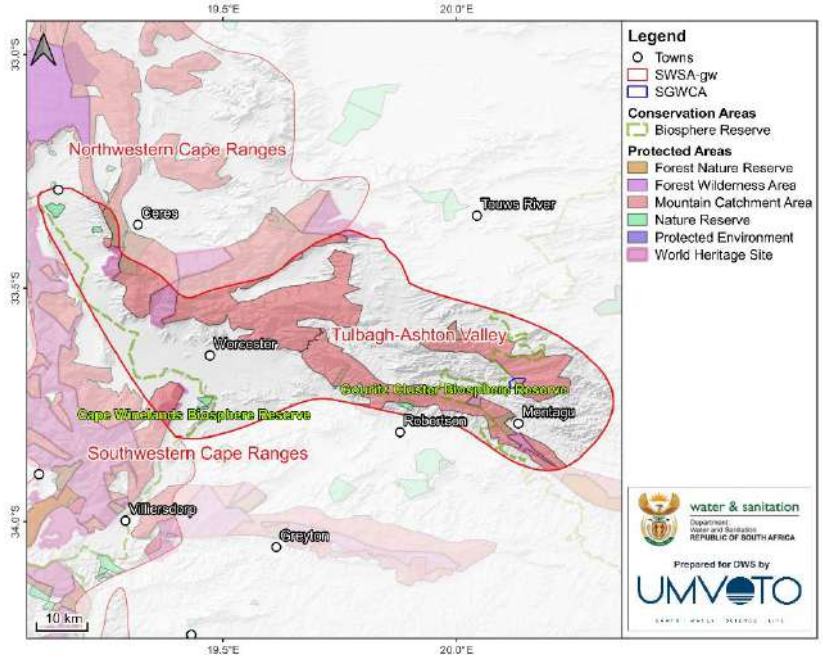
SWSA-gw Name:	**Tulbagh-Ashton Valley**
Area:	**3560 km^2**
Elevation:	**103 to 2029**

Protection Status and Ecosystems

Biodiversity and Conservation

A small portion of the Cape Winelands Biosphere Reserve (DFFE, 2024) is situated along the entire western edge of the SWSA-gw, while a relatively small portion of the Gouritz Cluster Biosphere Reserve sits at the eastern end of the SWSA-gw. The Gouritz Cluster Biosphere Reserve (DFFE, 2024) is a large biosphere reserve extending from the SWSA-gw east to the Eastern Cape Province, ending near the town of Willowmore and just north of the Swartberg Mountain range and south to the coast. The Matroosberg Mountain Catchment Area and the Langeberg-Wes Mountain Catchment Area are two major mountain catchment areas (DFFE, 2024) running diagonally through the SWSA-gw from northwest to southeast, as can be seen on the map. The Baden subterranean groundwater control area (SGWCA) (CSIR, 1998) covers a very small portion of the SWSA-gw, showing the area where the government had control of groundwater under the National Water Act no. 54 of 1956 (DWA, 2010)

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Cape Winelands Biosphere Reserve • Gouritz Cluster Biosphere Reserve	921.53	2
Protected Areas	• Cape Floral Region Protected Areas • Matroosberg Mountain Catchment Area • Langeberg-Wes Mountain Catchment Area • Hawequas Mountain Catchment Area • Koue Bokkeveld Mountain Catchment Area • Ceres Bergfynbos Reserve • Grootvlei Nature Reserve • And various other small nature reserves	1199.32	14
SGWCA	• Baden	5.81	1
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Tulbagh-Ashton Valley SWSA-gw that have protection status.

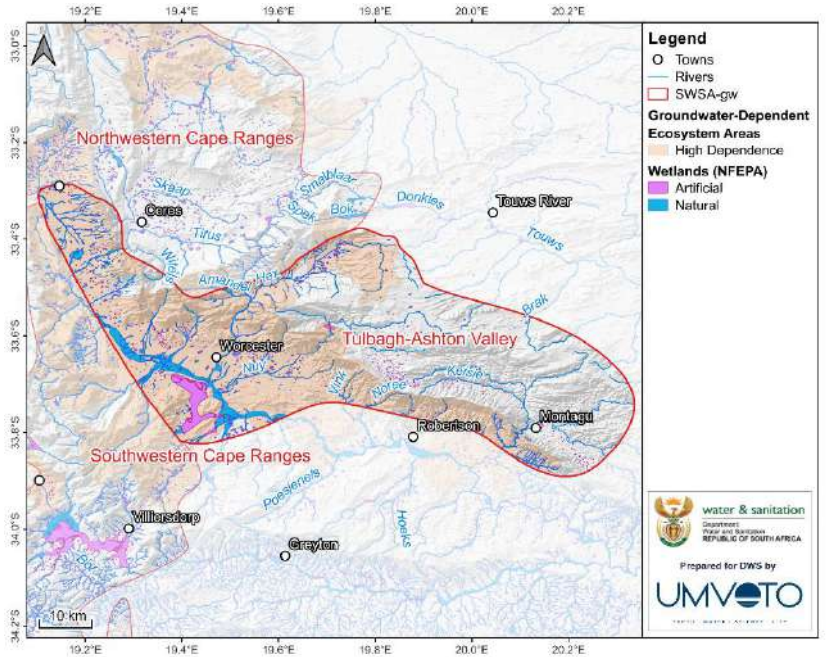
SWSA-gw Name:	Tulbagh-Ashton Valley
Area:	3560 km^2
Elevation:	103 to 2029

Protection Status and Ecosystems

Biodiversity and Conservation

The major waterbodies in the Tulbagh-Ashton Valley SWSA-gw are the Brandvlei Dam (DWS, 2011) next to the Breede River and the Breede River. The floodplain along the Breede River is considered a significant wetland (CSIR, 2011). There are additional wetlands, some of which are considered potentially highly dependent on groundwater (DWA, 2010).

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Brandvlei Dam • Kwaggaskloof Dam • Breede River	72.51	3
Ramsar Sites	None		0
Wetlands	Various natural and artificial wetlands	209	

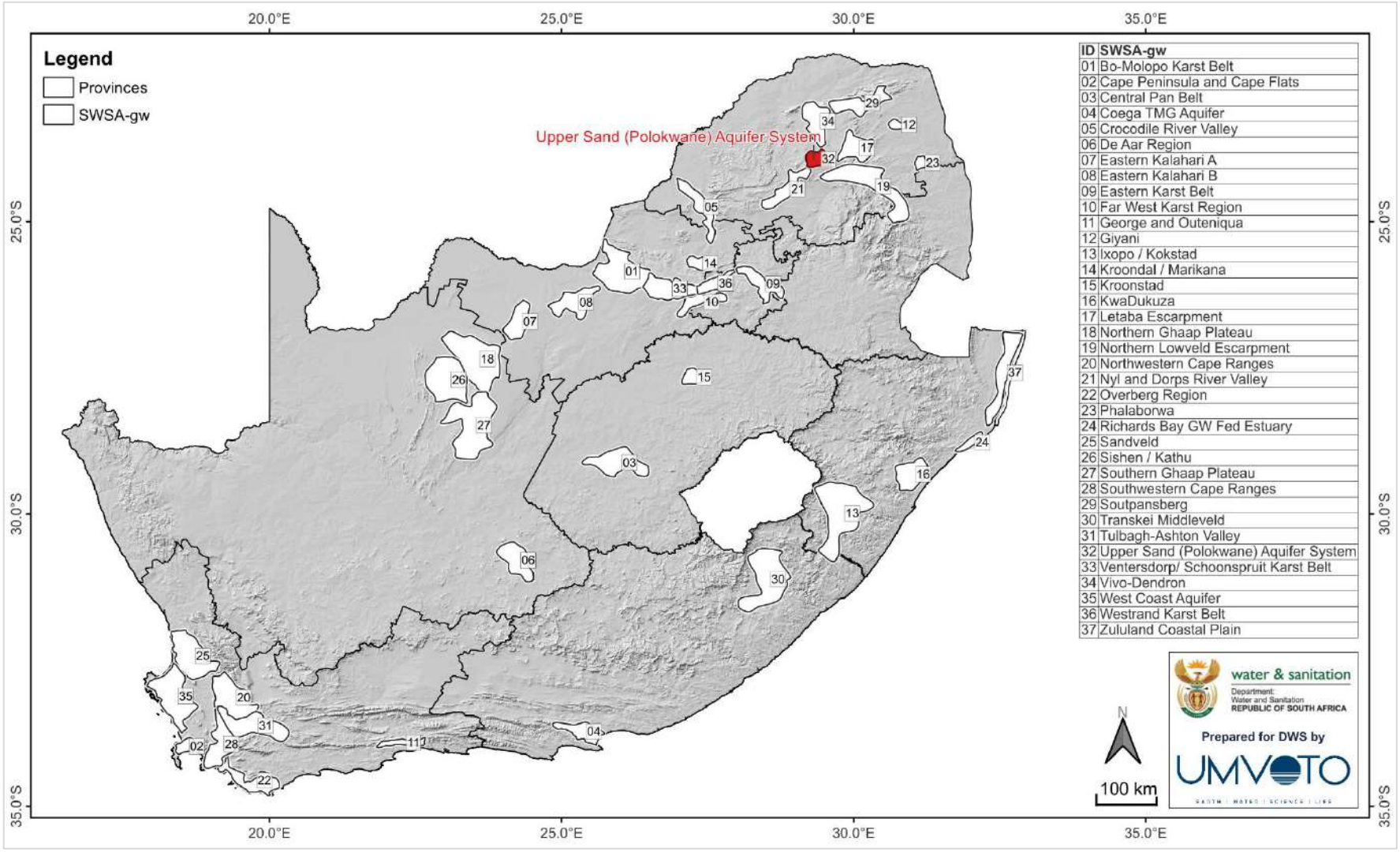


Map showing the major water bodies, Ramsar sites and GDEs in the Tulbagh-Ashton Valley SWSA-gw.

APPENDIX 32

UPPER SAND (POLOKWANE) AQUIFER SYSTEM SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE UPPER SAND (POLOKWANE) AQUIFER SYSTEM SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

32. Upper Sand (Polokwane) Aquifer System

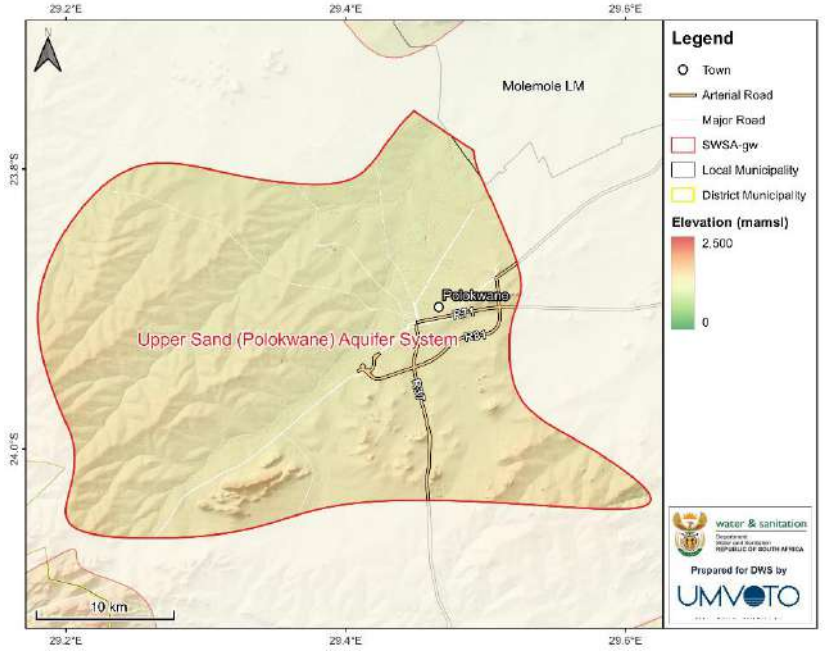
32.1. Description

SWSA-gw Name:	**Upper Sand (Polokwane) Aquifer System**
Area:	**966 km²**
Elevation:	**1 310 to 1 350 mamsl**
Geospatial Context	

The topography of the Upper Sand (Polokwane) Aquifer System SWSA-gw, as depicted in the map, is characterized by a combination of gently rolling hills, undulating plains, and elevated plateaus. To the north and west of Polokwane, the terrain becomes more rugged, with the Waterberg Mountains forming a prominent geological feature. The landscape is interspersed with small valleys, riverbeds, and rocky outcrops, particularly along the course of the Nyl River and its tributaries.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Limpopo
District Municipality	Capricorn
Local Municipality	Polokwane and Molemole
Towns	Polokwane
Major Roads	N1, R37, R101, R71 and R81
Major Water Supply Networks	



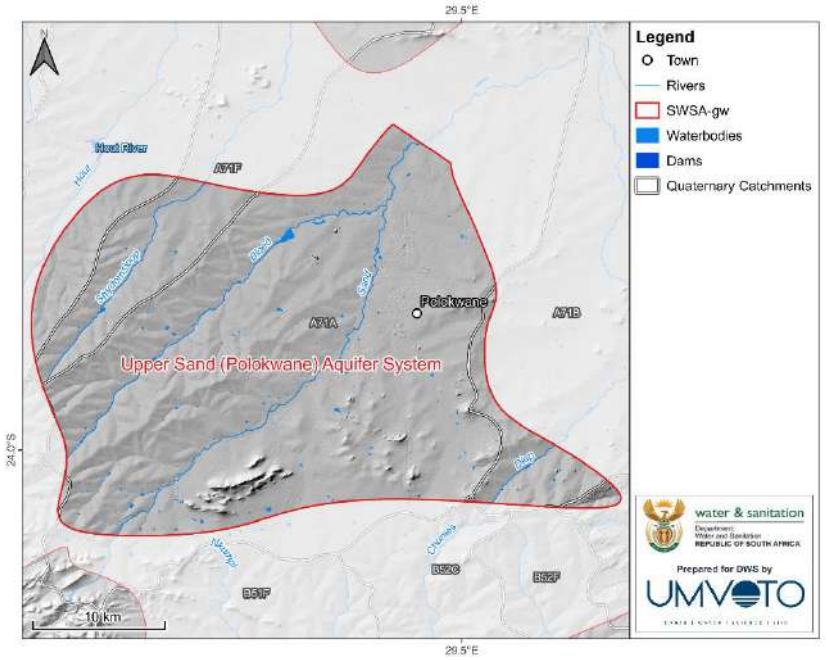
Locality map of Major Towns, District and Local Municipalities in the Upper Sand (Polokwane) Aquifer System SWSA-gw.

SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km²
Elevation:	1 310 to 1 350 mamsl

Hydrology and Drainage

The Upper Sand (Polokwane) Aquifer System SWSA-gw and surrounding areas include a few major surface water systems, summarised below and displayed in the map on the right. The three perennial rivers are fed by the A7 catchment and flow in a northwestern direction.

Quaternary Catchments	A71A, A71B, A71E, A71F, B52H and a small section of A61F, B52C, B52F,
Rivers	Perennial: Bloed, Diep, Sand
	Ephemeral: Strydomsloop
Natural and manmade water bodies	Nylsvlei floodplain
Major Dams:	Gert Combrink
Water Management Areas:	Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Upper Sand (Polokwane) Aquifer System SWSA-gw.

SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km²
Elevation:	1 310 to 1 350 mamsl
Geology	

Geology

The region contains outcrops of Quaternary sandy soils. The southern section of the area features multiple Karoo dolerite and diabase dyke intrusions.

The Goudplaats-Hout River Gneiss Suite covers the majority of the area, comprising leucocratic, strongly migmatized biotite gneiss, greyish weakly migmatized biotite gneiss, minor leucogneiss, and dark grey biotite gneiss.

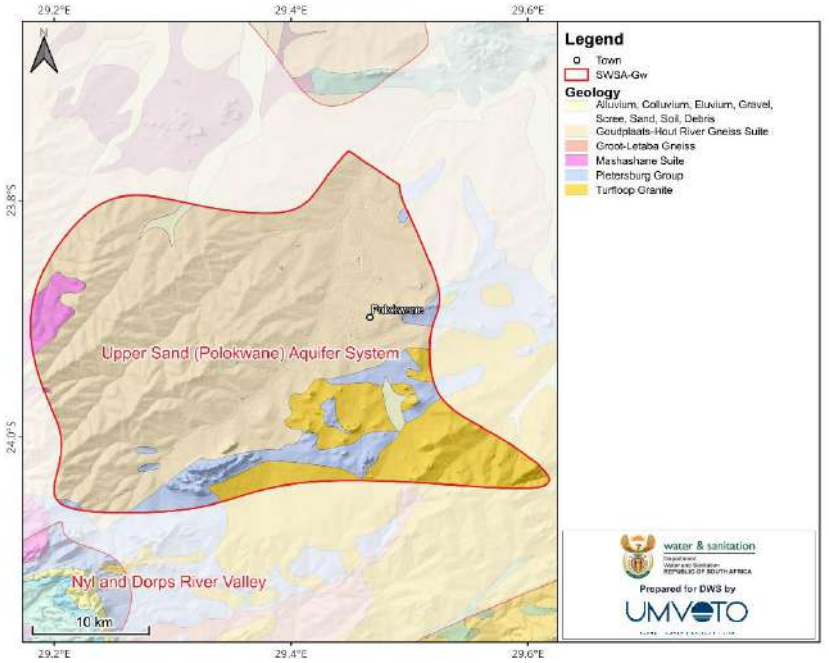
There is also an outcrop of the Lunsklip Granite, Mashashane Suite, in the western section, characterised by pink, medium- to coarse-grained, hornblende-biotite granite.

The Pietersburg Group in the southeastern section features ultramafic volcanic rocks and banded ironstone.

The Turfloop Granite is present in the southeastern section, grey to pink, medium- to coarse-grained, adamellitic or granodioritic biotite granite.

Hydrogeology

The Quaternary sandy soils form a primary intergranular aquifer system. The Goudplaats-Hout River Gneiss Suite constitutes a secondary aquifer system due to its highly fractured and weathered nature. The Lunsklip Granite and Pietersburg Group create a secondary, fractured aquifer system. Alluvial deposits along major rivers act as a primary intergranular aquifer system, providing significant groundwater storage.



Geology Map of the Upper Sand (Polokwane) Aquifer System SWSA-gw region.

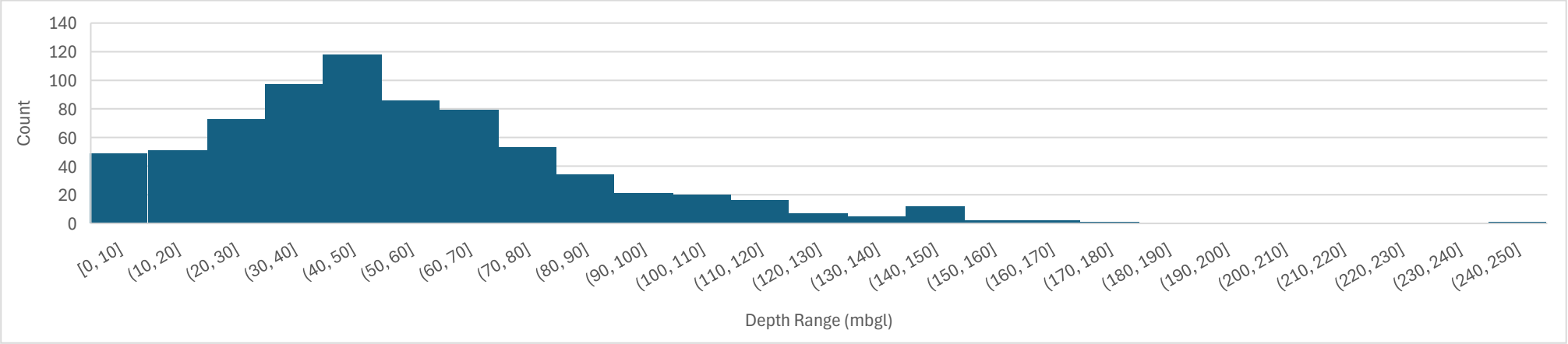
32.2. Current Status

SWSA-gw Name:	**Upper Sand (Polokwane) Aquifer System**
Area:	**966 km²**
Elevation:	**1 310 to 1 350 mamsl**
Quantity & Quality	
Aquifer Classification	

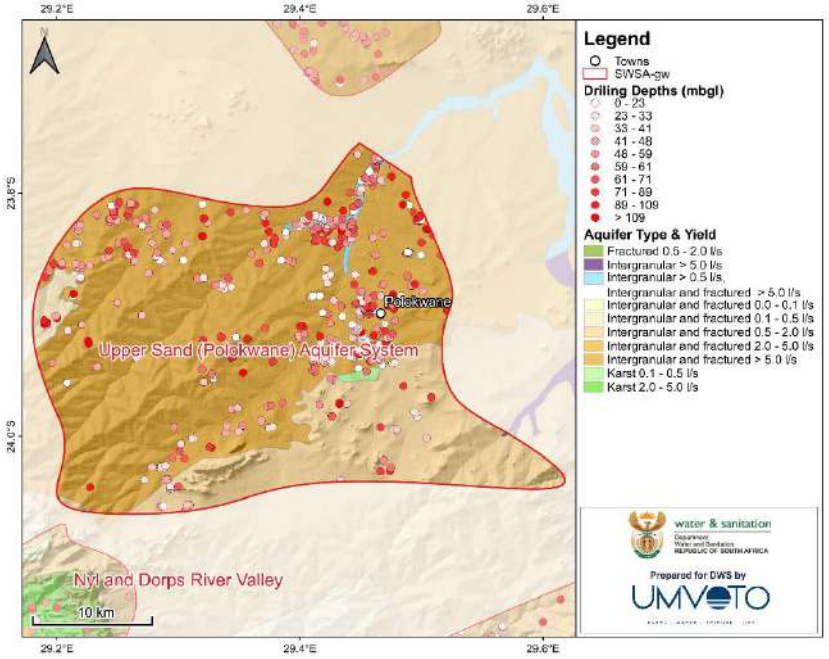
The aquifer systems within the Upper Sand (Polokwane) Aquifer System SWSA-gw exhibit varying yields across dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw consists of a combination of major and minor aquifer systems, with the minor aquifer system located in the southeastern section and a small part of the western section. The major aquifer system has an average dual-porosity yield of over 5.0 l/s, while the minor aquifer system has a dual-porosity yield averaging between 0.5 and 2.0 l/s.
Groundwater Targets	The average drilling depth is 54 mbgl, and the most common depth is around 50 mbgl, with the majority of the boreholes targeting the dual-porosity aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 31 and 70 mbgl. Based on the past 25 years of NGA water level data, the average groundwater level in the region is ~ 6 mbgl, with values ranging from 2 to 30 mbgl and a standard deviation of ~ 3 mbgl. Statistical analysis of the available NGA data reveals a trend of dropping groundwater levels during this period.

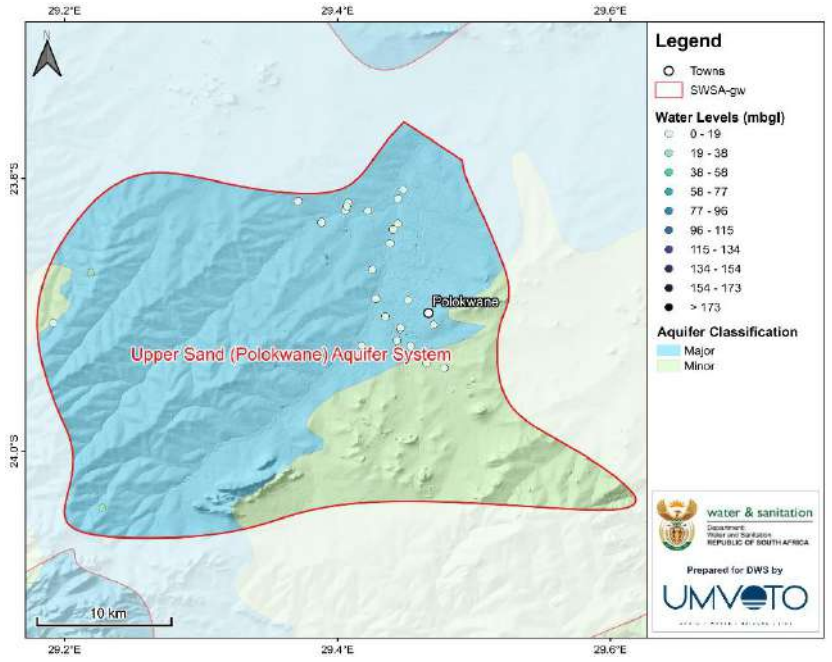
Graph of NGA drilling depths of the Upper Sand (Polokwane) Aquifer System SWSA-gw region



SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km²
Elevation:	1 310 to 1 350 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Upper Sand (Polokwane) Aquifer System SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Upper Sand (Polokwane) Aquifer System SWSA-gw region.

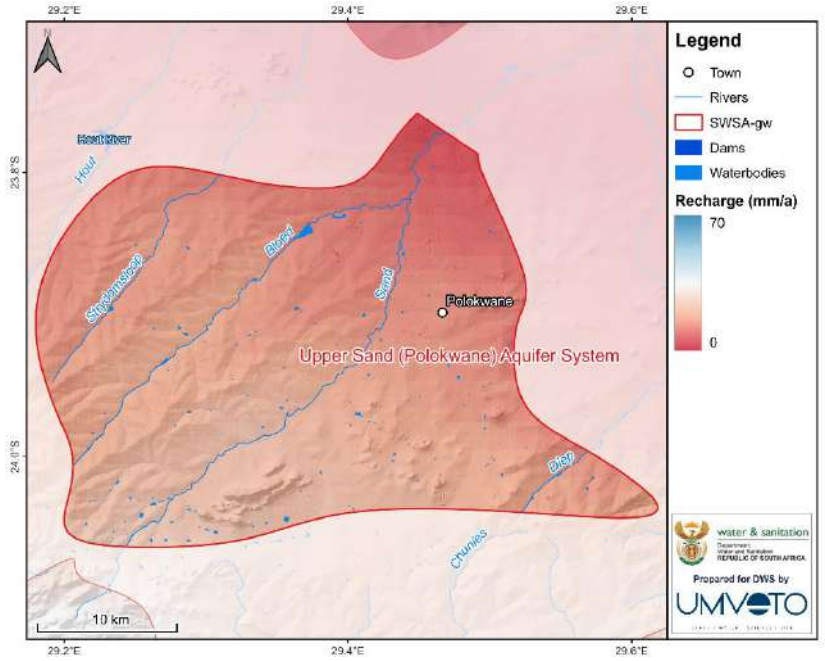
SWSA-gw Name:	**Upper Sand (Polokwane) Aquifer System**
Area:	**966 km²**
Elevation:	**1 310 to 1 350 mamsl**

Quantity & Quality

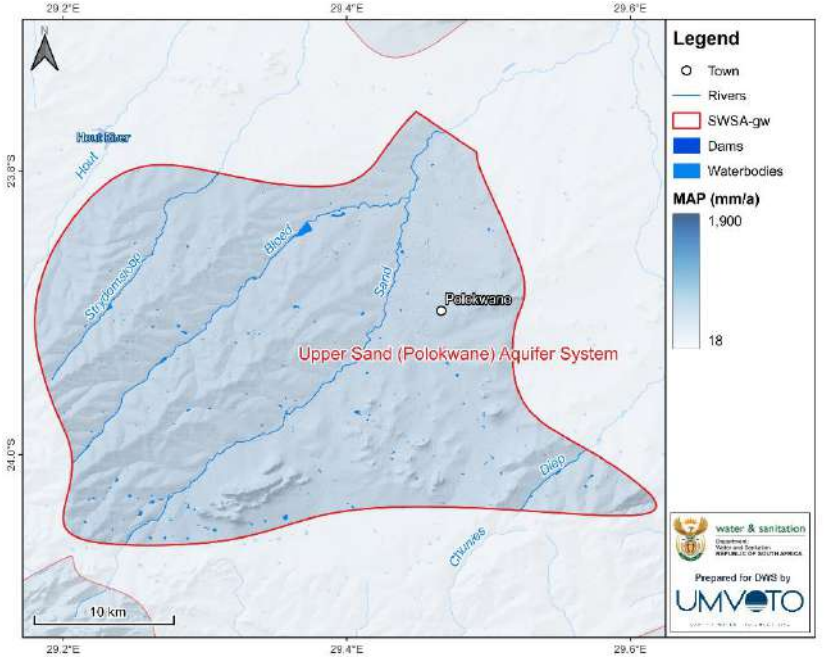
Groundwater Recharge

The Upper Sand Aquifer receives a total MAP volume of 475 Mm^3/a, with an average rainfall of 490 mm/a. However, only 15.5 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 3.3% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Upper Sand (Polokwane) Aquifer System	475	490	15.5	16	3.3%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km²
Elevation:	1 310 to 1 350 mamsl

Quantity & Quality

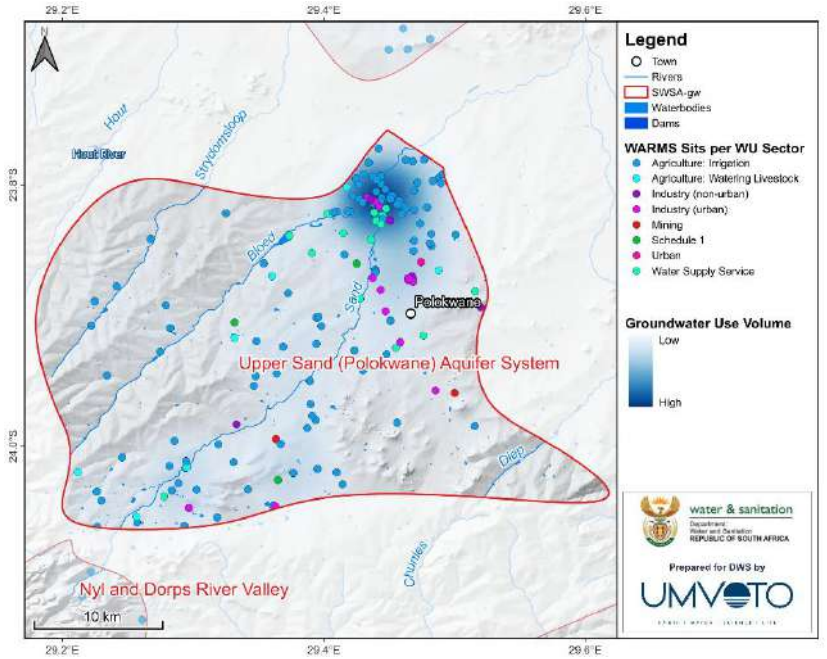
Groundwater Use

The Upper Sand (Polokwane) Aquifer System SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Polokwane (Conjunctive) and Seshego (Conjunctive), which rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 12.9 Mm^3/a to sustain crop production. While there is scattered use around the area, most of the use is clustered in the north for irrigation.
- Municipal water supply services, at 7.2 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. The distribution of this sector is similar to the previous, with use primarily in the north and around Polokwane.
- Urban industrial follows, using 4 Mm^3/a allocated for manufacturing, processing, and other industrial activities in urban centres. This sector is also concentrated in the north like the other two sectors. It appears that most of the groundwater dependence is in the north of the region, with the rest of the region less reliant on it.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Polokwane and Seshego, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	12.9
	Agriculture: Watering Livestock	0.6
	Industry (Non-urban)	0.5
	Industry (Urban)	4
	Mining	0.2
	Schedule 1	0.2
	Urban (excluding industrial/domestic)	0.01
	Water Supply Service	7.2
	Total	**25.5**



Water use map for the Upper Sand (Polokwane) Aquifer System SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

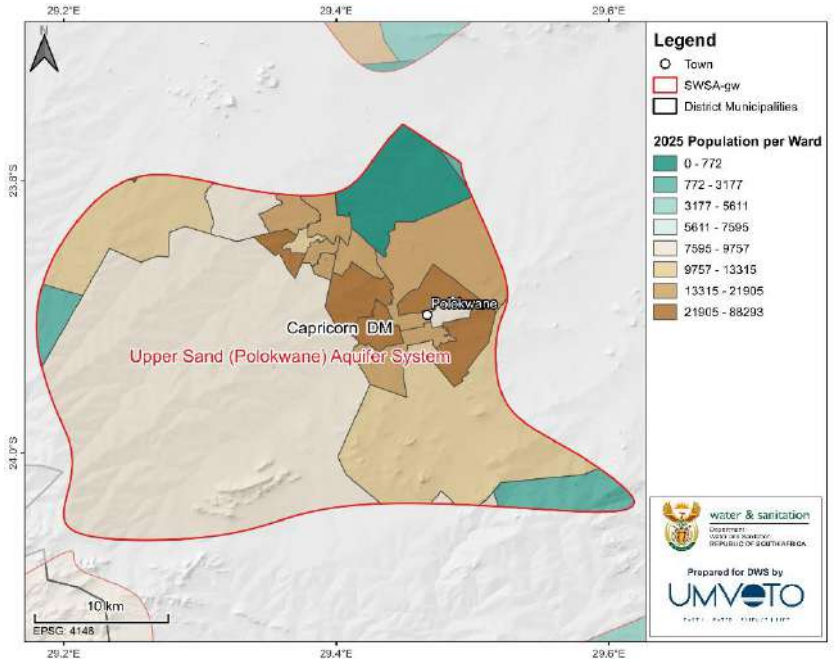
SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km²
Elevation:	1 310 to 1 350 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Upper Sand (Polokwane) Aquifer System SWSA-gw is located within the Limpopo-Olifants Water Management Areas (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. LOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the LOCMA to manage water resources in the Limpopo-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	LOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The Polokwane local municipality is the Water Service Authorities (WSA) and Water Service Providers (WSP) in its jurisdiction, while the Capricorn District Municipality is the WSA and WSP for the remaining portion of its jurisdictions.

The estimated population within the Upper Sand (Polokwane) Aquifer System SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 1.7% per year, resulting in a projected population of approximately 358,320.

As shown in the map and table below, Polokwane Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 358,308. Population concentrations within the SWSA-gw are also highest around Polokwane LM.



Projected population distribution in 2025 for the Upper Sand (Polokwane) Aquifer System SWSA-gw.

SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km²
Elevation:	1 310 to 1 350 mamsl

Quantity & Quality

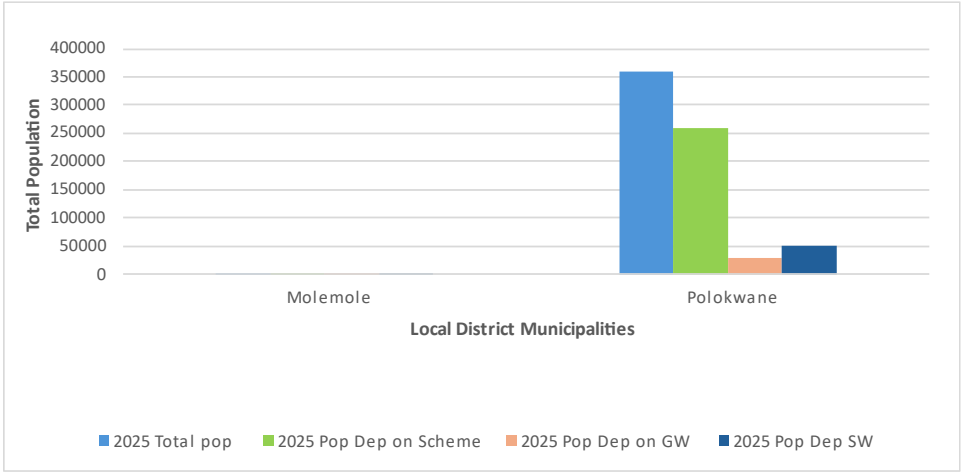
Socio Economic & Governance

In terms of water reliance within the Upper Sand (Polokwane) Aquifer System SWSA-gw, an estimated 72.2% of the population depends on the regional water scheme, 14.24% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources). and 8.2% on groundwater sources (including boreholes and springs).

Among the LMs, the Molemole LM has the highest proportion of groundwater reliance, with approximately 54.8% and 15.12% on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Molemole	12	5	7	2
Polokwane	358,308	258,813	29,384	51,021
Total	358,320	258,818	29,391	51,023



Projected population dependence on water sources in 2025.

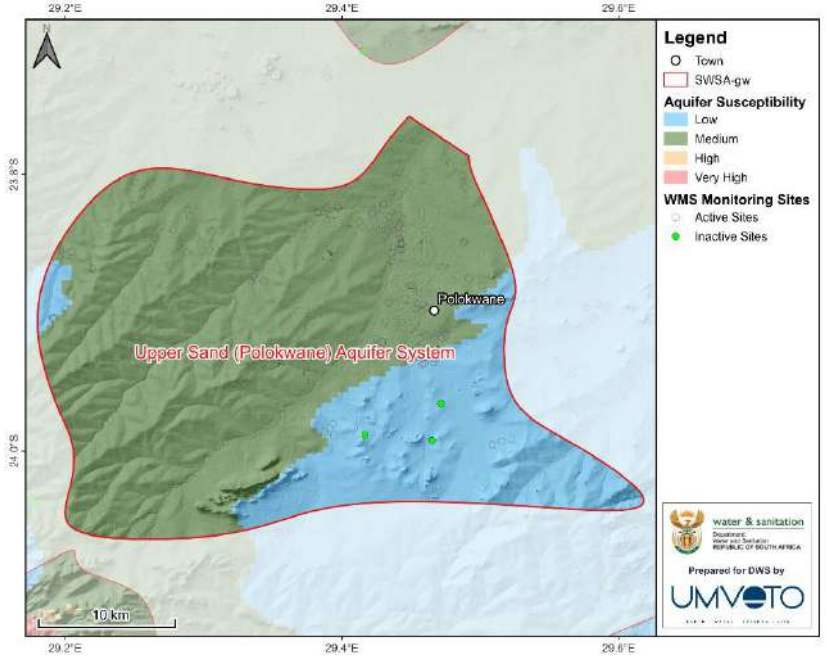
SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km²
Elevation:	1 310 to 1 350 mamsl
Quantity & Quality	
Groundwater Quality	

The Upper Sand (Polokwane) Aquifer System SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater. The Minor Aquifer system is moderately productive and has variable water quality (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 200.29 km^{2,} which is 20.74% of the Upper Sand (Polokwane) Aquifer System SWSA-gw total area. Urban/Built-up areas cover 197.42 km^2 (20.44%), while mines and quarries account for 5.13 km^2 (0.53%) of the total area. These land uses contribute to diffuse contamination sources, with urban areas being the primary concern. Urban areas tend to include informal settlements and townships, and this places the groundwater source under a high risk of contamination (Le Maitre et al., 2018). Several water quality indicators help assess aquifer vulnerability and contamination risks:

WMS data is only available for the least vulnerable aquifer areas in the Minor Aquifer System.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 7- 115.2 mS/m in the Minor aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.05 - 0.80 mg/L in the Minor aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.025 - 11.8 mg/L in the Minor aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.10 - 9.09 in the Minor aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 2 - 45.7 mg/L in the Minor aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Upper Sand (Polokwane) Aquifer System**
Area:	**966 km²**
Elevation:	**1 310 to 1 350 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Upper Sand (Polokwane) Aquifer System SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	2	1.75	114	75.81	mS/m	7- 115.2 mS/m (Avg.: 75.81 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <70 - 150 mS/m.	-
Fluoride	2	1.89	106	0.28	mg/L	0.05 - 0.80 mg/L (Avg.: 0.28 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: <0.5 - 1.5 mg/L.	-
Nitrate + Nitrite Nitrogen	2	1.75	114	2.53	mg/L	0.025 - 11.8 mg/L (Avg.: 2.53 mg/L). 2014-2024 GW Geosites: <11-20 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	2014-2024 GW Geosites: <11 mg/L.	-
pH	2	1.75	114	8.27	pH unit	6.10 - 9.09 (Avg.: 8.27). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	2014-2024 GW Geosites: 7-9.	-
Sulphate	2	1.75	114	21.97	mg/L	2 - 45.7 mg/L (Avg.: 21.97 mg/L). 2014-2024 GW Geosites: <200 mg/L. Mostly consistent with WMS (2000-2024).	2014-2024 GW Geosites: <200 mg/L.	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Upper Sand (Polokwane) Aquifer System SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

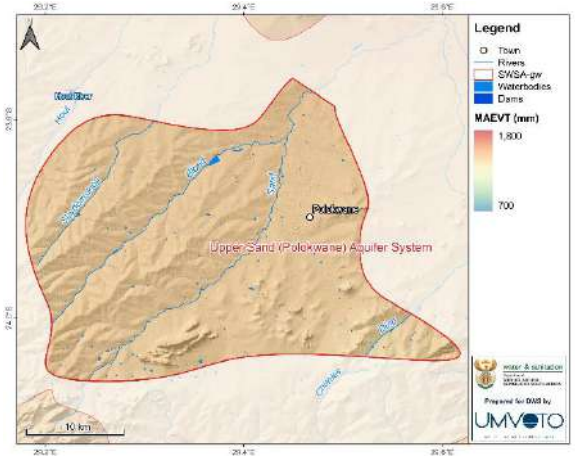
SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km²
Elevation:	1 310 to 1 350 mamsl

Threats & Risks

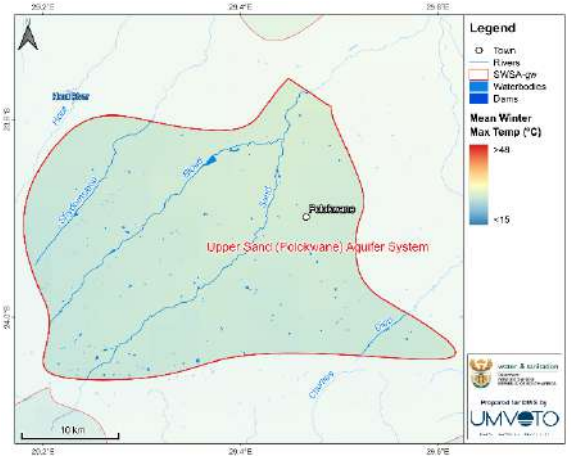
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Upper Sand (Polokwane) Aquifer System SWSA-gw has a Cwb, subtropical highland, type climate characterised by dry winters and warm summers in the northeast section that changes to a BSk, cold semi-arid, type climate characterised by cold winters and hot, dry summers towards the southwest. Temperatures in the SWSA-gw range from 2.1 – 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

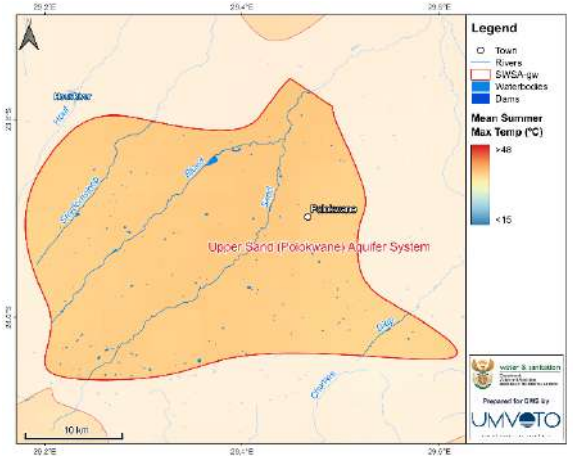
Temperature	Summer: 24.7 to 29.2 ºC, Winter: 2.1 to 6 °C
Evapotranspiration	Maximum 1449 mm/a with an average of 1414 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, but an increase in recharge (ranging from ~ 19.9 to 29.2 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Upper Sand (Polokwane) Aquifer System SWSA-gw region.



Mean winter temperatures of the Upper Sand (Polokwane) Aquifer System SWSA-gw region.



Mean summer temperatures of the Upper Sand (Polokwane) Aquifer System SWSA-gw region.

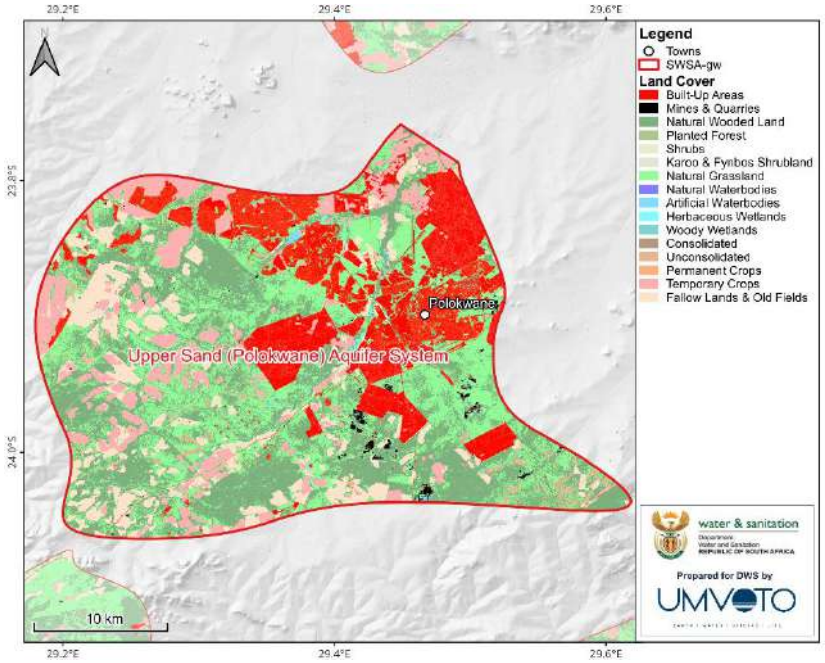
SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km^2
Elevation:	1 310 to 1 350 mamsl

Threats & Risks

Land Use

Forest land, which consists of natural wooded land and planted forest, and grassland cover more than half of the Upper Sand (Polokwane) Aquifer System SWSA-gw. The SWSA-gw has scattered areas of cultivated land, which includes permanent crops, temporary crops, fallow land and old fields. Built-up areas, which is made up of residential, industrial and commercial areas and small holdings, are concentrated to the town of Polokwane and surrounds towards the northern edge of the SWSA-gw.

Land Use Type	Area (km^2)	Area (%)
Barren Land	19	1.9
Built-Up	197	20.4
Cultivated	200	20.8
Forest Land	293	30.4
Grassland	245	25.4
Mines and quarries	5	0.5
Shrubland	3	0.2
Waterbodies	2	0.2
Wetlands	3	0.3



Land Cover 24-class map (DFFE, 2022) to show the types of land use and extent of each occurring in the Upper Sand (Polokwane) Aquifer System SWSA-gw.

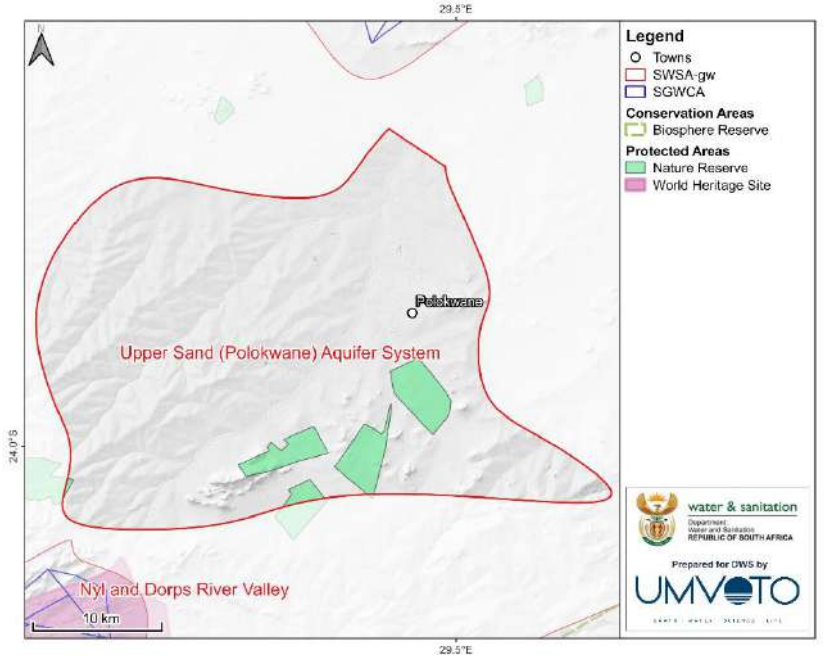
SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km^2
Elevation:	1 310 to 1 350 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Upper Sand (Polokwane) Aquifer System SWSA-gw contains four nature reserves (DFFE, 2024), with the Pietersburg Nature Reserve falling just outside the town of Polokwane, as displayed on the map.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	• Pietersburg Nature Reserve • Nawilger Private Nature Reserve • Kuschke Nature Reserve • Percy Fyfe Nature Reserve	47.80	4
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Upper Sand (Polokwane) Aquifer System SWSA-gw that have protection status.

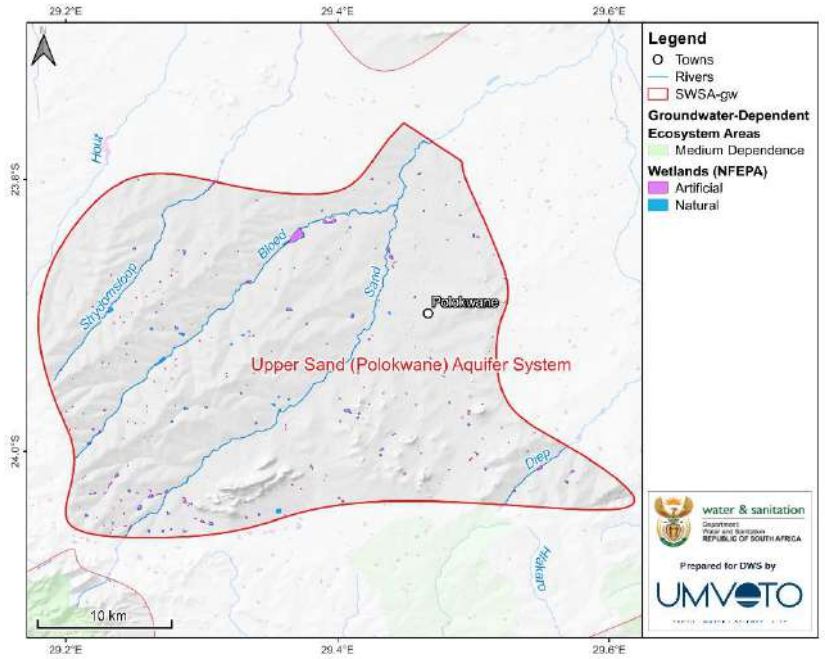
SWSA-gw Name:	Upper Sand (Polokwane) Aquifer System
Area:	966 km^2
Elevation:	1 310 to 1 350 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Upper Sand (Polokwane) Aquifer System SWSA-gw does not contain any major waterbodies, Ramsar sites or groundwater-dependent ecosystems but has some small wetlands (CSIR, 2011) throughout the SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	5	

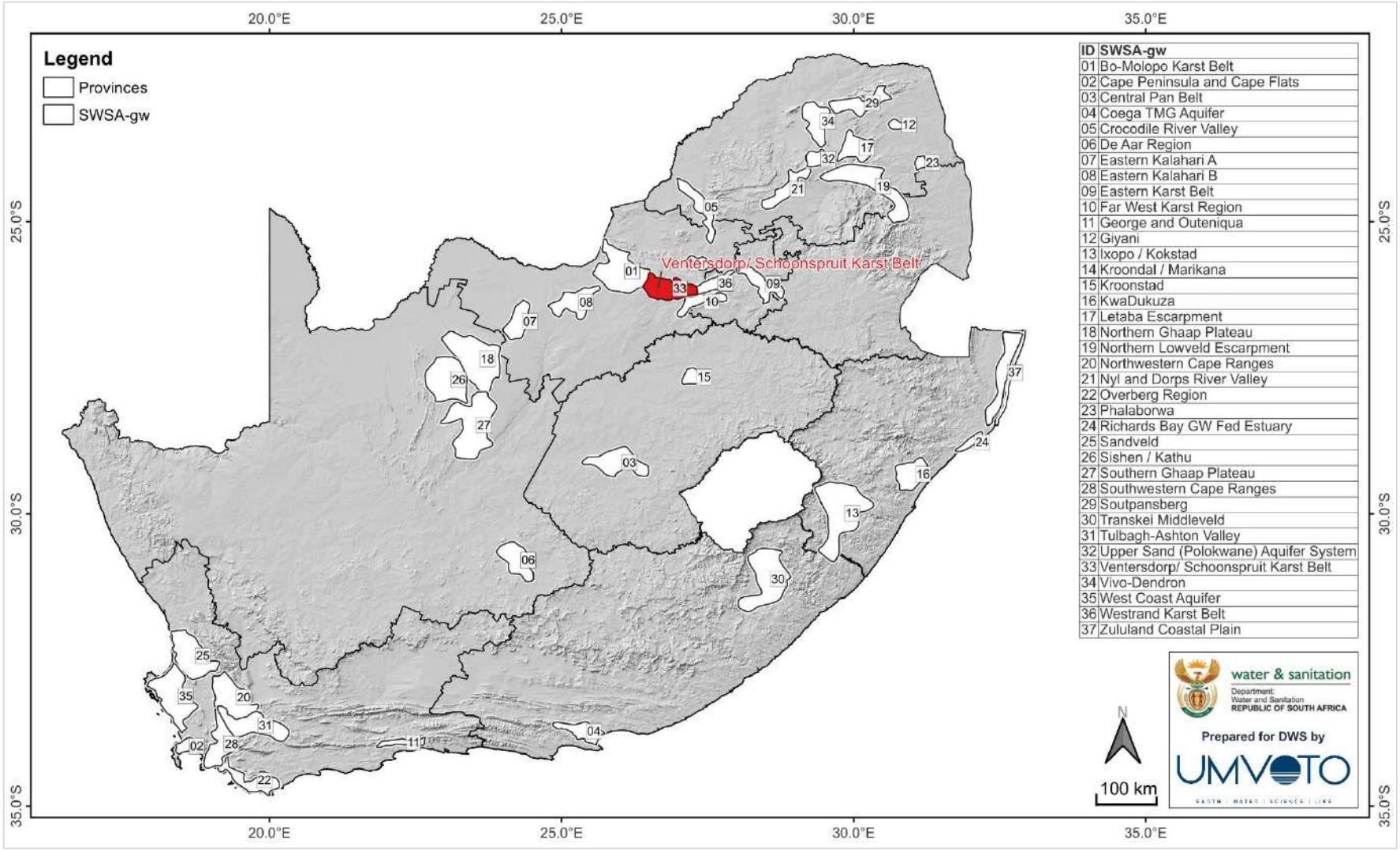


Map showing the major water bodies, Ramsar sites and GDEs in the Upper Sand (Polokwane) Aquifer System SWSA-gw.

APPENDIX 33

VENTERSDORP / SCHOONSPRUIT KARST BELT SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE VENTERSDORP / SCHOONSPRUIT KARST BELT SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

33. Ventersdorp / Schoonspruit Karst Belt

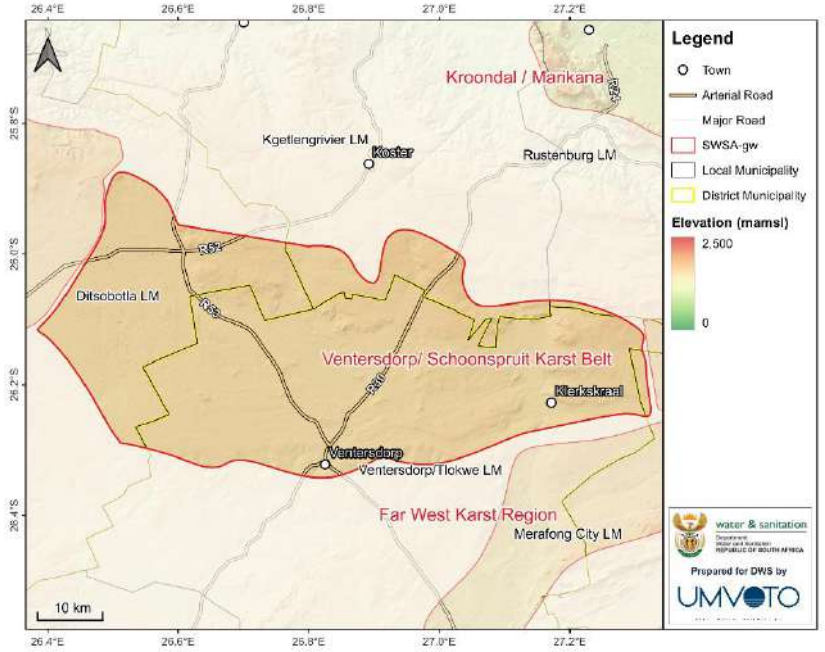
33.1. Description

SWSA-gw Name:	**Ventersdorp/Schoonspruit Karst Belt**
Area:	**2875 km^2**
Elevation:	**1431 to 1641 mamsl**
Geospatial Context	

The map depicts the topography of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw, which consists of gently undulating plains, low ridges, and scattered rocky outcrops. The terrain is flat around Ventersdorp and Koster.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	North West and Gauteng
District Municipality	West Rand, Bojanala, Ngaka Modiri Molema and Dr Kenneth Kaunda
Local Municipality	Ditsobotla, Kgetlengrivier, Rustenburg, Merafong and Ventersdorp/Tlokwe
Towns	Ventersdorp
Major Roads	N14, R30 and R53
Major Water Supply Networks	



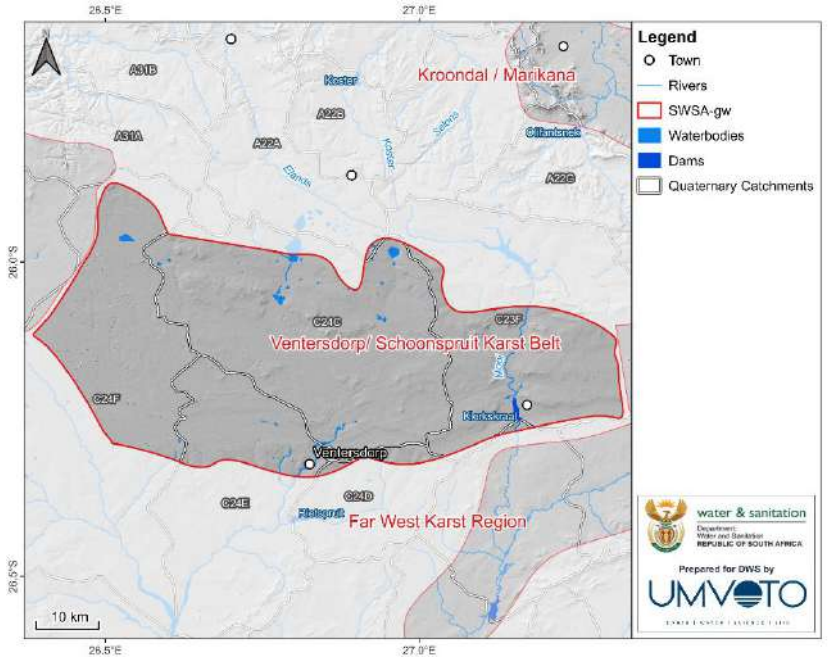
Locality map of Major Towns, District and Local Municipalities in the Ventersdorp/Schoonspruit Karst Belt SWSA-gw.

SWSA-gw Name:	Ventersdorp/Schoonspruit Karst Belt
Area:	2875 km^2
Elevation:	1431 to 1641 mamsl

Hydrology and Drainage

The Ventersdorp/Schoonspruit Karst Belt SWSA-gw and surrounding areas include a few major surface water systems, summarised below and displayed in the map on the right. The C2 catchment feeds the Klerkskraal reservoir, Mooi, and Skoonspruit perennial rivers, which flow north and south, respectively.

Quaternary Catchments	A22A, A31A, C23F, C23G, C24C, C24D, C24E and C24F
Rivers	Perennial: Mooi and Skoonspruit
	Ephemeral: Unnamed
Natural and manmade water bodies	
Major Dams:	Klerkskraal
Water Management Areas:	Vaal Orange and a small section of Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Ventersdorp/Schoonspruit Karst Belt SWSA-gw.

SWSA-gw Name:	Ventersdorp/Schoonspruit Karst Belt
Area:	2875 km^2
Elevation:	1431 to 1641 mamsl
Geology	

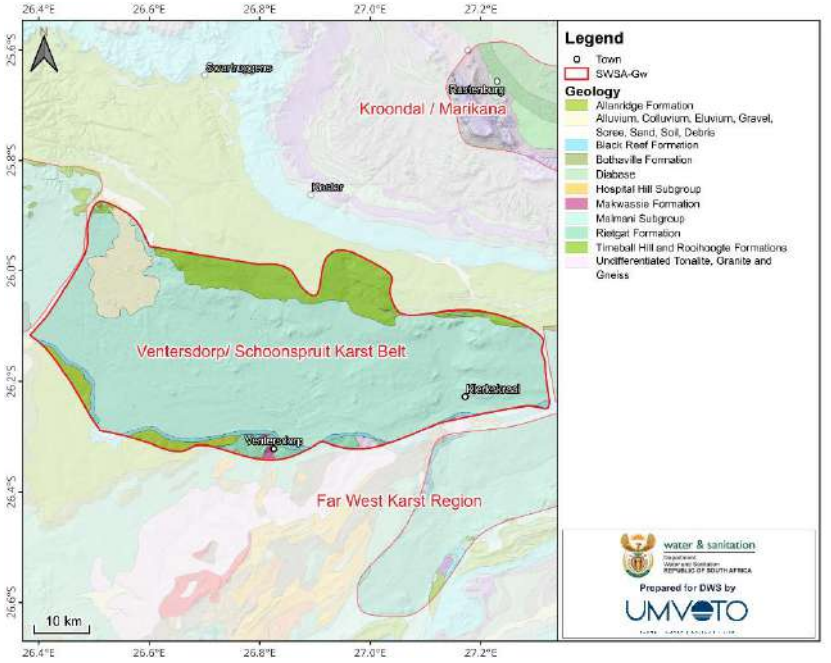
Geology

Quaternary soil cover dominates the northwestern section of the Ventersdorp/Schoonspruit Karst Belt area, with occasional outcroppings of gravel that are diamondiferous in places.

The majority of the area is covered by the Transvaal Supergroup. The central area features formations of the Chuniespoort Group, with the Black Reef Formation outcropping to the south and the Pretoria Group to the north. The Chuniespoort Group is dominated by the Malmani Subgroup, which is comprised of dolomites, cherts, and minor shale and limestone. The Pretoria Group includes quartzites, mudrocks, and breccias. Along the southern border, the Platberg Group and other formations of the Ventersdorp Supergroup outcrop, characterised by breccias, greywacke, shale, and porphyritic mafic lavas.

Hydrostratigraphy

The Quaternary sediments form a primary, intergranular aquifer system. The Malmani Subgroup forms a secondary karstified aquifer system. The Pretoria Group constitutes a secondary, fractured aquifer system with variable permeability. The Ventersdorp Supergroup forms a secondary, fractured aquifer system.



Geology Map of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw region.

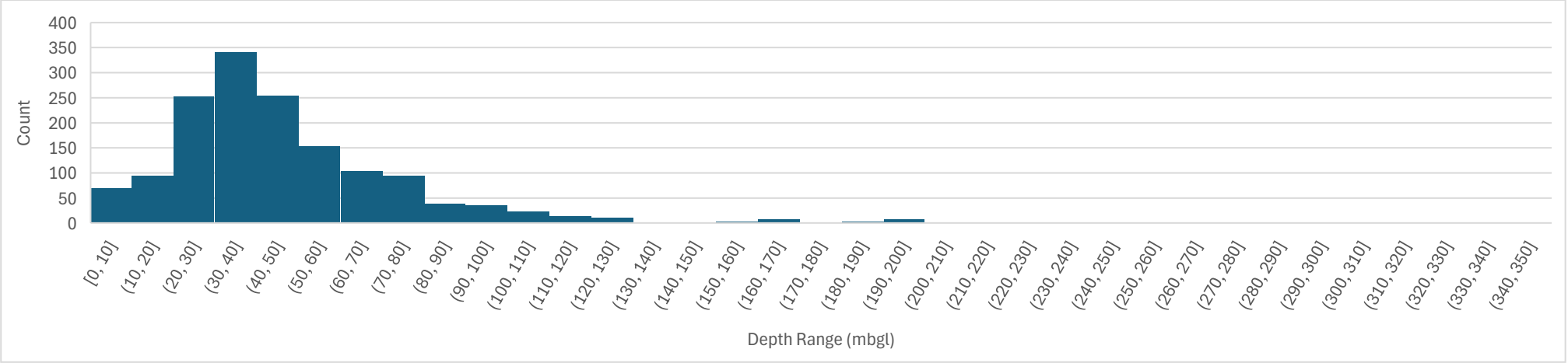
33.2. Current Status

SWSA-gw Name:	**Ventersdorp/Schoonspruit Karst Belt**
Area:	**2875 km²**
Elevation:	**1431 to 1641mamsl**
Quantity & Quality	
Aquifer Classification	

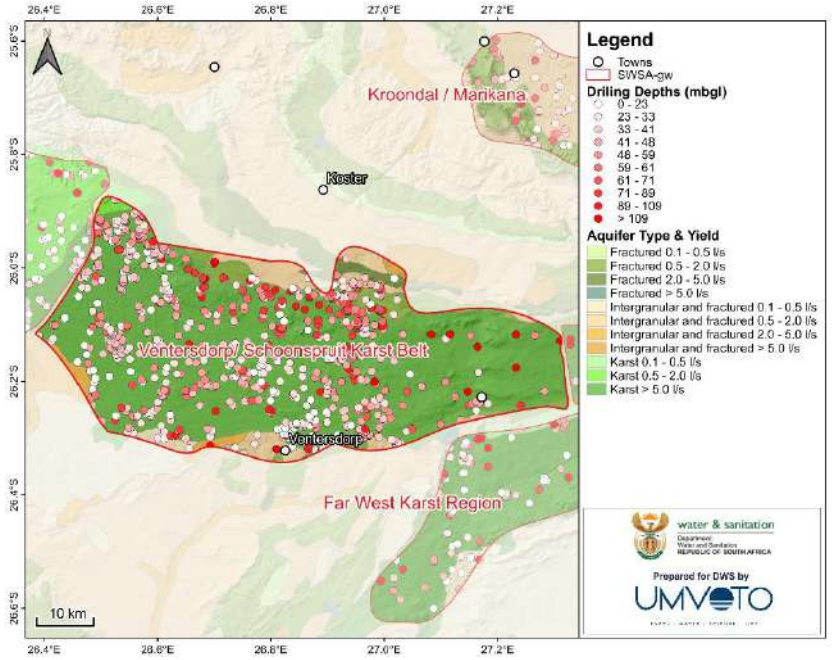
The aquifer systems within the Ventersdorp/Schoonspruit Karst Belt SWSA-gw exhibit varying yields across karst and dual-porosity aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw is predominantly a major aquifer system, with two minor aquifer systems along the northern and southern edges. The major aquifer system has an average karst yield of over 5.0 l/s. The minor aquifer systems have an average dual-porosity yield ranging from 0.5 to 5.0 l/s.
Groundwater Targets	The average drilling depth is 48 mbgl, and the most common depth is around 30 mbgl, suggesting the targeting of a shallow central karst aquifer system and minimal deeper boreholes (> 200 mbgl) targeting the fractured basement aquifer. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 30 and 58 mbgl. Based on the past 25 years of NGA water level data, the average groundwater level in the region is ~ 17 mbgl, with values ranging from 0 to 80 mbgl and a standard deviation of ~ 16 mbgl.

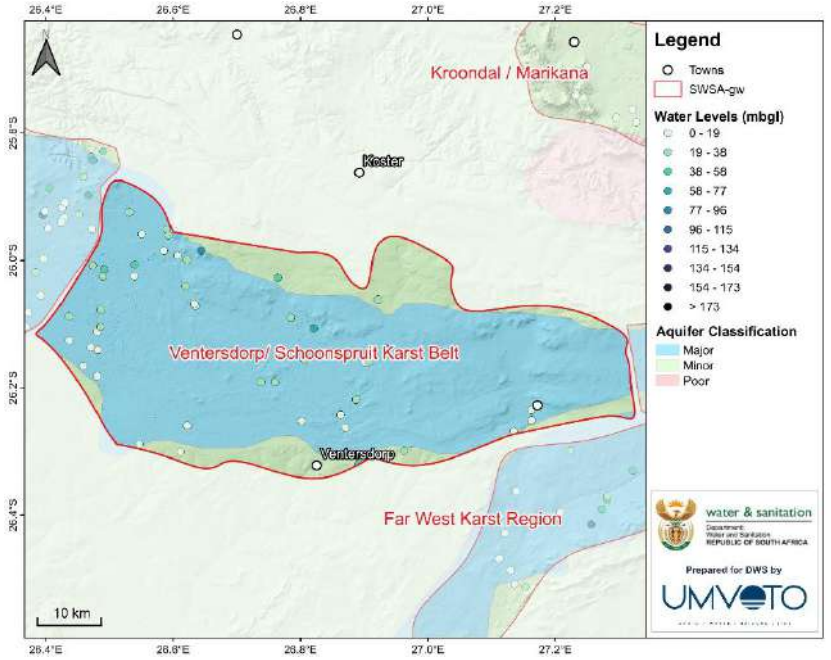
Graph of NGA drilling depths (after DWS, n.d.) of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw region



SWSA-gw Name:	Ventersdorp/Schoonspruit Karst Belt
Area:	2875 km^2
Elevation:	1431 to 1641mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw region.

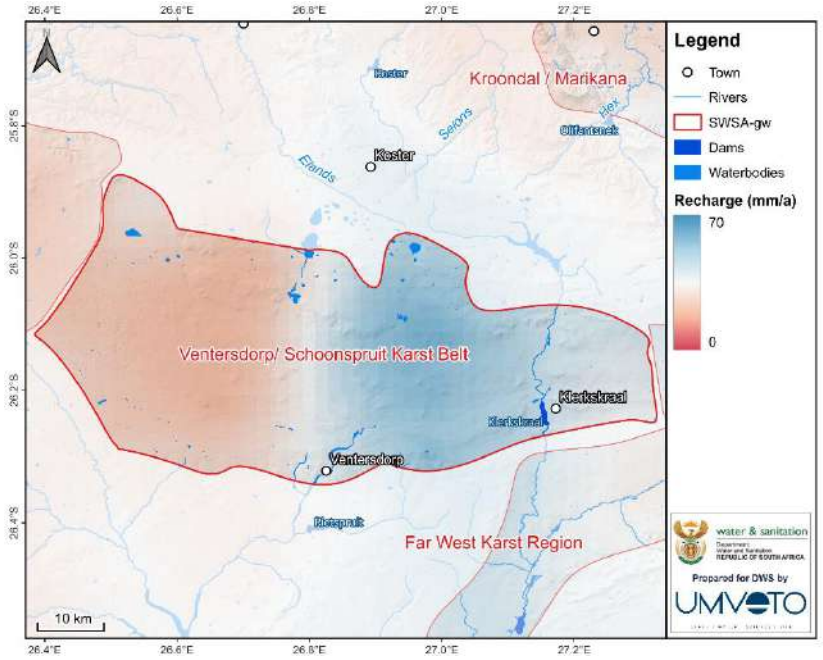
SWSA-gw Name:	**Ventersdorp/Schoonspruit Karst Belt**
Area:	**2875 km²**
Elevation:	**1431 to 1641mamsl**

Quantity & Quality

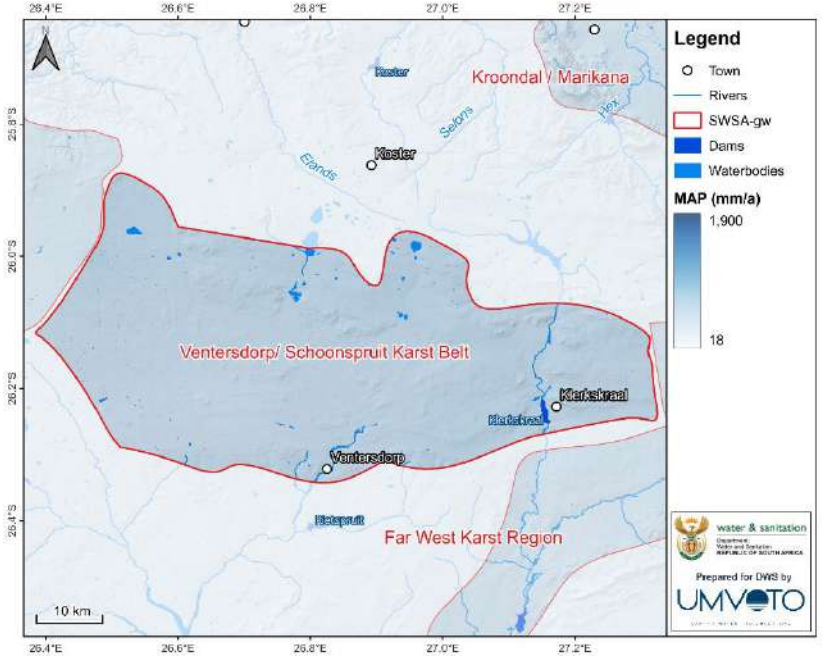
Groundwater Recharge

The Ventersdorp/Schoonspruit Karst Belt region receives a total MAP volume of 1645 Mm^3/a, with an average rainfall of 573 mm/a. However, only 103.7 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 6.3% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Ventersdorp/Schoonspruit Karst Belt	1645	573	103.7	36.1	6.3%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Ventersdorp/Schoonspruit Karst Belt
Area:	2875 km^2
Elevation:	1431 to 1641mamsl

Quantity & Quality

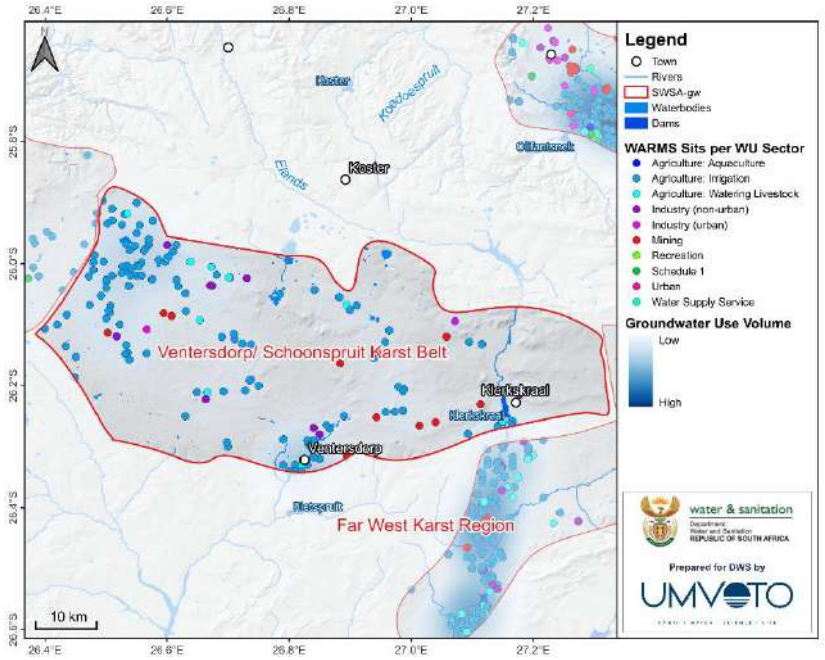
Groundwater Use

The Ventersdorp Schoonspruit Karst Belt SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Ventersdorp (Groundwater), who rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 48.2 Mm^3/ a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. Most of the irrigational use is concentrated in the western areas of the map
- Agricultural livestock watering follows, using 2.9 Mm^3/ a to provide water for livestock animals to drink and graze. The use for this sector is scattered throughout the area and is mostly in the northern areas of the map. Given that two of the largest water use sectors are agriculture in this area, it can be concluded that agriculture in this region relies heavily on groundwater.
- Mining use has 1.5Mm^3/a allocated. Water is a vital resource in the mining process. Groundwater can offer a reliable water source in water-scarce or remote areas. Groundwater mining use is also randomly distributed throughout the area. The highest concentration is in the southeastern parts of the area.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Ventersdorp, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	48.2
	Agriculture: Watering Livestock	2.9
	Industry (Non-urban)	0.2
	Mining	1.5
	Power Generation	1.4
	Total	**54.1**



Water use map for the Ventersdorp Schoonspruit Karst Belt SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

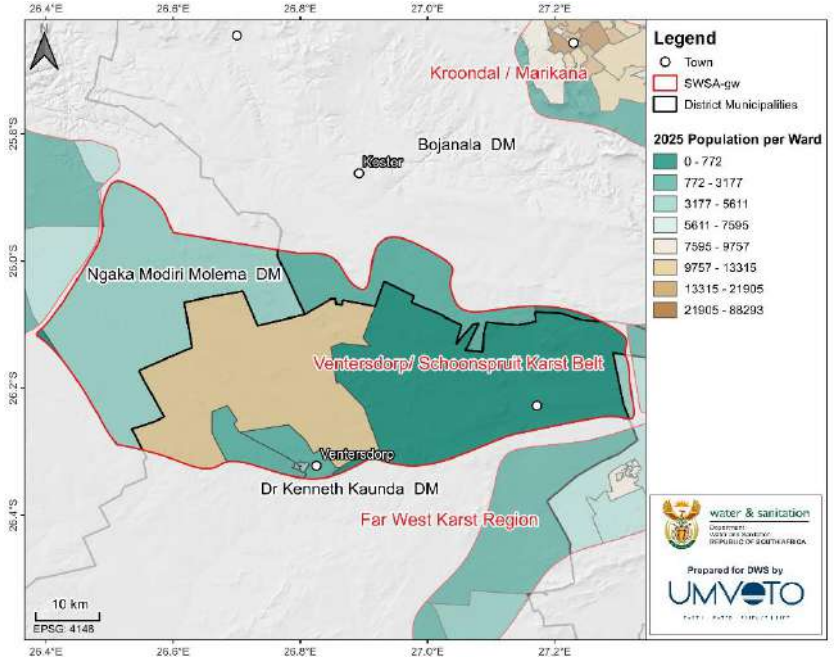
SWSA-gw Name:	Ventersdorp/Schoonspruit Karst Belt
Area:	2875 km^2
Elevation:	1431 to 1641mamsl
Quantity & Quality	
Socio Economic & Governance	

The Ventersdorp/Schoonspruit Karst Belt SWSA-gw is located within the Vaal-Orange Water Management Area (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA to manage water resources in the Vaal-Orange WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction, except for Ditsobotla LM, which falls under Ngaka Modiri Molema DM, which is the WSA and WSP for its jurisdiction.

The estimated 2025 population within the Ventersdorp/Schoonspruit Karst Belt SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of -0.89% per year, resulting in a projected population of approximately 31,841.

As shown in the map and table below, Ventersdorp/Tlokwer Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 25,849.



Projected population distribution in 2025 for the Ventersdorp/Schoonspruit Karst Belt SWSA-gw.

SWSA-gw Name:	Ventersdorp/Schoonspruit Karst Belt
Area:	2875 km^2
Elevation:	1431 to 1641mamsl

Quantity & Quality

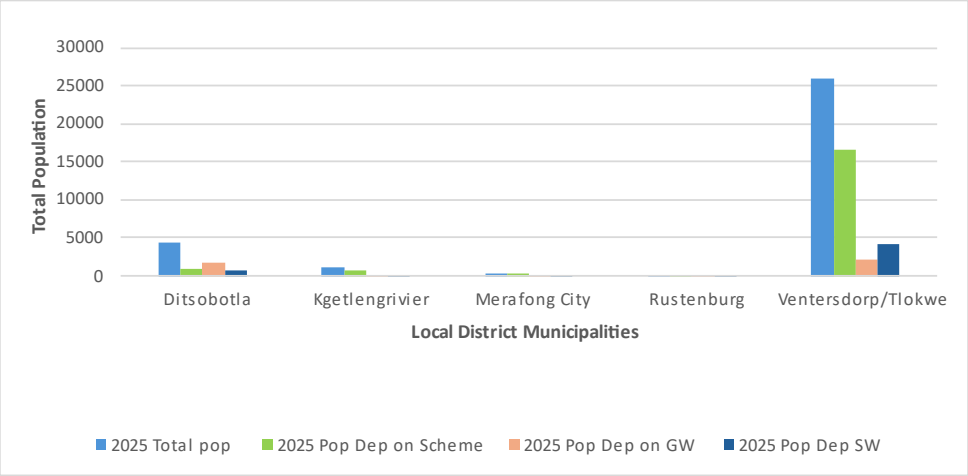
Socio Economic & Governance

In terms of water reliance within the Ventersdorp/Schoonspruit Karst Belt SWSA-gw, an estimated 58.5% of the population depends on the regional water supply scheme, 15.54% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 13.54% on groundwater sources (including boreholes and springs)

Among the LMs, the Rustenburg LM has the highest proportion of groundwater reliance, with approximately 68.5%, and minimal reliance on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Ditsobotla	4,351	851	1,731	665
Kgetlengrivier	1,094	803	182	52
Merafong City	409	276	83	29
Rustenburg	138	16	95	12
Ventersdorp/Tlokwe	25,849	16,674	2,221	4,190
Total	**31,841**	**18,619**	4,311	4,948



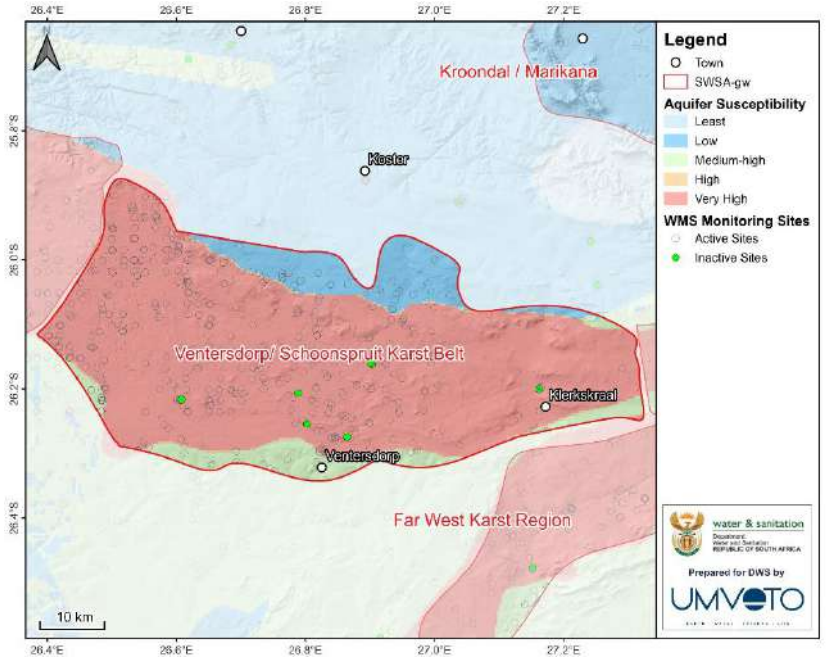
Projected population dependence on water sources in 2025.

SWSA-gw Name:	Ventersdorp/Schoonspruit Karst Belt
Area:	2875 km^2
Elevation:	1431 to 1641 mamsl
Quantity & Quality	
Groundwater Quality	

The Ventersdorp/Schoonspruit Karst Belt SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 1053.93 km^2, which is 36.66% of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw total area. Urban/Built-up areas cover 28.62 km^2 (1.00%), while mines and quarries account for 4.47 km^2 (0.16%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 30.7 – 113 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 0.59 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.07 - 13.45 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.99 - 8.88 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 1.17 - 441.35 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Ventersdorp/Schoonspruit Karst Belt**
Area:	**2875 km^2**
Elevation:	**1431 to 1641 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Ventersdorp/Schoonspruit Karst Belt SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	6	4.14	145	54.80	mS/m	2014-2024 GW Geosites: <70 mS/m.	2014-2024 GW Geosites: <70 mS/m.	30.7 - 113 mS/m (Avg.: 54.80 mS/m). 2014-2024 GW Geosites: <70 mS/m. Consistent with WMS (2000-2024).
Fluoride	6	4.14	145	0.16	mg/L	2014-2024 GW Geosites: <0.5 mg/L.	2014-2024 GW Geosites: <0.5 mg/L.	0.025 - 0.59 mg/L (Avg.: 0.16 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	6	4.11	146	3.88	mg/L	2014-2024 GW Geosites: <11 mg/L.	2014-2024 GW Geosites: <11 mg/L.	0.07 - 13.45 mg/L (Avg.: 3.88 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	6	4.11	146	8.23	pH unit	2014-2024 GW Geosites: 7-9.	2014-2024 GW Geosites: 7-9.	6.99 - 8.88 (Avg.: 8.23). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	6	4.11	146	12.71	mg/L	2014-2024 GW Geosites: <200 mg/L.	2014-2024 GW Geosites: <200 mg/L.	1.17 - 441.35 mg/L (Avg.: 12.71 mg/L). 2014-2024 GW Geosites: <200 mg/L. Consistent with WMS (2000-2024), except for values above the upper limit.

- *"Average" refers to the average concentrations for the Total Active Sites of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw, taken from the WMS database from 2000-2024.*

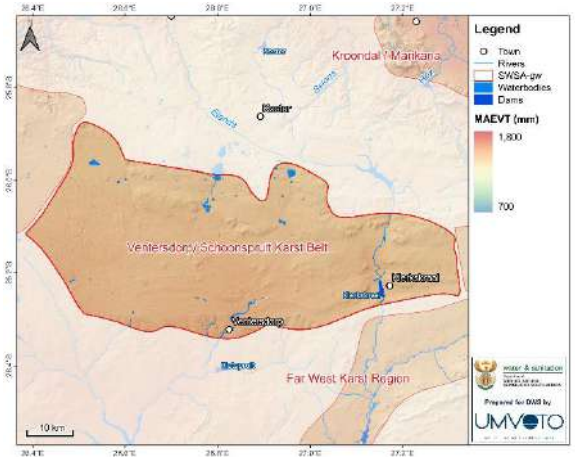
SWSA-gw Name:	**Ventersdorp/Schoonspruit Karst Belt**
Area:	**2875 km^2**
Elevation:	**1431 to 1641 mamsl**

Threats & Risks

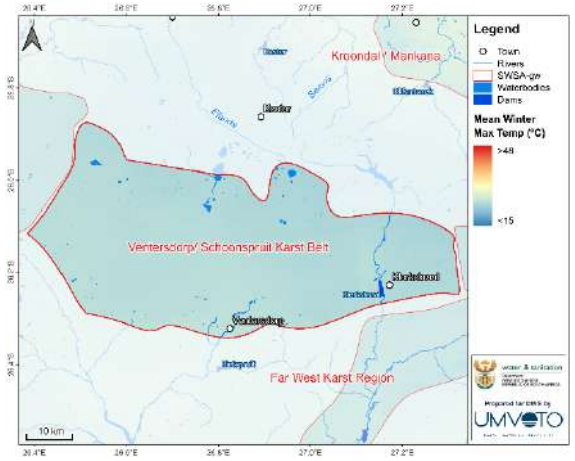
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Ventersdorp/Schoonspruit Karst Belt SWSA-gw has a predominantly Cwb, subtropical highland, type climate characterized by warm summers and dry winters, towards the west edges it changes to a BSk, cold semi-arid, type climate characterised by cold winters and warm to hot summers. Temperatures in the SWSA-gw range from -1.9 – 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

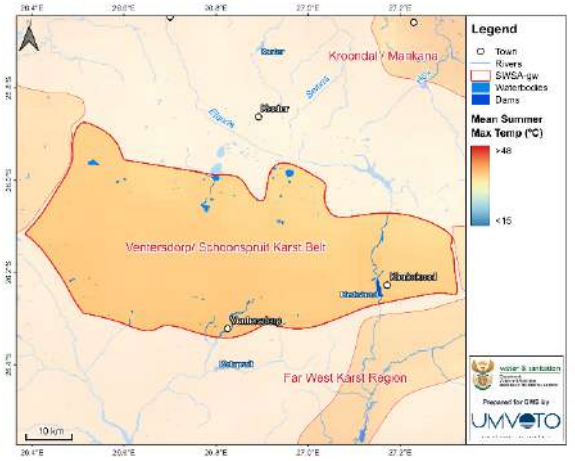
Temperature	Summer: 24.7 to 29.2 °C, Winter: -1.9 to 2 ºC
Evapotranspiration	Maximum value of 1553 mm/a with an average value of 1472 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, but an increase in recharge (ranging from ~ -2.3 to 6.1 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw region.



Mean winter temperatures of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw region.



Mean summer temperatures of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw region.

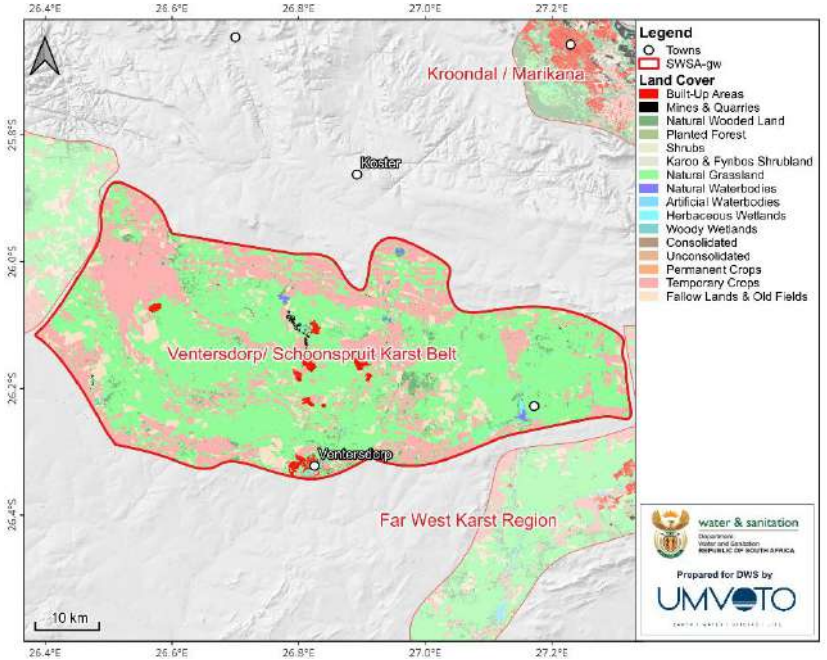
SWSA-gw Name:	Ventersdorp/Schoonspruit Karst Belt
Area:	2875 km^2
Elevation:	1431 to 1641 mamsl

Threats & Risks

Land Use

The Ventersdorp/Schoonspruit Karst Belt SWSA-gw is primarily covered by grassland, followed by cultivated land, which consists of permanent crops, temporary crops, fallow land and old fields (DFFE, 2022), making up a combined 94.8% of the SWSA-gw. There is minimal development in this SWSA-gw, with small and scattered residential areas. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.2% of the area, located predominantly in the northwest of the area.

Land Use Type	Area (km^2)	Area (%)
Barren Land	1	0.03
Built-Up	29	1
Cultivated	1054	36.7
Forest Land	97	3.4
Grassland	1669	58.1
Mines and quarries	4	0.2
Shrubland	1	0.05
Waterbodies	8	0.3
Wetlands	12	0.4



Land Cover 24-class map to show the types of land use and extent of each occurring in the Ventersdorp/Schoonspruit Karst Belt SWSA-gw.

SWSA-gw Name:	Ventersdorp/Schoonspruit Karst Belt
Area:	2875 km^2
Elevation:	1431 to 1641

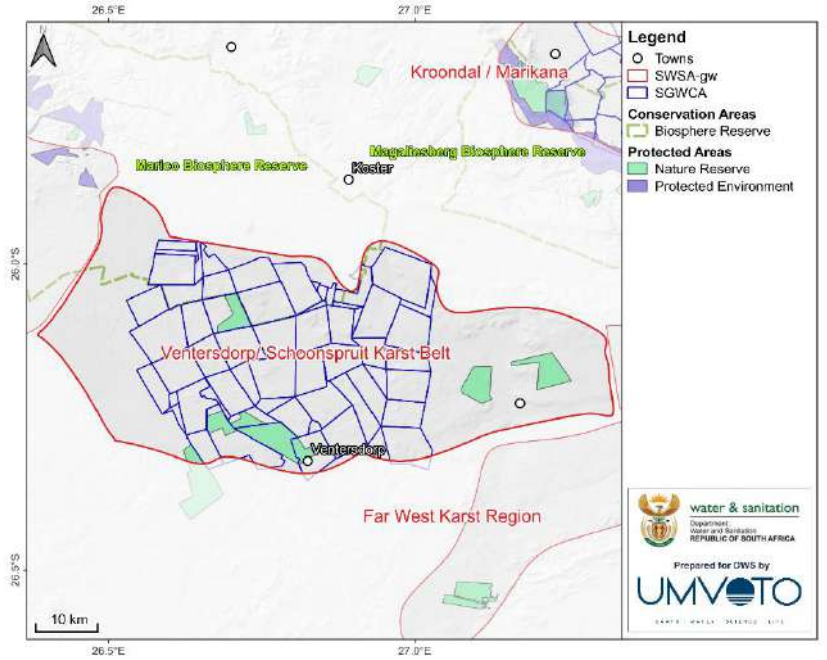
Protection Status and Ecosystems

Biodiversity and Conservation

The Marico Biosphere Reserve (DFFE, 2024) covers a portion of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw on the northwestern edge. The biosphere reserve then extends westward towards the towns of Zeerust and Mafikeng and into the Bo-Molopo Karst Belt SWSA-gw. The Schoonspruit Nature Reserve is the largest of six nature reserves (DFFE, 2024) in the SWSA-gw, bordering the town of Ventersdorp, as displayed on the map.

The Ventersdorp-Eye subterranean groundwater control area (SGWCA) (CSIR, 1998) covers approximately 55% of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw and shows the area where the government controlled groundwater on private land under the Water Act No. 54 of 1956 (DWA, 2010).

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Marico Biosphere Reserve	464.95	1
Protected Areas	• Witkrans Private Nature Reserve • Klipstraat Private Nature Reserve • Schoonspruit Nature Reserve • Makokskraal Private Nature Reserve • Fred Coetzee Private Nature Reserve • Somerville Private Nature Reserve	141.54	6
SGWCA	• Ventersdorp-Eye	1583.49	1
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw that have protection status.

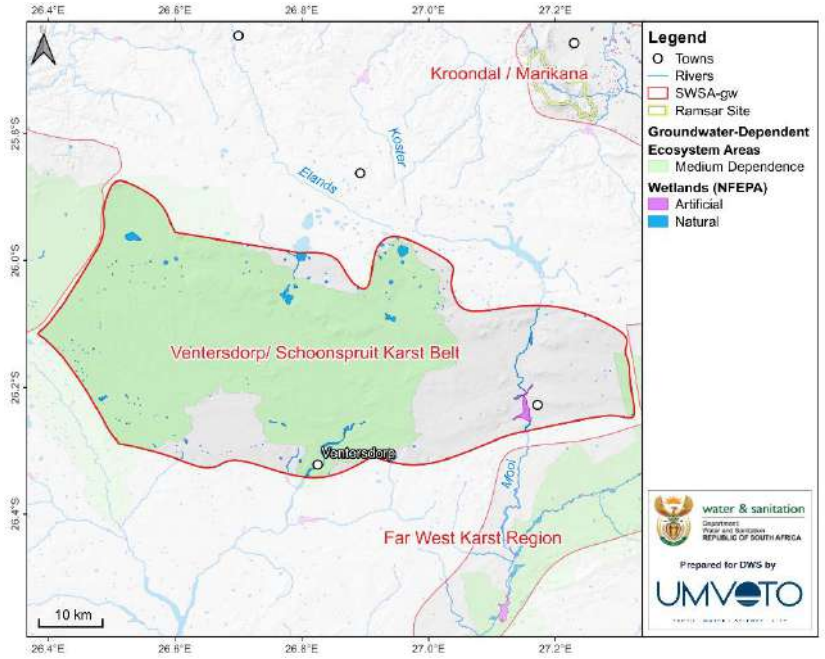
SWSA-gw Name:	Ventersdorp/Schoonspruit Karst Belt
Area:	2875 km^2
Elevation:	1431 to 1641

Protection Status and Ecosystems

Biodiversity and Conservation

A broad area of the Ventersdorp/Schoonspruit Karst Belt SWSA-gw contains dolomite vegetation wetlands, with a potentially medium dependence on groundwater (DWA, 2010. Most of the Ventersdorp-Eye SGWCA overlaps with these groundwater-dependent ecosystems.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	• Klerkskraal Dam	4.02	1
Ramsar Sites	None		0
Wetlands	Various natural and artificial wetlands	26	4

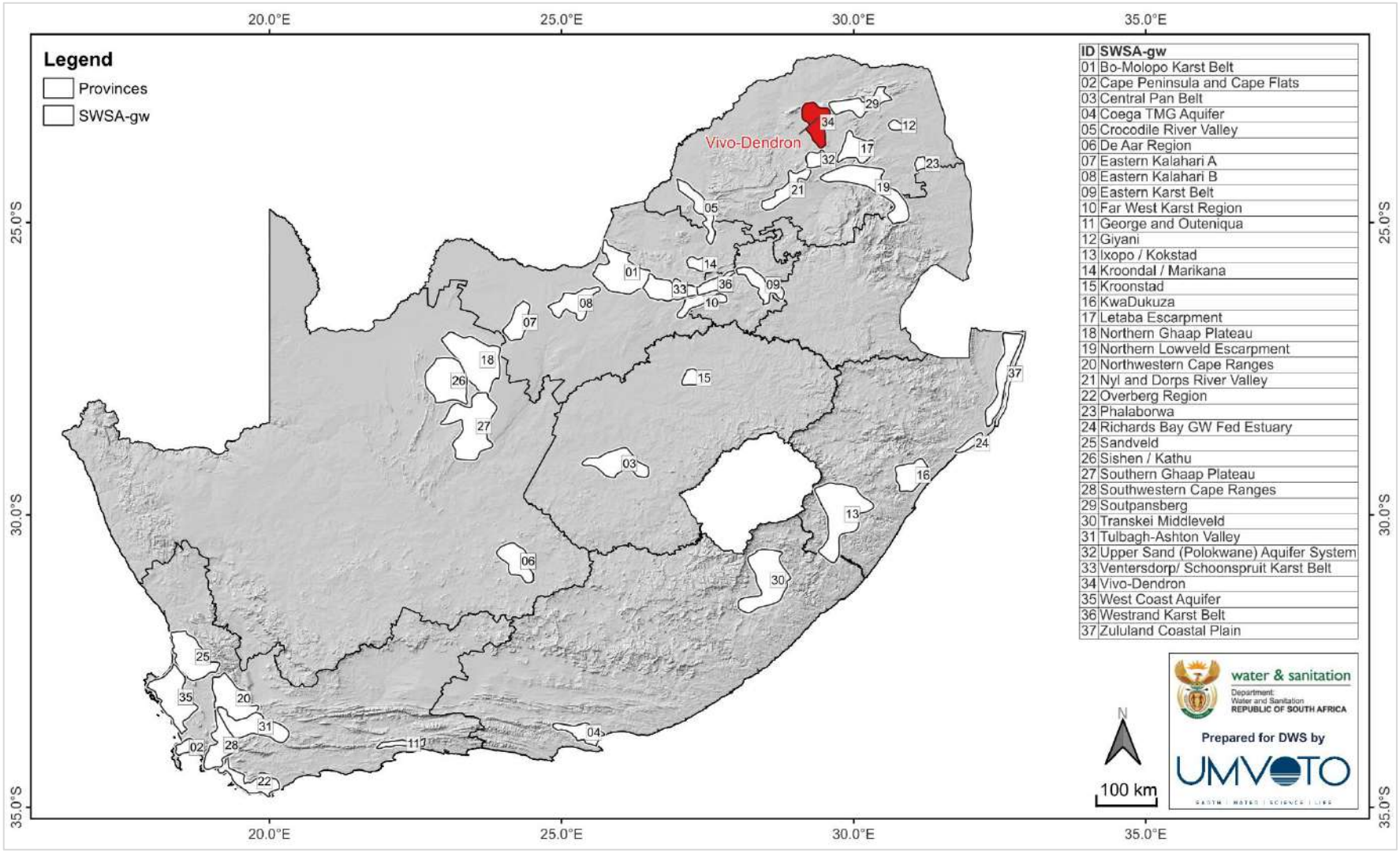


Map showing the major water bodies, Ramsar sites and GDEs in the Ventersdorp/Schoonspruit Karst Belt SWSA-gw.

APPENDIX 34

VIVO-DENDRON SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE VIVO-DENDRON SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

34. Vivo-Dendron

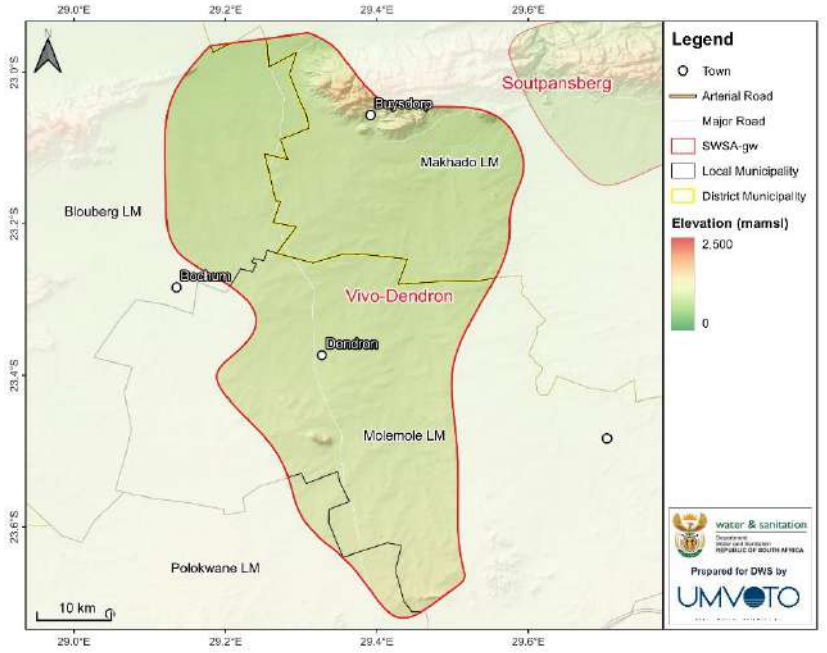
34.1. Description

SWSA-gw Name:	Vivo-Dendron
Area:	2555 km²
Elevation:	779 to 1621 mamsl
Geospatial Context	

The topography of the Vivo-Dendron SWSA-gw, as depicted in the map, is characterized by a mix of rugged terrain, undulating hills, and elevated plateaus. The region lies within the western Bushveld, with the Blouberg Mountains influencing the landscape, particularly to the north. The area around Ga-Semenya and Mogwadi features more gently rolling hills and small river valleys. As you move towards Ga-Maponto and Muungadi, the terrain becomes more rugged, with rocky outcrops, steep slopes, and riverbeds.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Limpopo
District Municipality	Capricorn and Vhembe
Local Municipality	Blouberg, Makhado, Molemole and Polokwane
Towns	Mogwadi
Major Roads	R521
Major Water Supply Networks	



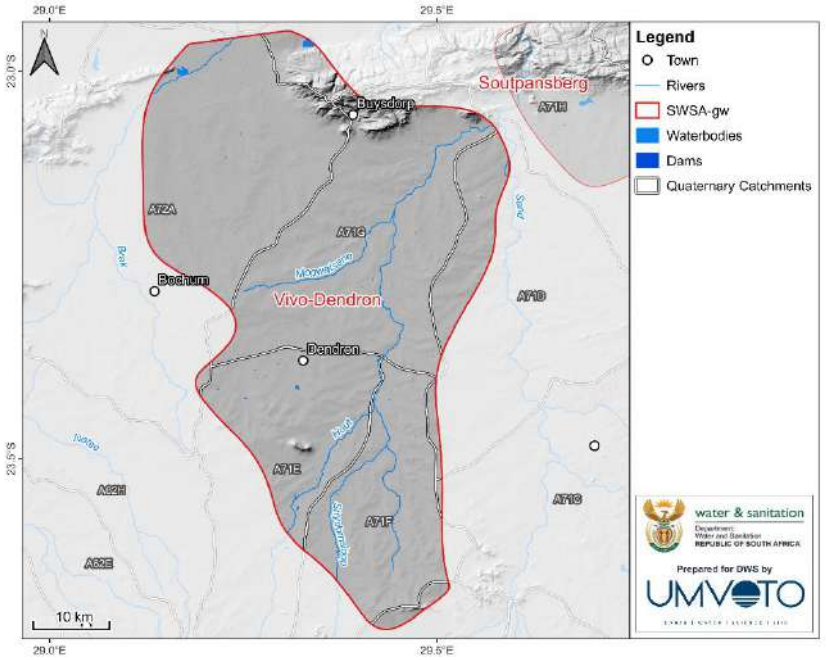
Locality map of Major Towns, District and Local Municipalities in the Vivo-Dendron SWSA-gw.

SWSA-gw Name:	Vivo-Dendron
Area:	2555 km²
Elevation:	779 to 1621 mamsl

Hydrology and Drainage

The Vivo-Dendron SWSA-gw and surrounding areas include a few major surface water systems summarised below and displayed in the map on the right. The one perennial river is the Hout river, and its fed by the A7 catchment, flowing in a north northeasterly direction.

Quaternary Catchments	A71A, A71D, A71E, A71F, A71G, A71J, A72A and small sections of A71C
Rivers	Perennial: Hout
	Ephemeral: Brak, Brakspruit, Mogwatsane, Strydomsloop
Natural and manmade water bodies	Unnamed flood planes
Major Dams:	No major dams
Water Management Areas:	Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Vivo-Dendron SWSA-gw.

SWSA-gw Name:	Vivo-Dendron
Area:	2555 km²
Elevation:	779 to 1621 mamsl
Geology	

Geology

Quaternary sandy soils are scattered across the area, with the majority found in the northern section. Diabase dike intrusions crisscross the upper two-thirds of the area.

The majority of the area is covered by the Goudplaats-Hout River Gneiss Suite, comprising leucocratic, strongly migmatized biotite gneiss, greyish weakly migmatized biotite gneiss, minor leucogneiss, and dark grey biotite gneiss.

Outcrops of the Bandelierkop Complex can also be found across the area, featuring magnetite quartzite and metaquartzite.

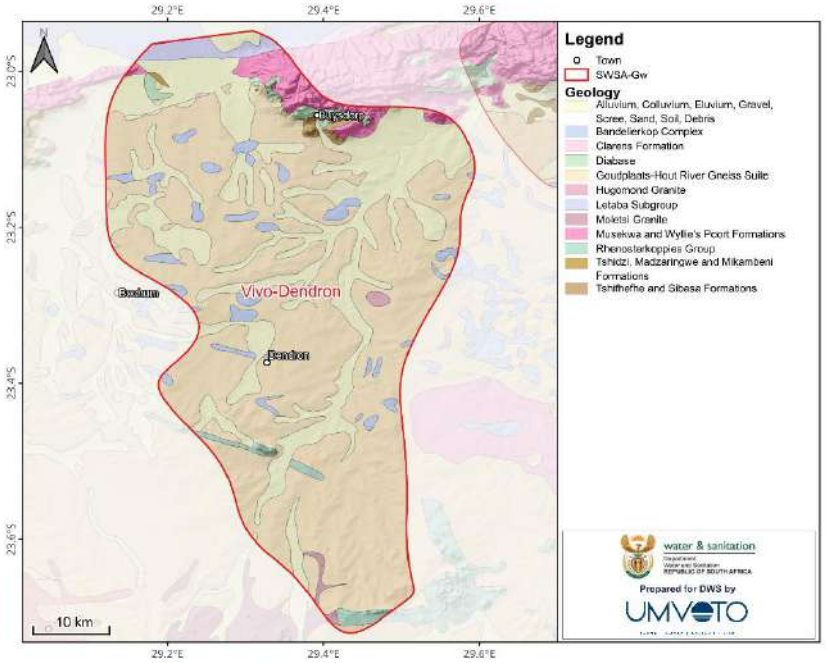
The Soutpansberg Group outcrops in the north, consisting of reddish or brown, medium- to coarse-grained sandstone and quartzite, minor conglomerate, basaltic lava, and tuff.

The Lebombo Group of the Karoo Supergroup also outcrops in the northern section of the area, characterised by basic volcanic rocks such as tholeiites, picrite basalts, and nephelinites.

The Vivo fault is observed in the northwestern section of the area.

Hydrostratigraphy

Quaternary sandy soils form a primary intergranular aquifer system. The gneissic rocks, including the Goudplaats-Hout River Gneiss Suite and the Bandelierkop Complex, form a secondary, fractured aquifer system. Granitic intrusions, such as the Younger Granites, also contribute to a fractured aquifer system. Alluvial deposits along major rivers create a primary intergranular aquifer system.



Geology Map of the Vivo-Dendron SWSA-gw region.

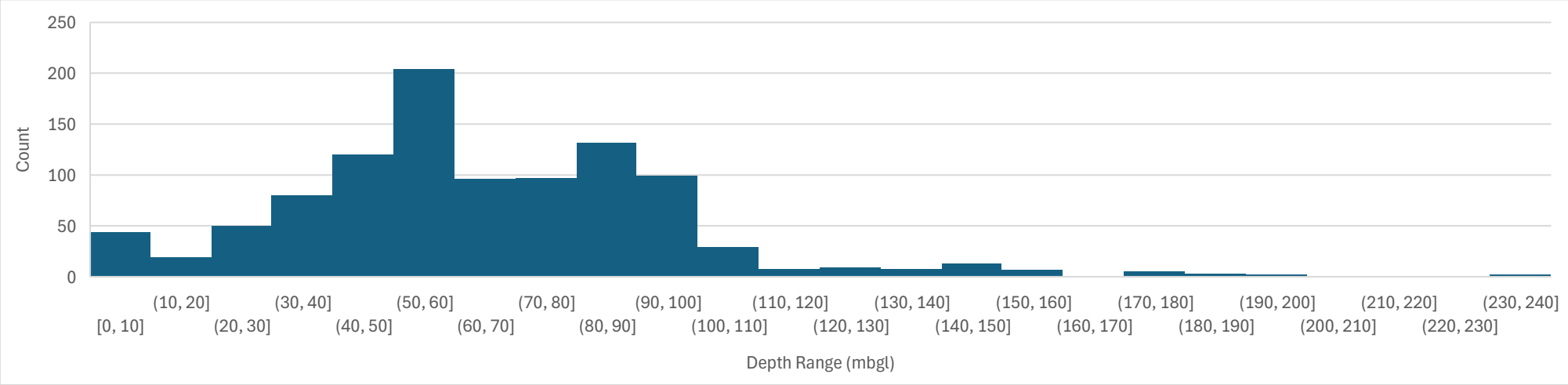
34.2. Current Status

SWSA-gw Name:	**Vivo-Dendron**
Area:	**2555 km²**
Elevation:	**779 to 1621 mamsl**
Quantity & Quality	
Aquifer Classification	

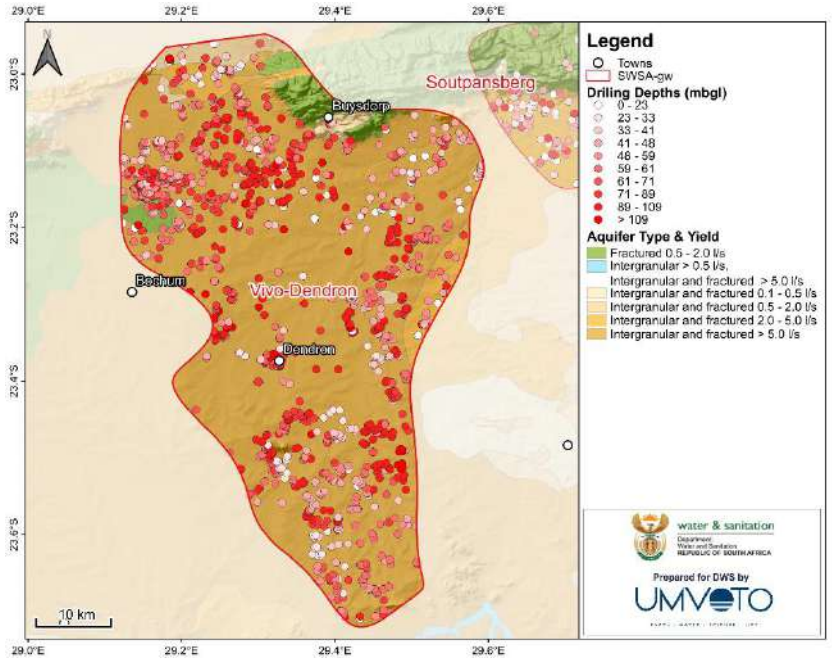
The aquifer systems within the Vivo-Dendron SWSA-gw exhibit varying yields across fractured aquifers, as summarised in the table and maps below.

Aquifer Classification	The majority of the SWSA-gw consists of a major aquifer system, with a minor aquifer system along the northern edge. The major aquifer system has an average dual-porosity yield ranging from 0.5 to over 5.0 l/s. The Minor aquifer system has a dual-porosity yield of 0.5 to 5.0 l/s.
Groundwater Targets	The average drilling depth is 67 mbgl, and the most common depth is around 60 mbgl. Boreholes target the high-yielding dual-porosity aquifer systems. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 45 and 90 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 24 mbgl, with values ranging from 4 to 56 mbgl and a standard deviation of ~14 mbgl.

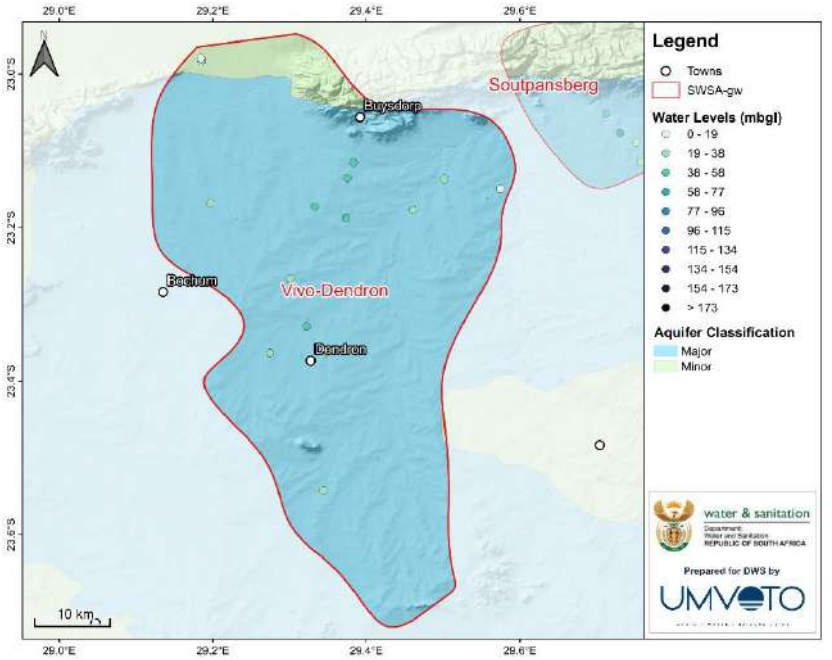
Graph of NGA drilling depths of the Vivo-Dendron SWSA-gw region



SWSA-gw Name:	Vivo-Dendron
Area:	2555 km²
Elevation:	779 to 1621 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Vivo-Dendron SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Vivo-Dendron SWSA-gw region.

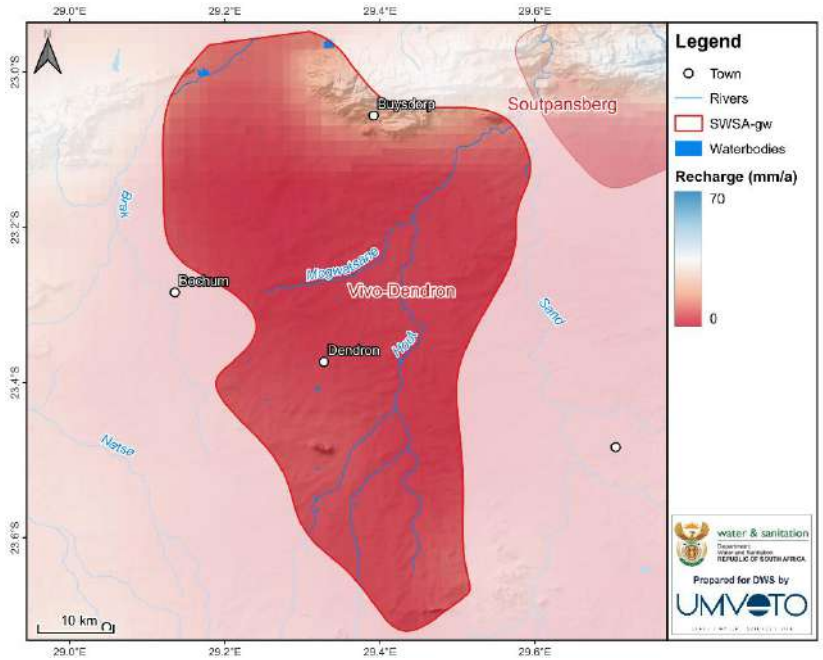
SWSA-gw Name:	**Vivo-Dendron**
Area:	**2555 km²**
Elevation:	**779 to 1621 mamsl**

Quantity & Quality

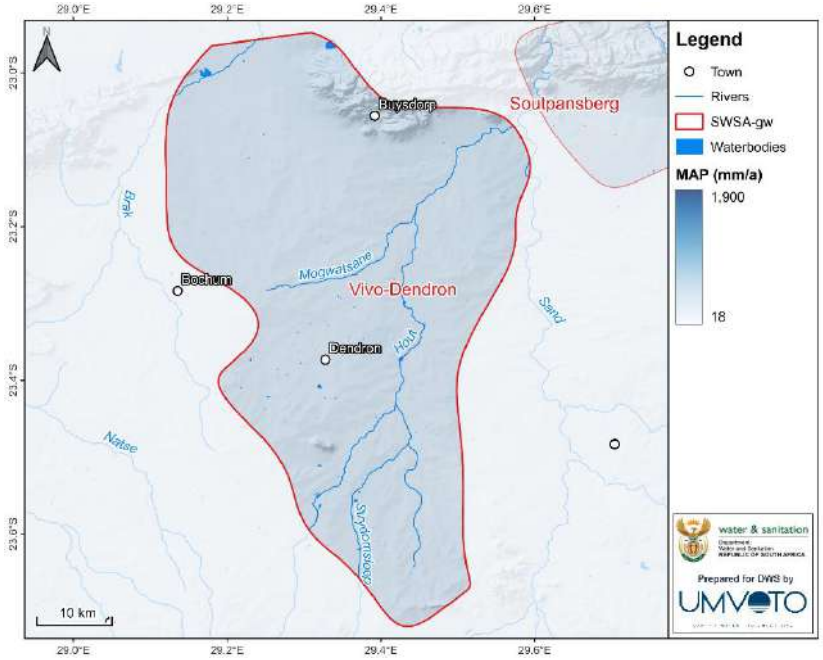
Groundwater Recharge

The Vivo-Dendron receives a total MAP volume of 994 Mm^3/a, with an average rainfall of 390 mm/a. However, only 12.7 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in an extremely low recharge of 1.3% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Vivo-Dendron	994	390	12.7	5.1	1.3%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

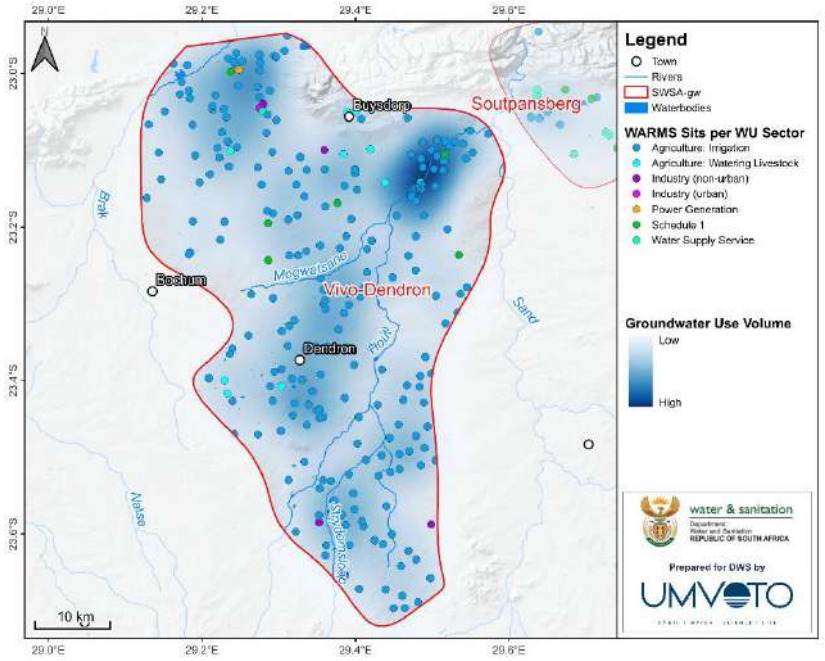
SWSA-gw Name:	Vivo-Dendron
Area:	2555 km²
Elevation:	779 to 1621 mamsl
Quantity & Quality	
Groundwater Use	

The Vivo-Dendron SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region include Mogwadi (Groundwater) and Senwabarwana (Groundwater), which rely significantly on groundwater resources for industrial use and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 45.2 Mm^3/ a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. This sector is spread throughout the region. There is clustering in areas like the northwest and near Mogwadi. Given how much of the region relies on groundwater for irrigation, it is a vital resource for this area.
- Agricultural livestock watering follows, using 0.1 Mm^3/a to provide water for livestock animals to drink and graze. While the distribution is not as widespread as the irrigation, the watering of livestock is in quite a few areas, particularly the northern and western parts of the region.
- Non-urban industrial follows, using 0.02 Mm^3/a for manufacturing, processing, and other industrial activities outside urban centres. These are primarily located in the north and south of the region and are quite scattered.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Mogwadi, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	45.2
	Agriculture: Watering Livestock	0.1
	Industry (Non-urban)	0.02
	Schedule 1	0.01
	Total	**45.33**



Water use map for the Vivo-Dendron SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

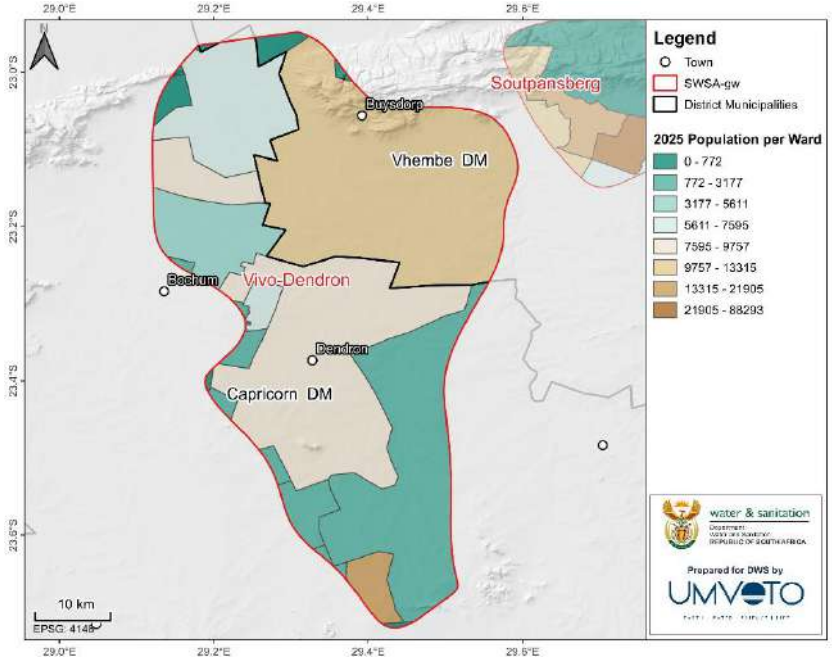
SWSA-gw Name:	Vivo-Dendron
Area:	2555 km²
Elevation:	779 to 1621 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Vivo-Dendron SWSA-gw is located within the Limpopo-Olifants Water Management Areas (WMA, 2023). The groundwater resources within the Eastern Kalahari A SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. LOCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the LOCMA to manage water resources in the Limpopo-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	LOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	Lebalelo and Kalahari East WUAs are the local water management group that assists the CMA with allocation decisions among water users and oversees groundwater infrastructure and monitoring within the SWSA-gw.
WSA & WSP	The district municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction, except for Polokwane LM, which is WSA and WSP for its jurisdiction.

The estimated 2025 population within the Vivo-Dendron SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 1.68% per year, resulting in a projected population of approximately 81,239.

As shown in the map and table below, Molemole Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 25,628, followed by Blouberg with 23,916. Population concentrations within the SWSA-gw are highest around the Makhodo and Polokwane LMs.



Projected population distribution in 2025 by ward for the Vivo-Dendron SWSA-gw.

SWSA-gw Name:	Vivo-Dendron
Area:	2555 km²
Elevation:	779 to 1621 mamsl

Quantity & Quality

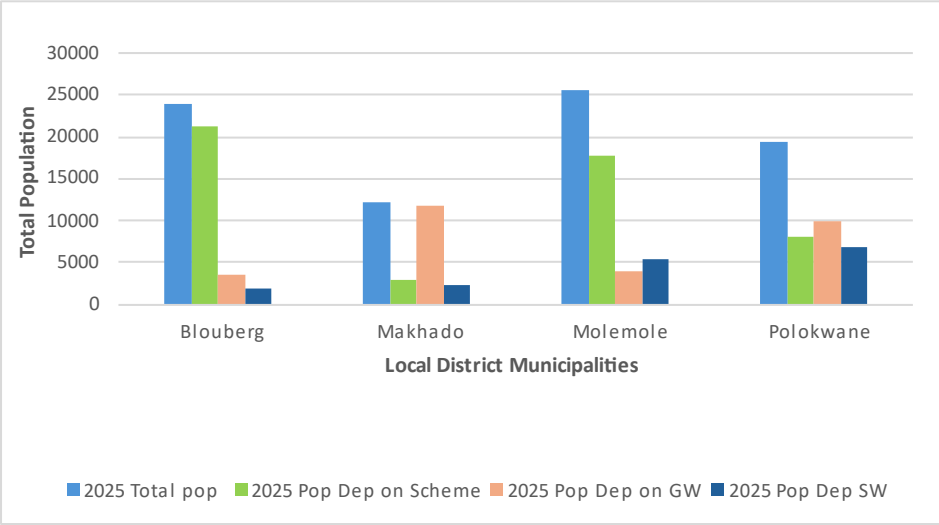
Socio Economic & Governance

In terms of water reliance within the Vivo-Dendron SWSA-gw, an estimated 61.7% of the population depends on the regional water supply scheme, 36.4% on groundwater sources (including boreholes and springs), and 20.2% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources).

Among the LMs, the Makhado LM has the highest proportion of groundwater reliance, with approximately 96.6% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Blouberg	23,916	21,323	3,598	1,928
Makhado	12,293	2,986	11,873	2,242
Molemole	25,628	17,812	4,050	5,402
Polokwane	19,402	8,043	10,022	6,820
Total	**81,239**	**50,165**	29,544	16,392



Projected population dependence on water sources in 2025.

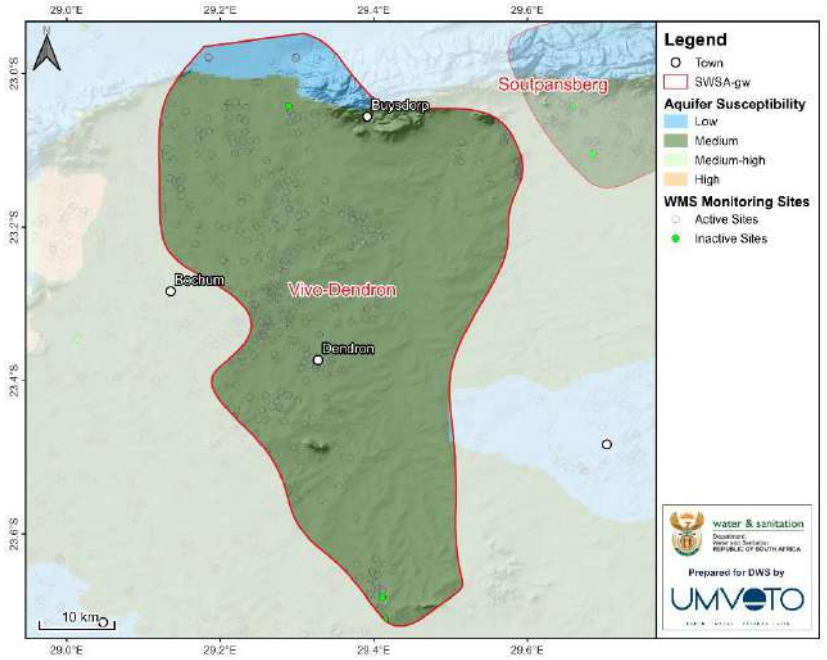
SWSA-gw Name:	Vivo-Dendron
Area:	2555 km²
Elevation:	779 to 1621 mamsl
Quantity & Quality	
Groundwater Quality	

The Vivo-Dendron SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 743.27 km^2, which is 29.09% of the Vivo-Dendron SWSA-gw total area. Urban/Built-up areas cover 29.80 km^2 (1.17%), while mines and quarries account for 0.94 km^2 (0.04%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

WMS data is only available for the moderately vulnerable aquifer areas in the Major aquifer system.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 45 – 283 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.11 - 0.98 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 1.76 - 64.34 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5–8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 6.66 - 8.90 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 9.52 - 956.22 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Vivo-Dendron**
Area:	**2555 km²**
Elevation:	**779 to 1621 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Vivo-Dendron SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	4	5.00	80	137.44	mS/m	2014-2024 GW Geosites: >150 - 370 mS/m.	45 - 283 mS/m (Avg.: 137.44 mS/m). 2014-2024 GW Geosites: 70 - 370 mS/m. Mostly consistent with WMS (2000-2024).	-
Fluoride	4	5.19	77	0.44	mg/L	2014-2024 GW Geosites: <0.5 mg/L.	0.11 - 0.98 mg/L (Avg.: 0.44 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Mostly consistent with WMS (2000-2024).	-
Nitrate + Nitrite Nitrogen	4	5.19	77	15.20	mg/L	2014-2024 GW Geosites: >11-20 mg/L.	1.76 - 64.34 mg/L (Avg.: 15.20 mg/L). 2014-2024 GW Geosites: <11-50 mg/L. Mostly consistent with WMS NO_3+NO_2 (2000-2024).	-
pH	4	5.00	80	8.24	pH unit	2014-2024 GW Geosites: 7-9.	6.66 - 8.90 (Avg.: 8.24). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	-
Sulphate	4	5.00	80	159.34	mg/L	2014-2024 GW Geosites: <200 mg/L.	9.52 - 956.22 mg/L (Avg.: 159.34 mg/L). 2014-2024 GW Geosites: <200-500 mg/L. Mostly consistent with WMS (2000-2024).	-

- *"Average" refers to the average concentrations for the Total Active Sites of the Vivo-Dendron SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

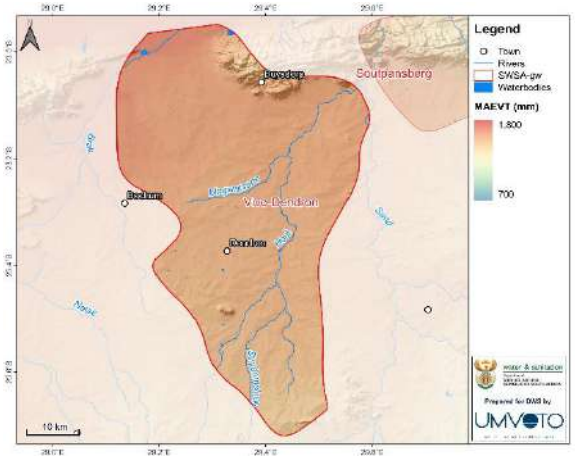
SWSA-gw Name:	Vivo-Dendron
Area:	2555 km²
Elevation:	779 to 1621 mamsl

Threats & Risks

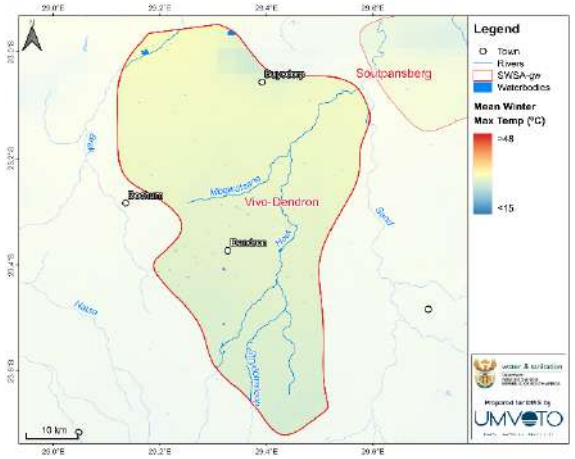
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Vivo-Dendron SWSA-gw has a predominantly a BSh, hot semi-arid, type climate characterized by hot summers, warm to cool winters, and little to no precipitation, the climate changes to a Cwa, humid subtropical, type climate characterized by hot and humid summers in the southeast. Temperatures in the SWSA-gw range from 2.1 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

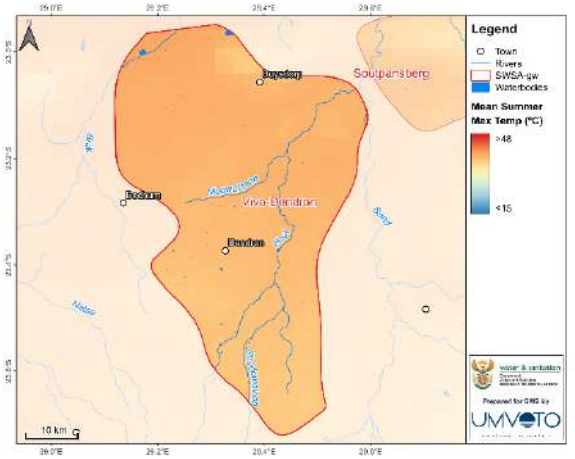
Temperature	Summer: 24.7 to 31 ºC, Winter: 2.1 to 8 °C
Evapotranspiration	Maximum value of 1651 mm/a with an average value of 1546 mm/a
Climate Change Predictions	Increased temperatures, reduced rainfall, but a small increase in recharge (ranging from ~ 21.7 to 33.5 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Vivo-Dendron SWSA-gw region.



Mean winter temperatures of the Vivo-Dendron SWSA-gw region.



Mean summer temperatures of the Vivo-Dendron SWSA-gw region.

SWSA-gw Name:	Vivo-Dendron
Area:	2555 km^2
Elevation:	779 to 1621 mamsl

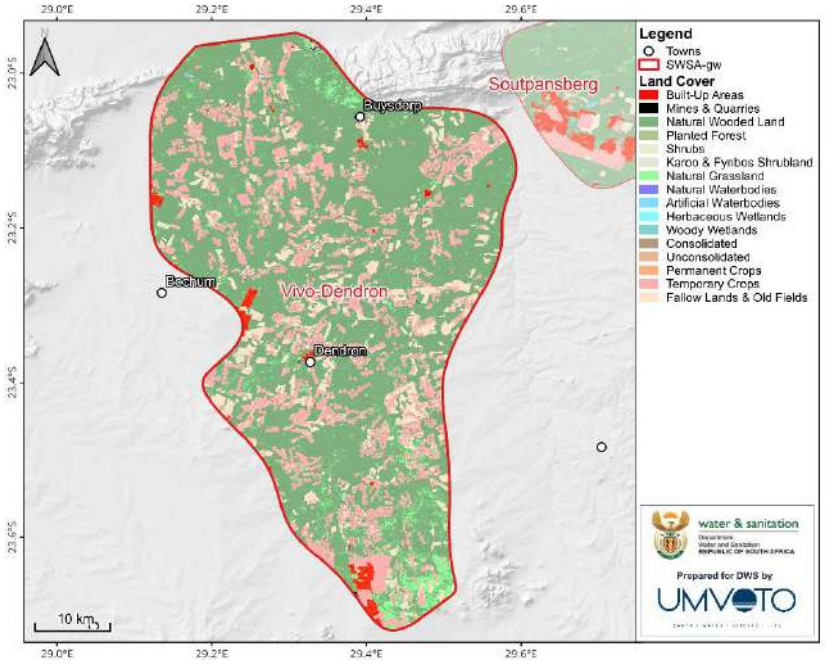
Threats & Risks

Land Use

The Vivo-Dendron SWSA-gw consists of cultivated land, which consists of temporary crops, permanent crops, fallow lands and old fields scattered throughout the SWSA-gw (DFFE, 2022). Making up the majority of the SWSA-gw, however, is forested land, which includes natural wooded land and planted forests, indicating minimal development in the SWSA-gw. Built-up areas, made up of residential, commercial and industrial areas, are small and scattered within the SWSA-gw.

Most of the agricultural land falls within the farms that are part of the Vivo-Dendron SGWCA, as seen in the Biodiversity and Conservation section below.

Land Use Type	Area (km^2)	Area (%)
Barren Land	2	0.1
Built-Up	30	1.2
Cultivated	743	29.1
Forest Land	1659	64.9
Grassland	115	4.5
Mines and quarries	1	0.0
Shrubland	0	0.0
Waterbodies	1	0.1
Wetlands	4	0.1



Land Cover 24-class map to show the types of land use and extent of each occurring in the Vivo-Dendron SWSA-gw.

SWSA-gw Name:	Vivo-Dendron
Area:	2555 km^2
Elevation:	779 to 1621

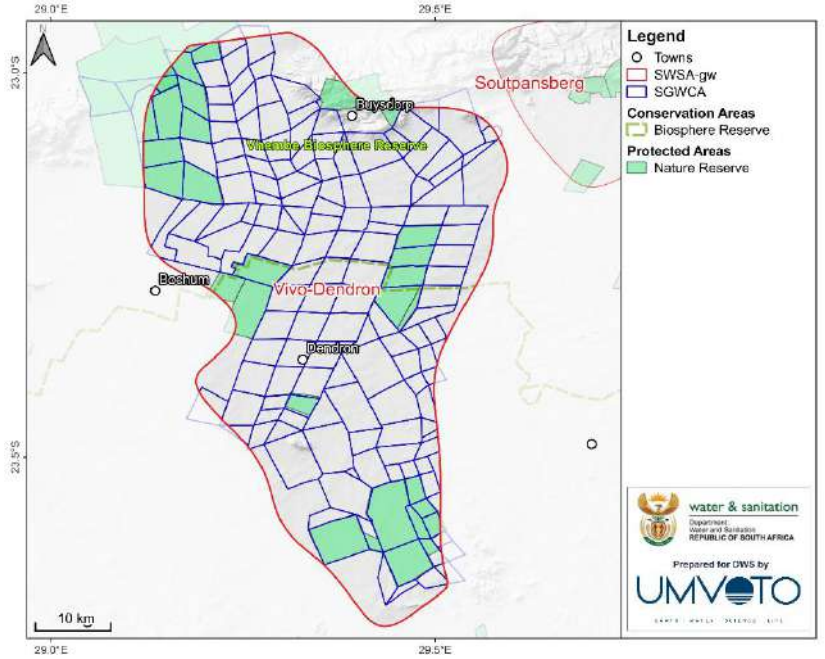
Protection Status and Ecosystems

Biodiversity and Conservation

The northern half of the Vivo-Dendron SWSA-gw falls within the Vhembe Biosphere Reserve (DFFE, 2024). This is a large biosphere reserve covering roughly a quarter of the Limpopo province, from within the Vivo-Dendron SWSA-gw up towards the border of Zimbabwe and to the border of Mozambique.

The Vivo-Dendron subterranean groundwater control area (SGWCA) (CSIR, 1998) covers approximately 86% of the SWSA-gw and shows the area where the government controlled groundwater on private land under the Water Act No.54 of 1956 (DWA, 2010).

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Vhembe Biosphere Reserve	1337.15	1
Protected Areas	• Blouberg Private Nature Reserve • Capricorn Private Nature Reserve • Nore Ellis Private Nature Reserve • Queenie Private Nature Reserve • Leyden Private Nature Reserve • And various other small nature reserves	476.14	9
SGWCA	• Vivo-Dendron	2204.72	1
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Vivo-Dendron SWSA-gw that have protection status.

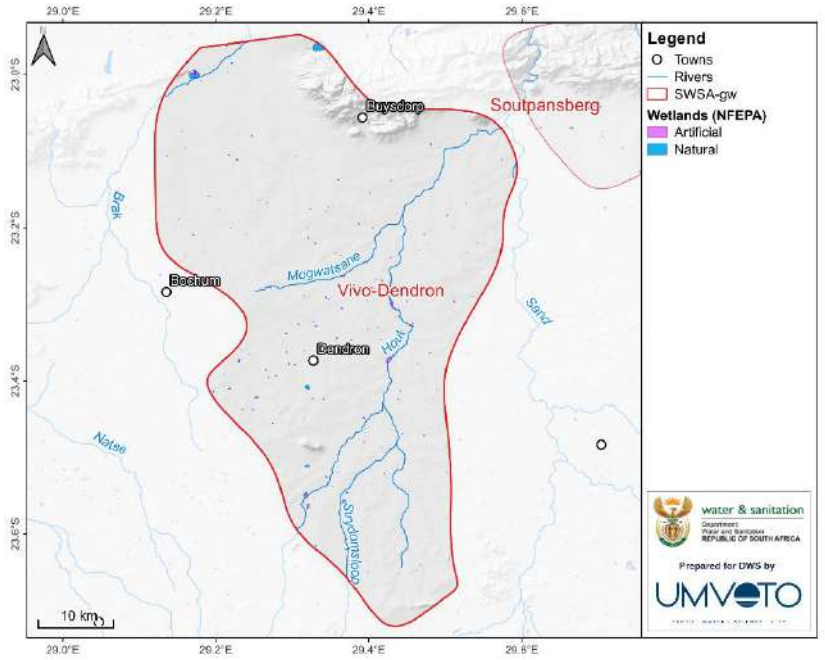
SWSA-gw Name:	Vivo-Dendron
Area:	2555 km^2
Elevation:	779 to 1621

Protection Status and Ecosystems

Biodiversity and Conservation

There are small natural and artificial wetlands (CSIR, 2011) in the Vivo-Dendron SWSA-gw. However, there are no major water bodies, Ramsar sites or groundwater-dependent ecosystems.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	6	0

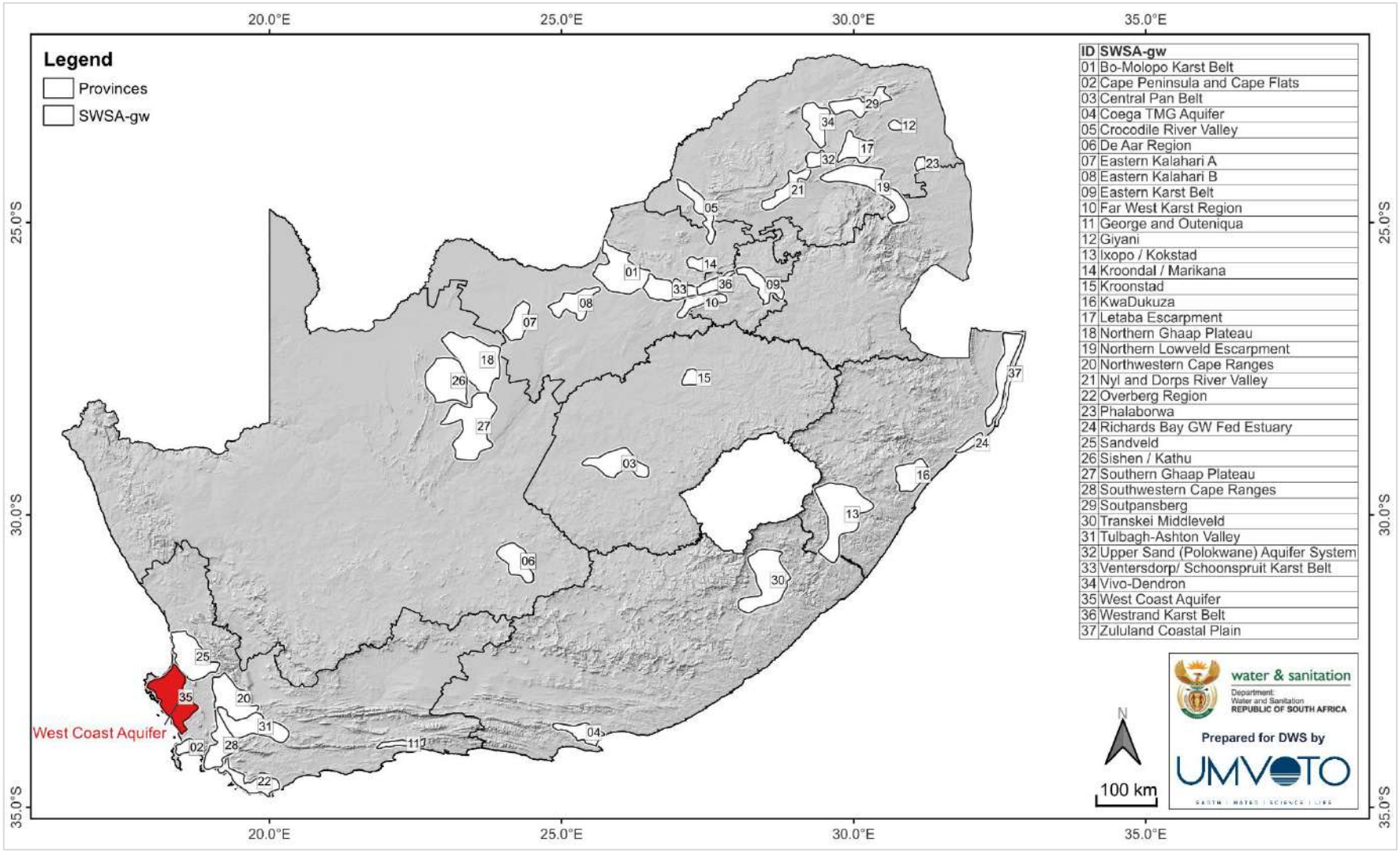


Map showing the major water bodies, Ramsar sites and GDEs in the Vivo-Dendron SWSA-gw.

APPENDIX 35

WEST COAST AQUIFER SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE WEST COAST AQUIFER SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

35. West Coast Aquifer

35.1. Description

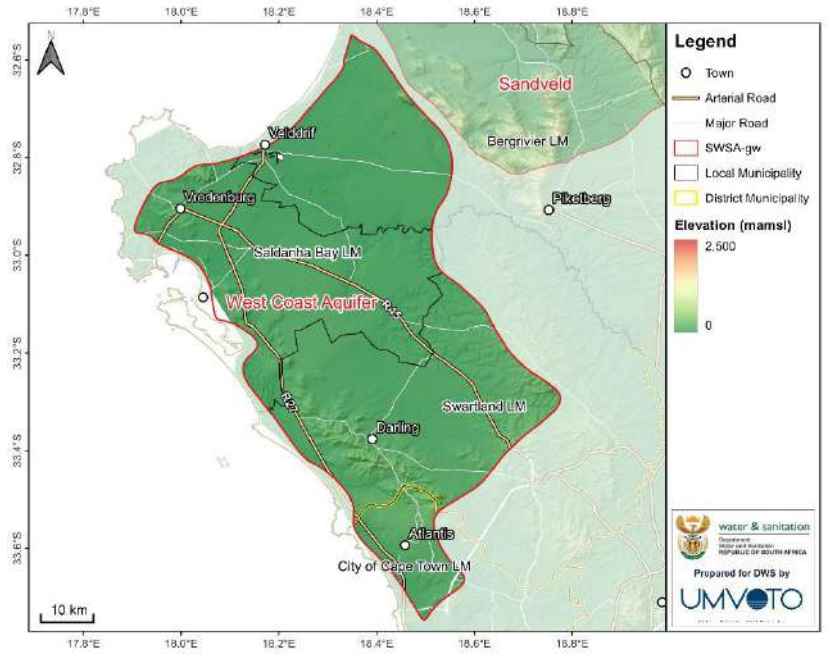
SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl

Geospatial Context

The topography of the West Coast Aquifer SWSA-gw, as depicted in the map, exhibits a predominantly low-relief coastal plain, with elevations mostly near sea level, particularly along the western and northern portions adjacent to the Atlantic Ocean. The terrain gradually increases in elevation towards the east, transitioning into the Swartland, Bergriver and Cape Winelands regions, which feature more rugged topography with elevated hills and mountains.

This topographical variation has influenced the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Western Cape Province
Metropolitan Municipality	City of Cape Town
District Municipality	West Coast
Local Municipalities	Bergriver, Swartland and Saldhanha Bay
Towns	Melkbosstrand, Moorreesburg, Paternoster, Philadelphia, Port Owen, Rust, Saldanha, Sauer, St. Helena Bay, Stompneus Bay, Velddrif, Vredenburg and Yzerfontein
Major Roads	N7, R399, R27 and R45
Major Water Supply Networks	Western Cape Water Supply System (WCWSS) with City of Cape Town Bulk Scheme, Misverstand Bulk Scheme and Voelvlei Bulk Scheme



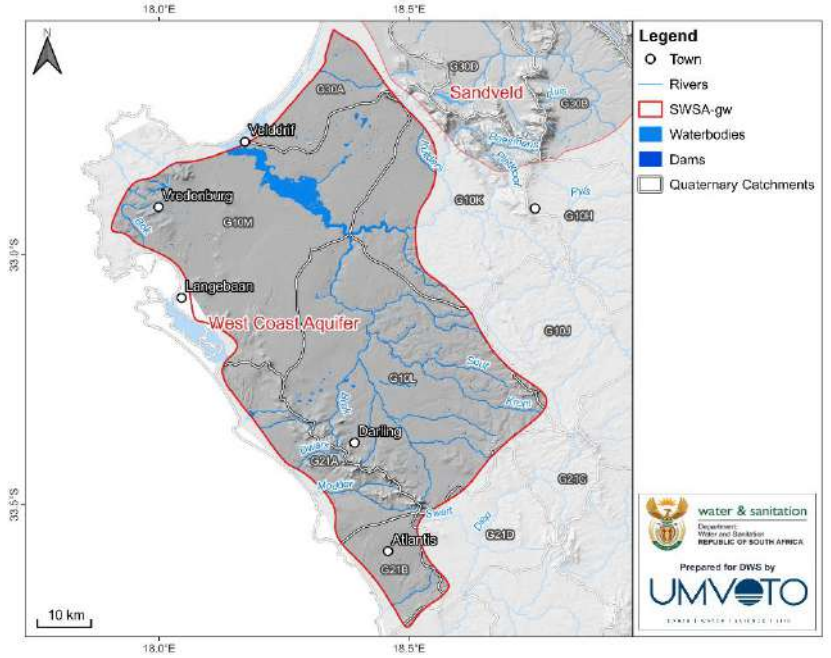
Locality map of Major Towns, District and Local Municipalities in the West Coast Aquifer SWSA-gw.

SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl

Hydrology and Drainage

The West Coast Aquifer SWSA-gw includes major surface water systems as well as several unnamed seeps and floodplains, which are summarised below and shown on the map to the right. The primary surface water features are the Langebaan Lagoon and the Berg River Estuary, both of which are known to be groundwater-fed. Perennial rivers in the area include the Berg and Papkuil Rivers, which flow northwest, and the Modder River, which flows west. The Langebaan Lagoon and Modder River are fed by the G2 catchment, while the Berg River Estuary, the Berg River and Papkuil River are fed by the G1 catchment.

Quaternary Catchments	G30A, G10M, G10K, G10L, G21A, G21B as well as small sections of G21D and G10J
Rivers	Perennial: Berg, Modder and Papkuil
	Ephemeral: Soutkloof, Sout, Silwerstroom, Louwskloof, Kuilders, Krom, Groen, Dwars, Brak and Bok
Natural and manmade water bodies	Langebaan Lagoon and Groot Berg River Estuary as well as a number of seeps and floodplains
Major Dams	No major dams
Water Management Area	Breede Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the West Coast Aquifer SWSA-gw.

SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl

Geology

Geology

Portions of the eastern section of the West Coast Aquifer SWSA-gw area are overlain by various Quaternary sedimentary deposits, including alluvium, calcareous soils, ferricrete, clay, and sandy to loamy soils. However, the area is predominantly covered by the Witzand Formation of the Sandveld Group, which consists mainly of unconsolidated calcareous dune sand. Other formations in this group include shelly sands, aeolian calcarenite, quartzose sand, phosphorite, carbonaceous clay, peat, and shelly limestone and sandstone.

Small outcrops of the Table Mountain Group (~490–460 Ma) occur along the outskirts of the area, including the Graafwater, Peninsula, and Piekenierskloof Formations, which are comprised mostly of sedimentary rocks such as sandstone, conglomerate, and siltstone.

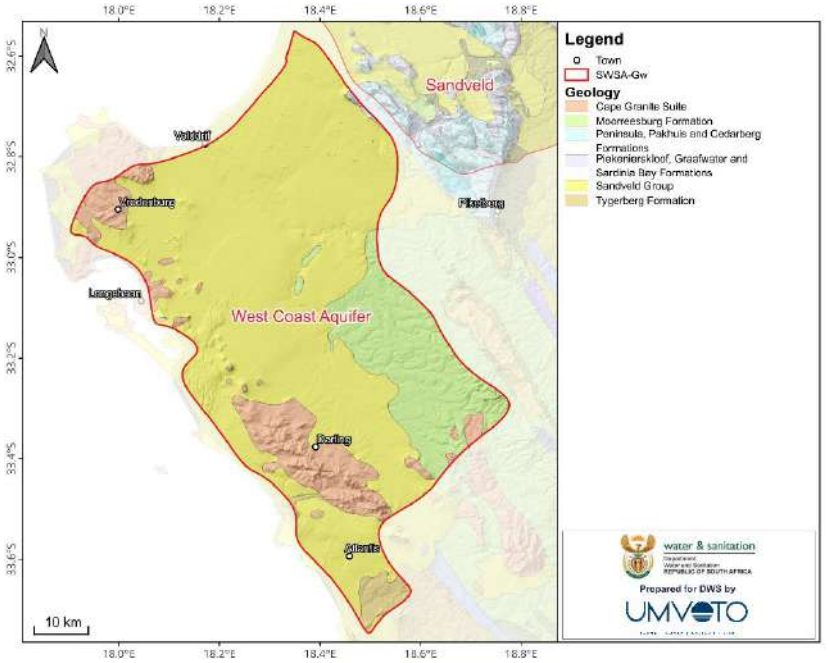
The Cape Granite Suite (~550–540 Ma) is represented by batholiths and plutons that outcrop along the coast and in the southeastern portion of the SWSA-gw. These granitic rocks are characterised by porphyritic textures and biotite-rich compositions.

In the eastern part of the SWSA-gw, the Tygerberg Formation of the Malmesbury Group (~800–550 Ma) consists of sedimentary rocks such as greywacke, shale, phyllite, schist, limestone, and quartzite, with minor volcanic components. Both Cape Granite Suite and Tygerberg Formation form the basement rocks underneath the Sandveld Group deposits.

Structurally, the Colenso Fault runs diagonally from northwest to southeast across the area, with several minor faults (observed and inferred) in the northeasternmost section. Additionally, dikes from the False Bay Suite are present in the southern part of the area.

Hydrostratigraphy

The Quaternary sediments constitute a primary intergranular aquifer system, while the granites and Tygerberg Formation, forming the basement and some outcrop areas, constitute an intergranular-fractured aquifer system, where they are significantly weathered.



Geology Map of the West Coast Aquifer SWSA-gw region.

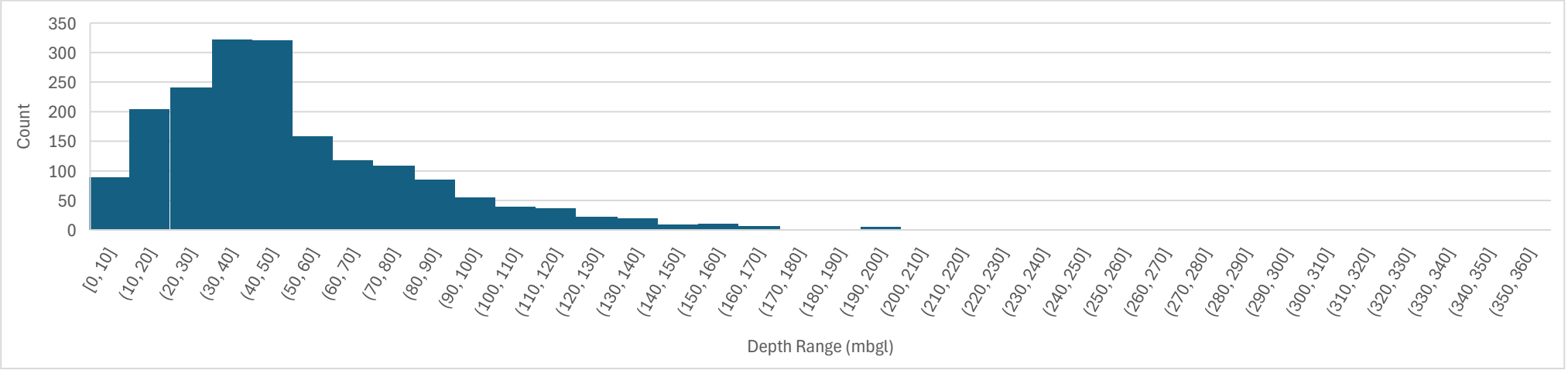
35.2. Current Status

SWSA-gw Name:	**West Coast Aquifer**
Area:	**4,586 km²**
Elevation:	**12 to 428 mamsl**
Quantity & Quality	
Aquifer Classification	

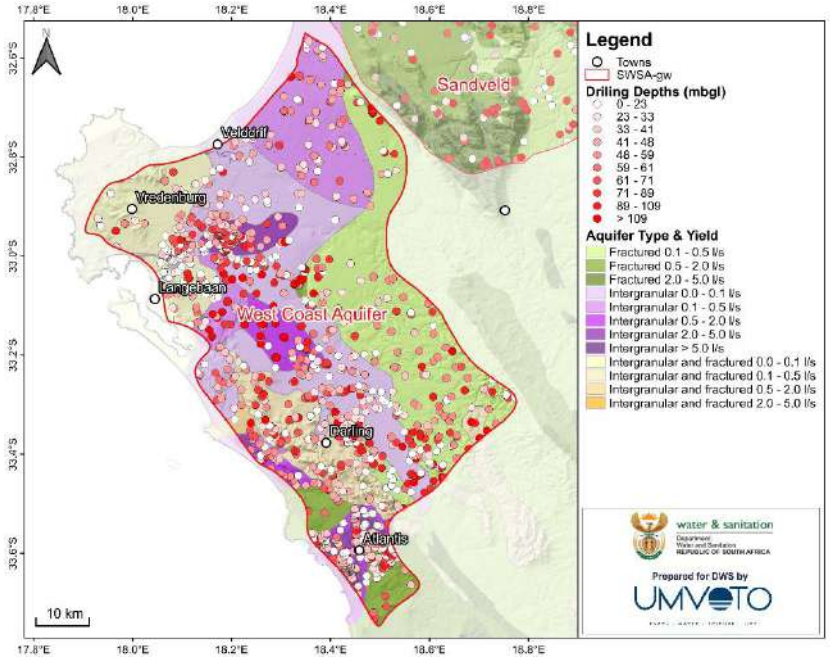
The aquifer systems within the West Coast Aquifer SWSA-gw exhibit varying yields across both fractured and intergranular aquifers (see summary in the table and maps below).

Aquifer Classification	The SWSA-gw includes aquifer systems that are classified as Poor, Minor, and Major. • Major aquifers are predominantly intergranular in nature, with average groundwater yields ranging from 0.0 to over 5.0 l/s, while • Minor aquifers consist of dual-porosity aquifer types, with average yields ranging between 0.1 and 2.0 l/s.
Groundwater Targets	The average and most common drilling depths are around 50 mbgl, suggesting that boreholes predominantly target the upper intergranular aquifer. In the central-western section, boreholes reaching depths >150 mbgl likely tap into the underlying fractured basement aquifer, providing a secondary groundwater target. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 28 and 63 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 11 mbgl, with values ranging from 0 to 78 mbgl and a standard deviation of ~ 9 mbgl.

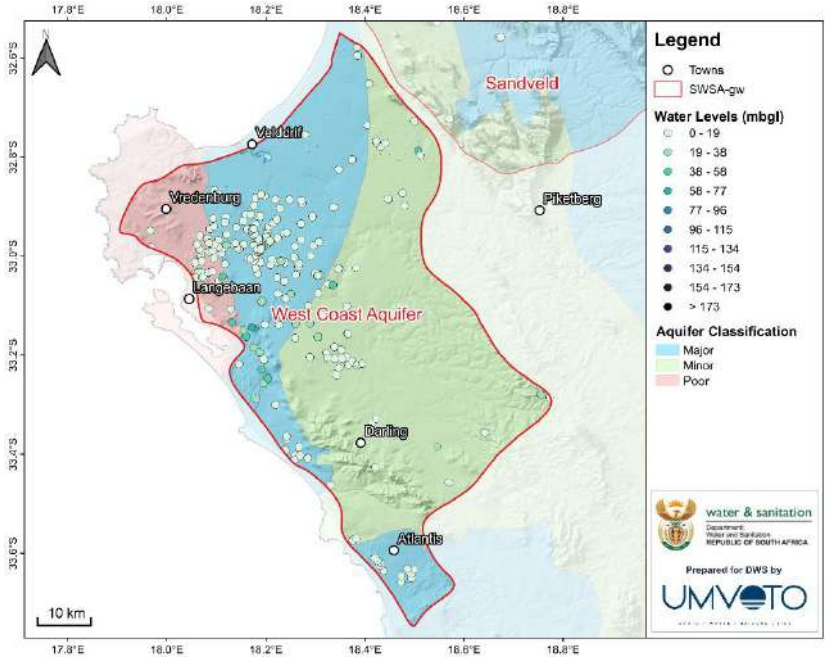
Graph of NGA drilling depths (after DWS, n.d.) of the West Coast Aquifer SWSA-gw region



SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the West Coast Aquifer SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the West Coast Aquifer SWSA-gw region.

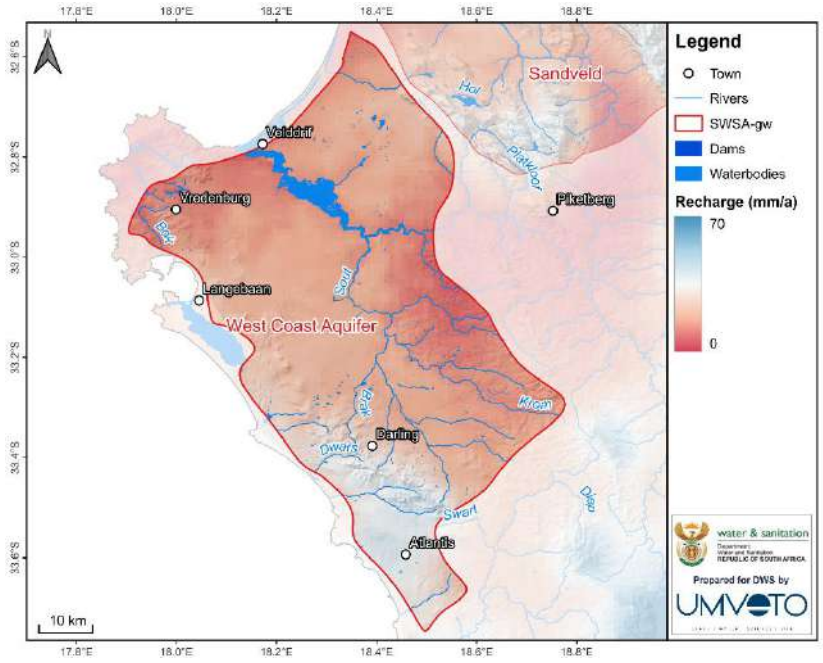
SWSA-gw Name:	**West Coast Aquifer**
Area:	**4,586 km²**
Elevation:	**12 to 428 mamsl**

Quantity & Quality

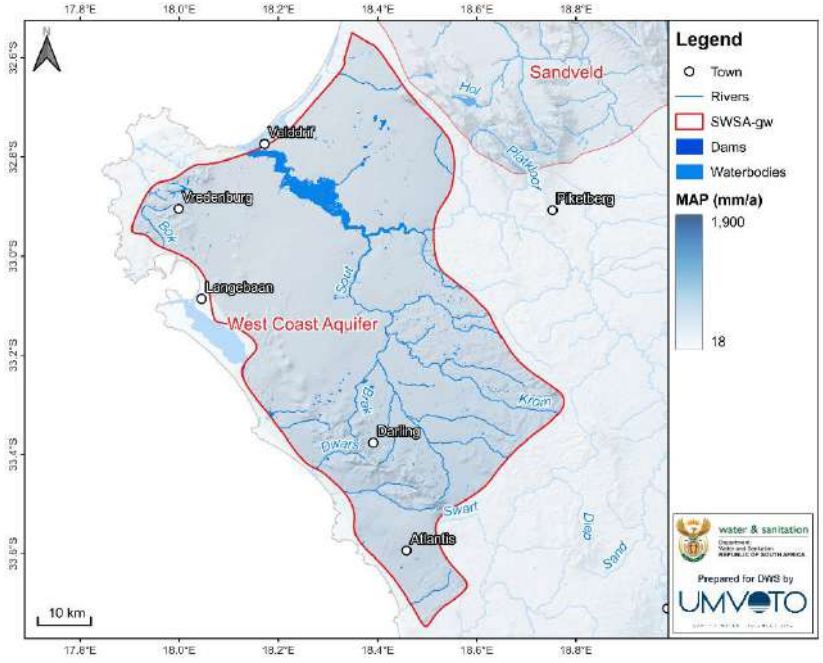
Groundwater Recharge

The West Coast Aquifer receives a total Mean Annual Precipitation (MAP) volume of 1,569 Mm^3/a, with an average rainfall of 343 mm/a. However, only 89.8 Mm^3/a of this water infiltrates to recharge groundwater systems, resulting in a recharge of 5.7% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume (Mm^3/a)	Average of MAP (mm/a)	Sum of Recharge Vol (Mm^3/a)	Average of recharge (mm/a)	% MAP Considered Recharge (Mm^3/a)
West Coast Aquifer	1569	343	89.8	19.6	5.7%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl

Quantity & Quality

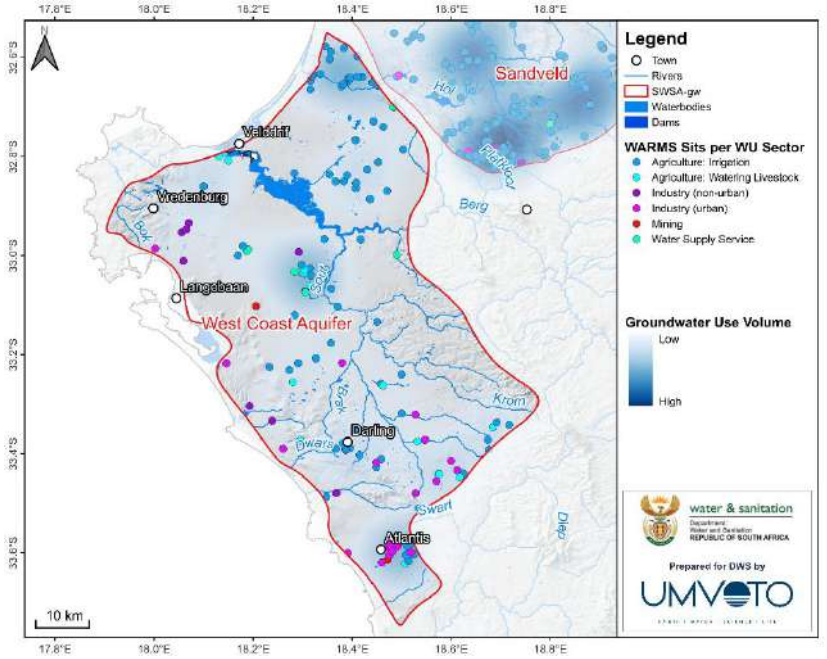
Groundwater Use

The West Coast Aquifer SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. The primary groundwater-dependent towns within this region are Saldanha (conjunctive use) and Atlantis (conjunctive use), which rely significantly on groundwater resources for municipal supply, industrial use, and agricultural activities (see Table below). Analysis of active groundwater use licences from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation is the largest groundwater user, extracting 10.5 Mm^3/a to sustain crop production, particularly in areas such as Hopefield, Oudekraalfontein, and Darling. These regions rely heavily on groundwater due to the low rainfall and semi-arid climate of the West Coast. The extensive use of groundwater underscores the need for sustainable abstraction practices to prevent long-term depletion.
- Urban industrial groundwater use follows closely, with 6.5 Mm^3/a allocated to manufacturing, processing, and industrial activities concentrated around Atlantis, Vredenburg, and Pella. These towns, situated in areas where surface water is scarce, have become industrial hubs dependent on groundwater resources. The pressure from this sector necessitates efficient water-use strategies to balance economic growth with aquifer sustainability.
- Municipal water supply services account for 1.6 Mm^3/a, serving groundwater-dependent towns with limited surface water access, such as Atlantis, Darling, and Velddrif. These towns rely on groundwater as their primary drinking water source, highlighting the aquifer's role in ensuring water security for local communities. The presence of water use hotspots around Atlantis suggests concentrated abstraction, which requires monitoring to maintain sustainable yields

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Atlantis, Pella, Hopefield, and Velddrif, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	10.5
	Agriculture: Watering Livestock	0.5
	Industry (Non-urban)	0.1
	Industry (Urban)	6.5
	Mining	0.9
	Water Supply Service	1.6
	Total	**20**



Water use map for the West Coast Aquifer SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl

Quantity & Quality

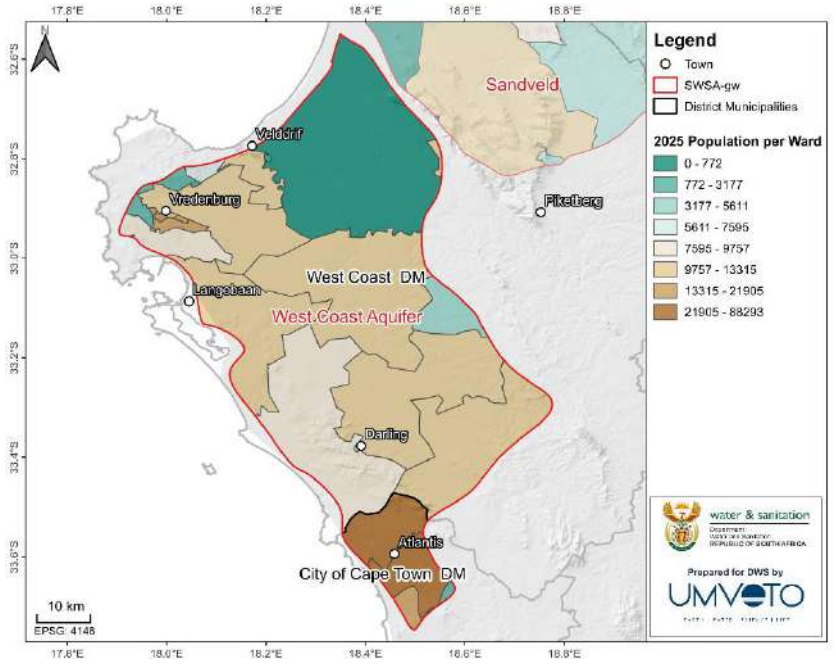
Socio Economic & Governance

The West Coast Aquifer SWSA-gw is located within the Breede-Olifants Water Management Area (WMA, 2023). The groundwater resources within the West Coast Aquifer SWSA-gw fall under the overarching jurisdiction of the DWS at a national level. Regional management is overseen by the Breede-Olifants Catchment Management Agency (BOCMA), which was formed as part of a national restructuring process that consolidated CMAs. BOCMA is therefore responsible for water allocation, licensing, groundwater monitoring, and resource management in this SWSA-gw in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (NWA, Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the BOCMA to manage water resources in the Breede-Olifants WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	BOCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Breede-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	Local municipalities are the Water Service Authorities (WSA), while the West Coast DM and the City of Cape Town DM are the Bulk Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the West Coast Aquifer SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 1.8% per year, resulting in a projected population of approximately 234,532.

As shown in the map and table below, Saldanha Bay Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 100,374, followed by the City of Cape Town (88,695). Population concentrations within the SWSA-gw are highest around the City of Cape Town and Vredenburg LMs.



Projected population distribution 2025 for the West Coast Aquifer SWSA-gw.

SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl

Quantity & Quality

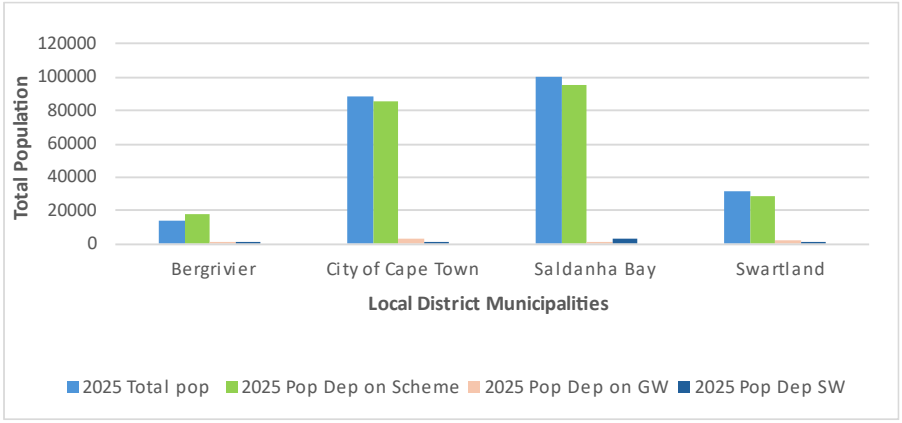
Socio Economic & Governance

In terms of water reliance within the West Coast Aquifer SWSA-gw, an estimated 97.2% of the population depends on a regional water scheme, 3% on groundwater sources (including boreholes and springs), and 2.6% on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources).

Among the LMs, Swartland LM has the highest groundwater dependence at 3.9%, with minimal surface water reliance.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Bergrivier	13,818	17,724	440	148
City of Cape Town	88,695	85,401	3,463	1,562
Saldanha Bay	100,374	95,811	1,213	3,673
Swartland	31,644	28,945	1,816	614
Total	**234,532**	**227,882**	**6,932**	**5,997**



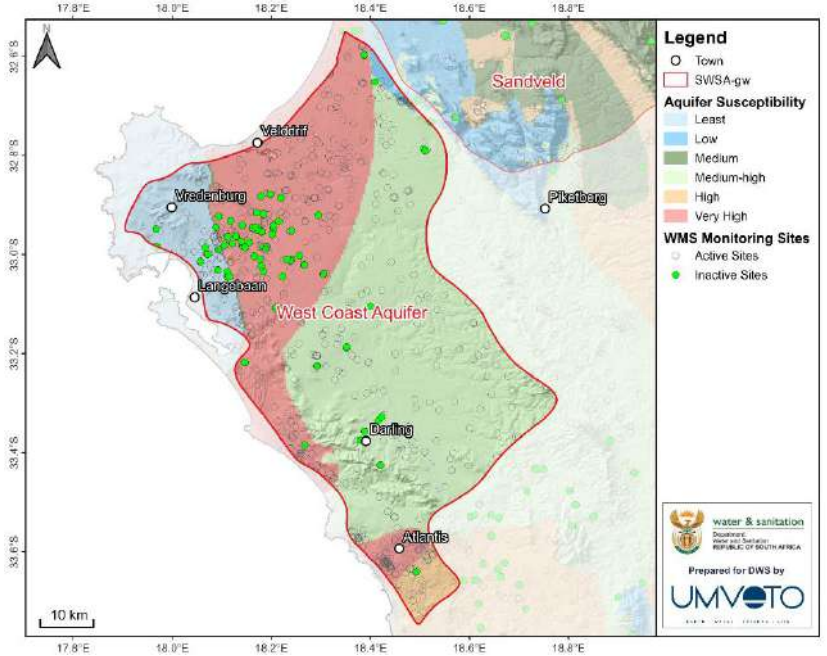
Projected population dependence on water sources in 2025.

SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl
Quantity & Quality	
Groundwater Quality	

The West Coast Aquifer SWSA-gw consists of Poor, Minor, and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 2458.73 km^2, which is 53.61% of the West Coast Aquifer SWSA-gw total area. Urban/Built-up areas cover 65.20 km^2 (1.42%), while mines and quarries account for 17.05 km^2 (0.37%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. In the West Coast Aquifer SWSA-gw, EC ranges from 9.6 – 1950 mS/m in the Major aquifer system. Coastal aquifers typically show an EC gradient, with higher values near the coastline due to seawater intrusion or marine aerosol deposition.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. In the West Coast Aquifer SWSA-gw, fluoride levels range from 0.025 - 3.43 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. In the West Coast Aquifer SWSA-gw, concentrations range from 0 - 22.11 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5–8.5 range can lead to corrosion, contamination, and health risks. In the West Coast Aquifer SWSA-gw, pH ranges from 5.7 - 11.00 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. In the West Coast Aquifer SWSA-gw, sulphate levels range from 0 - 1303.15 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**West Coast Aquifer**
Area:	**4,586 km²**
Elevation:	**12 to 428 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the West Coast Aquifer SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ Results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	81	61.36	123	278.38	mS/m	97.9 - 1620 mS/m (Avg.: 671.12 mS/m). 2014-2024 GW Geosites: 70 - 130 mS/m, some >500 mS/m. Consistent with WMS (2000-2024).	61.5 - 3360 mS/m (Avg.: 349.98 mS/m). 2014-2024 GW Geosites: 70 - 370 mS/m. Consistent with WMS (2000-2024). The upper limit of 1950 mS/m may be an outlier.	9.6 - 1950 mS/m (Avg.: 222.81 mS/m). 2014-2024 GW Geosites: 70 - 370 mS/m. Consistent with WMS (2000-2024), but 1950 mS/m deviates from the mean. High values mostly from 2002-2012.
Fluoride	80	60.61	121	0.67	mg/L	0.194 - 2.11 mg/L (Avg.: 0.85 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	0.136 - 3.38 mg/L (Avg.: 0.74 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).	0.025 - 3.43 mg/L (Avg.: 0.64 mg/L). 2014-2024 GW Geosites: <0.5 - 1.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	81	61.36	122	1.53	mg/L	0.005 - 17.04 mg/L (Avg.: 1.77 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	0.02 - 48.6 mg/L (Avg.: 13.02 mg/L). 2014-2024 GW Geosites: 0 - 11 mg/L, some 20 - 50 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	0 - 22.11 mg/L (Avg.: 0.89 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	82	62.12	122	8.04	pH unit	4.35 - 8.64 (Avg.: 7.96). 2014-2024 GW Geosites: 7 - 9. Consistent with WMS (2000-2024).	6.15 - 8.5 (Avg.: 7.96). 2014-2024 GW Geosites: 7 - 9. Consistent with WMS (2000-2024).	5.7 - 11.00 (Avg.: 8.06). 2014-2024 GW Geosites: 7 - 9. Mostly consistent with WMS (2000-2024), except some WMS values >9.
Sulphate	81	61.36	122	102.89	mg/L	0.6 - 897.22 mg/L (Avg.: 232.21 mg/L). 2014-2024 GW Geosites: 0 - 200 mg/L, some >800 mg/L. Consistent with WMS.	1.5 - 1363.44 mg/L (Avg.: 157.13 mg/L). 2014-2024 GW Geosites: 0 - 200 mg/L. Mostly consistent with WMS (2000-2024), but upper limit 1363.44 mg/L may be an outlier.	0 - 1303.15 mg/L (Avg.: 82.93 mg/L). 2014-2024 GW Geosites: 0 - 200 mg/L. Mostly consistent with WMS (2000-2024), except some WMS values >200 mg/L.

- *"Average" refers to the average concentrations for the Total Active Sites of the West Coast Aquifer SWSA-gw, taken from the WMS database from 2000-2024.*

SWSA-gw Name:	**West Coast Aquifer**
Area:	**4,586 km²**
Elevation:	**12 to 428 mamsl**

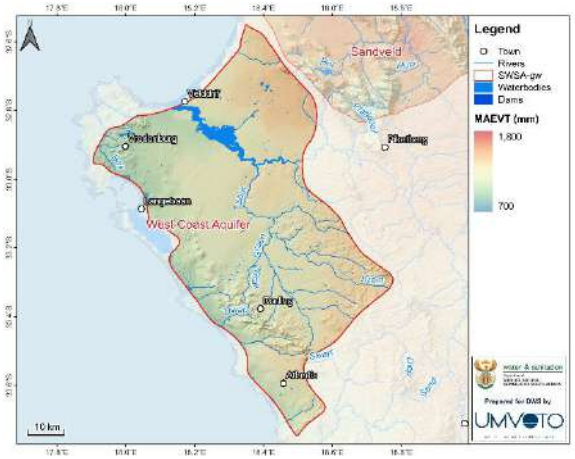
Threats & Risks

Climate

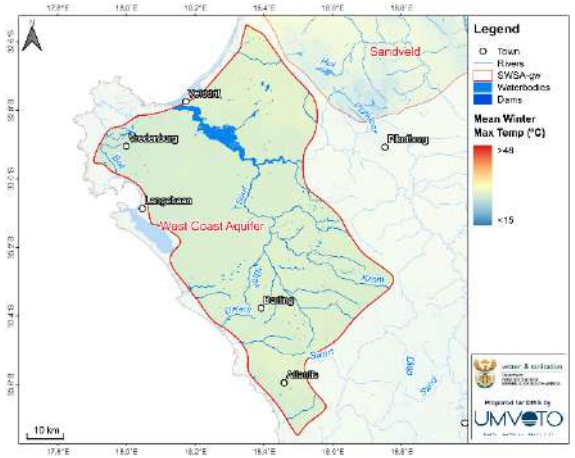
According to the Köppen-Geiger Climate Classification (Beck et al., 2018), the West Coast Aquifer SWSA-gw predominantly has Csa and Csb, Mediterranean-type, type climate characterised by hot, dry summers and mild, wet winters. The northern portion of the SWSA-gw, near the Langebaan Lagoon and Berg River Estuary, falls under the BSh and BSk climate type, which represent dry, semi-arid grasslands with hot, dry conditions and occasional rainfall. Temperatures in the SWSA-gw range from 15 - 30 ºC (i.e., winter min and summer max).

Climate change is expected to result in higher temperatures, less rainfall and extended dry periods. This will probably lead to a reduction in groundwater recharge and increased water demand.

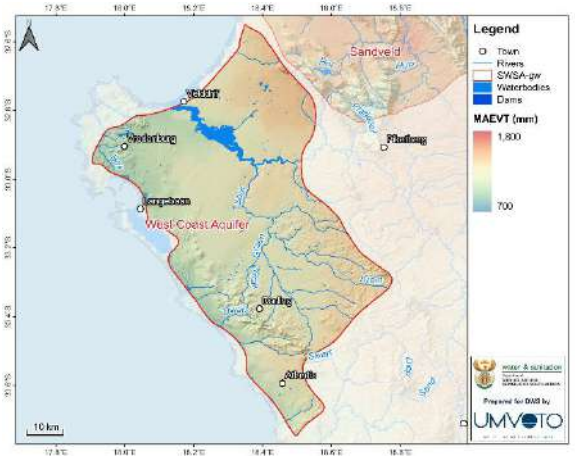
Temperature	Summer: 25 - 30 ºC, Winters: 15 - 20 ºC
Evapotranspiration	Maximum 1508 mm/a with an average of 1240 mm/a
Climate Change Prediction	Increased temperatures, reduced rainfall, and a decline in recharge (ranging from ~-6 to 0.8 mm/a). The DART Index indicates an overall worsening of drought conditions.



Mean annual A-Pan evaporation of the West Coast Aquifer SWSA-gw region.



Mean winter temperatures of the West Coast Aquifer SWSA-gw region.



Mean annual A-Pan evaporation of the West Coast Aquifer SWSA-gw region.

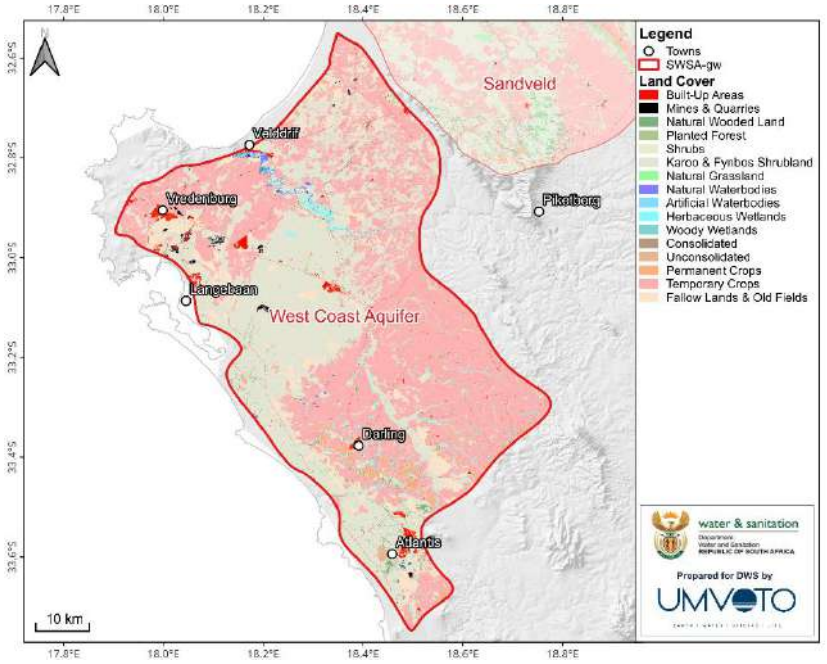
SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl

Threats & Risks

Land Use

The majority of the West Coast Aquifer SWSA-gw, roughly 53.6%, is covered by cultivated land, which is made up of permanent and temporary crops as well as fallow lands and old fields. Shrubland, which includes vegetation of the Karoo & Fynbos shrubland, follows closely at 40.7%. There is minimal development present due to most of the SWSA-gw being a conservation area within the Cape West Coast Biosphere Reserve, as can be seen in the conservation table and map below (in the Protection Status and Ecosystems section). However, there are built-up areas made up of residential, commercial and industrial zones concentrated in the main towns of Atlantis, Darling, Vredenburg and Velddrif, as displayed in the map. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.4% of the area, located predominantly in the northwest of the area.

Land Use Type	Area (km²)	Area (%)
Barren Land	30	0.6
Built-Up	65	1.4
Cultivated	2459	53.6
Forest Land	45	1.0
Grassland	34	0.7
Mines and quarries	17	0.4
Shrubland	1868	40.7
Waterbodies	17	0.4
Wetlands	52	1.1



Land Cover 24-class map to show the types of land use and extent of each occurring in the West Coast Aquifer SWSA-gw.

SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl

Protection Status and Ecosystems

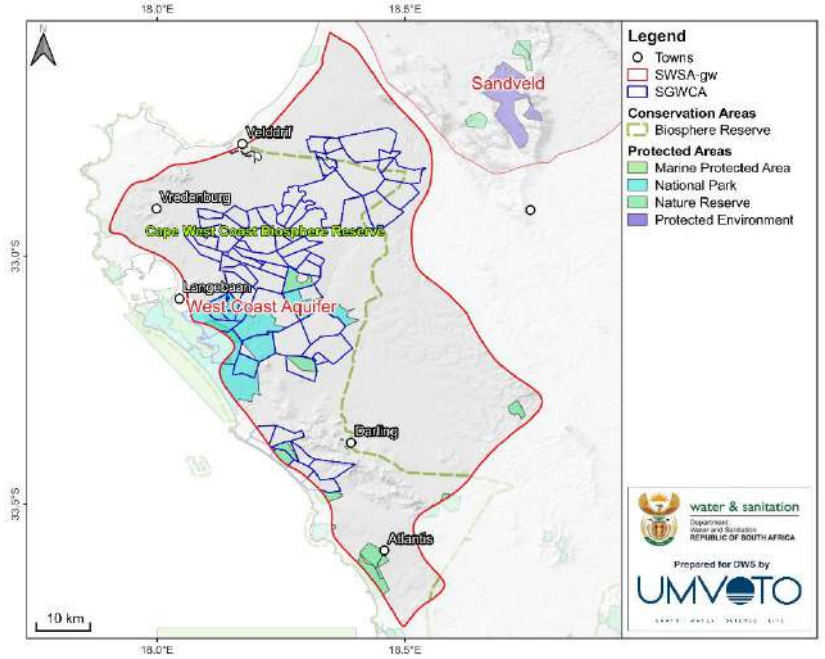
Biodiversity and Conservation

A significant portion of the West Coast Aquifer SWSA-gw falls within the Cape West Coast Biosphere Reserve, which comprises both formally and informally protected areas (DFFE, 2018). This conservation area includes various protected zones, such as national parks, nature reserves, and marine protected areas (DFFE, 2018).

The West Coast National Park is the largest protected area within the West Coast Aquifer SWSA-gw (DFFE, 2024). It is located along the western edge near Langebaan and extends towards the coast, encompassing the Langebaan Lagoon, a Ramsar-designated conservation site. It is important to note that although the Langebaan Lagoon is known to be groundwater-fed, the current delineation excludes it from the West Coast Aquifer SWSA-gw.

Three subterranean government water control (SGWCA) areas fall within the West Coast Aquifer SWSA-gw (CSIR, 1998), covering about 28% of the SWSA-gw and showing areas where the government had control over groundwater on private land under Water Act No. 54 of 1956 (DWA, 2010).

Protection Status	Names	Area (km²)	Count
Conservation Areas	• Cape West Coast Biosphere Reserve	2769.55	1
Protected Areas	• Witzands Aquifer Nature Reserve • Hopefield Private Nature Reserve • Sonquas Fontein Wildlife Private Nature Reserve • Radyn Dam Private Nature Reserve • Koeberg Private Nature Reserve • And various other small nature reserves	102.23	13
SGWCA	• Lower Berg River Valley • Saldanha • Yzerfontein	1305.85	3
National Parks	• West Coast National Park	229.58	1



Biospheres, Protected Areas and SGWCAs to show the portions of the West Coast Aquifer SWSA-gw that have protection status.

SWSA-gw Name:	West Coast Aquifer
Area:	4,586 km²
Elevation:	12 to 428 mamsl

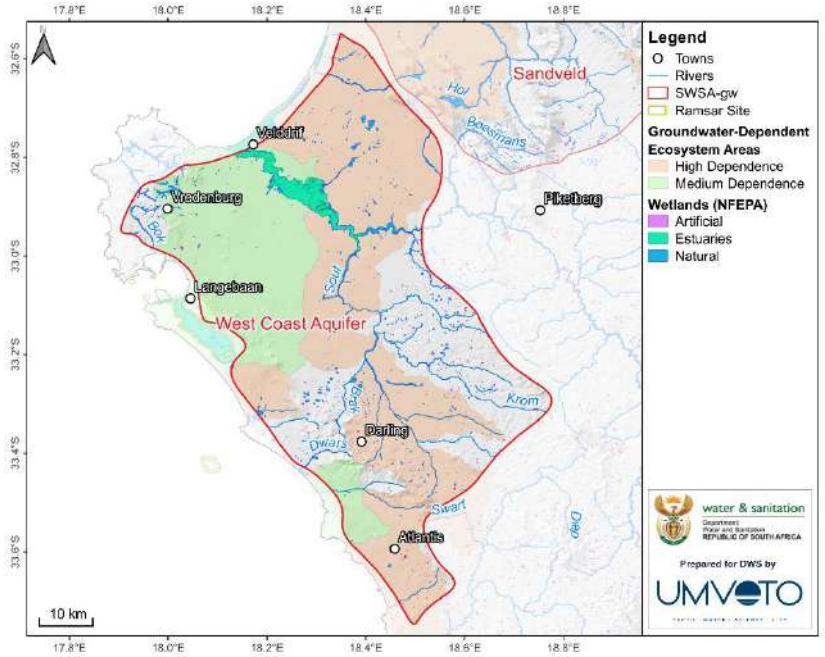
Protection Status and Ecosystems

Biodiversity and Conservation

A significant portion of the West Coast Aquifer SWSA-gw is covered by wetlands (CSIR, 2018), some of which are considered groundwater-dependent ecosystems (GDE), falling within a zone of high dependence along the centre of the SWSA-gw and medium dependence towards the coast between the towns of Langebaan and Velddrif, as can be seen on the map.

The Groot Berg Estuary is a large wetland in the SWSA-gw that runs along the Berg River towards the river mouth, which also falls within the Cape West Coast Biosphere Reserve.

Protection Status	Names	Area (km²)	Count
Major Water Bodies	• Groot Berg Estuary	78.77	1
Ramsar Sites	• Langebaan Lagoon		1
Wetlands	Various natural, artificial and estuary wetlands	139	

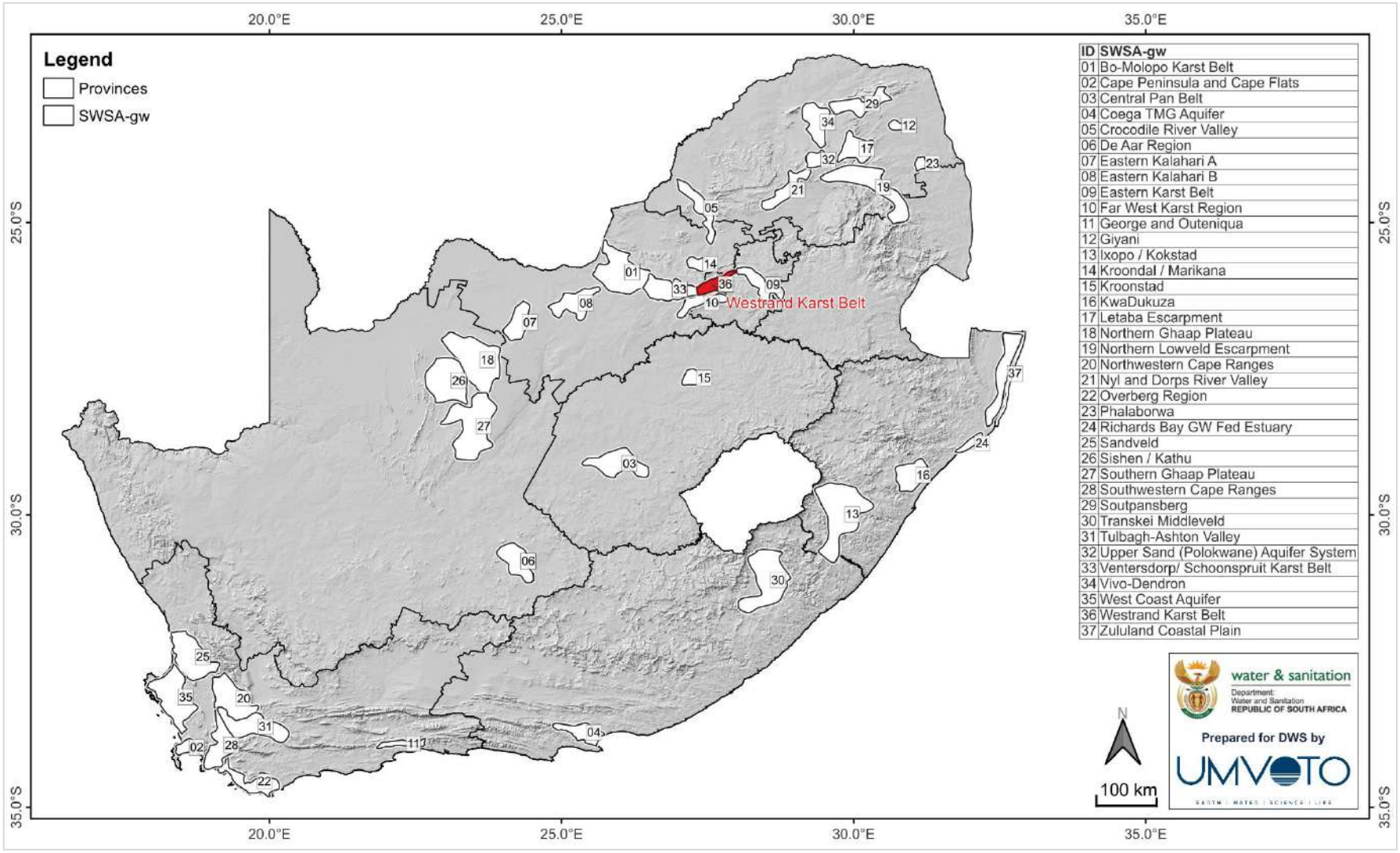


Map showing the major water bodies, Ramsar sites and GDEs in the West Coast Aquifer SWSA-gw.

APPENDIX 36

WESTRAND KARST BELT SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE WESTRAND KARST BELT SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

36. Westrand Karst Belt

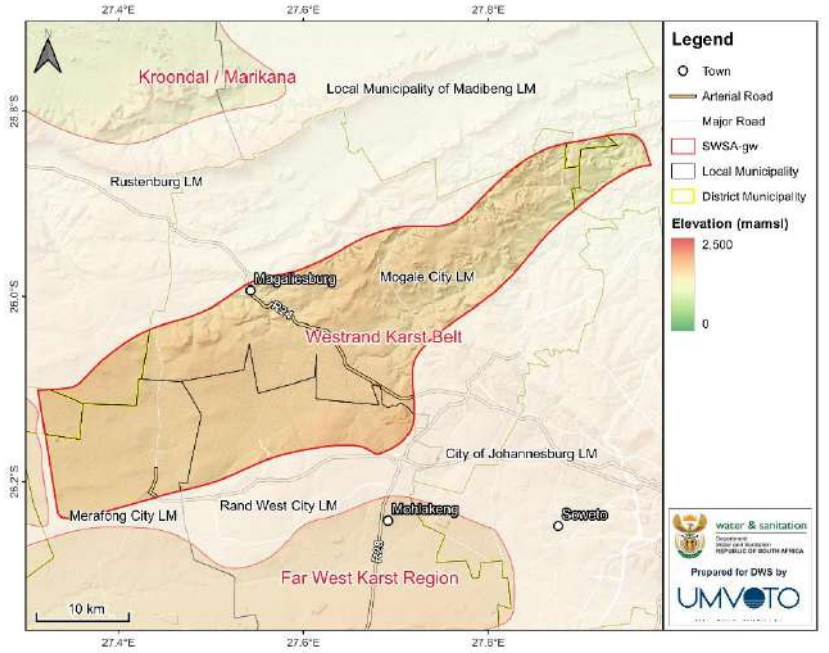
36.1. Description

SWSA-gw Name:	**Westrand Karst Belt**
Area:	**1090 km²**
Elevation:	**1190 to 1757 mamsl**
Geospatial Context	

The topography of the Westrand Karst Belt SWSA-gw, as depicted in the map, is characterized by elevated hills and mountainous terrain, particularly near Magaliesburg, where the Magaliesberg mountain range forms a prominent feature of the landscape. The terrain is marked by steep slopes, deep valleys, and rocky outcrops. As you move towards areas like Randfontein and Carletonville, the landscape becomes more undulating, with a mix of gently sloping hills and broad valleys.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	Gauteng and North West
Metropolitan Municipality	City of Tshwane
District Municipality	Bojanala, Dr Kenneth Kaunda, West Rand
Local Municipality	Rustenburg, Ventersdorp/Tlokwe, Merafong City, Rand West City, Mogale City, and Madibeng
Towns	Mogale City, Magaliesburg and Randfontein
Major Roads	N14, R41, R24 and R374
Major Water Supply Networks	



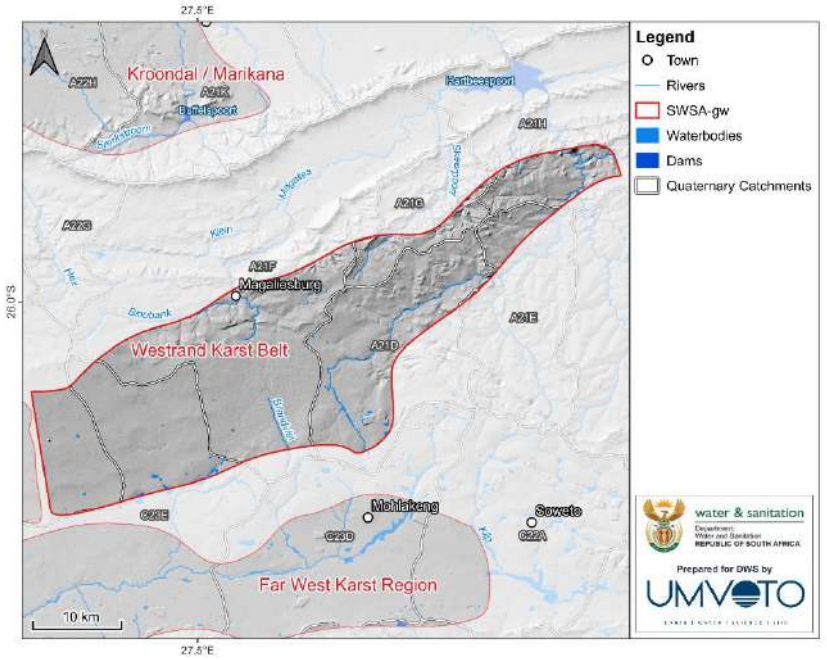
Locality map of Major Towns, District and Local Municipalities in the Westrand Karst Belt SWSA-gw.

SWSA-gw Name:	Westrand Karst Belt
Area:	1090 km²
Elevation:	1190 to 1757 mamsl

Hydrology and Drainage

The Westrand Karst Belt SWSA-gw and surrounding areas include no major surface water systems other than a few ephemeral rivers summarised below and displayed in the map on the right. The rivers flow predominantly in a northeasterly direction and are fed by the D4 catchment.

Quaternary Catchments	A21E, A21F, A21G, A21H, C23E and C23F
Rivers	Perennial: Bloubankspruit, Crocodile, Hennops, Jukskei and Magalies
	Ephemeral: Bloubank, Brandvlei and Skeerpoort
Natural and manmade water bodies	
Major Dams:	No major dams
Water Management Areas:	Vaal Orange and Limpopo Olifants



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Westrand Karst Belt SWSA-gw.

SWSA-gw Name:	Westrand Karst Belt
Area:	1090 km²
Elevation:	1190 to 1757 mamsl
Geology	

Geology

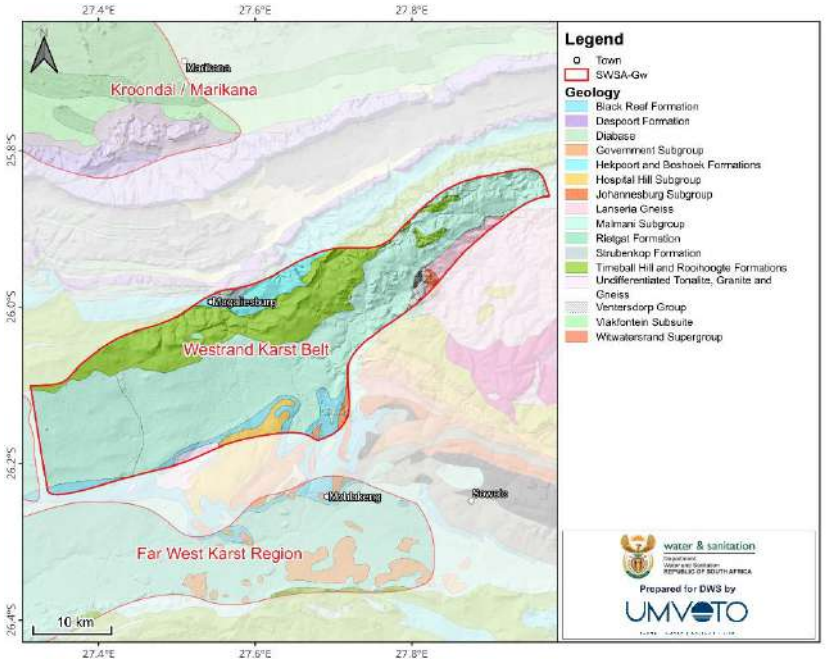
Karoo dolerite dike intrusions are present in the easternmost section of the area.

The Chuniespoort and Pretoria Groups, along with the Black Reef Formation of the Transvaal Supergroup, cover the majority of the area. The Chuniespoort Group of the Transvaal Supergroup covers the central section, extending from east to west across the area, and consists of chert-rich and chert-free dolomite, as well as stromatolitic dolomite. The Pretoria Group, located in the central northern section of the study area, comprises arkosic quartzite, sub-greywacke, siltstone, shale, conglomerate, andesite with subordinate pyroclastic rocks, chert breccia, and mudrock, along with minor occurrences of quartzite, diamictite, and siltstone. The Black Reef Formation outcrops in the southern section of the area consist of quartzite, subordinate conglomerate, and shale.

The Witwatersrand Supergroup, which consists of fine- to medium-grained quartzite, shale, subordinate conglomerate, amygdaloidal lava, and minor diamictite, also outcrops in the southern section. Minor outcrops of Swazian-era undifferentiated granite and gneiss can be found along the southern edge of the area.

Hydrostratigraphy

The Chuniespoort and Pretoria Groups, including the Malmani Subgroup dolomites, form a karst aquifer system. The dolerite intrusions in the eastern section create secondary fractured aquifer systems, while the Black Reef and Witwatersrand Supergroups contribute to fractured aquifers.



Geology Map of the Westrand Karst Belt SWSA-gw region.

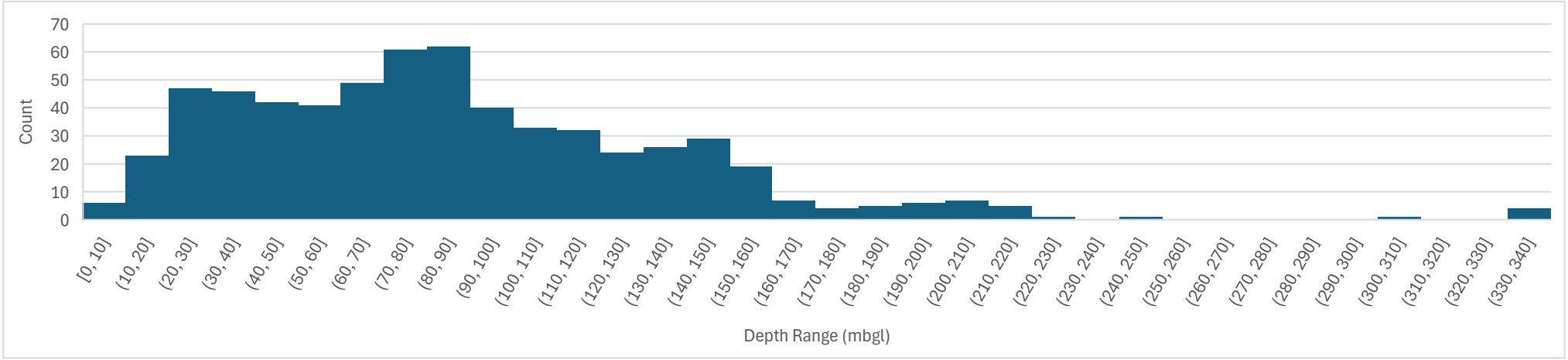
36.2. Current Status

SWSA-gw Name:	**Westrand Karst Belt**
Area:	**1090 km²**
Elevation:	**1190 to 1757 mamsl**
Quantity & Quality	
Aquifer Classification	

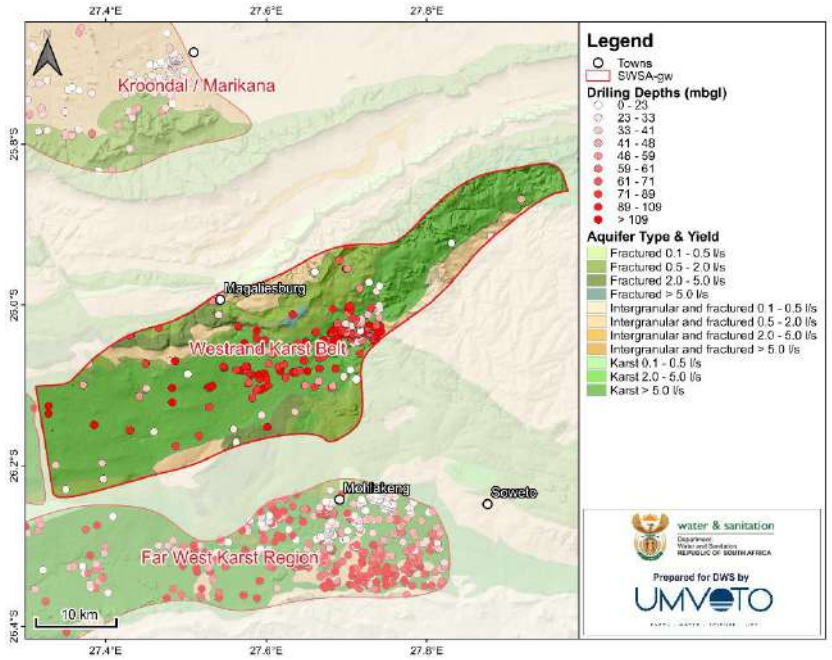
The aquifer systems within the Westrand Karst Belt SWSA-gw exhibit varying yields across karst and fractured aquifers, as summarised in the table and maps below.

Aquifer Classification	The SWSA-gw consists of a combination of major and minor aquifer systems. The major aquifer systems have an average karst yield of over 5.0 l/s and a fractured yield ranging from 0.5 to 2.0 l/s. The Minor Aquifer System has an average fractured yield of 0.5 to 5.0 l/s.
Groundwater Targets	The average drilling depth is 86 mbgl, and the most common depths are 80 and 90 mbgl, respectively. The majority of the boreholes target the high-yielding karst aquifer. Some boreholes in the central section reach depths > 150 mbgl, suggesting deep fractured basement aquifer abstraction. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 49 and 116 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 45 mbgl, with values ranging from 0 to 112 mbgl and a standard deviation of ~ 24 mbgl.

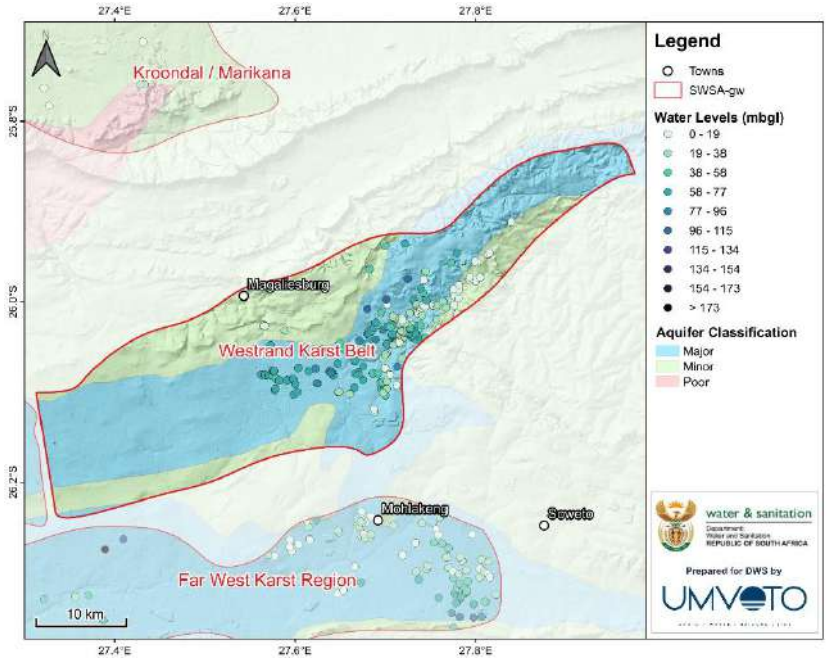
Graph of NGA drilling depths of the Westrand Karst Belt SWSA-gw region



SWSA-gw Name:	Westrand Karst Belt
Area:	1090 km²
Elevation:	1190 to 1757 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depth of the Westrand Karst Belt SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Westrand Karst Belt SWSA-gw region.

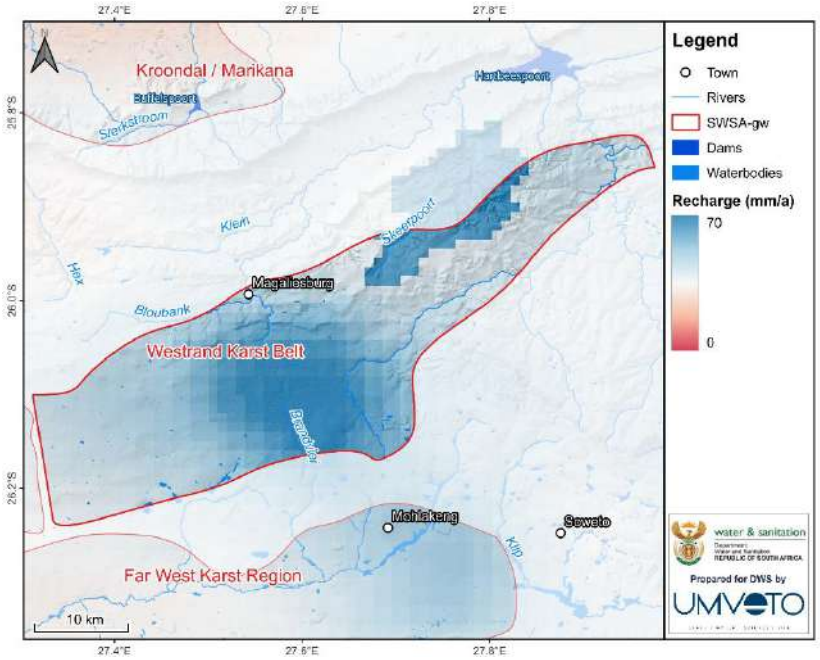
SWSA-gw Name:	**Westrand Karst Belt**
Area:	**1090 km²**
Elevation:	**1190 to 1757 mamsl**

Quantity & Quality

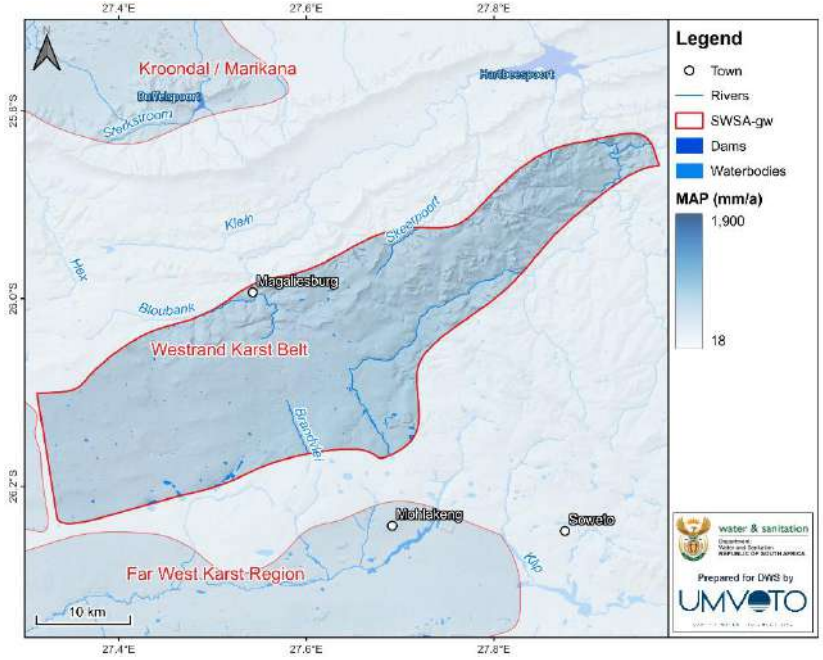
Groundwater Recharge

The Westrand Karst Belt receives a total MAP volume of 694 Mm^3/a, with an average rainfall of 638 mm/a. However, only 51.8 Mm^3/a of this water infiltrates to recharge the aquifer, resulting in a low recharge of 8.2% of MAP. This suggests that most rainfall is lost to evaporation or runoff, indicating limited groundwater replenishment and potential water scarcity concerns.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Westrand Karst Belt	694	638	56.9	51.8	8.2%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Westrand Karst Belt
Area:	1090 km²
Elevation:	1190 to 1757 mamsl

Quantity & Quality

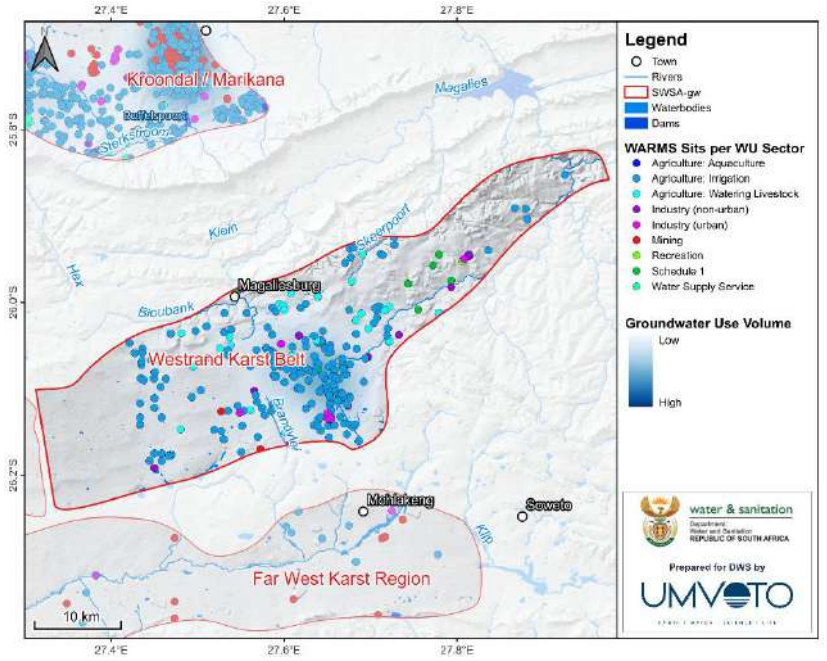
Groundwater Use

The Westrand Karst Belt SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. While no towns in this region rely primarily on groundwater for municipal supply, industrial use, or agriculture (see Table below), an analysis of active groundwater use licenses from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Agricultural irrigation use is the largest, with 37.9 Mm^3/ a to sustain crop production. Groundwater is essential for farming, supporting food production and local economies. Most of the registered use for this sector is scattered around the area. However, there is a large cluster south of Magaliesberg where use is particularly dense.
- Agricultural livestock watering follows, using 0.7 Mm^3/a to provide water for livestock animals to drink and graze. While this sector's use is significantly less than irrigation, groundwater is still a vital resource used to sustain the animals. Registered use follows the same distribution pattern as irrigation, with scattered use throughout the region and denser use south of Magaliesberg.
- Non-Urban industrial follows, using 0.4 Mm^3/a allocated for manufacturing, processing, and other industrial activities outside urban centres. Interestingly, non-urban industrial use does not follow the same distribution as the first two. Instead, use is concentrated in the westernmost and easternmost areas of the map.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Magaliesburg, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	37.9
	Agriculture: Watering Livestock	0.7
	Industry (Non-urban)	0.4
	Industry (Urban)	0.1
	Mining	0.1
	Recreation	0.01
	Schedule 1	0.1
	Total	**39.4**



Water use map for the Westrand Karst Belt SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

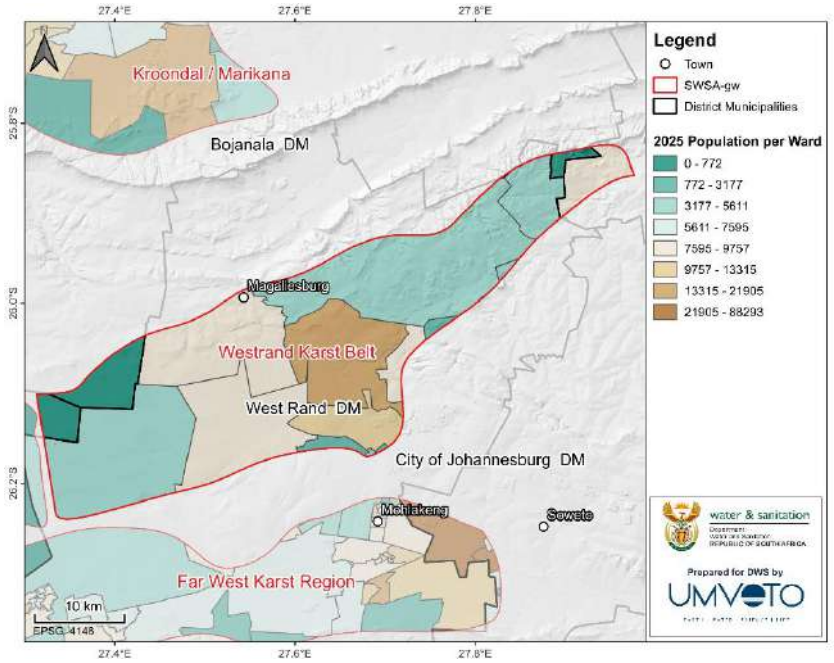
SWSA-gw Name:	Westrand Karst Belt
Area:	1090 km²
Elevation:	1190 to 1757 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Westrand Karst Belt SWSA-gw is located within both the Vaal-Orange Water Management Area (WMA, 2023) and the Limpopo-Olifants WMA (2023). The groundwater resources within the Bo-Molopo Karst Belt SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Vaal-Orange Catchment Management Agency (VOCMA) and Limpopo-Olifants Catchment Management Agency (LOCMA), which was formed as part of a national restructuring process that consolidated CMAs. VOCMA and LOCMA are responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the VOCMA and LOCMA to manage water resources in the Vaal-Orange WMA and Limpopo-Olifants. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	VOCMA and LOCMA are the regional authorities responsible for water allocation, monitoring, and compliance in the Vaal-Orange WMA and Limpopo-Olifants WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	
WSA & WSP	The local municipalities in Gauteng and the City of Tshwane Metro are the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Westrand Karst Belt SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 0.41% per year, resulting in a projected population of approximately 78,021.

As shown in the map and table below, Mogale City Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 40,133. Population concentrations within the SWSA-gw are highest around Mogale City and Rand West City LMs.



Projected population distribution in 2025 for the Westrand Karst Belt SWSA-gw.

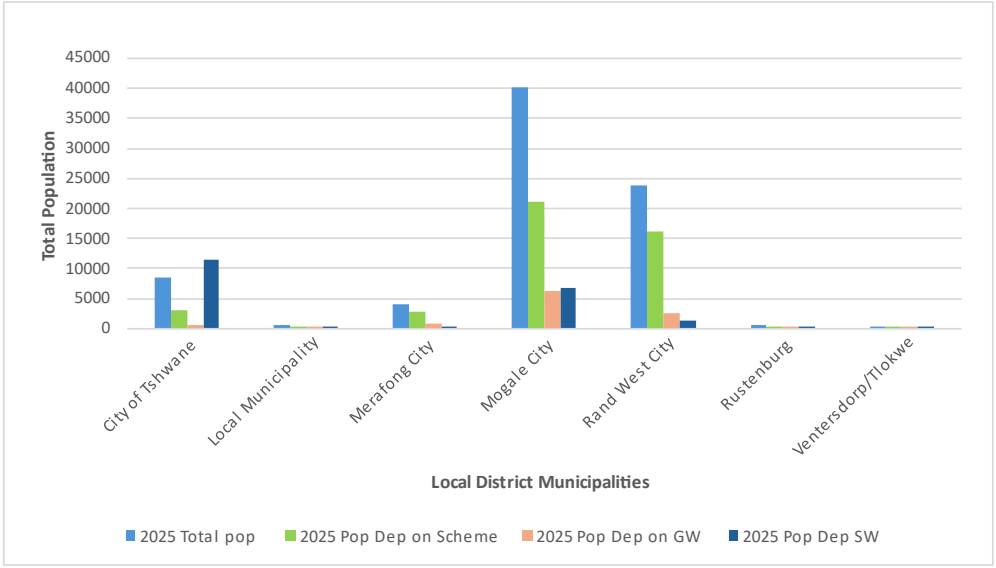
SWSA-gw Name:	Westrand Karst Belt
Area:	1090 km²
Elevation:	1190 to 1757 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Westrand Karst Belt SWSA-gw, 55.7% of the population depends on the regional water scheme, 25.7% on surface water (such as rainwater, dams, rivers, water vendors, tankers, and other sources) and 14.4% on groundwater (including boreholes and springs).

Among the LMs, the Rustenburg LM has the highest groundwater dependence at 68.5%, with minimal reliance on surface water.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
City of Tshwane	8,621	3,122	599	11,592
Local Municipality of Madibeng	560	76	352	126
Merafong City	4,171	2,813	842	298
Mogale City	40,133	21,212	6,331	6,659
Rand West City	23,767	16,113	2,652	1,259
Rustenburg	630	71	431	54
Ventersdorp/Tlokwe	139	17	29	32
Total	**78,021**	**43,425**	**11,237**	**20,020**



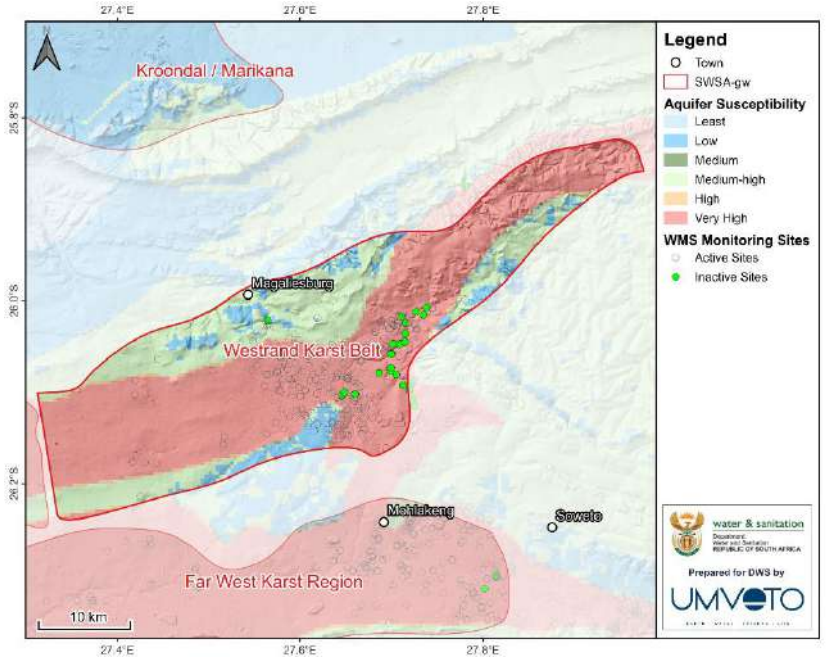
Projected population dependence on water sources in 2025.

SWSA-gw Name:	Westrand Karst Belt
Area:	1090 km²
Elevation:	1190 to 1757 mamsl
Quantity & Quality	
Groundwater Quality	

The Westrand Karst Belt SWSA-gw consists of Minor and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), cultivated areas cover a total of 384.56 km^2, which is 35.28% of the Westrand Karst Belt SWSA-gw total area. Urban/Built-up areas cover 55.07 km^2 (5.05%), while mines and quarries account for 4.26 km^2 (0.39%) of the total area. These land uses contribute to diffuse contamination sources, with agricultural chemicals being the primary concern. Irrigated agriculture is more intensive than dryland farming, requiring agrochemicals such as pesticides, herbicides, and fertilisers for weed and pest control as well as soil enrichment. Several water quality indicators help assess aquifer vulnerability and contamination risks:

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 1 - 378 mS/m in the Major aquifer system.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 3.5 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.025 - 31.045 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 4.1 - 9.10 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 2.5 - 2447.47 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Westrand Karst Belt**
Area:	**1090 km²**
Elevation:	**1190 to 1757 mamsl**
Quantity & Quality	
Groundwater Quality	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Westrand Karst Belt SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	22	70.97	31	103.45	mS/m	2014-2024 GW Geosites: <70 - 150 mS/m.	19.8 - 10.4 mS/m (Avg.: 26.57 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024).	1 - 378 mS/m (Avg.: 131.11 mS/m). 2014-2024 GW Geosites: <70 - 150 mS/m. Consistent with WMS (2000-2024), except for values above the upper limit.
Fluoride	22	73.33	30	0.12	mg/L	2014-2024 GW Geosites: <0.5 mg/L.	0.025 - 0.69 mg/L (Avg.: 0.15 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).	0.025 - 3.5 mg/L (Avg.: 0.10 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	22	70.97	31	3.11	mg/L	2014-2024 GW Geosites: <11 mg/L.	0.005 - 4.088 mg/L (Avg.: 0.36 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).	0.025 - 31.045 mg/L (Avg.: 4.07 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	22	70.97	31	7.66	pH unit	2014-2024 GW Geosites: 7-9.	6.3 - 8.7 (Avg.: 8.26). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).	4.1 - 9.10 (Avg.: 7.44). 2014-2024 GW Geosites: 7-9. Consistent with WMS (2000-2024).
Sulphate	22	70.97	31	451.19	mg/L	2014-2024 GW Geosites: <200 mg/L, >500-800 mg/L.	0.375 - 36.15 mg/L (Avg.: 3.11 mg/L). 2014-2024 GW Geosites: <200 mg/L, >500-800 mg/L. Mostly consistent with WMS (2000-2024).	2.5 - 2447.47 mg/L (Avg.: 614.79 mg/L). 2014-2024 GW Geosites: <200 mg/L, >500-800 mg/L. Mostly consistent with WMS (2000-2024), except for values above the upper limit.

- *"Average" refers to the average concentrations for the Total Active Sites of the Westrand Karst Belt SWSA-gw, taken from the WMS database from 2000-2024.*

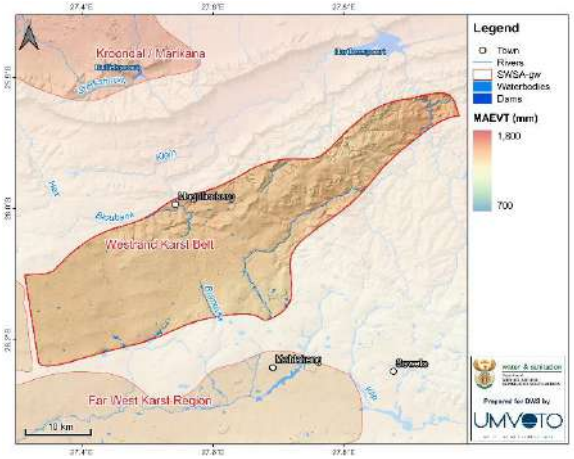
SWSA-gw Name:	**Westrand Karst Belt**
Area:	**1090 km²**
Elevation:	**1190 to 1757 mamsl**

Threats & Risks

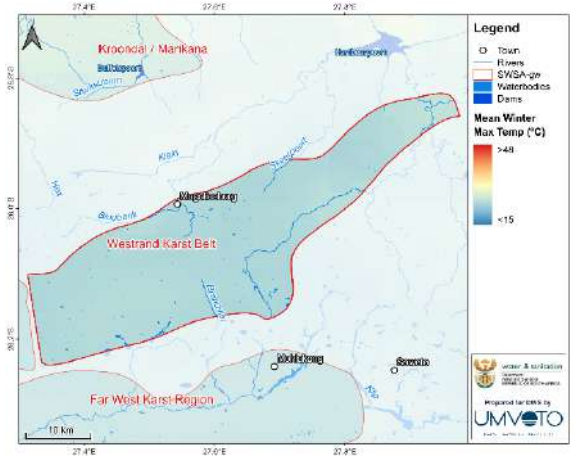
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Westrand Karst Belt SWSA-gw has a Cwb, a subtropical highland-type climate characterized by warm summers and cold, dry winters. Rainfall increases towards the central eastern section. Temperatures in the SWSA-gw range from -1.9 – 29.2 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

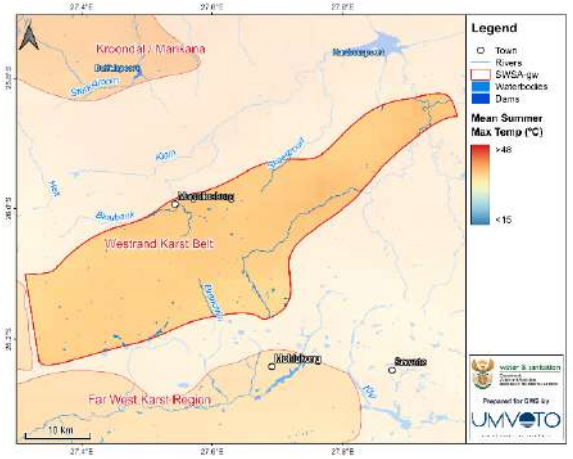
Temperature	Summer: 24.7 to 29.2 ºC, Winter: -1.9 to 4 °C
Evapotranspiration	Maximum value of 1538 mm/a with an average value of 1438 mm/a
Climate Change Predictions	Increased temperatures, Disrupted rainfall patterns, but an increase in recharge (ranging from ~ 11.3 to 18.2 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Westrand Karst Belt SWSA-gw region.



Mean winter temperatures of the Westrand Karst Belt SWSA-gw region.



Mean summer temperatures of the Westrand Karst Belt SWSA-gw region.

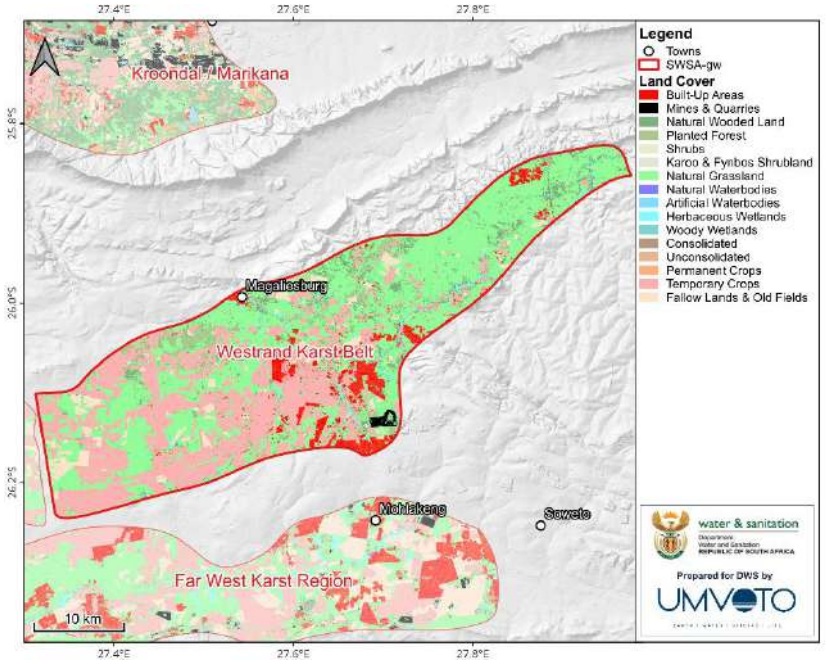
SWSA-gw Name:	Westrand Karst Belt
Area:	1090 km^2
Elevation:	1190 to 1757 mamsl

Threats & Risks

Land Use

Grassland dominates the Westrand Karst Belt SWSA-gw at 47%, with cultivated land, which includes temporary and permanent crops, also representing a significant 35% (DFFE, 2022), indicating a strong agricultural presence. Forested land, made up of natural wooded land and planted forests, contributes a smaller share, suggesting limited forest cover and unmanaged fields. Wetlands and waterbodies are minimal, which could impact local biodiversity and water resource management. Built-up areas, which include residential, commercial and industrial areas, are limited at 5%, highlighting the predominantly rural character of the region. Mines and quarries, which include surface infrastructure extraction sites and waste and resource dumps, take up a small but impactful 0.4% of the area, located predominantly in the south.

Land Use Type	Area (km^2)	Area (%)
Barren Land	2	0.2
Built-Up	55	5
Cultivated	385	35
Forest Land	113	10
Grassland	514	47
Mines and quarries	4	0.4
Shrubland	1	0.1
Waterbodies	2	0.2
Wetlands	15	1



Land Cover 24-class map to show the types of land use and extent of each occurring in the Westrand Karst Belt SWSA-gw

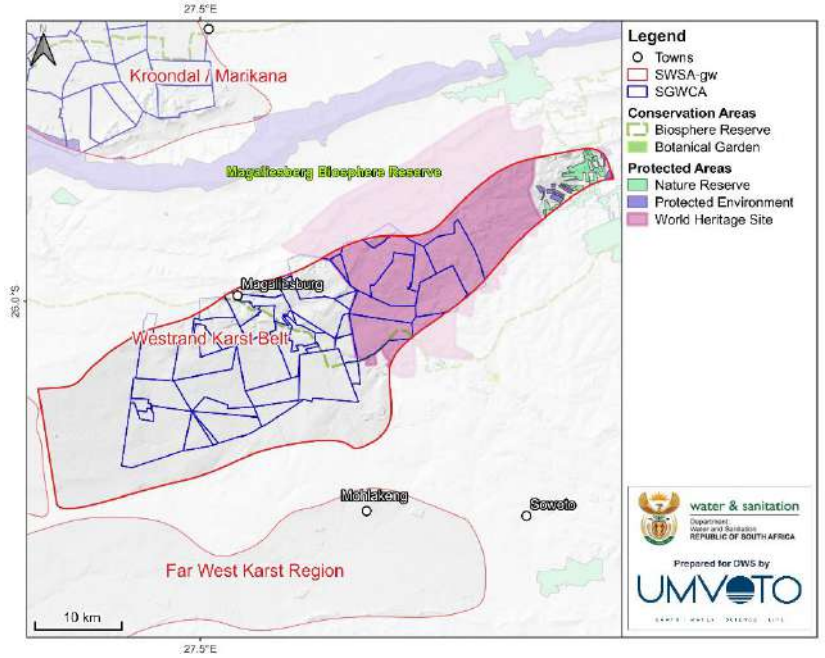
SWSA-gw Name:	Westrand Karst Belt
Area:	1090 km^2
Elevation:	1190 to 1757 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Westrand Karst Belt SWSA-gw features a major conservation area (DFFE, 2024), the Magaliesberg Biosphere Reserve, which spans 423.01 km² and plays a key role in preserving biodiversity and cultural heritage. In addition, three protected areas (DFFE, 2024) totalling 291.75 km²—including parts of the Crocodile River Reserve and the Fossil Hominid Sites of SA—further enhance conservation efforts. The Tarlton subterranean government water control area (SGWCA)(CSIR, 1998) covers approximately 57% of the SWSA-gw. This SGWCA shows areas where the government had control over groundwater on private land under the Water Act No. 54 of 1956 (DWA, 2010).

Protection Status	Names	Area (km^2)	Count
Conservation Areas	• Magaliesberg Biosphere Reserve	423.01	1
Protected Areas	• Crocodile River Reserve Central Nature Reserve Cluster • Crocodile River Reserve Protected Environment • Fossil Hominid Sites of SA	291.75	3
SGWCA	• Tarlton	617.71	1
National Parks	None		0

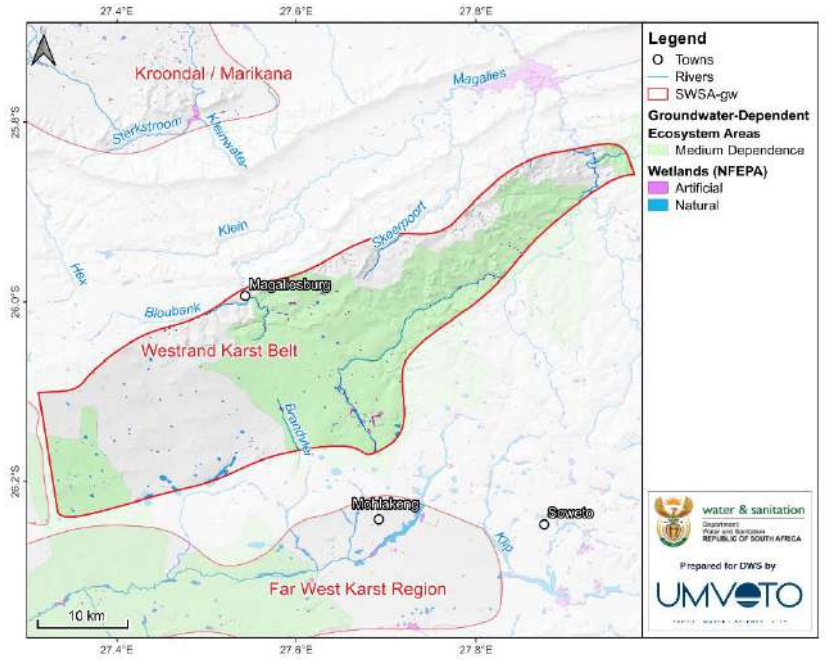


Biospheres, Protected Areas and SGWCAs to show the portions of the Westrand Karst Belt SWSA-gw that have protection status.

SWSA-gw Name:	Westrand Karst Belt
Area:	1090 km^2
Elevation:	1190 to 1757 mamsl
Protection Status and Ecosystems	
Biodiversity and Conservation	

The region has no designated major waterbodies or Ramsar sites, indicating a lack of prominent surface water resources. However, wetlands (CSIR, 2018) with potentially medium-dependence groundwater-dependent ecosystems (DWA, 2010) are found across the area. Although there are no major water bodies within the SWSA-gw, the Hartbeespoort Dam (DWS, 2011) is approximately 7 km north of the SWSA-gw.

Protection Status	Names	Area (km^2)	Count
Major Waterbodies	None		0
Ramsar Sites	None		0
Wetlands	Various natural, artificial and estuary wetlands	6	

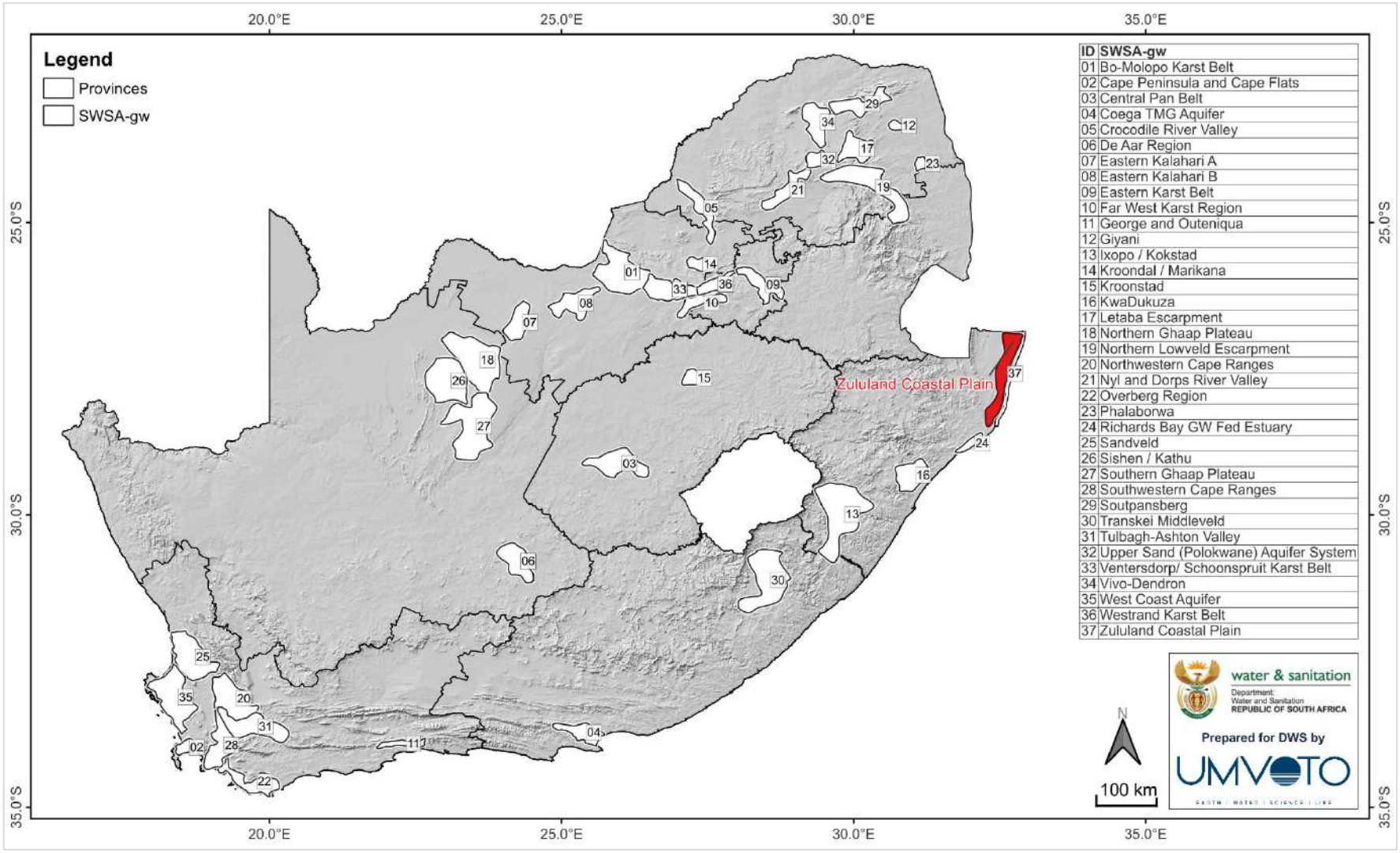


Map showing the major water bodies, Ramsar sites and GDEs in the Westrand Karst Belt SWSA-gw.

APPENDIX 37

ZULULAND COASTAL PLAIN SWSA-GW

OVERVIEW MAP OF THE LOCATION OF THE ZULULAND COASTAL PLAIN SWSA-GW



ID	SWSA-gw
01	Bo-Molopo Karst Belt
02	Cape Peninsula and Cape Flats
03	Central Pan Belt
04	Coega TMG Aquifer
05	Crocodile River Valley
06	De Aar Region
07	Eastern Kalahari A
08	Eastern Kalahari B
09	Eastern Karst Belt
10	Far West Karst Region
11	George and Outeniqua
12	Giyani
13	Ixopo / Kokstad
14	Kroondal / Marikana
15	Kroonstad
16	KwaDukuza
17	Letaba Escarpment
18	Northern Ghaap Plateau
19	Northern Lowveld Escarpment
20	Northwestern Cape Ranges
21	Nyl and Dorps River Valley
22	Overberg Region
23	Phalaborwa
24	Richards Bay GW Fed Estuary
25	Sandveld
26	Sishen / Kathu
27	Southern Ghaap Plateau
28	Southwestern Cape Ranges
29	Soutpansberg
30	Transkei Middleveld
31	Tulbagh-Ashton Valley
32	Upper Sand (Polokwane) Aquifer System
33	Ventersdorp/ Schoonspruit Karst Belt
34	Vivo-Dendron
35	West Coast Aquifer
36	Westrand Karst Belt
37	Zululand Coastal Plain

37. Zululand Coastal Plain

37.1. Description

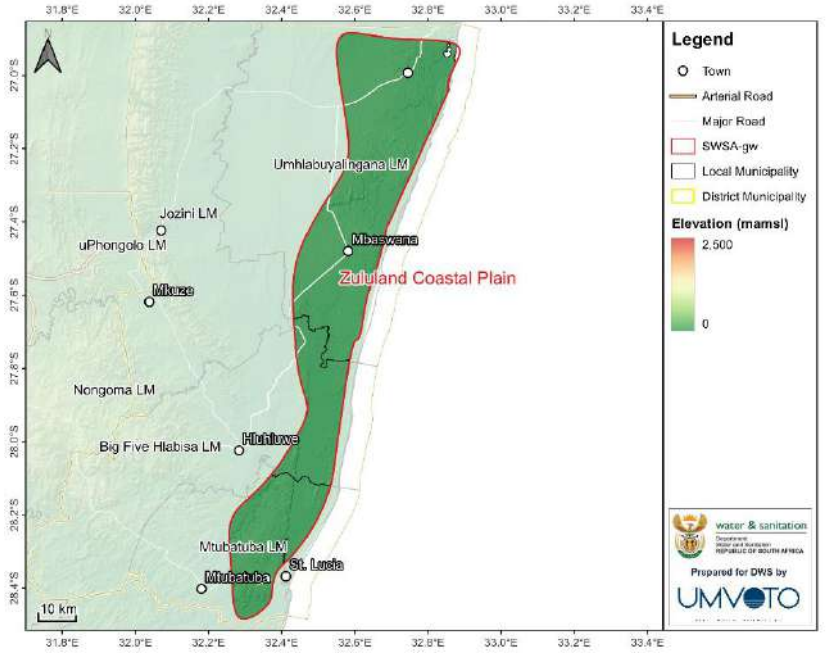
SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km²
Elevation:	19 to 100 mamsl

Geospatial Context

The topography of the Zululand Coastal Plain SWSA-gw, as depicted in the map, is predominantly characterized by a low-relief coastal plain, with elevations generally near sea level along the eastern portions adjacent to the Indian Ocean. The landscape consists of flat to gently undulating terrain, shaped by coastal dunes, floodplains, and wetland systems. Moving westward, the topography gradually rises into slightly elevated sandy plains and rolling hills, particularly around Manguzi and inland areas. The region also features numerous lakes, pans, and estuaries, contributing to a complex hydrological system. The transition towards the western edge of the aquifer sees low-lying hills and minor ridges, though no significant mountainous features are present.

This topographical variation influences the spatial distribution of municipalities, towns, major roads, and water supply networks within the SWSA-gw. These features are summarised below and displayed in the map on the right.

Province	KwaZulu-Natal
District Municipality	Umkhanyakude
Local Municipality	Umhlabuyalingana, Big Five Hlabisa and Mtubatuba
Towns	Manguzi, Mtubatuba and Hluhluwe
Major Roads	R22
Major Water Supply Networks	Umkhanyakude Bulk pipeline



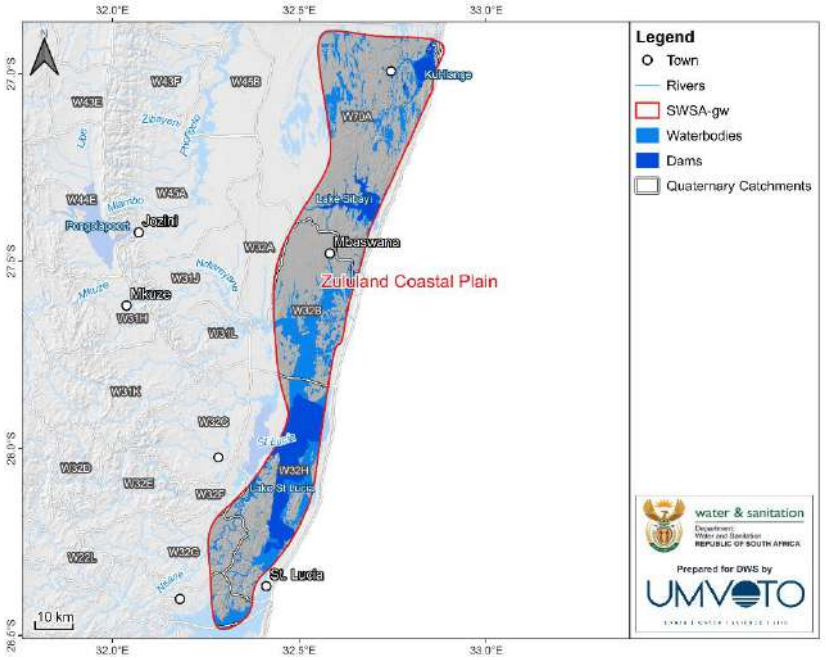
Locality map of Major Towns, District and Local Municipalities in the Zululand Coastal Plain SWSA-gw.

SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km²
Elevation:	19 to 100 mamsl

Hydrology and Drainage

The Zululand Coastal Plain SWSA-gw and surrounding areas include a few large surface water systems, along with several unnamed seeps and floodplains, which are summarised below and displayed on the map to the right. The primary surface water features include Lake Sibayi, as well as the Mgobezeleni, KuShengeza, and KuHlange dams, all of which, along with the uMgobezeleni Estuary, are recharged by the W7 catchment. The St Lucia Lake and Estuary are fed by the W3 catchment, while the iMfolozi/uMsunduze Estuary is fed by the W2 catchment. The area contains several perennial rivers and one ephemeral river with varying flow directions.

Quaternary Catchments	W23D, W32A, W32B, W32G, W32H, W70A
Rivers	Perennial: Hlazane, Hluhluwe, Mfolozi, Mkuze, Nyalazi, St Lucia, Swamanzi
	Ephemeral: Khobeyane, Kosi, Malangeni, Mbazwana, Mpate, Siphudwini
Natural and manmade water bodies	uMgobezeleni estuary, St Lucia estuary, iMfolozi/uMsunduze KuHlange, Kosi Estuary, as well as several flood plains and depressions
Major Dams:	Lake Sibayi, Mgobezeleni, Lake St. Lucia, KuShengeza, and Amanzimnyama
Water Management Areas:	Pongola Mtamvuna



Hydrology map displaying Quaternary and Secondary Catchments as well as Rivers and Water Bodies in the Zululand Coastal Plain SWSA-gw.

SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km²
Elevation:	19 to 100 mamsl

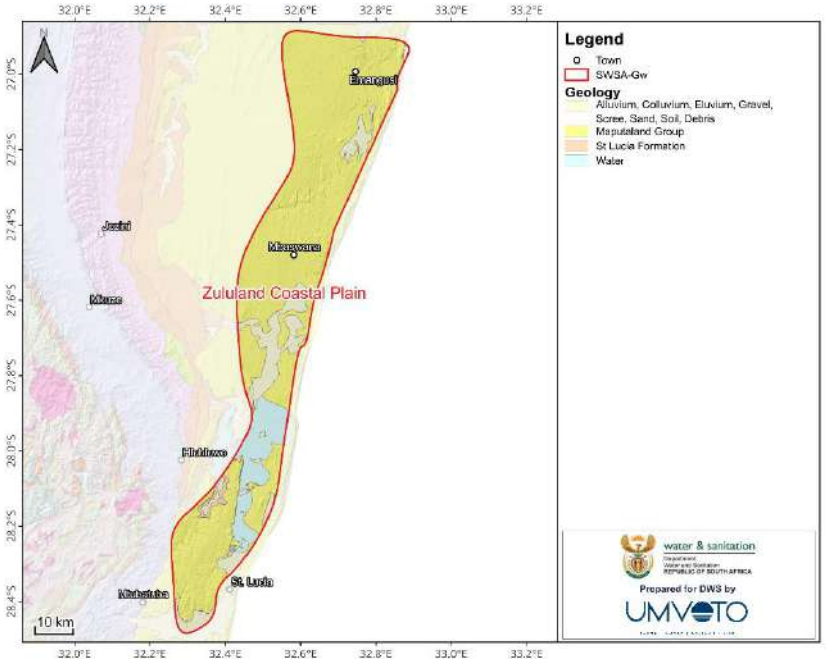
Geology

Geology

The majority of the area is covered by Quaternary deposits, which include aeolian sand, alluvium, dune and beach sand, as well as yellowish redistributed sand. Minor outcroppings of the Zululand and Maputuland Groups are interspersed with the Quaternary deposits. These formations consist of red decalcified sand in inland dune cordons, fossiliferous limestone with coral, fine to medium-grained sand, clayey sand, silt with a lignite bed up to 2.5 m thick, fossiliferous glauconitic siltstone and sandstone, coquina, calcarenite, and conglomerate.

Hydrostratigraphy

Quaternary and Maputuland Group sediments form a multi-layered primary aquifer system. The shallow, unconfined aquifer is composed of intergranular dune sands, while deeper units act as leaky confined to confined aquifers, with some karstic characteristics. The Zululand Group forms the regional basement, acting as an aquiclude that restricts groundwater flow.



Geology Map of the Zululand Coastal Plain SWSA-gw region.

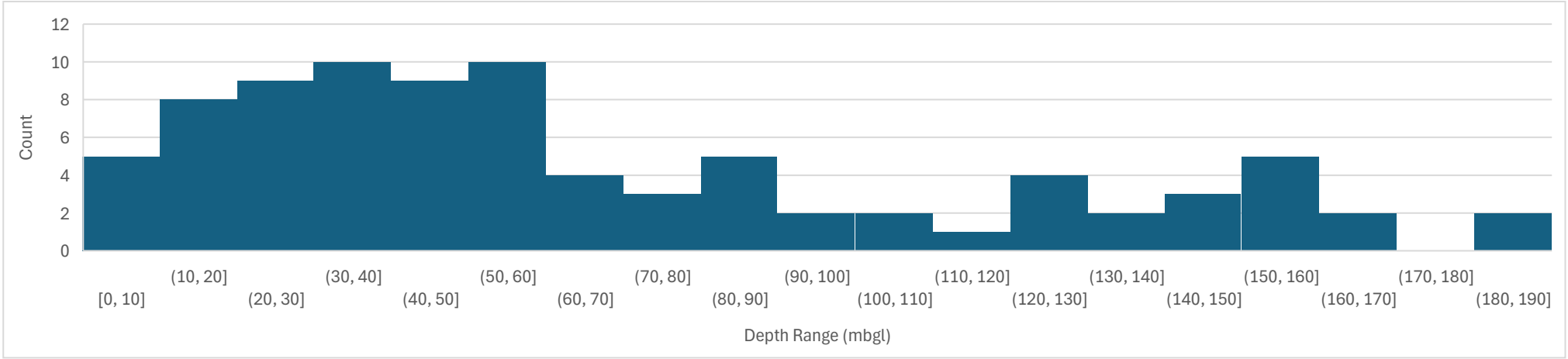
37.2. Current Status

SWSA-gw Name:	**Zululand Coastal Plain**
Area:	**3305 km²**
Elevation:	**19 to 100 mamsl**
Quantity & Quality	
Aquifer Classification	

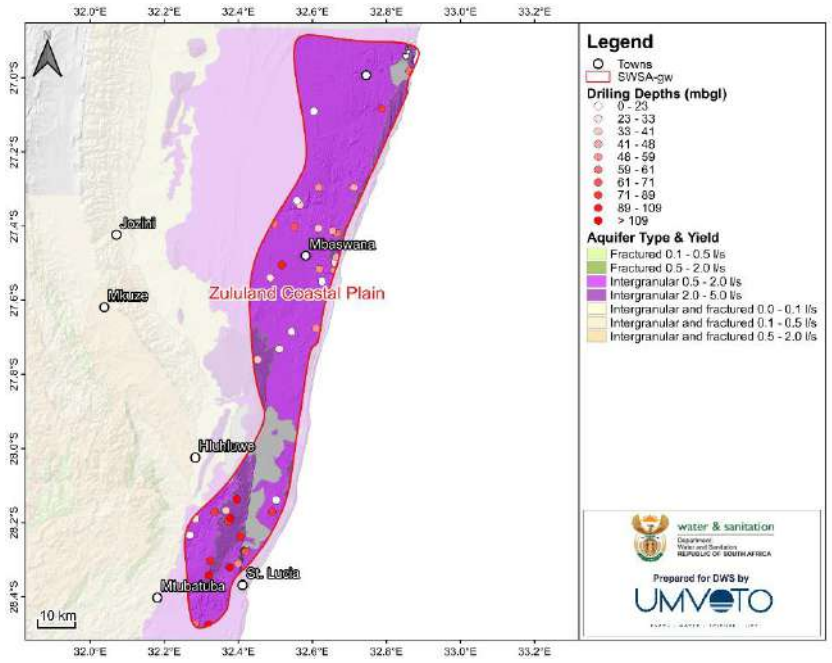
The aquifer systems within the Zululand Coastal Plain SWSA-gw exhibit varying yields across intergranular aquifers, as summarised in the table and maps below.

Aquifer Classification	The majority of the SWSA-gw consists of a major aquifer system, with a minor aquifer system along the southwestern edge. The major aquifer system has an average intergranular yield of 0.5 to 5.0 l/s, while the minor aquifer system has an average intergranular yield of 0.5 to 2.0 l/s.
Groundwater Targets	The average drilling depth is 68 mbgl, and the most common depths are between 20 and 60 mbgl. The absence of significant deeper boreholes (> 200 mbgl) suggests no targeting of the basement aquifer. The majority of the boreholes target the intergranular aquifer system. The 25th and 75th percentiles indicate that the primary focus for groundwater development lies between 30 and 92 mbgl. Based on the last 25 years of NGA water level data, the average groundwater level in the region is ~ 10 mbgl, with values ranging from 2 to 27 mbgl with a standard deviation of ~ 5 mbgl.

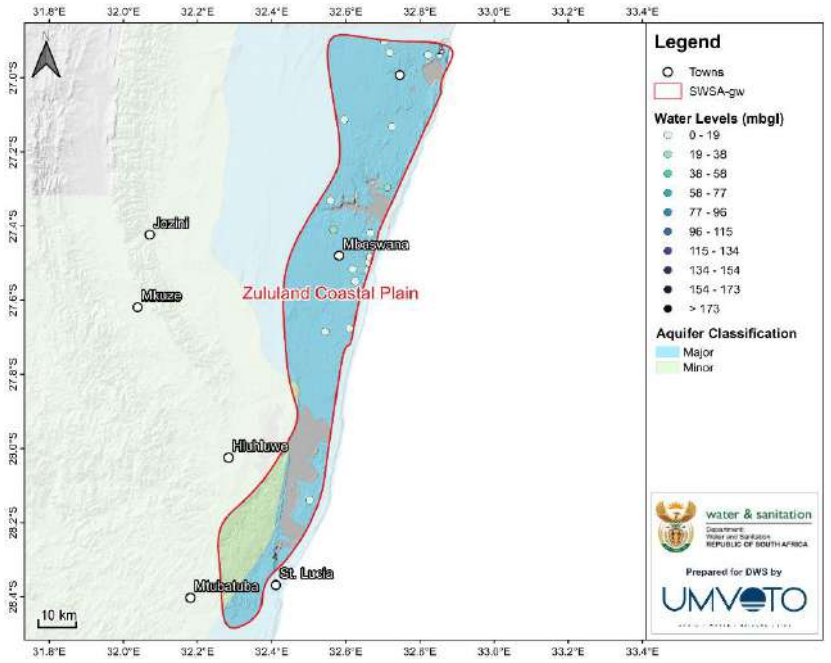
Graph of NGA drilling depths of the Zululand Coastal Plain SWSA-gw region



SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km²
Elevation:	19 to 100 mamsl
Quantity & Quality	
Aquifer Classification	



Map of the Aquifer Type and Associated Yield and NGA drilling depths of the Zululand Coastal Plain SWSA-gw region.



Map of the Aquifer Classification and NGA water levels of the Zululand Coastal Plain SWSA-gw region.

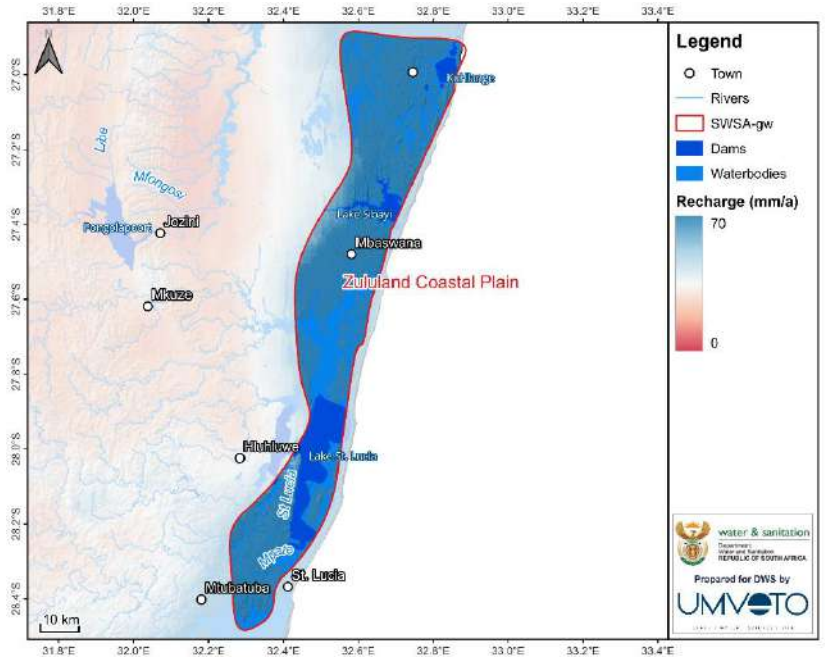
SWSA-gw Name:	**Zululand Coastal Plain**
Area:	**3305 km²**
Elevation:	**19 to 100 mamsl**

Quantity & Quality

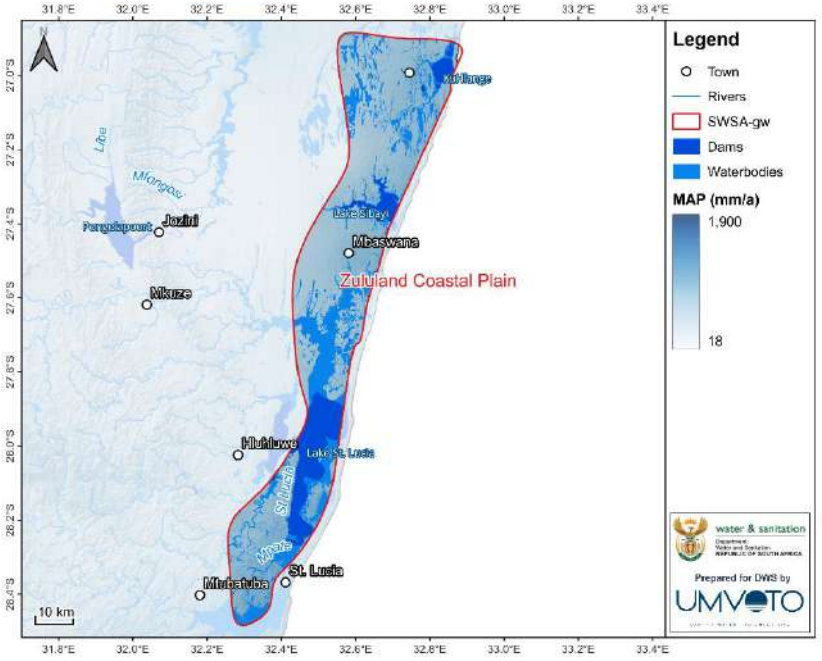
Groundwater Recharge

The Zululand Coastal Plain receives a total MAP volume of 2805 Mm^3/a, with a high average rainfall of 850 mm/a. Despite this, only 316 Mm^3/a contributes to groundwater recharge, resulting in a moderate recharge of 11.3% of MAP. This suggests that while the area experiences relatively high rainfall, a substantial portion is still lost to runoff, evaporation, or surface water flow, though recharge efficiency is better compared to drier regions.

SWSA-gw	Sum of MAP Volume Mm^3/a	Average of MAP mm/a	Sum of Recharge Vol Mm^3/a	Average of Recharge mm/a	% MAP Considered Recharge (Mm^3/a)
Zululand Coastal Plain	2805	850	316	95.4	11.3%



Groundwater recharge map per SWSA-gw and surrounding areas based on GRAII recharge.



Mean Annual Precipitation (MAP) distribution map per SWSA-gw and surrounding areas, including SAWS rainfall stations.

SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km²
Elevation:	19 to 100 mamsl

Quantity & Quality

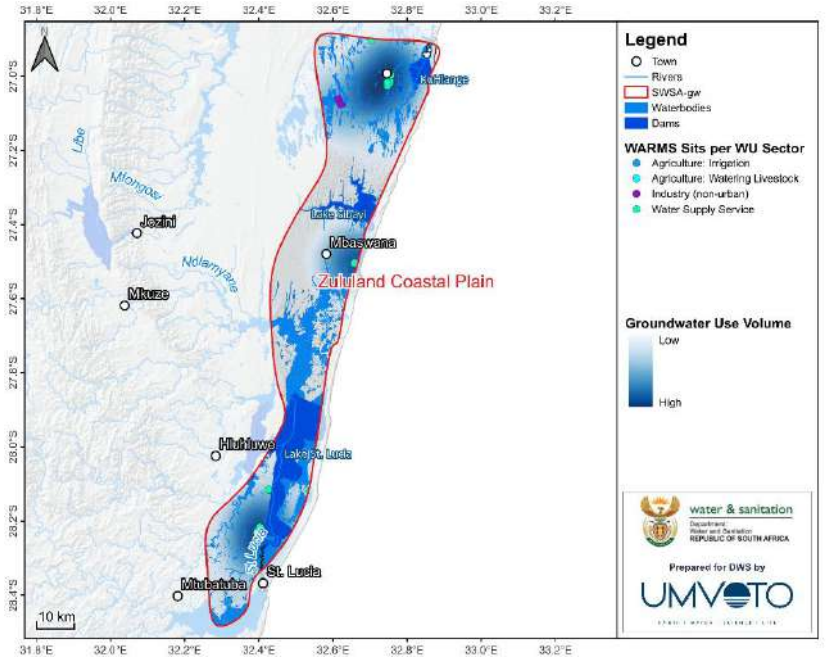
Groundwater Use

The Zululand Coastal Plain SWSA-gw plays a crucial role in sustaining water demand across multiple sectors. While no towns in this region rely primarily on groundwater for municipal supply, industrial use, or agriculture (see Table below), an analysis of active groundwater use licenses from WARMS reveals that three sectors account for the highest registered water volumes in the SWSA-gw:

- Municipal water supply services, at 1.6 Mm^3/a, provide essential water for groundwater-dependent towns with limited surface water access. The Zululand Coastal Plain is not a major groundwater consumer when compared to the other areas. The north of the region around Manguzi appears to rely heavily on municipal groundwater supply.
- Agricultural irrigation, with 0.1 Mm^3/a used for crop production. Just south of Manguzi is where agricultural irrigation is mainly used. This makes sense as the Manguzi towns rely on the groundwater municipal supplies, so the same preferences extend to the agricultural areas.
- Agricultural livestock watering follows closely, using 0.02 Mm^3/a to provide water for livestock animals to drink and graze. Just like the first two sectors, agricultural livestock is in the northern area around Manguzi. Given that groundwater use is concentrated in the north, it suggests that alternate water sources are less easy to come across, causing the north to rely on groundwater more than the rest of the region.

The map highlights water use hot spots, indicating areas of high groundwater abstraction. These are primarily located around Manguzi, where groundwater use is highest due to industrial, municipal, and agricultural activities.

	Water User Sector	Registered Volume (Mm^3/a)
Active Groundwater Use Licences	Agriculture: Irrigation	0.1
	Agriculture: Watering Livestock	0.02
	Industry (Non-urban)	0.01
	Water Supply Service	1.6
	Total	**1.8**



Water use map for the Zululand Coastal Plain SWSA-gw displaying registered water use per sector as well as high groundwater use hotspots.

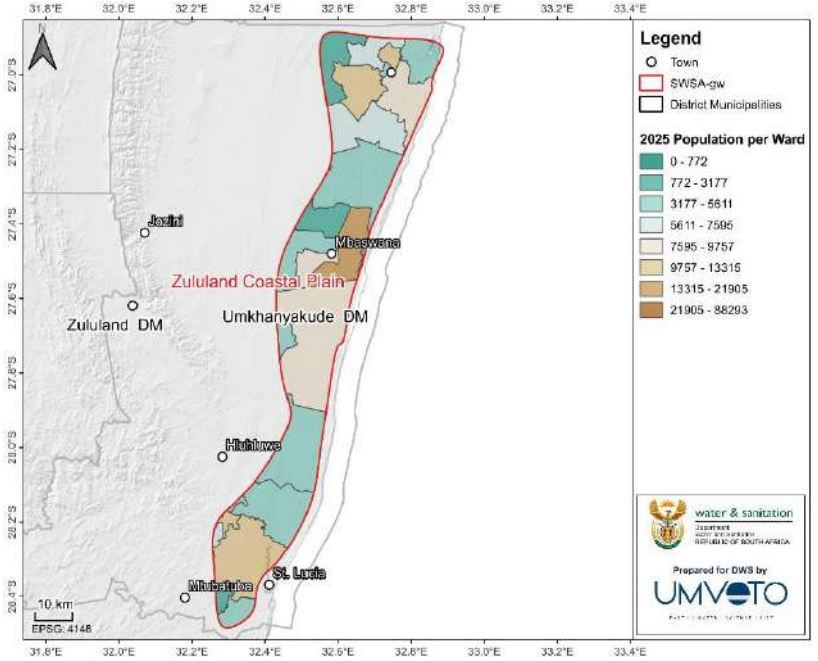
SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km²
Elevation:	19 to 100 mamsl
Quantity & Quality	
Socio Economic & Governance	

The Zululand Coastal Plain SWSA-gw is located within the Pongola-Mtamvuna Water Management Area (WMA, 2023). The groundwater resources within the Zululand Coastal Plain SWSA-gw fall under the jurisdiction of the DWS at a national level. Regional management is overseen by the Pongola-Mtamvuna Catchment Management Agency (PUCMA), which was formed as part of a national restructuring process that consolidated CMAs. PUCMA is responsible for water allocation, licensing, groundwater monitoring, and resource management in alignment with national policies and strategies.

Governing Institution	Roles and Responsibilities
DWS	As the national custodian of water resources, the DWS enforces the National Water Act (Act No. 36 of 1998), oversees water use licensing, and ensures compliance with national regulations. It established the PUCMA to manage water resources in the Pongola-Mtamvuna WMA. DWS also sets water allocation rules and implements use restrictions for urban, industrial, and agricultural sectors.
CMA	PUCMA is the regional authority responsible for water allocation, monitoring, and compliance in the Pongola-Mtamvuna WMA. It works with Water User Associations (WUAs), municipalities, and industries to implement resource protection measures and manage groundwater and surface water use.
WUA	Makhathini Lower Pongola Water User Association is the local water management group that assists the CMA with allocation decisions among water users and oversees groundwater infrastructure and monitoring within the SWSA-gw.
WSA & WSP	The district municipality is the Water Service Authorities (WSA) and Water Service Providers (WSP) for their jurisdiction.

The estimated 2025 population within the Zululand Coastal Plain SWSA-gw was calculated using Census 2011 and 2022 data to determine a population growth rate of 0.18% per year, resulting in a projected population of approximately 114,606.

As shown in the map and table below, Umhlabuyalingana Local Municipality (LM) has the highest estimated population within the SWSA-gw, with approximately 73,322. Population concentrations within the SWSA-gw are highest in the towns of Mbaswana and Emangusi.



Projected population distribution in 2025 for the Zululand Coastal Plain SWSA-gw.

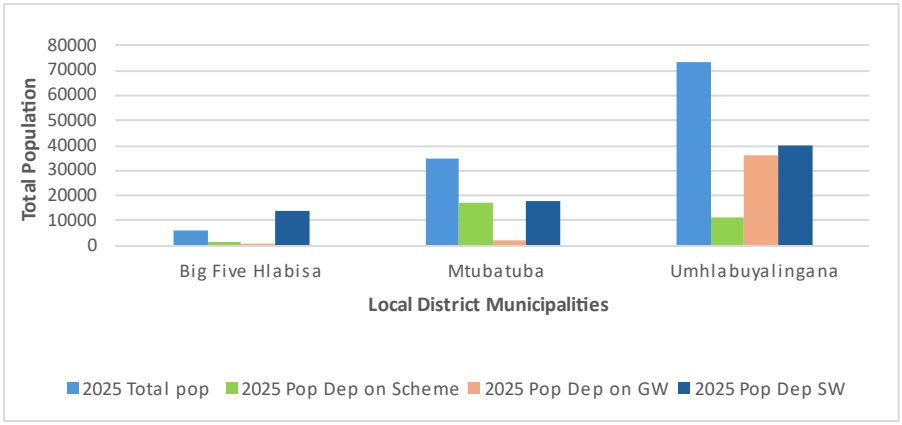
SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km²
Elevation:	19 to 100 mamsl
Quantity & Quality	
Socio Economic & Governance	

In terms of water reliance within the Zululand Coastal Plain SWSA-gw, an estimated 61.91% of the population depends on surface water sources (such as rainwater, dams, rivers, water vendors, tankers, and other sources), 33.44% on groundwater sources (including boreholes and springs), and 26.3% the regional water supply scheme.

Among the LMs, Umhlabuyalingana LM has the highest proportion of groundwater reliance, with approximately 49.2% of its population depending on groundwater.

The estimated 2025 population dependent on the regional scheme, groundwater and surface water are shown in the table below. The calculations are based on Census 2011 data and annual growth rates.

LM	2025 Total pop	2025 Pop Dep on Scheme	2025 Pop Dep on GW	2025 Pop Dep SW
Big Five Hlabisa	6,302	1,398	425	13,666
Mtubatuba	34,983	17,365	1,851	17,560
Umhlabuyalingana	73,322	11,385	36,044	39,730
Total	**114,606**	**30,148**	**38,319**	**70,956**



Projected population dependence on water sources in 2025.

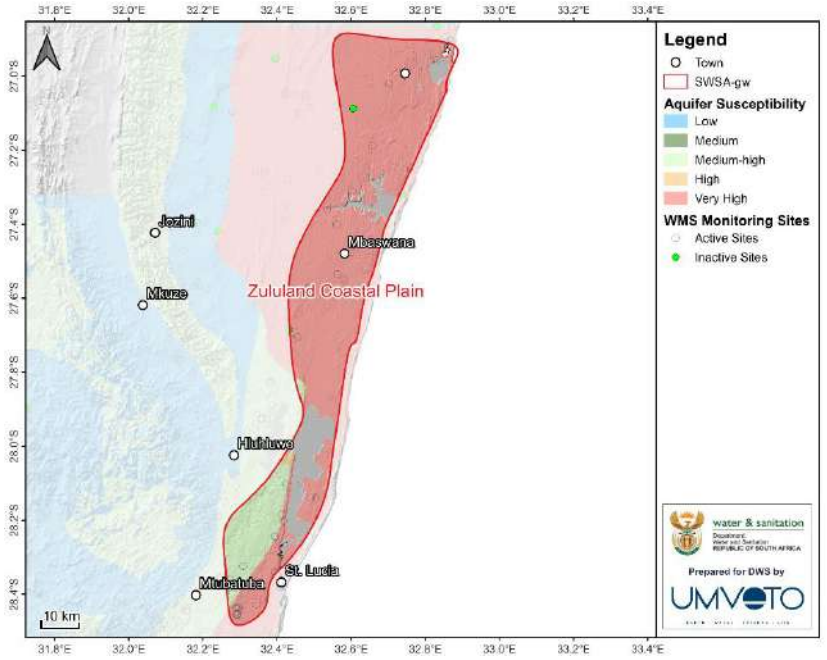
SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km²
Elevation:	19 to 100 mamsl
Quantity & Quality	
Groundwater Quality	

The Zululand Coastal Plain SWSA-gw consists of Minor, and Major aquifer systems, classified based on their yield and water quality. The Major aquifer system is the most productive and has the best water quality but is also the most vulnerable to contamination, as pollutants introduced at the surface are more likely to reach the groundwater (DWS, 2012).

According to the National Land Cover 73-class (DFFE, 2022), Urban/Built-up areas cover a total of 330 km^2, which is 9.99% of the Zululand Coastal Plain SWSA-gw total area. Cultivated areas cover 122.26 km^2 (3.70%), while mines and quarries account for 3.96 km^2 (0.12%) of the total area. These land uses contribute to diffuse contamination sources, with urban areas being the primary concern. Urban areas tend to include informal settlements and townships, and this places the groundwater source under a high risk of contamination (Le Maitre et al., 2018). Several water quality indicators help assess aquifer vulnerability and contamination risks:

The Major Aquifer consists of areas with moderate and high aquifer vulnerability. The majority of the Major Aquifer is characterized by areas that have the most vulnerability, while moderate vulnerability areas are found along the southwestern edges of the major aquifer system.

- **Electrical Conductivity (EC)** serves as an early indicator of groundwater contamination and salinity intrusion. The EC ranges from 0.5 – 110 mS/m in the Major aquifer system. Coastal aquifers typically show an EC gradient, with higher values near the coastline due to seawater intrusion or marine aerosol deposition.
- **Fluoride** naturally occurs in groundwater, posing a concern if concentrations are too high or low. The fluoride levels range from 0.025 - 1.07 mg/L in the Major aquifer system.
- **Nitrate and Nitrite** contamination primarily originates from agricultural activities, particularly nitrogen-based fertilisers and livestock manure. Elevated levels pose environmental and health risks. Nitrate & nitrite concentrations range from 0.02 - 1.30 mg/L in the Major aquifer system.
- **pH** is a crucial factor in groundwater quality, influencing safety and usability. Values outside the ideal 6.5 - 8.5 range can lead to corrosion, contamination, and health risks. The pH ranges from 5.05 - 8.11 in the Major aquifer.
- **Sulphate** is generally not a direct health risk but can affect taste and water usability at high concentrations. Sulphate levels range from 0.38 - 13.65 mg/L in the Major aquifer system.



The map provides a qualitative assessment of groundwater contamination risk, considering both aquifer vulnerability and classification, which reflects its importance.

SWSA-gw Name:	**Zululand Coastal Plain**
Area:	**3305 km²**
Elevation:	**19 to 100 mamsl**
Quantity & Quality	
Socio Economic & Governance	

Water Quality Parameters and Aquifer Vulnerability Categorization across the Zululand Coastal Plain Aquifer SWSA-gw

Parameter	Total Active Sites	% of Active Sites	Totals Sites with WQ results	Average Conc.	Units	Least Vulnerable	Moderate Vulnerable	Most Vulnerable
EC	1	8.33	12	16.92	mS/m	-	-	0.5 - 110 mS/m (Avg.: 16.92 mS/m). 2014-2024 GW Geosites: <70 mS/m, some >500 mS/m. Consistent with WMS (2000-2024).
Fluoride	1	8.33	12	0.11	mg/L	-	-	0.025 - 1.07 mg/L (Avg.: 0.11 mg/L). 2014-2024 GW Geosites: <0.5 mg/L. Consistent with WMS (2000-2024).
Nitrate + Nitrite Nitrogen	1	8.33	12	0.17	mg/L	-	-	0.02 - 1.30 mg/L (Avg.: 0.17 mg/L). 2014-2024 GW Geosites: <11 mg/L. Consistent with WMS NO_3+NO_2 (2000-2024).
pH	1	8.33	12	6.87	pH unit	-	-	5.05 - 8.11 (Avg.: 6.87). 2014-2024 GW Geosites: 7 - 9. Mostly consistent with WMS (2000-2024).
Sulphate	1	8.33	12	3.65	mg/L	-	-	0.38 - 13.65 mg/L (Avg.: 3.64 mg/L). 2014-2024 GW Geosites: <200 - 500 mg/L. Mostly consistent with WMS (2000-2024).

- *"Average" refers to the average concentrations for the Total Active Sites of the Zululand Coastal Plain SWSA-gw, taken from the WMS database from 2000-2024.*
- *"-" refers to no available data from the WMS database from 2000-2024 and the 2014-2024 GW Geosites.*

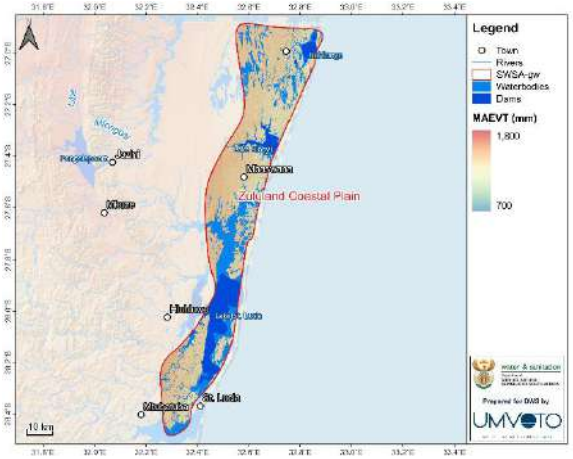
SWSA-gw Name:	**Zululand Coastal Plain**
Area:	**3305 km²**
Elevation:	**19 to 100 mamsl**

Threats & Risks

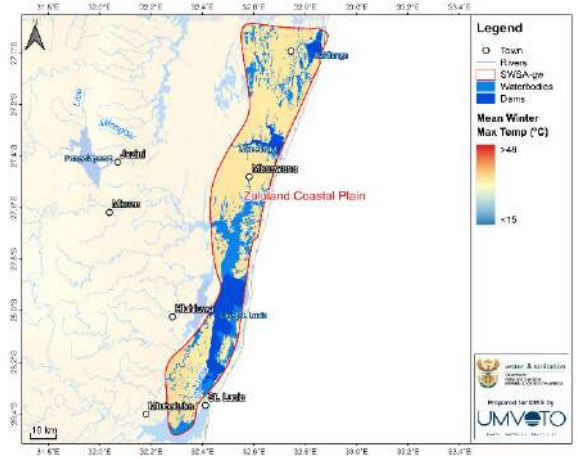
Climate

According to the Köppen-Geiger Climate Zones (Beck et al., 2018), the Zululand Coastal Plain SWSA-gw has a combination of Aw, tropical savanna, type climate with dry winter and moving inland a Cfa, subtropical-temperate, type climate, characterized by long and hot summers and cool to mild winters. Temperatures in the SWSA-gw range from >8 – 31 ºC (i.e., winter min and summer max). For more details, see the table and maps below.

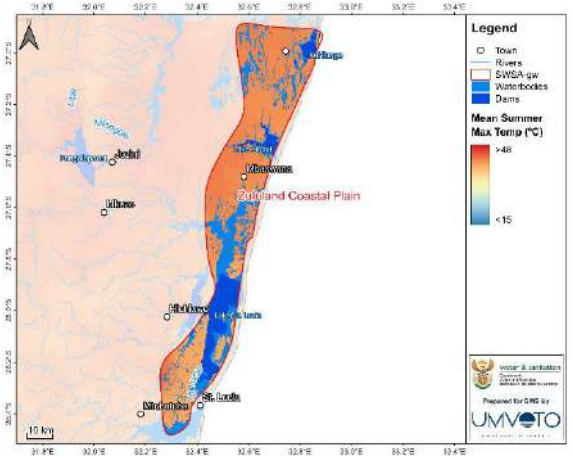
Temperature	Summer: 27 to 31 °C, Winter: >8 mm
Evapotranspiration	Maximum value of 1503 mm/a with an average value of 1368 mm/a
Climate Change Predictions	Increased temperatures, disrupted rainfall patterns, and an increase in recharge (ranging from ~-2.5 to 9.5 mm/a). The DART Index indicates a combination of stable and improving conditions.



Mean annual A-Pan evaporation of the Zululand Coastal Plain SWSA-gw region.



Mean winter temperatures of the Zululand Coastal Plain SWSA-gw region.



Mean summer temperatures of the Zululand Coastal Plain SWSA-gw region.

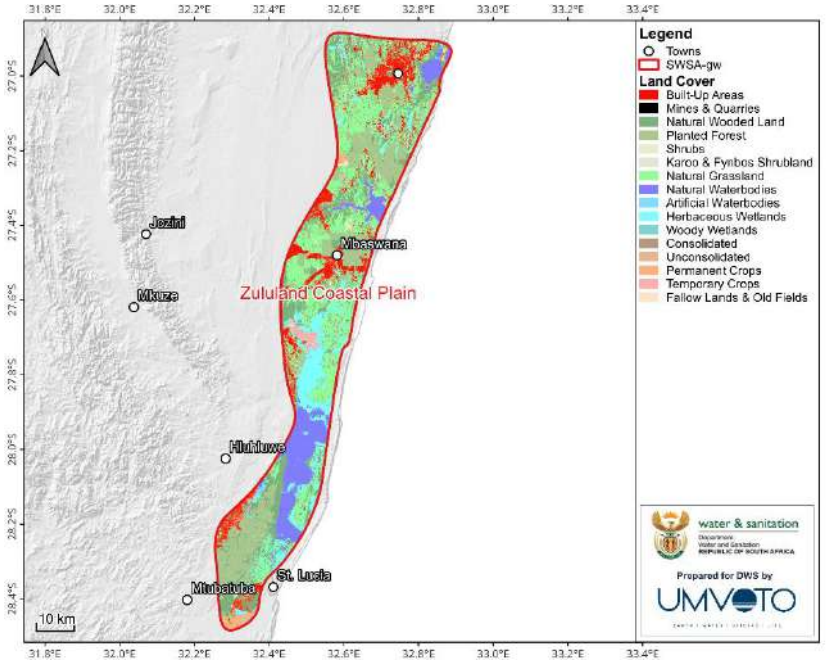
SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km^2
Elevation:	19 to 100 mamsl

Threats & Risks

Land Use

The Zululand Coastal Plain SWSA-gw is predominantly covered by grassland and forested land, which includes both natural wooded land and planted forests, making up the largest land cover (DFFE, 2022) categories at a total of 64% of the land cover. The notable presence of waterbodies and wetlands underscores the area's significant freshwater resources with most of it falling within the Ramsar-protected St. Lucia System (DFFE, 2024). Built-up areas, which consist of residential, commercial and industrial areas, constitute 10%, suggesting moderate human settlement relative to the extent of natural landscapes. There is a small percentage of mines and quarries, which includes surface infrastructure extraction sites and waste and resource dumps, in are. Although cultivated land, including permanent and temporary crops, fallow lands and old fields, are present, the overall dominance of natural land cover points to a region that still supports substantial biodiversity.

Land Use Type	Area (km^2)	Area (%)
Barren Land	59	1.8
Built-Up	330	10
Cultivated	122	3.7
Forest Land	1162	35.2
Grassland	951	28.8
Mines and quarries	4	0.1
Shrubland	0.1	0.003
Waterbodies	351	10.6
Wetlands	325	9.8



Land Cover 24-class map to show the types of land use and extent of each occurring in the Zululand Coastal Plain SWSA-gw.

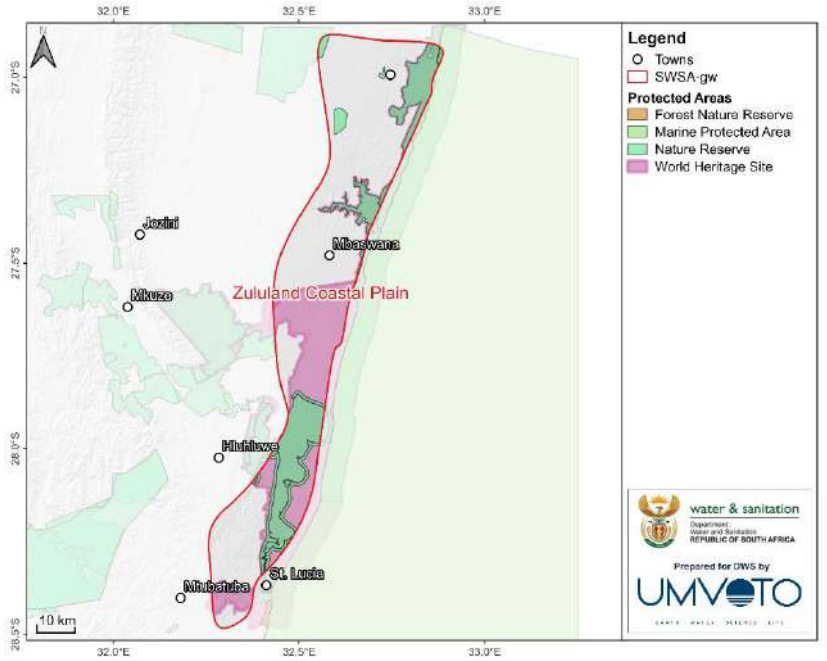
SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km^2
Elevation:	19 to 100 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Zululand Coastal Plain SWSA-gw includes a substantial network of protected areas (DFFE, 2024) totalling 1,910.90 km² (57.8% of the SWSA-gw) across nine sites, highlighted by iSimangaliso Wetland Park, a world heritage site, and its associated Marine Protected Area. Other notable reserves, such as Tembe Elephant Park and Lake Sibayi Fresh Water Reserve, safeguard important wetland, forest, and coastal ecosystems. However, there are no designated conservation areas or national parks.

Protection Status	Names	Area (km^2)	Count
Conservation Areas	None		0
Protected Areas	• iSimangaliso Wetland Park • iSimangaliso Marine Protected Area • St. Lucia Game Park • St. Lucia Park • Lake Sibayi Fresh Water Reserve • Coastal Forest Reserve • Sileza Nature Reserve • Tembe Elephant Park • Manguzi Forest Reserve • Maputaland Marine Reserve	1910.90	9
SGWCA	None		0
National Parks	None		0



Biospheres, Protected Areas and SGWCAs to show the portions of the Zululand Coastal Plain SWSA-gw that have protection status.

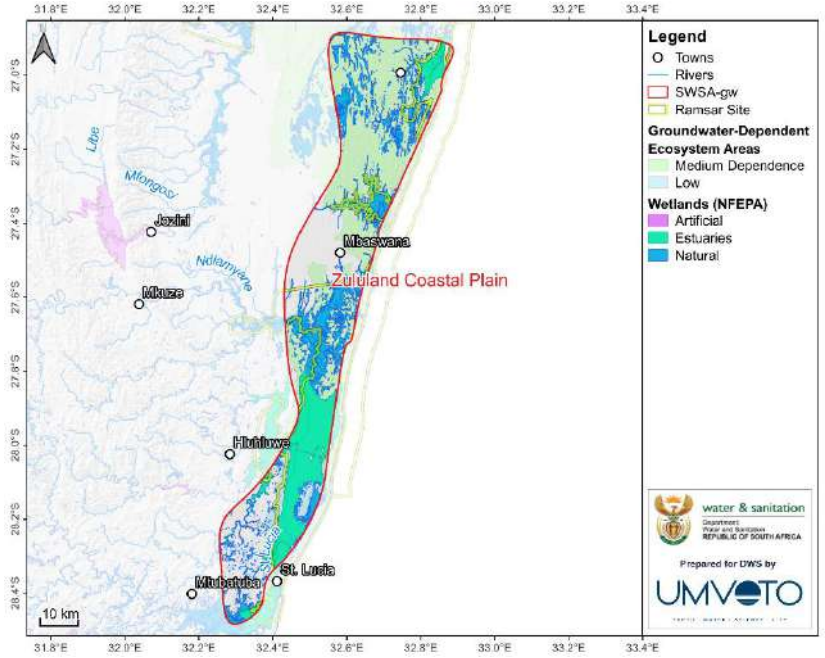
SWSA-gw Name:	Zululand Coastal Plain
Area:	3305 km²
Elevation:	19 to 100 mamsl

Protection Status and Ecosystems

Biodiversity and Conservation

The Zululand Coastal Plain SWSA-gw hosts significant major waterbodies (CSIR, 2011)—St Lucia Wetlands, St Lucia Estuary, and Lake Sibaya—covering 18.4% of the SWSA-gw. Four Ramsar sites (DFFE, 2024) are present, covering 33.4% of the SWSA-gw and highlighting the region's international importance for wetland and coastal conservation. The St. Lucia System covers a significant part of the SWSA-gw, situated on the southern half of the SWSA-gw, as displayed on the map. Wetlands (CSIR, 2018) with groundwater-dependent ecosystems (GDEs) (DWA, 2010) are also prominent, with medium- and low-dependence areas totalling 2,373.13 km² across nine locations.

Protection Status	Names	Area (km²)	Count
Major Waterbodies	• St Lucia Wetlands • St Lucia Estuary • Lake Sibaya	608.06	3
Ramsar Sites	• Kosi Bay • Lake Sibaya • St. Lucia System • Turtle Beaches/Coral Reefs of Tongaland	1103.42	4
Wetlands	Various natural, artificial and estuary wetlands	1065	



Map showing the major water bodies, Ramsar sites and GDEs in the Zululand Coastal Plain SWSA-gw.