High Confidence Groundwater Reserve Determination Study in the Berg Catchment

WP11398
Ecological Reference Conditions Report

Report Number: RDM/WMA19/02/CON/COMP/0522

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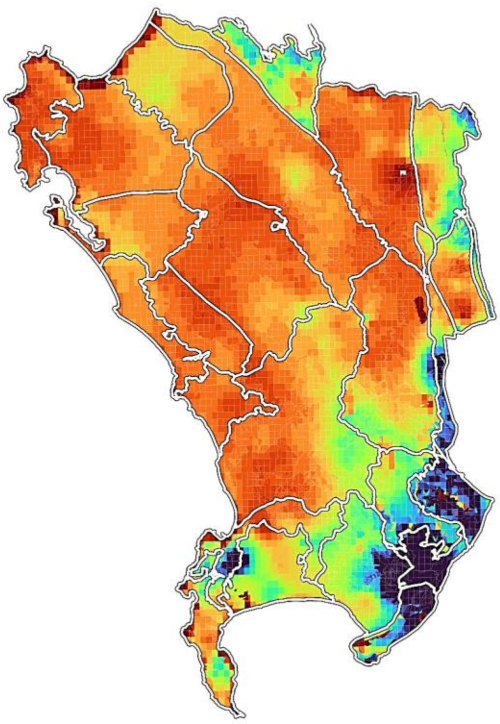

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Chief Directorate: Water Ecosystems Management

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Executive Summary

Due to the increasing number of Water Use Licence Applications (WULAs), and the associated effects the proposed developments may have on the groundwater Reserve in the Berg catchment, the Department of Water and Sanitation's (DWS) Chief Directorate: Water Ecosystems Management (CD: WEM) has initiated a High Confidence Groundwater Reserve Determination Study in order to assist the DWS in making sound management decisions regarding stressed or over-utilised water resources.

Through the implementation of the Resource Directed Measures (RDM), a process outlined in Regulation 2(4) of the National Water Act (No. 36 of 1998), and its obligation to ensure that all significant water resources are afforded a sustainable level of protection, the groundwater Reserve determination aims to support the gazetted Water Resource Classes and associated Resource Quality Objectives (RQOs) in completing the RDM.

Following the eight-step Reserve determination process, this report aims to describe the ecological reference conditions of aquifer-specific groundwater resource units (GRUs) and re-evaluate their present status. In the context of this study, 'ecological reference conditions' refers to the ambient or natural state of a groundwater system while the 'present status' refers to the current status in terms of utilisation and water quality. The report provides an overview of the previous groundwater status quo assessments and details around the criteria considered for a revised assessment.

The re-assessment of the groundwater status quo for the Berg catchment is Step 3 of the eight-step RDM: groundwater Reserve determination procedure (WRC, 2013), and, where appropriate, aligns with Step 1 and Step 2 of the Water Resource Classification process set out in Regulation 2(4). Five key hydrogeological components are discussed in this report, viz. Recharge, Groundwater Use, Discharge, Groundwater Quality and Aquifer Stress; which are important considerations for the implementation of an effective water resource management strategy.

Recharge

Several recharge estimation techniques were undertaken based on the hydrogeological nature of the specific GRUs. The selection considered the level of confidence and associated limitations of the methodology; the amount, spread and availability of data across the GRU; and the applicability of published datasets. Artificial recharge has been taken into account in the assessment, while lateral recharge from another aquifer unit will be addressed in the following step.

Groundwater Use

A variety of data sources were collated to assess the current groundwater use in the study area to provide a quantitative means of assessment (per GRU) as input to the groundwater Stress Index (SI). The index considers both groundwater water availability (natural/artificial recharge) and groundwater water use and aims to quantify Aquifer Stress by means of an associated Present Status (PS) category.

Discharge

Groundwater discharge represents the outflow of groundwater from aquifers to the surface or surface water systems as either direct or lateral via an adjacent aquifer unit. Groundwater contribution to baseflow was calculated to provide an aquifer specific estimation.

Groundwater Quality

Data from various sources was collated to provide a hydrochemical summary per GRU. Baseline water quality was assessed for each GRU (for select parameters) and potential sources of contamination identified. Selected groundwater parameters have also been evaluated for compliance with DWS (2019b:121) RQOs and groundwater quality Present Status categories assigned per GRU.

Aquifer Stress

In terms of the overall groundwater Reserve determination process, and in order to correlate the results of this study to existing Water Resource Classes & RQOs outlined in DWS (2019b: 121), the current ecological reference conditions were re-evaluated and the present state of the GRUs re-assessed. Three guidance tables were used in the groundwater characterisation including 1) sustainable use, 2) level of stress, and 3) contamination / water quality, to define Present Status Category for both groundwater availability and groundwater quality per GRU.

Guide for determining groundwater availability Present Status Category

Groundwater Availability Present Status Category	Description	Stress Index (GW use / Recharge)
A	Unstressed or slightly stressed	<0.05
B		0.05 – 0.20
C	Moderatly stressed	0.20 – 0.40
D		0.40 – 0.65
E	Highly stressed	0.65 – 0.95
F	Critically stressed	>0.95

Guide for determining groundwater contamination / groundwater quality Present Status Category

Water Quality (Present Status) Category	Description	Percentage exceedance
A	Unmodified, pristine conditions	<16.7 %
B	Localised, low levels of contamination, but no negative impacts apparent	16.7 – 33.4 %
C	Moderate levels of localised contamination, but little or no negative impacts apparent	33.4 – 50.1 %
D	Moderate levels of widespread contamination, which limit the use of potential use of the aquifer	50.1 – 66.8 %
E	High levels of local contamination which render parts of the aquifer unusable	66.8 – 83.5 %
F	High levels of widespread contamination which render the aquifer unusable	>83.5 %

Summary of Present Status Category per Groundwater Resource Unit in the Berg catchment

GRU	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
Cape Flats	D	D
Atlantis	C	C
Yzerfontein	A	A
Elandsfontein	B	B
Langebaan Road	C	B
Adamboerskraal	B	B
Cape Peninsula	B	B
Steenbras-Nuweberg	B	B
Drakensteinberge	A	-
Wemmershoek	A	A
Voëlvlei-Slanghoek	A	-
Witsenberg	A	-
Groot Winterhoek	B	-
Piketberg	C	-
Cape Town Rim	C	C
Stellenbosch-Helderberg	C	C
Paarl-Franschhoek	C	-
Malmesbury	C	B
Wellington	B	B
Tulbagh	C	-
Eendekuil Basin	C	C
Middle-Lower Berg	B	C
Northern Swartland	B	C
Darling	B	C
Vredenberg	B	-

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List of Abbreviations

%	Percentage
~	Approximately
<	Less than
BH	Borehole
BHN	Basic Human Needs
BRBS	Breede River Basin Study
CD: WEM	Chief Directorate: Water Ecosystems Management
CFA	Cape Flats Aquifer
CAGE	Citrusdal Artesian Groundwater Exploration
CMB	Chloride Mass Balance
CoCT	City of Cape Town
CRD	Cumulative Rainfall Departure
DEM	Digital Elevation Model
DWA	Department of Water
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
E	East
EC	Electrical Conductivity
e.g.	For example
Et al.	and others
etc.	etcetera
EWR	Ecological Water Requirements
Fm.	Formation
GIS	Geographic Information System
GRAII	Groundwater Resource Assessment (Phase II)
GRDM	Groundwater Resource Directed Measure
GRU	Groundwater Resource Unit
H	Hydrogen
i.e.	That is
IUA	Integrated Unit of Analysis
IWRM	Integrated Water Resource Management
Km	Kilometres
l/s	Litres per second
Ltd.	Limited Liability
m	Metres
m^3	Cubic Meters
M m^3	Million Cubic Meters
Ma	Million Years
MAE	Mean annual evaporation
mamsl	Meters above mean sea level
MAP	Mean Annual Precipitation
MAR	Managed Aquifer Recharge
mm	Millimetres
mm/a	Millimetres per annum
MOF	Model Overland Flow
MWL	Meteoric Water Line
N	North
NGA	National Groundwater Archive
NGDB	National Groundwater Database
NGwQMP	National Groundwater Quality Monitoring Programme
NWA	National Water Act
NWP	New Water Programme

PCA	Potentially Contaminating Activities
PES	Present Ecological State
pg.	Page
PHA	Philippi Horticultural Area
PS	Present Status
PSP	Professional Service Provider
Pty.	Proprietary
QGIS	Quantum Geographic Information System
RDM	Resource Directed Measure
RIB	Rainfall Infiltration Breakthrough
RQIS	Resource Quality Information Services
RQO	Resource Quality Objective
RU	Resource Unit
S	South
SA	South African
SAWS	South African Weather Service
SI	Stress Index
SVF	Saturated Volume Fluctuation
TEC	Target Ecological Category
TMG	Table Mountain Group
TMGA	Table Mountain Group Aquifer
TOR	Terms of Reference
UTM	Universal Transverse Mercator
W	West
WAAS	Water Availability Assessment Study
WARMS	Water Use Allocation and Registration Management System
WCWSS	Western Cape Water Supply System
WGS	World Geodetic System
WGS84	World Geodetic System (84)
WMA	Water Management Area
WMS	Water Management System
WR2012	Water Resources of South Africa 2012
WRC	Water Research Commission
WRCs	Water Resource Classes
WRCS	Water Resource Classification System
WULA	Water Use Licence Application

1. INTRODUCTION

1.1. Background

The Department of Water and Sanitation (DWS) Chief Directorate: Water Ecosystems Management (CD: WEM) has initiated a "High Confidence Groundwater Reserve Determination Study for the Berg Catchment". The project will support the gazetted Water Resource Classes and Resource Quality Objectives (RQOs) for the Berg catchment (Gazette No.42451:121 of 10 May 2019; hereafter referred to as DWS, 2019b: 121). The increasing number of water use licence applications (WULAs), the associated impacts that the proposed developments might have on the availability or quality of water, the conservation status of various resources within the Berg catchment, and the complexity of the study site's geological and hydrogeological characteristics make it increasingly impossible to assess WULAs using a low confidence desktop groundwater Reserve.

Integrated Units of Analysis (IUAs), Water Resource Classes and associated RQOs, delineated for the Berg catchment (DWS, 2019b: 121), have been gazetted as outcomes of the "Determination of Water Resource Classifications and Resource Quality Objectives in the Berg Catchment" study completed by Aurecon (Pty) Ltd from 15 April 2016 to 15 October 2018 (hereafter referred to as DWS, 2016). The Gazette (DWS, 2019b: 121) includes both Water Classes (in terms of Section 13(4)(a)(i)(aa) of the National Water Act (NWA), 1998) and RQOs for prioritized Resource Units (RUs) (in terms of Section 13(4)(a)(i)(bb) of the NWA, 1998) according to the overall class per IUA within the Berg catchment.

- IUAs are classified into catchment configurations and Water Resource Classes (**Figure 1-1**). These configurations consist of various biophysical nodes representing estuary and river reaches/river RUs and provide the Target Ecological Category (TEC) to be achieved or maintained for each RU within each IUA. Water Resource Classes are classified into Class I (high environmental protection and minimal utilisation), Class II (moderate protection and moderate utilisation), or Class III (sustainable minimal protection and high utilisation).
- RQOs are defined for prioritised surface water RUs within each IUA in terms of water quantity, habitat and biota, and water quality (**Figure 1-2**). RQOs were established for RUs and biophysical nodes, including:
    - Rivers
    - Estuaries
    - Dams
    - Wetlands
- RQOs are defined for prioritised groundwater RUs within each IUA in terms of groundwater quantity (abstraction, low-flow in river, discharge and groundwater level) and groundwater quality (nutrients, salts, pathogens and various system variables).

This study aims to determine the required groundwater contribution in terms of quantity and quality to satisfy the Basic Human Needs (BHN) Reserve and Ecological Water Requirements (EWR) for the Berg catchment (DWS, 2022a).

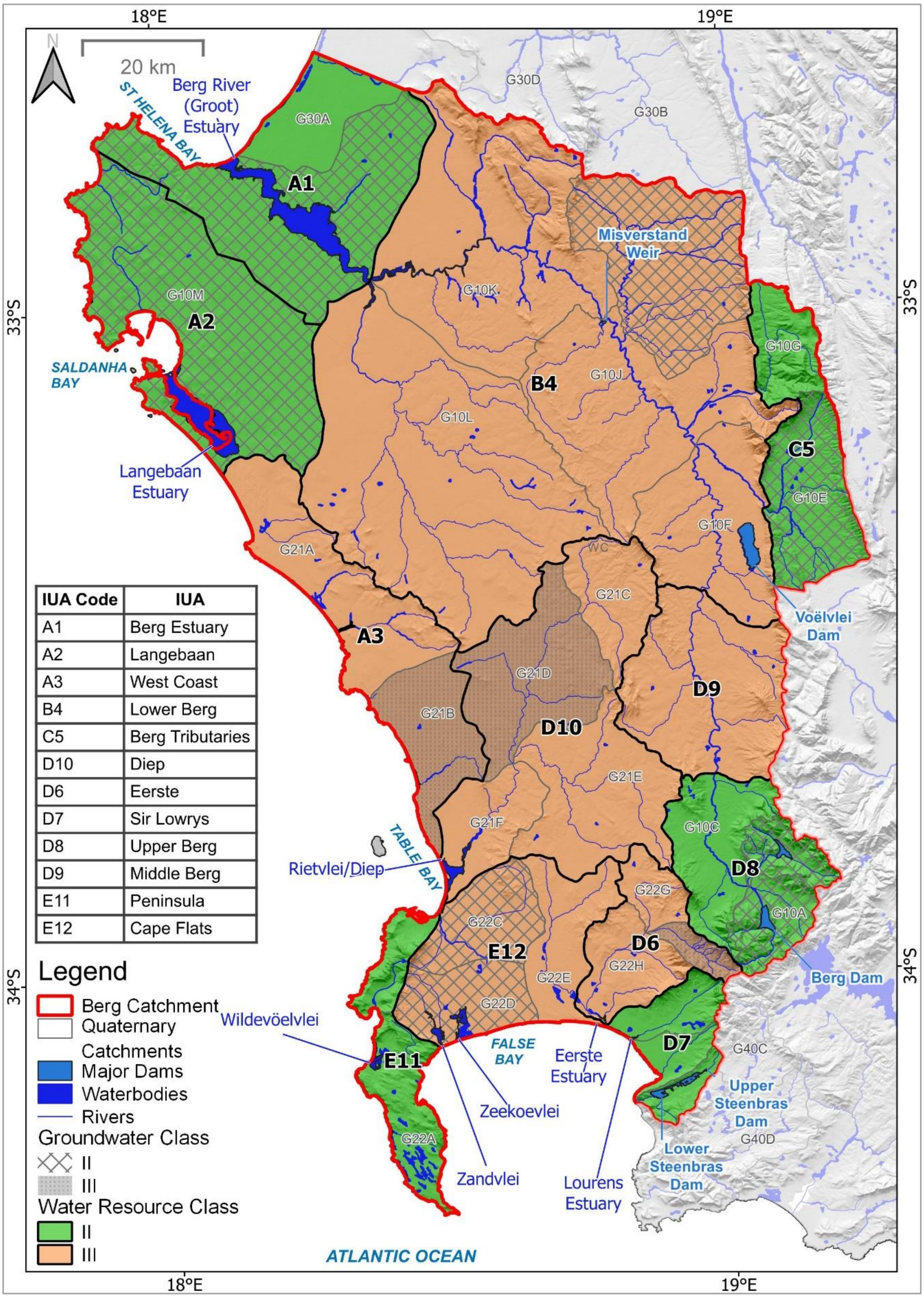


Figure 1-1 **Integrated Units of Analysis (IUAs), Water Resource Classes (WRCs) and Groundwater Classes for the Berg catchment after DWS (2019b: 121).**

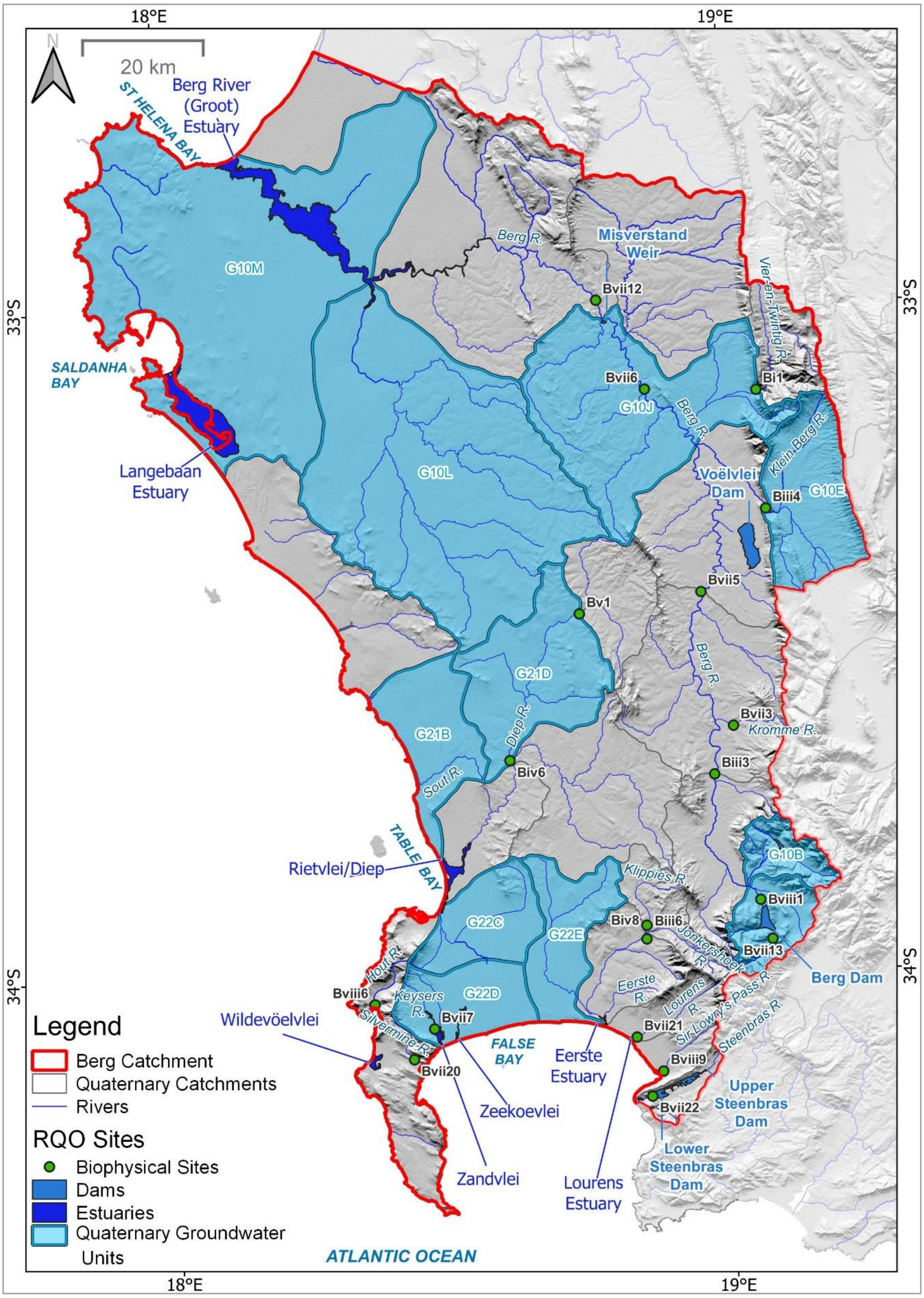


Figure 1-2 **Priority quaternary catchments, biophysical sites (rivers nodes and estuaries nodes), and dams with gazetted Resource Quality Objectives (RQOs) after DWS (2019b: 121).**

1.2. Terms of Reference

The Terms of Reference (TOR) for the study, as provided by the DWS CD: WEM, stipulates the aims and objectives as follows:

"The primary objective of this study is to determine a high confidence groundwater Reserve requirements (quantity and quality) to satisfy the basic human needs and to protect aquatic ecosystems in different priority water resources within the Berg catchment"

"Detailed determinations aim to produce high-confidence results, are based on site-specific data collected by specialists and are used for all compulsory licensing exercises, as well as for the individual licence applications that could have a large impact on any catchment, or a relatively small impact on ecologically important and sensitive catchments"

The groundwater Reserve determination aims to support the gazetted Water Resource Classes and associated RQOs (DWS, 2019b: 121) in completing the Resource Directed Measures (RDM) process as defined by Regulation 2(4) of the NWA (No. 36 of 1998; referred to as Regulation 2(4) hereafter). The Reserve will assist the DWS in making sound management decisions regarding stressed or over-utilised catchments, and also ensuring that water resources are afforded a level of protection that will assure a sustainable level of utilisation in the future (DWS, 2022a).

1.3. Aims of this report

According to Regulation 2(4), the Reserve determination process must follow the eight-step procedure outlined in the RDM manuals. To distinguish between RDM in general and RDM related to groundwater, the term Groundwater Resource Directed Measures (GRDM) will be used. The GRDM manuals consulted for this report include WRC (2013), WRC (2007), as well as the preliminary findings from an ongoing review of RDM manuals by the Water Research Commission (WRC).

The aim of this report is to describe the ecological reference conditions and present state (i.e., Step 3 of the eight-step GRDM: Reserve determination procedure) of the aquifer-specific groundwater resource units (GRUs) delineated as part of Step 2 of the Reserve determination process (see DWS, 2022d). The ecological reference conditions and Present Status (PS) assessment will, where appropriate, align with Step 1 and Step 2 of the 7 step GRDM: Water Resource Classification procedure set out in Regulation 2(4) and outlined in WRC (2013).

This report will provide an overview of previous status quo assessments for groundwater in the Berg catchment and provide detail on both the approach and criteria considered for a revised groundwater status quo based on updated GRUs. Status quo descriptions will be provided per RU and summarised for the GRU as a whole. **The Ecological Status Report is Deliverable 3.2** of Phase 3 of this study.

A detailed overview of the study approach and the scope of work is outlined in the projects Inception Report (DWS, 2022a) and summarised in **Table 1-1**.

Table 1-1 Summary of project phases, tasks, and associated deliverables for the High Confidence Groundwater Reserve Determination Study in the Berg Catchment. Reserve determination steps according to WRC (2013).

Phase 1	**Project Inception**		
Task 1	Inception		Deliverable 1: Inception Report
Phase 2	**Review of Water Resource Information and Data**		
Task 2.1	Data collection and collation		Deliverable 2.1: Gap Analysis Report Deliverable 2.2: Inventory of Water Resource Models
Phase 3	**Reserve Determination**		
Task 3.1	Step 1	Initiate Groundwater Reserve Study	Recorded in Deliverable 2.1 and Deliverable 2.2
Task 3.2	Step 2	Water RU Delineation	Deliverable 3.1: Delineation of Water RUs Report
Task 3.3	**Step 3**	**Ecological Reference Conditions of RUs**	**Deliverable 3.2: Ecological Reference Conditions Report**
Task 3.4	Step 4	Determine BHN and EWR	Deliverable 3.3: BHN and EWR Requirement Report
Task 3.5	Step 5	Operational Scenarios & Socio-economic	Deliverable 3.4: Operational Scenarios & Socio-Economic and Ecological Consequences Report
Task 3.6	Step 6	Evaluate Operational Scenarios with Stakeholders	Deliverable 3.5: Stakeholder Engagement of Operational Scenarios Report
Task 3.7	Step 7	Monitoring Programme	Deliverables 3.6: Monitoring Programme Report
Task 3.8	Step 8	Gazette & implement Reserve	Deliverable 3.7: Groundwater Reserve Determination Report Deliverable 3.8: Database Deliverable 3.9: Gazette Template

2. PREVIOUS STATUS QUO

As part of the initiation of the RDM and the process for determining the Water Resource Classification in the Berg catchment, DWS (2016) provides a status quo assessment of all significant water resources (both surface water and groundwater) per IUA. The outcome of “The Determination of Water Resource Classifications and Resource Quality Objectives in the Berg Catchment” (DWS, 2016) will therefore be used as the foundational input for this study.

2.1. Summary of Surface Water Status Quo

DWS (2016) presents information relating to the individual sub-steps under Step 1 (i.e., Delineation of IUA and describe the status quo of the water resources) of the 7-Step RDM Water Resource Classification procedure (WRC, 2007), and includes descriptions of the present-day socio-economic status, the present-day community wellbeing, the value of water use, the value of ecosystem use, and the network of significant water resources and associated biophysical and allocation nodes within each IUA.

As stated in the Inception Report (DWS, 2022a), the outcomes and associated datasets that informed the gazetted Water Resource Classes and RQOs for the Berg catchment (DWS, 2019b: 121), specifically the DWS (2016) study and the resultant compilation of reports (DWS, 2016a - e, 2017a - d, 2018a - e, 2019), will provide the framework for the socio-economic, surface water (rivers, dams, estuaries, and wetlands) and ecological understandings of this high confidence groundwater Reserve determination. This data is considered sufficient as a PS assessment for surface water and will be used as inputs into the revised groundwater status quo.

2.2. Summary of Previous Groundwater Status Quo

Ten GRUs were delineated during the DWS (2016) study. The Resource Unit Delineation and Integrated Units of Analysis Report (DWS, 2016d) together with the Status Quo Report (DWS, 2017a) outlines the present status of groundwater in the Berg catchment (**Figure 2-1** and **Table 2-1**; after DWS, 2019b: 121).

The delineation approach, as described in DWS (2016d), considered both previous hydrogeological delineations, including the Integrated Water Resources Management (IWRM) domains delineated as part of DWAF (2007), as well as other hydrogeological features such as geological structures (fault zones, lithological contact zones and hydrostratigraphy), river systems, potential recharge and discharge zones, groundwater use, groundwater management (in terms of the size and extent of the units), and surface water divides on a quaternary and secondary catchment level scale. The Berg Water Availability Assessment Study’s (WAAS) hydrogeological delineation, specifically the DWAF (2007), DWAF (2008a) and DWAF (2008b) reports, was a significant contributor to the previous GRUs defined for the Berg catchment. It formed the basis of the groundwater understanding in the DWS (2016) study in terms of GRU boundary extents, aquifer types, aquifer characteristics, regional groundwater flow, potential recharge, water quality and the overall conceptual understanding of the study area (see DWS, 2022d).

The status quo assessment, presented in DWS (2017a), provides a trend analysis of both groundwater quality and groundwater levels, and includes descriptions of estimated recharge (**Table 2-2**), groundwater use (**Table 2-3, Table 2-4**, and **Table 2-5**), groundwater quality (**Table 2-7**), and discharge estimations per GRU.

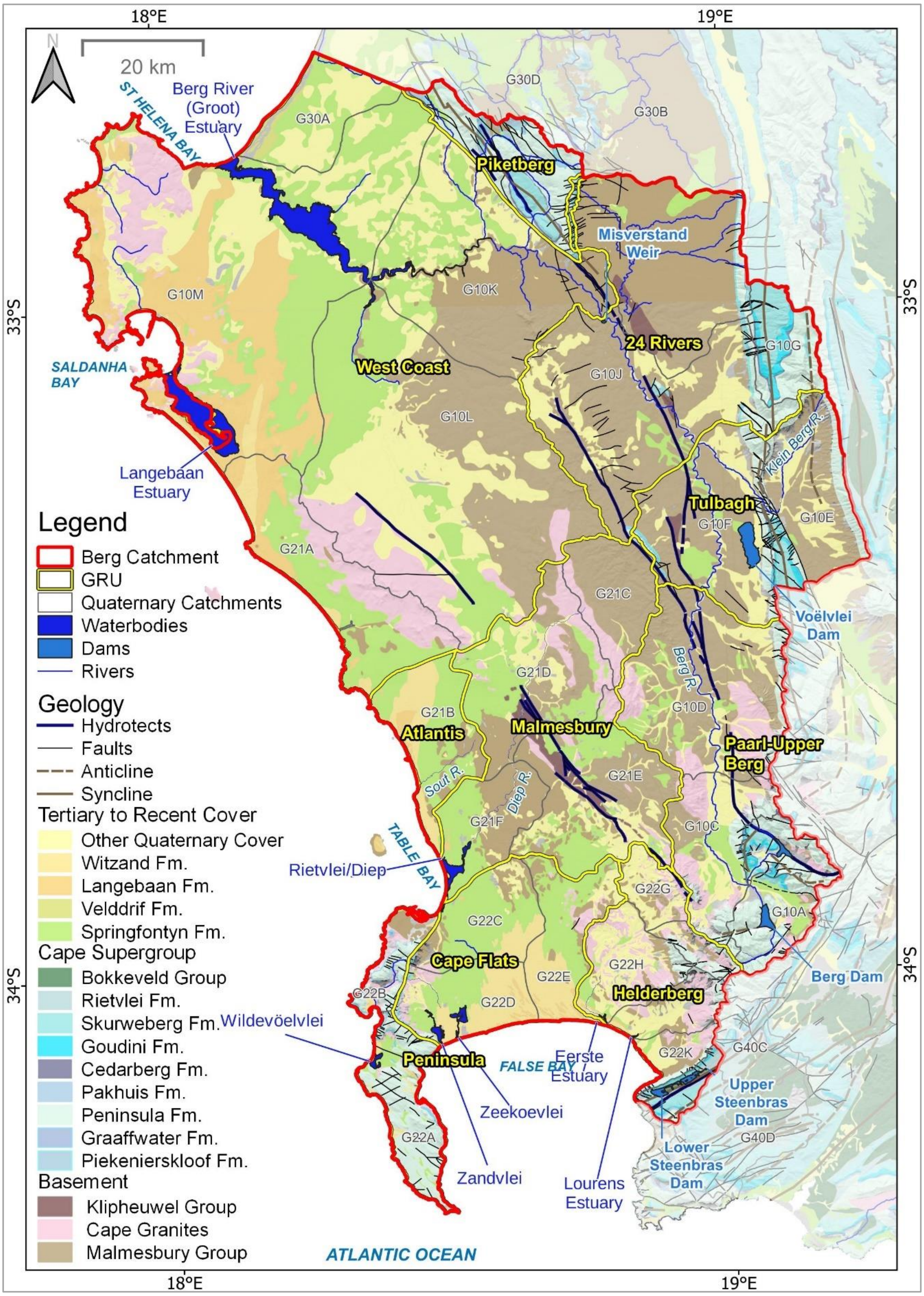


Figure 2-1 Previously defined Groundwater Resource Units (GRUs) for the Berg catchment (after DWS, 2016d).

Comments on the monitored groundwater level decline (and what that may represent) were provided for each GRU by comparing both rainfall variations and the shape of the groundwater level decline curves to typical pump curves (by eye). This technique was applied based on the theoretical background described in DWS (2017a) that discusses how groundwater level decline alone cannot be used as an indication of maintainable abstraction rates or as a measure of un-sustainability (based on the definition of sustainable groundwater use (DWS, 2017a) as "groundwater use that is socially, environmentally (ecologically), and economically acceptable").

Table 2-1 Summary of previously defined GRUs for the Berg catchment with the associated boundary-forming surface water quaternary catchments (after DWS, 2016d). Areal extents of previous GRUs are shown in Figure 2-1.

Sub-region	GRU	Associated Surface Water Quaternary Catchment
Greater Cape Town	Peninsula	G22A and G22B
	Cape Flats	G22C; G22D and G22E
	Helderberg	G22G; G22H; G22K; G22J and G22F
Upper Berg	Paarl- Upper Berg	G10A; G10B; G10C and G10D
	Tulbagh Valley	G10E and G10F
	24 Rivers	G10G; G10H and G10J
Lower Berg	Piketberg	G30A; G30D and G10K
	West Coast	G10K; G10M; G10L; G21A and G30A
	Atlantis	G21B
	Malmesbury	G21C; G21D; G21E and G21F

Table 2-2 Estimated recharge as a sum (M m^3/a) and average (mm/a) per previously delineated GRU (after DWS, 2017a).

Name	Sum (M m^3/a)	Average (mm/a)
24 Rivers	59.61	35
Atlantis	16.36	40
Cape Flats	66.13	86
Helderberg	88.08	145
Malmesbury	48.52	35
Paarl-Upper Berg	197.14	150
Peninsula	50.68	146
Piketberg	31.56	23
Tulbagh	50.85	54
West Coast	112.37	21
Total	**721.3**	**n/a**

Table 2-3 Summary of groundwater use as registered in WARMS, including the number and sum of registrations (M m^3/a) per previously delineated GRU (after DWS, 2017a).

Name	Number of Registrations	Sum of Registrations (M m^3/a)
24 Rivers	37	2.00
Atlantis	23	7.51
Cape Flats	125	11.62
Helderberg	109	3.33
Malmesbury	214	10.50
Paarl-Upper Berg	325	10.77
Peninsula	9	0.10
Piketberg	64	6.20
Tulbagh	104	5.66
West Coast	68	8.21
Total	**1078**	**65.89**

Table 2-4 Summary of groundwater use within the Berg catchment as registered in WARMS, including the sum of registrations (M m^3/a) per water use sector (after DWS, 2017a).

Water Use Sector	Sum of registrations (M m^3/a)
Agriculture: Irrigation	47.05
Industry (Urban)	13.38
Agriculture: Watering Livestock	3.02
Water Supply Service	1.40
Agriculture: Aquaculture	0.53
Industry (Non-Urban)	0.22
Schedule 1	0.16
Urban (Excluding Industrial &/or Domestic)	0.08
Mining	0.04
Recreation	0.01
Total	**65.89**

Table 2-5 Summary of groundwater use as registered in WARMS, per major geological grouping (based on assigned surface geology to point data) for the Berg catchment (after DWS, 2017a)

Geological grouping	Sum of registrations (M m^3/a)	Number of registrations	Average volume per registration (m^3/a)
Coastal Cenozoic Deposits	44.42	628	70 729
TMG	7.09	88	80 579
Basement And Intrusive	14.38	362	39 718
Total	**65.89**	**1078**	**n/a**

Table 2-6 Summary of settlements (per previously delineated GRU) supplied by groundwater within the Berg catchment (after DWS, 2017a).

GRU	Settlement	% GW supplied	GW Yield (M m³/a)
Atlantis	City of Cape Town (Atlantis Wellfield)	2	18.42
Cape Flats	City of Cape Town (Albion Spring)		
24 Rivers	Piketberg	25	0.24
	Porterville	23	0.2
Malmesbury	Malmesbury, Abbotsdale	1	0.02
Paarl-Upper Berg	Franschhoek & Groendal, La Motte, Wemmershoek, Roberstvlei	13	0.22
Piketberg	Redelinghuys	100	0.05
Tulbagh	Tulbagh	4	0.03
	Riebeek Kasteel	1	0.003
West Coast	Aurora	100	0.06
	Hopefield	30	0.16
	Langebaan, Langebaanweg, Saldanha	17	1.35
Total	**n/a**	**n/a**	**20.753**

2.3. Limitations

Although DWS (2016d) considered geological controls, GRUs were primarily delineated according to surface water catchments with varying aquifer types grouped (see **Table 2-1** and **Figure 2-1**). A number of RUs were grouped into different sub-catchments in order to achieve the integration of both surface water and groundwater systems. Additionally, important aquifers such as the Table Mountain Group Aquifers (TMGA) in the Steenbras area, that the City of Cape Town (CoCT) is currently developing, were not included in any of the previous GRUs defined as part of the DWS (2016) study.

It is important to note that although the entire GRU was delineated, only the parts of the GRU that fell within the study area (i.e., the former Berg Water Management Area (WMA) – a surface water derived management boundary) was considered in the groundwater status quo (i.e., DWS, 2017a). Additionally, surface geology was assigned to point data due to the scarcity of datapoints (i.e., boreholes) with available geological logs, water levels and water quality data. This, however, was not a conclusive indicator of the targeted RU, which according to the TORs of this high confidence groundwater Reserve determination, is required for a comprehensive present state assessment for groundwater.

Table 2-7 **Average groundwater quality parameters for major geological groupings (based on assigning surface geology to point data) and compared to DWAF Drinking Water Quality Limits [1] (DWS, 2017a).**

		Drinking Water Quality Limits - DWAF, 1996; DOH and WRC, 1998			Major Geology Grouping		
		Class 1	Class 2	Class 3	Basement	TMG	Coastal Cenozoic Deposits
No. of locations					487	53	1472
pH Value at 25⁰C	mg/l	5-6 or 9-9.5	4-5 or 9.5-10	3.5-4 or 10-10.5	7.37	6.31	7.25
Conductivity at 25⁰C	mS/m	70-150	150-370	370-520	329.76	70.18	185.34
Sodium (Na)	mg/l	100-200	200-600	600-1200	530.83	96.52	272.21
Calcium (Ca)	mg/l	80-150	150-300	>300	60.08	11.56	55.01
Magnesium (Mg)	mg/l	30-70	70-100	100-200	80.56	14.57	42.23
Fluoride (F)	mg/l	0.7-1	1-1.5	1.5-3.5	0.64	0.27	0.4
Chloride (Cl)	mg/l	100-200	200-600	600-1200	985.62	181.24	521.88
Sulphate (SO_4)	mg/l	200-400	400-600	600-1000	120.83	25.46	81.06
Total Alkalinity ($CaCO_3$)	mg/l				124.25	25.46	97.65
NO_3-N	mg/l	0-10	10-20	20-40	4.25	1.74	2.8

[1] Mean averages are presented. Medians are preferable for analysis of water quality however due to the large datasets automated averaging was necessary which does not accommodate medians. The values should be considered maximums as a mean can be significantly skewed by outliers.

3. GROUNDWATER RESOURCE UNITS

In order to meet the TOR for this study, the previous GRU delineation for the Berg catchment was re-evaluated and updated to ensure all groundwater resources are aquifer specific. The term "aquifer-specific" in this context indicates that GRU extents where selected based on the physical geometry (predominantly controlled by geology), recharge areas, and aquifer boundary conditions, therefore, a single GRU may contain multiple RUs.

DWS (2022d) outlines the approach for delineating aquifer-specific GRUs and provides detail around the physical, management and functional criteria considered for selecting their extents. The revised aquifer-specific GRU extents are seen in **Figure 3-1** with the associated quaternary catchments they incorporate or overlap included in **Table 3-1**.

Table 3-1 Summary of Groundwater Resource Units (GRUs) in the Berg Catchment. Areal extents of GRUs are shown in Figure 3-1.

GRU name	Associated Surface Water Quaternary Catchment
Primary / Intergranular Aquifers	
Cape Flats	G22C, G22D and G22E
Atlantis	G21A, G21B and G21D
Yzerfontein	G21A
Elandsfontein	G10M and G10L
Langebaan Road	G10M and G10L
Adamboerskraal	G10M, G10K and G30A
Fractured Aquifers – Table Mountain Group (TMG)	
Cape Peninsula	G22A, G22B, G22C and G22D
Steenbras-Nuweberg	G40B, G40A, G40D, G22J, G22K, H60A and G40C
Drakensteinberge	G10A, G10C, G22F, G22J, H60A and H60B
Wemmershoek	G10B, G10A, G10C, H10J, H60B and H10K
Voëlvlei-Slanghoek	G10E, G10J, G10D, G10F, H10E, H10F and H10J
Witsenberg	G10E
Groot Winterhoek	G10J, G10E, G10H, E10C and G10G
Piketberg	G10M, G30D, G10K, G30A and G10H
Fractured and Intergranular Aquifers - Basement	
Cape Town Rim	G22C, G22E, G22B and G22D
Stellenbosch-Helderberg	G22G, G22H, G22F, G22J and G22K
Paarl-Franschhoek	G10C, G10A and G10B
Malmesbury	G201E, G21C, G21D, G21F and G21B
Wellington	G10D and G10F
Tulbagh	G10E and G10G
Eendekuil Basin	G10H, G10J, G10F and G10K
Middle-Lower Berg	G10J, G30A, G10K and G10M
Northern Swartland	G10L
Darling	G10L and G21A
Vredenburg	G10M

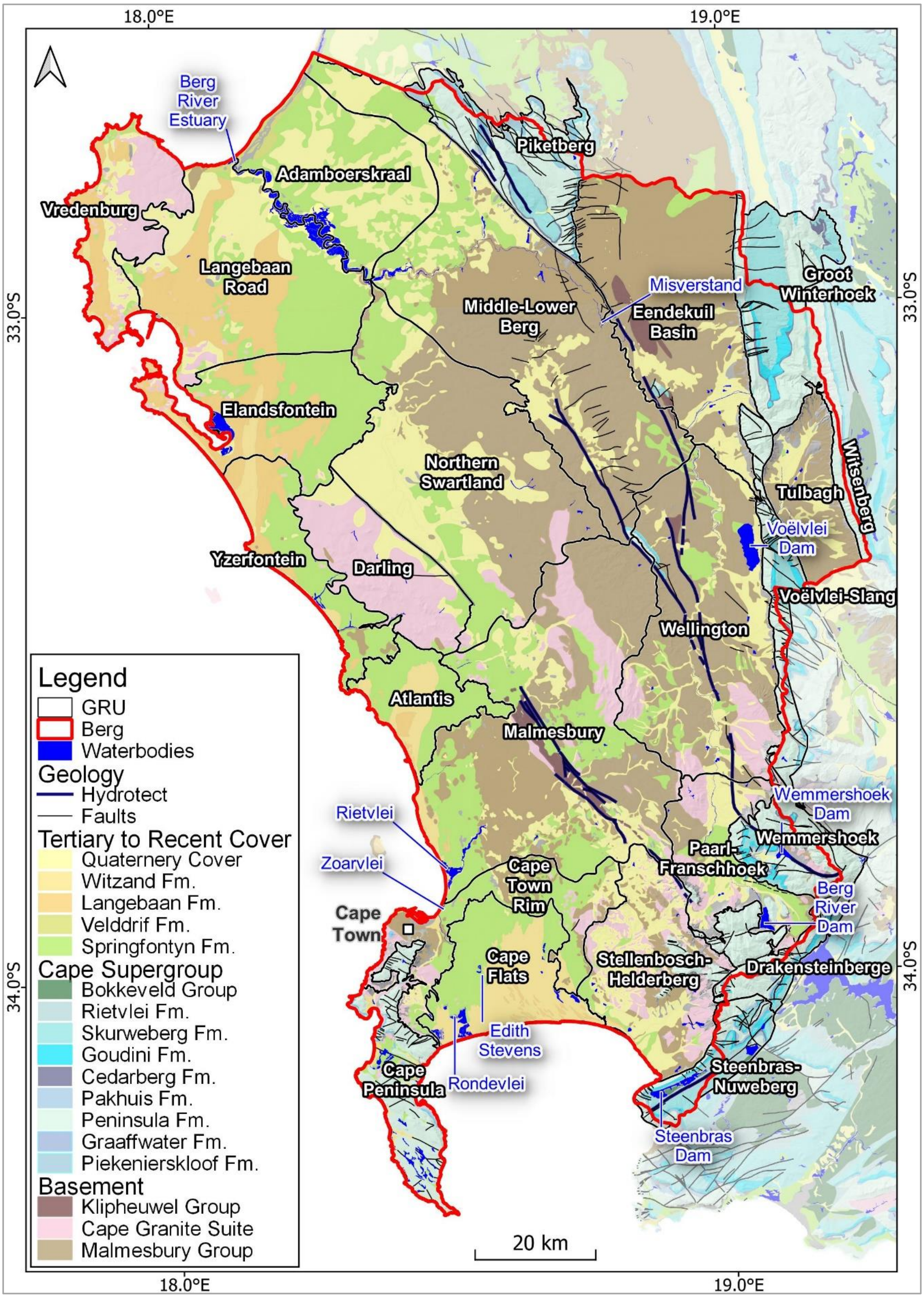


Figure 3-1 **Revised Groundwater Resource Units (GRU) extents for the Berg catchment with associated geology and structural features (including hydrotects). GRUs are extended outside of the Berg catchment area, i.e., the former Berg Water Management Area (WMA), therefore study boundary extends outside of the Berg catchment.**

3.1. Study Area Description

3.1.1. Geological Description

The geological history is described and can be followed alongside the summary in **Figure 3-1**. The basement geology of the Berg catchment predominantly comprises of the Neoproterozoic Malmesbury Group greywacke and shales deposited during the Saldanian orogeny (650 – 550 Ma; Barnett, et al., 1997). During and after orogenesis, the Malmesbury Group were intruded by the Cape Granite Suite plutons (630 – 520 Ma; Gresse, et al., 1992) and in some areas such (as Tulbagh and Franschhoek) some low-grade metamorphism took place on the Malmesbury Group rocks (Ransome & de Wit, 1992). A major unconformity separates the sequence after which the Klipheuwel Group was deposited in fault-bound basins defining the change in depositional environment from orogenic to rifting. This increase in accommodation space left by the Malmesbury Group allowed for the Klipheuwel Group to include more alluvial sediments (Broquet, 1992).

Significant erosion took place before the Cape Supergroup deposited, such that the TMG unconformably deposited over the Malmesbury Group ~510 Ma (Broquet, 1992). This began in a marine environment, starting with the Piekenierskloof and Graafwater formations followed by the Peninsula Formation. The Pakhuis and Cederberg formations (shale) deposited after this, followed by the Nardouw Subgroup hosting the Goudini (siltstone), Skuwerberg (sandstone) and Rietvlei (sandstone) formations. The TMG is known for forming the highly resistant sandstone/quartzite mountains of the Cape Fold Belt above the easily eroded valleys of the Malmesbury Group shales. After the deposition of the TMG, the Bokkeveld Group shales were deposited interbedded with thin sandstone strata (~390 Ma) representing an increase in subsidence and extension (Broquet, 1992). In the eastern part of the Berg area, the Witteberg Group is present as well as the unconformably overlain Karoo Supergroup.

Dolerite dykes intruded ~132 Ma into both the Malmesbury Group and the Cape Granite Suite and can be found in False Bay, in the south-western part of the Berg catchment (Reid, et al., 1991). The Cape orogeny, a mountain-building event of significant compressional tectonic activity was followed by rifting of the supercontinent Gondwana, whereby the Uitenhage Group deposited in basins (~177 Ma). After this period, significant erosion took place marking a major unconformity. The Tertiary to Recent cover unconformably overlayed the exposed geology, mostly being the Cape Supergroup or the basement cover of Malmesbury Group and Cape Granite Suite in the Berg catchment (see **Figure 3-1**). The Tertiary to Recent cover in the Berg area comprises of the erosive deposits some of which can be traced to the weathering of the TMG or Malmesbury Group. The Sandveld Group composing of the Elandsfontein, Saldana and Varswater formations of fluvial-marine, and the aeolian sands of the Springfontyn, Velddrif, Langebaan and Witzand formations are largely present.

Table 3-2 Stratigraphic overview of the Berg catchment area and its corresponding hydrostratigraphy (CoCT, 2020b; CoCT, 2021b).

Stratigraphy			Hydrostratigraphy		
Supergroup	**Group**	**Formation**	**Superunit**	**Unit**	**Sub-unit**
	Sandveld	Witzand	Major Primary Aquifer	-	-
		Springfontyn			
		Langebaan	Primary Aquifer	-	-
		Varswater			
		Elandsfontyn	Major Primary Aquifer	-	-
~~~~ Cape Orogeny (~280-230 Ma) and major unconformity / Gondwana breakup (~180-110 Ma) ~~~~					
Cape	Witteberg	(various)	-	Various minor sandstone aquifers (Witpoort/Floriskraal)	
	Bokkeveld	(various)	-	Gydo Mega-aquitard	Various minor sandstone formation subaquifers
	Table Mountain	Rietvlei	Table Mountain Superaquifer	Nardouw Aquifer	Rietvlei Subaquifer
					Verlorenvalley Mini-aquitard
		Skuwerberg			Skuwerberg Sub-aquifer
		Goudini		Winterhoek Mega-aquitard	Goudini Meso-aquitard
		Cedarberg			Cedarberg Meso-aquitard
		Pakhuis			Pakhuis Mini-aquitard
		Peninsula		Peninsula Aquifer	Platteklip Subaquifer
					Leeukop Subaquifer
		Graafwater		Graafwater Aquitard	-
		Piekenierskloof		Piekenierskloof Aquifer	-
	Klipheuwel			Pre-Cape Aquitards	-
~~~~ Major unconformity / period of rifting ~~~~					
Saldania Belt	Cape Granite Suite	-	-	Basement Aquifers / Aquitards / Aquicludes	-
	Malmesbury				-

3.1.2. Structural Description

Due to the orogenic events, the Malmesbury Group hosts some faulting of both dip-slip and strike-slip mechanisms along with NW-striking fabric (Hartnady, et al., 1974). Other than those that have undergone reactivation through the structural inheritance of the Cape Supergroup, the older Malmesbury Group faults are not considered to be relevant to the Berg catchment study.

The Cape Supergroup faults are separated into two branches connected by a syntaxis. The western branch is orientated N-S while the southern branch is E-W. The Berg catchment is positioned South of the syntaxis, hence the majority of the faulting is orientated NW-SE. Movement of the Cape Fold Belt faults have been found to be of Jurassic-Cretaceous age, with some recent reactivation having occurred on the Milnerton Fault and Worcester Fault (Halbich, 1992). Other faults in the Berg catchment include the Colenzo, Moorreersburg, Piketberg-Aurora, Tulbagh Road, Elandskloof, La Motte, Klein Drakenstein and Du Toit Faults (all normal extensional and orientated roughly NW-SE). The Steenbras Fault is strike-slip and is the only fault in the study area orientated NE-SW.

The fold axes in the northern section of the Berg catchment trend N-S, while the central and southern section hosts mostly NE-SW trending folds along the Cape Fold Belt syntaxis. Piketberg, the southern Franschhoek mountains and the eastern section of the Berg catchment hosts folds with axes trending NW-SE.

3.1.3. Aquifer Type Description

Three types of aquifers are distinguished in the study area and are seen in **Figure 3-1.** Primary or ‘intergranular’ aquifers are defined as porous, sandy aquifers. These are attributed to the sediments of the Bredasdorp and Sandveld Group as well as Quaternary deposits form the Cape Flats Aquifer, Atlantis/Silwerstroom and the West Coast Yzerfontein, Adamboerskraal, Elandsfontein and Langebaan Road aquifers. Due to the unconsolidated nature of the sediments, infiltration is high and consequently may increasing the risk of contamination.

Secondary or ‘fractured’ aquifers are related to fracturing of the geology supporting the permeability of the aquifer. The resistant sandstone/quartzite Table Mountain Group hosts formations that allow for high yielding fractured aquifers with good water quality, namely the Peninsula and Nardouw (Skuwerberg and Rietvlei formation) aquifers.

Tertiary, regolith or ‘intergranular-and-fractured’ aquifers have both near-surface fracturing and chemical weathering influencing the aquifer. Areas with the geomorphically weak Malmesbury Group have fractures considered to be incapable of supporting an aquifer and so are considered to be regolith aquifers (DWAF, 2005).

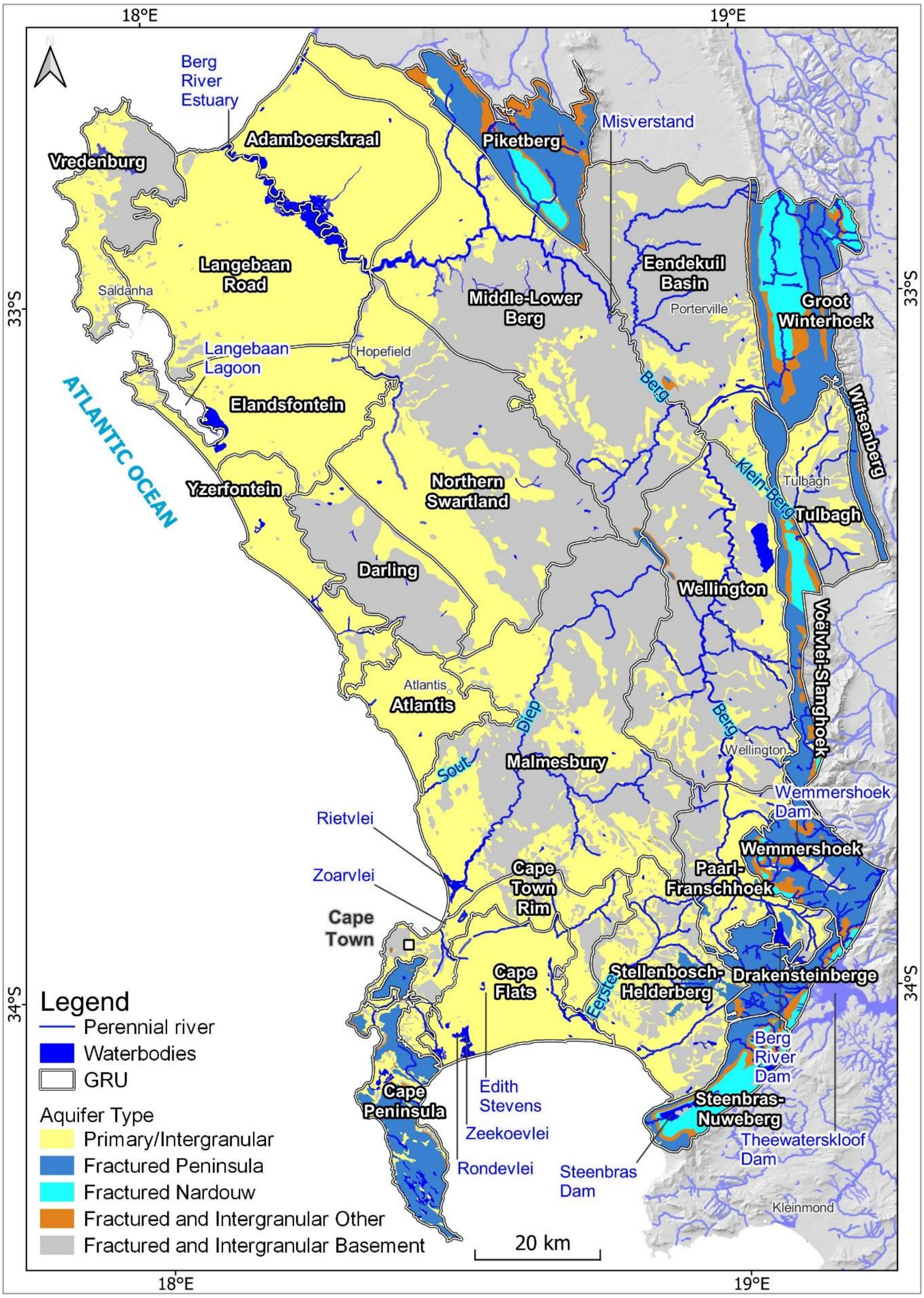


Figure 3-2 **Revised Groundwater Resource Units (GRU) extents for the Berg catchment with associated aquifer types.**

4. UPDATED STATUS QUO APPROACH

The determination of the groundwater status quo or Present Status (PS) of groundwater in the Berg catchment is Step 3 of the eight-step GRDM: Reserve determination procedure (WRC, 2013), and will, where appropriate, align with Step 1 and Step 2 of the Water Resource Classification process set out in Regulation 2(4) (**Figure 4-1**). Redefined aquifer-specific GRUs, delineated as part of Step 2 (DWS, 2022d), are used to provide an updated groundwater status quo (considering the limitations of the previous GRU extents and the aquifer-specific nature of the updated GRUs).

Five key hydrogeological components are assessed; viz. Recharge, Groundwater Use, Discharge, Groundwater Quality and Aquifer Stress. Particular outcomes from the previous groundwater status quo (DWS, 2017a) and the datasets that informed the gazetted Water Resource Classes and RQOs, specifically DWS (2016) and DWAF (2007) provide inputs for the updated status quo approach and assessment.

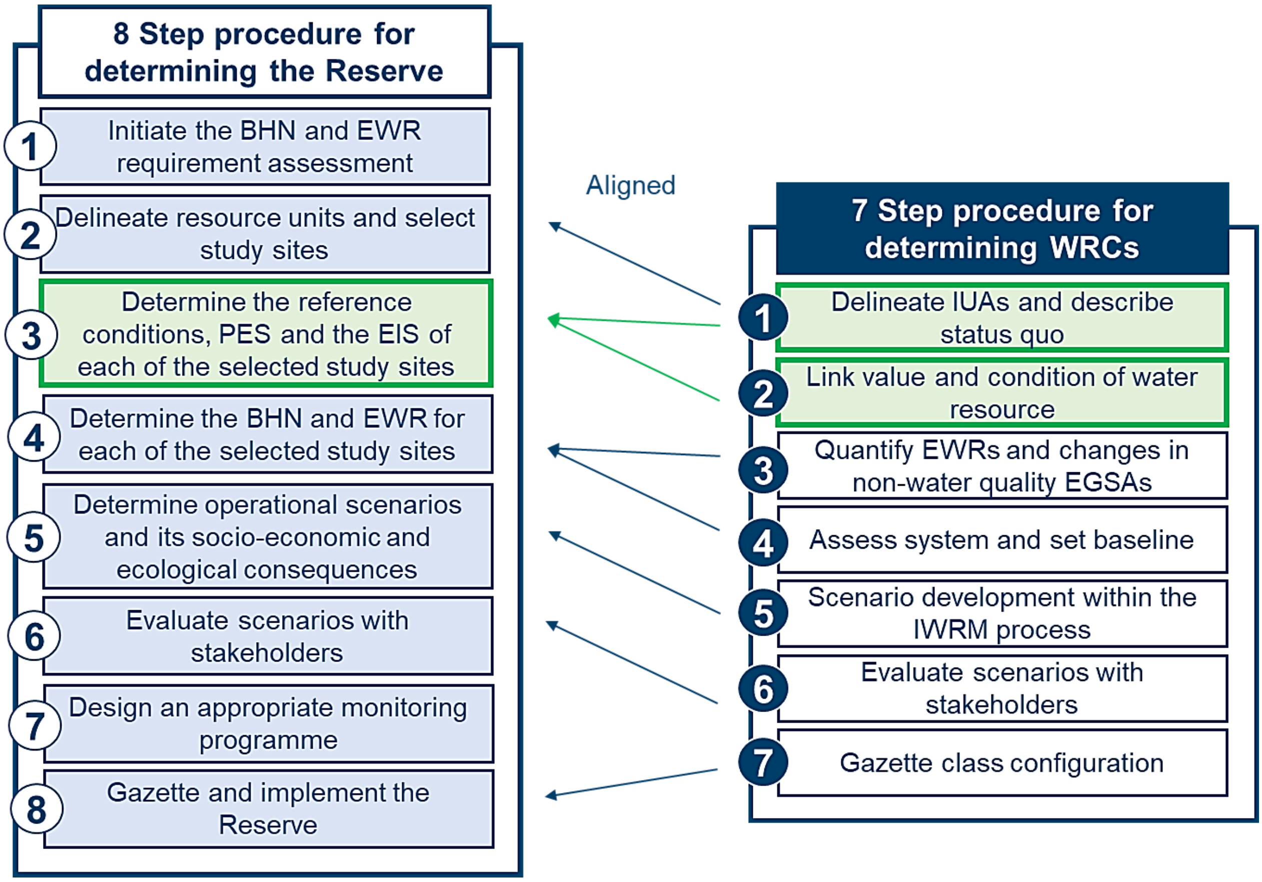


Figure 4-1 **The 8-step procedure for determining the groundwater Reserve and its alignment with the 7-step Water Resource Classification procedure as defined by Regulation 2(4) of the National Water Act (NWA, No. 36 of 1998) and outlined in WRC (2013).**

4.1. Rainfall Data Comparison

To determine whether the WR2012 rainfall dataset is still relevant and can be used as input for first order recharge estimations, a rainfall comparison was undertaken with more recent available data in the Berg catchment. Several weather stations with more than 10 years of recent records were selected, namely from the Cape Flats, Atlantis, Steenbras/Nuweberg, and Eendekuil Basin GRUs, as well as two additional South African Weather Service (SAWS) stations. The location of each station is listed in **Table 4-1**, together with the calculated Mean Annual Precipitation (MAP) for the available period. The 30-year Climate Norm[2] MAP is only available for two stations (Cape Town International Airport and Atlantis) and as such, the MAP is calculated for the available data range at each station. These are then compared to the surrounding WR2012 MAP (after WRC, 2012).

As **Table 4-1** indicates, the 30-year and available data MAPs fall within the WR2012 MAP range. Most of the available rainfall data indicates a percentage difference of between 4% and 13%, thereby confirming the relevance of the WR2012 data set for the current study and its applicability as a first order recharge estimation input, given that the last few years included extreme weather events such as the Western Cape drought from 2015-2017.

Table 4-1 Summary of the available rainfall (mm) data in the Berg catchment compared to the Mean Annual Precipitation (MAP) of the WR2012 study.

GRU	Station Name	Longitude	Latitude	30-yr MAP	Available MAP	Available MAP year range	WR2012 MAP
Cape Flats	Cape Town International Airport	18.60200	-33.96300	498.7	504.6	1989-2021	535
Atlantis	Atlantis	18.48301	-33.60701	430.5	431.1	1990-2021	431
Steenbras / Nuweberg	Purgatory AWS	19.17571	-33.94993	-	1101.0	2005-2021	932
	Steenbras II	18.90000	-34.19000	-	1010.0	2010-2018	1088
Eendekuil Basin	Piketberg-Sapd	18.75400	-32.90600	-	424.5	2010-2021	410
Other (SAWS)	Eendekuil	18.88200	-32.68900	-	245.2	2010-2021	282
	Middeldeurvlei	18.92500	-32.79500	-	254.0	2010-2021	360

[2] *30-year Climate Norm (1991 to 2020): Climate Normal is a three-decade average of climatological parameters.*

4.2. Recharge

The quantification of groundwater recharge is essential for determining the present status of groundwater in the Berg catchment and is an important consideration for the implementation of an effective water resource management strategy.

Several recharge estimation techniques are available, each having specific limitations. As a first-order recharge estimation, which is a review and update of the Berg WAAS aquifer-specific estimations (DWAF, 2008a), four recharge estimation methods were selected (see **Section 4.2.1**). These include: 1) the Fixed Percentage of Mean Annual Precipitation (MAP) method; 2) the Groundwater Resource Assessment – Phase II (GRAII) Spatial Distribution (Modified) method; 3) the Empirical Rainfall-Recharge Relationship method; and 4) the Map-Centric Simulation method.

A GIS-based approach was undertaken to estimate recharge which is initially estimated per RU (subdivided into aquifer types including primary/intergranular aquifers, fractured TMGA, and fractured and intergranular basement aquifers) and totalled to provide a recharge estimation per GRU. To validate the result, the estimated recharge per RU is tabulated, and where significant variation exist between estimation methods, second-order recharge estimations will be undertaken or, where appropriate, recharge estimations from available literature will be used.

Second-order methods were selected based on the hydrogeological nature of the RUs and will only be used where sufficient data is available for any one method (see **Section 4.2.2**). These methods include 1) the Chloride Mass Balance (CMB) method, 2) the Cumulative Rainfall Departure (CRD) method, 3) the Saturated Volume Fluctuation (SVF) method, and 4) the Isotope method.

4.2.1. First-Order Recharge Estimation Methodologies

4.2.1.1. Fixed Percentage of MAP

The Fixed Percentage of MAP method, described in Bredenkamp *et al*., (1995), provides an initial approximation of recharge by means of a simple rainfall / recharge relationship. From a literature review of previous recharge ranges within the TMG terrane, recharge to the Peninsula Aquifer, estimated using various methods (see DWAF, 2007), vary spatially between 7% and 43% of MAP with a spatial recharge average of approximately 23% of MAP (200 – 2000 mm/a). The infiltration rates for both TMG aquifers (i.e., the Peninsula and Nardouw Aquifers) were conservatively assumed in the Berg WAAS (DWAF, 2008b).

Recharge estimates; after Gerber (1980), Vandoolaeghe (1989), and SRK (2004), for primary/intergranular aquifers and fractured and intergranular basement aquifers; posit various percentages of MAP per RU, however, the estimates are mostly neither aquifer specific nor spatially weighted.

A GIS based approach was undertaken using the Water Resources of South Africa 2012 (WR2012) Study MAP data (after WRC, 2012) and applying the fixed percentage of MAP factors listed in **Table 4-2** per RU based on surface outcrop (see **Figure 4-2**). The results are aquifer specific (**APPENDIX A: Recharge**) and are summarised per GRU in **Table 4-6**.

Table 4-2 Fixed percentage of MAP (per aquifer) used to estimate recharge in the Berg catchment (after DWAF, 2008b).

Resource Unit	Fixed percentage of MAP (%)
Peninsula Aquifer	14
Nardouw Aquifer	7
Fractured Aquifers	6
Primary / Intergranular Aquifers	4
Fractured and Intergranular Aquifers	3

4.2.1.2. GRAII Spatial Distribution (Modified)

The final product of the GRAII (DWAF, 2006; Task 3aE: Recharge) is the calculation of groundwater recharge per quaternary catchment. Recharge rates were determined as both a long-term average value as well as a value per hydrological year, based on four recharge estimation methodologies, including: 1) the CMB method; 2) the Empirical Rainfall-Recharge Relationship method; 3) a layered GIS-based model and, 4) a cross calibration where the results were checked against available field measurements. The resulting recharge is a 1km-by-1km grid which is aggregated per quaternary catchment (DWAF, 2006).

Although the GRAII has been proven reliable against other recharge estimations (DWAF, 2008a); rainfall duration, rainfall intensity and groundwater flow processes (such as fracture dominated flow) were not factored.

A GIS based approach was undertaken using WR2012 rainfall data and applying the GRAII recharge percentage per WR2012 MAP pixel. The output was then applied per RU based on surface outcrop (see **Figure 4-2**). The results are aquifer specific (**APPENDIX A: Recharge**) and are summarised per GRU in **Table 4-6**.

4.2.1.3. Empirical Rainfall-Recharge Relationship

The Rainfall-Recharge Relationship method, developed during the Breede River Basin Study (DWAF, 2002), is a recharge estimation method which considers both MAP per quaternary catchment as well as the varying rock types and associated permeability within the study area.

This method proves useful in differentiating recharge between primary and secondary aquifers or aquifer type but is somewhat limited as it does not account for evapotranspiration rates and assumes that the aquifer is homogenous across the entire RU/aquifer domain.

A GIS based approach was undertaken using MAP from the WR2012 dataset and applying a rainfall factor (i.e., a rainfall-dependent percentage of MAP) (see **Table 4-3**) and a recharge factor based on aquifer type (see **Table 4-4**). The results (**Figure 4-2**) are aquifer specific (**APPENDIX A: Recharge)** and are summarised per GRU in **Table 4-6**.

Table 4-3 Rainfall dependent percentage of MAP factors after DWAF (2002).

MAP	Recharge % of MAP applied
0 – 300	3
300 – 600	6
600 – 900	9
900 – 1 200	12
1 200 – 1 500	15
1 500 – 1 800	18
1 800 – 2 100	21
2 100 – 2 400	24
2 400 – 2 700	27
2 700 – 3 000	30
3 000 – 3 300	33
3 300 – 3 600	36

Table 4-4 Aquifer-specific recharge factors after DWAF (2002).

Aquifer type	Recharge Factor
Peninsula Aquifer	1.0
Nardouw Aquifer	1.0
Fractured and Intergranular Basement Aquifers	0.7
Primary / Intergranular Aquifer	1.5

4.2.1.4. Map-Centric Simulation

The Map-Centric Simulation Method, which considers monthly winter rainfall, evapotranspiration, and mean annual runoff, was used as part of (DWAF, 2000b) and later modified for the Berg WAAS (DWAF, 2008a) to estimate aquifer-specific recharge, with the emphasis on altitude and slope (these being the controlling variables on MAP, temperature, and runoff). The method accounts for the following:

1. The seasonal fluctuations of recharge by using the average monthly precipitation (re-calculated to match the revised Berg WAAS MAP distribution) as inputs to the recharge model.
2. Missing surface-run-off information for infiltration is overcome by using a calculated Model Overland Flow (MOF) per slope element as an input to the terrain model.
3. The actual evapotranspiration per Digital Elevation Model (DEM) pixel based on monthly temperature distribution and effective infiltration (i.e., MAP - MOF).

A GIS based approach was undertaken for this report which uses the outputs of the Berg WAAS recharge estimations applied to RUs (established using surface outcrop, see **Figure 4-2**). The results are aquifer specific (**APPENDIX A: Recharge**) and are summarised per GRU (**Table 4-6**).

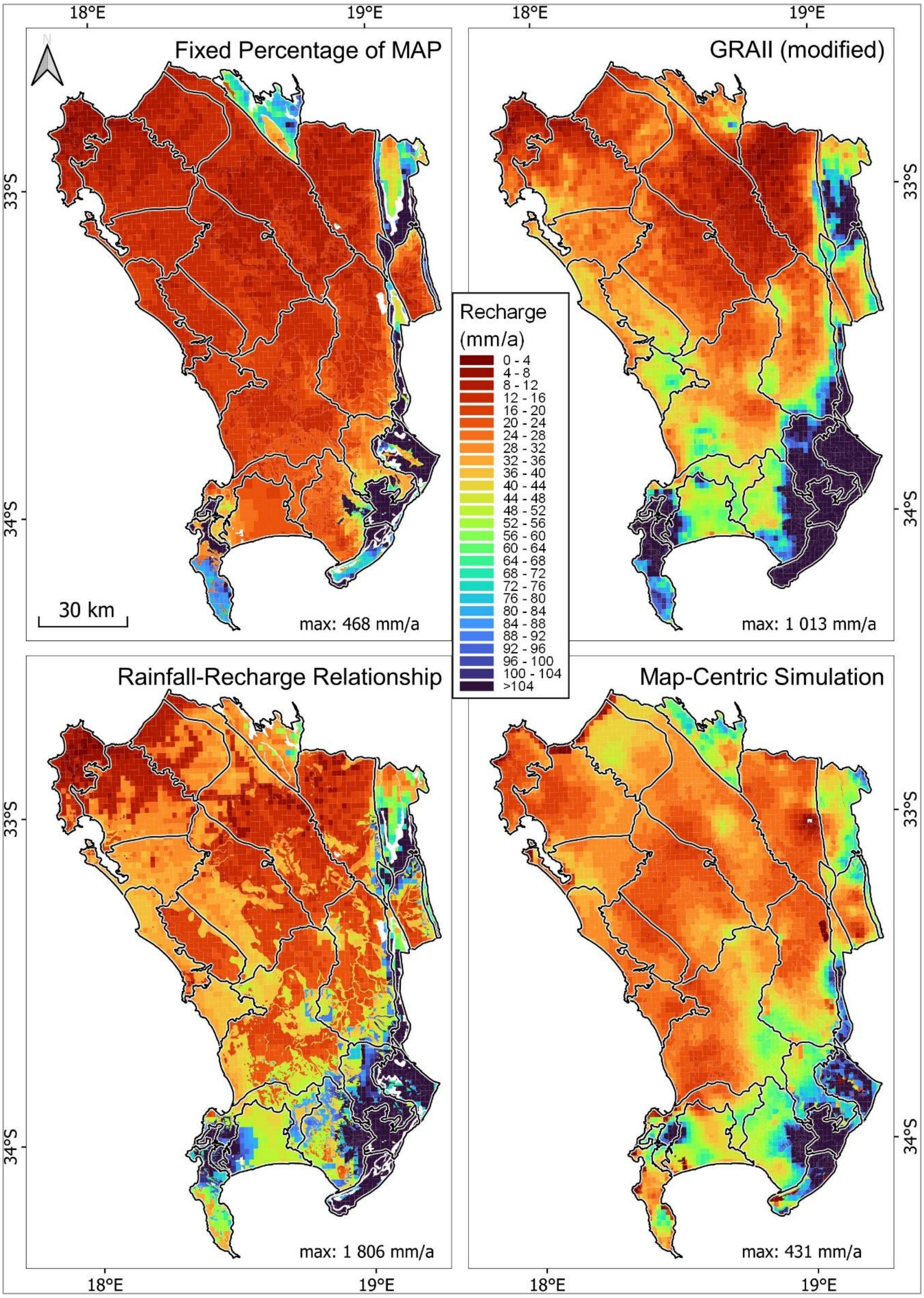


Figure 4-2 Rainfall recharge distribution maps based on first order recharge estimation methods.

4.2.2. Second-Order Recharge Estimation Methodologies

As stated previously in **Section 4.2**, validation against first-order recharge estimations for selected RUs will only be done (where data is available and if the recharge estimations in the available literature is no longer relevant) via methods listed in Section **4.2.2.4** to **4.2.2.4**. This will be combination of an Excel and GIS-based approach to estimate aquifer specific second-order recharge.

4.2.2.1. Chloride Mass Balance

The CMB technique estimates recharge by comparing the chloride concentration at the soil surface (from precipitation and dry deposition) with the chloride concentrations in the soil moisture (from wet deposition) (WRC, 2013). Because most plants do not absorb a considerable amount of chloride, the chloride ions concentrate in the soil through interception and evapotranspiration (Allison, et al., 1994). A piston-flow regime is assumed in the unsaturated zone such that the concentration of chloride increases through the root zone of the soil until a constant value is achieved; which indicates that no evaporation takes place below this depth (Gardner, 1967; Lerner, 1990).

This method uses the MAP, dry chloride deposition, chloride concentration in rain and chloride concentration of soil water below the active root zone (or in groundwater if there is a large presence of boreholes in the area). From this, a chloride depth profile can be created indicating wet/dry precipitation events.

Developed by Eriksson & Khunakasem (1969), the CMB method is considered a suitable environmental tracer for recharge estimation due to chloride's conservative properties and its abundance in rainwater (Allison, et al., 1994). This method calculates the moisture fluxes and recharge rates in the unsaturated zone but includes various limiting assumptions of the aquifer's characteristics: 1) a piston-flow regime is present, although this may be invalidated by complex pathways through the unsaturated zone, which may occur due to seasonal variability in rainfall, evapotranspiration and uneven topography, 2) the conservative nature of chloride (i.e., the conservation of mass between chloride in the atmosphere and the chloride flux below the surface), 3) chloride is only added to the system via precipitation, and 4) that the system maintains a steady-state in terms of chloride concentration and long-term precipitation (Edmunds, et al., 1988).

Possible complications include the lateral movement of chloride towards the root zone resulting in an overestimation of recharge; lithologies with anions (such as negatively charged clay particles) can repel chloride ions, causing them to move faster than water molecules (James & Rubin, 1986; Bresler, 1973), some vegetation may take up chloride (through weathering and dissolution) although nutrient cycling may balance this, fertilisers may add chloride to the system; preferential flow may extend further than the root zone (Edmunds, 1988) and anthropogenic activities may add to the amount of chloride in the groundwater (Gvirtzman & Magaritz, 1986).

4.2.2.2. Cumulative Rainfall Departure

The Cumulative Rainfall Departure (CRD) method assumes that variations in groundwater levels directly correlate to rainfall events and that equilibrium between these will be reached over time (WRC, 2013; Bredenkamp, 1995).

This method provides an integrated recharge estimate by considering monthly abstraction, inflow and outflow rates and groundwater level data, although can be considered somewhat ambiguous due to the uncertainty introduced in the calculation of the amount of inflow and outflow from the aquifer (particularly for deep aquifers where rainfall recharge may be weakened).

4.2.2.3. Saturated Volume Fluctuation

The Saturated Volume Fluctuation (SVF) method considers water level fluctuations, abstraction from the aquifer and natural inflow and outflow rates (Bredenkamp, et al., 1995). This provides a representation of the aquifer with an arbitrary aquifer size determined such that the volumes are positive.

Uncertainty is introduced in the calculation of the amount of inflow and outflow from the aquifer. Successful application of this method requires a substantial spatial distribution of boreholes which are ideally situated outside the areas of influence of active pumping scheme.

4.2.2.4. Isotopes

Isotopes of oxygen-18 (^{18}O) and deuterium (^{2}H) are naturally occurring stable isotopes and are commonly used to determine the origin of groundwater (Selaolo, 1998). According to Allison *et al.*, (1983), recharge estimates may be derived from the $^{2}\delta$ displacement of soil moisture from the local meteoric water line (MWL), which is proportional to the inverse of the square root of the recharge rate. The amount of displacement from the MWL is a result of isotopic enrichment in the upper soil layers due to evaporation - which may in turn be balanced by dilution due to rainfall described by the following general equation:

$$\Delta\delta = \frac{C}{\sqrt{Recharge}}$$

The constant C represents the slope of a line through the inverse of the square root of recharge rates obtained from other recharge estimation methods (e.g., chloride profiling of soil moisture (Selaolo, 1998). In South Africa, the constant C is usually considered as 20 (WRC, 2013). One notable limitation to this method is that an uncertainty is introduced for aquifers which receive < 20 mm/a.^{18}O and ^{2}H enriches in the soil by evaporation and dilutes by rainfall, hence the concentration of ^{18}O and ^{2}H decreases at a rate of the square root of time from the last rainfall event (WRC, 2013).

4.2.3. Available Literature

Recharge estimates from available literature is provided in **Table 4-5** per GRU, where available. Where appropriate, second-order recharge estimation results from available literature are used. The results are summarised per GRU in **Table 4-6**.

Table 4-5 Available literature of estimated recharge per GRU for Primary / Intergranular Aquifers, Fractured Table Mountain Group Aquifers, and Fractured and Intergranular Basement Aquifers

GRU		Source	Methods	Recharge Volume (M m^3/a)	Avg. Recharge Rate (mm/a)
Primary / Intergranular Aquifer					
Cape Flats		(CoCT, 2018)	Water Balance	57.9	134.4
			Qualified Guess - Soil	30.6	70.9
			Qualified Guess - Geology	46.6	108.2
			Qualified Guess - Vegter	28.0	65.0
			Qualified Guess - Acru	43.1	100.0
			Harvest Potential	32.3	75.0
			CMB	36.6	85.0
			CRD	49.5	114.9
			Isotopes: 2H	45.3	105.2
		(DWAF, 2002)	BRBS	27.8	64.6
		(Seyler, et al., 2016)	Surface Water Model	52.6	-
		(Vandoolaeghe, 1989)	Not Specified	117.0	145.9
		(Gerber, 1980)	Not Specified	61.5	76.7
Atlantis		(CoCT, 2020c)	Qualified Guess - Soil	20.7	80.0
			Qualified Guess - Geology	29.2	113.0
			Qualified Guess - Vegter	8.3	32.0
			Qualified Guess - Acru	18.1	70.0
			Harvest Potential	19.4	75.0
			CMB	21.7	84.0
			CRD	28.2	109.0
		(Du Toit, et al., 1995)	Not Specified	-	9.0 - 44.0
		(Zhang, et al., in prep)	Second Model Calibration	-	18 - 69.0
Elandsfontein	Upper	(Spannenberg, 2015)	CMB[3]	16.9	31.7
			Rainfall Infiltration Breakthrough RIB[3]	20.7	38.8
	Lower	(Ebrahim, 2015)	CMB[3]	-	29.0
				-	48.8
			RIB[3]	-	0.74
				-	2.5

[3] *Recharge estimates have been converted from percentage MAP based on (WRC, 2000)*

GRU		Source	Methods	Recharge Volume (M m^3/a)	Avg. Recharge Rate (mm/a)
Langebaan Road	Upper	(Andries, 2019)	CMB	4.7	5.2
		(Spannenberg, 2015)	CMB[3]	17.8	19.7
			RIB[3]	20.5	22.7
	Lower	(Ebrahim, 2015)	CMB[3]	-	19.6
				-	36.3
			RIB[3]	-	3.2
				-	15.2
	Whole GRU	(Weaver & Talma, 2005)	CMB[3]	-	25.7 – 35.8
		(Tiimerman, 1985)	Not Specified[3]	-	39.5
Fractured Table Mountain Group Aquifers					
Steenbras-Nuweberg		(CoCT, 2022)	GRAII	28.6	391.11
Fractured And Intergranular Basement Aquifers					
Middle-Lower Berg		(Naicker & Demlie, 2014)	Water Balance	-	25 - 90
Vredenberg		(Du Toit & Weaver, 1995)	Reverse Modelling Techniques	-	25 - 38

4.2.4. Summary

Recharge estimations were selected from the methods described in **Section 4.2.1** - **4.2.3** per GRU, and are summarized in **Table 4-6**. The selection considered, 1) the level of confidence and associated limitations of the methodology; 2) the amount, spread and availability of data across the GRU; and 3) the applicability of published datasets. No second order recharge was necessary due to the validity of available literature data.

Table 4-6 Summary of estimated recharge per GRU for Primary / Intergranular Aquifers, Fractured Table Mountain Group Aquifers, and Fractured and Intergranular Basement Aquifers.

GRU	Area (km^2)	Rainfall Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)	Total Recharge Volume (M m^3/a)
Primary / Intergranular Aquifers				
Cape Flats[4]	421.94	41.25	97.76	55.85
Atlantis[5]	255.68	22.74	88.94	27.85
Yzerfontien[6]	320.33	9.20	28.72	9.20
Elandsfontien[6]	532.57	15.47	29.05	15.47
Langebaan Road[6]	903.71	23.28	25.76	23.28
Adamboerskraal[6]	612.30	21.61	35.29	21.61
Fractured Table Mountain Group Aquifers				
Cape Peninsula[6]	292.53	10.99	37.57	10.99
Steenbras-Nuweberg[7]	150.24	58.76	391.11	58.76
Drakensteinberge[6]	164.95	27.60	167.32	27.60
Wemmershoek[6]	229.13	26.83	117.10	26.83
Voëlvlei-Slanghoek[6]	184.26	14.10	76.52	14.10
Witsenberg[6]	39.95	2.78	69.59	2.78
Grootwinterhoek[6]	379.26	22.50	59.33	22.50
Piketberg[6]	298.29	20.33	68.16	20.33
Fractured and Intergranular Basement Aquifers				
Cape Town Rim[6]	814.62	18.60	22.83	18.60
Stellenbosch-Helderberg[6]	570.58	41.52	72.77	41.52
Paarl-Franschoek[6]	368.50	26.61	72.21	26.61
Malmesbury[6]	1600.36	52.65	32.90	52.65
Wellington[6]	1068.81	39.49	36.95	39.49
Tulbagh[6]	291.38	10.87	37.31	10.87
Eendekuil Basin[6]	936.94	21.88	23.35	21.88
Middle-Lower Berg[6]	1485.40	42.49	28.61	42.49
Northern Swartland[6]	1257.65	31.85	25.33	31.85
Darling[6]	408.82	9.95	24.34	9.95
Vreedenberg[6]	376.18	7.43	19.75	7.43
Total	**13964.38**	**1313.09**	**n/a**	**597.38**

[4] Rainfall recharge value is from a model-based calibrated recharge estimation (after CoCT, 2018). The total recharge volume includes MAR of up to 14.6 M m^3/a as per NWA Section 21(e) water use licence.
[5] Rainfall recharge value is from a model-based calibrated recharge estimation (after CoCT, 2020b). The total recharge volume includes MAR of up to 5.11 M m^3/a as per NWA Section 21(e) water use licence.
[6] Rainfall recharge value is from the first order Map-Centric Simulation method.
[7] Rainfall recharge value is from the first order GRAII Spatial Distribution (modified after CoCT, 2022)

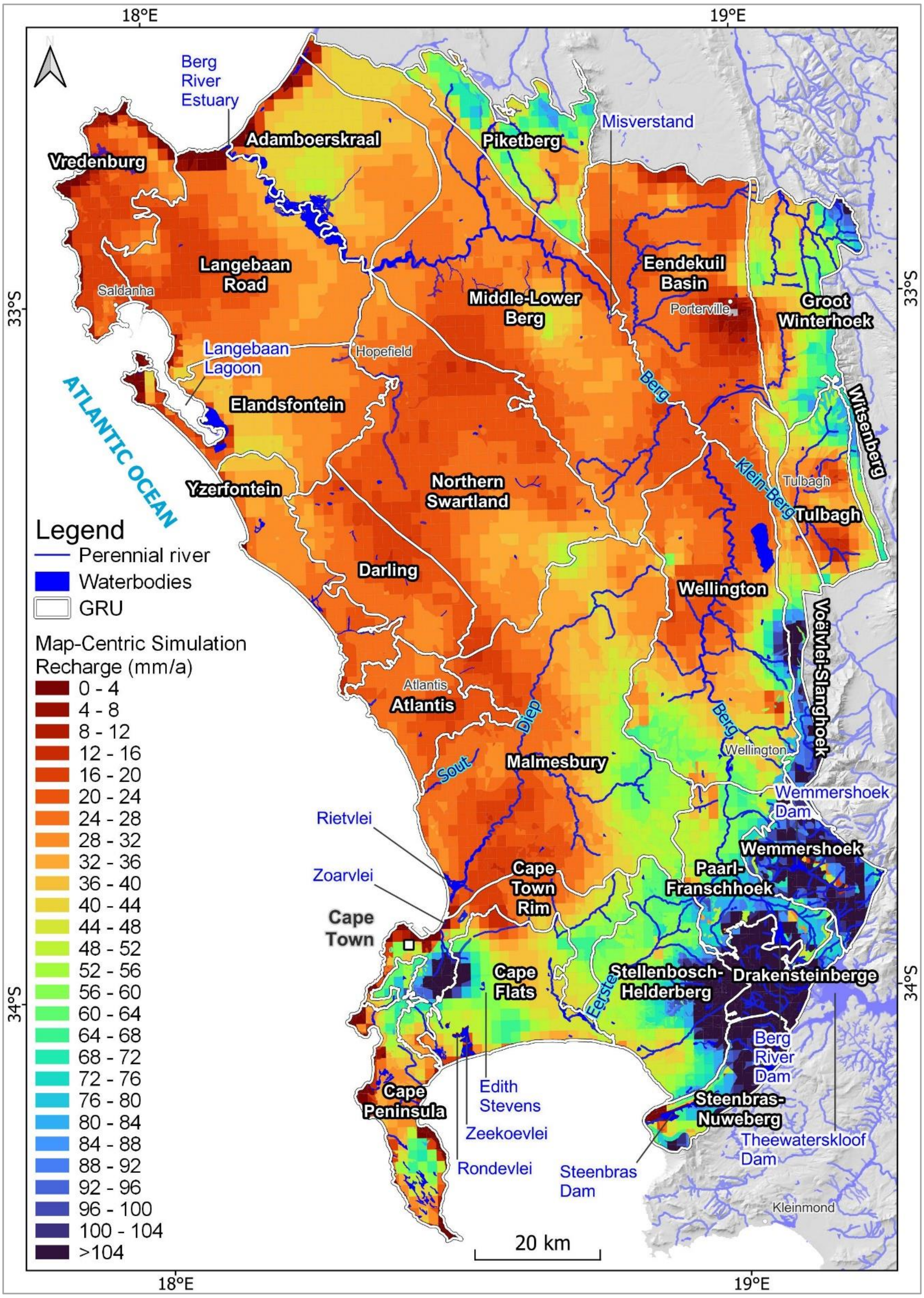


Figure 4-3 **Natural recharge distribution map based on the map-centric recharge estimations method per GRU**

4.3. Water use

To provide a quantitative means of assessment, a groundwater Stress Index (SI) has been developed (see **Section 4.6**), which considers groundwater water availability (recharge) and groundwater water use (an important input for defining Aquifer Stress and determining the Present Status category).

4.3.1. Data Sources

A variety of data sources were collated to assess the current groundwater use in the study area. Data sources include: 1) Water Use Authorization and Registration Management System (WARMS – downloaded September 2022); 2) the National Groundwater Archive (NGA – downloaded April 2022); 3) Augmentation and reconciliation strategies and other ongoing studies, including the All Towns Reconciliation Strategies for the Southern Planning Region (DWA, 2014, and updates from the current study) and the Water Reconciliation Strategy for the Western Cape Water Supply System (WCWSS; DWS, 2015), and 4) GRAII's calculation of urban and domestic water use.

4.3.2. Assigning Resource Units

Unfortunately, the data, on which the GRAII results are based, were not available to recalculate the results and to assign groundwater abstraction to the different RUs. Therefore, the required detail of the spatial component of the data is lost and will not be included in this present status assessment. The WARMS database is lacking as far as assigning registered volumes to an aquifer unit (see DWS, 2022b); therefore, two approaches were used to broach this data gap.

1. Where appropriate, it was decided to liaise with various project specialists to provide qualified guesses on registered use and associated aquifer unit.
2. Assigning the registered groundwater abstraction in the WARMS database to aquifer units by linking registered use with boreholes in the NGA and assigning registered volumes pro rata to the number of boreholes in different aquifers.

4.3.3. Summary

The registered groundwater use from the WARMS dataset is outlined in **Table 4-7** according to the number of registered users and the total volume per GRU. The dataset is further subdivided according to RUs across the entire study area (see **Table 4-8**).

Registered groundwater use per water use sector is provided in **Table 4-9** as the percentage of total registered volume per GRU. The distributions of registrations and the associated water use sectors are displayed in **Figure 4-4**.

Table 4-7 Summary of total groundwater use, as registered in WARMS, for Primary / Intergranular Aquifers, Fractured Table Mountain Group Aquifers, Fractured and Intergranular Basement Aquifers.

GRU	No. of Registered Users	Total Volume (M m^3/a)
Primary / Intergranular Aquifers		
Cape Flats[8]	95	26.6
Atlantis[9]	24	6.76
Yzerfontein[10]	1	0.26
Elandsfontein	4	1.09
Langebaan Road	33	8.59
Adamboerskraal	12	2.13
Fractured Table Mountain Group Aquifers		
Cape Peninsula	8	0.07
Steenbras-Nuweberg[11]	1	9.13
Drakensteinberge	2	0.05
Wemmershoek	15	0.81
Voëlvlei-Slanghoek	3	0.13
Witsenberg	3	0.08
Groot Winterhoek	11	1.39
Piketberg	52	5.58
Fractured and Intergranular Basement		
Cape Town Rim	161	6.21
Stellenbosch-Helderberg	163	8.81
Paarl-Franschhoek	268	9.82
Malmesbury	245	14.75
Wellington	117	4.48
Tulbagh	81	3.78
Eendekuil Basin	33	4.85
Middle-Lower Berg	32	2.23
Northern Swartland	19	1.79
Darling[10]	9	0.76
Vredenberg	66	1.16
Total	**1458**	**121.31**

Table 4-8 Summary of water use registrations, as registered in WARMS, per RU.

Aquifer Unit	Sum of volumes of registrations (M m^3/a)	Mean registration volume (M m^3/a)	Number of registrations
Primary / Intergranular Aquifers	79.75	0.09	843
Peninsula Aquifer	6.07	0.08	78
Nardouw Aquifer	10.87	0.64	17
Fractured and Intergranular Basement Aquifers	24.01	0.05	459
Fractured and Intergranular Other Aquifers	0.61	0.07	9

[8] *Includes city municipal abstraction of 20 M m^3/a in development as per NWA Section 21(a)*
[9] *Includes city municipal abstraction of 5 M m^3/a as per NWA Section 21(a).*
[10] *The WARMS dataset places Yzerfontein's municipal abstraction of 0.26 M m^3/a in the Darling GRU. It has been updated to reflect for the Yzerfontein GRU.*
[11] *Includes city municipal abstraction of 9.13 M m^3/a in development (phase 1) as per NWA Section 21(a)*

Table 4-9 Summary of water use sectors, as registered in WARMS, in terms of volume percent of water use per GRU.

GRU	Agriculture: Aquaculture (% of Total Volume)	Agriculture: Irrigation (% of Total Volume)	Agriculture: Watering Livestock (% of Total Volume)	Industry (Non-Urban) (% of Total Volume)	Industry (Urban) (% of Total Volume)	Mining (% of Total Volume)	Recreation (% of Total Volume)	Schedule 1 (% of Total Volume)	Urban Excluding (Industrial &/Or Domestic) (% of Total Volume)	Water Supply Service (% of Total Volume)
Primary / Intergranular Aquifers										
Cape Flats	-	15.3	0.2	3.9	3.7	1.5	-	-	0.1	75.4
Atlantis	-	2.3	4.8	0.6	86.8	5.4	-	-	-	-
Yzerfontein	-	-	-	-	-	-	-	-	-	100
Elandsfontein	-	35.3	-	-	0.6	64.1	-	-	-	-
Langebaan Road	-	18.4	1.1	0.1	0.4	-	-	-	-	79.9
Adamboerskraal	-	62.9	-	-	37.1	-	-	-	-	-
Fractured Table Mountain Group Aquifers										
Cape Peninsula	-	71.2	13.9	-	14.9	-	-	-	-	-
Steenbras-Nuweberg	-	-	-	-	-	-	-	-	-	100
Drakensteinberge	-	100	-	-	-	-	-	-	-	-
Wemmershoek	36.3	53.8	-	-	9.9	-	-	-	-	-
Voëlvlei-Slanghoek	-	26.9	73.1	-	-	-	-	-	-	-
Witsenberg	-	100	-	-	-	-	-	-	-	-
Groot Winterhoek	-	99.6	-	0.4	-	-	-	-	-	-
Piketberg	-	97.8	-	-	1.0	-	-	-	-	1.2
Fractured and Intergranular Basement										
Cape Town Rim	0.1	39.0	1.5	3.6	43.5	-	-	0.4	0.5	11.5
Stellenbosch-Helderberg	-	21.9	0.1	1.9	11.2	-	0.2	0.4	-	64.3
Paarl-Franschhoek	2.2	61.1	1.8	4.4	15.1	-	-	0.6	0.1	14.7
Malmesbury	0.1	67.5	17.0	0.9	12.4	-	-	0.1	0.1	1.9
Wellington	3.6	82.7	7.1	0.1	5.2	-	0.1	0.3	-	1.0
Tulbagh	-	97.6	0.4	0.4	1.0	-	-	0.1	-	0.6
Eendekuil Basin	-	36.7	1.3	-	0.1	-	-	-	-	61.9
Middle-Lower Berg	-	97.5	-	-	-	-	-	-	-	2.5
Northern Swartland	-	72.3	8.7	-	19.0	-	-	-	-	-
Darling	-	93.0	6.2	-	0.8	-	-	-	-	-
Vredenburg	-	21.8	-	-	12.8	-	-	-	65.4	-

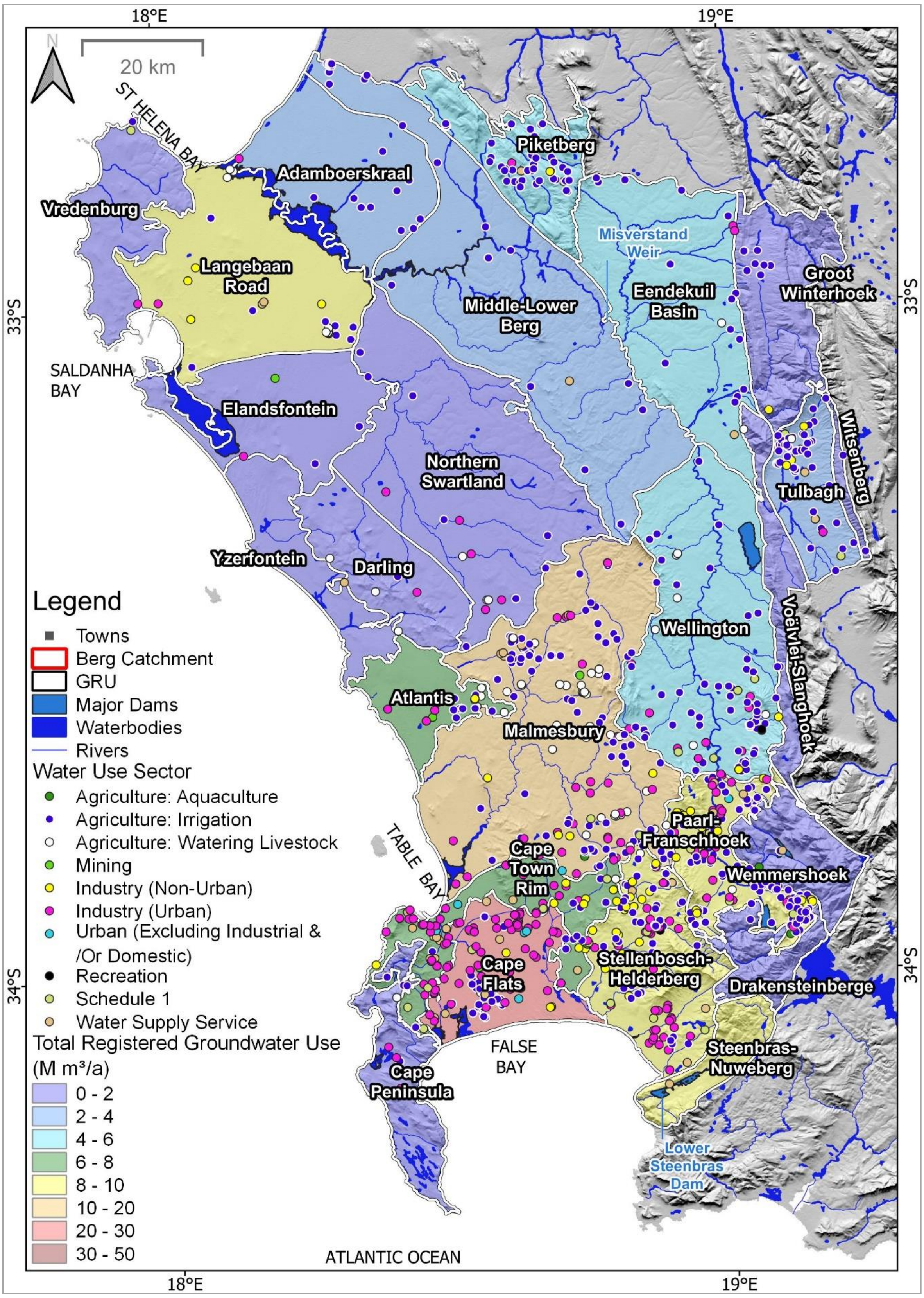


Figure 4-4 **Total registered groundwater use per GRU, as registered in WARMS, indicating boreholes and associated water use sector.**

4.4. Discharge

Groundwater discharge represents the outflow of groundwater from aquifers to surface or sub-surface water systems. Discharge from aquifers occur as either: 1) natural discharge via groundwater contribution to surface water systems (i.e., river baseflow, seeps, and springs) and 2) lateral discharge into another aquifer unit.

4.4.1. Natural discharge

The conventional way to estimate natural discharge from aquifers into river reaches is to use the baseflow separation methodology (DWAF, 2008b). Historically, hydrologists separated river flow into floods and baseflow components based on flow characteristics, while geohydrologists considered the component derived from groundwater (i.e., groundwater's contribution to the surface water system).

Baseflow estimates were presented in the Berg WAAS (DWAF, 2008b) based on methods by Schulze, et al.,(1997); Pitman, (1973) and Hughes & Metzler, (1998). The findings showed that baseflow estimates obtained a high degree of variation and were somewhat subjective due to the limitations of the methods applied. Therefore, these results were not considered. The baseflow data from the GRDM however was deemed suitable for a "groundwater contribution to baseflow" estimate as it was prepared for a groundwater Reserve determination and resource evaluation. The disadvantage with using this dataset is that baseflow or groundwater contribution to baseflow is quantified per quaternary catchment (i.e., not aquifer specific).

To calculate aquifer-specific groundwater contribution to baseflow the sourced 'Groundwater Contribution to Baseflow' per Aquifer, based on equivalent recharge' from DWAF (2008b) was spatially disaggregated and totalled to provide a groundwater contribution to baseflow estimate per GRU. The results per RU are presented in **APPENDIX C: Discharge** and summarised per GRU in **Table 4-10.**

Although this is sufficient as first order discharge estimation, there are some limitations to the approach. The spatial disaggregation of data lacks some physical meaning as it is assuming all RUs present in the catchment have continuous contact with a river and neglects the three-dimensional relationship between different aquifers (including subsurface transfer between aquifer units), surface water bodies (including groundwater discharge to the ocean) and springs. It also neglects the fact that runoff, through flow and interflow contribution to baseflow can vary significantly at different points along a river reach.

This element will be further investigated in Step 4 (i.e., Determine BHN and EWR) of the Reserve determination process.

4.4.2. Lateral Discharge/Recharge

Groundwater can also discharge from one aquifer unit into another adjacent aquifer through lateral or vertical subsurface flow, which is termed lateral discharge or lateral recharge. There are geological interpretations and anecdotal evidence that support this being a relevant factor for several of the GRUs. The Berg WAAS study (DWS, 2008b) investigated this phenomenon and the potential hydraulic connection between the Peninsula and Nardouw aquifers, and identified zones of direct geological contact that potentially lead to lateral flows between these units. There are also major fault structures (so-called hydrotects) that connect different aquifer units and potentially recharge aquifers in other RUs or GRUs.

The quantification of lateral discharge will be addressed in Step 4 (i.e., Determine BHN and EWR) of the Reserve determination process, where anecdotal evidence exists.

Table 4-10 Summary of estimated discharge per GRU for Primary / Intergranular Aquifers, Fractured Table Mountain Group Aquifers, and Fractured and Intergranular Basement Aquifers.

GRU	GRDM Total Groundwater contribution to Baseflow (M m^3/a)
Primary / Intergranular Aquifers	
Cape Flats[12]	2.70
Atlantis[12]	0.20
Yzerfontein[12]	0.19
Elandsfontein[12]	0.0005
Langebaan Road[12]	0.00
Adamboerskraal[12]	0.00
Fractured Table Mountain Group Aquifers	
Cape Peninsula[12]	4.31
Steenbras-Nuweberg[12]	7.93
Drakensteinberge	7.56
Wemmershoek	9.92
Voëlvlei-Slanghoek	4.18
Witsenberg	0.93
Grootwinterhoek	7.62
Piketberg[12]	0.12
Fractured and Intergranular Basement Aquifers	
Cape Town Rim[12]	3.03
Stellenbosch-Helderberg[12]	7.60
Paarl-Franschoek	4.73
Malmesbury	11.83
Wellington	7.95
Tulbagh	3.64
Eendekuil Basin	4.53
Middle-Lower Berg[12]	3.57
Northern Swartland	0.02
Darling	0.08
Vredenberg[12]	0.00
Total	**90.19**

[12] *Submarine discharge was not included in the discharge estimation.*

4.5. Water Quality

This section aims to describe the present status of groundwater quality in the Berg catchment. Data from various sources has been considered and a basic hydrochemical analysis undertaken. The baseline water quality has been assessed for each GRU and RU, for select parameters, and potential sources of contamination investigated. Select parameters have also been assessed for compliance with DWS, 2019b:121 Resource Quality Objectives (RQOs) and water quality classes established per parameter and per GRU.

4.5.1. Data Sources

To assess the present status of groundwater quality of the Berg catchment, available monitoring data from the following sources were assessed:

- Water Management System (WMS)
- City of Cape Town (CoCT)
    - New Water Programme (Cape Flats Aquifer (CFA), Atlantis, TMGA)
    - Historical data (Steenbras-Nuweberg and Wemmershoek exploration)

The WMS data was used as the primary dataset, with CoCT data used to supplement in GRUs where no WMS monitoring points were available, with the exception of the Steenbras-Nuweberg and Wemmershoek GRUs, where CoCT data was used as the primary dataset due to the absence of WMS data. **Table 4-11** shows the number of monitoring locations (boreholes) per GRU, with a total of 358 unique locations. Of the 25 GRUs under consideration, 6 had no monitoring data, 5 of which are within the group of fractured Table Mountain Group Aquifers (TMGA). Monitoring locations are presented in **Figure 4-5**.

Evaluation of the present status of groundwater quality is based on the following two-fold approach:

1. Baseline chemistry and groundwater quality assessment
2. Comparison of data to the DWS, (2019b:121) RQOs established for groundwater.

Assessment of the water quality per GRU is based on the 3 types of aquifers that occur in the study area (**Table 4-11**). In the absence of borehole construction data and geological logs for the boreholes, where more than one aquifer type is present in a GRU, the aquifer penetrated by a borehole cannot be known conclusively. Therefore, monitoring points are assigned to the prevailing aquifer type. For the Steenbras-Nuweberg GRU, the aquifer type is further divided into two resource units, the Nardouw Aquifer and Peninsula Aquifer, as these are the two main aquifers that make up the TMGA

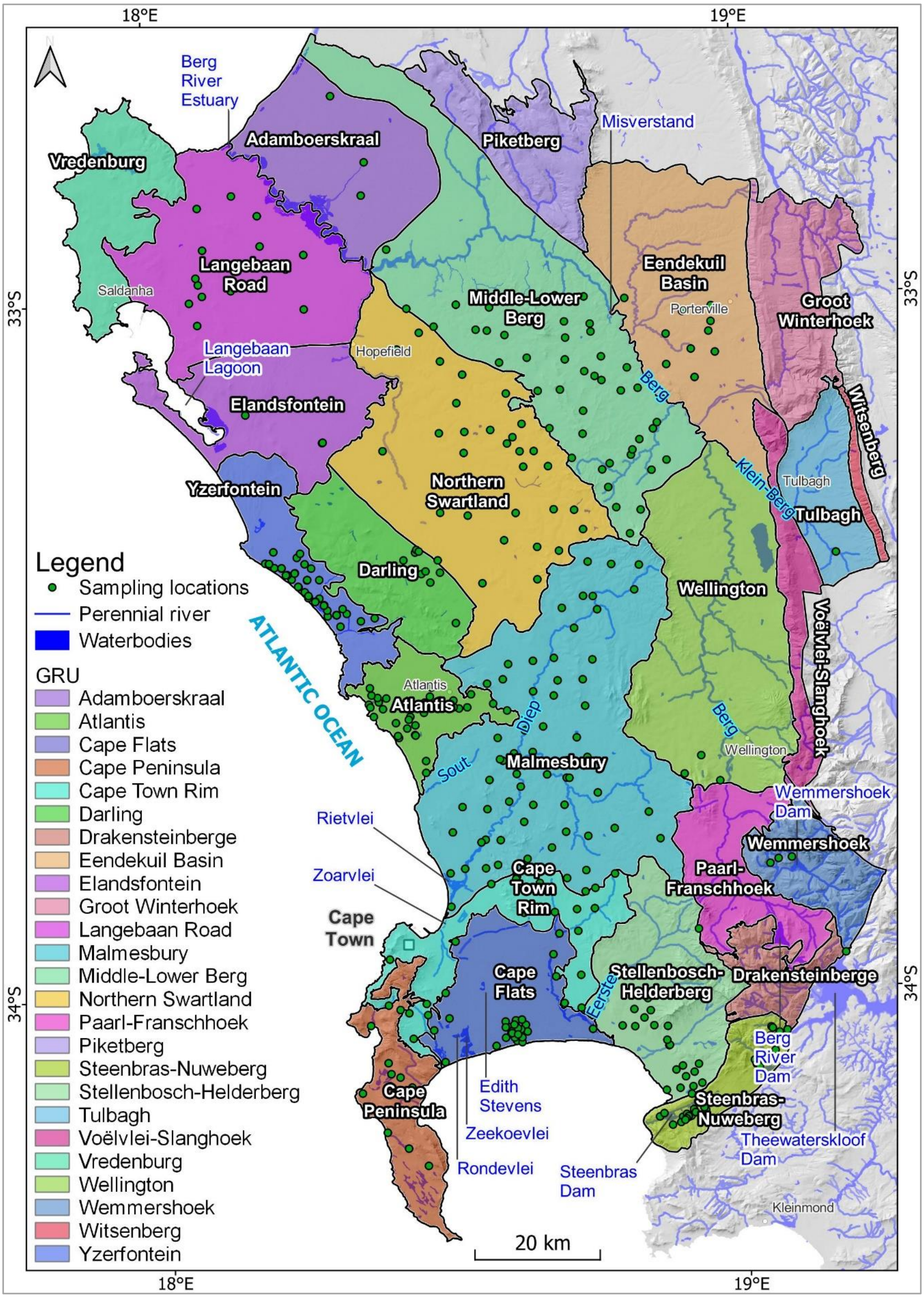


Figure 4-5 **Groundwater monitoring locations per GRU in the Berg Catchment.**

Table 4-11 Number of groundwater quality monitoring locations per GRU.

Groundwater Resource Unit	Number of boreholes
Primary / Intergranular Aquifers	
Adamboerskraal	3
Atlantis	31
Cape Flats	37
Elandsfontein	3
Langebaan Road	15
Yzerfontein	41
Fractured Table Mountain Group Aquifers	
Cape Peninsula	11
Drakensteinberge	*No data*
Groot Winterhoek	*No data*
Piketberg	*No data*
Steenbras-Nuweberg	15 (Peninsula Aquifer)
	16 (Nardouw Aquifer)
Vöelvlei-Slanghoek	*No data*
Wemmeshoek	4
Witsenberg	*No data*
Fractured and Intergranular Basement Aquifers	
Cape Town Rim	21
Darling	9
Eendekuil Basin	10
Malmesbury	66
Middle-Lower Berg	46
Northern Swartland	31
Paarl-Franschhoek	1
Stellenbosch-Helderberg	13 (Cape Granite Suite)
	6 (Tygerberg Formation)
Tulbagh	1
Vredenberg	*No data*
Wellington	3

4.5.2. Assigning Resource Units

Unfortunately, no borehole construction information and geological logs were available for the WMS data. Thus, RUs could be established for all GRUs except for Steenbras-Nuweberg, where monitoring data was available to assign two RUs: Peninsula Aquifer and Nardouw Aquifer. For all other GRUs, surface geology was assigned to monitoring locations to establish RUs.

4.5.3. Baseline Water Quality

Edmunds and Shand (2008) describe the baseline concentration of a substance as the range of concentrations derived entirely from natural, geological, biological or atmospheric sources, under conditions not impacted by anthropogenic activity. In the study area, given the wide ranges of anthropogenic activities, particularly farming in the greater Berg area and industrial activities in urban aquifers like the CFA, true baselines concentrations cannot be determined conclusively. However, the baseline can be approximated from representative monitoring locations within areas with limited anthropogenic activity.

To establish the baseline concentrations, the 95^{th} percentile for a parameter, using data from a representative borehole per GRU, was calculated and applied as a threshold concentration against which all other data were compared. Instead of using maximum concentrations, the 95^{th} percentile statistical method was chosen as it accounts for most of the data but excludes outliers that can skew analyses. Representative sites as well as descriptions of the datasets and rationale for their selection are presented in **Table 4-12**. Overall, the selection was based on the following factors:

- Distance from potentially contaminating activities (PCAs). The ideal borehole is to be located in an area as far from PCAs as reasonably possible.
- Length of data record. A longer record can span multiple seasons and will account for seasonal differences.
- Spatial centrality within GRU. Depending on the location of recharge and discharge areas, a central borehole will represent groundwater that has had some residence time in the aquifer, with appreciable rock-water interaction, but prior to discharge.

For the Stellenbosch-Helderberg GRU, 2 representative boreholes have been selected due to the extensive nature of both the Tygerberg Formation and Cape Granites, lithologies with distinct impacts on the water quality.

Table 4-12 Selection of boreholes representing the natural groundwater quality per GRU and rationale behind selection of each borehole (BH). The Stellenbosch-Helderberg GRU consists of two representative boreholes due to the predominance of both the Tygerberg and Cape Granite Suite formations across the GRU.

Groundwater Resource Unit	Representative Borehole	Rationale for borehole selection
Primary / Intergranular Aquifers		
Adamboerskraal	93313	1 of 3 BHs, central, only 4 samples
Atlantis	91738	Limited anthropogenic impact, long record
Cape Flats	88847	Long record. All BHs prone to anthropogenic contamination
Elandsfontein	93871	1 of 3 BHs, longest record and drilled in most extensive geological unit. May have some influence from farming
Langebaan Road	93873	Long record with greatest distance from PCAs
Yzerfontein	89820	Central, long record, limited anthropogenic impact
Fractured Table Mountain Group Aquifers		
Cape Peninsula	96073	On representative geology, all BHs have 1 sample
Drakensteinberge	*No data*	-
Groot Winterhoek	*No data*	-
Piketberg	*No data*	-
Steenbras-Nuweberg	H8A1 (Peninsula Aquifer)	Long record
	H1A3b (Nardouw Aquifer)	Long record
Vöelvlei-Slanghoek	*No data*	-
Wemmeshoek	W7D1	Central
Witsenberg	*No data*	-
Fractured and Intergranular Basement Aquifers		
Cape Town Rim	96211	Central. Located on farmland, all BHs have 1 sample
Darling	94570	Central. All BHs located on farmland and have 1 sample
Eendekuil Basin	96167	Central. All BHs located on farmland and have 1 sample
Malmesbury	89665	Central. Most BHs located on farmland
Middle-Lower Berg	96095	Central. All BHs located on farmland and have 1 sample. Exception is 90113 adjacent to what appears to be a livestock farm
Northern Swartland	96144	Central, limited anthropogenic impact. All BHs located on farmland and have 1 sample
Paarl-Franschhoek	96019	Only BH in GRU
Stellenbosch-Helderberg	96029 (Tygerberg Formation)	Long record
	96033 (Cape Granite Suite)	Long record, central
Tulbagh	89812	Only BH in GRU
Vredenberg	*No data*	-
Wellington	96016	1 of 3 sites, each with 1 sample, on most prevalent geological unit

The WMS dataset consists of 35 unique parameters, including major ions, physical parameters, nutrients and dissolved metals, from samples collected between 1978 and 2021. Only 14 parameters were selected for detailed analysis based on the following rationale:

Physical parameters: Electrical conductivity (EC) and pH – EC is an essential, general water quality parameter which indicates the salinity of groundwater. pH is an indicator of how acidic or basic groundwater is and can determine the solubility and therefore toxicity of metals or corrosivity of water to infrastructure.

Nutrients: Ammonia, Nitrate + Nitrite and Orthophosphate – nutrients are mostly the result of anthropogenic impacts and can indicate contamination from agriculture (a prevalent activity in the study area) and sewage.

Dissolved metals: Aluminium, arsenic, chromium, iron, lead, manganese, mercury – although many more metals than analysed can be toxic if consumed by humans, the listed metals have been chosen based on a combination of toxicity, common occurrence and elevated concentrations observed from routine monitoring undertaken by the City of Cape Town (CoCT, 2020a; CoCT, 2021c; CoCT, 2021d)

Sulphate & Fluoride: Sulphate can be an indicator of seawater intrusion and contamination from agriculture and manufacturing industries, with excess concentrations having adverse human health impacts. Excess fluoride has adverse human health impacts.

Table 4-13 shows the number of samples exceeding baseline threshold concentrations, per parameter, per GRU. Baseline threshold values are presented in **APPENDIX D: Water Quality**. Overall, limited data was available for dissolved metals in the WMS dataset. Therefore, baseline concentrations for these parameters could not be established for most GRUs.

Primary/Intergranular Aquifers

Primary aquifers in the study area consist of various formations of the Sandveld Group, and natural groundwater has moderate salinity levels (relative to TMG and Basement aquifers), slightly acidic to slightly basic pH, moderate to high hardness (due to calcium dissolution), low fluoride and moderate levels of iron and manganese (relative to TMG).

For all GRUs of this aquifer type, many samples exceeded the baseline concentrations for all investigated parameters, with the exception of nutrients in Adamboerskraal and Elandsfontein. However, this is also a function of a limited dataset, with only 4 and 5 samples collected from these GRUs, respectively. The largest number of samples and exceedances were recorded in the Cape Flats Aquifer, including dissolved metals, and over 50% of samples exceeding the sulphate baseline. Urbanisation in the Cape Flats has led to deterioration in the natural water quality of the CFA due to exposure to multiple PCAs, including agriculture, wastewater treatment works and a variety of industries.

In Adamboerskraal, the high number of exceedances and elevated sulphate (52.5 – 1125.9 mg/l) and EC (499.1 – 4548 mS/m) suggests that boreholes within this GRU penetrate the basement (Tygerberg Formation) aquifer, where high salinity levels are expected. With limited spatial hydrochemical data and in the absence of geological logs and water level data from this GRU, the available hydrochemical data leads to potentially erroneous conclusions about the present water quality status of Adamboerskraal if the GRU is classified as a primary aquifer.

Fractured Table Mountain Group Aquifers

Natural groundwater in the TMGA is pristine with low salinity levels, slightly to highly acidic pH, low fluoride, low nutrients and moderate to high levels of iron and manganese.

Exceedances of the threshold baseline concentrations are observed across all GRUs, with 50% of samples exceeding the sulphate and EC baselines in the Cape Peninsula and Steenbras-Nuweberg, as well as nitrate + nitrite baseline in the Cape Peninsula. The Steenbras-Nuweberg and Wemmershoek samples were collected from areas of high elevation, with limited anthropogenic impact, as well as samples from 4 locations in the Cape Peninsula. Therefore, almost all the data collected from these GRUs is representative of variations in natural groundwater conditions. Exceedances for ammonia, nitrate + nitrite in the Cape Peninsula may also be due to contamination in the low-lying urban and residential areas of Fish Hoek, Sunnydale, Noordhoek and Kommetjie, while alkaline pH values in Wemmershoek and Steenbras-Nuweberg can be attributed to the influence of drilling fluids during exploration drilling.

The Steenbras-Nuweberg GRU consists of the Nardouw and Peninsula Aquifer resource units. The lower number of exceedances in the Nardouw compared to Peninsula suggests that concentrations of unique parameters from different samples have a lower range and do not vary widely from each other, while more variation is observed in the Peninsula Aquifer. Although low in both aquifers, the slightly higher EC (2.4 – 38 mS/m) in the Peninsula Aquifer may be the result of influence from the overlying Cederberg Formation, where exploratory core holes are uncased through the formation, while the higher but still acidic pH (4.9 – 9.3) is the result of some buffering from basic ions Ca and HCO_3. In the Nardouw Aquifer, EC and pH are lower (2 – 24.2 mS/m and 4.6 – 8.6, respectively) with the more acidic pH being the result of dissolution of humic compounds from overlying plants, dissolution of CO_2 (which forms carbonic acid) in recharge water and limited presence of basic ions (compared to Peninsula Aquifer) to buffer acidic waters.

Fractured and Intergranular Aquifers

Basement aquifers of the study area are hosted within the Tygerberg Formation and Cape Granite Suite. Natural groundwater has moderate to high salinity levels, neutral pH and moderate to high fluoride concentrations in some areas.

Exceedances of the threshold baseline concentrations are observed across all GRUs, with 50% of samples exceeding baselines for different parameters in all GRUs, particularly pH and fluoride. Exceedances of sulphate, ammonia and nitrate + nitrite are likely due to the use of fertilizers in the study area, where there is extensive agricultural activity. The relatively high number of exceedances suggests a large variation in parameter concentrations within individual GRUs, many of which can also be attributed to naturally elevated concentrations, particularly major ions and EC.

Table 4-13 Number of exceedances of baseline concentrations per GRU. Dashes indicate GRUs where no exceedance of the baseline concentration was recorded or where no baseline was able to be calculated due to lack of data. Red highlighted cells indicate parameters where at least 50% of samples exceeded the baseline concentration.

GRU	Repres-entative Borehole	Number of samples	Sulphate (mg/l)	EC (mS/m)	pH	Ammonia (mg/l)	Nitrate + nitrite (mg/l)	Fluoride (mg/l)	Ortho-phosphate (mg/l)	Dissolved Aluminium (mg/l)	Dissolved Arsenic (mg/l)	Dissolved Chromium (mg/l)	Dissolved Iron (mg/l)	Dissolved Lead (mg/l)	Dissolved Manganese (mg/l)	Dissolved Mercury mg/l)
			Number of Exceedances													
Primary / Intergranular Aquifers																
Adamboerskraal	93313	4	3	3	1	1	-	1	-	-	-	-	-	-	-	-
Atlantis	91733	46	19	16	14	1	17	2	7	-	-	-	-	-	-	-
Cape Flats	88847	588	302	22	20	248	46	35	86	1	4	13	21	24	66	5
Elandsfontein	93871	5	1	1	1	-	-	1	1	-	-	-	-	-	-	-
Langebaan Road	93873	139	54	52	8	1	42	46	33	-	-	-	1	-	-	-
Yzerfontein	89820	144	4	58	3	22	12	6	75	-	-	-	-	-	-	-
Fractured Table Mountain Group Aquifers																
Cape Peninsula	96073	11	10	10	6	3	8	1	1	-	-	-	-	-	-	-
Steenbras-Nuweberg (Peninsula)	H8A1	61	47	34	26	23	1	22	3	3	-	-	1	-	12	-
Steenbras-Nuweberg (Nardouw)	H1A3b	56	3	11	10	1	3	-	-	4	1	-	9	1	8	-
Wemmershoek	W7D1	31	4	11	5	1	1	1	3	1	-	1	1	-	-	-
Fractured and Intergranular Basement Aquifers																
Cape Town Rim	96211	21	18	6	3	2	7	18	10	-	-	-	-	-	-	-
Darling	94570	9	4	6	7	2	4	7	2	-	-	-	-	-	-	-
Eendekuil Basin	96167	10	7	6	4	1	5	5	1	-	-	-	-	-	-	-
Malmesbury	89665	320	19	6	166	18	5	126	17	23	48	16	36	61	5	-
Middle-Lower Berg	96095	61	9	10	36	33	10	34	49	-	-	-	-	-	-	-
Northern Swartland	96144	31	15	7	19	10	18	13	15	-	-	-	-	-	-	-
Paarl-Franschhoek	96019	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellenbosch-Helderberg (Tygerberg)	96029	6	5	4	2	4	5	1	4	-	-	-	-	-	-	-
Stellenbosch-Helderberg (Cape Granite Suite)	96033	13	4	3	6	10	9	2	12	-	-	-	-	-	-	-
Tulbagh	89812	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wellington	96016	3	-	-	-	1	-	-	1	-	-	-	-	-	-	-

Piper diagrams in **Figure 4-6** show the distribution of water types in the Berg catchment. Water types are determined by the distribution of major ions, sodium + potassium (Na + K), calcium (Ca), magnesium (Mg), sulphate (SO_4), chloride (Cl) and bicarbonate + carbonate (HCO_3 + CO_3 – alkalinity).

Primary/Intergranular Aquifers

Primary aquifers consist primarily of Na-Cl type waters, with mixed Ca-Mg-Cl and Ca-HCO_3 type water in the Atlantis and Cape Flats GRUs. Na-Cl type waters are due to the deposition of marine aerosols and recharge by coastal rainfall, which has a typical Na-Cl signature. Where boreholes are located near shallow basement rocks of the Tygerberg Formation, the elevated Na and Cl ion concentration of this lithology can also impart the Na-Cl character to groundwater in the overlying primary aquifer. In the CFA, the Na-Cl character has also been attributed to irrigation return flow in the Philippi Horticultural Area (PHA) and infiltration of surface waters (dams) that have undergone salinization due to evaporation (CoCT, 2020a). Irrigation return flow across the extensive farmlands of the Berg can also be attributed as the source of the Na-Cl type waters.

In Atlantis and the Cape Flats, Ca-HCO_3 type waters are due to the dissolution of calcium carbonate minerals from calcareous sands of the Witzands Formation and shelly material of the Varswater Formation while Ca-Mg-Cl type waters are due Na^+ cation exchange between Na-Cl type waters and Ca^{2+} and Mg^{2+} ions in the lithology.

Fractured Table Mountain Group Aquifers

TMGA consist primarily of Na-Cl type waters as a result of the deposition of marine aerosols and recharge by coastal rainfall. Ca-HCO_3 and Ca-Na-HCO_3 are also present in the Peninsula Aquifer of the Wemmershoek GRU, as well as Ca-Mg-Cl in the Steenbras-Nuweberg GRU. Although the Peninsula Formation consists primarily of quartzitic sandstones, due to the relatively high solubility of carbonate minerals, their dissolution often dominates chemical evolution of natural waters, even if these minerals are available in only small amounts. Thus, the presence of marine minerals can be expected in the Peninsula Formation, due to deposition in a clastic marginal marine setting, leading to Ca-HCO_3, while Ca-Na-HCO_3 type waters are due to ion exchange between Ca^+ ions from Ca-HCO_3 waters and Na^+ ions in the lithology. In the Nardouw Aquifer, concentrations of Ca and HCO_3 ions are lower than in the Peninsula, hence fewer samples indicating a Ca-HCO_3 water type.

Fractured and Intergranular Basement Aquifers

Basement aquifers consist primarily of Na-Cl type waters across all GRUs due to the elevated concentrations of Na and Cl ions relative to the other major ions, likely as a result of increased groundwater residence time in the relatively low transmissivity granitic and clay rich shale and siltstone basement aquifers causing the dissolution of salts. Few samples also show mixed Ca-Mg-Cl character in the Eendekuil Basin, Northern Swartland, Malmesbury and Stellenbosch-Helderberg GRUs. Although limited, this suggests that there is some Na^+ cation exchange between Na-Cl type waters and Ca^{2+} and Mg^{2+} ions in the lithology.

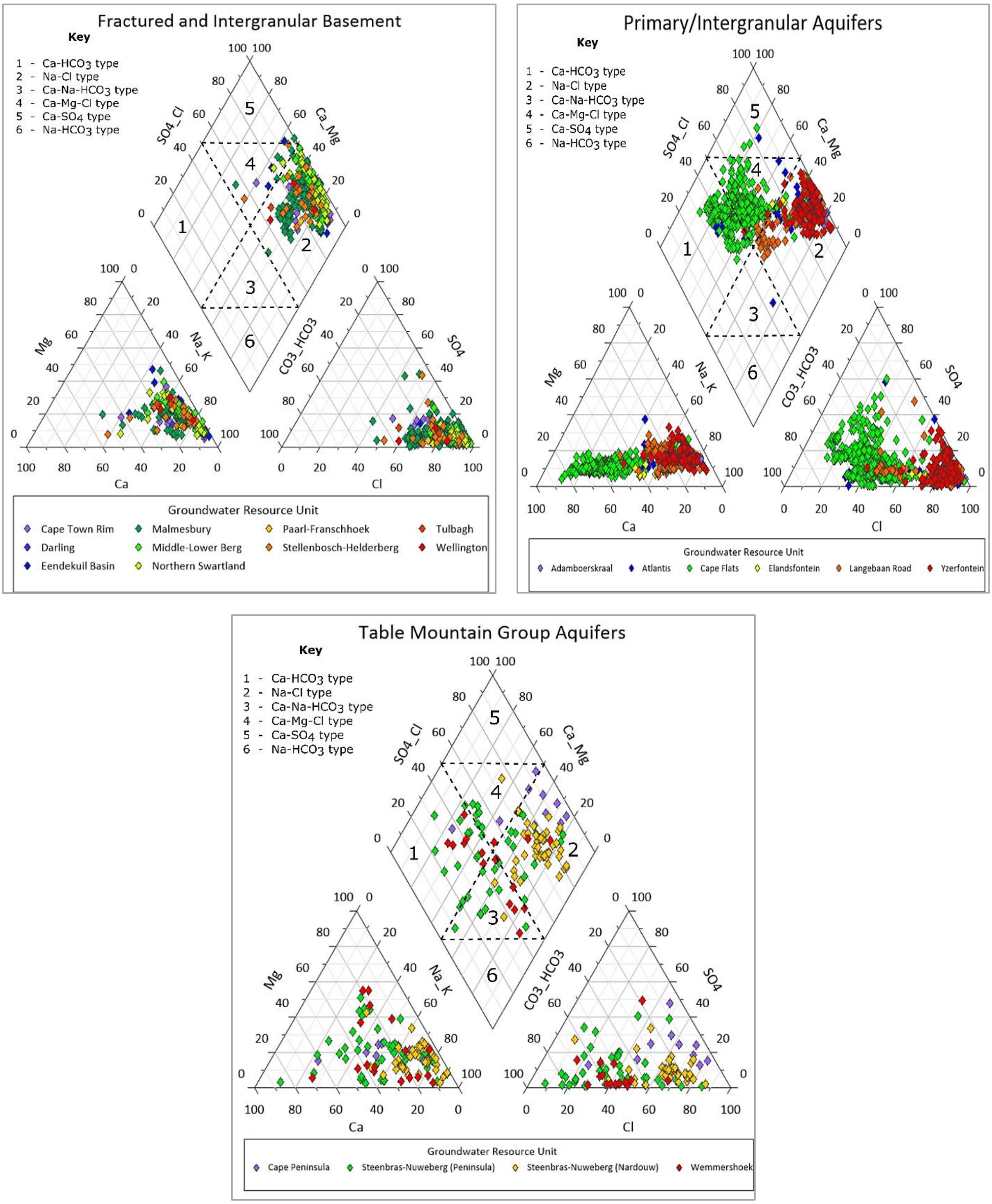


Figure 4-6 **Piper plots showing the distribution of water types across the Berg catchment. All GRUs consist predominantly of Na-Cl type waters. Other water types include mixed Ca-Mg-Cl, $Ca\text{-}HCO_3$ and $Ca\text{-}Na\text{-}HCO_3$ types.**

4.5.4. Resource Quality Objectives

DWS (2019b:121) outlines RQOs for groundwater in the Berg catchment. These RQOs are specific goals related to groundwater quality management of groundwater reserves and are established according to drainage region. **Table 4-14** summarises parameters exceeding RQOs for a given drainage region and GRU. Only 12 out of the 25 GRUs fall within a drainage region with established groundwater quality related RQOs.

It must be noted that RQOs have only been established for nitrate (NO_3). However, WMS data only includes combined NO_3 and NO_2, and this has been used as a proxy. Extensive monitoring by CoCT in the Atlantis, Cape Flats and TMG Aquifers, has shown that NO_3 almost always makes up the largest or whole proportion of the NO_3 and NO_2 sum.

Primary/Intergranular Aquifers

The Atlantis and Cape Flats GRU results indicate exceedance of RQOs for all parameters, except for $NO_3 + NO_2$ in Atlantis. CoCT monitoring data from the Atlantis indicates that 17% of (435) samples collected between 2018 and 2021 exceed the 0 counts/100 ml RQO for *E. Coli* and 64.8% of samples exceed the <10 counts/100 ml RQO for total coliforms. In the Cape Flats, CoCT monitoring data indicates that 13.7% of (830) samples collected between 2018 and 2021 exceed the 0 counts/100 ml RQO for *E. Coli* and 70.6% of samples exceed the <10 counts/100 ml RQO for total coliforms. *E. Coli* counts may be due to the application of manure in farming areas of the CFA, as well as contamination from wastewater treatment works and poor sanitation infrastructure in both GRUs.

In the Cape Flats, elevated $NO_3 + NO_2$ concentrations are the result of multiple contaminating activities including agriculture (use of fertilizers), wastewater treatment works, infiltration of nutrient rich surface waters and cemeteries (CoCT, 2020a). Acidic waters in the Cape Flats, Atlantis and Langebaan Road GRUs (below RQO thresholds) may be due to the leaching of basic ions from soils and dissolution of humic compounds from overlying vegetation. In Langebaan Road, exceedance of the EC RQO is likely the result of naturally elevated EC due to the underlying Tygerberg Formation basement lithology.

Overall, given the large number of samples, the exceedance count of 0.3 – 17.4% of samples indicates that groundwater quality in these GRUs typically meets RQOs. Only 1 sample exceeds the RQO threshold for EC in Adamboerskraal, while all samples from the Elandsfontein GRU meet RQOs.

Fractured Table Mountain Group Aquifers

No RQOs have been established for TMG Aquifers. For the G22D drainage region, within which the Cape Peninsula falls, RQOs are established only for primary and basement aquifers.

Fractured and Intergranular Basement Aquifers

The Middle-Lower Berg and Malmesbury GRU results indicate exceedance of RQOs for all parameters, while Northern Swartland GRU exceeds RQOs for EC, pH and $NO_3 + NO_2$ and exceedances for pH in the Eendekuil Basin GRU. $NO_3 + NO_2$ exceedances are likely the result of fertilizer use in farming while elevated EC can be attributed to natural variation due to the Tygerberg Formation lithology. In Middle-Lower Berg GRU, pH exceedances are predominantly above the 8.1 upper limit and may be due to the elevated Ca, Mg and HCO_3, relative to other GRUs. In the Darling GRU, only 1 exceedance for EC was recorded. Overall, the exceedance count is 0.7 – 26% of samples collected, except for Eendekuil Basin where only 4 samples were collected, 50% of which exceed the pH RQO.

Table 4-14 Number of exceedances of Resource Quality of Objectives (RQOs) per drainage region. Dashes indicate for which no exceedance was recorded.

Drainage Region	GRU	Parameter	RQO	Number of samples	Exceedance Count
G10E	Tulbagh	No RQOs established except for total coliforms and *E. Coli*			
G10J	Eendekuil Basin	EC (mS/m)	875	4	-
		pH	5.2-8.1		2
		$NO_3 + NO_2$ (mg/l)	11		-
	Middle-Lower Berg	EC (mS/m)	875	46	4
		pH	5.2-8.1		12
		$NO_3 + NO_2$ (mg/l)	11		3
G10L	Darling	EC (mS/m)	899	9	1
		pH	6.7-8.3		-
		$NO_3 + NO_2$ (mg/l)	11		-
		PO_4 mg/l)	0.3		-
	Northern Swartland	EC (mS/m)	899	31	5
		pH	6.7-8.3		1
		$NO_3 + NO_2$ (mg/l)	11		3
		PO_4 mg/l)	0.3		-
	Elandsfontein	EC (mS/m)	520	4	-
		pH	6.7-8.3		-
		$NO_3 + NO_2$ (mg/l)	0.2		-
		PO_4 (mg/l)	0.3		-
G10M	Adamboerskraal	EC (mS/m)	520	2	1
		pH	7.1 - 8.4		-
		$NO_3 + NO_2$ (mg/l)	11		-
		PO_4	0.3		-
	Elandsfontein	EC (mS/m)	520	1	-
		pH	7.1 - 8.4		-
		$NO_3 + NO_2$ (mg/l)	11		-
		PO_4 (mg/l)	0.3		-
	Langebaan Road	EC (mS/m)	520	103	9
		pH	7.1 - 8.4		18
		$NO_3 + NO_2$ (mg/l)	11		1
		PO_4 mg/l)	0.3		-
G21B	Atlantis	EC (mS/m)	287	39	3
		pH	6.7 - 8.3		4
		$NO_3 + NO_2$ (mg/l)	2.3		-
G21D	Malmesbury	EC mS/m)	617	141	5
		pH	6.3-8.6		1
		$NO_3 + NO_2$ (mg/l)	6.4		34
G22C, D, E	Cape Town Rim	EC (mS/m)	953	19	-
		pH	-		-
		$NO_3 + NO_2$ (mg/l)	11		-
G22D	Cape Flats	EC (mS/m)	180	581	2
		pH	6.6 - 8.4		14
		$NO_3 + NO_2$ (mg/l)	9.2		40
	Cape Peninsula	No RQOs established for fractured TMGA			

4.5.5. Water Quality Categories

Using WMS and CoCT data, water quality categories have been determined for each GRU based on the percentage exceedance of baseline threshold value per parameter and per GRU. Adjusted water quality categories have also been established taking into consideration that natural variation in water quality may lead to elevated parameter concentrations in some GRUs (i.e., not the result of anthropogenic contamination) and that extensive spatial monitoring may mask localised contamination when water quality patterns are averaged across a GRU. Six categories adapted after WRC (2007) have been established and are described in **Table 4-15**.

WRC (2007) recommends the use of a site-specific assessment using the DRASTIC approach to map aquifer vulnerability. However, in the absence of vulnerability mapping undertaken for this study, the formula below was applied to obtain a water quality category for each GRU (presented in **Table 4-16**):

$$\frac{Total\ number\ of\ exceedances\ per\ GRU}{Number\ of\ samples\ per\ GRU\ \times Number\ of\ parameters\ analysed\ per\ sample} \times 100$$

Table 4-15 Guide for determining groundwater contamination / groundwater quality Present Status Category of a GRU. Adapted after WRC (2007).

Water Quality (Present Status) Category	Percentage exceedance	Description	Guide
A	<16.7 %	Unmodified, pristine conditions	Natural groundwater quality conditions prevail
B	16.7 – 33.4 %	Localised, low levels of contamination, but no negative impacts apparent	Largly natural groundwater quality conditions prevail
C	33.4 – 50.1 %	Moderate levels of localised contamination, but little or no negative impacts apparent	Some localised contamination detected; may impact the purpose for which groundwater is used
D	50.1 – 66.8 %	Moderate levels of widespread contamination, which limit the use of potential use of the aquifer	Groundwater contamination is quite widespread but levels are relitavly low; may impact the purpose for which groundwater is used
E	66.8 – 83.5 %	High levels of local contamination which render parts of the aquifer unusable	High levels of contamination detected in places; use of groundwater from impacted area to be restricted or prohibited
F	>83.5 %	High levels of widespread contamination which render the aquifer unusable	Very high levels of contamination widspread thoughout the aquifer. Groundwater use to be restricted or prohibited

Primary/Intergranular Aquifers

The majority of parameter concentrations in these GRUs fall under Category A and B. Parameters falling under Category D are observed in the Cape Flats (sulphate) and Yzerfontein (orthophosphate), while parameters falling under Category E are observed in Adamboerskraal (sulphate and EC). The overall water quality categories for all GRUs are A, B and C. A large discrepancy is observed between the GRU water quality category (A) and adjusted water quality category (D) in the Cape Flats Aquifer, due to the well-documented contaminated status of the CFA. Overall, the adjusted water quality categories of primary/intergranular aquifers indicates that the groundwater quality ranges from pristine to moderately contaminated.

Fractured Table Mountain Group Aquifers

The majority of parameter concentrations in these GRUs fall under Category A. Parameters falling under Category C are observed in Steenbras-Nuweberg (pH, ammonia, fluoride) and Wemmershoek (EC), while parameters falling under Category D and E are observed in the Cape Peninsula (pH and NO_2 + NO_3, respectively). Parameters falling under Category F are observed in the Cape Peninsula (sulphate and EC). However, it must be noted that TMG aquifers consist of pristine groundwater and that even samples exceeding baseline concentrations are still representative of pristine conditions, despite naturally elevated iron and manganese and naturally low pH, which are a water quality concern. Due to these parameters of concern, the adjusted water quality category for Steenbras-Nuweberg is B and the adjusted category is A for Wemmershoek. These categories indicate that on average, groundwater quality in the TMGA is pristine.

Fractured and Intergranular Basement Aquifers

The majority of parameter concentrations in these GRUs fall under Category A, followed by Category B, C and D. Overall, the higher occurrence of parameters under Category C and D (relative to other aquifer types) indicates that groundwater within these GRUs has undergone moderate to high localised and widespread contamination. However, it must be noted that for parameters such as EC and sulphate, the high exceedance percentage and categories indicating poorer quality water can be attributed to naturally high concentrations in the Tygerberg Formation lithology. Taking natural variation into consideration, the adjusted water quality Category is B for Malmesbury and Wellington and Category C for all other GRUs, indicating that on average, the groundwater quality in fractured and intergranular basement aquifers represents largely natural to moderately contaminated conditions.

Table 4-16 **Derived water quality categories per parameter per GRU, based on percentage exceedance of baseline threshold concentrations. Dashes indicate parameters for which categories could not be established due to lack of data for a given parameter. For the Paarl-Franschhoek and Tulbagh GRU, categories have not been established because there is data from only one borehole in these GRUs, thus exceedance of baseline concentrations cannot be calculated.**

GRU	Sulphate (mg/l)	Electrical conductivity (mS/m)	pH	Ammonia (mg/l)	Nitrate + nitrite (mg/l)	Fluoride (mg/l)	Orthophosphate (mg/l)	Dissolved Aluminium (mg/l)	Dissolved Arsenic (mg/l)	Dissolved Chromium (mg/l)	Dissolved Iron (mg/l)	Dissolved Lead (mg/l)	Dissolved Manganese (mg/l)	Dissolved Mercury (mg/l)	GRU Water Quality Category	Adjusted Water Quality Category
Percentage exceedance																
Primary / Intergranular Aquifers																
Adamboerskraal	75.0	75.0	25.0	25.0	-	25.0	-	-	-	-	-	-	-	-	**C**	**B**
Atlantis	41.3	34.8	30.4	2.2	37.0	4.3	15.2	-	-	-	-	-	-	-	**B**	**C**
Cape Flats	51.4	3.7	3.4	42.2	7.8	6.0	14.6	0.2	0.7	2.2	3.6	4.1	11.2	0.9	**A**	**D**
Elandsfontein	20.0	20.0	20.0	0.0	0.0	20.0	20.0	-	-	-	-	-	-	-	**A**	**B**
Langebaan Road	38.8	37.4	5.8	0.7	30.2	33.1	23.7	-	-	-	0.7	-	-	-	**B**	**B**
Yzerfontein	2.8	40.3	2.1	15.3	8.3	4.2	52.1	-	-	-	-	-	-	-	**B**	**A**
Fractured Table Mountain Group Aquifers																
Cape Peninsula	90.9	90.9	54.5	27.3	72.7	9.1	9.1	-	-	-	-	-	-	-	**D**	**B**
Steenbras-Nuweberg (Peninsula)	77.0	55.7	42.6	37.7	1.6	36.1	4.9	4.9	-	-	1.6	-	19.7	-	**B**	**B**
Steenbras-Nuweberg (Nardouw)	5.4	19.6	17.9	1.8	5.4	-	-	7.1	1.8	-	16.1	1.8	14.3	-	**A**	**B**
Wemmershoek	12.9	35.5	16.1	3.2	3.2	3.2	9.7	3.2	-	3.2	3.2	-	-	-	**A**	**A**
Fractured and Intergranular Basement Aquifers																
Cape Town Rim	85.7	28.6	14.3	9.5	33.3	85.7	47.6	-	-	-	-	-	-	-	**C**	**C**
Darling	44.4	66.7	77.8	22.2	44.4	77.8	22.2	-	-	-	-	-	-	-	**D**	**C**
Eendekuil Basin	70.0	60.0	40.0	10.0	50.0	50.0	10.0	-	-	-	-	-	-	-	**C**	**C**
Malmesbury	5.9	1.9	51.9	5.6	1.6	39.4	5.3	7.2	15.0	5.0	11.3	19.1	1.6	-	**A**	**B**
Middle-Lower Berg	14.8	16.4	59.0	54.1	16.4	55.7	80.3	-	-	-	-	-	-	-	**C**	**C**
Northern Swartland	48.4	22.6	61.3	32.3	58.1	41.9	48.4	-	-	-	-	-	-	-	**C**	**C**
Paarl-Franschhoek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**N/A**	**N/A**
Stellenbosch-Helderberg (Tygerberg)	83.3	66.7	33.3	66.7	83.3	16.7	66.7	-	-	-	-	-	-	-	**D**	**C**
Stellenbosch-Helderberg (Cape Granite Suite)	33.3	25.0	50.0	83.3	75.0	16.7	100.0	-	-	-	-	-	-	-	**D**	**C**
Tulbagh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**N/A**	**N/A**
Wellington	-	-	-	33.3	-	-	33.3	-	-	-	-	-	-	-	**B**	**B**

Key

Colour	Category	Description
Blue	A	<16.7 of samples exceed the baseline concentration for a parameter
Green	B	16.7 – 33.4 of samples exceed the baseline concentration for a parameter
Light yellow	C	33.4 – 50.1 of samples exceed the baseline concentration for a parameter
Yellow-orange	D	50.1 – 66.8 of samples exceed the baseline concentration for a parameter
Orange	E	66.8 – 83.5 of samples exceed the baseline concentration for a parameter
Red	F	>83.5 of samples exceed the baseline concentration for a parameter

4.5.6. Summary

A summary of water types and water quality categories per GRU is presented in **Table 4-17**. A detailed summary including baseline concentrations, summary statistics, water types and water quality category per parameter, per GRU is presented in **APPENDIX D: Water Quality**. Overall, it is evident that given the lack of data, more monitoring is required in four of the seven TMGA GRUs – Drakensteinberge, Grootwinterhoek, Piketberg and Witsenberg.

Table 4-17 Summary of water types and water quality categories per GRU for Primary / Intergranular Aquifers, Fractured Table Mountain Group Aquifers, and Fractured and Intergranular Basement Aquifers. *For the Paarl-Franschhoek and Tulbagh GRU, categories have not been established because there is data from only one borehole in these GRUs, thus exceedance of baseline concentrations (and therefore categories) cannot be calculated.

GRU	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Primary / Intergranular Aquifers				
Adamboerskraal	Na-Cl	B, E	C	B
Atlantis	Na-Cl, Ca-Mg,Cl, Ca-HCO_3, Ca-Na-HCO_3, Ca-SO_4	A, B, C	B	C
Cape Flats	Na-Cl, Ca-Mg-Cl, Ca-HCO_3, Ca-SO_4	A, C, D	A	D
Elandsfontein	Na-Cl, Ca-Mg-Cl	A, B	A	B
Langebaan Road	Na-Cl, Ca-Mg-Cl	A, B, C	B	B
Yzerfontein	Na-Cl, Ca-Mg-Cl	A, C, D	B	A
Fractured Table Mountain Group Aquifers				
Cape Peninsula	Na-Cl, Ca-Mg-Cl, Ca-HCO_3	A, B, D, E, F	D	B
Drakensteinberge	No data available	No data available	N/A	N/A
Grootwinterhoek	No data available	No data available	N/A	N/A
Steenbras-Nuweberg	Na-Cl, Ca-Mg-Cl, Ca-HCO_3, Ca-Na-HCO_3	A, B, C	B	B
Piketberg	No data available	No data available	N/A	N/A
Wemmershoek	Na-Cl, Ca-HCO_3, Ca-Na-HCO_3	A, C	A	A
Witsenberg	No data available	No data available	N/A	N/A
Fractured and Intergranular Basement				
Cape Town Rim	Na-Cl, Ca-Mg-Cl	A, B, D, E, F	C	C
Darling	Na-Cl	B, C, D, E	D	C
Eendekuil Basin	Na-Cl, Ca-Mg-Cl, Ca-SO_4	A, C, D, E	C	C
Malmesbury	Na-Cl, Ca-Mg-Cl, Ca-SO_4	A, B, C, D	A	B
Middle-Lower Berg	Na-Cl	A, D, E	C	C
Northern Swartland	Na-Cl, Ca-Mg-Cl	B, C, D	C	C
Paarl-Franschhoek	Na-Cl	No data available*	N/A	N/A
Stellenbosch-Helderberg	Na-Cl, Ca-Mg-Cl	B, C, D, E, F	D	C
Tulbagh	Na-Cl	No data available*	N/A	N/A
Vredenberg	No data available	No data available	N/A	N/A
Wellington	Na-Cl	B	B	B

4.6. Aquifer Stress

In terms of the overall groundwater Reserve determination process, and in order to correlate the results of this study to existing Water Resource Classes outlined in DWS (2019b: 121), the current ecological reference conditions need to be re-evaluated and the present status of the GRUs re-assessed.

In the context of this study, 'ecological reference conditions' refer to the ambient or natural state of the groundwater system while the 'present status' relates to the current status of the groundwater system. A significant difference between the ecological reference conditions and the present status indicates a degrading state of the groundwater water resource.

The GRDM (WRC, 2007) provides three guidance tables around various groundwater characterisation approaches including 1) sustainable use, 2) level of stress, and 3) contamination / water quality. These are outlined below in terms of their applicability at this stage of the groundwater Reserve determination procedure.

4.6.1. Methodology and Considerations

4.6.1.1. Sustainable Use

In terms of both the Water Resource Classification and the groundwater Reserve determination process, it is assumed that the 'limit' of sustainability is marked by what would be considered 'acceptable' verses 'unacceptable' groundwater use in terms of Reserve requirements (i.e., the quantity and quality of groundwater Reserve required to satisfy the BHN and to protect aquatic ecosystems in different priority water resources within the Berg catchments). This, however, is an outcome of this study and therefore can only be properly assessed once Steps 5 -7 of the groundwater Reserve determination procedure is complete.

4.6.1.2. Level of Stress

Section 8 of the NWA addresses the concept of a 'stressed water resource', and although it is not defined, qualitative examples of 'water stress' are provided in WRC (2007), these include 1) where demands for water are approaching or exceed the available supply, 2) where water quality problems are imminent or already exist, and 3) where water resource quality is under threat.

To provide a quantitative means of assessment for defining aquifer stress, a groundwater Stress Index (SI) has been developed (after WRC, 2007), which considers groundwater water availability verses water use. The Stress Index is defined as follows:

$$\mathrm{SI} = \frac{\mathrm{GW\ Use}}{\mathrm{Recharge}}$$

Where

GW Use = Current groundwater use (M m^3/a)

Recharge = Recharge (M m^3/a)

After calculating the Stress Index, the "Level of Stress" guidance table is used (see **Table 4-18**) to set the groundwater present status category per GRU. A present status summary is presented in **Table 4-19**.

Table 4-18 Guide for determining Present Status Category of a GRU based on the groundwater Stress Index (after WRC, 2007).

Present Status Category	Description	Stress Index (GW use / Recharge)
A	Unstressed or slightly stressed	<0.05
B		0.05 – 0.20
C	Moderatly stressed	0.20 – 0.40
D		0.40 – 0.65
E	Highly stressed	0.65 – 0.95
F	Critically stressed	>0.95

4.6.1.3. Contamination and groundwater quality

In most cases, it's quite apparent when a groundwater resource is being overused or stressed, typically indicated by declining water levels, worsening groundwater quality, and reduced baseflow. Assessing less impacted RUs is sometimes more difficult as the signs of impact are less apparent. This is particularly important when assessing groundwater contamination and the current status of the aquifer in terms of groundwater quality. WRC (2007) provides a guidance table that is used to provide a present status category based on groundwater quality (see **Table 4-15** in **Section 4.5.5**). This has been adapted to include categories based on the percentage exceedance of baseline threshold values for each parameter and per GRU.

After evaluating the groundwater quality in the Berg catchment, the groundwater contamination / groundwater quality guidance table is used (see **Table 4-15**) to set the groundwater quality present status category per GRU and an adjusted category taking into account natural variation in water quality and spatial masking of localised contamination.

4.6.2. Summary

The present status in terms of water availability and groundwater quality is summarised per GRU in **Table 4-19**.

Table 4-19 A summary of the present status category for both groundwater (recharge and use) and groundwater quality for the Berg catchment.

GRU	Recharge Volume (M m³/a)	Groundwater Use (M m³/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
Primary / Intergranular Aquifers					
Cape Flats[13]	55.85	26.60	0.48	D	D
Atlantis[14]	27.85	6.76	0.24	C	C
Yzerfontien	9.20	0.26	0.03	A	A
Elandsfontien	15.47	1.09	0.07	B	B
Langebaan Road	23.28	8.59	0.37	C	B
Adamboerskraal	21.61	2.13	0.10	B	B
Fractured Table Mountain Group Aquifers					
Cape Peninsula	10.99	0.07	0.01	B	B
Steenbras-Nuweberg[15]	58.76	9.13	0.16	B	B
Drakensteinberge	27.60	0.05	0.00	A	-
Wemmershoek	26.83	0.81	0.03	A	A
Voëlvlei-Slanghoek	14.10	0.13	0.01	A	-
Witsenberg	2.78	0.08	0.03	A	-
Grootwinterhoek	22.50	1.39	0.06	B	-
Piketberg	20.33	5.58	0.27	C	-
Fractured and Intergranular Basement					
Cape Town Rim	18.60	6.21	0.33	C	C
Stellenbosch-Helderberg	41.52	8.81	0.21	C	C
Paarl-Franschhoek	26.61	9.82	0.37	C	-
Malmesbury	52.65	14.75	0.28	C	B
Wellington	39.49	4.48	0.11	B	B
Tulbagh	10.87	3.78	0.35	C	-
Eendekuil Basin	21.88	4.85	0.22	C	C
Middle-Lower Berg	42.49	2.23	0.05	B	C
Northern Swartland	31.85	1.79	0.06	B	C
Darling	9.95	0.76	0.08	B	C
Vredenberg	7.43	1.16	0.16	B	-

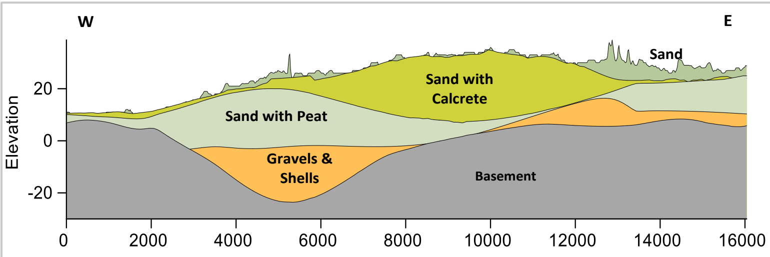
[13] City municipal abstraction of 20 M m³/a in development as per NWA Section 21(a) water use licence, with associated Managed Aquifer Recharge (MAR) of 14.6 M m³/a.
[14] City municipal abstraction of 5 M m³/a, with associated Managed Aquifer Recharge (MAR) of 5.11 M m3/a.
[15] City municipal abstraction of 9.13 M m³/a (Phase 1 development), recharge from GRAII – Note, storage is not considered (see CoCT, 2021a).

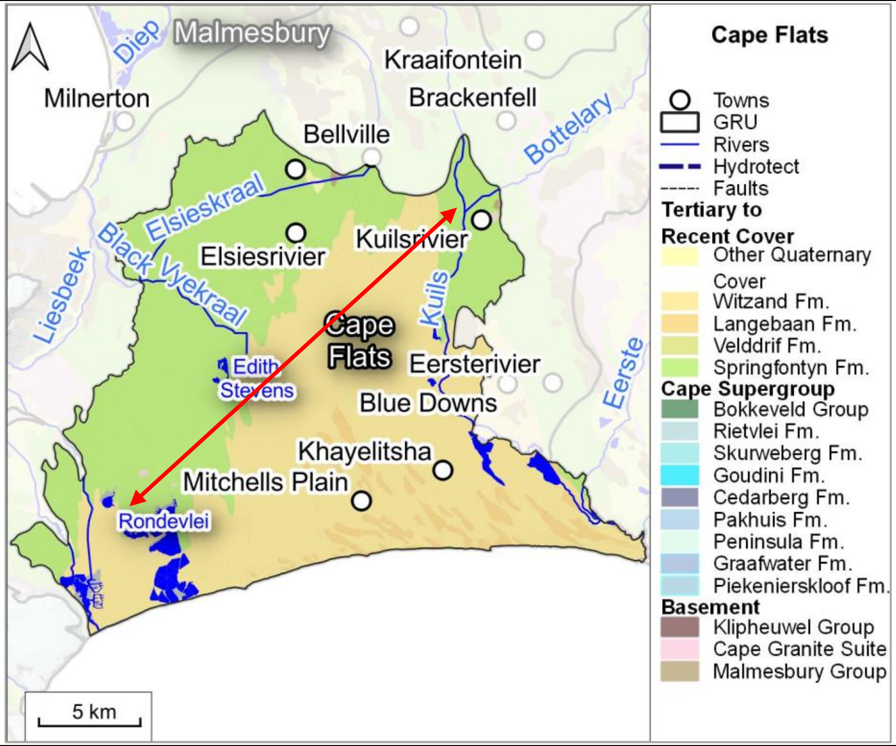
5. Status Quo per GRU

5.1. Primary / Intergranular GRUs

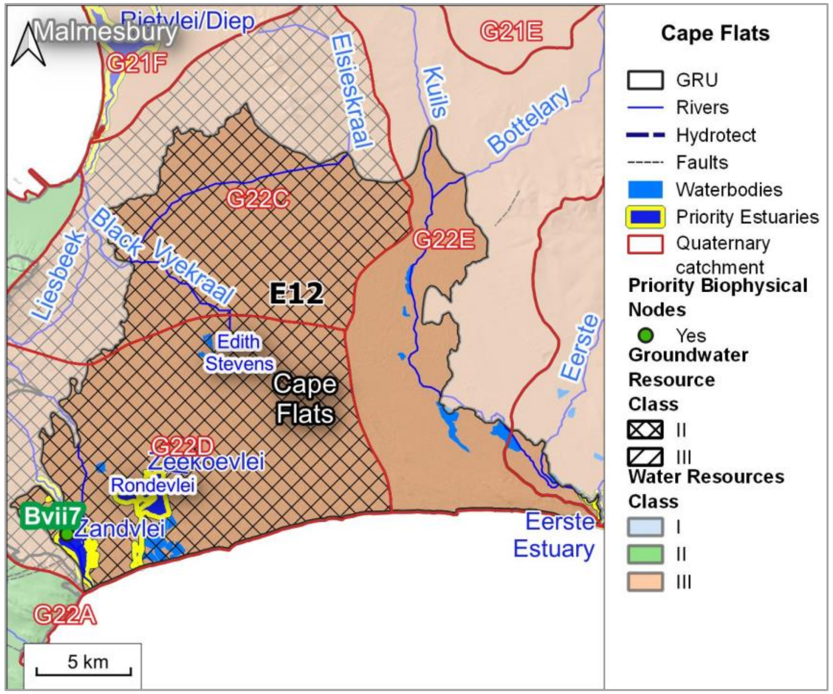
5.1.1. Cape Flats GRU

GRU	**GRU Name: Cape Flats**
	Main Suburbs: Philippi, Bellville and Kuilsriver
	Total Area (km²): 421.94
GRU Boundary Description	The City of Cape Town's aquifer model boundary (CoCT, 2018 and CoCT, 2020a) was used to define the extent of the Cape Flats GRU (see DWS, 2022d). The aquifer model used a slope separation (<2 degree) of the Cape Flats and the adjacent hills and mountains, as well as an interpolated geological extent of the basement (i.e., the Cape Granite Suite and the Malmesbury Group rocks) on the periphery of the GRU. The GRU is bound by the False Bay coastline in the south.
Quaternary Catchments	G22C, G22D, G22E and G22H
Resource Unit	Primary / Intergranular Aquifer
Description	Geologically, the Cape Flats GRU comprises of the fluvial, marine and aeolian Tertiary and Quaternary sedimentary deposits of the Sandveld Group, which unconformably overlie weathered Neoproterozoic to early Cambrian Malmesbury Group and Cape Granite Suite basement rocks (see **Section 3.1**). Hydrostratigraphically, the Elandsfontyn, Varswater and Springfontyn formations form the major aquifer units within the larger CFA, which is a large heterogeneous, stratified, intergranular or primary (i.e., porous sedimentary/sandy) aquifer within the Sandveld Group. The primary aquifer thickens to ~50 m towards the centre of the GRU and infills the palaeochannels carved into the basement topography, one of which coincides with the Philippi Horticultural Area (PHA; DWAF, 2008a).





GRU	GRU Name: Cape Flats
	Main Suburbs: Philippi, Bellville and Kuilsriver
	Total Area (km^2): 421.94
Surface Water System	Main rivers comprise of the Kuils, Lotus and Elsieskraal Rivers. Other important surface water bodies include Zandvlei, Zeekoevlei, Rondvlei and the Eerste Estuary. Rivers and wetlands are likely to be hydraulically connected to the relatively shallow groundwater. Where the aquifer is semi-confined (e.g., within the deep gravels in the palaeochannels), or at small local scale, where the aquifer is semi-confined by laterally discontinuous calcrete or clay lenses, rivers and wetlands are only likely to be in hydraulic connection with the shallow groundwater in the uppermost unconfined sand unit (CoCT, 2021). Various wetlands across the Cape Flats GRU are mostly duneslack wetlands associated with interflow from surrounding dunes and perched aquifer systems.
Water Resource Classes & RQOs	The GRU falls entirely within the Cape Flats IUA (E12) and has a Water Resource Class III. The GRU has Groundwater Resource Class II for the portions of the RU that fall within catchments G22C and G22D. The rest of the GRU has no Groundwater Resource Class. There are also no EWR sites within this IUA, although there are 3 priority biophysical nodes (2 estuary and 1 river node).



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
E12 Cape Flats	III	G22D	E12-R15	Keysers	Bvii7	D	93
		G22K	E12-E05	Zandvlei	Bxi9	C	93
		G22K	E12-E05	Zeekoevlei	Bxi9	D	N/A

GRU	GRU Name: Cape Flats Main Suburbs: Philippi, Bellville and Kuilsriver Total Area (km²): 421.94

Recharge

An estimated recharge of **41.25 M m³/a** was acquired from a model-based calibrated recharge (see **Section 4.2.3**; after CoCT, 2018) for the Cape Flats Primary / Intergranular Aquifer. The average recharge rate was calculated to **97.76 mm/a** based on the total GRU area. For the Aquifer Stress (**Section 4.6.1.2**) assessment a MAR volume of **14.6 M m³/a** for the CFAMS was added to the recharge volume.

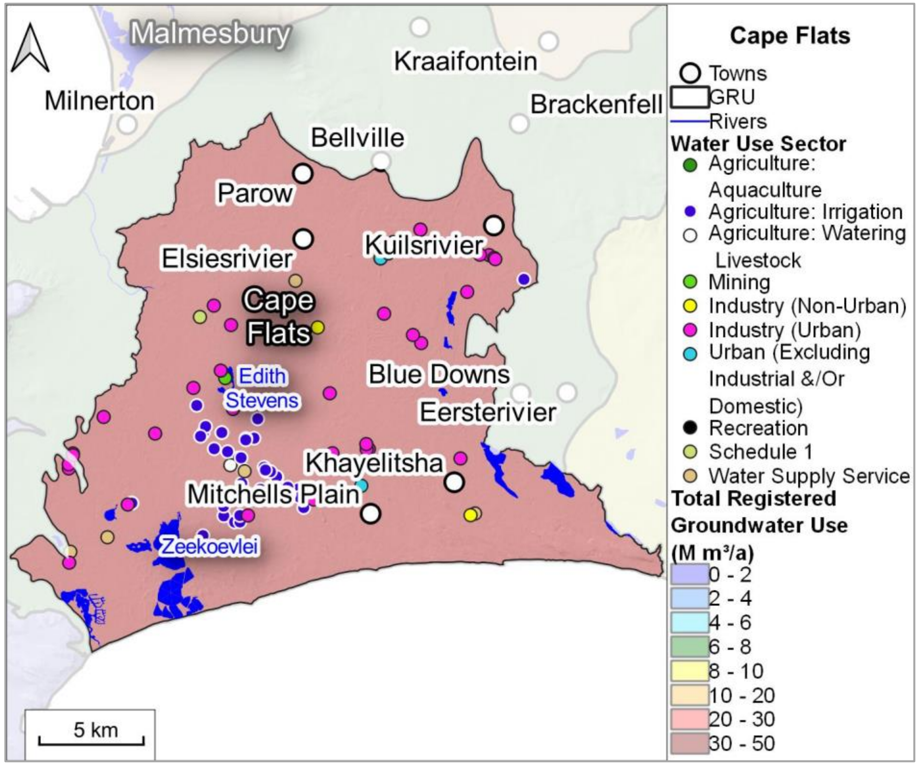
Method	Area (km²)	Recharge Volume (M m³/a)	Average Recharge Rate (mm/a)
Model-based calibrated recharge (after CoCT, 2018)	421.94	41.25	97.76

First-order recharge calculation was done for the GRU (see **Section 4.2.1**). The first order recharge estimations differ from the CoCT (2018) estimations because the model calibration considers both natural recharge and Irrigation Return Flow (IRF). See **Section 4.2.3** for additional recharge estimations from available literature.

Groundwater Use

There are 95 registered groundwater users in the Cape Flats GRU with a combined groundwater use of **26.66 M m³/a.** Major groundwater use sectors include Water Supply Services and Agriculture (irrigation), which comprises 75.4% and 15.32% respectively of the total groundwater use volume per annum (see **Section 4.3.3** for detail). It is however known that farmers likely abstract double the registered volume. Registered groundwater use is focussed in the PHA, with some Industry use in the northern portion of the GRU, as well as on the lower eastern slopes of the Peninsula Mountain range (i.e., Southern suburbs). None of the settlements within the GRU rely on groundwater as sole supply.

Water Use Sector	No. of Users	Total Volume (M m³/a)
Agriculture: Irrigation	50	4.08
Agriculture: Watering livestock	2	0.05
Industry (Non-urban)	2	1.05
Industry (Urban)	31	0.97
Mining	1	0.39
Schedule 1	1	0
Urban (Excluding industrial and/or domestic)	3	0.02
Water Supply Service	5	20.09
Total	**95**	**26.66**

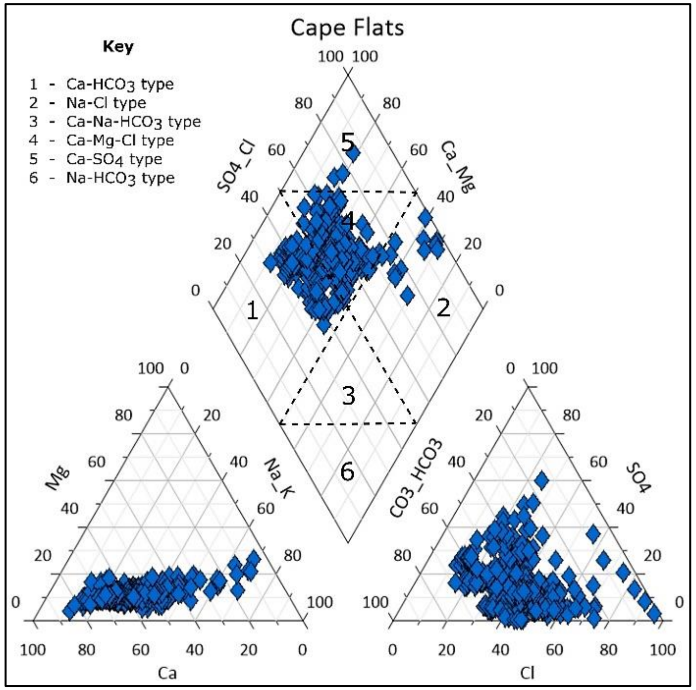


GRU	GRU Name: Cape Flats Main Suburbs: Philippi, Bellville and Kuilsriver Total Area (km^2): 421.94
Discharge	Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for the Cape Flats GRU is **2.70 M m^3/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m^3/a)
Primary/Intergranular	2.69
Fractured and Intergranular Basement	0.01
Total	**2.70**

Water Quality

The main water types in the CFA are Ca-Mg-HCO_3 and Ca-HCO_3 type. The Ca-HCO_3 waters are concentrated in the southern portion of the aquifer due to the influence of the shelly material found along the coastline, which dissolve to release Ca and HCO_3 ions. The northwest portion of the aquifer in the Philippi area is dominated by sodium-chloride type waters. These areas are associated with high organic rich and clay contents, which may be an influence on the water character. However, it has been previously noted that the irrigation waters used in the PHA have an influence on groundwater salinisation and may also be a source of the Na-Cl water types. Of the 581 samples collected, 2, 14 and 40 exceeded RQOs for EC, pH and NO_3 + NO_2, respectively. There are multiple known contaminating activities in the Cape Flats, thus the adjusted water quality category is D, indicating that there are moderate levels of widespread contamination.



GRU	GRU Name: Cape Flats Main Suburbs: Philippi, Bellville and Kuilsriver Total Area (km^2): 421.94

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Cape Flats	Sulphate (mg/l)	44.40	2.00	326.00	52.17	45.4	Na-Cl, Ca-Mg-Cl, Ca-HCO_3, Ca-SO_4	D	A	D
	Electrical conductivity (mS/m)	113.72	13.00	578.00	87.43	88.85		A		
	pH	8.30	5.07	8.55	7.79	7.84		A		
	Ammonia (mg/l)	0.08	0.02	31.89	0.72	0.059		C		
	Nitrate + nitrite (mg/l)	8.35	0.02	23.20	2.75	1.12		A		
	Fluoride (mg/l)	0.26	0.05	3.05	0.17	0.15		A		
	Orthophosphate (mg/l)	0.03	0.03	1.35	0.03	0.01		A		
	Dissolved Aluminium (mg/l)	0.500	0.015	1.070	0.499	0.5		A		
	Dissolved Arsenic (mg/l)	0.054	0.002	0.139	0.051	0.05		A		
	Dissolved Chromium (mg/l)	0.003	0.001	0.063	0.004	0.003		A		
	Dissolved Iron (mg/l)	2.918	0.006	22.990	1.113	0.65		A		
	Dissolved Lead (mg/l)	0.255	0.002	0.856	0.065	0.025		A		
	Dissolved Manganese (mg/l)	0.007	0.001	0.033	0.005	0.004		A		
	Dissolved Mercury (mg/l)	0.001	0.001	14.013	0.048	0.001		A		

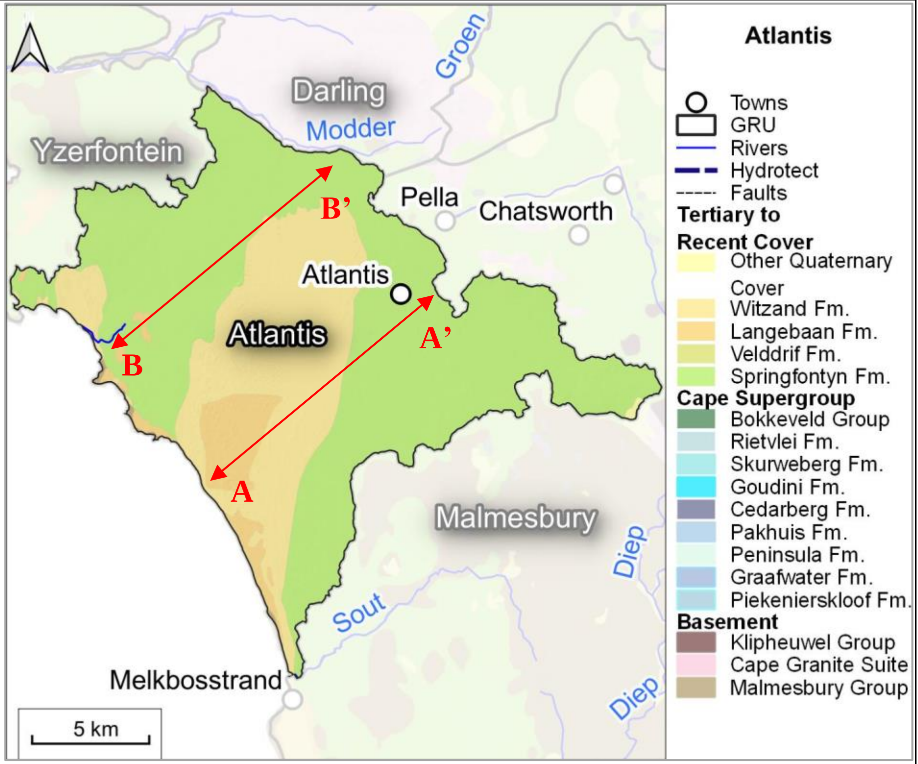
Aquifer Stress

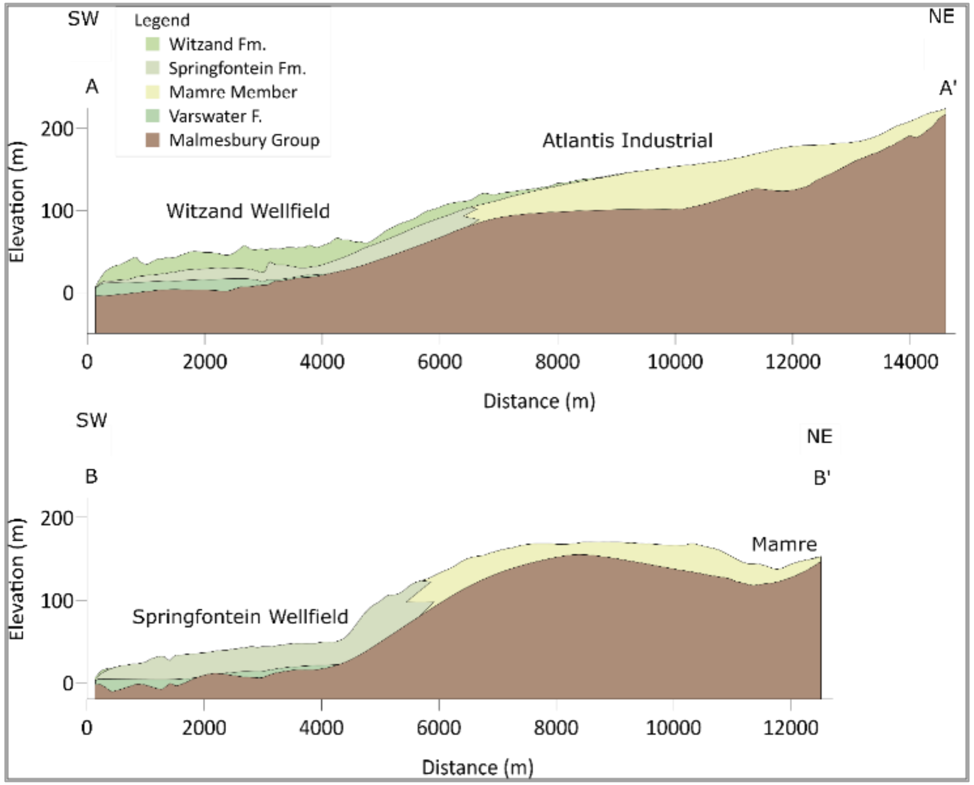
The GRU is considered to have a Groundwater Availability Present Status Category of 'D', indicating a **moderately stressed** aquifer, and a Groundwater Quality Present Status of 'D', indicating **moderate levels of widespread contamination, which limit the potential use of the aquifer**.

Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
55.85	26.60	0.48	D	D

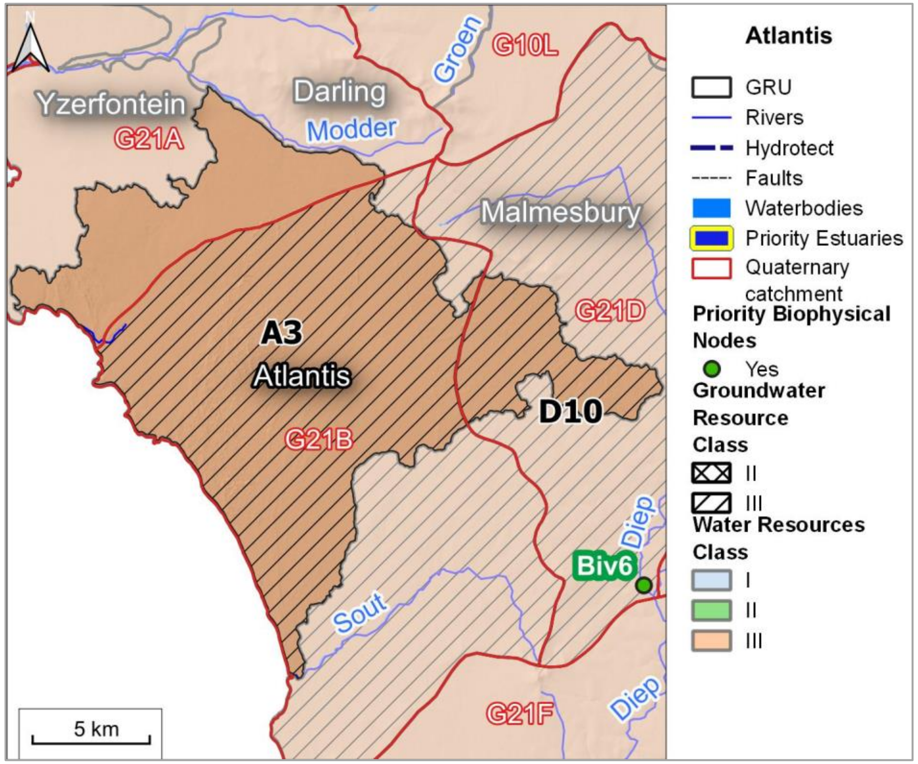
5.1.2. Atlantis GRU

GRU	GRU Name: Atlantis Main Towns: Atlantis and Melkbosstrand Total Area (km²): 255.68
GRU Boundary Description	The City of Cape Town's aquifer model boundary (CoCT, 2020b) outlines the extent of the Atlantis GRU (see DWS, 2022b). The aquifer model boundary uses areas with a marginal thickness of 0 m (i.e., where the aquifer pinches out) as the basis of the aquifer extent. The northeast and southeast boundary is then further defined by the outcrop extent of the low permeability basement lithologies (i.e., the Malmesbury Group and the Cape Granite Suite). The Modder and Louwskloof Rivers bound the northern extent of the GRU, with the Sout River bounding the southwest extent, and the coastline bounding the western edge. Preferential flow directions towards the coastline (on the eastern edge of the GRU) were also considered when defining the boundary of the GRU.
Quaternary Catchments	G21A, G21B and G21D
Resource Unit	**Primary / Intergranular Aquifer**
Description	The Atlantis Aquifer comprises Tertiary to Quaternary aged marine, and aeolian sedimentary deposits of the Sandveld Group. The Sandveld Group in the area unconformably overlies the Neoproterozoic to early Cambrian Tygerberg Formation (Malmesbury Group) and Darling Pluton (Cape Granite Suite). In the Atlantis area, the Sandveld Group comprises the Langebaan, Witzand, Springfontyn and Varswater formations. The ~40-60 m thick Cenozoic aquifer unit is classified as a primary, unconsolidated, intergranular aquifer as groundwater moves through the pores between sediment. It is mainly classified as unconfined, however, due to the presence of intermittent clay and calcrete lenses in the Springfontyn Formation, semi-confined conditions may occur. The basement aquifer consists of the Malmesbury Group (Tygerberg Formation shales/phyllites) and plutonic Cape Granite Suite basement rocks. Previously interpolated basement geology (CoCT, 2020b) illustrates a westwards decrease in bedrock elevation from the Atlantis town region to the coast. This decrease in bedrock elevation is parallel to the coast and is expected to influence groundwater flow. The Malmesbury Group is hypothesised to act as a basal aquiclude to the overlying aquifer. An aspect which is not definitive and may require further investigation is the possibility of interaction between the groundwater with the weathered shales of the Tygerberg Formation and the overlying Sandveld Group.



<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Atlantis</th></tr>
<tr><th>Main Towns: Atlantis and Melkbosstrand</th></tr>
<tr><th>Total Area (km²): 255.68</th></tr>
<tr><td></td><td>Two cross-sections are displayed which indicate the spatial variation of geology across the aquifer. In cross-section A, the overlying Witzand Formation is present, whereas in cross-section B, the Springfontyn Formation is more prevalent.

</td></tr>
<tr><td>Surface Water System</td><td>The Atlantis GRU comprises of the perennial Silwerstroom River which is fed by the Silwerstroom spring. The Donkergat and Sout Rivers flow to the south of the Atlantis area in winter, while surface drainage to the north and east of Atlantis contributes to the catchment areas of the Modder, Louwskloof and Diep rivers respectively. All these rivers are non-perennial, drying up in summer (Tredoux et al., 2009). Groundwater may discharge and support minor wetlands in coastal dunes, and to submarine discharge.</td></tr>
<tr><td>Water Resource Classes & RQOs</td><td>The GRU falls within the West Coast (A3) and Diep (D10) IUAs and both have Water Resource Class III and Groundwater Resource Class of III (only for portions of the GRU that fall within catchments G21B and G21D). There are no EWR sites within this IUA nor any priority biophysical nodes.</td></tr>
</table>

GRU	GRU Name: Atlantis Main Towns: Atlantis and Melkbosstrand Total Area (km^2): 255.68



Recharge

An estimated recharge of **22.74 M m^3/a** was acquired from a model-based calibrated recharge (see **Section 4.2.3**; CoCT, 2020b) for the Atlantis Primary / Intergranular Aquifer. The average recharge rate was calculated as **88.94 mm/a** based on the total GRU area. For the Aquifer Stress (**Section 4.6.1.2**) assessment a MAR volume of **5.11 M m^3/a** for the AWRMS was added to the recharge volume.

Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Model-based calibrated recharge (after CoCT, 2020b)	255.68	22.74	88.94

GRU	
GRU	GRU Name: Atlantis
	Main Towns: Atlantis and Melkbosstrand
	Total Area (km²): 255.68

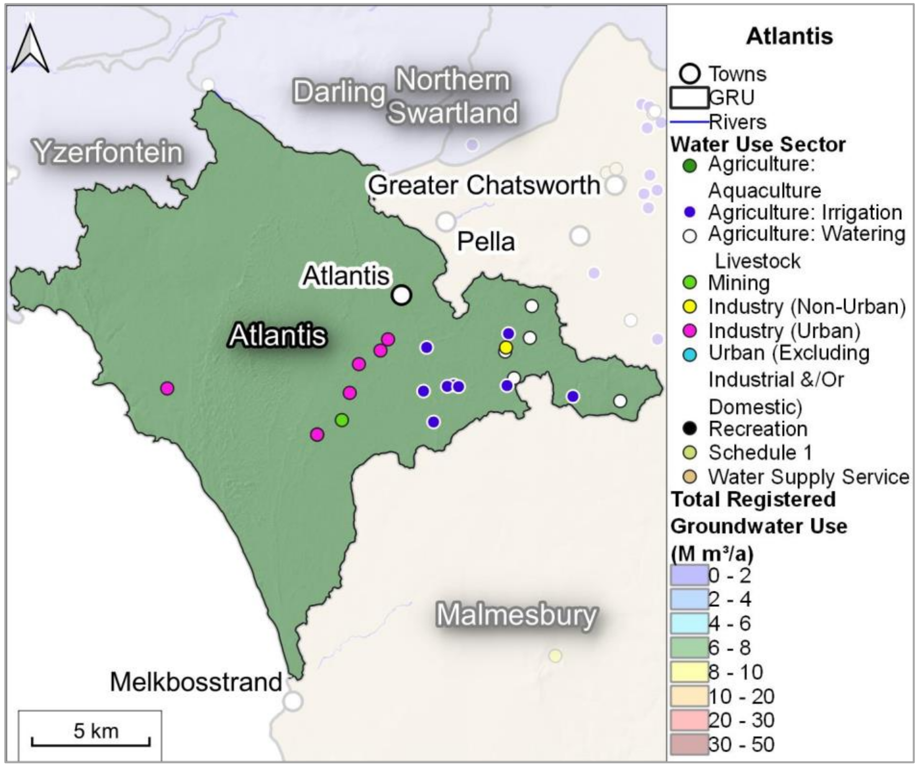
Groundwater Use

There are 24 registered groundwater users in the Atlantis GRU with a combined groundwater use of **6.76 M m³/a.**

Industry (urban) is the major groundwater use sector according to WARMS database that constitutes 86.8% of the water use. Although, this is a high value, WARMS classifies the Atlantis Water Resource Scheme (Municipal Water Supply) under 'Industrial use' instead of Water Supply Service for Atlantis. Both the Mining and Agricultural Sectors constitute of approximately 0.5 M m³/a of annual groundwater use each.

It is also important to note that the abstraction of 1 M m³/a by Eskom, is not registered in the WARMS database.

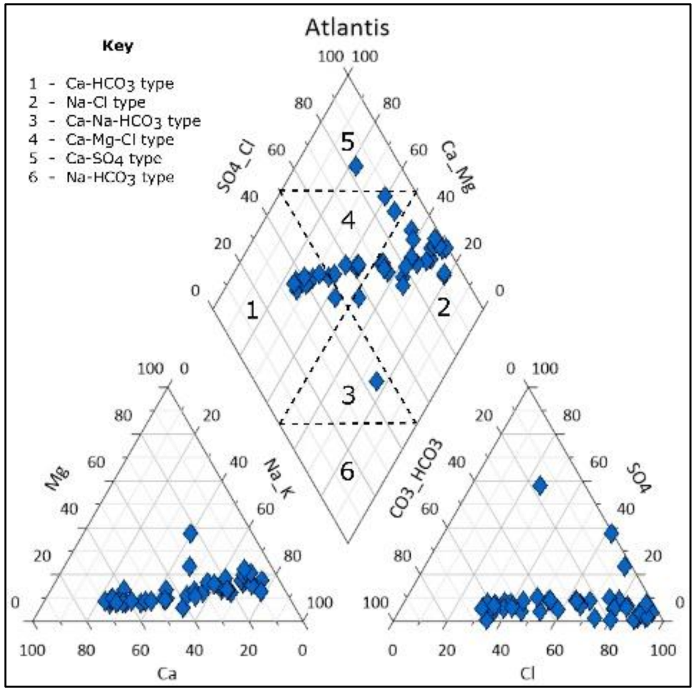
Water Use Sector	No. of Users	Total Volume (M m³/a)
Agriculture: Irrigation	9	0.16
Agriculture: Watering livestock	6	0.33
Industry (Non-urban)	1	0.04
Industry (Urban)	7	5.87
Mining	1	0.37
Total	**24**	**6.76**



Discharge

Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for the Atlantis GRU is **0.2 M m³/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m³/a)
Primary/Intergranular	0.20341
Fractured and Intergranular Basement	0.00013
Total	**0.2036**

<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Atlantis</th></tr>
<tr><th>Main Towns: Atlantis and Melkbosstrand</th></tr>
<tr><th>Total Area (km²): 255.68</th></tr>
<tr><td>Water Quality</td><td>The main water types in Atlantis are Na-Cl and Ca-HCO3 type. The Na-Cl waters predominantly due to the deposition of marine aerosols and recharge by coastal rainfall, which has a typical Na-Cl signature. Where boreholes are located near shallow basement rocks of the Tygerberg Formation, the elevated Na and Cl ion concentration of this lithology can also impart the Na-Cl character to groundwater in the overlying primary aquifer. Ca-HCO3 waters are due to the dissolution of calcium carbonate minerals from calcareous sands of the Witzands Formation, which dissolve to release Ca and HCO3 ions. Of the 39 samples collected, 3 exceeded RQO for EC and 4 exceeded the RQO for pH. Acidic waters in Atlantis (below RQO thresholds) may be due to the leaching of basic ions from soils, anthropogenic inputs and dissolution of humic compounds from overlying vegetation. The adjusted water quality category is C, indicating that some localised contamination is present.

</td></tr>
</table>

GRU	GRU Name: Atlantis Main Towns: Atlantis and Melkbosstrand Total Area (km^2): 255.68

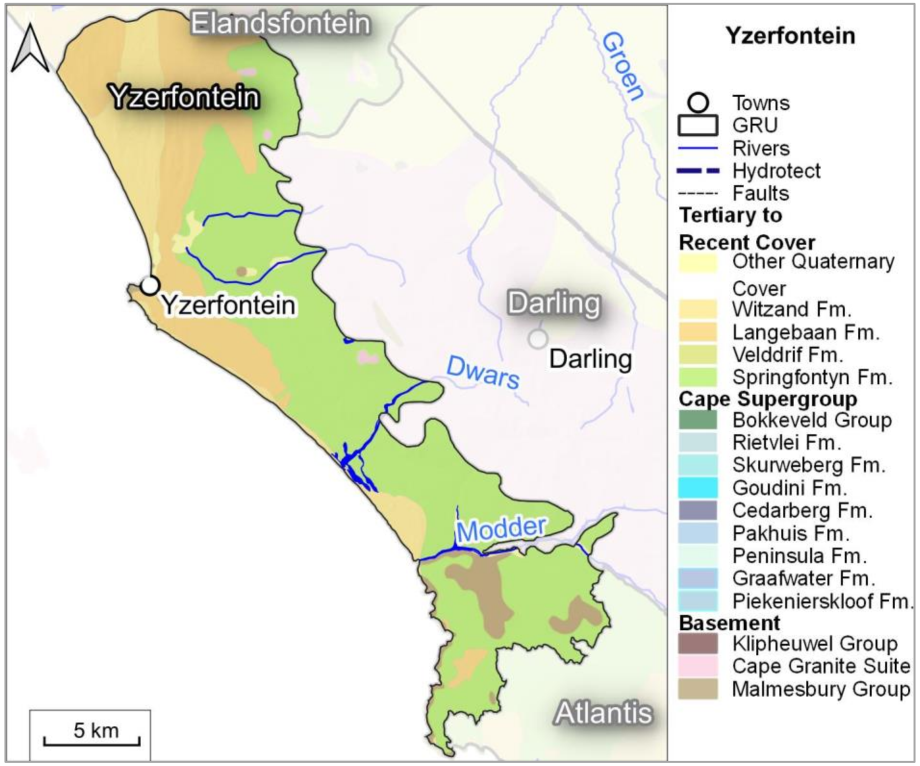
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Atlantis	Sulphate (mg/l)	24.70	2.00	355.70	39.01	19.8	Na-Cl, Ca-Mg,Cl, Ca-HCO3, Ca-Na-HCO3, Ca-SO4	C	B	C
	Electrical conductivity (mS/m)	99.74	38.10	1122.70	125.54	92.2		C		
	pH	7.73	2.60	8.35	7.42	7.59		B		
	Ammonia (mg/l)	1.16	0.02	1.22	0.14	0.05		A		
	Nitrate + nitrite (mg/l)	0.05	0.02	2.19	0.12	0.02		C		
	Fluoride (mg/l)	1.16	0.05	1.33	0.27	0.16		A		
	Orthophosphate (mg/l)	0.10	-	1.30	0.08	0.022		A		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of 'C', indicating a **moderately stressed** aquifer, and a Groundwater Quality Present Status Category of '**C**' indicating **moderate levels of widespread contamination, which limit the use of potential use of the aquifer**

Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
27.85	6.76	0.24	C	C

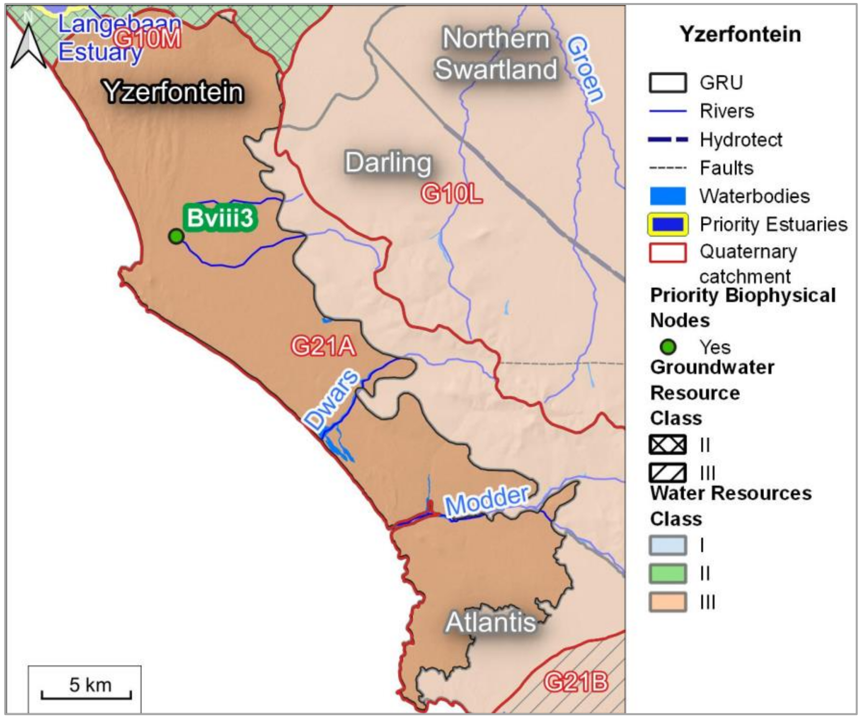
5.1.3. Yzerfontein GRU

GRU	**GRU Name: Yzerfontein** **Main Towns: Yzerfontein** **Total Area (km²): 320.33**
GRU Boundary Description	The Yzerfontein GRU is bound by the (CoCT 2020) Atlantis aquifer model boundary in the south, as well as the Cape Granite Suite outcrop to the north-east and the Modder River along the south/south-eastern edge. The divide between the Yzerfontein GRU and the Elandsfontein GRU is between the G10M and G21A surface water quaternary catchment and considers the south-westerly preferential flow and discharge direction. The coastline bounds the western edge of the GRU. It is noted that there may be a hydraulic connection between the two aquifers.
Resource Unit	**Primary / Intergranular Aquifer**
Quaternary Catchments	G21A
Description	This primary aquifer is composed of laterally continuous layers of the Sandveld Group reaching significant thicknesses. Various geophysical prospecting methods were used to estimate aquifer depth due to the difficultly in distinguishing between the unconsolidated deposits and the weathered bedrock materials. However, the thickness is estimated to be ~ 50 m (Tiimerman, 1985). The Sandveld Group includes the Springfontyn Formation (present in the majority of the GRU), as well as the Witzand and Langebaan formations to the north-west. The basement is composed of the Malmesbury Group, outcropping mainly in the areas surrounding the Modder River in the southern portion and in other intermittent outcrops of the GRU. 
Surface Water System	The main surface water bodies include the Dwars, Jakkals and Modder rivers. Groundwater may discharge and support minor wetlands in coastal dunes, as well as to the ocean as submarine discharge.

GRU	GRU Name: Yzerfontein
	Main Towns: Yzerfontein
	Total Area (km²): 320.33

Water Resource Classes & RQOs

The GRU falls within the West Coast (A3), has a Water Resource Class of III and no Groundwater Resource Class. There are no EWR sites within this IUA, although there is 1 priority biophysical river node with a TEC of D.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
A3 Wast Coast	III	G21A	A3-R01		Bviii3	D	14.6

Recharge

An estimated recharge of **9.20 M m³/a** was acquired from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessment. The average recharge rate was calculated to **28.72 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

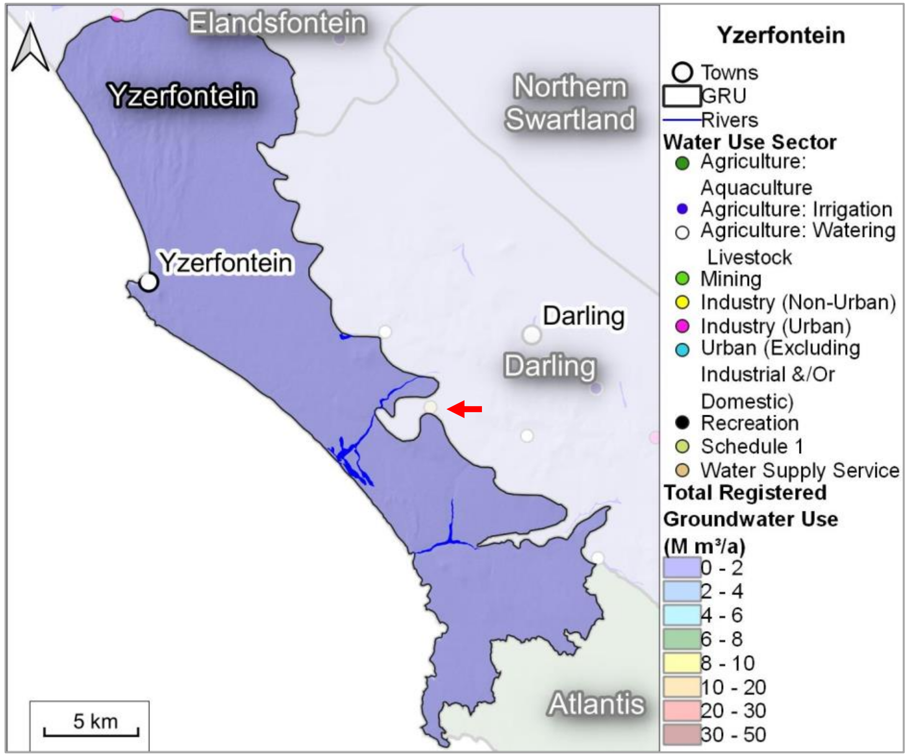
Method	Area (km²)	Recharge Volume (M m³/a)	Average Recharge Rate (mm/a)
Map-Centric Simulation method	320.33	9.20	28.72

GRU	GRU Name: Yzerfontein Main Towns: Yzerfontein Total Area (km^2): 320.33

Groundwater Use

There is one registered groundwater user in this GRU using a total of **0.26 M m^3/a** in the Water Supply Scheme Service Sector (see **Section 4.3.3** for details). The WARMS dataset places Yzerfontein's municipal abstraction of 0.26 M m^3/a in the Darling GRU (indicated by the red arrow in the figure). It has been updated to reflect for the Yzerfontein GRU.

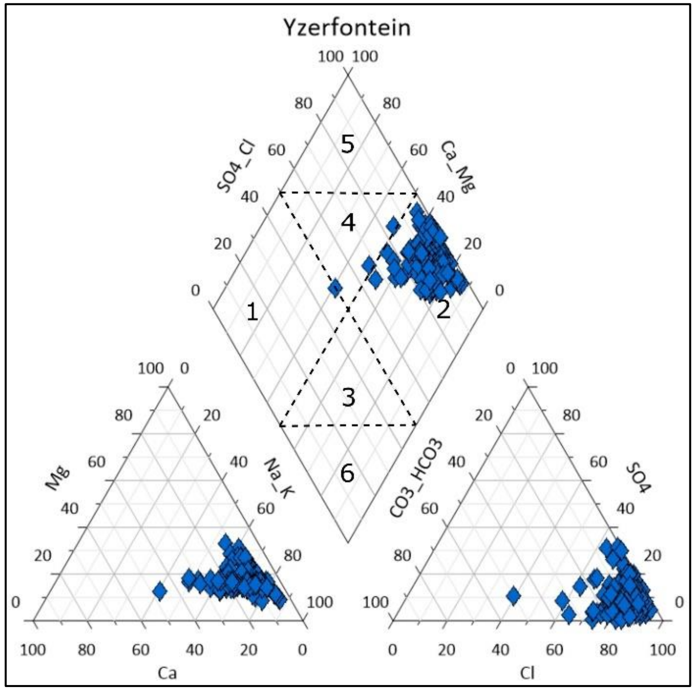
RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Primary / Intergranular Aquifers	Water Supply Service	1	0.26
Total		**1**	**0.26**



Discharge

Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **0.19 M m^3/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m^3/a)
Primary/Intergranular	0.18
Fractured and Intergranular Basement	0.01
Total	**0.19**

GRU	**GRU Name: Yzerfontein** **Main Towns: Yzerfontein** **Total Area (km²): 320.33**
Water Quality	The main water types in Yzerfontein are Na-Cl and Ca-Mg-Cl types. Na-Cl waters are due to the deposition of marine aerosols and recharge by coastal rainfall, which has a typical Na-Cl signature. Ca-Mg-Cl type waters are due Na^{+} cation exchange between Na-Cl type waters and Ca^{2+} and Mg^{2+} ions in the lithology, primarily from the Langebaan and Witzands Formations. No RQOs have been gazetted for the G21A drainage region. Exceedance of baseline threshold values are observed for EC and orthophosphate, which may be the result of influence from the Cape Granite Suite (for EC) and fertilizer use (for orthophosphate) in agriculture. However, the adjusted water quality category for this GRU is A, indicating that on average, the aquifer is pristine. 

GRU	GRU Name: Yzerfontein
	Main Towns: Yzerfontein
	Total Area (km²): 320.33

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Yzerfontein	Sulphate (mg/l)	109.04	2.00	277.90	51.61	40.128	Na-Cl, Ca-Mg-Cl	A	B	A
	Electrical conductivity (mS/m)	111.70	35.20	588.00	127.01	104.1		C		
	pH	7.97	1.00	8.76	7.21	7.235		A		
	Ammonia (mg/l)	0.11	0.02	1.16	0.08	0.042		A		
	Nitrate + nitrite (mg/l)	0.51	0.01	4.18	0.24	0.087		A		
	Fluoride (mg/l)	0.44	0.03	0.88	0.23	0.2		A		
	Orthophosphate (mg/l)	0.05	-	0.81	0.11	0.058		D		
	Dissolved Aluminium (mg/l)	0.026	0.019	0.026	0.023	0.0225		-		
	Dissolved Arsenic (mg/l)	0.061	0.002	0.064	0.033	0.033		-		
	Dissolved Chromium (mg/l)	0.005	0.003	0.005	0.004	0.004		-		
	Dissolved Iron (mg/l)	0.118	0.020	0.123	0.072	0.0715		-		
	Dissolved Lead (mg/l)	0.034	0.002	0.036	0.019	0.019		-		
	Dissolved Manganese (mg/l)	0.001	0.001	0.001	0.001	0.001		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

Aquifer Stress

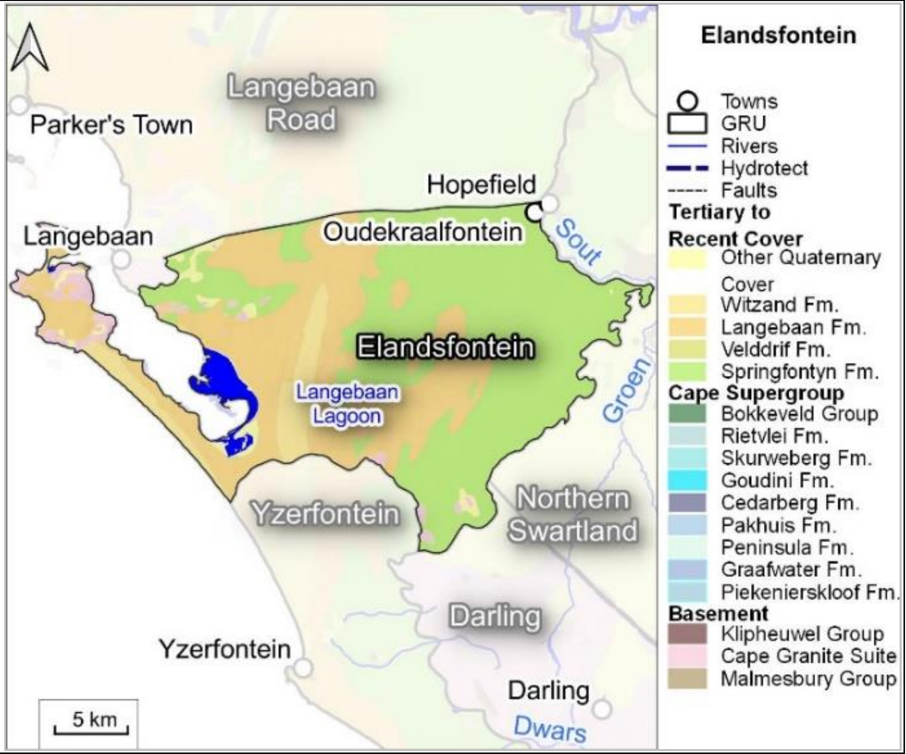
The GRU is considered to have a Groundwater Availability Present Status Category of ‘A’, indicating an **unstressed or slightly stressed** aquifer, and a Groundwater Quality Present Status Category of ‘A’ indicating **unmodified, pristine conditions.**

Recharge Volume (M m³/a)	Groundwater Use (M m³/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
9.20	0.26	0.03	A	A

5.1.4. Elandsfontein GRU

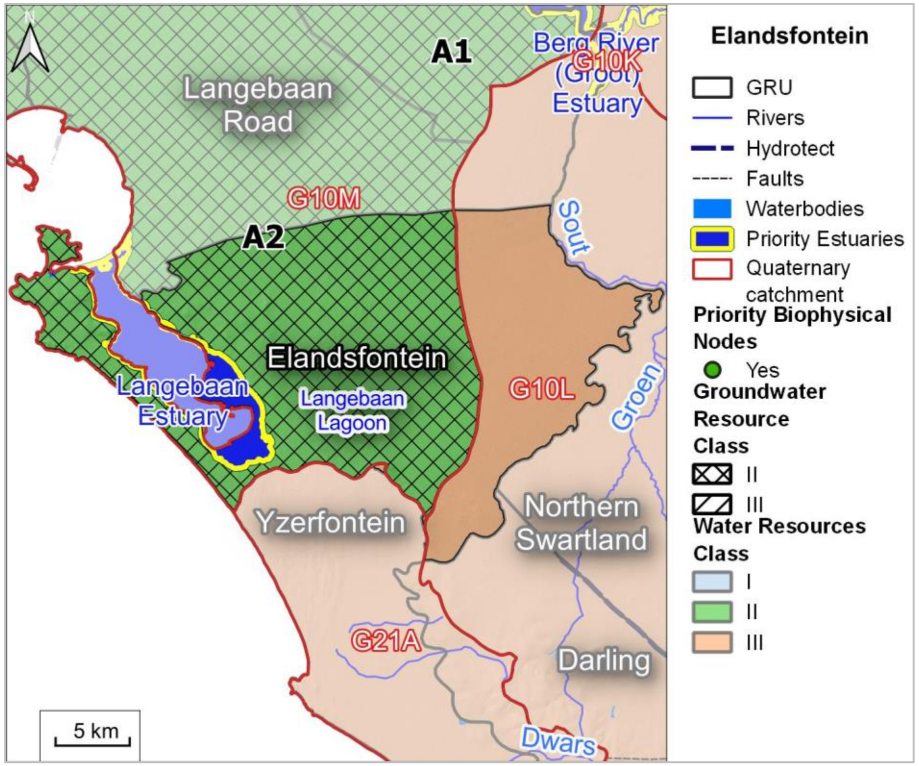
<table>
<tr><th rowspan="3">GRU</th><th colspan="2">GRU Name: Elandsfontein</th></tr>
<tr><th colspan="2">Main Towns: None</th></tr>
<tr><th colspan="2">Total Area (km^2): 531.57</th></tr>
<tr><td>GRU Boundary Description</td><td colspan="2">The Elandsfontein GRU is bound by the extent of the Springfontyn Formation in the east including portions of the Sout River, as well as by an interpolated extent of the Cape Granite Suite outcrop to south. The Yzerfontein and Elandsfontein GRU share the surface water quaternary catchment divide at G10M and G21A, which considers the south-westerly preferential flow direction and discharge. The divide between the Elandsfontein and Langebaan Road GRU is based on an inferred basement high (i.e., Malmesbury Group and Cape Granite Suite) which extends from the eastern edge of the GRU towards the coast. However, it is noted that there might be a hydraulic connection between the Elandsfontein and Langebaan Road aquifers. The coastline bounds the western edge of the GRU.</td></tr>
<tr><th rowspan="2">Resource Unit</th><th colspan="2">Primary / Intergranular Aquifer</th></tr>
<tr><th>Upper RU</th><th>Lower RU</th></tr>
<tr><td>Quaternary Catchments</td><td colspan="2">G10M and G10L</td></tr>
<tr><td>Description</td><td>This primary aquifer is composed of laterally continuous layers of the Sandveld Group reaching an average thickness of approximately 70 m. The Sandveld Group includes the Springfontyn Formation (present in the majority of the GRU) which is predominantly covered with Tertiary and Quaternary unconsolidated with semi-consolidated dune sands and calcrete. The basement topography (palaeochannels), faults, fissures, contact zones and the stratigraphy of the Cenozoic deposits all contribute to the complexity of the groundwater recharge, flow and discharge. Nonetheless, the Elandsfontein Aquifer System comprises of a lower and upper sand aquifer separated by clay unit and is situated between Hopefield and Langebaan Lagoon. Palaeo-courses of the Berg River (Timmerman, 1985a, 1985b and 1985c, DWAF, 2008e) have created incisions in the basement topography, which are infilled by fluvial sediment of the Elandsfontyn Formation, within the Sandveld Group, and represent high yielding zones.

The basement is formed by Malmesbury Group shales and granites from the Cape Granite Suite. Granite outcrops occur in a number of places, with granite underlying the Tertiary layers in the west and Malmesbury shale in the east.</td><td>



</td></tr>
</table>

GRU	GRU Name: Elandsfontein Main Towns: None Total Area (km^2): 531.57
Surface Water System	Surface water is limited in the region, related to low rainfall, subdued topography and the highly permeable sand-dominated geology. The aquifer discharges into the Langebaan Lagoon, which is the main surface water system in the GRU.
Water Resource Classes & RQOs	The GRU falls within the Langebaan (A2) and Lower Berg (B4) IUAs and has Water Resource Class II and III respectively. The portions of the GRU that fall within IUA A2 (catchment G10M) has a Groundwater Resource Class of II, and no Groundwater Resource Class for the portions that fall within IUA B4 (catchment G10L). There is 1 priority estuary EWR site within the GRU – the Langebaan Lagoon, which has a TEC of A.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
A2 Langebaan	II	G10M	A2-E04	Langebaan	Bxi3	A	N/A

GRU	
	GRU Name: Elandsfontein
	Main Towns: None
	Total Area (km^2): 531.57

Recharge

An estimated recharge of **15.47 M m^3/a** was acquired from First-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessment. The average recharge rate equates to **29.05 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map-Centric Simulation method	532.57	15.47	29.05

A leaky hydraulic connection is presumed to exist between the upper and lower RU. This will be further investigated in Step 4 (i.e., EWR and BHN Reserve determination).

Groundwater Use

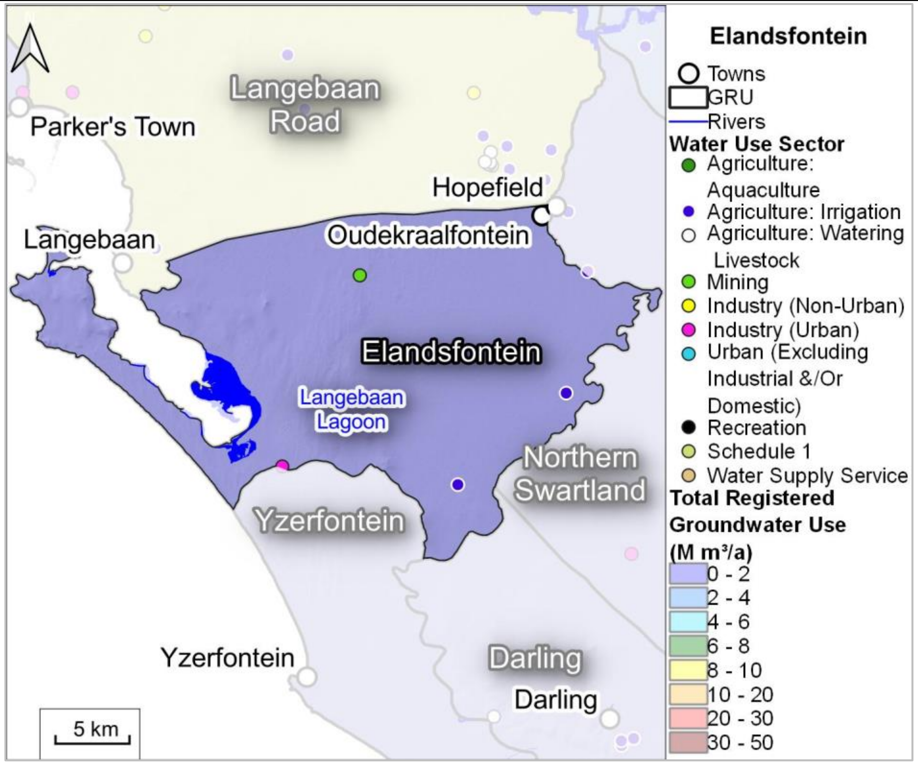
There are 3 registered groundwater users in this Upper Primary Intergranular Aquifer with a combined groundwater use of **0.87 M m^3/a**. Major groundwater use sectors include Mining and Agriculture (irrigation) which comprise of 80.5% and 18.3% respectively of total groundwater use volume per annum (see **Section 4.3.3** for detail).

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Primary / Intergranular Aquifers (Upper)	Agriculture: Irrigation	1	0.16
	Industry (Urban)	1	0.01
	Mining	1	0.70
Total		**3**	**0.87**

Agriculture (irrigation) is the only groundwater user in the Lower Primary Intergranular Aquifer abstracting a **0.22 M m^3/a** (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Primary / Intergranular Aquifers (Lower)	Agriculture: Irrigation	1	0.22
Total		**1**	**0.22**

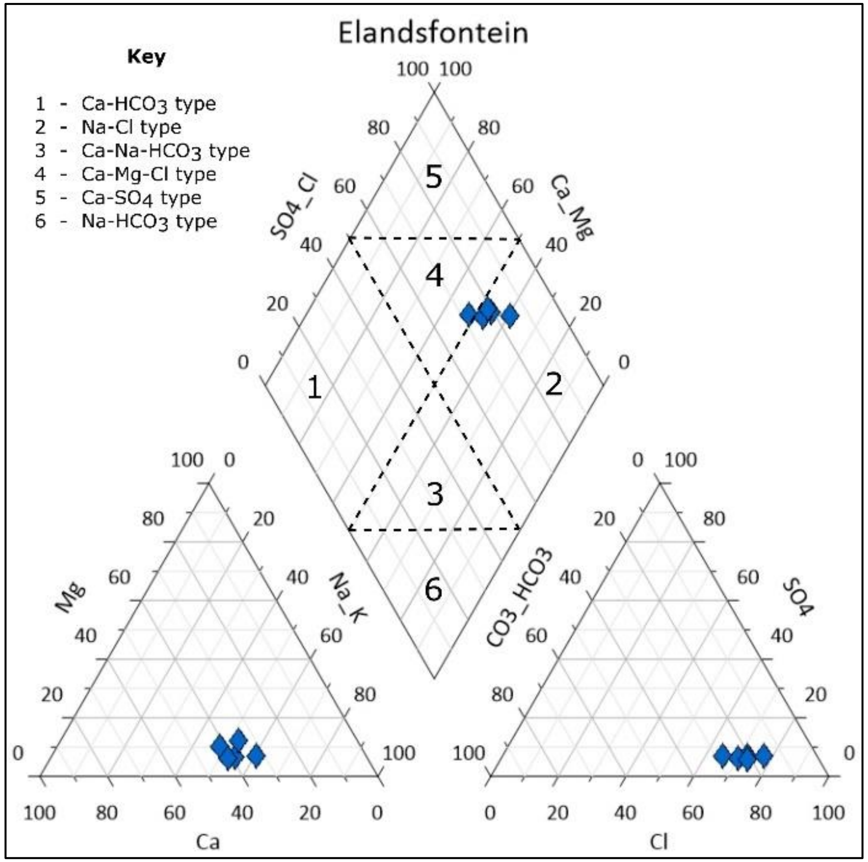
GRU	GRU Name: Elandsfontein
	Main Towns: None
	Total Area (km^2): 531.57



Discharge

Groundwater's contribution to baseflow is minimal due to discharge to lagoons and the ocean not being included. However, groundwater is known to discharge into the Langebaan Lagoon and this will be further investigated in Step 4 (i.e., EWR and BHN Reserve determination).

RU	Sum of Baseflow per component (M m^3/a)
Primary/Intergranular	0
Fractured and Intergranular Basement	0.00048
Total	**0.00048**

<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Elandsfontein</th></tr>
<tr><th>Main Towns: None</th></tr>
<tr><th>Total Area (km²): 531.57</th></tr>
<tr><td>Water Quality</td><td>The main water types in Elandsfontein are Na-Cl and Ca-Mg-Cl types. Na-Cl waters are due to the deposition of marine aerosols and recharge by coastal rainfall, which has a typical Na-Cl signature. Ca-Mg-Cl type waters are due Na^{+} cation exchange between Na-Cl type waters and Ca^{2+} and Mg^{2+} ions in the lithology, primarily from the Langebaan and Witzands formations. The Elandsfontein GRU falls under the G10L and G10M drainage regions. Four samples were collected from G10L and 1 from G10M and all samples meet RQOs. The adjusted water quality category is B, indicating that although some low levels of contamination exist, largely natural groundwater quality conditions prevail. However, monitoring of more locations within the Elandsfontein GRU is required to establish a more robust groundwater quality status.

</td></tr>
</table>

GRU	
GRU	**GRU Name: Elandsfontein**
	Main Towns: None
	Total Area (km²): 531.57

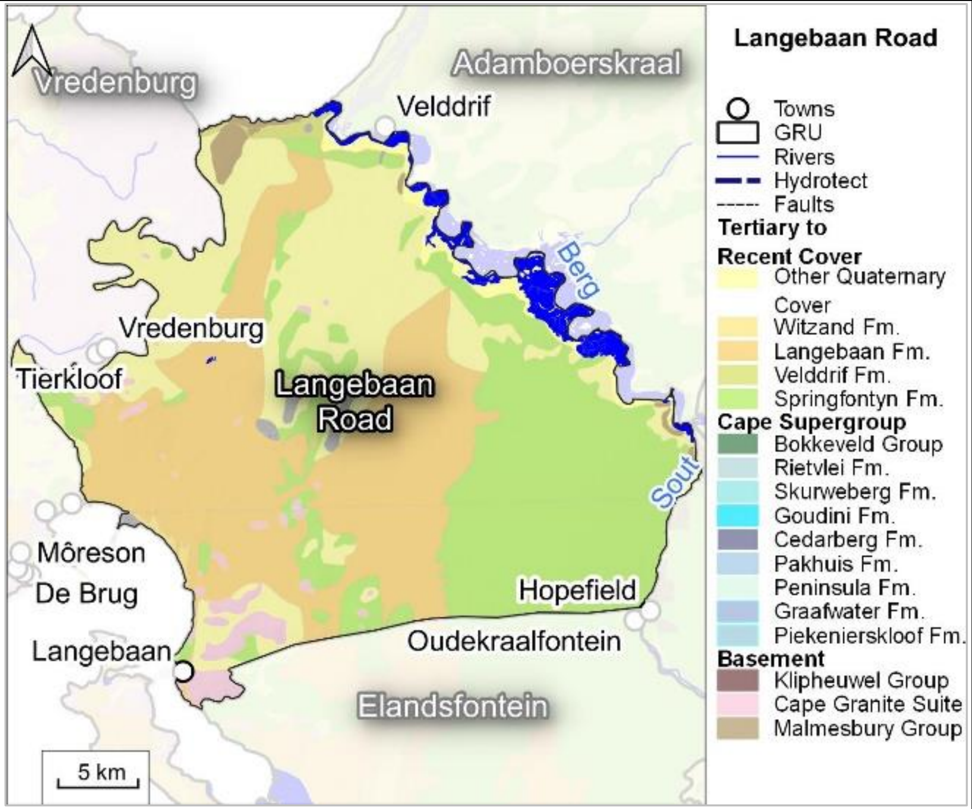
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Elandsfontein	Sulphate (mg/l)	12.90	12.10	29.20	15.68	12.1	Na-Cl, Ca-Mg-Cl	B	A	B
	Electrical conductivity (mS/m)	49.10	45.50	101.90	58.98	49.1		B		
	pH	7.49	7.17	7.60	7.39	7.35		B		
	Ammonia (mg/l)	0.14	0.04	0.14	0.10	0.12		A		
	Nitrate + nitrite (mg/l)	4.62	0.15	4.62	1.65	1.51		A		
	Fluoride (mg/l)	0.24	0.17	0.82	0.32	0.19		B		
	Orthophosphate (mg/l)	0.19	0.01	0.30	0.17	0.185		B		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

Aquifer Stress

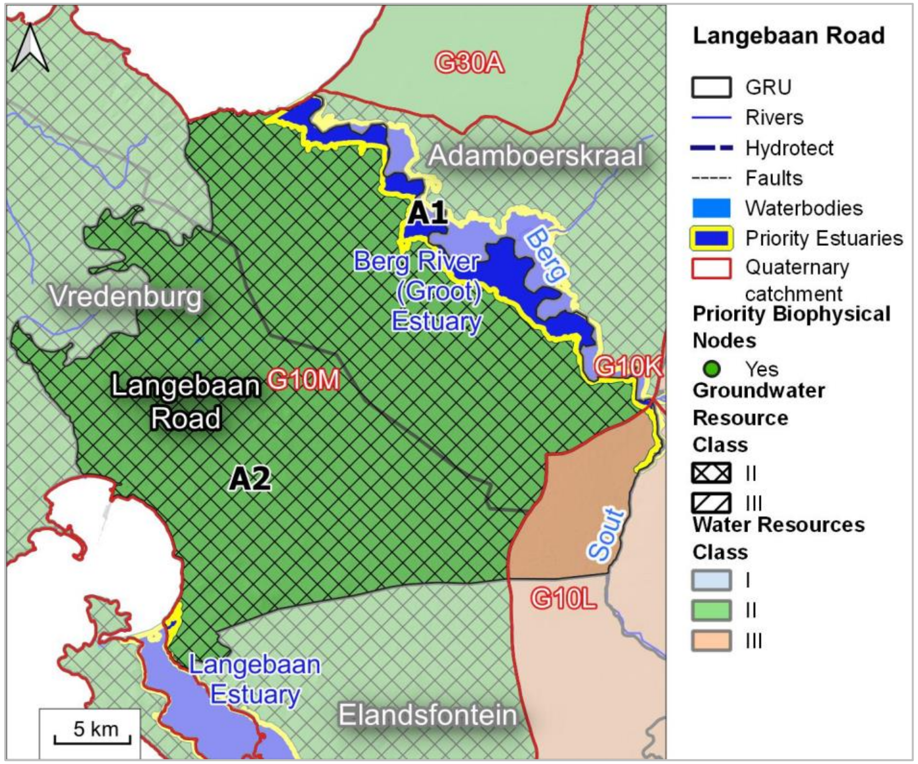
The GRU is considered to have a Groundwater Availability Present Status Category of 'B', indicating an **unstressed or slightly stressed** aquifer, and a Groundwater Quality Present Status Category of 'B' indicating **localised, low levels of contamination, but no negative impacts apparent.**

Recharge Volume (M m³/a)	Groundwater Use (M m³/a)	Stress Index	Groundwater Present Status Category (after WRC, 2007)	Adjusted Groundwater Quality Present Status Category
15.47	1.09	0.07	B	B

5.1.5. Langebaan Road GRU

<table>
<tr><td rowspan="3">GRU</td><td colspan="2">GRU Name: Langebaan Road</td></tr>
<tr><td colspan="2">Main Towns: Langebaan</td></tr>
<tr><td colspan="2">Total Area (km^2): 903.71</td></tr>
<tr><td>GRU Boundary Description</td><td colspan="2">The north-western extent of Langebaan Road GRU is bound by the interpolated extent of the Cape Granite Suite outcrop. The divide between the Elandsfontein and Langebaan Road GRU is based on an inferred basement high (i.e., the Malmesbury Group and the Cape Granite Suite) which extends from the eastern edge of the GRU towards the Saldanha Bay coast. The Berg and Sout rivers bound the eastern and south-eastern edge of the GRU, with the Saldanha Bay and St Helena Bay coastline’s bounding the western and northern edge respectively. Preferential flow direction towards Saldanha Bay was also considered when defining the boundary for the GRU.</td></tr>
<tr><td rowspan="2">Resource Unit</td><td colspan="2">Primary / Intergranular Aquifer</td></tr>
<tr><td>Upper RU</td><td>Lower RU</td></tr>
<tr><td>Quaternary Catchments</td><td colspan="2">G10M and G10L</td></tr>
<tr><td>Description</td><td>The Langebaan region is dominated by semi- to unconsolidated Cenozoic (65 Ma to present) sediments (reaching an average thickness of between ~ 50m – 70m), which unconformably overlie the metamorphosed shales of the Malmesbury Group and granites of the Cape Granite Suite which form the basement. The division between the Langebaan Road Aquifer System and Elandsfontein Aquifer System should simply be considered a spatial one, as the two are in hydraulic connection in both the shallow and deep aquifers (WRC, 2016a). The Berg River flows approximately parallel to and just east of the regional contact between the Malmesbury Group and Cape Granite Suite, and forms the eastern extent boundary of the GRU. The basement topography (palaeochannels), faults, fissures, contact zones and the stratigraphy of the Cenozoic deposits all contribute to the complexity of the groundwater recharge, flow and discharge of the Langebaan Road aquifer system.</td><td>
</td></tr>
</table>

GRU	GRU Name: Langebaan Road Main Towns: Langebaan Total Area (km^2): 903.71
Surface Water System	The Langebaan Road Aquifer System discharges into Saldanha Bay, St Helena Bay and the Berg River/Groot Estuary, which forms the main surface water system in this GRU.
Water Resource Classes & RQOs	The GRU falls within the Berg Estuary (A1), Langebaan (A2), and Lower Berg (B4) IUAs and has Water Resource Class II, II and III respectively. The portions of the GRU that fall within IUAs A1 and A2 (catchment G10M) have a Groundwater Resource Class of II, and no Groundwater Resource Class for the portions that fall within IUA B4 (catchment G10L). There are 2 priority estuaries within the GRU, 1) the Langebaan Lagoon (an Estuary EWR site) with a TEC of A, and 2) the Berg River (Groot) Estuary which has a TEC of C.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
A1 Berg Estuary	II	G10M	A1-E01	Berg (Groot)	Bxi1	C	52
A2 Langebaan	II	G10M	A2-E04	Langebaan	Bxi3	A	N/A

GRU	
GRU	GRU Name: Langebaan Road
	Main Towns: Langebaan
	Total Area (km^2): 903.71

Recharge

An estimated recharge of **23.28 M m^3/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **25.76 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (see **Section 4.2.3**).

Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map-Centric Simulation method	903.71	23.28	25.76

A leaky hydraulic connection is presumed to exist between the upper and lower RU. This will be further investigated in Step 4 (i.e., EWR and BHN Reserve determination).

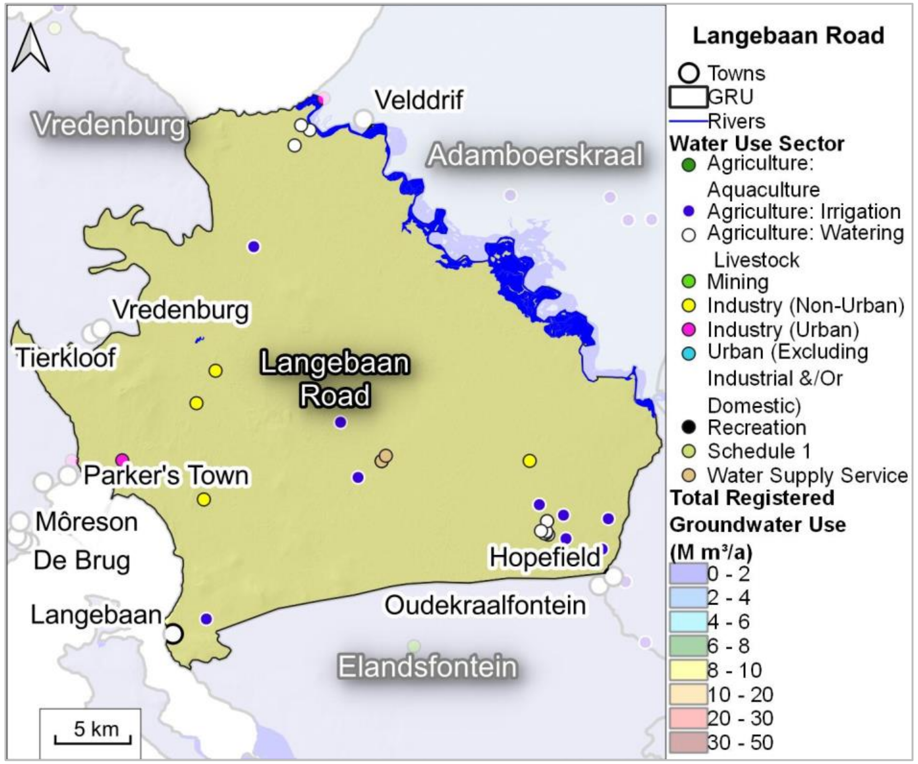
Groundwater Use

There are 16 registered groundwater users in the Upper Primary / Intergranular Aquifer with a combined groundwater use of **0.78 M m^3/a**. Agriculture (irrigation) is the major groundwater user which constitutes 91.0% of the total groundwater use volume per annum (see **Section 4.3.3** for detail).

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Primary / Intergranular Aquifers (Upper)	Agriculture: Irrigation	9	0.71
	Agriculture: Watering livestock	2	0.02
	Industry (Non-urban)	4	0.01
	Industry (Urban)	1	0.04
Total		**16**	**0.78**

There are 17 registered groundwater users in the Lower Primary / Intergranular Aquifer with a combined groundwater use of **7.82 M m^3/a**. Water Supply services is the major groundwater user which constitutes 87.4% of the total groundwater use volume per annum (see **Section 4.3.3** for detail).

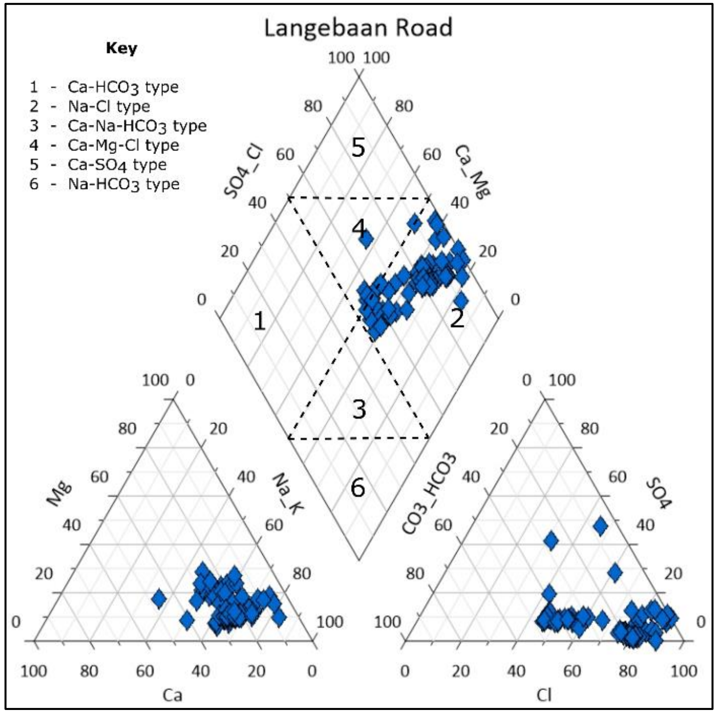
RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Primary / Intergranular Aquifers (Lower)	Agriculture: Irrigation	6	0.87
	Agriculture: Watering livestock	8	0.08
	Water Supply Service	3	6.87
Total		**17**	**7.82**

GRU	GRU Name: Langebaan Road Main Towns: Langebaan Total Area (km^2): 903.71
	

Discharge

Groundwater's contribution to baseflow is minimal / unknown due to discharge to estuaries and the ocean not being included (DWAF 2008b). This will however be further investigated in Step 4 (i.e., EWR and BHN Reserve determination).

RU	Sum of Baseflow per component (M m^3/a)
Primary/Intergranular	0
Fractured and Intergranular Basement	0
Total	**0**

<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Langebaan Road</th></tr>
<tr><th>Main Towns: Langebaan</th></tr>
<tr><th>Total Area (km^2): 903.71</th></tr>
<tr><td>Water Quality</td><td>The main water type in Langebaan Road is Na-Cl. The Na-Cl waters predominantly due to the deposition of marine aerosols and recharge by coastal rainfall, which has a typical Na-Cl signature. Ca-HCO_3 waters are also expected, given the extensive, calcite rich Langebaan Formation. However, no samples show this water type. Where boreholes are located near shallow basement rocks of the Tygerberg Formation, the elevated Na and Cl ion concentration of this lithology can also impart the Na-Cl character to groundwater in the overlying primary aquifer. Of the 103 samples collected, 9 exceeded the RQO for EC, 18 for pH and 1 for NO_3 + NO_2. High EC values are likely due to the influence of the underlying Tygerberg Formation. The predominantly basic pH is due to the dissolution of basic Ca and HCO_3 ions from the extensive, Langebaan Formation. The adjusted water quality category is B, indicating that although some low levels of contamination exist, largely natural groundwater quality conditions prevail.

</td></tr>
</table>

GRU	GRU Name: Langebaan Road
	Main Towns: Langebaan
	Total Area (km²): 903.71

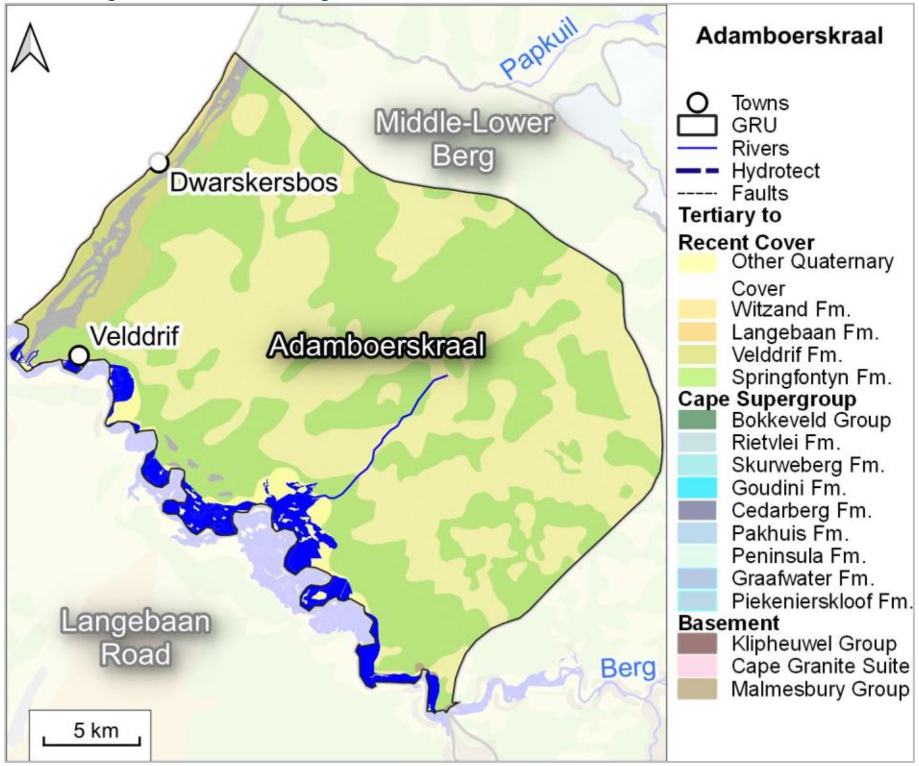
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Langebaan Road	Sulphate (mg/l)	25.18	0.60	1149.50	103.48	56.1	Na-Cl, Ca-Mg-Cl	C	B	B
	Electrical conductivity (mS/m)	155.60	59.50	2365.20	261.62	166.3		C		
	pH	8.41	6.77	8.75	8.01	8.1		A		
	Ammonia (mg/l)	0.14	-	0.55	0.05	0.025		A		
	Nitrate + nitrite (mg/l)	0.25	0.02	25.34	1.42	0.1055		B		
	Fluoride (mg/l)	0.70	0.22	2.55	0.86	0.81		B		
	Orthophosphate (mg/l)	0.04	0.04	0.24	0.04	0.025		B		
	Dissolved Aluminium (mg/l)	0.091	0.001	0.099	0.035	0.03		-		
	Dissolved Arsenic (mg/l)	0.085	0.002	0.103	0.035	0.027		-		
	Dissolved Chromium (mg/l)	0.010	0.000	0.021	0.004	0.003		-		
	Dissolved Iron (mg/l)	0.014	0.001	0.031	0.008	0.006		A		
	Dissolved Lead (mg/l)	0.063	0.000	0.063	0.026	0.027		-		
	Dissolved Manganese (mg/l)	0.006	0.001	0.024	0.003	0.001		-		
	Dissolved Mercury (mg/l)	0.029	0.010	0.029	0.020	0.019		-		

Aquifer Stress

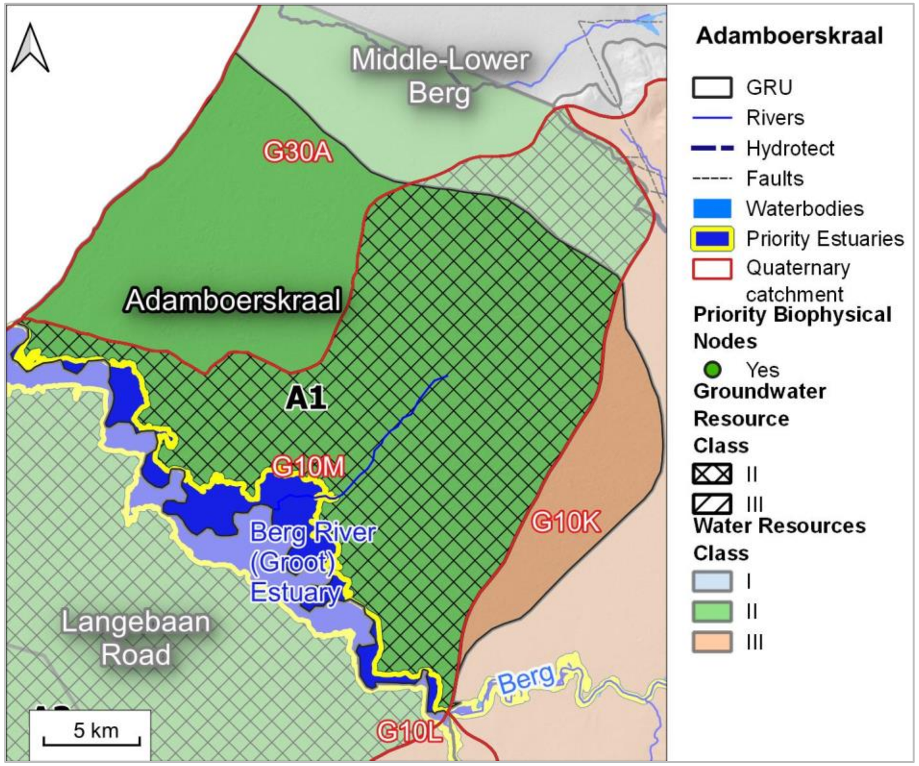
The GRU is considered to have a Groundwater Availability Present Status Category of 'C', indicating a **moderately stressed** aquifer, and a Groundwater Quality Present Status Category of 'B' indicating **localised, low levels of contamination, but no negative impacts apparent.**

Recharge Volume (M m³/a)	Groundwater Use (M m³/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
23.28	8.59	0.37	C	B

5.1.6. Adamboerskraal GRU

GRU	GRU Name: Adamboerskraal
	Main Towns: Velddrif
	Total Area (km^2): 612.30
GRU Boundary Description	The Adamboerskraal aquifer model boundary (SRK, 2004) was used as the extent of the GRU. The Berg River bounds the south-western edge, with the eastern/southern boundary defined by an interpolated basement lithology extent (i.e., the Malmesbury Group and the Cape Granite Suite overlain by a thin layer of the Springfontyn Formation) as well as the north-westerly preferential flow direction (i.e., at the Berg River Estuary). The St Helena Bay coastline bounds the north/north-western edge of the GRU.
Quaternary Catchments	G10M, G10K and G30A
Description	The Adamboerskraal region is dominated by semi- to unconsolidated Cenozoic (65 Ma to present) sediments, ~50 – 70 m thick, which unconformably overlie the metamorphosed shales of the Malmesbury Group and granites of the Cape Granite Suite. The Berg River flows approximately parallel to and just west of the regional contact between the Malmesbury Group and Cape Granite Suite. The basement topography (palaeochannels), faults, fissures, contact zones and the stratigraphy of the Cenozoic deposits all contribute to the complexity of the groundwater recharge, flow and discharge. 
Surface Water System	The Adamboerskraal Aquifer discharges into St Helena Bay and the Berg River/Groot Estuary, which forms the main surface water system in this GRU. There is likely a hydraulic connection between the Adamboerskraal Aquifer System and the Langebaan Road Aquifer System, beneath the Berg River (WRC, 2016a).

GRU	GRU Name: Adamboerskraal
	Main Towns: Velddrif
	Total Area (km^2): 612.30
Water Resource Classes & RQOs	The GRU falls within the Berg Estuary (A1) and Lower Berg (B4) IUAs and has Water Resource Class II and III respectively. The portion of the GRU that fall within IUA A1 (catchment G10M) has a Groundwater Resource Class of II, and no Groundwater Resource Class for the portions that fall within IUA A1 (catchment G30A) and IUA B4 (catchment G10K). There is 1 priority estuary EWR site within the GRU – the Berg River (Groot) Estuary, with a TEC of C.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
A1 Berg Estuary	II	G10M	A1-E01	Berg (Groot)	Bxi1	C	52

Recharge

An estimated recharge of **21.61 M m^3/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **35.29 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

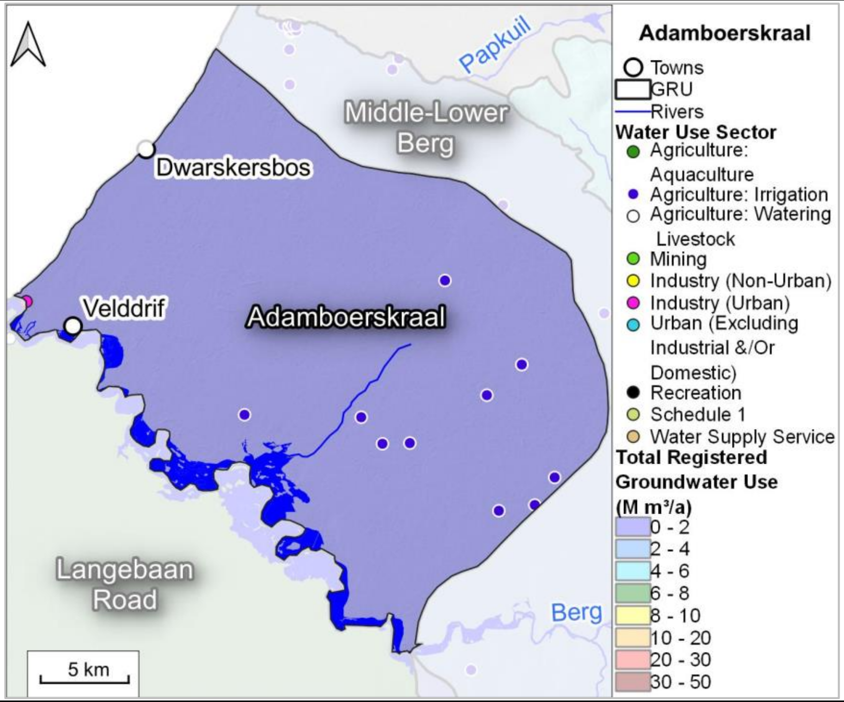
Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map-Centric Simulation method	612.30	21.61	35.29

GRU	
	GRU Name: Adamboerskraal
	Main Towns: Velddrif
	Total Area (km^2): 612.30

Groundwater Use

There are 12 registered groundwater users in this GRU with a combined groundwater use of **2.13 M m^3/a**. Major groundwater use sectors include Agriculture (irrigation) and industry, which constitute 62.9% and 37.1% respectively of the total groundwater use volume per annum (see **Section 4.3.3** for detail).

Water Use Sector	No. of Users	Total Volume (M m^3/a)
Agriculture: Irrigation	11	1.34
Industry (Urban)	1	0.79
Total	**12**	**2.13**



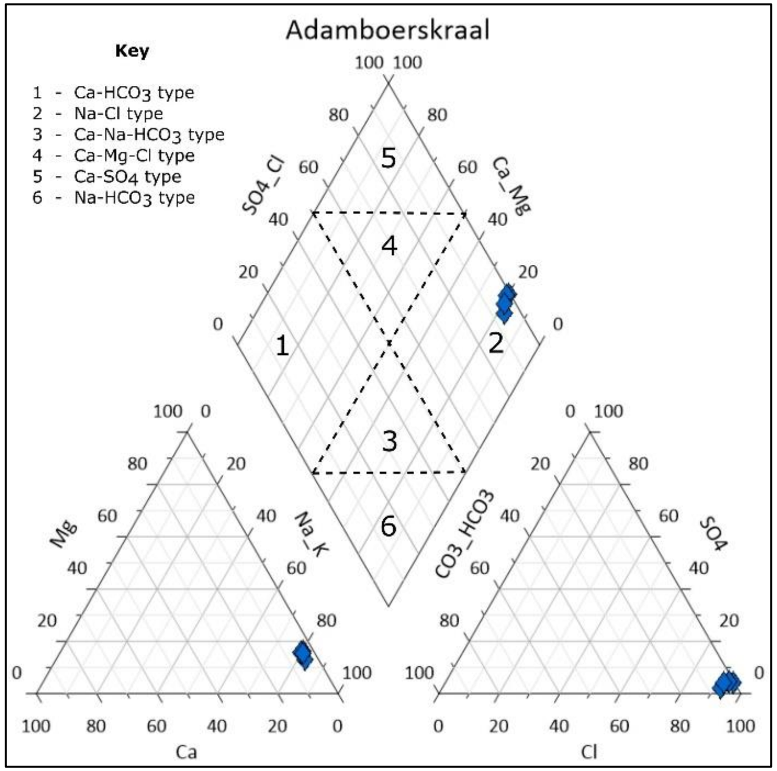
Discharge

Groundwater's contribution to baseflow is minimal / unknown due to discharge to estuaries and the ocean not being included (DWAF 2008b). This will however be further investigated in Step 4 (i.e., EWR and BHN Reserve determination).

RU	Sum of Baseflow per component (M m^3/a)
Primary Intergranular	0
Fractured and Intergranular Basement	0
Total	0

Water Quality

The main water type in Adamboerskraal is Na-Cl. The Na-Cl waters are predominantly due to the deposition of marine aerosols and recharge by coastal rainfall, which has a typical Na-Cl signature. However, elevated salinity suggest that boreholes in this GRU may intersect the underlying basement aquifer, which is the likely reason for the Na-Cl waters and high exceedance count for EC and SO_4. Of the 2 samples collected, 1 exceeded the RQO for EC. The adjusted water quality category is B, indicating that although some low levels of contamination exist, largely natural groundwater quality conditions prevail.

GRU	GRU Name: Adamboerskraal
	Main Towns: Velddrif
	Total Area (km^2): 612.30
	

GRU	
	GRU Name: Adamboerskraal
	Main Towns: Velddrif
	Total Area (km²): 612.30

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Adamboerskraal	Sulphate (mg/l)	52.20	52.20	1125.90	371.35	153.65	Na-Cl	E	C	B
	Electrical conductivity (mS/m)	499.10	499.10	4548.00	1655.58	787.6		E		
	pH	7.00	6.50	7.33	6.86	6.8		B		
	Ammonia (mg/l)	0.19	0.12	0.62	0.28	0.185		B		
	Nitrate + nitrite (mg/l)	0.10	0.02	0.10	0.04	0.02		-		
	Fluoride (mg/l)	0.31	0.14	0.50	0.31	0.305		B		
	Orthophosphate (mg/l)	0.24	0.04	0.24	0.10	0.056		-		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

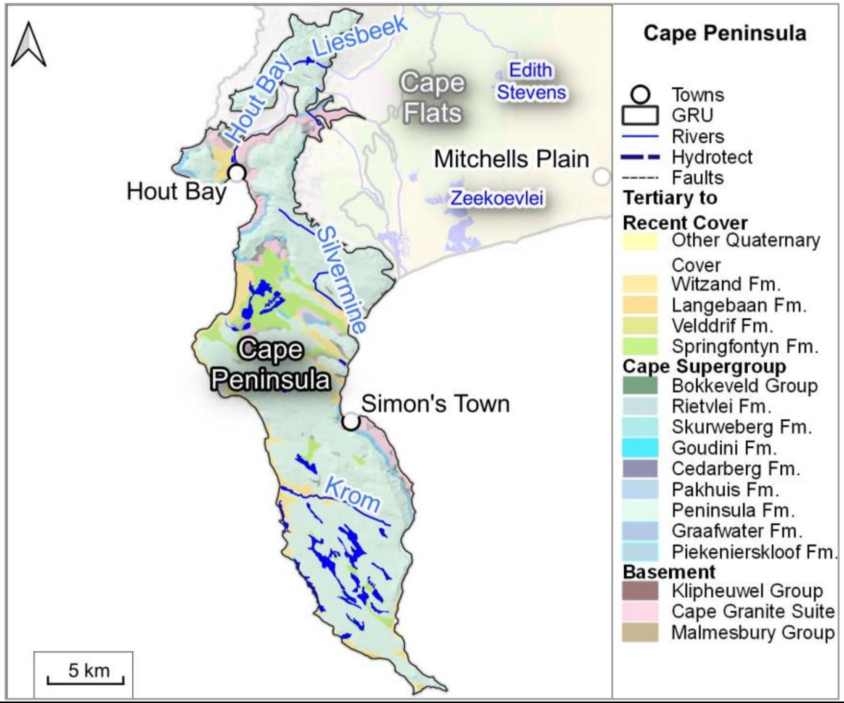
Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of 'B', indicating an **unstressed or slightly stressed** aquifer, and a Groundwater Quality Present Status Category of 'B' indicating **localised, low levels of contamination, but no negative impacts apparent.**

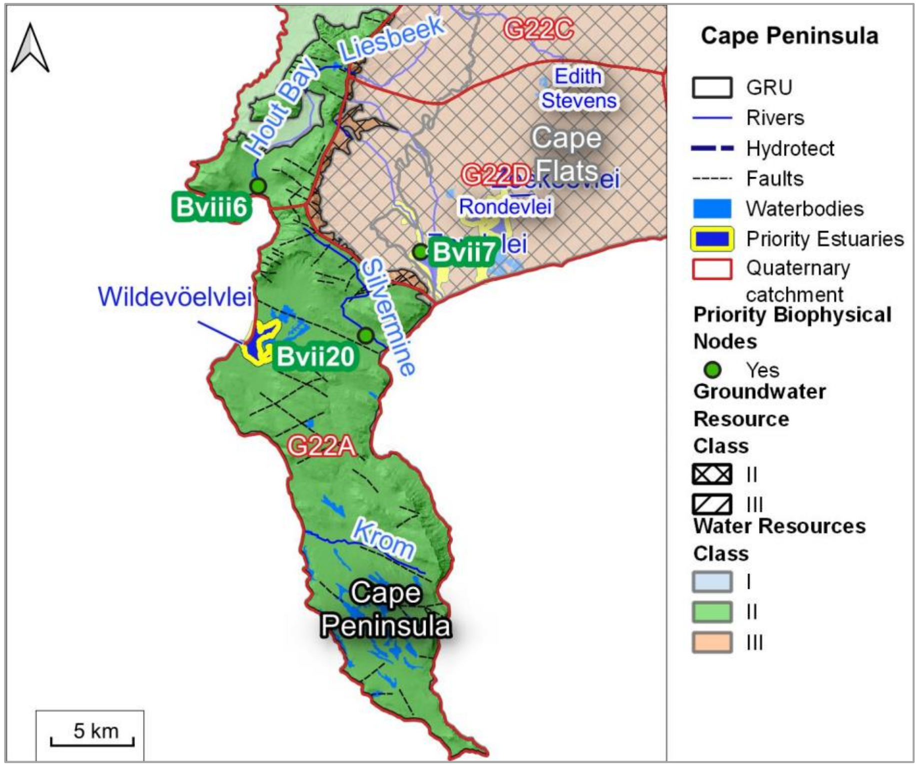
Recharge Volume (M m³/a)	Groundwater Use (M m³/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
21.61	2.13	0.10	B	B

5.2. Fractured Table Mountain Group GRUs

5.2.1. Cape Peninsula GRU

GRU	**GRU Name: Cape Peninsula** **Main Towns: Hout Bay, Kommetjie and Fish Hoek** **Total Area (km^2): 292.53**
GRU Boundary Description	The Cape Peninsula GRU is bound by the extent of the TMG outcrop mostly Peninsula Formation, overlying the Cape Granite Suite along the length of the Cape Peninsula GRU, and the Malmesbury Group under the City Bowl and Devils Peak, which includes scree aprons occurring on the slopes of the mountains, especially around Table Mountain. The Atlantic and False Bay coastlines bounds the western and eastern extent of the GRU respectively. Cenozoic sands occur in the Fish Hoek Valley where high-water tables support wetlands and streams around Fish Hoek and Noordhoek. Deep groundwater flow is unlikely to be significant, although some drainage from the Cape Peninsula may recharge surface water and groundwater on the Cape Flats.
Resource Unit	**Fractured Table Mountain Group Aquifer**
Quaternary Catchments	G22A, G22B, G22C and G22D
Description	The Cape Peninsula is dominated by the presence of the TMG outcrops, mostly the Peninsula Formation. The basement is composed of Cape Granite Suite along the length of the Peninsula, and Malmesbury Group under the City Bowl and Devils Peak. This unconformity/nonconformity dips gently to the south, from around 400m in the north, around the city, to below sea level south of Fish Hoek. The Peninsula Formation varies in thickness from 60-140m. The TMG outcrop generates the rugged areas, which are mostly delineated within the Table Mountain National Park. 

GRU	GRU Name: Cape Peninsula
	Main Towns: Hout Bay, Kommetjie and Fish Hoek
	Total Area (km^2): 292.53
Surface Water System	Numerous surface water features occur in this GRU including Lake Michelle, Wildevöelvlei, the Kleinplaas Dam in the centre of the GRU. The Silvermine, Hout Bay, Liesbeek and Krom rivers originate from Peninsula Formation outcrops in the GRU.
Water Resource Classes & RQOs	The GRU falls within the Peninsula (E1) and Cape Flats (E12) IUAs and has Water Resource Class II and III respectively. The portion of the GRU that fall within IUA E12 (catchments G22D and G22C) has a Groundwater Resource Class of II, and no Groundwater Resource Class for the portions that fall within IUA E11 (catchments G22A and G22B). There are no EWR sites within this IUA, although there are 3 priority biophysical nodes - 1 estuary node (Wildevöelvlei) with a TEC of C and 2 river nodes (see TEC in table below).



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
E11 Peninsula	II	G22B	E11-R13	Hout Bay	Bviii6	D	97
		G22A	E11-R14	Silvermine	Bvii20	C	98
		G22A	E11-E04	Wildevöelvlei	Bxi14	C	107

GRU	GRU Name: Cape Peninsula
	Main Towns: Hout Bay, Kommetjie and Fish Hoek
	Total Area (km²): 292.53

Recharge

Recharge in the GRU is mainly from rainfall, but may also occur from cloud moisture, especially from the south-east wind in summer. Although recharge on the Peninsula is significantly higher than surroundings, its thickness results in low aquifer storage and often recharge is discharged as springs in a short time frame. Some of these are permanent seeps feeding mountain streams and wetlands. Scree aprons occur on the slopes of the Peninsula-formed mountain, especially around Table Mountain itself, and are recharged by the streams cascading off the steep cliffs. Various springs emanating from the scree aquifers ultimately dependent on the Peninsula Aquifer, cumulatively discharging over 100 l/s to the City Bowl and Newlands areas combined (GEOSS, 2015).

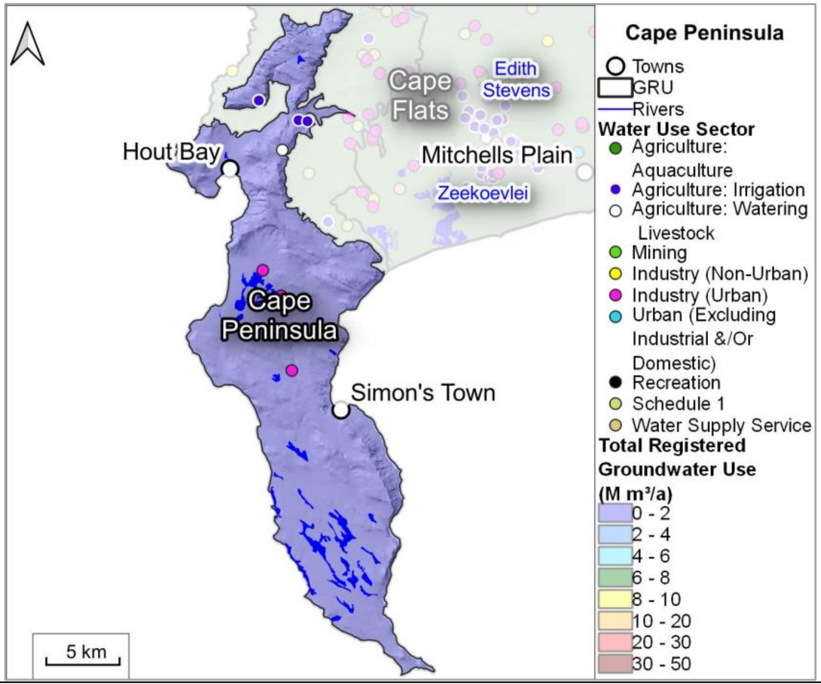
An estimated recharge of **10.99 M m³/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **37.57 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km²)	Recharge Volume (M m³/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	292.53	10.99	37.57

Groundwater Use

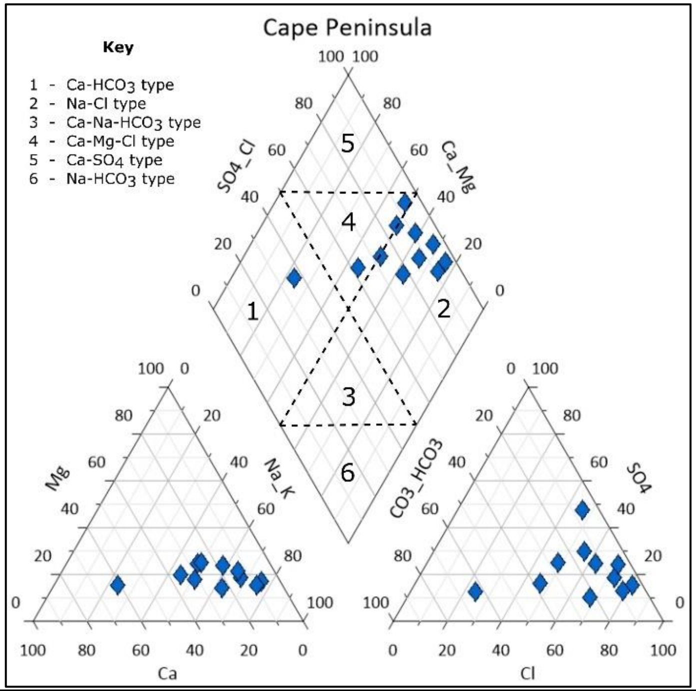
There are 8 registered groundwater users in this GRU with a combined groundwater use of 0.73 M m³/a. Major groundwater use sectors include Agriculture (irrigation) and Agriculture (livestock watering), which make up a combined 90.7% of the total groundwater use volume per annum (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m³/a)
Fractured Table Mountain Group	Agriculture: Aquaculture	1	0.01
Peninsula Aquifer	Agriculture: Irrigation	1	0.02
	Agriculture: Watering livestock	1	0.01
	Industry (Urban)	1	0.01
Primary / Intergranular Aquifers	Agriculture: Irrigation	2	0.02
	Industry (Urban)	2	0.0003
Total		**8**	**0.073**



<table>
<tr><td rowspan="3">GRU</td><td>GRU Name: Cape Peninsula</td></tr>
<tr><td>Main Towns: Hout Bay, Kommetjie and Fish Hoek</td></tr>
<tr><td>Total Area (km²): 292.53</td></tr>
<tr><td>Discharge</td><td>Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is <u>4.31 M m³/a</u> (see Section 4.4.1 for details).

<table>
<tr><th>RU</th><th>Sum of Baseflow per component (M m³/a)</th></tr>
<tr><td>Primary / Intergranular Aquifers</td><td>0.75</td></tr>
<tr><td>Peninsula Aquifer</td><td>3.32</td></tr>
<tr><td>Fractured and Intergranular Other (TMG)</td><td>0.10</td></tr>
<tr><td>Fractured and Intergranular Basement</td><td>0.14</td></tr>
<tr><td>Total</td><td>4.31</td></tr>
</table></td></tr>
<tr><td>Water Quality</td><td>The main water types in the Cape Peninsula are Na-Cl and Ca-Mg-Cl type. The Na-Cl waters are due to the deposition of marine aerosols and recharge by coastal rainfall, while Ca-Mg-Cl type waters are due Na^{+} cation exchange between Na-Cl type waters and Ca^{2+} and Mg^{2+} ions in the lithology. 50% of samples exceeded baselines for sulphate, EC, nitrate + nitrite, with activities in urbanised areas being potential sources of contamination. The adjusted water quality category is B, indicating that largely natural water quality conditions prevail, although natural, acidic pH, elevated iron and manganese are water quality concerns.



</td></tr>
</table>

GRU	GRU Name: Cape Peninsula
	Main Towns: Hout Bay, Kommetjie and Fish Hoek
	Total Area (km^2): 292.53

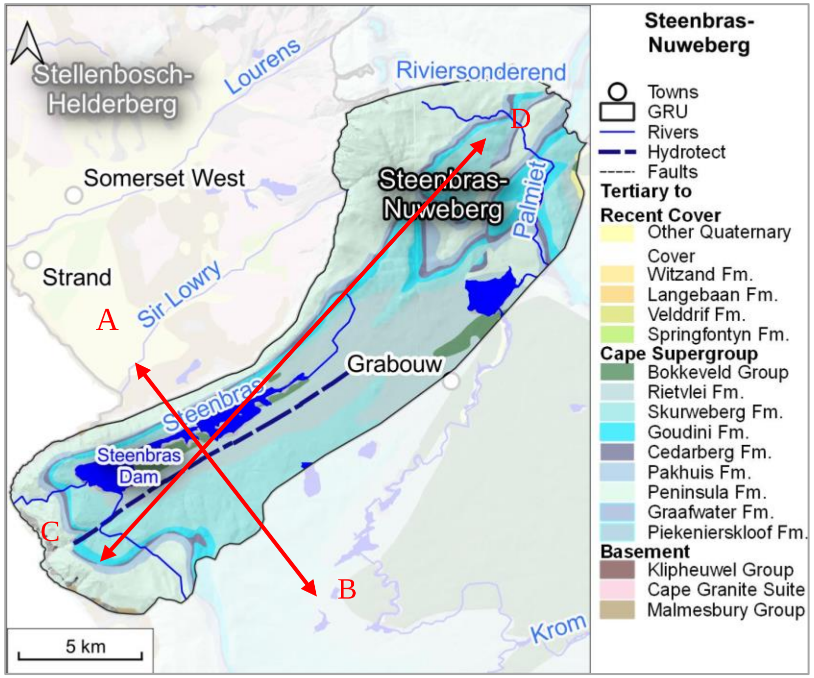
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Cape Peninsula	Sulphate (mg/l)	12.20	12.20	107.40	64.75	72.2	Na-Cl, Ca-Mg-Cl, Ca-HCO_3	F	D	B
	Electrical conductivity (mS/m)	25.80	25.80	119.00	78.52	89.8		F		
	pH	6.96	6.54	7.57	7.07	7.1		D		
	Ammonia (mg/l)	0.02	0.02	2.51	0.34	0.02		B		
	Nitrate + nitrite (mg/l)	0.07	0.02	10.89	3.67	0.319		E		
	Fluoride (mg/l)	0.26	0.05	0.33	0.16	0.15		A		
	Orthophosphate (mg/l)	1.02	0.01	1.08	0.21	0.016		A		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

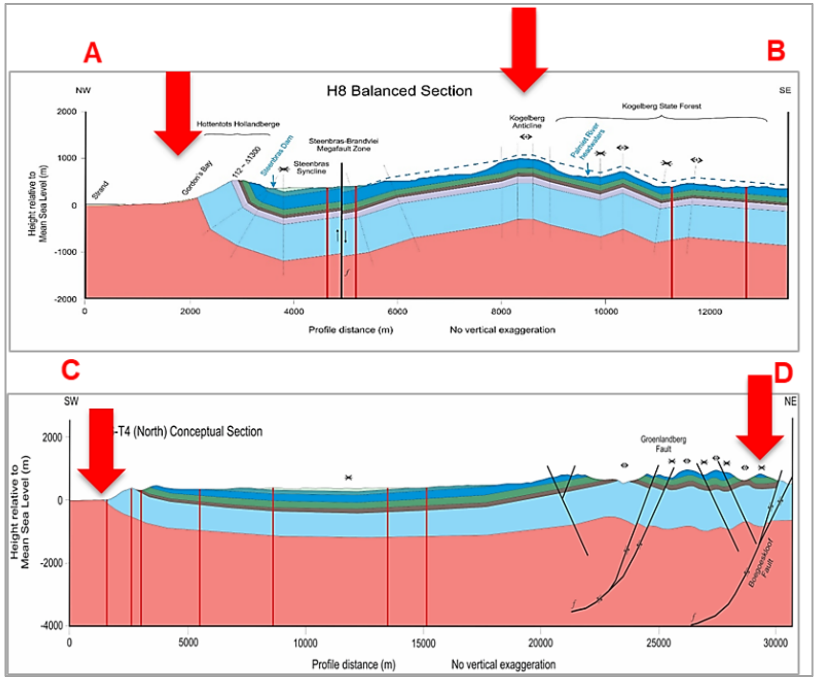
Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of ‘A’, indicating an **unmodified, pristine conditions** aquifer, and a Groundwater Quality Present Status Category of ‘B’ indicating **localised, low levels of contamination, but no negative impacts apparent.**

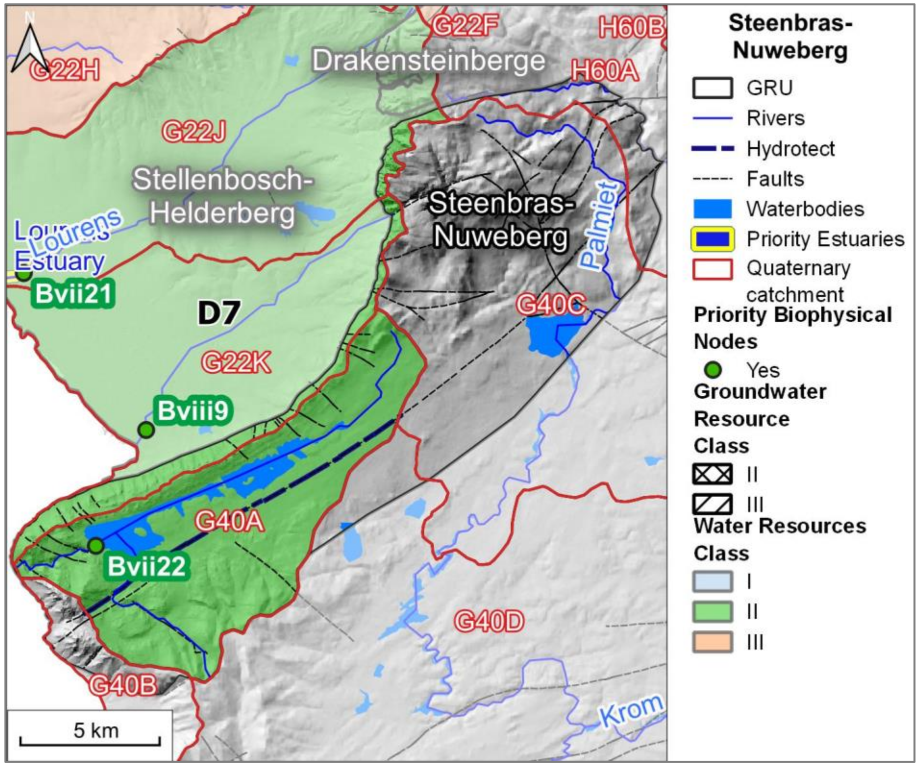
Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Availability Present Status Category
10.99	0.07	0.01	A	B

5.2.2. Steenbras-Nuweberg GRU

<table>
<tr><td rowspan="3">GRU</td><td colspan="2">GRU Name: Steenbras-Nuweberg</td></tr>
<tr><td colspan="2">Main Towns: Grabouw</td></tr>
<tr><td colspan="2">Total Area (km^2): 195.18</td></tr>
<tr><td>GRU Boundary Description</td><td colspan="2">The CoCT (2021) aquifer model boundary is used for the extent of the Steenbras-Nuweberg GRU. It is bound by TMGA outcrop in the Steenbras and Theewaterskloof areas, the La Motte Fault in the northern recharge area (DWAF,2008a; CoCT, 2004), and the Kogelberg and Stettyns anticlines including portions of the G40A surface water catchment boundary) on its eastern margin. The northern extent of the GRU is bound by the extent of interpolated basement lithologies (Malmesbury Group and the Cape Granite Suite outcrop) and the False Bay coastline to the west.</td></tr>
<tr><td>Quaternary Catchments</td><td colspan="2">G40C, G40A, G40D, G22J, G22K, H60A and G40B</td></tr>
<tr><td rowspan="2">Resource Unit</td><td colspan="2">Fractured Table Mountain Group Aquifer</td></tr>
<tr><td>Peninsula</td><td>Nardouw</td></tr>
<tr><td rowspan="2">Description</td><td>The Table Mountain Group Super aquifer is composed of the larger Peninsula Aquifer (apparent thickness approximately 600 - 700 m in this area) and the lesser Nardouw Aquifer (with its component sub-aquifers). The Peninsula Aquifer and the Skurweberg Sub-aquifer are the main deep aquifer targets.</td><td>The TMG syncline exposes the Goudini, Skuwerberg and Rietvlei formations of the Nardouw Sub-group within the valley of the syncline. The aquifers consist of the Skuwerberg and Rietvlei formations. (~700 – 800m thick)</td></tr>
<tr><td colspan="2">


</td></tr>
</table>

GRU	GRU Name: Steenbras-Nuweberg
	Main Towns: Grabouw
	Total Area (km²): 195.18
	The confining unit that overlies the Peninsula Aquifer and separates it from the overlying Nardouw Aquifer, consists of a conformable package of three aquitard units (Goudini, Cedarberg, and Pakhuis) named the Winterhoek Mega-aquitard. Hydrogeologically, the entire Pakhuis – Goudini sequence is an effective aquitard, although the Goudini Formation is considered part of the Nardouw Subgroup. The TMG has been folded into a syncline, exposing the Peninsula Formation in the limbs forming steep mountainsides alongside the valley. The Peninsula, Pakhuis, Cedarberg and Goudini Formations outcrop in the topographically elevated synclinal/anticlinal limbs in the mountainous regions adjacent to the dam area
Surface Water System	The major surface water bodies of this GRU include the Steenbras dam that forms part of the Western Cape Water Supply System (WCWSS) as well as the Eikenhof and Nuweberg dams along with the Palmiet River. Surface water runoff follows topography, flowing from a north-east to south-west, namely the Steenbras River.
Water Resource Classes & RQOs	Only a portion of the GRU is in the Sir Lowry's IUA (D7), while the rest of the GRU lies outside of the D7 IUA as the GRU extended outside of the Berg catchment area, i.e., the former Berg WMA. The portions of the GRU that fall within the D7 IUA (catchments G40A and G22K) has a Water Resource Class of II and has no Groundwater Resource Class. This GRU has no EWR sites, although it hosts 1 priority biophysical site - the Steenbras estuary node with a TEC of B/C.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
D7 Sir Lowry's	II	G40A	D7-R20	Steenbras	Bvii22	B/C	23

GRU	GRU Name: Steenbras-Nuweberg
	Main Towns: Grabouw
	Total Area (km^2): 195.18

Recharge

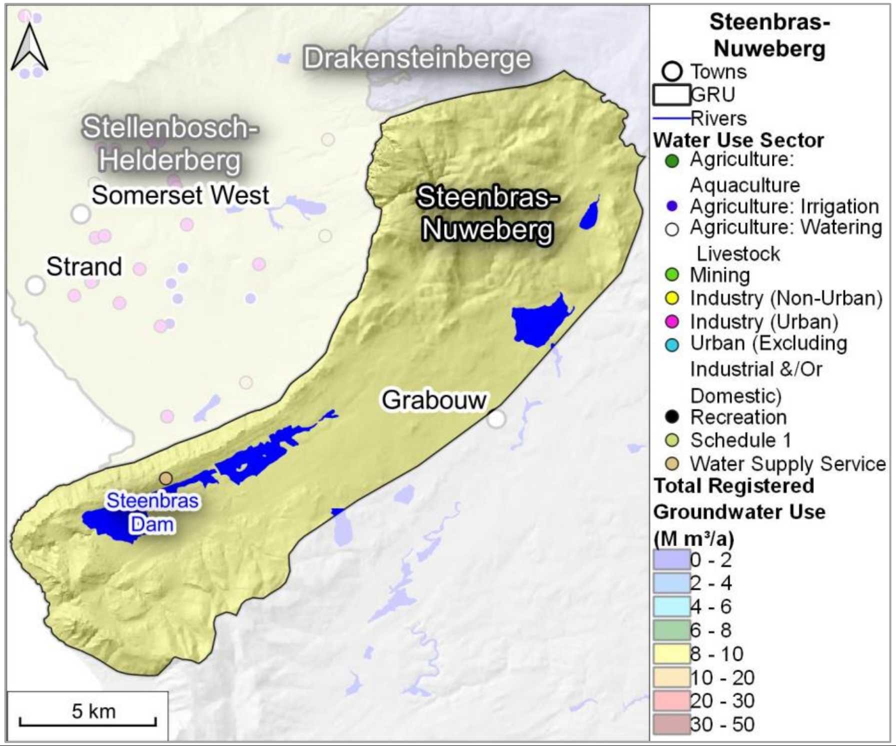
An estimated recharge of **58.76 M m^3/a** was determined from GRAII based on the hydrogeological technical assessment (CoCT, 2022). This recharge value was carried over into the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **391.11 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
After (CoCT, 2022) hydrogeological technical assessment for IWULA	150.24	58.76	391.11

Groundwater Use

Water Supply services is the only registered groundwater user in this GRU using a total of **9.13 M m^3/a** (see **Section 4.3.3** for detail). This is split by **3.65 M m^3/a** in the Peninsula Aquifer and **5.48 M m^3/a** in the Nardouw Aquifer.

Water Use Sector	No. of Users	Total Volume (M m^3/a)
Water Supply service	1	9.13
Total	**1**	**9.13**



GRU	
GRU	**GRU Name: Steenbras-Nuweberg**
	Main Towns: Grabouw
	Total Area (km^2): 195.18

Discharge

Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **7.93 M m^3/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m3/a)
Primary / Intergranular Aquifers	0.08
Nardouw Aquifer	3.94
Peninsula Aquifer	2.31
Fractured and Intergranular Other (TMG & Bokkeveld)	1.37
Fractured and Intergranular Basement	0.24
Total	**7.93**

Water Quality

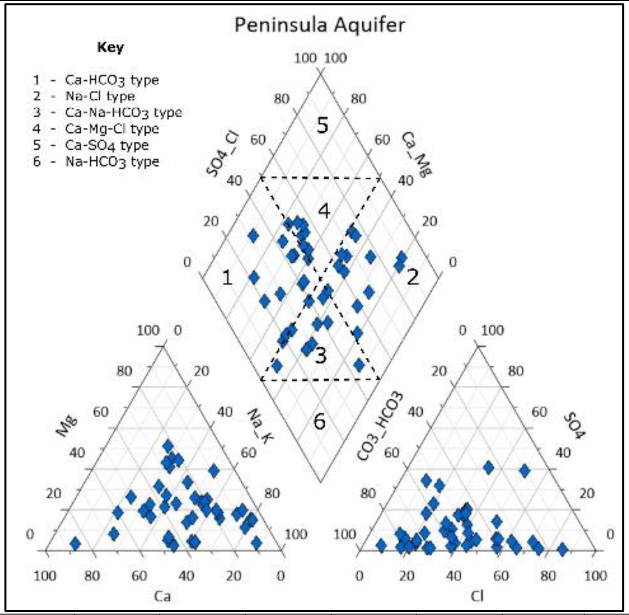
The main water types in the Peninsula Aquifer are Na-Cl, Ca-Na-HCO_3 and Ca-HCO_3 type. The Na-Cl waters are due to the deposition of marine aerosols and recharge by coastal rainfall. Ca-HCO_3 type waters are due to the dissolution of carbonate minerals, while Ca-Na-HCO_3 type water are due to ion exchange between Ca^+ ions from Ca-HCO_3 and Na^+ ions in the lithology.

Exceedance of baseline concentrations was observed for all parameters except dissolved arsenic, chromium, lead and mercury, with 50% of samples exceeding baselines for sulphate and EC. The adjusted water quality category is B, indicating that largely natural water quality conditions prevail, although natural, acidic pH, elevated iron and manganese are water quality concerns.

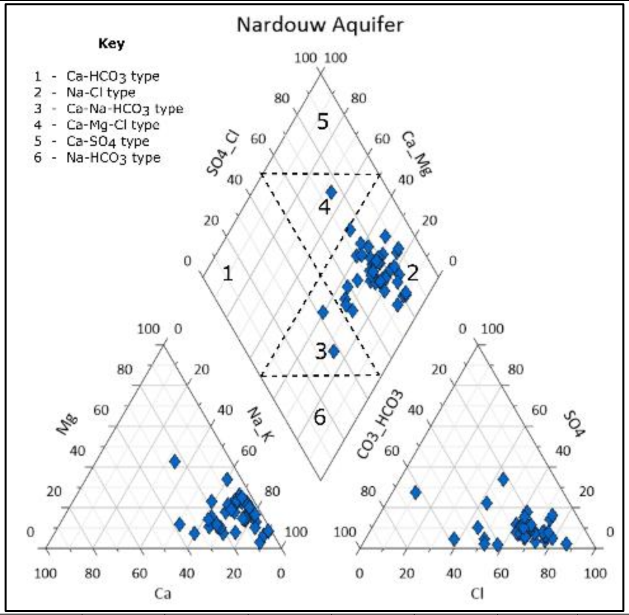
The main water types in the Nardouw Aquifer are Na-Cl, with 3 samples showing Ca-Na-HCO_3 and Ca-Mg-Cl type. The Na-Cl waters are due to the deposition of marine aerosols and recharge by coastal rainfall.

EC and pH are lower than in the Peninsula Aquifer, with the more acidic pH being the result of dissolution of humic compounds from overlying plants, dissolution of CO_2 (which forms carbonic acid) in recharge water and limited presence of basic ions (compared to Peninsula Aquifer) to buffer acidic waters. Exceedance of baseline concentrations were observed for all parameters except fluoride, orthophosphate, dissolved chromium and mercury. The adjusted water quality category is B, indicating that largely natural water quality conditions prevail, although natural, acidic pH, elevated iron and manganese are water quality concerns.

GRU	
GRU	**GRU Name: Steenbras-Nuweberg**
	Main Towns: Grabouw
	Total Area (km^2): 195.18



GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Steenbras-Nuweberg (Peninsula)	Sulphate (mg/l)	1.49	0.20	61.00	6.25	4.2	Na-Cl, Ca-Mg-Cl, Ca-HCO$_3$, Ca-Na-HCO$_3$	E	D	B
	Electrical conductivity (mS/m)	14.00	2.47	38.00	14.14	13		D		
	pH	7.18	4.87	9.35	7.01	6.8		C		
	Ammonia (mg/l)	0.12	0.00	12.00	0.42	0.1		C		
	Nitrate + nitrite (mg/l)	1.05	0.00	1.20	0.12	0.1		A		
	Fluoride (mg/l)	0.28	0.10	0.76	0.40	0.5		C		
	Orthophosphate (mg/l)	0.32	0.00	0.97	0.15	0.1		A		
	Dissolved Aluminium (mg/l)	0.012	0.001	0.080	0.040	0.04		A		
	Dissolved Arsenic (mg/l)	0.003	0.001	0.010	0.007	0.01		-		
	Dissolved Chromium (mg/l)	0.007	0.007	0.020	0.015	0.02		-		
	Dissolved Iron (mg/l)	7.755	0.004	12.06	4.998	2.153		A		
	Dissolved Lead (mg/l)	0.007	0.001	0.010	0.008	0.01		-		
	Dissolved Manganese (mg/l)	0.527	0.006	3.162	0.625	0.387		B		
	Dissolved Mercury (mg/l)	0.005	0.001	0.005	0.004	0.005		-		



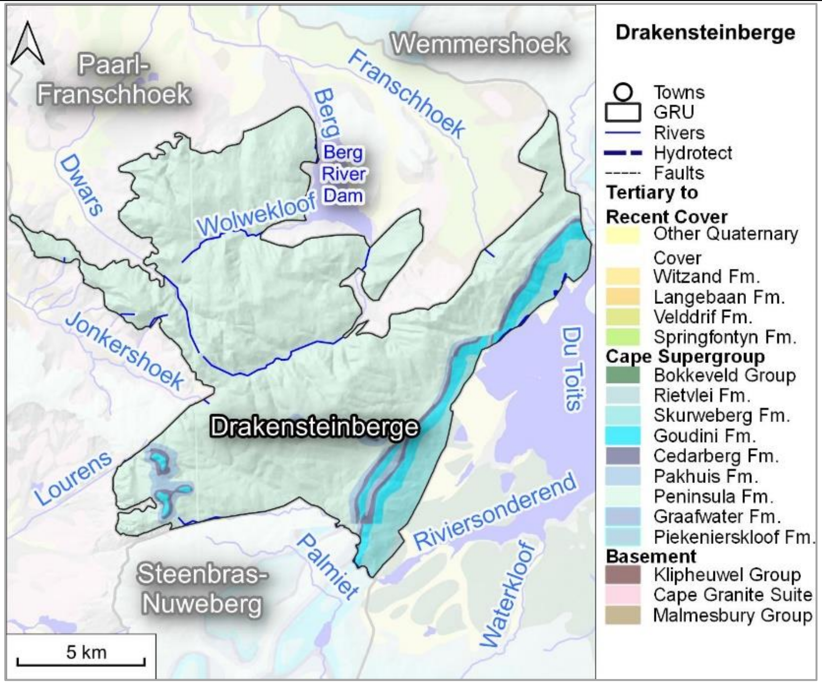
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Steenbras-Nuweberg (Nardouw)	Sulphate (mg/l)	6.50	0.40	17.70	3.66	3.35	Na-Cl, Ca-Mg-Cl, Ca-Na-HCO$_3$	A	B	B
	Electrical conductivity (mS/m)	10.0	2.00	24.20	10.60	9		B		
	pH	5.91	4.63	8.61	5.75	5.57		B		
	Ammonia (mg/l)	2.88	0.01	12.22	0.64	0.1		A		
	Nitrate + nitrite (mg/l)	0.20	-	3.66	0.30	0.2		A		
	Fluoride (mg/l)	0.50	0.05	0.50	0.21	0.1		-		
	Orthophosphate (mg/l)	0.20	-	0.20	0.10	0.1		-		
	Dissolved Aluminium (mg/l)	0.040	0.001	0.074	0.024	0.012		A		
	Dissolved Arsenic (mg/l)	0.010	0.001	0.040	0.006	0.003		A		
	Dissolved Chromium (mg/l)	0.020	0.001	0.020	0.010	0.007		-		
	Dissolved Iron (mg/l)	0.024	0.024	5.266	0.363	0.024		A		
	Dissolved Lead (mg/l)	0.010	0.001	0.040	0.008	0.007		A		
	Dissolved Manganese (mg/l)	0.025	0.019	0.700	0.063	0.019		A		
	Dissolved Mercury (mg/l)	0.005	0.001	0.005	0.005	0.005		-		

Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of ‘B, indicating an **unstressed or slightly stressed** aquifer, and a Groundwater Quality Present Status Category of ‘B’ indicating **localised, low levels of contamination, but no negative impacts apparent.**

Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
58.76	9.13	0.16	B	B

5.2.3. Drakensteinberge GRU

GRU	**GRU Name: Drakensteinberge**	
	Main Towns: None	
	Total Area (km^2): 182.70	
GRU Boundary Description	The Drakensteinberge GRU is bound TMG outcrop mostly Peninsula Formation, and portions of Skurweberg, Goudini, Cedarberg, and Pakhuis formations as well as the Lourens River in the southwest. The La Motte Fault bounds the southern extent of the GRU (DWAF, 2008a; CoCT, 2004).	
Resource Unit	**Fractured Table Mountain Group Aquifer**	
	Peninsula	**Nardouw**
Quaternary Catchments	G10A, G10C, G22F, G22J, H60A and H60B	
Description	The Table Mountain Group Super aquifer is composed of the larger Peninsula Aquifer (~600m to 1000m thick) and the lesser Nardouw Aquifer (with its component sub-aquifers, roughly 150- 300m thick). The Peninsula Aquifer and the Skurweberg Sub-aquifer are the main deep aquifer targets in this area.	The Goudini, Skuwerberg and minor portions of the Rietvlei formation, part of the Nardouw Sub-group, is present in the south-eastern portion of this GRU as the western limb of a syncline. The Nardouw Aquifer mainly consist of the Skuwerberg Formation and potentially parts of the Rietvlei Formation in the area, which can be between 150m to 300m thick.
		

GRU

GRU Name: Drakensteinberge

Main Towns: None

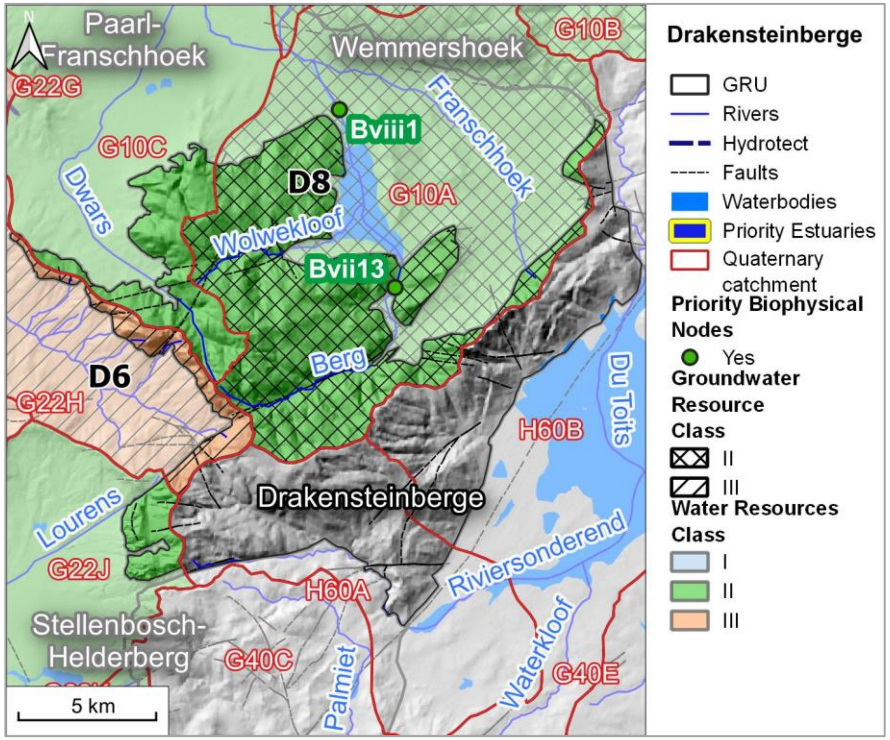
Total Area (km^2): 182.70

Surface Water System

Tributaries of the Berg River i.e., Wolwekloof and Dwars rivers originate from this GRU and form the main surface water systems in this GRU. The Berg River dam, just east of the GRU, forms the GRUs eastern edge boundary.

Water Resource Classes & RQOs

Only a portion of the GRU is in the Eerste (D6) and Upper Berg (D8) IUAs, while the rest of the GRU lies outside of the IUAs as the GRU extended outside of the Berg catchment area, i.e., the former Berg WMA. The portions of the GRU that fall within the D6 and D8 IUAs (catchments G10A and G22F) have a Water Resource Class of III and II respectively. The portion of the GRU that fall within the D6 IUA (catchment G22F) has a Groundwater Resource Class III and the portion that falls within the D8 IUA (catchment G10A) has a Groundwater Resource class of II. The GRU has 1 priority biophysical site with a TEC of A.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
D8 Upper Bergs	II	G10A	D8-R01	Berg	Bvii13	A	98

GRU	
GRU	**GRU Name: Drakensteinberge**
	Main Towns: None
	Total Area (km^2): 182.70

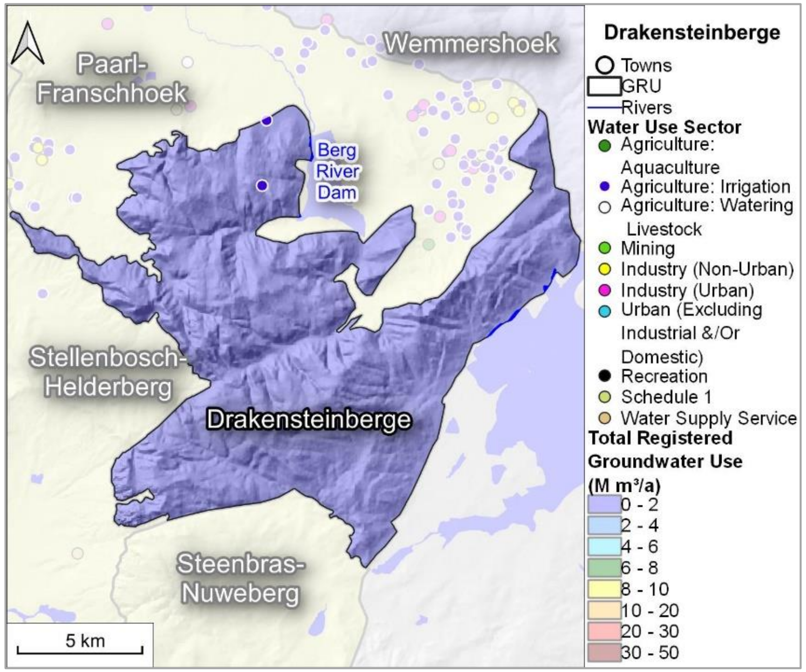
Recharge

An estimated recharge of **27.6 M m^3/a** was determined from First-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **167.32 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	164.95	27.6	167.32

Groundwater Use

There are 2 registered groundwater users in this GRU which form part of the Agricultural (Watering Livestock) sector, using a total of **0.05 M m^3/a** (see **Section 4.3.3** for details).



Water Use Sector	No. of Users	Total Volume (M m^3/a)
Agriculture: Watering livestock	2	0.05
Total	**2**	**0.05**

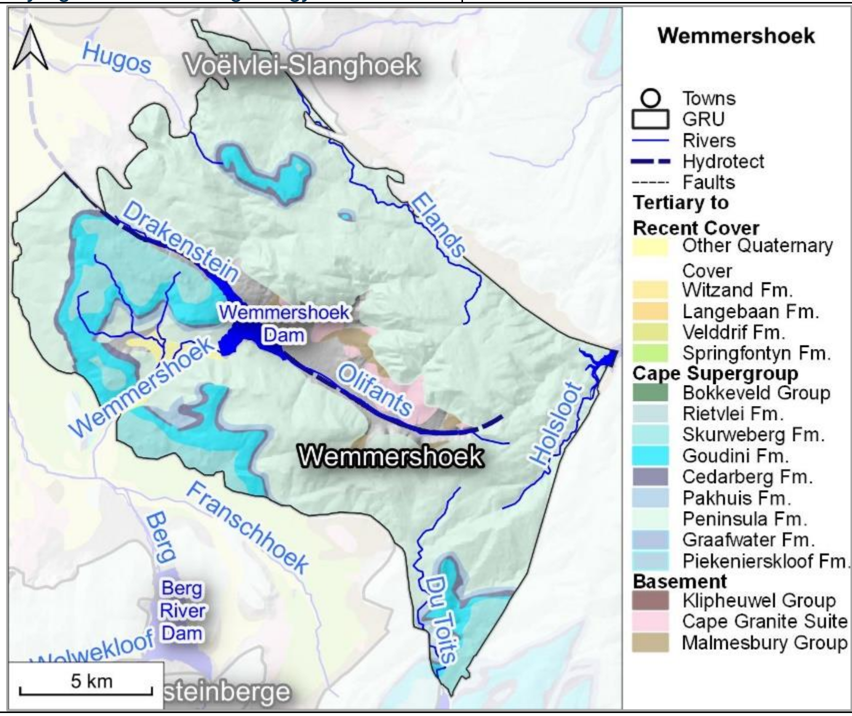
<table>
<tr><td rowspan="3">GRU</td><td>GRU Name: Drakensteinberge</td></tr>
<tr><td>Main Towns: None</td></tr>
<tr><td>Total Area (km²): 182.70</td></tr>
<tr><td>Discharge</td><td>Groundwater’s contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is <u>7.56 M m³/a</u> (see Section 4.4.1 for details).

<table>
<tr><th>RU</th><th>Sum of Baseflow per component (M m³/a)</th></tr>
<tr><td>Primary / Intergranular Aquifers</td><td>0.00345</td></tr>
<tr><td>Nardouw Aquifer</td><td>0.40</td></tr>
<tr><td>Peninsula Aquifer</td><td>6.57</td></tr>
<tr><td>Fractured and Intergranular Other (TMG)</td><td>0.58</td></tr>
<tr><td>Fractured and Intergranular Basement</td><td>0.00</td></tr>
<tr><td>Total</td><td>7.56</td></tr>
</table></td></tr>
<tr><td>Water Quality</td><td>No water quality data available</td></tr>
<tr><td>Aquifer Stress</td><td>The GRU is considered to have a Groundwater Availability Present Status Category of ‘A’, indicating an unstressed or slightly stressed aquifer, and the Groundwater Quality Present Status Category cannot be determined due to limited data availability.

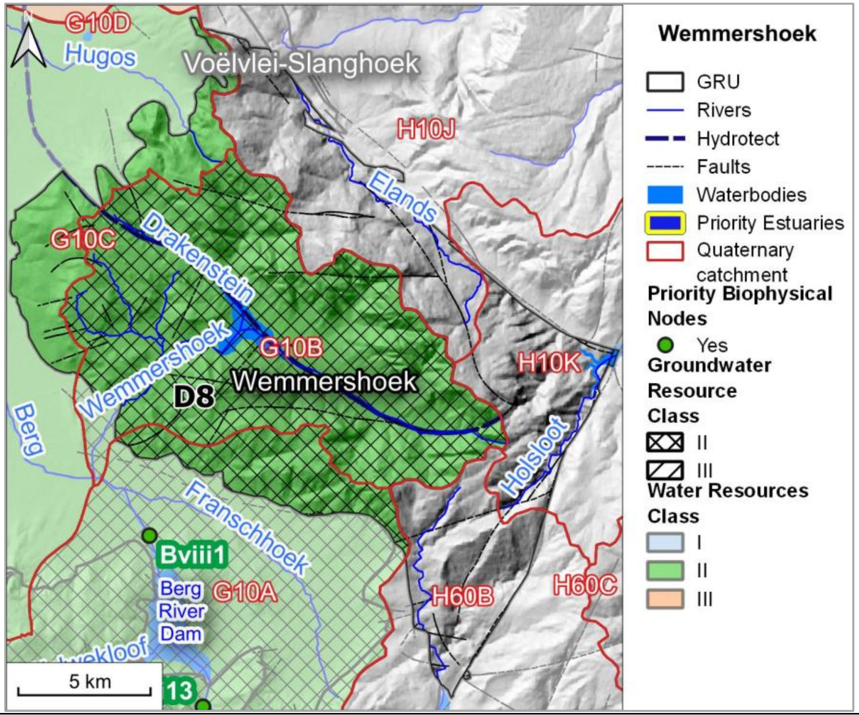
<table>
<tr><th>Recharge Volume (M m³/a)</th><th>Groundwater Use (M m³/a)</th><th>Stress Index</th><th>Groundwater Availability Present Status Category</th><th>Groundwater Quality Present Status Category</th></tr>
<tr><td>27.6</td><td>0.05</td><td>0.00</td><td>A</td><td>-</td></tr>
</table></td></tr>
</table>

5.2.4. Wemmershoek GRU

GRU	GRU Name: Wemmershoek	
	Main Towns: None	
	Total Area (km²): 268.01	
GRU Boundary Description	The Wemmershoek GRU is bound by the TMG extent and its contact with the basement lithologies the Cape Granite Suite and the Malmesbury Group of the Franschhoek valley and Stettyns anticline in the east. The GRU is also bounded by the Du Toits/Wellington fault in the north (DWAF, 2008a) as well as the La Motte fault/basement aquitard in the south.	
Resource Unit	**Fractured Table Mountain Group Aquifer**	
	Peninsula	**Nardouw**
Quaternary Catchments	G10B, G10A, G10C, H10J, H60B and H10K	
Description	The GRU is dominated by the Peninsula Formation (thickly bedded quartzite with an average thickness of ~ 600m -1000m) of the TMG, forming an unconfined aquifer and at depth, becoming a confined aquifer. This overlies the Malmesbury Group and Cape Granite Suite basement (composed of granites and metasediments), with the contact visible in the base of the mountain slopes, exposed in the valley. Younger Cenozoic sediments infill the valley more extensively, overlying the basement geology.	The Goudini, Skuwerberg and Rietvlei formations, part of the Nardouw Sub-group (~150m - 300m thick), outcrops in the surrounding the Wemmershoek valley, in the south-western section of the GRU and in portions of the north-east. The basement rocks of the Malmesbury Group and the Cape Granite Suite are exposed in the valley, including younger Cenozoic sediments infilling valleys.



<table>
<tr><td rowspan="3">GRU</td><td>GRU Name: Wemmershoek</td></tr>
<tr><td>Main Towns: None</td></tr>
<tr><td>Total Area (km^2): 268.01</td></tr>
<tr><td>Surface Water System</td><td>The Wemmershoek Dam which forms part of the Western Cape Water Supply System (WCWSS) is located within the GRU. There are several rivers that flow though this GRU including the Hugos, Elands, Holsloot, Du Toits, as well as the Drakenstein and Olifants rivers which flow into the Wemmershoek Dam.</td></tr>
<tr><td>Water Resource Classes & RQOs</td><td>Only a portion of the GRU is in the Upper Berg (D8) IUA, while the rest of the GRU lies outside the D8 IUA as the GRU extended outside of the Berg catchment area, i.e., the former Berg WMA. The portions of the RU that fall within the D8 IUA (catchments G10A and G10B) has a Water Resource Class of II and a Groundwater Resource Class of II. The GRU has no EWR sites nor any priority biophysical nodes.


</td></tr>
<tr><td>Recharge</td><td>An estimated recharge of <u>26.83 M m^3/a</u> was determined from first-order recharge calculations using the Map-Centric Simulation method (see Section 4.2.3), and was selected as the estimated recharge value for the Aquifer Stress (Section 4.6.1.2) assessments. The average recharge rate equates to <u>117.10 mm/a</u> based on the total GRU area. Additional recharge estimations are available in literature (See Section 4.2.3).

<table>
<tr><th>Method</th><th>Area (km^2)</th><th>Recharge Volume (M m^3/a)</th><th>Average Recharge Rate (mm/a)</th></tr>
<tr><td>Map Centric Simulation Method</td><td>229.13</td><td>26.83</td><td>117.10</td></tr>
</table></td></tr>
</table>

GRU	GRU Name: Wemmershoek
	Main Towns: None
	Total Area (km^2): 268.01

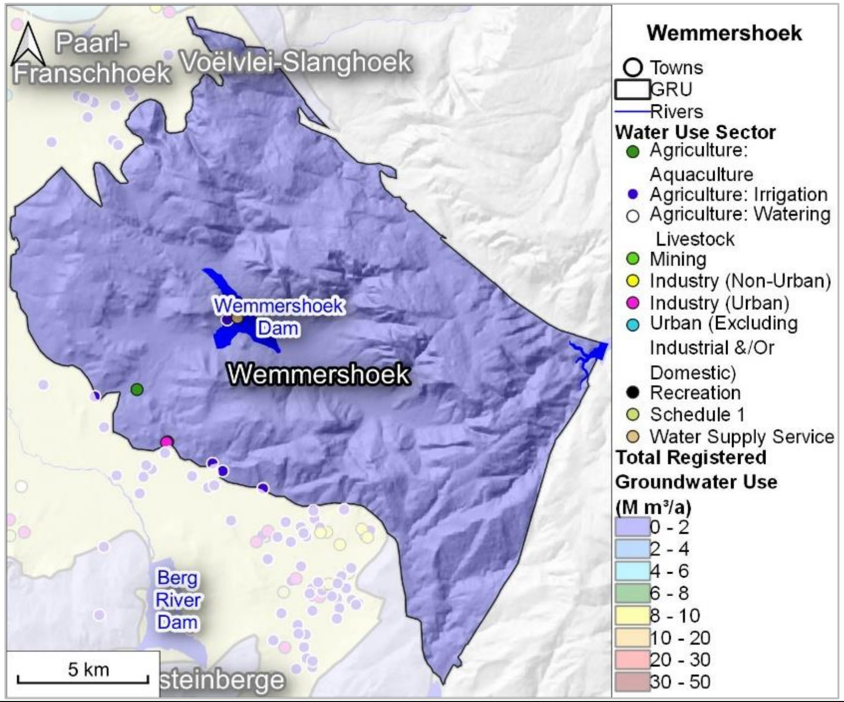
Groundwater Use

There are 11 registered groundwater users in the Peninsula RU with a combined groundwater use of **0.73 M m^3/a**. Major groundwater use sectors include Agriculture (irrigation) and Agriculture (aquaculture), which comprise 58.9% and 41.1% of the total groundwater use volume per annum (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured Table Mountain Group **(Peninsula)**	Agriculture: Irrigation	10	0.43
Primary / Intergranular Aquifers	Agriculture: Aquaculture	1	0.30
Total		**11**	**0.73**

There are 4 registered groundwater users in the Nardouw RU with a combined groundwater use of **0.09 M m^3/a**. The Agriculture (irrigation) sector uses a total of 89% of the total groundwater use volume per annum (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured Table Mountain Group **(Nardouw)**	Agriculture: Irrigation	2	0.01
	Industry (Non-urban)	2	0.08
Total		**4**	**0.09**



GRU	GRU Name: Wemmershoek
	Main Towns: None
	Total Area (km^2): 268.01

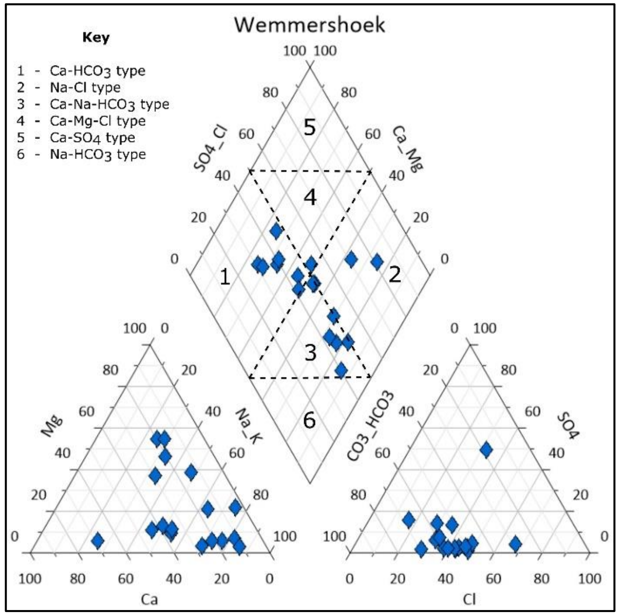
Discharge

Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **9.92 M m^3/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m^3/a)
Primary / Intergranular Aquifers	0.95
Nardouw Aquifer	0.80
Peninsula Aquifer	6.84
Fractured and Intergranular Other (TMG)	1.21
Fractured and Intergranular Basement	0.13
Total	**9.92**

Water Quality

The main water types in the Wemmershoek are Ca-HCO_3 and Ca-Mg-Cl type. Ca-HCO_3 type waters are due to the dissolution of carbonate minerals, while Ca-Na-HCO_3 type waters are due Na^+ cation exchange between Na-Cl type waters and Ca^{2+} and Mg^{2+} ions in the lithology. Exceedance of baseline concentrations was observed for all parameters except dissolved arsenic, lead, manganese and mercury. The adjusted water quality category is A, indicating that largely natural water quality conditions prevail, although natural, acidic pH and elevated iron are water quality concerns.



GRU	GRU Name: Wemmershoek
	Main Towns: None
	Total Area (km^2): 268.01

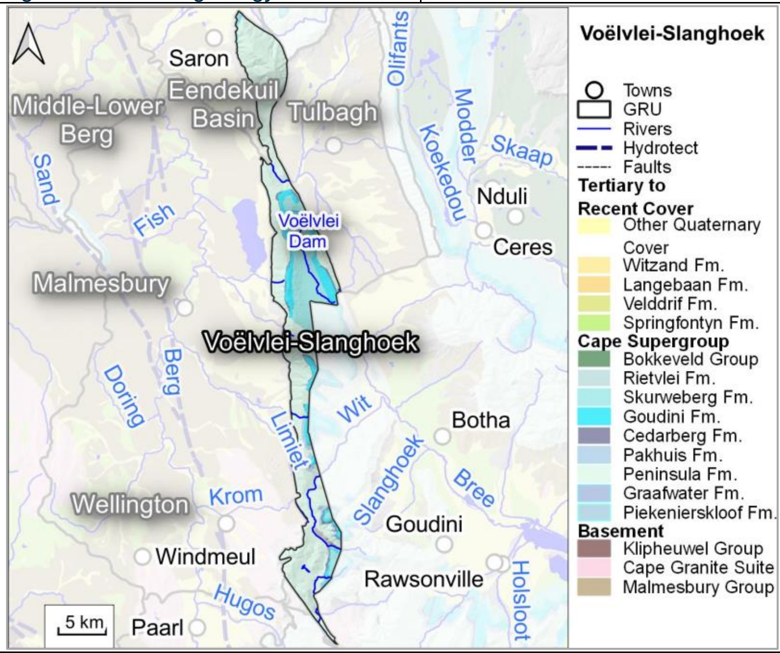
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Wemmershoek	Sulphate (mg/l)	3.45	0.20	20.90	2.77	0.72	Na-Cl, Ca-HCO3, Ca-Na-HCO3	A	A	A
	Electrical conductivity (mS/m)	9.27	4.66	16.00	8.74	8.1		C		
	pH	8.26	6.40	10.01	7.58	7.3		A		
	Ammonia (mg/l)	0.45	0.01	0.66	0.13	0.048		A		
	Nitrate + nitrite (mg/l)	0.53	-	1.27	0.13	0.017		A		
	Fluoride (mg/l)	0.16	0.05	0.39	0.17	0.11		A		
	Orthophosphate (mg/l)	0.05	-	0.43	0.06	0.016		A		
	Dissolved Aluminium (mg/l)	0.001	0.001	0.008	0.003	0.001		A		
	Dissolved Arsenic (mg/l)	0.001	0.001	0.001	0.001	0.001		-		
	Dissolved Chromium (mg/l)	0.001	0.001	0.001	0.001	0.001		A		
	Dissolved Iron (mg/l)	0.539	0.006	0.827	0.457	0.539		A		
	Dissolved Lead (mg/l)	0.001	0.001	0.001	0.001	0.001		-		
	Dissolved Manganese (mg/l)	0.714	0.001	0.714	0.240	0.003		-		
	Dissolved Mercury (mg/l)	0.001	0.001	0.001	0.001	0.001		-		

Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of ‘A’, indicating an **unstressed or slightly stressed** aquifer, and a Groundwater Quality Present Status Category of ‘A’ indicating **unmodified, pristine conditions.**

Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Adjusted Groundwater Quality Present Status Category
26.83	0.81	0.03	A	A

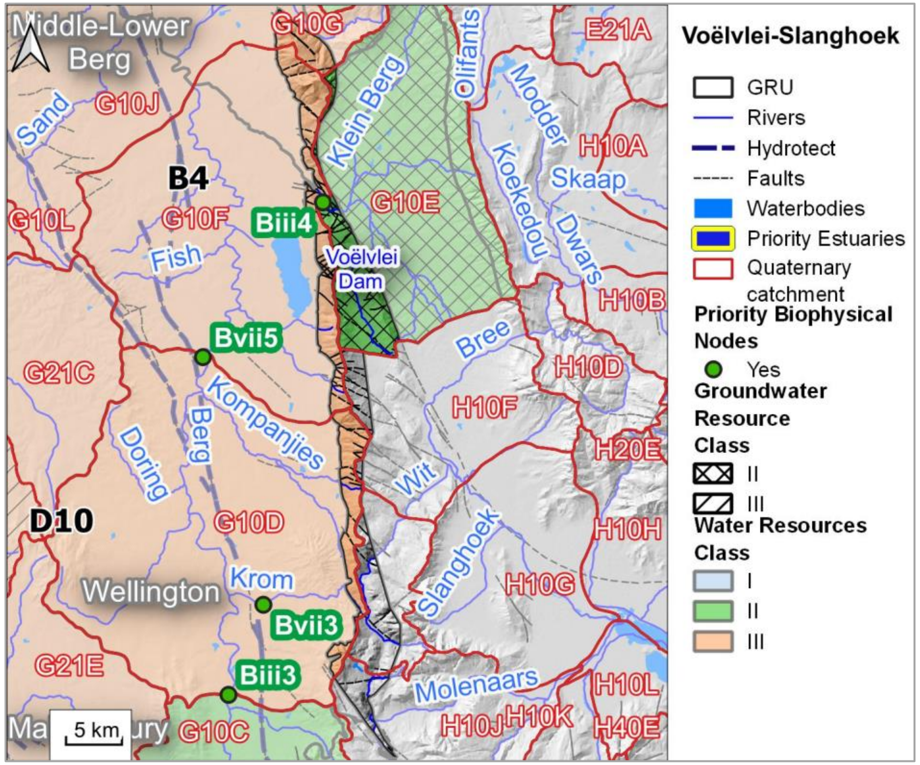
5.2.5. Voëlvlei-Slanghoek GRU

<table>
<tr><td rowspan="3">GRU</td><td colspan="2">GRU Name: Voëlvlei-Slanghoek</td></tr>
<tr><td colspan="2">Main Towns: None</td></tr>
<tr><td colspan="2">Total Area (km²): 220.49</td></tr>
<tr><td>GRU Boundary Description</td><td colspan="2">The Voëlvlei-Slanghoek GRU is bound by the TMG extent and its contact with the basement lithologies Klipheuwel Group, Cape Granite Suite, and Malmesbury Group on both the western and eastern/north-eastern edge of the GRU. In the north, the Voëlvlei-Slanghoek GRU is separated from the Groot Winterhoek GRU by the Roodezandspas Fault. The eastern/south-eastern fringe is bound by the Stettyns and Koue Bokkeveld anticline and portions of the Du Toits/Wellington fault.</td></tr>
<tr><td rowspan="2">Resource Unit</td><td colspan="2">Fractured Table Mountain Group Aquifer</td></tr>
<tr><td>Peninsula</td><td>Nardouw</td></tr>
<tr><td>Quaternary Catchments</td><td colspan="2">G10E, G10J, G10D, G10F, H10E, H10F and H10J</td></tr>
<tr><td rowspan="2">Description</td><td>The Table Mountain Group Super aquifer is composed of the larger Peninsula Aquifer (thickly bedded quartzite) and forms the main deep aquifer targets in this RU, reaching an average thickness of between 600m and 1500m. This overlies the Malmesbury Group and Cape Granite Suite basement, with the contact visible in the base of the mountain slopes, exposed in the valley on the eastern edge of the RU. Younger Cenozoic sediments infill the valley more extensively, overlying the basement geology.</td><td>The Goudini, Skuwerberg and Rietvlei formations, part of the Nardouw Sub-group, are present along the slopes of this GRU. The aquifers include the Skuwerberg and Rietvlei formation which have an average thickness of 200 – 300m and 150 – 200m respectively.</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

GRU	GRU Name: Voëlvlei-Slanghoek
	Main Towns: None
	Total Area (km^2): 220.49
Surface Water System	The GRU sits just west of the Voëlvlei Dam, the second largest reservoir of the Western Cape Water Supply System (WCWSS). It includes a canal that can supply water from the reservoir from a weir in the Nuewkloof Pass on the Klein Berg River.

Water Resource Classes & RQOs

Only a portion of the GRU is in the Middle Berg (D9), the Berg tributaries (C5) and the Lower Berg (B4) IUAs, while the rest of the RU lies outside of the IUAs as the GRU extended outside of the Berg catchment area, i.e., the former Berg WMA. The portions of the GRU that fall within the D9 and B4 IUAs (catchments G10D and G10F) has a Water Resource Class of III, and the portions that fall within the C5 IUA has a Water Resource Class of II with a corresponding Groundwater Resource Class of II. The rest of the GRU has no Groundwater Resource Class. This site has 1 priority biophysical site - the Klein Berg River node with a TEC of C.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
C5 Berg Tributaries	II	G10E	C5-R07	Klein Berg	Biii4	C	82

.

GRU	GRU Name: Voëlvlei-Slanghoek
	Main Towns: None
	Total Area (km^2): 220.49

Recharge

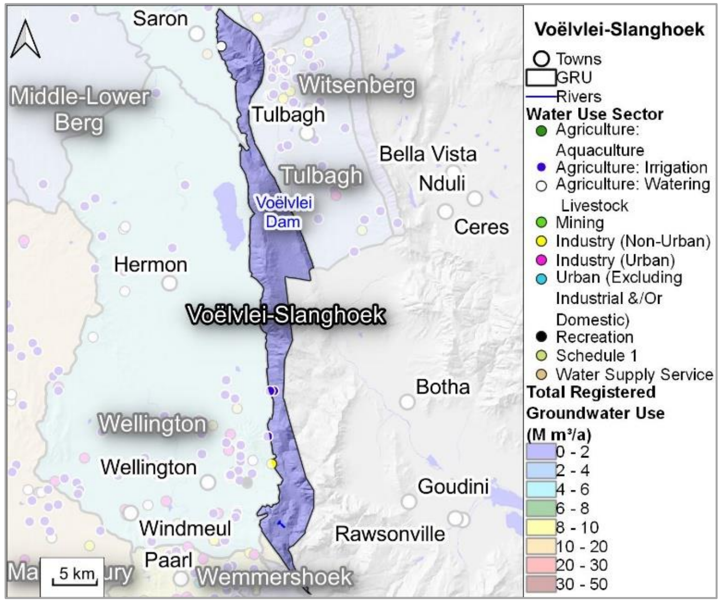
An estimated recharge of **14.1 M m^3/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **76.52 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	184.26	14.1	76.52

Groundwater Use

There are 3 registered groundwater users in the Peninsula RU with a combined groundwater use of **0.14 M m^3/a.** Major groundwater use sectors in this GRU include Agriculture (watering livestock) and Agriculture (irrigation) which comprise of 73.1% and 26.9% respectively of total groundwater use volume per annum (see **Section 4.3.3** for details).

Water Use Sector	No. of Users	Total Volume (M m^3/a)
Agriculture: Irrigation	2	0.04
Agriculture: Watering livestock	1	0.10
Total	**3**	**0.14**

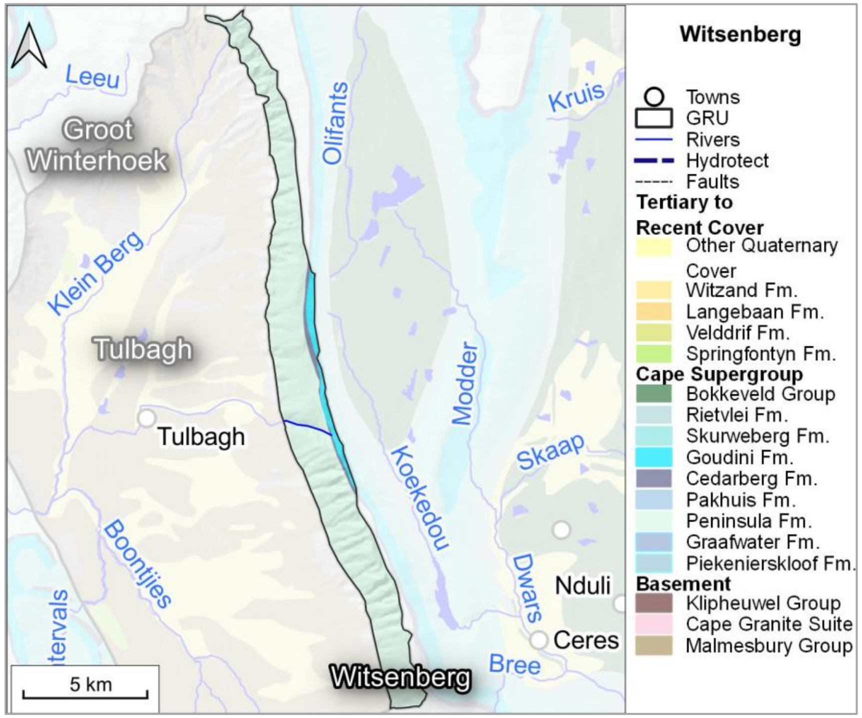


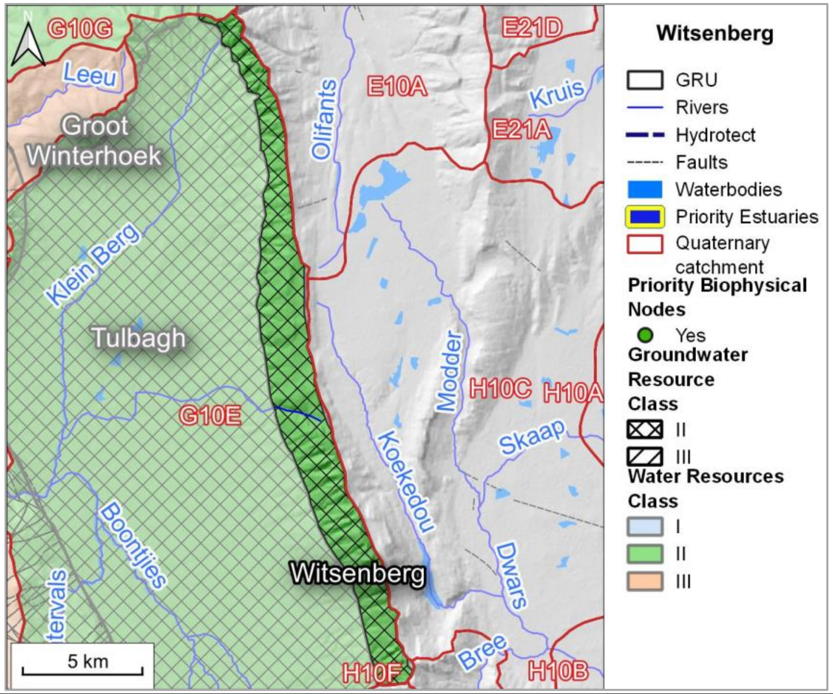
GRU	GRU Name: Voëlvlei-Slanghoek Main Towns: None Total Area (km^2): 220.49
Discharge	Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **4.18 M m^3/a** (see **Section 4.4.1** for details).
Water Quality	*No water quality data available*
Aquifer Stress	The GRU is considered to have a Groundwater Availability Present Status Category of 'A', indicating an **unstressed or slightly stressed** aquifer, and the Groundwater Quality Present Status Category cannot be determined due to limited data availability.

RU	Sum of Baseflow per component (M m^3/a)
Primary / Intergranular Aquifers	0.12
Nardouw Aquifer	0.54
Peninsula Aquifer	2.79
Fractured and Intergranular Other (TMG)	0.74
Fractured and Intergranular Basement	1.86E-08
Total	**4.18**

Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
14.1	0.14	0.01	A	N/A

5.2.6. Witsenberg GRU

<table>
<tr><th rowspan="3">GRU</th><th colspan="2">GRU Name: Witsenberg</th></tr>
<tr><th colspan="2">Main Towns: None</th></tr>
<tr><th colspan="2">Total Area (km^2): 220.49</th></tr>
<tr><td>GRU Boundary Description</td><td colspan="2">The western extent of the Witsenberg GRU is bound by the extent of the TMG (predominantly Peninsula Formation) and its contact with the basement lithologies (Malmesbury Group). The extent of the Berg catchment bounds the eastern and southern fringe, with the G10G surface water quaternary catchment divide bounding the northern portion of the GRU.</td></tr>
<tr><th rowspan="2">Resource Unit</th><th colspan="2">Fractured Table Mountain Group Aquifer</th></tr>
<tr><th>Peninsula</th><th>Nardouw</th></tr>
<tr><td>Quaternary Catchments</td><td colspan="2">G10E</td></tr>
<tr><td rowspan="2">Description</td><td>The Peninsula Formation, composed of thickly bedded quartzites, dominates the mountains of the GRU and forms an unconfined aquifer. The formation ranges in thickness from between 550-1500m thick.</td><td>The Goudini, Skuwerberg and Rietvlei formations, part of the Nardouw Sub-group, are present in this GRU. The aquifers include the Skuwerberg and Rietvlei formation which have an average thickness of 200 – 300m and 150 – 200m respectively.</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

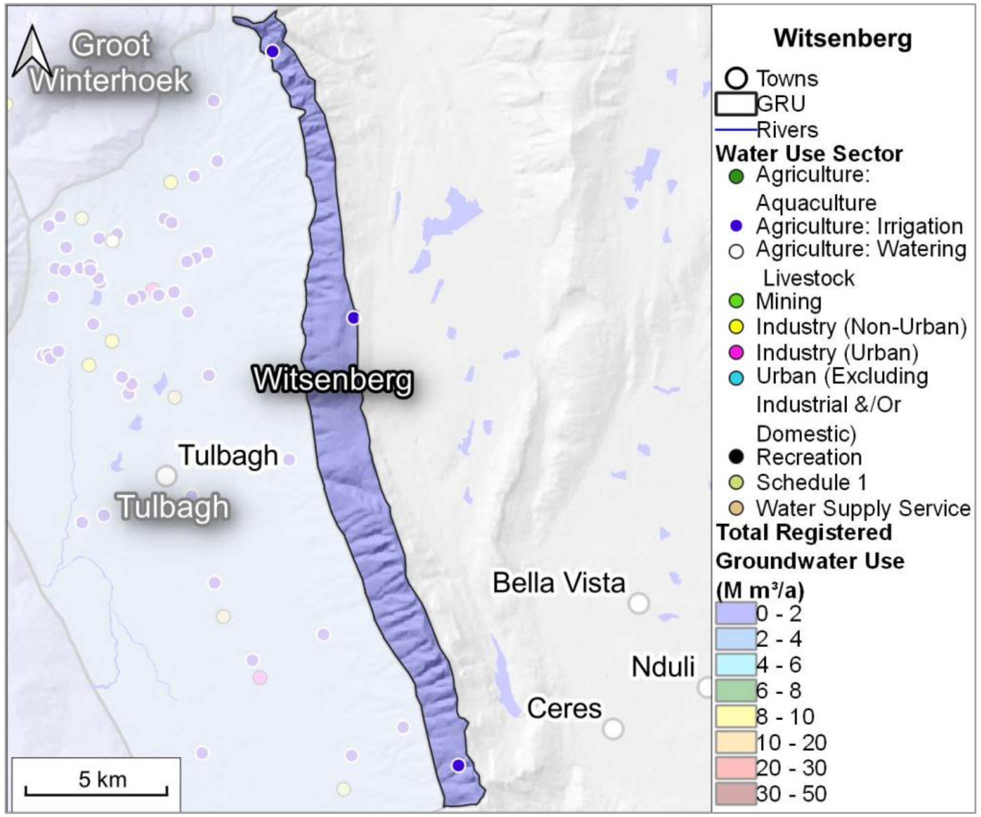
<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Witsenberg</th></tr>
<tr><th>Main Towns: None</th></tr>
<tr><th>Total Area (km^2): 220.49</th></tr>
<tr><td>Surface Water System</td><td>There are no major surface water systems in this RU except for a tributary of the Klein-Berg River.</td></tr>
<tr><td>Water Resource Classes & RQOs</td><td>The GRU falls entirely in the Berg Tributaries (C5) IUA and has a Water Resource Class is II and a Groundwater Resource Class of II. There are no EWR sites nor any priority biophysical nodes.

</td></tr>
<tr><td>Recharge</td><td>An estimated recharge of <u>2.78 M m^3/a</u> was determined from first-order recharge calculations using the Map-Centric Simulation method (see Section 4.2.3), and was selected as the estimated recharge value the Aquifer Stress (Section 4.6.1.2) assessments. The average recharge rate equates to <u>69.59 mm/a</u> based on the total GRU area. Additional recharge estimations are available in literature (See Section 4.2.3).
<table>
<tr><th>Method</th><th>Area (km^2)</th><th>Recharge Volume (M m^3/a)</th><th>Average Recharge Rate (mm/a)</th></tr>
<tr><td>Map Centric Simulation Method</td><td>184.26</td><td>2.78</td><td>69.59</td></tr>
</table></td></tr>
</table>

GRU	GRU Name: Witsenberg
	Main Towns: None
	Total Area (km^2): 220.49

Groundwater Use

There are 3 registered groundwater users in this GRU with a combined groundwater use of **0.08 M m^3/a.** Major groundwater use sector include Agriculture (watering) and Agriculture (irrigation) which comprise of 100% of total groundwater use volume per annum (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured Table Mountain Group	Agriculture: Irrigation	3	0.08
Total		**3**	**0.08**

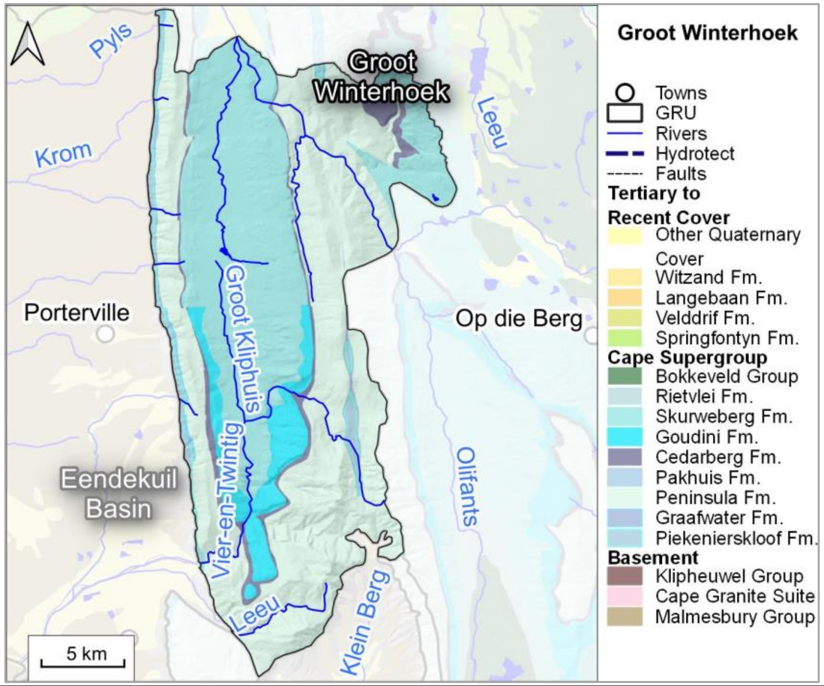


<table>
<tr><td rowspan="3">GRU</td><td>GRU Name: Witsenberg</td></tr>
<tr><td>Main Towns: None</td></tr>
<tr><td>Total Area (km²): 220.49</td></tr>
<tr><td>Discharge</td><td>Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is <u>0.93 M m³/a</u> (see Section 4.4.1 for details).

<table>
<tr><th>RU</th><th>Sum of Baseflow per component (M m³/a)</th></tr>
<tr><td>Primary / Intergranular Aquifers</td><td>0.00</td></tr>
<tr><td>Peninsula Aquifer</td><td>0.85</td></tr>
<tr><td>Fractured and Intergranular Other (TMG)</td><td>0.08</td></tr>
<tr><td>Fractured and Intergranular Basement</td><td>0.00</td></tr>
<tr><td>Total</td><td>0.93</td></tr>
</table></td></tr>
<tr><td>Water Quality</td><td>No water quality data available</td></tr>
<tr><td>Aquifer Stress</td><td>The GRU is considered to have a Groundwater Availability Present Status Category of 'A', indicating an unstressed or slightly stressed aquifer, and the Groundwater Quality Present Status cannot be determined due to limited data availability.

<table>
<tr><th>Recharge Volume (M m³/a)</th><th>Groundwater Use (M m³/a)</th><th>Stress Index</th><th>Groundwater Availability Present Status Category</th><th>Groundwater Quality Present Status Category</th></tr>
<tr><td>2.78</td><td>0.08</td><td>0.03</td><td>A</td><td>N/A</td></tr>
</table></td></tr>
</table>

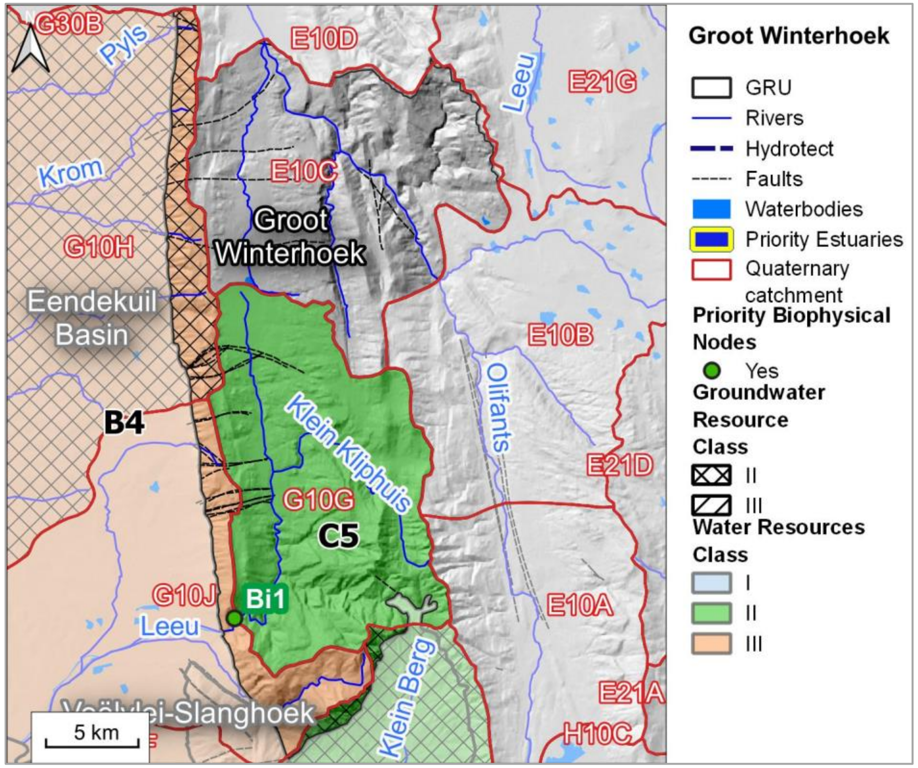
5.2.7. Groot Winterhoek GRU

<table>
<tr><th rowspan="3">GRU</th><th colspan="2">GRU Name: Groot Winterhoek</th></tr>
<tr><th colspan="2">Main Towns: None</th></tr>
<tr><th colspan="2">Total Area (km^2): 454.92</th></tr>
<tr><td>GRU Boundary Description</td><td colspan="2">The Groot Winterhoek GRU is bound by the extent of the TMG and its contact with the basement lithologies on its western flank (Malmesbury Group). The southern boundary, and its separation from Voëlvlei-Slanghoek and the Witsenberg GRUs, are defined by the Roodezandspas Fault line, the contact with the Malmesbury Group basement, and portions of the G10G surface water quaternary catchment divide. Sections of the E10C surface water quaternary catchment divide, and the extent of the Berg catchment marks the north-eastern edge of the GRU.</td></tr>
<tr><th rowspan="2">Resource Unit</th><th colspan="2">Fractured Table Mountain Group Aquifer</th></tr>
<tr><th>Peninsula</th><th>Nardouw</th></tr>
<tr><td>Quaternary Catchments</td><td colspan="2">G10J, G10E, G10H, E10C and G10G</td></tr>
<tr><td rowspan="2">Description</td><td>The TMG in the Groot Winterhoek has been folded into a syncline, exposing the Peninsula Formation (composed of thickly bedded, super mature quartzite/ quartz sandstones) in the steep limbs to the east and west of the GRU. The formation ranges in thickness from between 600m and 1000m in this area.</td><td>The Goudini, Skuwerberg and Rietvlei formations of the Nardouw Sub-group (150m – 300m thick) are present at the centre of the syncline, with the Groot-Kliphuis River closely following the syncline axis. The aquifers include the Skuwerberg (thickly bedded quartzite) and Rietvlei (feldspathic sandstone with minor shales) formations.</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

GRU	
GRU	**GRU Name: Groot Winterhoek**
	Main Towns: None
	Total Area (km^2): 454.92
Surface Water System	The Olifants River, originating from the northern extent of the Groot Winterhoek GRU, comprises of various tributaries, including the Klein Kliphuis River and the Vier-en-Twintig River. The major surface water system in this GRU is the Olifants River which passes directly though the GRU at its north/north eastern edge. Most surface water featured follow the general topography of the Groot Drakenstein Mountains.

Water Resource Classes & RQOs

Only a portion of the GRU is in the Berg Tributaries (C5) and the Lower Berg (B4) IUAs, while the rest of the GRU lies outside the IUAs as the GRU extended outside of the Berg catchment area, i.e., the former Berg WMA. The portions of the RU that fall within the B4 IUA (catchments G10H and G10J) has a Water Resource Class of III and the portions of the GRU that fall within the C5 IUA (catchment G10G and G10E) has a Water Resource Class of II. The portions of the GRU that fall within the B4 IUA (catchment G10H) has Groundwater Resource Class of II and the portions that fall within the C5 IUA (catchment G10E) has a Groundwater Resource Class of II. This site has 1 priority biophysical site – the Vier-en-twintig River node of TEC B/C



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
C5 Berg Tributaries's	II	G10G	C5-R08	Vier-en-Twintig	Bi1	B/C	23

GRU	
GRU	**GRU Name: Groot Winterhoek**
	Main Towns: None
	Total Area (km^2): 454.92

Recharge

An estimated recharge of **22.5 M m^3/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **59.33 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	379.26	22.5	59.33

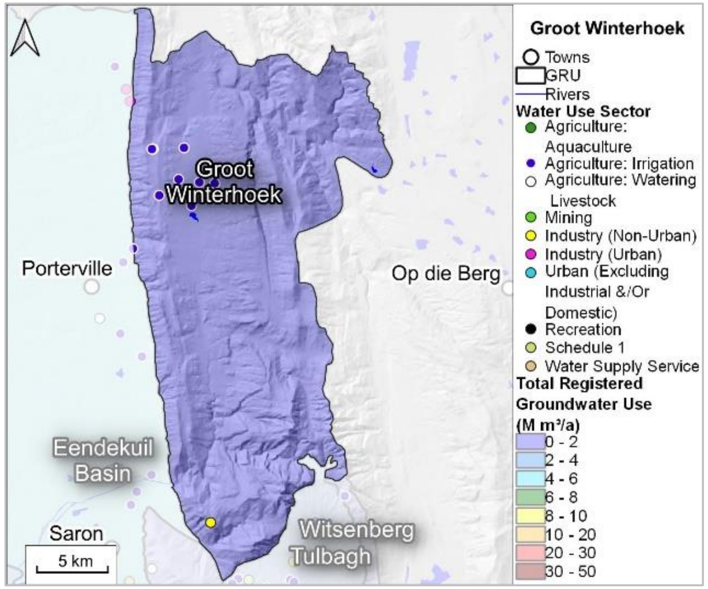
Groundwater Use

There are 4 registered groundwater users in the Peninsula RU with a combined groundwater use of **0.19 M m^3/a** (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured Table Mountain Group **(Peninsula)**	Agriculture: Irrigation	3	0.18
	Industry (Non-urban)	1	0.01
Total		**4**	**0.19**

There are 7 registered groundwater users in the Nardouw RU with a combined groundwater use of **0.21 M m^3/a.** The major groundwater use sector is Agriculture (irrigation) (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured Table Mountain Group **(Nardouw)**	Agriculture: Irrigation	7	1.21
Total		**7**	**1.21**

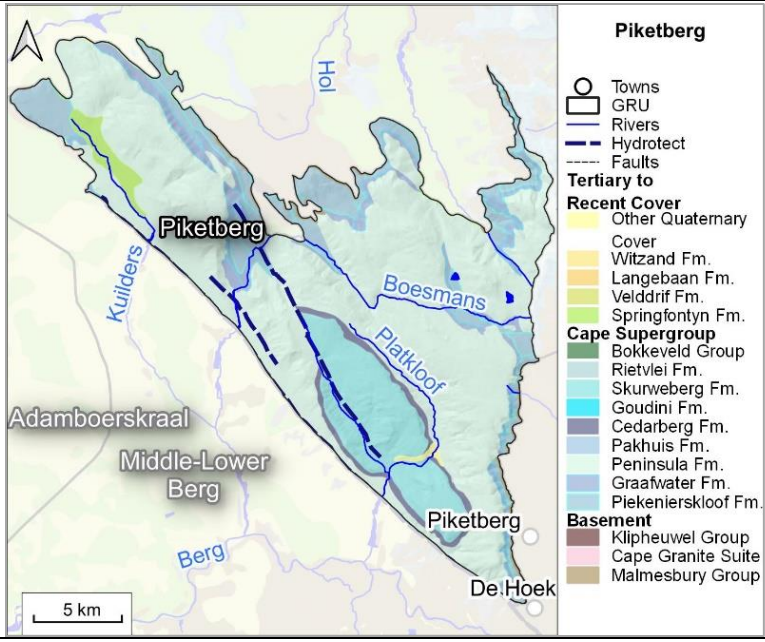


GRU	GRU Name: Groot Winterhoek Main Towns: None Total Area (km^2): 454.92
Discharge	Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **7.62 M m^3/a** (see **Section 4.4.1** for details).
Water Quality	*No water quality data available*
Aquifer Stress	The GRU is considered to have a Groundwater Availability Present Status Category of 'B', indicating an **unstressed or slightly stressed** aquifer, and the Groundwater Quality Present Status cannot be determined due to limited data availability.

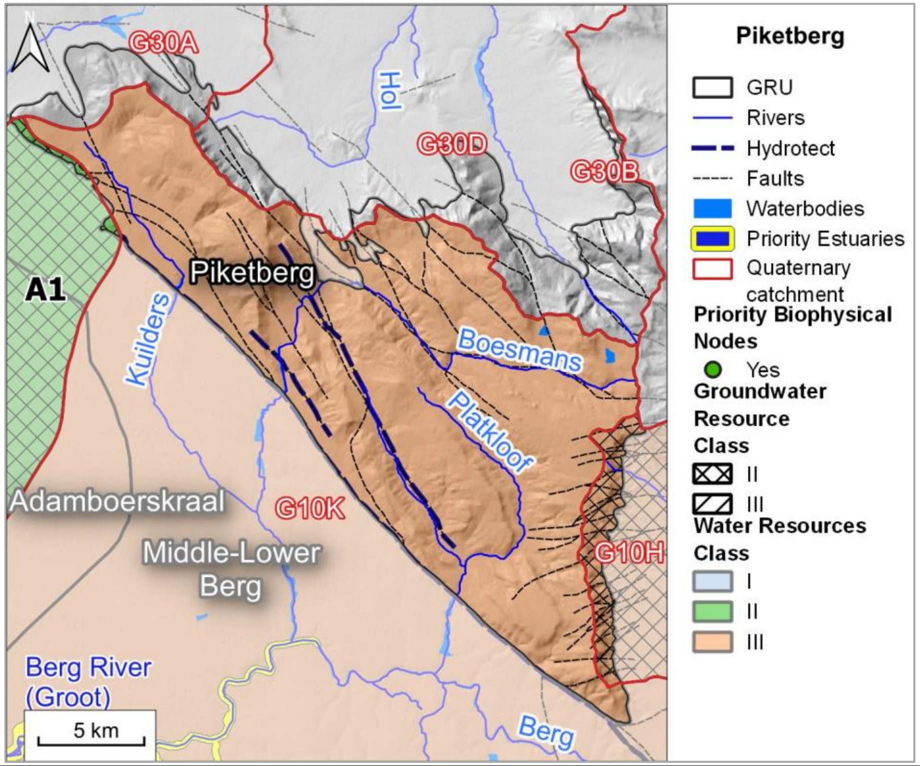
RU	Sum of Baseflow per component (M m^3/a)
Primary / Intergranular Aquifers	3.12E-04
Nardouw Aquifer	2.85
Peninsula Aquifer	3.74
Fractured and Intergranular Other (TMG)	1.02
Fractured and Intergranular Basement	2.61E-06
Total	**7.62**

Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
22.50	1.39	0.06	B	N/A

5.2.8. Piketberg GRU

GRU	GRU Name: Piketberg	
	Main Towns: Goedwerwacht	
	Total Area (km²): 389.07	
GRU Boundary Description	The Piketberg GRU is bound entirely by the extent of the TMG outcrop (predominantly the Peninsula, Rietvlei, Cederberg, Graafwaters and Piekenierskloof formations) and its contact with the surrounding basement lithologies (Malmesbury Group). The south/south-western edge of the GRU is bound by portions of the Aurora-Piketberg fault zone.	
Resource Unit	**Fractured Table Mountain Group Aquifer**	
	Peninsula	**Nardouw**
Quaternary Catchments	G10M, G30D, G10K, G30A and G10H	G10M, G30D, G10K, G30A and G10H
Description	This mountainous area of TMG contains the aquifer-bearing Peninsula formation (~600m – 1000m thick) in the limbs of a syncline, above the Malmesbury Group basement. The basement occurs at the base of the mountain on the eastern side outside this GRU - this forms a no-flow boundary for groundwater on the southeast of the Piketberg GRU, except for minor flow into screes and weathered zones of the Malmesbury Group. The Sandveld Group overlie flat areas and screes on the mountain slopes and overlies the TMG and basement to the northwest of the GRU.	This mountainous area is dominated in the Rietvlei formation (feldspathic sandstone with minor sandstone, roughly 150-200m thick) of the Nardouw Sub-group. This formation is present in the valley of the syncline. The Sandveld Group overlie flat areas and screes on the mountain slopes and overlies the TMG and basement to the northwest of the GRU.
		

<table>
<tr><td rowspan="3">GRU</td><td>GRU Name: Piketberg</td></tr>
<tr><td>Main Towns: Goedwerwacht</td></tr>
<tr><td>Total Area (km^2): 389.07</td></tr>
<tr><td>Surface Water System</td><td>Major surface water systems include the Boesmans and Platkloof Rivers. Surface-water flow occurs from the high lying Piketberg Mountains of the TMG outcrop.</td></tr>
<tr><td>Water Resource Classes & RQOs</td><td>Only a portion of the GRU is in the Lower Berg (B4) and the Berg Estuary (A1) IUAs, while the rest of the GRU lies outside the IUAs as the GRU extended outside of the Berg catchment area, i.e., the former Berg WMA. The portions of the RU that fall within the B4 IUA (catchments G10K and G10H) has a Water Resource Class of III and the portions that fall within the A1 IUA (catchment G10M) has a Water Resource Class of II. The portions of the GRU that fall within the B4 IUA (catchments G10H) has no Groundwater Resource Class (except for the small portion that falls within catchment G10H which as a Groundwater Resource Class of II; and the portions that fall within catchment G10M has a Groundwater Resource Class of II). This GRU has no EWR sites nor any priority biophysical nodes.



</td></tr>
<tr><td>Recharge</td><td>An estimated recharge of 20.33 M m^3/a was determined from First-order recharge calculations using the Map-Centric Simulation method (see Section 4.2.3), and was selected as the estimated recharge value for the Aquifer Stress (Section 4.6.1.2) assessments. The average recharge rate equates to 68.16 mm/a based on the total GRU area. Additional recharge estimations are available in literature (See Section 4.2.3).
<table>
<tr><th>Method</th><th>Area (km^2)</th><th>Recharge Volume (M m^3/a)</th><th>Average Recharge Rate (mm/a)</th></tr>
<tr><td>Map Centric Simulation Method</td><td>298.29</td><td>20.33</td><td>68.16</td></tr>
</table>
</td></tr>
</table>

GRU	GRU Name: Piketberg
	Main Towns: Goedwerwacht
	Total Area (km^2): 389.07

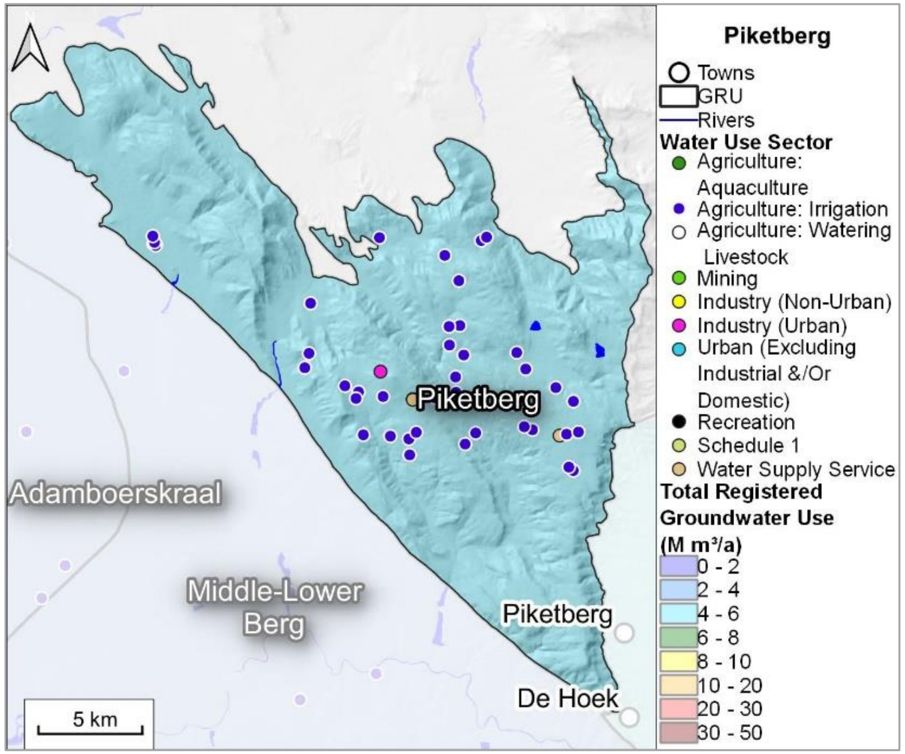
Groundwater Use

There are 46 registered groundwater users in the Peninsula RU with a combined groundwater use of **5.14 M m^3/a**. The major groundwater use sector is Agriculture (irrigation) which uses a total of 97.5% of the total groundwater use volume per annum (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured Table Mountain Group **(Peninsula)**	Agriculture: Irrigation	41	5.02
	Industry (Non-urban)	2	0.056
	Water Supply Service	3	0.07
Total		**46**	**5.146**

There are 6 registered groundwater users in the Nardouw RU with a combined groundwater use of **0.44 M m^3/a**. The major groundwater use sector is Agriculture (irrigation) which uses a total of 99.5% of the total groundwater use volume per annum (see **Section 4.3.3** for details).

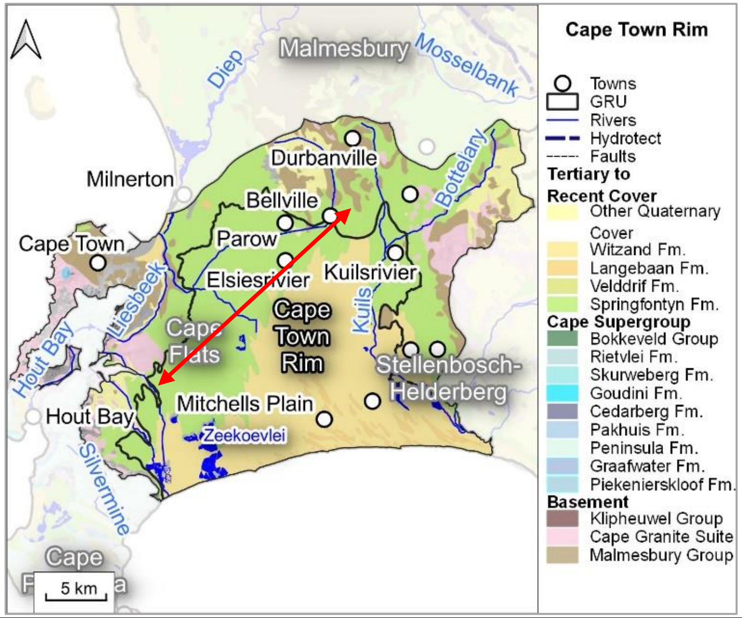
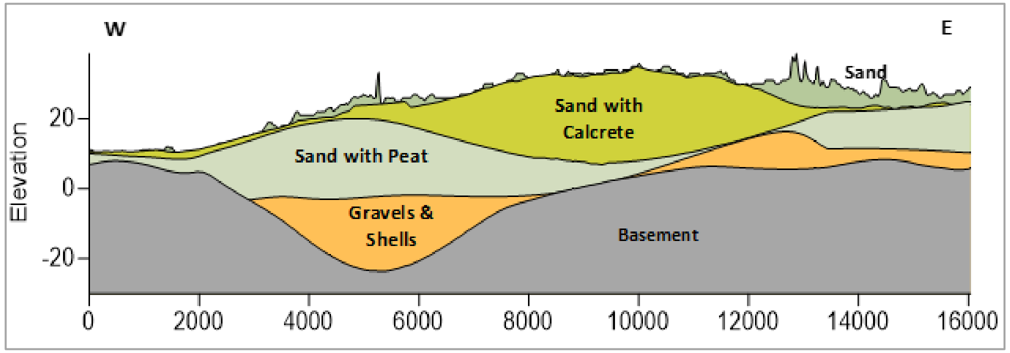
RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured Table Mountain Group **(Nardouw)**	Agriculture: Irrigation	5	0.44
Primary / Intergranular Aquifers	Agriculture: Irrigation	1	0.002
Total		**6**	**0.442**



<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Piketberg</th></tr>
<tr><th>Main Towns: Goedwerwacht</th></tr>
<tr><th>Total Area (km^2): 389.07</th></tr>
<tr><td>Discharge</td><td>Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is <u>0.12 M m^3/a</u> (see Section 4.4.1 for details).
<table>
<tr><th>RU</th><th>Sum of Baseflow per component (M m^3/a)</th></tr>
<tr><td>Primary / Intergranular Aquifers</td><td>0.00</td></tr>
<tr><td>Nardouw Aquifer</td><td>0.00</td></tr>
<tr><td>Peninsula Aquifer</td><td>0.07</td></tr>
<tr><td>Fractured and Intergranular Other (TMG)</td><td>0.05</td></tr>
<tr><td>Fractured and Intergranular Basement</td><td>0.00</td></tr>
<tr><td>Total</td><td>0.12</td></tr>
</table></td></tr>
<tr><td>Water Quality</td><td>No water quality data available</td></tr>
<tr><td>Aquifer Stress</td><td>The GRU is considered to have a Groundwater Availability Present Status Category of 'C', indicating a moderately stressed aquifer, and the Groundwater Quality Present Status cannot be determined due to limited data availability.
<table>
<tr><th>Recharge Volume (M m^3/a)</th><th>Groundwater Use (M m^3/a)</th><th>Stress Index</th><th>Groundwater Availability Present Status Category</th><th>Groundwater Quality Present Status Category</th></tr>
<tr><td>20.33</td><td>5.58</td><td>0.27</td><td>C</td><td>N/A</td></tr>
</table></td></tr>
</table>

5.3. Fractured and Intergranular Basement GRUs

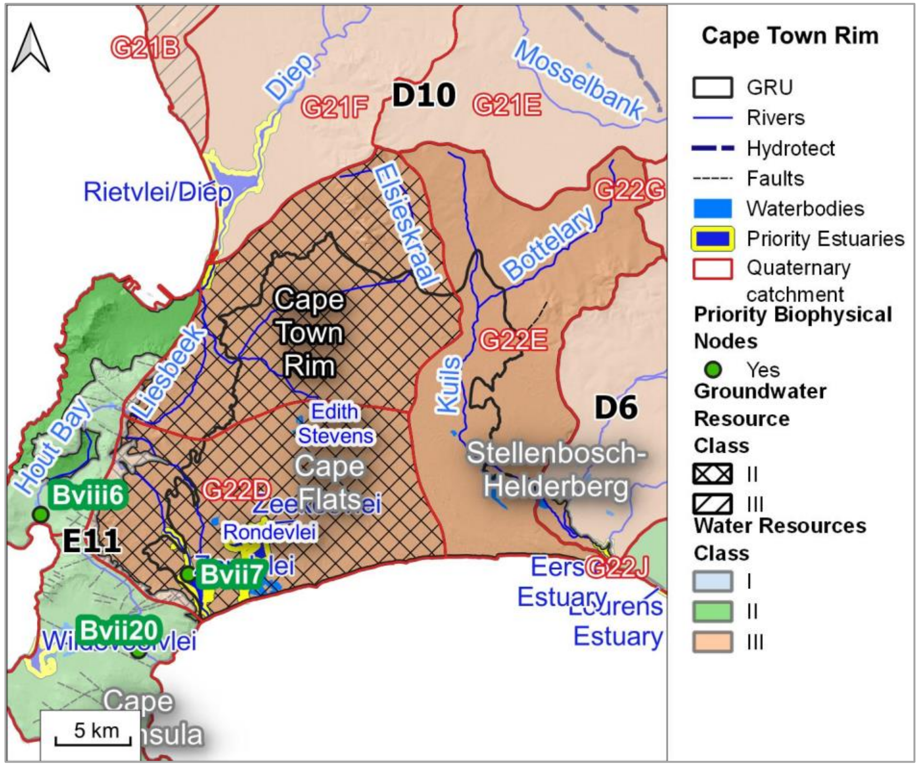
5.3.1. Cape Town Rim GRU

GRU	**GRU Name: Cape Town Rim**
	Main Towns: Cape Town, Cape Flats and Brackenfell
	Total Area (km^2): 826.03
GRU Boundary Description	Portions of the G21F, G21E, G22H and G22G surface water quaternary catchment divides form the northern and eastern edge of the GRU, with the extent of the basement lithologies (the Cape Granite Suite and the Malmesbury Group) and its contact with the TMG forming the boundary between the Cape Town Rim GRU and the Cape Peninsula GRU. Quaternary catchments were used because groundwater flow is often parallel to topography. The western/north-western fringe of the GRU is bound by the Table Bay and False Bay coastlines.
Resource Unit	**Fractured and Intergranular Basement Aquifer**
Quaternary Catchments	G22C, G22E, G22B and G22D
Description	The Cape Town Rim Basement underlies (see cross section of the CFA) and surrounds the Cape Flats Aquifer GRU. The basement geology comprises of Neoproterozoic rocks of the Tygerberg Formation (Malmesbury Group), which is intruded by the late Neoproterozoic to early Cambrian Cape Granite Suite. The Tygerberg Formation constitutes a relatively monotonous succession of deep water, turbiditic meta-sediments and shale deformed into simple folds, and is generally highly weathered. (see Section 3.1 for detail).  

GRU	GRU Name: Cape Town Rim
	Main Towns: Cape Town, Cape Flats and Brackenfell
	Total Area (km^2): 826.03
Surface Water System	Main rivers comprise of the Kuils, Lotus, Liesbeek and Elsieskraal rivers, although most of these occur on the CFA which overlies the basement.

Water Resource Classes & RQOs

The GRU falls within the Peninsula (E1) and Cape Flats (E12) IUAs and has Water Resource Class II and III respectively. The portion of the GRU that fall within IUA E12 (catchments G22D and G22C) has a Groundwater Resource Class of II, and no Groundwater Resource Class for the portions that fall within IUA E11 (catchments G22A and G22B). There are no priority EWR sites within this IUA, although portions of 1 estuary node (Rietvlei/ Diep) with a TEC of C fall within the GRU.



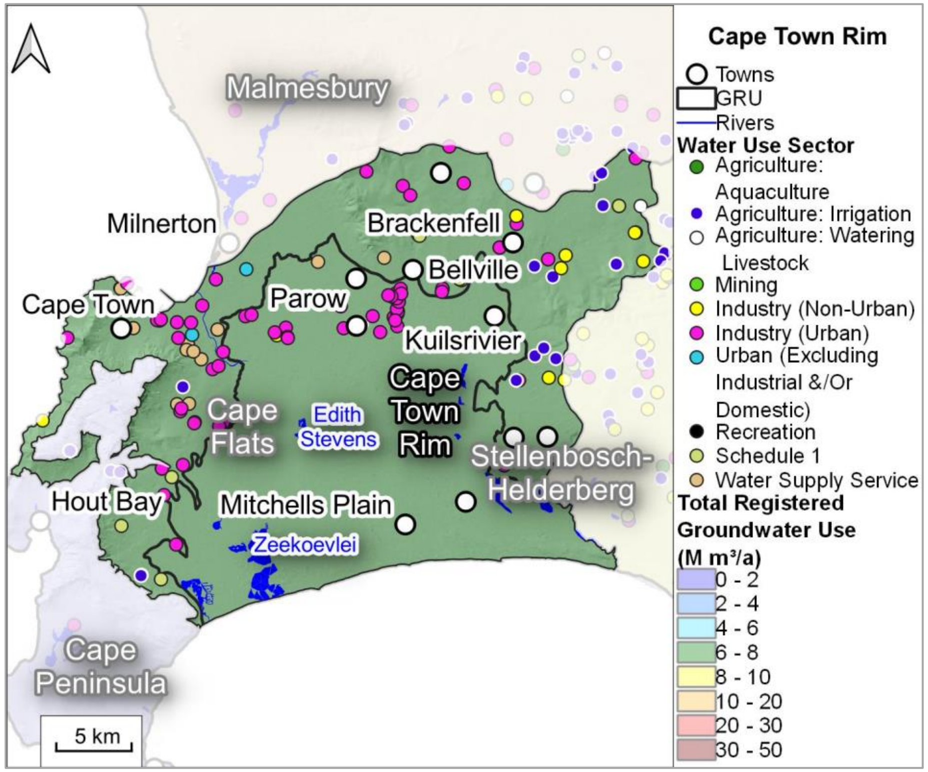
IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
D10 Diep	III	G21F	D10-E03	Rietvlei/ Diep	Bxi7	C	78

GRU	
GRU	**GRU Name: Cape Town Rim**
	Main Towns: Cape Town, Cape Flats and Brackenfell
	Total Area (km^2): 826.03
Recharge	An estimated recharge of **18.6 M m^3/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **22.83 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	298.29	18.6	22.83

Groundwater Use

There are 169 registered groundwater users in this GRU with a combined groundwater use of **6.11 M m^3/a**. Major groundwater use sectors include: Industry, and Agriculture (irrigation) which comprise of 43.5% and 39.0% respectively of total groundwater use volume per annum (see **Section 4.3.3** for details).



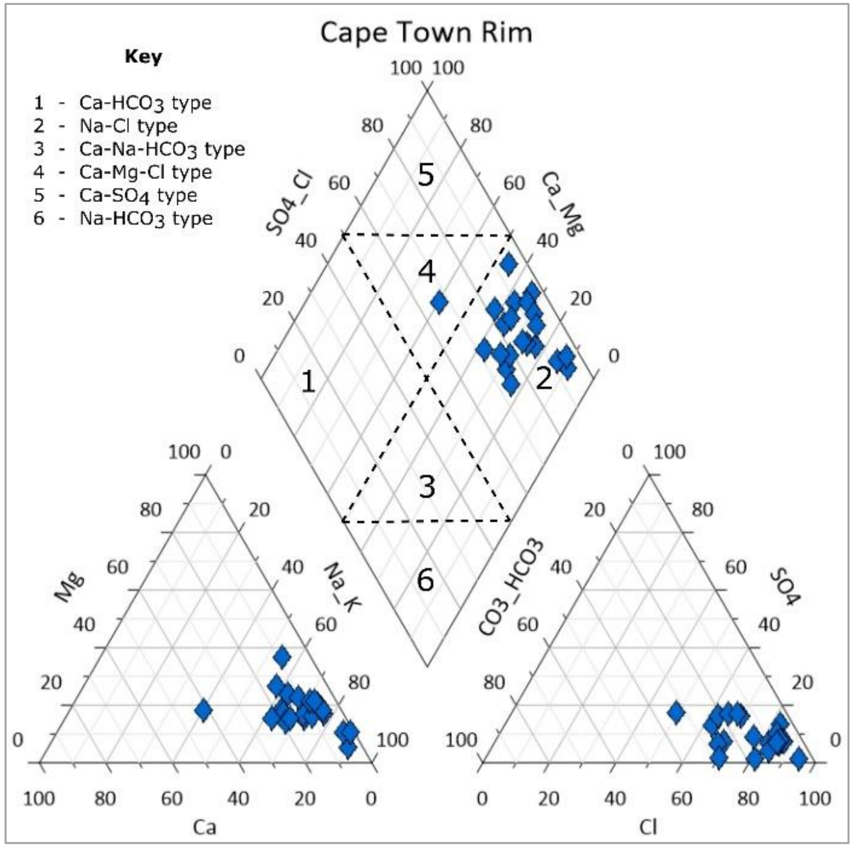
GRU	GRU Name: Cape Town Rim Main Towns: Cape Town, Cape Flats and Brackenfell Total Area (km^2): 826.03		

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured and Intergranular Basement	Agriculture: Irrigation	6	0.07
	Industry (Non-urban)	2	0.02
	Industry (Urban)	9	0.26
	Schedule 1	3	0.004
	Urban (Excluding industrial and/or domestic)	1	0.01
	Water Supply service	9	0.36
Fractured Table Mountain Group (Peninsula)	Agriculture: Irrigation	12	0.49
	Agriculture: Watering Livestock	1	0.03
	Industry (Urban)	1	0.03
	Water Supply service	1	0.03
Primary / Intergranular Aquifers (at surface but abstracting from underlying basment)	Agriculture: Aquaculture	1	0.004
	Agriculture: Irrigation	22	1.82
	Agriculture: Watering Livestock	3	0.06
	Industry (Urban)	9	0.20
	Industry (Non-urban)	70	2.37
	Schedule 1	7	0.02
	Urban (Excluding industrial and/or domestic)	3	0.02
	Water Supply service	9	0.31
Total		**169**	**6.11**

Discharge

Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **3.03 M m^3/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m^3/a)
Primary / Intergranular Aquifers	1.98
Peninsula Aquifer	3.97E-03
Fractured and Intergranular Other (TMG)	0.01
Fractured and Intergranular Basement	1.04
Total	**3.03**

<table>
<tr><td rowspan="3">GRU</td><td>GRU Name: Cape Town Rim</td></tr>
<tr><td>Main Towns: Cape Town, Cape Flats and Brackenfell</td></tr>
<tr><td>Total Area (km²): 826.03</td></tr>
<tr><td>Water Quality</td><td>The main water type in the Cape Town Rim is Na-Cl. The Na-Cl waters are due to and saturation of Na and Cl ions as a result of increased groundwater residence time in the relatively low transmissivity clay rich shale and siltstone basement aquifer. Exceedance of baseline concentrations was observed for EC, pH, ammonia, nitrate + nitrite and orthophosphate, with 50% of samples exceeding baselines for sulphate and fluoride. None of the 19 samples exceed RQOs for this GRU. The adjusted water quality category is C, indicating that moderate levels of localised contamination exist. Contaminating activities include agriculture and industry. However, naturally elevated concentration of dissolved ions is also a source of exceedances of baseline concentrations.

</td></tr>
</table>

GRU	
GRU	**GRU Name: Cape Town Rim** **Main Towns: Cape Town, Cape Flats and Brackenfell** **Total Area (km^2): 826.03**

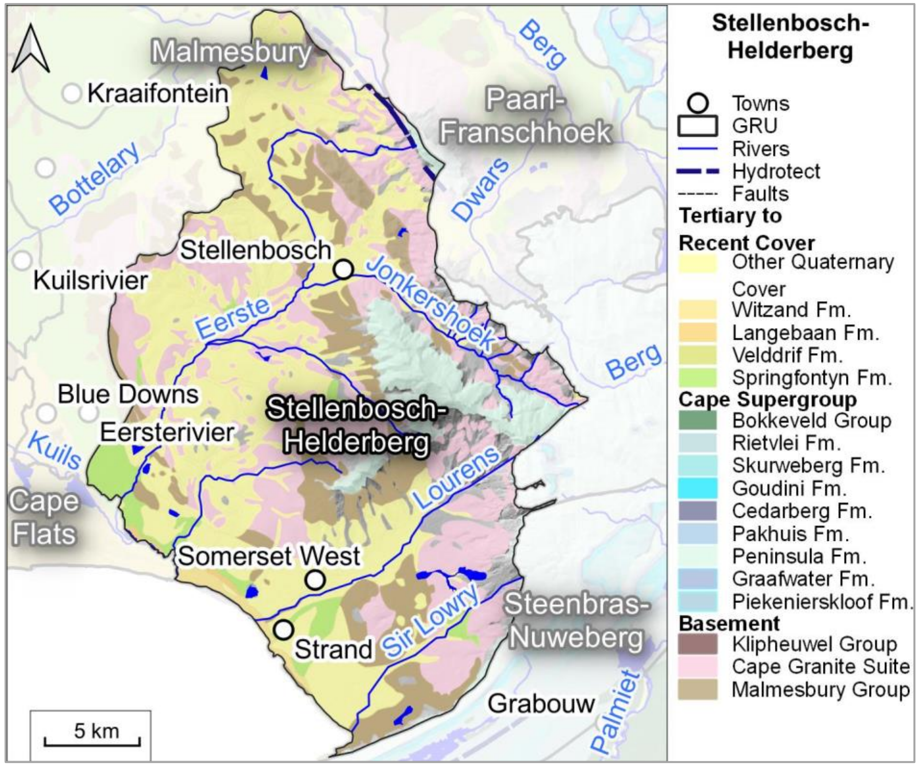
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Cape Town Rim	Sulphate (mg/l)	8.50	5.50	35-	60.92	34.1	Na-Cl, Ca-Mg-Cl	F	C	C
	Electrical conductivity (mS/m)	105.10	21.00	659.00	150.69	92		B		
	pH	7.78	7.00	8.62	7.51	7.47		A		
	Ammonia (mg/l)	0.02	0.02	0.75	0.06	0.02		A		
	Nitrate + nitrite (mg/l)	0.28	0.02	6.57	0.92	0.13		B		
	Fluoride (mg/l)	0.14	0.12	2.60	0.45	0.27		F		
	Orthophosphate (mg/l)	0.01	-	0.13	0.02	0.01		D		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of ‘C’, indicating a **moderately stressed** aquifer, and a Groundwater Quality Present Status Category of ‘C’ indicating m**oderate levels of localised contamination, but little or no negative impacts apparent**.

Recharge Volume ($M\ m^3/a$)	Groundwater Use ($M\ m^3/a$)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
18.6	6.11	0.33	C	C

5.3.2. Stellenbosch-Helderberg GRU

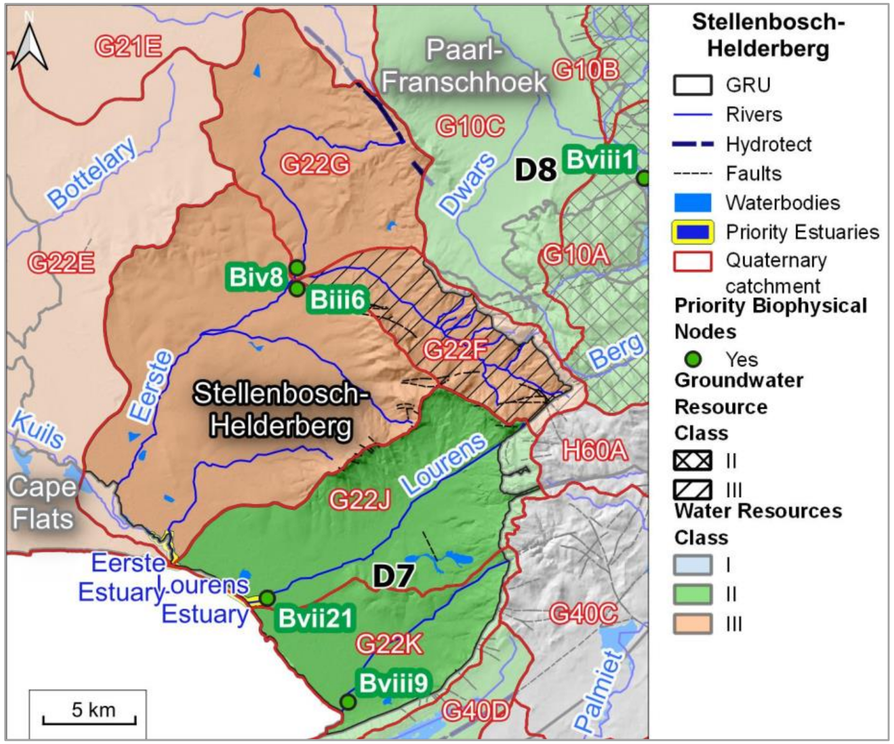
GRU	**GRU Name: Stellenbosch-Helderberg**
	Main Towns: Stellenbosch and Somerset West
	Total Area (km^2): 571.29
GRU Boundary Description	Portions of the G22E and G21E surface water quaternary catchments divide as well as the (CoCT 2018) aquifer model boundary (i.e., the Cape Flats GRU) form the northern and western extent of the Stellenbosch-Helderberg GRU. The G10C surface water quaternary catchment divide, as well as the contact between an interpolated extent of the basement lithology (the Cape Granite Suite and the Malmesbury Group). The TMG forms the eastern/south-eastern boundary of the GRU. The south-western edge of the GRU is bound by the False Bay coastline where preferential groundwater flow direction towards the southwest was also considered when defining the GRU boundary.
Resource Unit	**Fractured and Intergranular Basement Aquifer**
Quaternary Catchments	G22G, G22H, G22F, G22J and G22K
Description	This area is underlain predominantly by Malmesbury Group and Cape Granite Suite, the latter forming higher rocky hills, in contrast to the generally weathered lower rolling hills. The Peninsula Formation outcrops to the east and forms the Stellenbosch and Jonkershoek mountains. The Peninsula Aquifer is unconfined in this GRU, however it can form a significant aquifer. 

GRU	GRU Name: Stellenbosch-Helderberg
	Main Towns: Stellenbosch and Somerset West
	Total Area (km^2): 571.29
Surface Water System	This GRU comprises of the numerous rivers, namely: Eerste, Lourens, Jonkershoek and Sir Lowrys Pass rivers. The Blouklip, Jonkershoek and Klippies tributaries merge to form the Eerste River. All rivers follow topography, flowing from the higher lying mountainous areas to the north to the coastal in the south.

Water Resource Classes & RQOs

The GRU falls within the Eerste (D6) and Sir Lowry's (D7) IUAs and has Water Resource Class III and II respectively. The portion of the GRU that fall within IUA D6 (catchment G22F) has a Groundwater Resource Class of III, and no Groundwater Resource Class for the rest of the RU.

There is 1 priority EWR site - the Eerste (Jonkershoek), and 3 priority biophysical river nodes. The Eerste and Lourens estuaries are also present in this GRU, both with a TEC of D.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
D6 Eerste	III	G22F	D6-R16	Eerste (Jonkershoek)	Biii6	C	93
		G22G	D6-R17	Klippies	Biv8	D	77
		G22H	D6-E06	Eerste Estuary	Bxi3	D	90
D7 Sir Lower's	II	G22J	D7-R18	Lourens	Bvii21	D	114
		G22K	D7-R19	Sir Lowry's Pass*	Bviii9	C	84
		G22J	D7-E07	Lourens Estuary	Bxi4	D	85

GRU	
	GRU Name: Stellenbosch-Helderberg
	Main Towns: Stellenbosch and Somerset West
	Total Area (km²): 571.29

Recharge

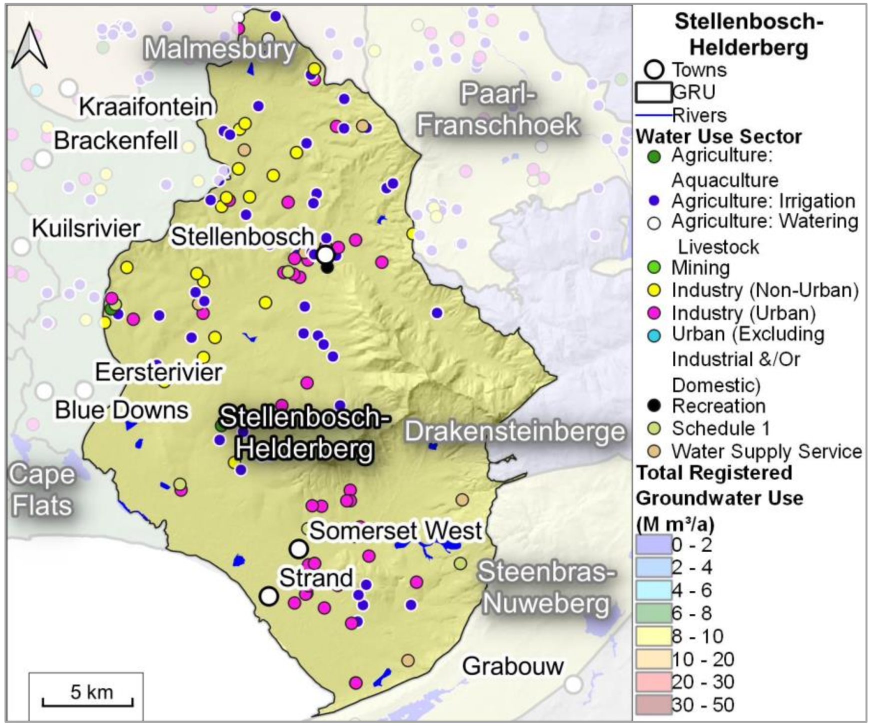
An estimated recharge of **41.52 M m³/a** was determined from First-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **72.77 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km²)	Recharge Volume (M m³/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	570.58	41.52	72.77

Groundwater Use

There are 163 registered groundwater users in this GRU with a combined groundwater use of **8.79 M m³/a**. Major groundwater use sectors include Water Supply Services and Agriculture (irrigation) which comprise of 64.3% and 21.9% respectively of total groundwater use volume per annum (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m3/a)
Fractured and Intergranular Basement	Agriculture: Aquaculture	3	0.001
	Agriculture: Irrigation	35	0.87
	Industry (Non-urban)	8	0.05
	Industry (Urban)	11	0.27
	Schedule 1	3	0.003
	Water Supply service	2	3.50
Primary / Intergranular Aquifers	Agriculture: Irrigation	38	1.06
	Agriculture: Watering Livestock	1	0.01
	Industry (Non-urban)	11	0.11
	Industry (Urban)	41	0.71
	Recreation	1	0.02
	Schedule 1	4	0.03
	Water Supply service	5	2.16
Total		**163**	**8.79**



GRU	
GRU	**GRU Name: Stellenbosch-Helderberg**
	Main Towns: Stellenbosch and Somerset West
	Total Area (km²): 571.29

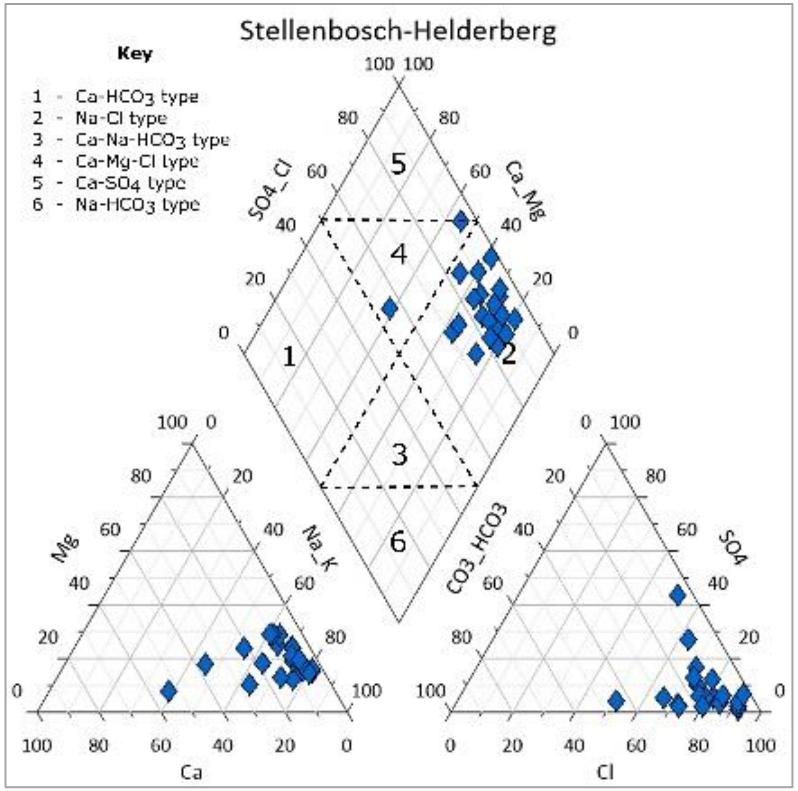
Discharge

Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **7.60 M m³/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m³/a)
Primary / Intergranular Aquifers	3.88
Peninsula Aquifer	1.03
Fractured and Intergranular Other (TMG)	0.02
Fractured and Intergranular Basement	2.67
Total	**7.60**

Water Quality

The main water type in Stellenbosch-Helderberg is Na-Cl type. The Na-Cl waters are due to the deposition of marine aerosols, recharge by coastal rainfall as well as dissolution and saturation of Na and Cl ions due to increased groundwater residence time in the relatively low transmissivity granitic and clay rich shale and siltstone basement aquifer.
No RQO have been established for the drainage regions in which this GRU falls. In boreholes targeting the Tygerberg Formation, at least 50% of samples exceeded the baseline concentrations for sulphate, EC, ammonia, nitrate + nitrite and orthophosphate. For this lithology, the adjusted water quality category is C, indicating that there is some localised contamination, which may impact the purpose for which groundwater is used. Anthropogenic impacts are likely from agriculture and industry, but exceedances are also due to naturally elevated salinity, which are water quality concerns.
In boreholes targeting the Cape Granite Suite, at least 50% of samples exceeded the baseline concentrations for pH, ammonia, nitrate + nitrite and orthophosphate. For this lithology, the final water quality category is C, indicating that there is some localised contamination, which may impact the purpose for which groundwater is used.



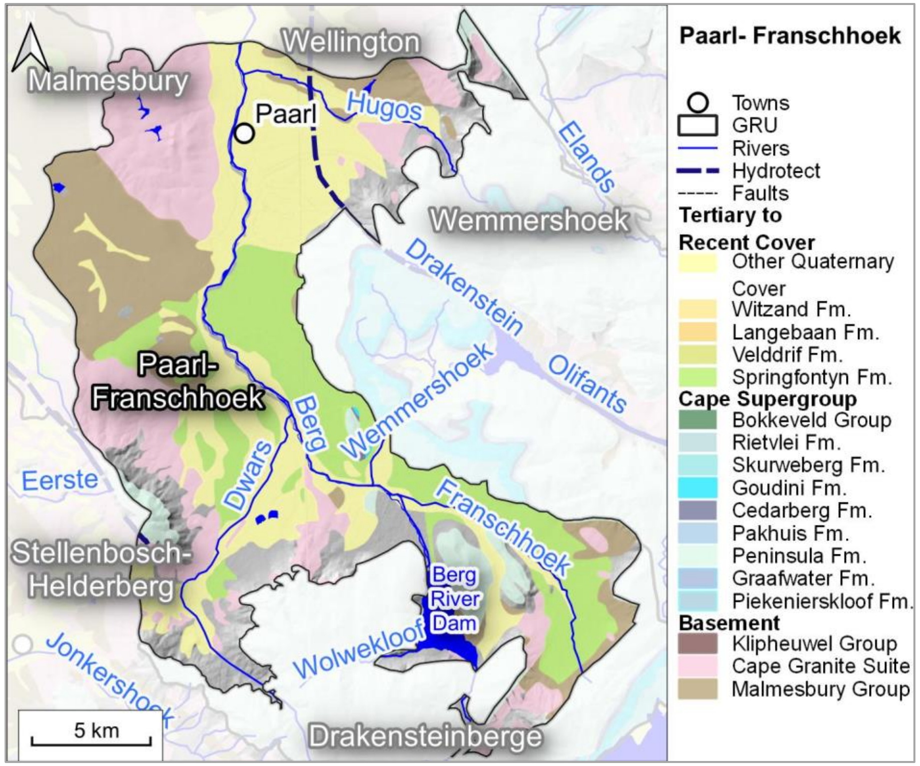
GRU	
GRU	GRU Name: Stellenbosch-Helderberg
	Main Towns: Stellenbosch and Somerset West
	Total Area (km^2): 571.29

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Stellenbosch-Helderberg (Tygerberg)	Sulphate (mg/l)	10.20	7.70	338.40	111.00	73.05	Na-Cl, Ca-Mg-Cl	E	D	C
	Electrical conductivity (mS/m)	197.00	32.70	885.00	289.10	203.00		D		
	pH	7.08	6.72	7.18	6.96	6.98		B		
	Ammonia (mg/l)	0.04	0.02	0.09	0.05	0.05		D		
	Nitrate + nitrite (mg/l)	0.02	0.02	5.61	1.25	0.21		E		
	Fluoride (mg/l)	2.35	0.05	2.61	1.10	0.67		B		
	Orthophosphate (mg/l)	0.01						D		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Stellenbosch-Helderberg (Cape Granite Suite)	Sulphate (mg/l)	14.80	2.00	289.80	35.00	5.9	Na-Cl	B	D	C
	Electrical conductivity (mS/m)	68.40	17.60	197.00	62.10	48.9		B		
	pH	7.00	6.41	7.48	6.90	7		C		
	Ammonia (mg/l)	0.04	0.04	0.11	0.10	0.05		E		
	Nitrate + nitrite (mg/l)	0.24	0.02	8.34	1.80	0.94		E		
	Fluoride (mg/l)	1.25	0.16	2.46	0.80	0.41		B		
	Orthophosphate (mg/l)	0.01						F		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

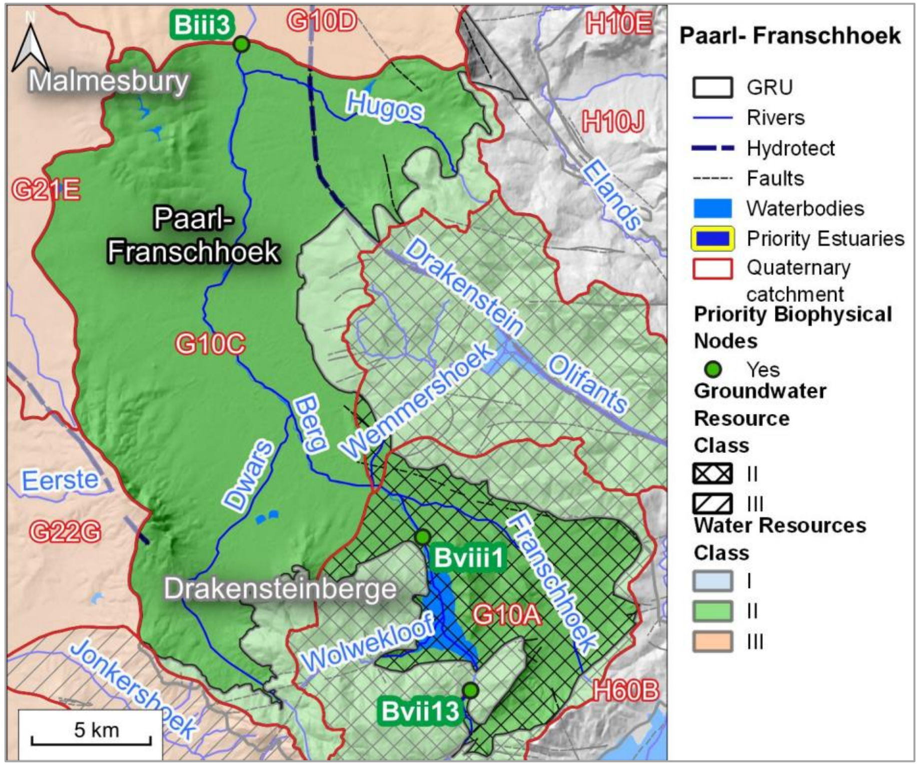
<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Stellenbosch-Helderberg</th></tr>
<tr><th>Main Towns: Stellenbosch and Somerset West</th></tr>
<tr><th>Total Area (km^2): 571.29</th></tr>
<tr><td>Aquifer Stress</td><td>The GRU is considered to have a Groundwater Availability Present Status Category of ‘C’, indicating a moderately stressed aquifer, and a Groundwater Quality Present Status Category of ‘C’ indicating moderate levels of localised contamination, but little or no negative impacts apparent.

<table><tr><th>Recharge Volume (M m^3/a)</th><th>Groundwater Use (M m^3/a)</th><th>Stress Index</th><th>Groundwater Availability Present Status Category</th><th>Groundwater Quality Present Status Category</th></tr><tr><td>41.52</td><td>8.81</td><td>0.21</td><td>C</td><td>C</td></tr></table></td></tr>
</table>

5.3.3. Paarl-Franschhoek GRU

<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Paarl-Franschhoek</th></tr>
<tr><th>Main Towns: Paarl, Franschhoek</th></tr>
<tr><th>Total Area (km2): 370.47</th></tr>
<tr><td>GRU Boundary Description</td><td>The Paarl-Franschhoek GRU is bound by the extent of the basement lithologies (the Cape Granite Suite and the Malmesbury Group) and its contact with the TMG on its eastern and southern edge. Portions of the G10D, G21E and G21D surface water quaternary catchment divides bound the GRU on its northern and western edge.</td></tr>
<tr><td>Resource Unit</td><td>Fractured and Intergranular Basement Aquifer</td></tr>
<tr><td>Quaternary Catchments</td><td>G10C, G10A and G10B</td></tr>
<tr><td>Description</td><td>The GRU comprises sequences of basement rocks, of the Malmesbury Group and the Cape Granite Suite, dominating the outcrop in the undulating northern and western areas. The Peninsula Formation of the TMG outcrops in the mountainous south-east and on the eastern boundary, with Quaternary cover such as the Springfontyn Formation and other younger Quaternary sediments infilling valleys, more extensively along the Berg River.

</td></tr>
</table>

GRU	GRU Name: Paarl-Franschhoek
	Main Towns: Paarl, Franschhoek
	Total Area (km2): 370.47
Surface Water System	The main surface water system is the Berg River (including the Dwars and Franschhoek tributaries) that flows north from the Berg River Dam to St Helena Bay.
Water Resource Classes & RQOs	The GRU falls entirely within the Upper Berg (D8) and has Water Resource Class II. The portion of the GRU that falls within catchments G10A and G10B have a Groundwater Resource Class of II. There are no priority EWR sites within this IUA, although there are 2 priority biophysical river nodes with TEC of C and D (see TEC in table below).



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
D8 Upper Berg	II	G10A	D8-R02	Berg	Bviii1	C	27
		G10C	D8-R03	Berg	Biii3	D	53

GRU	
GRU	**GRU Name: Paarl-Franschhoek**
	Main Towns: Paarl, Franschhoek
	Total Area (km2): 370.47

Recharge

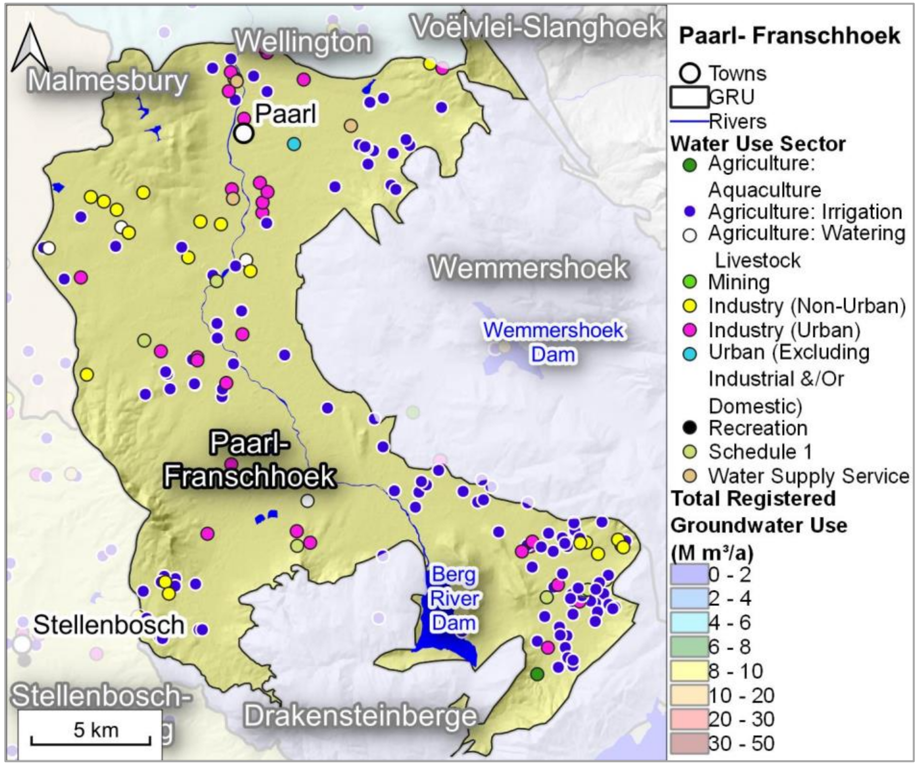
An estimated recharge of **26.61 M m³/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **72.21 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km^2)	Recharge Volume ($M\ m^3/a$)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	368.50	26.61	72.21

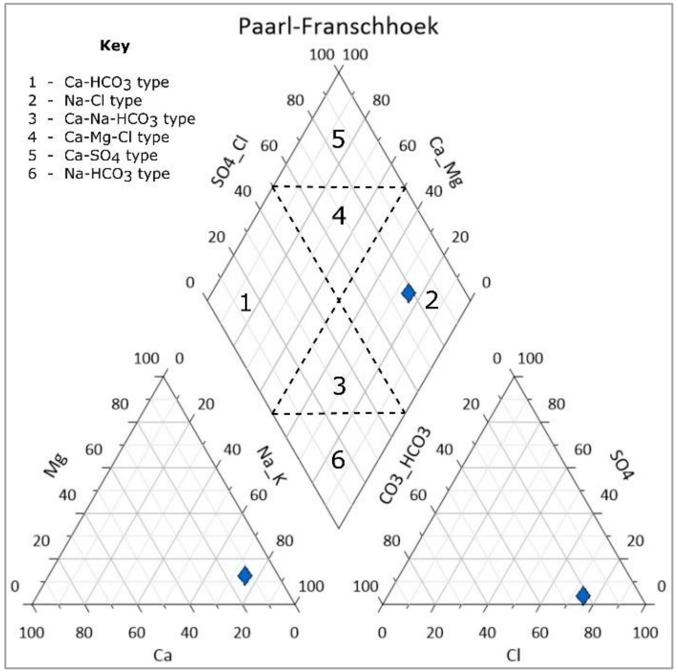
Groundwater Use

There are 268 registered groundwater users in this GRU with a combined groundwater use of **9.84 M m³/a**. Major groundwater use sectors include: Agriculture (irrigation), Industry (urban) and Water Supply Services which comprise 61.%1 ,15.1% and 14.7% respectively of total groundwater use volume per annum (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume ($M\ m^3/a$)
Fractured and Intergranular Basement	Agriculture: Aquaculture	1	0.22
	Agriculture: Irrigation	33	0.90
	Agriculture: Watering livestock	3	0.10
	Industry (Non-urban)	16	0.32
	Industry (Urban)	7	0.17
	Schedule 1	1	0.01
	Water Supply service	1	0.004
Primary / Intergranular Aquifers Fractured Table Mountain Group (Peninsula)	Agriculture: Irrigation	1	0.07
	Agriculture: Irrigation	140	5.04
	Agriculture: Watering Livestock	7	0.08
	Industry (Non-urban)	5	0.11
	Industry (Urban)	34	1.31
	Schedule 1	9	0.06
	Urban (Excluding industrial and/or domestic)	1	0.01
	Water Supply service	9	1.44
Total		**268**	**9.84**



<table>
<tr><td rowspan="3">GRU</td><td>GRU Name: Paarl-Franschhoek</td></tr>
<tr><td>Main Towns: Paarl, Franschhoek</td></tr>
<tr><td>Total Area (km2): 370.47</td></tr>
<tr><td>Discharge</td><td>Groundwater’s contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is <u>4.73 M m³/a</u> (see Section 4.4.1 for details).
<table>
<tr><th>RU</th><th>Sum of Baseflow per component (M m³/a)</th></tr>
<tr><td>Primary / Intergranular Aquifers</td><td>3.47</td></tr>
<tr><td>Nardouw Aquifer</td><td>0.00</td></tr>
<tr><td>Peninsula Aquifer</td><td>0.31</td></tr>
<tr><td>Fractured and Intergranular Other (TMG)</td><td>0.01</td></tr>
<tr><td>Fractured and Intergranular Basement</td><td>0.94</td></tr>
<tr><td>Total</td><td>4.73</td></tr>
</table>
</td></tr>
<tr><td>Water Quality</td><td>The main water type in Paarl-Franschhoek is Na-Cl. The Na-Cl waters are due to and saturation of Na and Cl ions as a result of increased groundwater residence time in the relatively low transmissivity of the granite and clay rich shale and siltstone basement aquifer. Only 1 sample exists for this GRU, thus although it can be used to establish a baseline, no other data exists for comparison and no water quality category has been established. However, although agriculture is prevalent within the GRU, the low parameter concentrations indicate that pristine water quality conditions prevail. More monitoring data is required to establish a more conclusive present status.



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GRU	GRU Name: Paarl-Franschhoek
	Main Towns: Paarl, Franschhoek
	Total Area (km2): 370.47

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Paarl-Franschhoek	Sulphate (mg/l)	2.00	2.00	2.00	-	-	Na-Cl	-	n/a	n/a
	Electrical conductivity (mS/m)	14.40	14.40	14.40	-	-		-		
	pH	7.04	7.04	7.04	-	-		-		
	Ammonia (mg/l)	0.06	0.06	0.06	-	-		-		
	Nitrate + nitrite (mg/l)	0.76	0.76	0.76	-	-		-		
	Fluoride (mg/l)	0.25	0.25	0.25	-	-		-		
	Orthophosphate (mg/l)	0.10	0.10	0.10	-	-		-		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

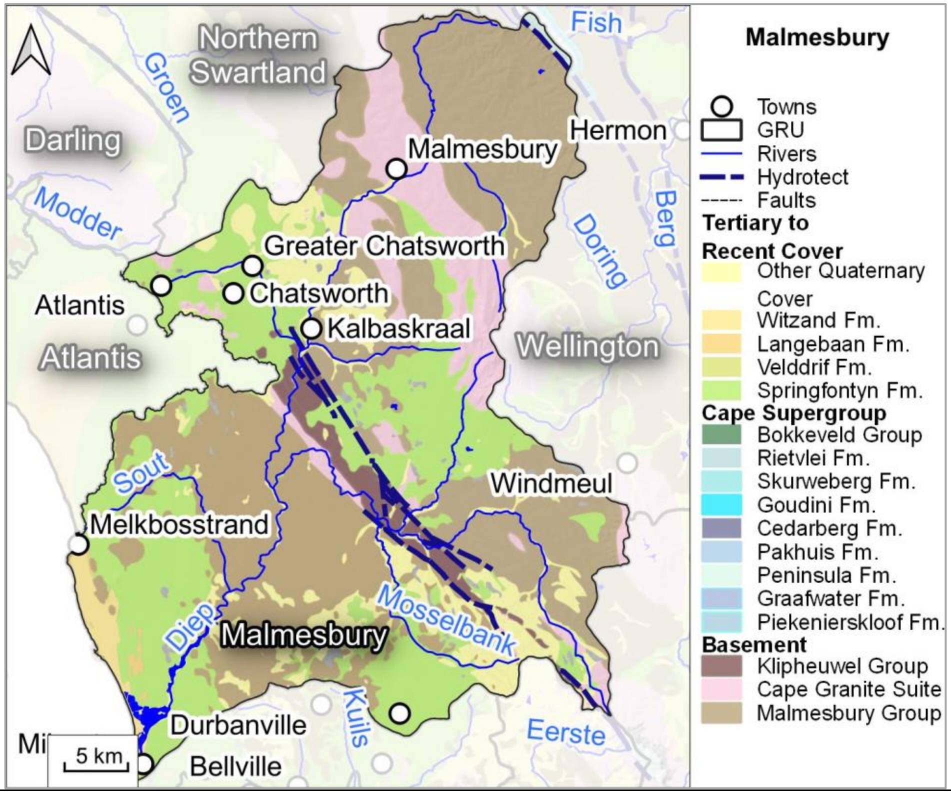
Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of ‘C’, indicating a **moderately stressed** aquifer, and the Groundwater Quality Present Status cannot be determined due to limited data availability.

Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
26.61	9.84	0.37	C	N/A

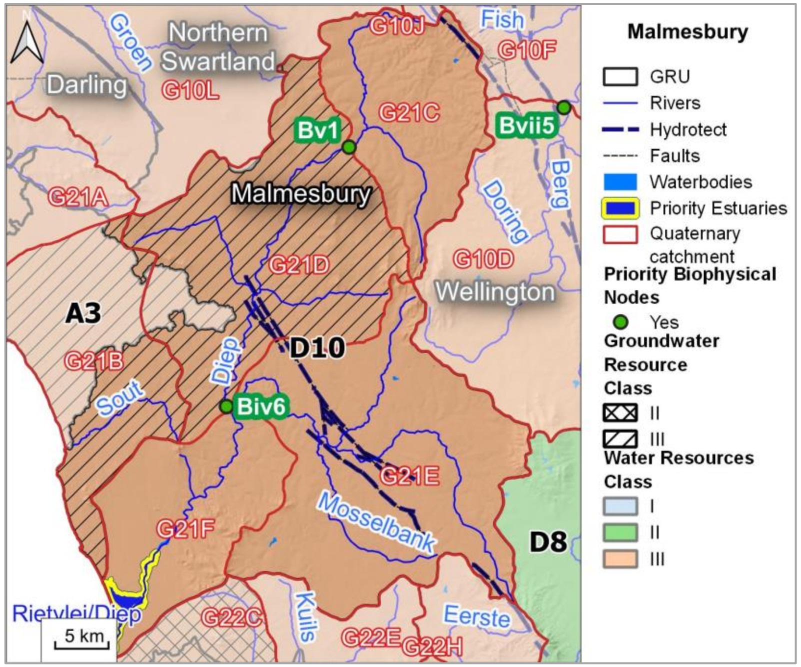
5.3.4. Malmesbury GRU

<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Malmesbury</th></tr>
<tr><th>Main Towns: Malmesbury and Melkbosstrand</th></tr>
<tr><th>Total Area (km2): 1603.5</th></tr>
<tr><td>GRU Boundary Description</td><td>The Malmesbury GRU is bound by a combination of an interpolated basement geology extent (i.e., the Klipheuwel Group, the Cape Granite Suite and the Malmesbury Group) and the G22G, G10D, G22C, G22E, G10C, G10J, G10L, G10F and G21A surface water quaternary catchment divides on its northern, eastern and southern fringe. Portion of the CoCT (2020) aquifer model boundary i.e., the Atlantis GRU and the Table Bay coastline were used as the western extent of the GRU.</td></tr>
<tr><th>Resource Unit</th><th>Fractured and Intergranular Basement Aquifer</th></tr>
<tr><td>Quaternary Catchments</td><td>G201E, G21C, G21D, G21F and G21B</td></tr>
<tr><td>Description</td><td>The GRU is underlain predominantly by Malmesbury Group intruded by Cape Granite Suite plutons, the latter forming higher rocky hills, in contrast to the generally weathered lower rolling hills. Groundwater flow is mainly restricted to weathered zones or granite scree slopes on the pluton flanks and little regional flow can be expected.



</td></tr>
</table>

GRU	GRU Name: Malmesbury Main Towns: Malmesbury and Melkbosstrand Total Area (km2): 1603.5
Surface Water System	Major surface water systems include the Diep, Sout, Mosselbank rivers.
Water Resource Classes & RQOs	The GRU falls within the West Coast (A3) and Diep (D10) IUAs both of which has a Water Resource Class III. The portion of the GRU that fall within IUA D10 (catchment G21D) and the portion of A3 (catchment G21B) both have a Groundwater Resource Class of II, and no Groundwater Resource Class for the rest of the GRU. There are no EWR sites within this IUA, although there are 3 priority biophysical nodes; 1 estuary node (Rietvlei/Diep) with a TEC of C and 2 river nodes (see TEC in table below).



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
D10 Diep	III	G21D	D10-R11	Diep	Bv1	D	66
		G21D	D10-R12	Diep	Biv6	D	68
		G21F	D10-E03	Rietvlei/ Diep	Bxi7	C	78

GRU	GRU Name: Malmesbury
	Main Towns: Malmesbury and Melkbosstrand
	Total Area (km2): 1603.5

Recharge

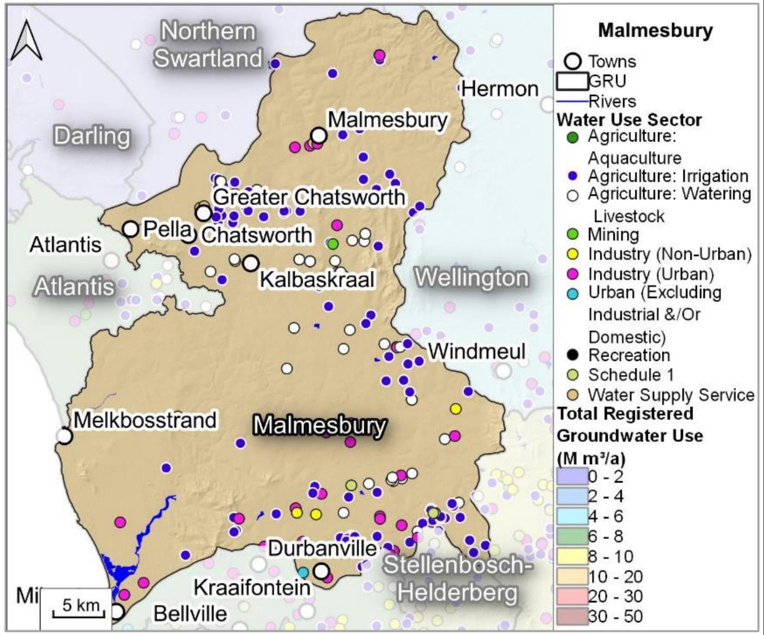
An estimated recharge of **52.65 M m³/a** was determined from First-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **32.90 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km²)	Recharge Volume (M m³/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	1600.36	52.65	32.90

Groundwater Use

There are 245 registered groundwater users in this GRU with a combined groundwater use of **14.8 M m³/a**. Major groundwater use sectors include: Agriculture (irrigation), Agriculture (watering livestock) and Industry (urban) which comprise 67.5% ,17.0% and 12.4% respectively of total groundwater use volume per annum (see **Section 4.3.3** for details)

RU	Water Use Sector	No. of Users	Total Volume (M m³/a)
Fractured and Intergranular Basement	Agriculture: Irrigation	78	5.44
	Agriculture: Watering livestock	18	0.67
	Industry (Non-urban)	2	0.002
	Industry (Urban)	19	1.44
	Mining	1	0.003
	Schedule 1	4	0.01
Primary / Intergranular Aquifers	Water Supply service	1	0.01
	Agriculture: Aquaculture	63	4.51
	Agriculture: Irrigation	28	1.84
	Agriculture: Watering livestock	2	0.13
	Industry (Non-urban)	20	0.39
	Industry (Urban)	1	0.02
	Urban (Excluding industrial and/or domestic)	6	0.27
	Water Supply service	1	0.01
Total		245	14.75



GRU	GRU Name: Malmesbury
	Main Towns: Malmesbury and Melkbosstrand
	Total Area (km2): 1603.5

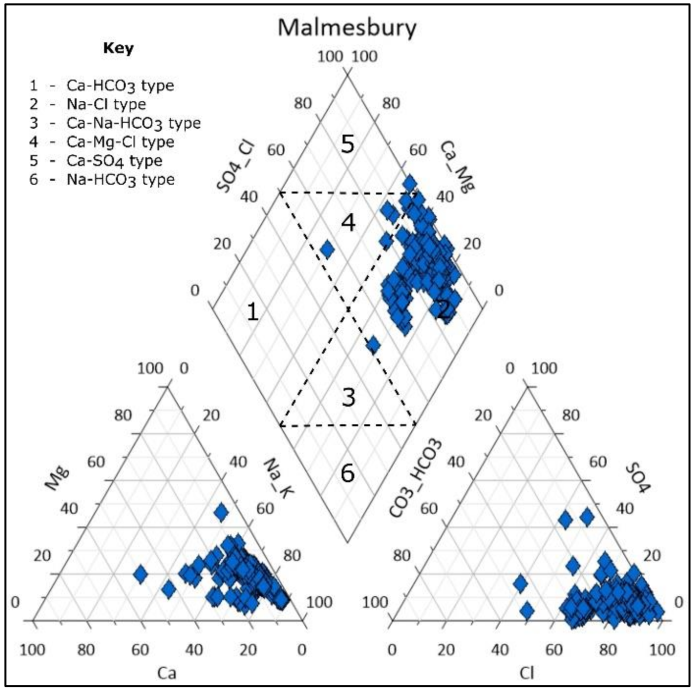
Discharge

Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **11.83 M m^3/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m^3/a)
Primary / Intergranular Aquifers	4.49
Peninsula Aquifer	0.03
Fractured and Intergranular Other (TMG)	4.59E-03
Fractured and Intergranular Basement	7.30
Total	**11.83**

Water Quality

The main water type in Malmesbury is Na-Cl. The Na-Cl waters are due to and saturation of Na and Cl ions as a result of increased groundwater residence time in the relatively low transmissivity clay rich shale and siltstone basement aquifer. Exceedances of baseline concentrations were observed for all parameters except dissolved mercury, with 50% of samples exceeding the baseline for pH. Of the 149 samples collected, 5 samples exceeded the RQO for EC, 1 for pH and 34 for nitrate + nitrite. Exceedances are the result of contamination from agriculture and industry, but also naturally elevated concentrations of dissolved ions. The adjusted water quality category is B, indicating that low levels of contamination exist, but largely natural conditions prevail.



GRU	GRU Name: Malmesbury
	Main Towns: Malmesbury and Melkbosstrand
	Total Area (km2): 1603.5

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Malmesbury	Sulphate (mg/l)	172.57	1.50	360.70	63.47	33.3	Na-Cl, Ca-Mg-Cl, Ca-SO_4	A	A	B
	Electrical conductivity (mS/m)	1549.90	29.66	211.0	220.90	107.9		A		
	pH	7.15	1.00	8.60	7.38	7.644		D		
	Ammonia (mg/l)	0.10	-	1.27	0.05	0.025		A		
	Nitrate + nitrite (mg/l)	503.08	0.02	589.68	20.16	0.562		A		
	Fluoride (mg/l)	0.26	0.03	2.94	0.50	0.375		C		
	Orthophosphate (mg/l)	0.10	-	14.00	0.12	0.022		A		
	Dissolved Aluminium (mg/l)	0.033	0.001	0.139	0.025	0.018		A		
	Dissolved Arsenic (mg/l)	0.025	0.002	0.103	0.034	0.025		A		
	Dissolved Chromium (mg/l)	0.007	0.000	0.026	0.004	0.003		A		
	Dissolved Iron (mg/l)	0.014	0.002	1.892	0.031	0.003		A		
	Dissolved Lead (mg/l)	0.008	0.000	0.063	0.024	0.008		A		
	Dissolved Manganese (mg/l)	0.677	0.001	1.190	0.073	0.001		A		
	Dissolved Mercury (mg/l)	0.00	0.008	0.075	0.021	0.019		A		

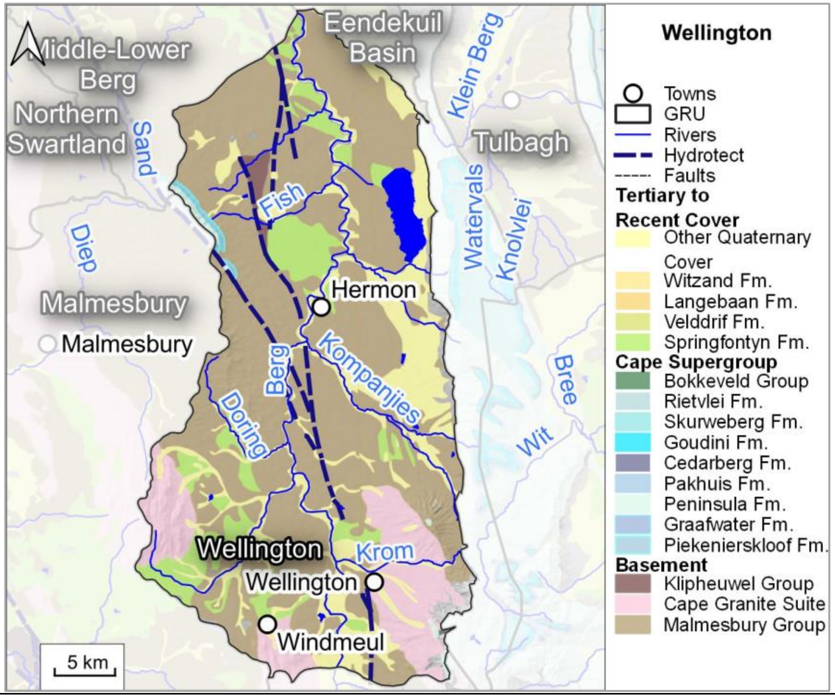
Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of ‘C’, indicating a **moderately stressed** aquifer, and a Groundwater Quality Present Status of ‘B’, indicating **localised, low levels of contamination, but no negative impacts apparent.**

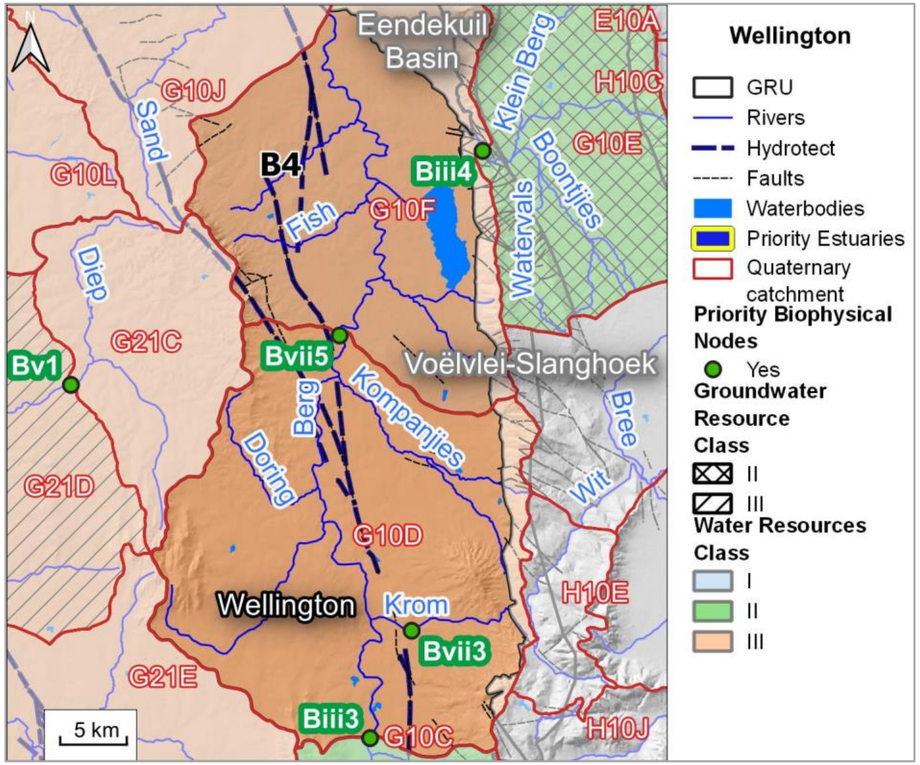
Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
52.65	14.75	0.28	C	B

5.3.5. Wellington GRU

GRU	GRU Name: Wellington Main Towns: Wellington Total Area (km^2): 1087.0
GRU Boundary Description	The Wellington GRU is bound by a combination of an interpolated basement geology extent (i.e., the Cape Granite Suite and Malmesbury Group), and the G21E, G21C, G10C and G10J surface water quaternary catchment divides on its western and southern edge, including portions of the Berg River. The contact between the TMG and the basement lithologies, as well as portions of the G10D surface water quaternary catchment divide on the eastern edge.
Resource Unit	**Fractured and Intergranular Basement Aquifer**
Quaternary Catchments	G10D and G10F
Description	The GRU is dominantly composed of the Malmesbury Group, intruded by Cape Granite Suite plutons, the latter forming higher rocky hills, in contrast to the generally weathered lower rolling hills. Groundwater flow is mainly restricted to weathered zones, deeper structures or granite scree slopes on the pluton flanks and little regional flow can be expected. Relatively thin and laterally discontinuous outcrops of the Sandveld Group scatter the GRU. Groundwater mostly discharges to streamflow along the various streams and perennial rivers. The dominant land use in the area is agriculture.



GRU	GRU Name: Wellington
	Main Towns: Wellington
	Total Area (km^2): 1087.0
Surface Water System	The main surface water system is the Berg River (including many tributaries such as the Fish, Kompanjies, Limiet, Doring and Krom). This GRU also hosts the second largest reservoir of the Western Cape Water Supply System – the Voëlvlei Dam. Other smaller dams are also situated in this GRU including Kersfontien Dam.
Water Resource Classes & RQOs	The GRU falls within the Lower Berg (B1) and Middle Berg (D9) IUAs and both have Water Resource Class III. The GRU has no Groundwater Resource Class. There are no priority EWR sites within this IUA, although there are 2 priority biophysical nodes (see TECs in table below).



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
D9 Middle Berg	III	G10D	D9-R05	Kromme	Bvii3	D	89
		G10D	D9-R06	Berg	Bvii5	D	49

GRU	GRU Name: Wellington
	Main Towns: Wellington
	Total Area (km²): 1087.0

Recharge

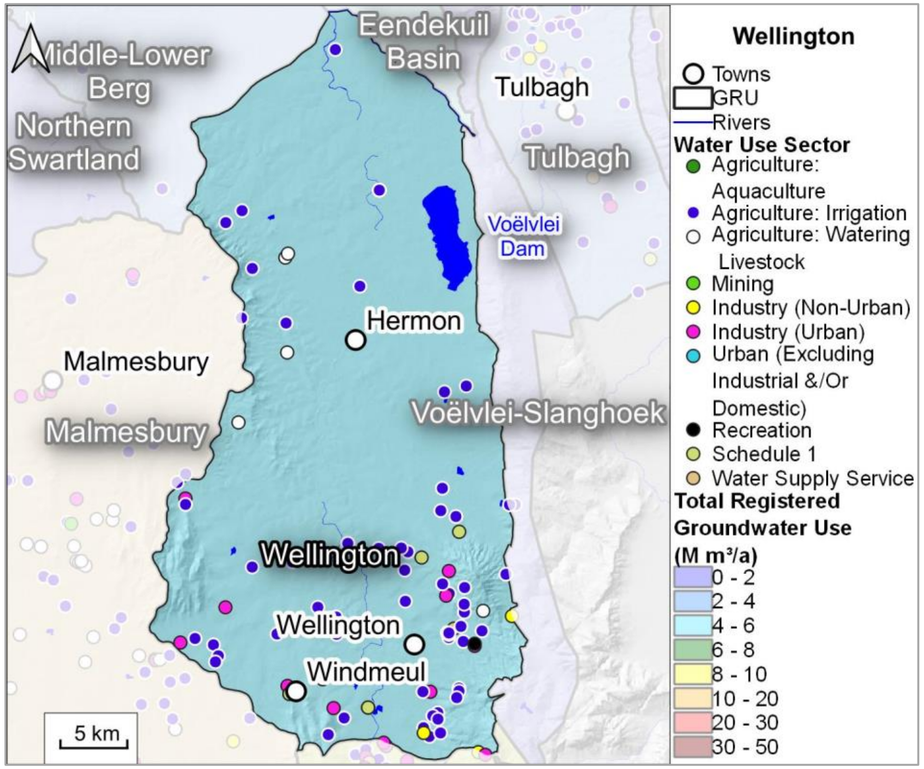
An estimated recharge of **39.49 M m³/a** was determined from First-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **36.95 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km²)	Recharge Volume (M m³/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	1068.81	39.49	36.95

Groundwater Use

There are 117 registered groundwater users in this GRU with a combined groundwater use of **4.48 M m³/a**. Major groundwater use sectors include Agriculture (irrigation) and Agriculture (livestock watering), which make up a combined 89.8%of the total groundwater use volume per annum (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m³/a)
Fractured and Intergranular Basement	Agriculture: Aquaculture	1	0.16
	Agriculture: Irrigation	70	3.08
	Agriculture: Watering livestock	5	0.26
	Industry (Non-urban)	2	0.00
	Industry (Urban)	11	0.12
	Recreation	1	0.00
	Schedule 1	6	0.01
	Water Supply service	3	0.04
Primary Intergranular Aquifers	Agriculture: Watering livestock	14	0.63
	Industry (Non-urban)	1	0.06
	Industry (Urban)	3	0.12
Total		**117**	**4.48**



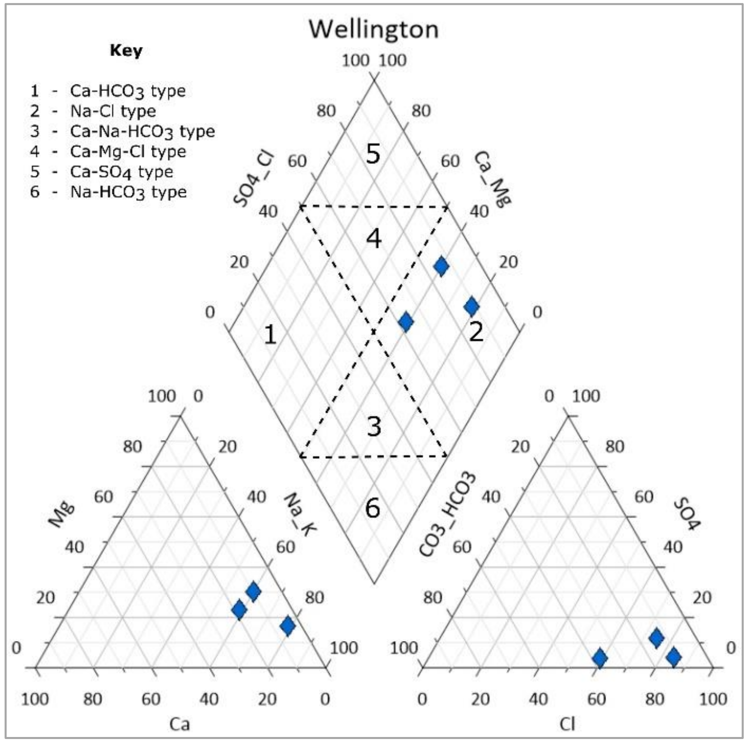
<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Wellington</th></tr>
<tr><th>Main Towns: Wellington</th></tr>
<tr><th>Total Area (km²): 1087.0</th></tr>
<tr><td>Discharge</td><td>

Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **7.95 M m³/a** (see **Section 4.4.1** for details).

<table>
<tr><th>RU</th><th>Sum of Baseflow per component (M m³/a)</th></tr>
<tr><td>Fractured Peninsula Aquifer</td><td>0.06</td></tr>
<tr><td>Primary/Intergranular</td><td>2.82</td></tr>
<tr><td>Fractured and Intergranular Basement</td><td>5.06</td></tr>
<tr><td>Total</td><td>7.95</td></tr>
</table>

</td></tr>
<tr><td>Water Quality</td><td>

The main water type in Wellington is Na-Cl. The Na-Cl waters are due to and saturation of Na and Cl ions as a result of increased groundwater residence time in the relatively low transmissivity clay rich shale and siltstone basement aquifer. Exceedances of baseline concentrations were observed for ammonia and orthophosphate. No RQOs have been established for this GRU. Nutrient exceedances are the result of contamination from agriculture. The adjusted water quality category is B, indicating that low levels of contamination exist, but largely natural conditions prevail.



</td></tr>
</table>

GRU	GRU Name: Wellington
	Main Towns: Wellington
	Total Area (km^2): 1087.0

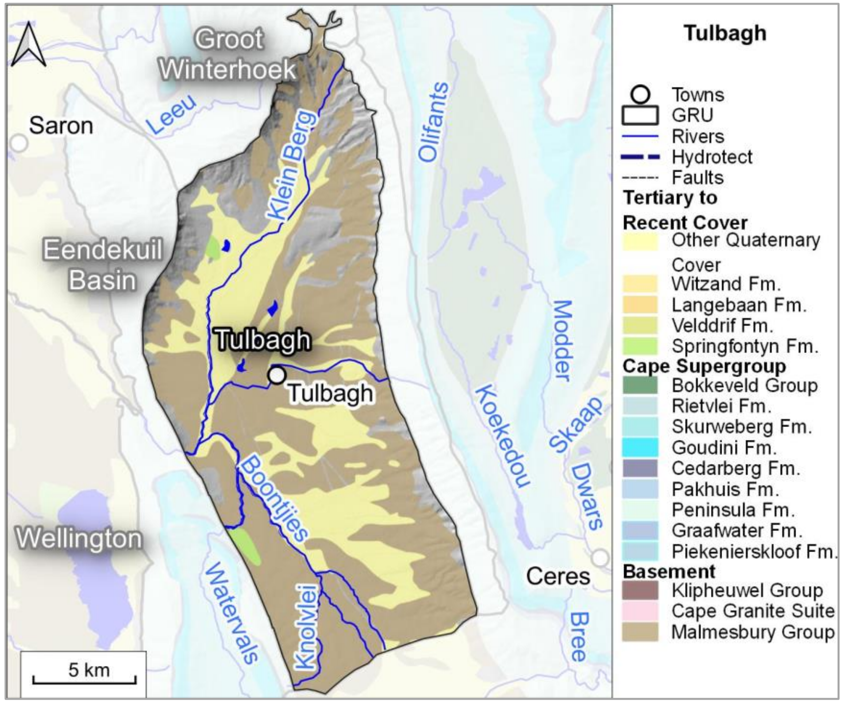
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Wellington	Sulphate (mg/l)	118.00	4.30	118.00	42.20	4.3	Na-Cl	-	B	B
	Electrical conductivity (mS/m)	202.00	25.60	202.00	85.77	29.7		-		
	pH	7.56	7.03	7.56	7.33	7.4		-		
	Ammonia (mg/l)	0.14	0.05	0.21	0.13	0.142		B		
	Nitrate + nitrite (mg/l)	1.39	1.26	1.39	1.31	1.278		-		
	Fluoride (mg/l)	1.09	0.22	1.09	0.52	0.26		-		
	Orthophosphate (mg/l)	0.01	0.01	0.14	0.05	0.011		B		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of 'B', indicating an **unstressed or slightly stressed** aquifer, and a Groundwater Quality Present Status of 'B', indicating l**ocalised, low levels of contamination, but no negative impacts apparent.**

Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
39.49	4.48	0.11	B	B

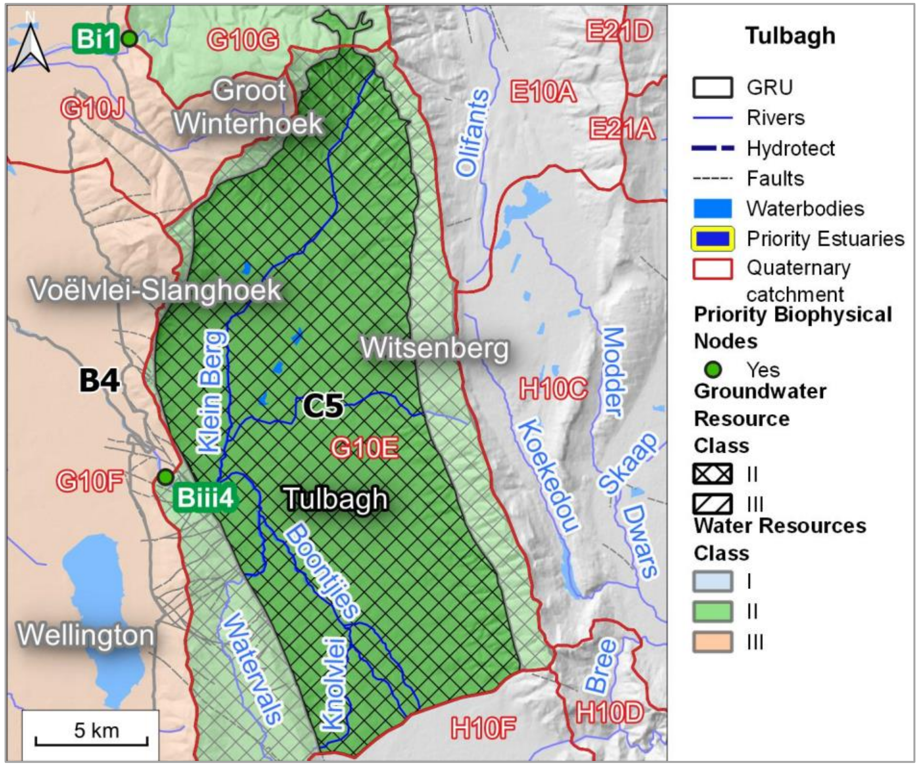
5.3.6. Tulbagh GRU

GRU	GRU Name: Tulbagh
	Main Towns: Tulbagh
	Total Area (km^2): 291.21
GRU Boundary Description	The Tulbagh GRU is bound by the extent of the basement lithology (i.e., the Malmesbury Group) and its contact with the TMG on its northern, eastern and western edge. The southern boundary is marked by the Berg catchment (i.e., the H10F surface water quaternary catchment divide).
Resource Unit	**Fractured and Intergranular Basement Aquifer**
Quaternary Catchments	G10E and G10G
Description	This area is predominantly underlain by Malmesbury Group with thin and discontinuous Cenozoic cover in only a few places, such as gravel terraces from the palaeo Breede River, in the Klein Berg catchment. In the east of the GRU, the Tulbagh Valley is bounded on east, west and north by slopes of the TMG (predominantly Peninsula Formation). The western boundary of the Tulbagh valley (Waterval Mountains Nature Reserve) comprises of a syncline of the TMG, exposing the Nardouw Sub-group in the centre. 
Surface Water System	The Klein-Berg River is the major surface water system in this GRU which combines with its tributaries, namely the Boontjies, Waterval, Brakkloof and Knolvlei rivers.

GRU	GRU Name: Tulbagh
	Main Towns: Tulbagh
	Total Area (km^2): 291.21

Water Resource Classes & RQOs

The GRU falls entirely within the Berg Tributaries (C5) IUA and has a Water Resource Class II. The portions of the GRU that fall within catchment G10E has Groundwater Resource Class of II, while the rest of the GRU has no Groundwater Resource Class. There are no EWR sites or priority biophysical nodes in this GRU.



Recharge

An estimated recharge of **10.87 M m^3/a** was determined from First-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **37.31 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

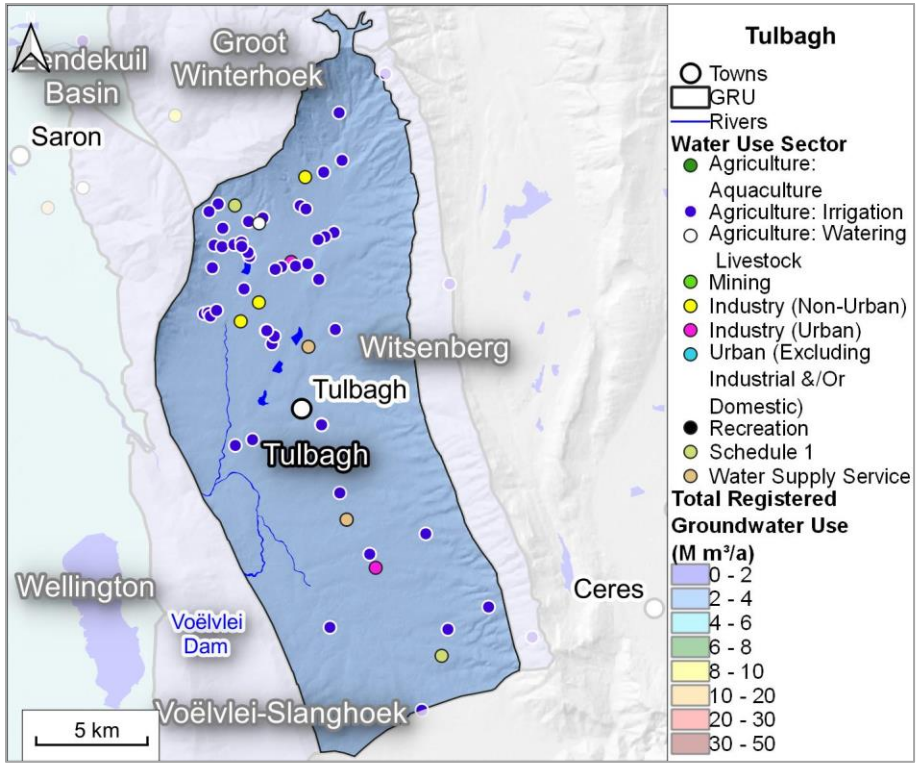
Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	291.38	10.87	37.31

GRU	GRU Name: Tulbagh
	Main Towns: Tulbagh
	Total Area (km²): 291.21

Groundwater Use

There are 81 registered groundwater users in this GRU with a combined groundwater use of **3.78 M m³/a**. Agriculture (irrigation) is the major groundwater use sector for this GRU, which makes up 97.6% of the total groundwater use volume per annum (see **Section 4.3.3** for detail).

RU	Water Use Sector	No. of Users	Total Volume (M m³/a)
Fractured and Intergranular Basement	Agriculture: Irrigation	30	2.00
	Industry (Non-urban)	1	0.0004
	Schedule 1	1	0.001
	Water Supply service	2	0.01
Primary / Intergranular Aquifers	Agriculture: Irrigation	38	1.69
	Agriculture: Watering Livestock	2	0.01
	Industry (Non-urban)	3	0.01
	Industry (Urban)	2	0.04
	Schedule 1	1	0.001
	Water Supply service	1	0.01
Total		**81**	**3.78**



Discharge

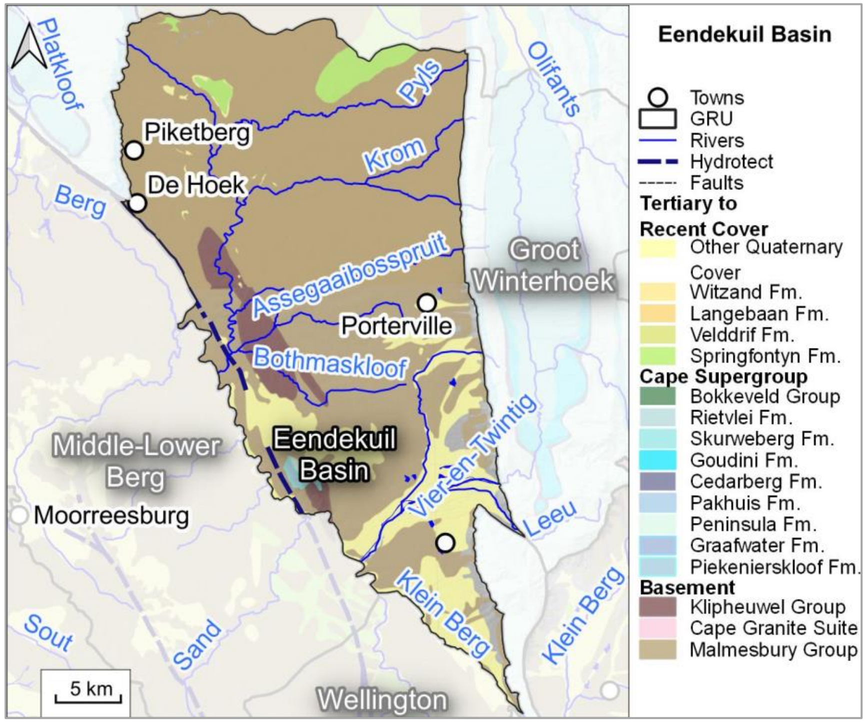
Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **3.64 M m³/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m³/a)
Primary / Intergranular Aquifers	2.82
Fractured Peninsula Aquifer	0.06
Fractured and Intergranular Other (TMG)	0.03
Fractured and Intergranular Basement	5.03
Total	**3.64**

<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Tulbagh</th></tr>
<tr><th>Main Towns: Tulbagh</th></tr>
<tr><th>Total Area (km^2): 291.21</th></tr>
<tr><td>Water Quality</td><td>No water quality data</td></tr>
<tr><td>Aquifer Stress</td><td>The GRU is considered to have a Groundwater Availability Present Status Category of ‘C’, indicating a moderately stressed aquifer, and the Groundwater Quality Present Status could not be determined due to limited data availability.

<table>
<tr><th>Recharge Volume (M m^3/a)</th><th>Groundwater Use (M m^3/a)</th><th>Stress Index</th><th>Groundwater Availability Present Status Category</th><th>Groundwater Quality Present Status Category</th></tr>
<tr><td>10.87</td><td>3.78</td><td>0.35</td><td>C</td><td>N/A</td></tr>
</table></td></tr>
</table>

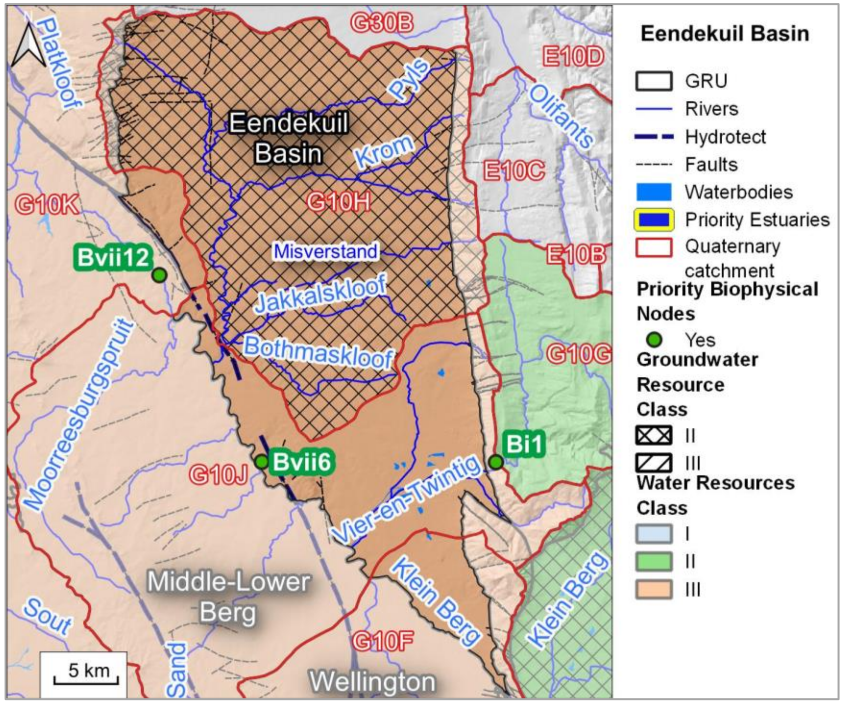
5.3.7. Eendekuil Basin GRU

GRU	**GRU Name: Eendekuil Basin** **Main Towns: Porterville and Piketberg** **Total Area (km²): 939.92**
GRU Boundary Description	The Eendekuil Basin GRU is bound by the extent of the basement lithologies (i.e., the Malmesbury Group) and its contact with the TMG outcrop on the eastern flank of the GRU and portions of the Aurora-Piketberg fault zone in the north. The Berg and Klein Berg rivers form the south/south-western boundaries. The preferential groundwater flow direction and inferred discharge directions towards both the north and south were considered to bound the GRU.
Resource Unit	**Fractured and Intergranular Basement Aquifer**
Quaternary Catchments	G10H, G10J, G10F and G10K
Description	This GRU is mainly composed of the Malmesbury Group with some outcrops of the Klipheuwel Group making up the basement lithology. Some Quaternary-recent sediment deposits from the weathering of the TMG mountains to the east of the GRU and transported by the Vier-en-Twintig River, overly the basement in places. 

GRU	GRU Name: Eendekuil Basin
	Main Towns: Porterville and Piketberg
	Total Area (km^2): 939.92
Surface Water System	The western edge of the GRU has been delineated along the Berg River, which is the main surface water system in the GRU. Other Surface water systems include the Misverstand Dam, which is fed by multiple rivers originating the mountains areas of the Groot Winterhoek, including the Krom, Pyls, Assegaaibosspruit, Jakkalskloof, Bothmankloof and Vier-en_Twintig rivers.

Water Resource Classes & RQOs

The GRU falls entirely within the Lower Berg (B4) and has a Water Resource Class III and Groundwater Resource Class of III for the portions of the GRU that fall within catchment G10H. The rest of the GRU has no groundwater Resource Class. There are no EWR sites within this IUA nor any priority biophysical nodes.



Recharge

An estimated recharge of **21.88 M m^3/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **23.35 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

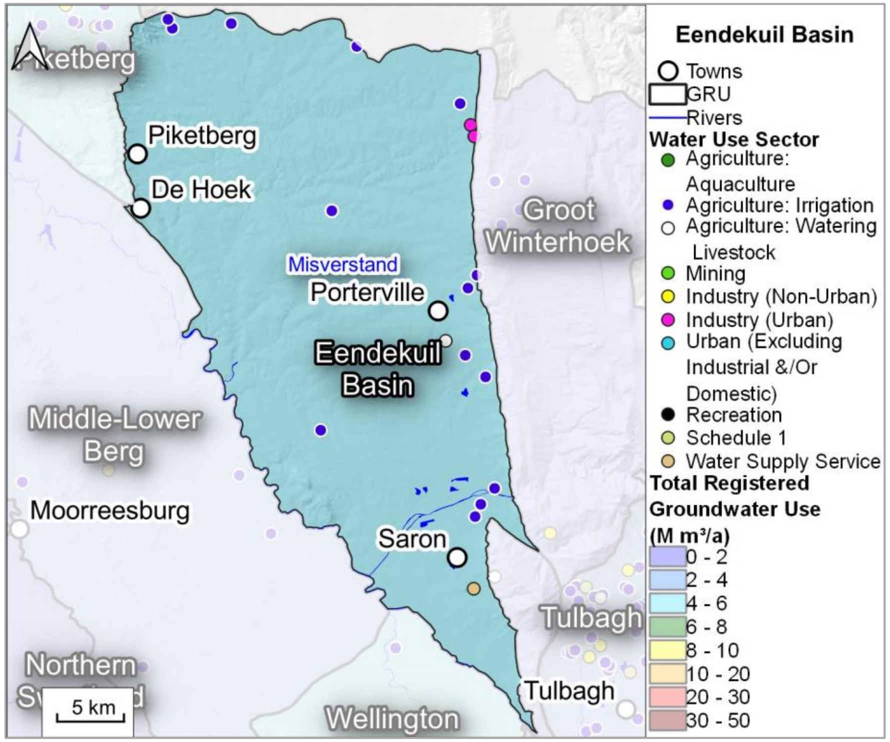
Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	936.94	21.88	23.35

GRU	GRU Name: Eendekuil Basin
	Main Towns: Porterville and Piketberg
	Total Area (km²): 939.92

Groundwater Use

There are 33 registered groundwater users in this GRU with a combined groundwater use of **4.85 M m³/a**. Major groundwater use sectors include Water Supply Services and Agriculture (irrigation), which comprise 61.9% and 36.7% respectively of the total groundwater use volume per annum (see **Section 4.3.3** for details).

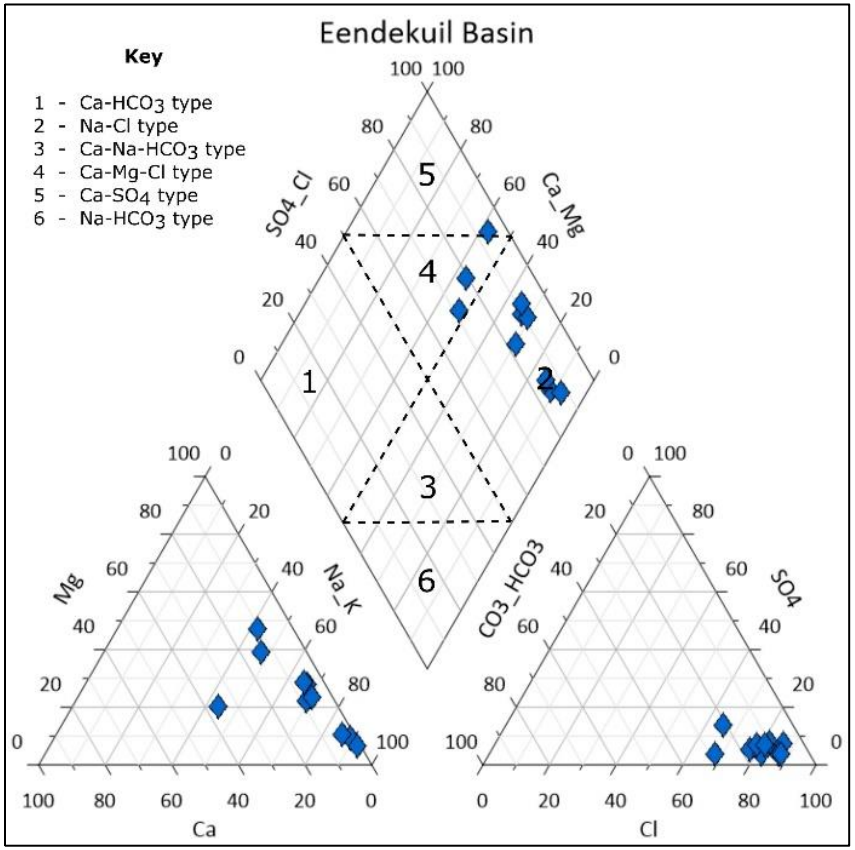
RU	Water Use Sector	No. of Users	Total Volume (M m³/a)
Fractured and Intergranular Basement	Agriculture: Irrigation	19	1.52
	Agriculture: Watering livestock	3	0.06
	Industry (Urban)	3	0.01
Primary / Intergranular Aquifers	Agriculture: Irrigation	7	0.26
	Water Supply service	1	3.00
Total		**33**	**4.85**



Discharge

Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **4.53 M m³/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m³/a)
Fractured Peninsula Aquifer	**0.00**
Primary / Intergranular	**0.96**
Fractured and Intergranular Basement	**3.57**
Total	**4.53**

<table>
<tr><td rowspan="3">GRU</td><td>GRU Name: Eendekuil Basin</td></tr>
<tr><td>Main Towns: Porterville and Piketberg</td></tr>
<tr><td>Total Area (km^2): 939.92</td></tr>
<tr><td>Water Quality</td><td>The main water type in Eendekuil Basin is Na-Cl. The Na-Cl waters are due to and saturation of Na and Cl ions as a result of increased groundwater residence time in the relatively low transmissivity clay rich shale and siltstone basement aquifer. Exceedances of baseline concentrations were observed for multiple parameters, with more than 50% of samples exceeding baselines for sulphate, EC, nitrate + nitrite and fluoride. Two of the four samples collected exceed the RQO for pH. The adjusted water quality category is C, indicating that moderate levels of contamination exist.

</td></tr>
</table>

GRU	GRU Name: Eendekuil Basin
	Main Towns: Porterville and Piketberg
	Total Area (km²): 939.92

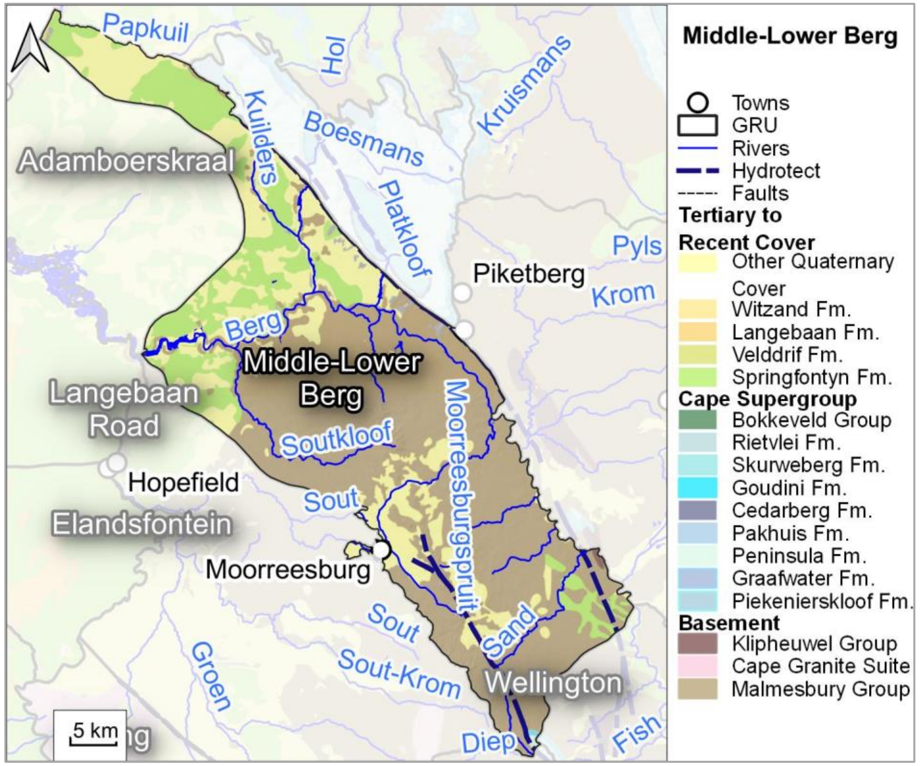
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Eendekuil Basin	Sulphate (mg/l)	52.60	7.30	219.00	91.19	79.55	Na-Cl, Ca-Mg-Cl, Ca-SO_4	E	C	C
	Electrical conductivity (mS/m)	205.00	42.10	583.00	286.01	233		D		
	pH	8.20	7.86	8.45	8.14	8.135		C		
	Ammonia (mg/l)	0.02	0.02	0.05	0.02	0.02		A		
	Nitrate + nitrite (mg/l)	0.84	0.04	5.39	1.38	0.855		C		
	Fluoride (mg/l)	0.94	0.20	1.87	0.85	1.005		D		
	Orthophosphate (mg/l)	0.01	0.01	0.02	0.01	0.007		A		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of ‘C’, indicating a **moderately stressed** aquifer, and a Groundwater Quality Present Status of ‘C’, indicating **moderate levels of localised contamination, but little or no negative impacts apparent.**

Recharge Volume (M m³/a)	Groundwater Use (M m³/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
21.88	4.85	0.22	C	C

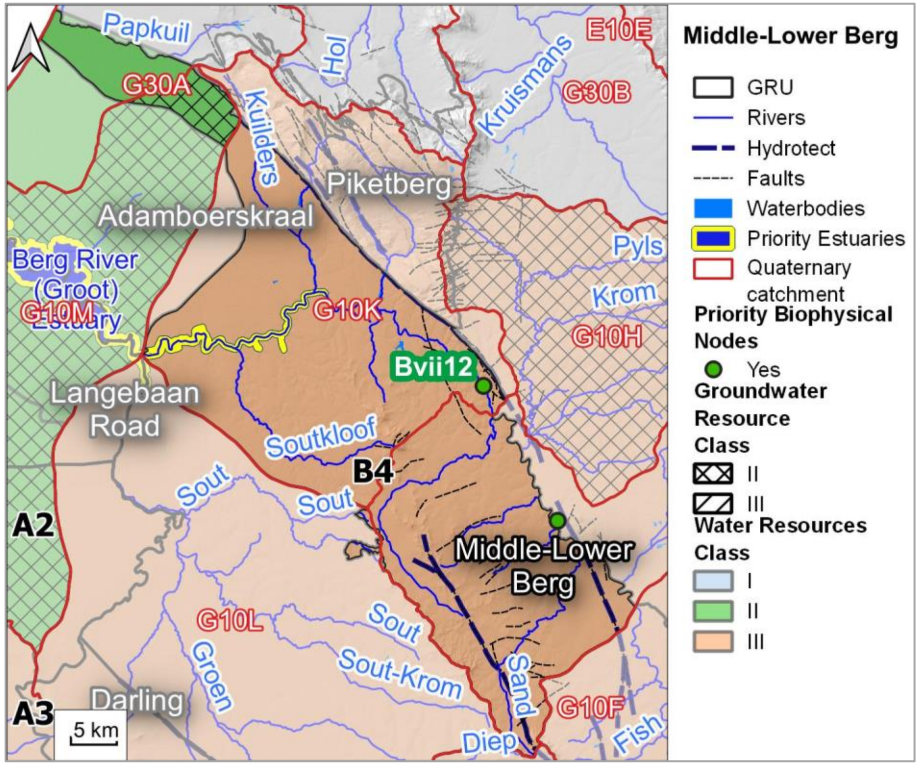
5.3.8. Middle-Lower Berg GRU

GRU	**GRU Name: Middle-Lower Berg**
	Main Towns: Moorreesburg and Aurora
	Total Area (km^2): 148.59
GRU Boundary Description	The Middle-Lower Berg GRU is bound by portions of the G21C, G10L and G10F surface water quaternary catchment divides on its south-western to south-eastern edge. Portions of the Aurora-Piketberg fault zone and the Berg and Klein Berg rivers on the eastern edge. The TMGs contact with interpolated basement lithologies of the Malmesbury Group, as well as portions of the Berg catchment boundary separate the Middle-Lower Berg GRU from the Piketberg GRU on its north-eastern border. The Adamboerskraal aquifer model boundary (SRK, 2004) and the St Helena Bay coastline forms the north/north-western boundary.
Resource Unit	**Fractured and Intergranular Basement Aquifer**
Quaternary Catchments	G10J, G30A, G10K and G10M
Description	This GRU is mainly composed of the Malmesbury Group basement lithology as well as some Quaternary-recent sediment deposits. To the north-west, laterally continuous Sandveld Group sediments dominate the GRU. 

GRU	GRU Name: Middle-Lower Berg
	Main Towns: Moorreesburg and Aurora
	Total Area (km²): 148.59
Surface Water System	The Berg Estuary starts in the north-western corner of this GRU and forms a major surface water system. The Kuilders, Boesmans and Platkloof rivers, originating in the mountainous Piketberg area, discharge into the Berg River. Other water systems include the Soutkloof and Sand rivers.

Water Resource Classes & RQOs

The GRU falls within the Lower Berg (B4) and Berg Estuary (A1) IUAs and has Water Resource Class III and II respectively. Only portions of the A1 IUA that fall within catchment G10M has Groundwater Resource Class of II, with the rest of the GRU having no Groundwater Resource Class. There are no priority EWR sites within this IUA, although there are two priority biophysical nodes, both with a TEC of D, as well as portions of the Berg (Groot) priority estuary.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
B4 Lower Berg	III	G10J	B4-R09	Berg	Bvii6	D	52
		G10K	B4-R10	Berg	Bvii12	D	51
A1 Berg Estuary	II	G10M	A1-E01	Berg (Groot)	Bxi1	C	52

GRU	GRU Name: Middle-Lower Berg
	Main Towns: Moorreesburg and Aurora
	Total Area (km^2): 148.59

Recharge

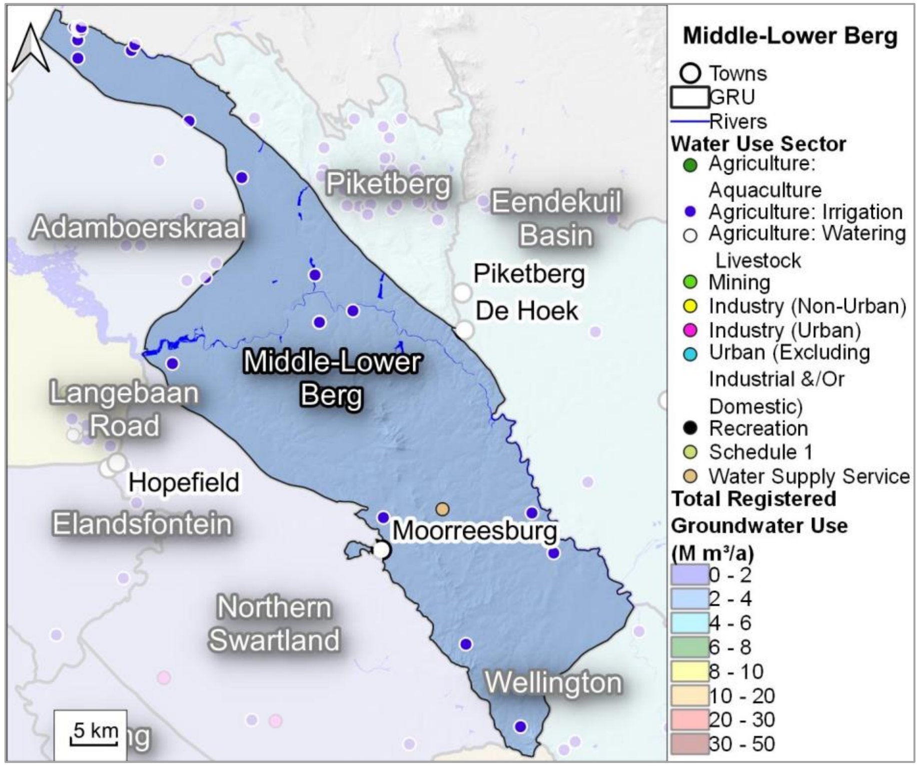
An estimated recharge of **42.49 M m^3/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **28.61 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	1485.40	42.49	28.61

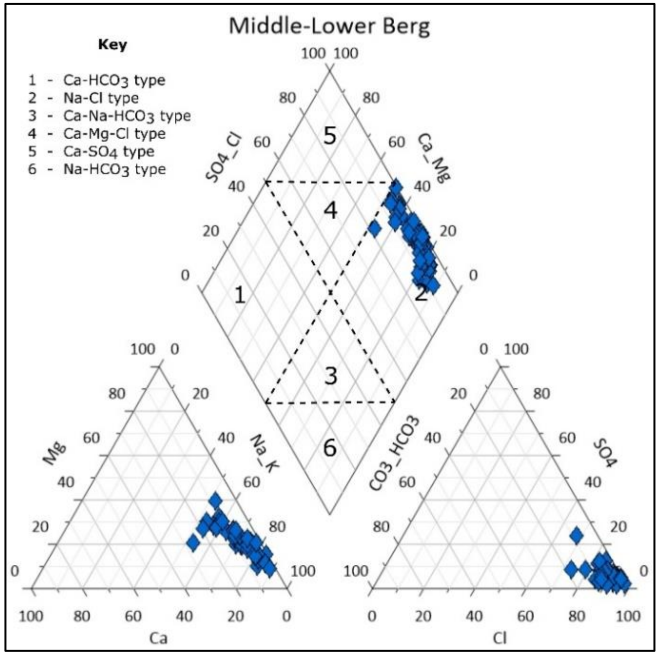
Groundwater Use

There are 32 registered groundwater users in this GRU with a combined groundwater use of **2.23 M m^3/a.** Agriculture (irrigation) is the major groundwater use sector for this GRU, which makes up 97.5% of the total groundwater use volume per annum (see **Section 4.3.3** for detail).

RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured and Intergranular Basement	Agriculture: Irrigation	5	0.09
	Industry (Urban)	1	0.0003
	Water Supply service	1	0.06
Primary / Intergranular Aquifers	Agriculture: Irrigation	25	2.08
Total		**32.00**	**2.23**



<table>
<tr><td rowspan="3">GRU</td><td>GRU Name: Middle-Lower Berg</td></tr>
<tr><td>Main Towns: Moorreesburg and Aurora</td></tr>
<tr><td>Total Area (km^2): 148.59</td></tr>
<tr><td>Discharge</td><td>
Groundwater’s contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is <u>3.57 M m^3/a</u> (see Section 4.4.1 for details).
<table>
<tr><th>RU</th><th>Sum of Baseflow per component (M m^3/a)</th></tr>
<tr><td>Primary / Intergranular Aquifers</td><td>0.73</td></tr>
<tr><td>Fractured Peninsula Aquifer</td><td>0.01</td></tr>
<tr><td>Fractured and Intergranular Other</td><td>4.22E-03</td></tr>
<tr><td>Fractured and Intergranular Basement</td><td>2.82</td></tr>
<tr><td>Total</td><td>3.57</td></tr>
</table>
</td></tr>
<tr><td>Water Quality</td><td>
The main water type in the Middle-Lower Berg is Na-Cl. The Na-Cl waters are due to and saturation of Na and Cl ions as a result of increased groundwater residence time in the relatively low transmissivity clay rich shale and siltstone basement aquifer. Exceedances of baseline concentrations were observed for multiple parameters, with 50% of samples exceeding the baseline for pH, ammonia, fluoride and orthophosphate. Of the 46 samples collected, 4 samples exceeded the RQO for EC, 12 for pH and 3 for nitrate + nitrite. Exceedances are the result of contamination from agriculture, but also naturally elevated concentrations of dissolved ions. The adjusted water quality category is C, indicating that moderate levels of contamination exist.



</td></tr>
</table>

GRU	GRU Name: Middle-Lower Berg
	Main Towns: Moorreesburg and Aurora
	Total Area (km^2): 148.59

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Middle-Lower Berg	Sulphate (mg/l)	342.80	3.52	799.60	216.13	196.9	Na-Cl	A	C	C
	Electrical conductivity (mS/m)	841.00	20.68	1212.00	601.50	636.0		A		
	pH	7.63	3.11	8.71	7.56	7.7		D		
	Ammonia (mg/l)	0.02	0.02	1.37	0.10	0.042		D		
	Nitrate + nitrite (mg/l)	6.16	0.02	24.96	3.72	1.237		A		
	Fluoride (mg/l)	0.57	0.17	2.22	0.69	0.673		D		
	Orthophosphate (mg/l)	0.01	-	0.13	0.02	0.013		E		
	Dissolved Aluminium (mg/l)	-	0.01	0.028	0.019	0.019		-		
	Dissolved Arsenic (mg/l)	-	0.002	0.025	0.014	0.014		-		
	Dissolved Chromium (mg/l)	-	0.002	0.012	0.007	0.007		-		
	Dissolved Iron (mg/l)	-	0.002	0.021	0.012	0.012		-		
	Dissolved Lead (mg/l)	-	0.002	0.008	0.005	0.005		-		
	Dissolved Manganese (mg/l)	-	0.001	0.001	0.001	0.001		-		
	Dissolved Mercury (mg/l)	-	0.00	0.00	0.00	0.00		-		

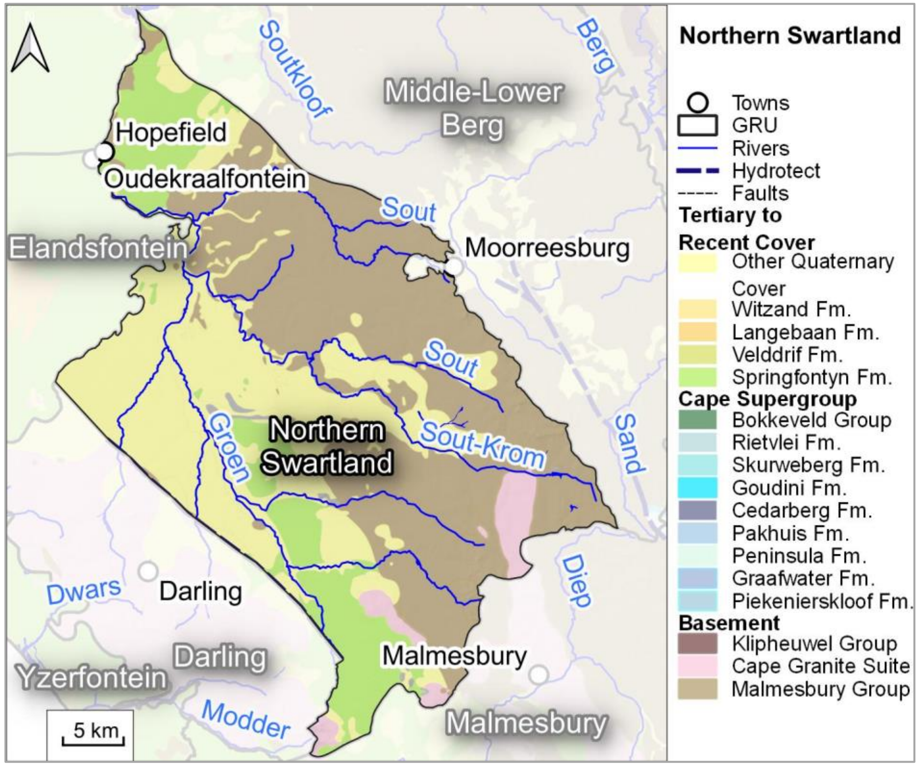
Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of 'B', indicating an **unstressed or slightly stressed aquifer**, and a Groundwater Quality Present Status of 'C', indicating **moderate levels of localised contamination, but little or no negative impacts apparent**.

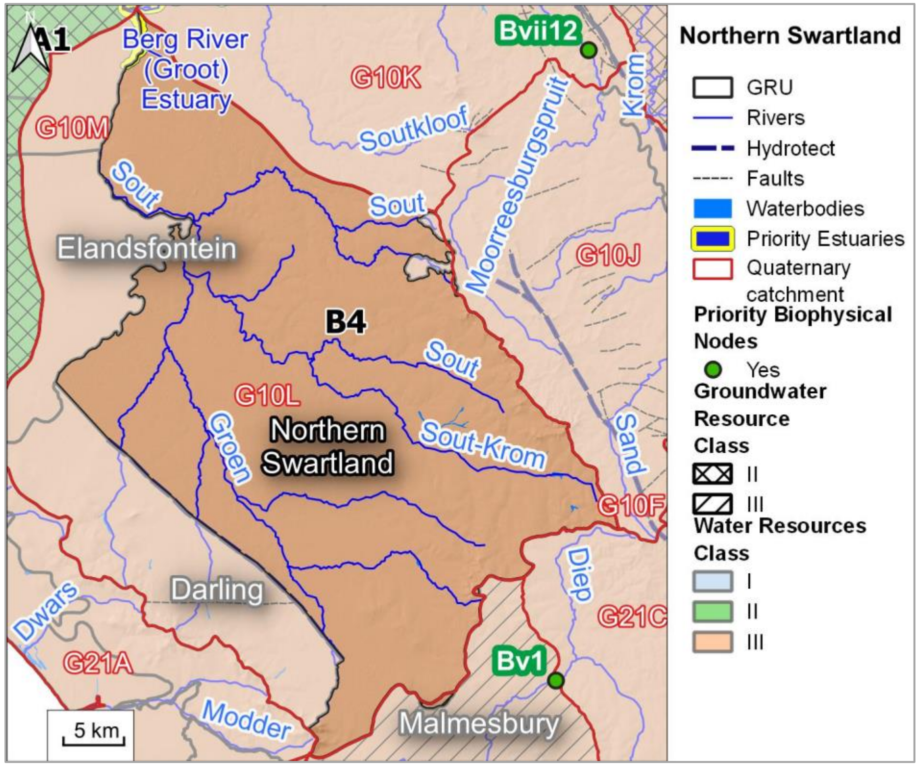
Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
42.49	2.23	0.05	B	C

5.3.9. Northern Swartland GRU

GRU	GRU Name: Northern Swartland
	Main Towns: None
	Total Area (km^2): 1262.87
GRU Boundary Description	The Northern Swartland GRU is bound by a combination of an interpolated basement lithology extent the Cape Granite Suite and the Malmesbury Group and portions of the G21C, G21D, G10J and G10K surface water quaternary catchment divides on its northern, eastern, and southern borders. Along the western edge of the GRU, the Colenso Fault, portions of the Modder River and the contact between Springfontyn Formation and the basement lithologies creates the south-western/western edge of the GRU. The Sout River marks western/north-western boarder of the Northern Swartland GRU.
Resource Unit	**Fractured and Intergranular Basement Aquifer**
Quaternary Catchments	G10L
Description	This GRU is formed by basement Malmesbury Group and various plutons of the Cape Granite Suite. Laterally continuous Sandveld Group sediments as well as fluvial sediments from ephemeral streams also dominate the GRU.



GRU	GRU Name: Northern Swartland
	Main Towns: None
	Total Area (km^2): 1262.87
Surface Water System	The general surface water flow direction is from the south-east to north-west. Numerous tributaries including the Sout, Sout-Krom and Groen rivers converge into the Sout River which feeds into the Berg River.
Water Resource Classes & RQOs	The GRU falls almost entirely within the Lower Berg (B4) IUA, has a Water Resource Class of III and no Groundwater Class for most of the GRU, except for the small portions that fall within the G21D catchment, which has a Groundwater Resource Class of III. There are no priority EWR sites within this IUA, although contains portions of the priority Berg (Groot) estuary with a TEC of C.



IUA	Water Resource Class	Quaternary Catchment	RU	Resource Name	Biophysical Node	TEC	nMAR
A1 Berg Estuary	II	G10M	A1-E01	Berg (Groot)	Bxi1	C	

GRU	GRU Name: Northern Swartland
	Main Towns: None
	Total Area (km²): 1262.87

Recharge

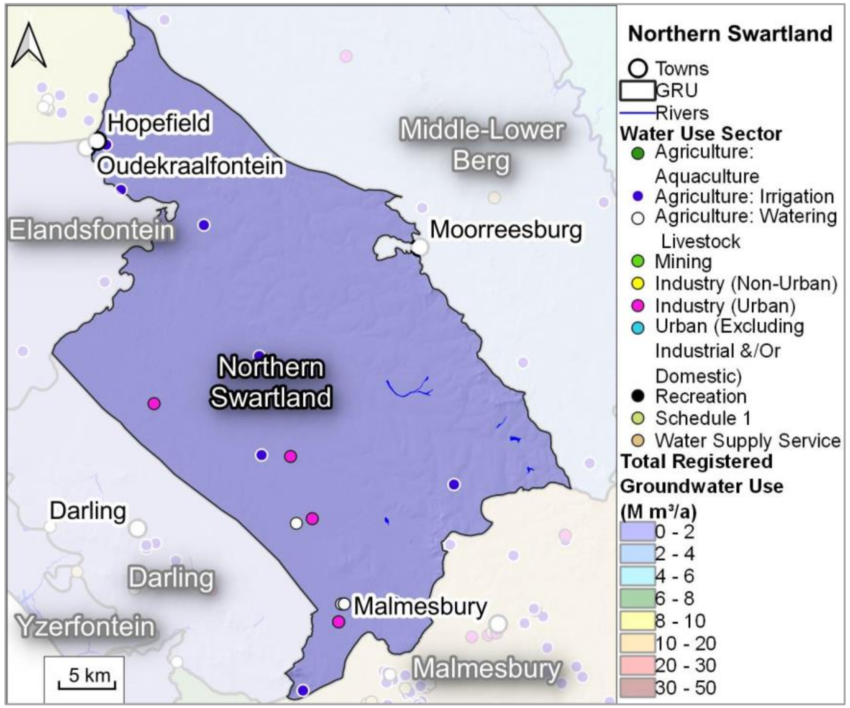
An estimated recharge of **31.85 M m³/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **25.33 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

Method	Area (km²)	Recharge Volume (M m³/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	1257.65	31.85	25.33

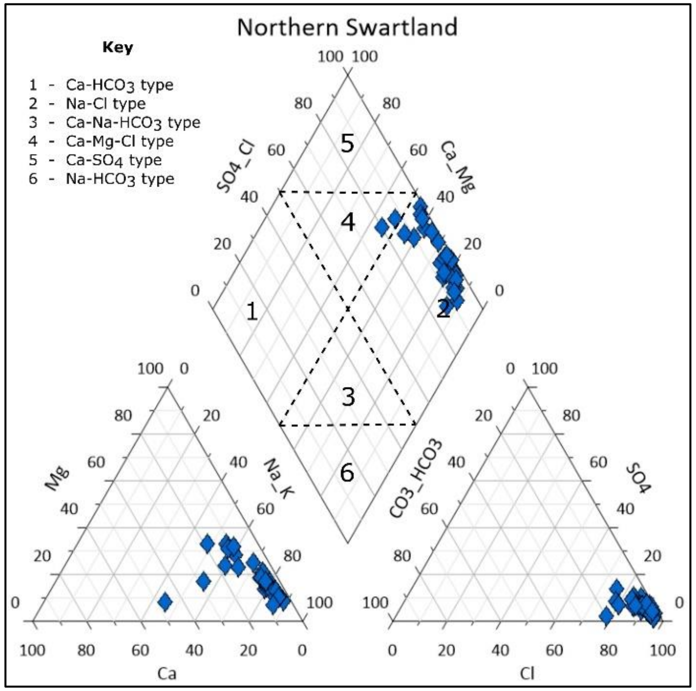
Groundwater Use

There are 19 registered groundwater users in this GRU with a combined groundwater use of **1.8 M m³/a**. Major groundwater use sectors include Agriculture (irrigation) and Industry (urban) which comprise 72.3% and 19% respectively of the total groundwater use volume per annum (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m³/a)
Fractured and Intergranular Basement	Agriculture: Irrigation	3	0.65
Primary / Intergranular Aquifers	Agriculture: Irrigation	6	0.65
	Agriculture: Watering livestock	5	0.16
	Industry (Urban)	5	0.34
Total		**19**	**1.80**



<table>
<tr><td rowspan="3">GRU</td><td>GRU Name: Northern Swartland</td></tr>
<tr><td>Main Towns: None</td></tr>
<tr><td>Total Area (km²): 1262.87</td></tr>
<tr><td>Discharge</td><td>Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is <u>0.02 M m³/a</u> (see Section 4.4.1 for details).
<table>
<tr><th>RU</th><th>Sum of Baseflow per component (M m³/a)</th></tr>
<tr><td>Primary / Intergranular Aquifers</td><td>2.86E-03</td></tr>
<tr><td>Fractured and Intergranular Basement</td><td>0.02</td></tr>
<tr><td>Total</td><td>0.02</td></tr>
</table>
</td></tr>
<tr><td>Water Quality</td><td>The main water type in Northern Swartland is Na-Cl. The Na-Cl waters are due to and saturation of Na and Cl ions as a result of increased groundwater residence time in the relatively low transmissivity clay rich shale and siltstone basement aquifer. Exceedances of baseline concentrations were observed for multiple parameters, with 50% of samples exceeding the baseline for pH and nitrate + nitrite. Of the 31 samples collected, 5 samples exceeded the RQO for EC, 1 for pH and 3 for nitrate + nitrite. Exceedances are the result of contamination from agriculture, but also naturally elevated concentrations of dissolved ions. The adjusted water quality category is C, indicating that moderate levels of contamination exist.



</td></tr>
</table>

GRU	GRU Name: Northern Swartland
	Main Towns: None
	Total Area (km^2): 1262.87

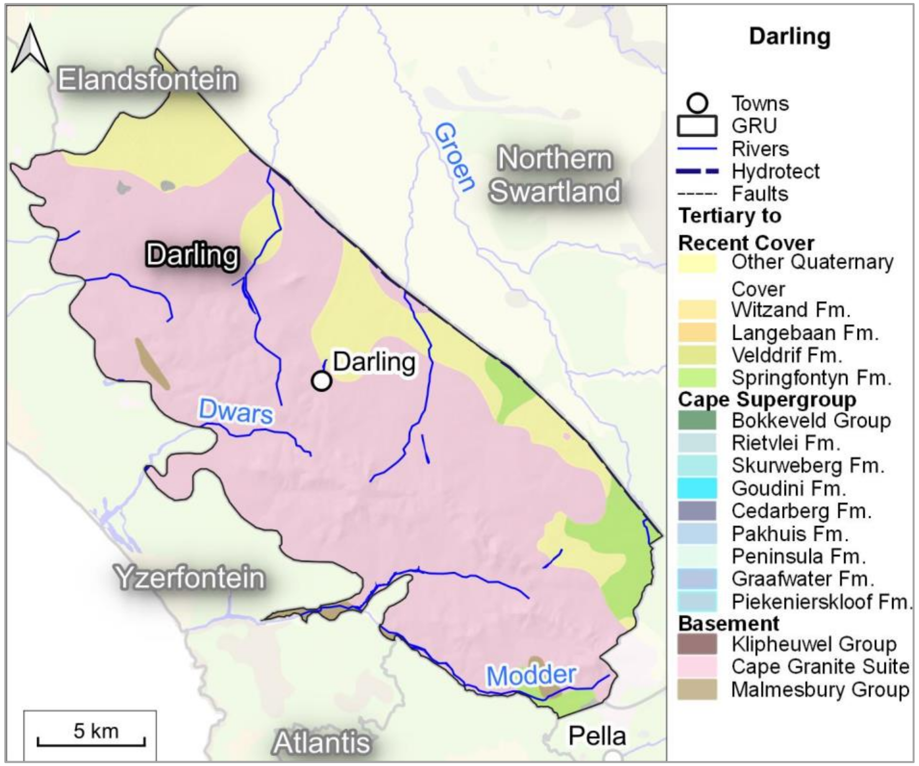
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Northern Swartland	Sulphate (mg/l)	114.70	7.90	484.70	140.03	114.7	Na-Cl, Ca-Mg-Cl	C	C	C
	Electrical conductivity (mS/m)	532.00	49.70	1175.50	457.35	400		B		
	pH	7.59	5.55	8.13	7.52	7.7		D		
	Ammonia (mg/l)	0.02	0.02	0.52	0.06	0.02		B		
	Nitrate + nitrite (mg/l)	0.87	0.02	21.53	3.48	0.962		D		
	Fluoride (mg/l)	0.72	0.15	1.25	0.63	0.7		C		
	Orthophosphate (mg/l)	0.01	-	0.11	0.02	0.014		D		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

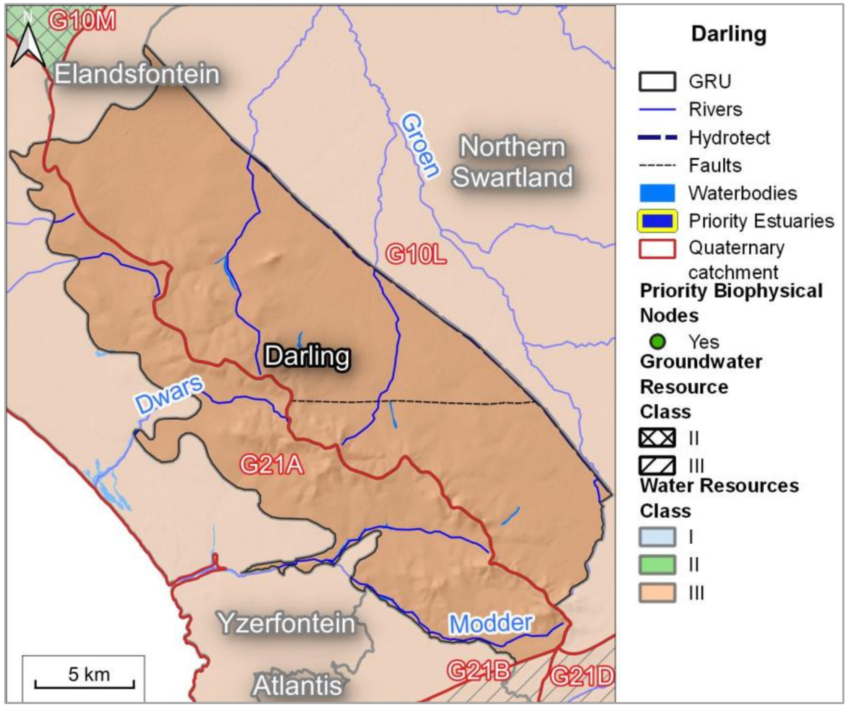
Aquifer Stress

The GRU is considered to have a Groundwater Availability Present Status Category of 'B', indicating an **unstressed or slightly stressed** aquifer, and a Groundwater Quality Present Status of 'C', indicating **moderate levels of localised contamination, but little or no negative impacts apparent**.

Recharge Volume (M m^3/a)	Groundwater Use (M m^3/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
31.85	1.8	0.06	B	C

5.3.10. Darling GRU

GRU	GRU Name: Darling
	Main Towns: Darling and Mamre
	Total Area (km²): 408.81
GRU Boundary Description	The eastern flank of the Darling GRU is bound by the Colenso Fault, Modder River, and Groen River (i.e., the extent of Northern Swartland GRU). The extent of the Springfontyn Formation and its contact with the Cape Granite Suite forms the boundary between the Elandsfontein and Yzerfontein GRUs. Portions of the G21B surface water quaternary catchment divide and CoCT (2020) aquifer model boundary (i.e., the Atlantis GRU) was used as the Darling GRU boarder in the south.
Resource Unit	**Fractured and Intergranular Basement Aquifer**
Quaternary Catchments	G10L and G21A
Description	This GRU is dominantly composed of the Cape Granite Suite plutons that has intruded the Malmesbury Group shales. Several ephemeral streams emanate from the granite hills after heavy rain and deposit fluvial sediments to the north-east of the GRU. 

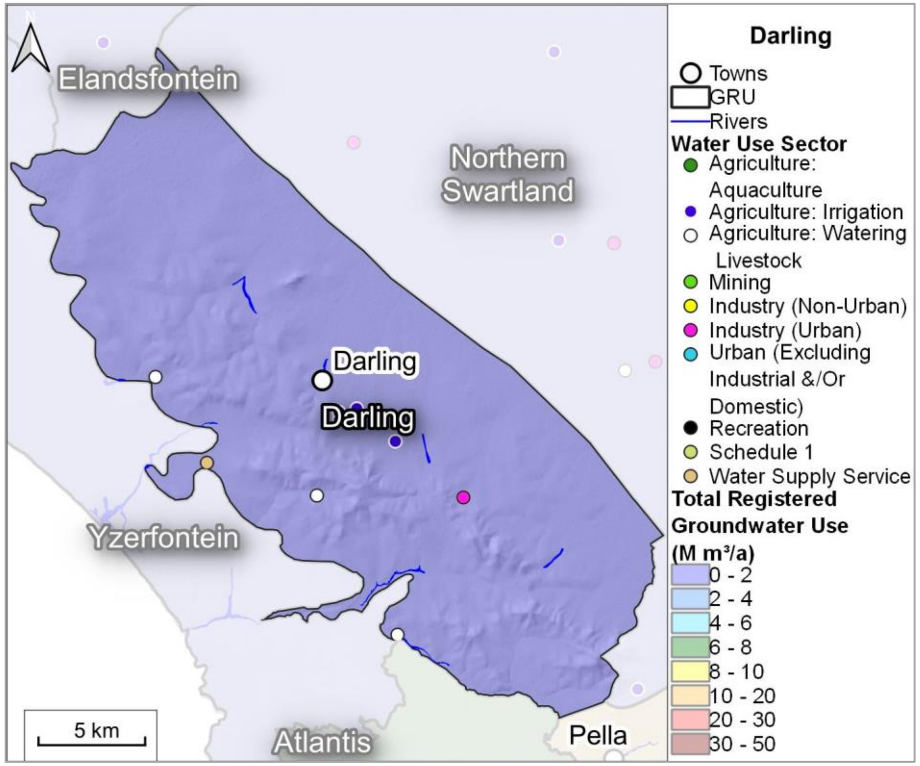
<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Darling</th></tr>
<tr><th>Main Towns: Darling and Mamre</th></tr>
<tr><th>Total Area (km^2): 408.81</th></tr>
<tr><td>Surface Water System</td><td>The surface water systems flow both towards the north and south. The Modder and Dwars tributaries flow towards the coast, whereas the tributaries in the north of the GRU flow towards the Groen River in the Northern Swartland GRU.</td></tr>
<tr><td>Water Resource Classes & RQOs</td><td>The GRU falls within the Lower Berg (B4) and West Coast (A3) IUAs and both have a Water Resource Class of III and no Groundwater Class. There are no EWR sites within this IUA nor any priority biophysical node.

</td></tr>
<tr><td>Recharge</td><td>An estimated recharge of <u>9.95 M m^3/a</u> was determined from first-order recharge calculations using the Map-Centric Simulation method (see Section 4.2.3), and was selected as the estimated recharge value for the Aquifer Stress (Section 4.6.1.2) assessments. The average recharge rate equates to <u>24.34 mm/a</u> based on the total GRU area. Additional recharge estimations are available in literature (See Section 4.2.3).
<table>
<tr><th>Method</th><th>Area (km^2)</th><th>Recharge Volume (M m^3/a)</th><th>Average Recharge Rate (mm/a)</th></tr>
<tr><td>Map Centric Simulation Method</td><td>408.82</td><td>9.95</td><td>24.34</td></tr>
</table></td></tr>
</table>

GRU	GRU Name: Darling
	Main Towns: Darling and Mamre
	Total Area (km^2): 408.81

Groundwater Use

There are 9 registered groundwater users in this GRU with a combined groundwater use of **0.77 M m^3/a**. Agriculture (irrigation) is the major groundwater use sector for this GRU, which makes up 93.0% of the total groundwater use volume per annum (see **Section 4.3.3** for detail).

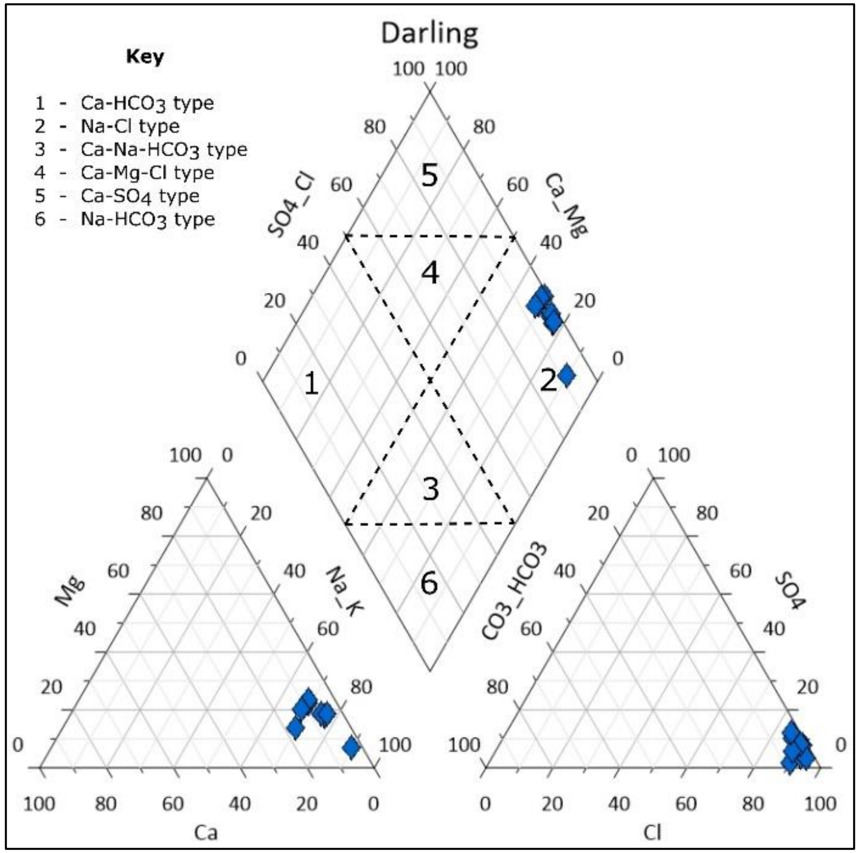
RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured and Intergranular Basement	Agriculture: Irrigation	5	0.71
	Agriculture: Watering livestock	3	0.05
	Industry (Urban)	1	0.01
Total		**9**	**0.77**



Discharge

Groundwater's contribution to baseflow was re-calculated using the aquifer specific baseflow estimates from DWAF (2008b) based on equivalent recharge. The total discharge for this GRU is **0.08 M m^3/a** (see **Section 4.4.1** for details).

RU	Sum of Baseflow per component (M m^3/a)
Primary / Intergranular Aquifers	2.08E-03
Fractured and Intergranular Basement	0.08
Total	**0.08**

<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Darling</th></tr>
<tr><th>Main Towns: Darling and Mamre</th></tr>
<tr><th>Total Area (km^2): 408.81</th></tr>
<tr><td>Water Quality</td><td>The main water type in Darling is Na-Cl. The Na-Cl waters are due to and saturation of Na and Cl ions as a result of increased groundwater residence time in the relatively low transmissivity granitic basement aquifer. Exceedances of baseline concentrations were observed for multiple parameters, with 50% of samples exceeding the baseline for EC, pH and fluoride. Of the 9 samples collected, 1 sample exceeded the RQO for EC. Exceedances are the result of contamination from agriculture, but also naturally elevated concentrations of dissolved ions. The adjusted water quality category is C, indicating that moderate levels of contamination exist.

</td></tr>
</table>

GRU	
	GRU Name: Darling
	Main Towns: Darling and Mamre
	Total Area (km²): 408.81

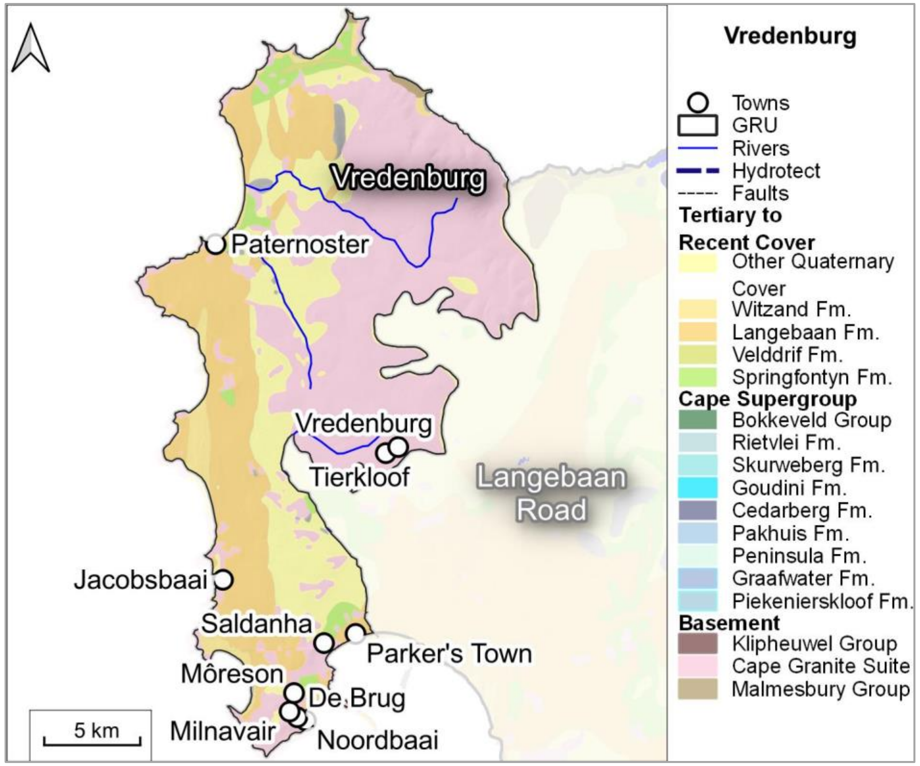
GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Darling	Sulphate (mg/l)	96.10	10.70	542.20	150.67	96.1	Na-Cl	C	D	C
	Electrical conductivity (mS/m)	192.00	108.60	110-	459.57	281.6		D		
	pH	6.80	6.70	7.86	7.22	7.2		E		
	Ammonia (mg/l)	0.02	0.02	0.08	0.03	0.02		B		
	Nitrate + nitrite (mg/l)	0.83	0.02	4.16	1.19	0.83		C		
	Fluoride (mg/l)	0.15	0.10	1.50	0.66	0.56		E		
	Orthophosphate (mg/l)	0.01	0.003	0.02	0.01	0.003		B		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		

Aquifer Stress

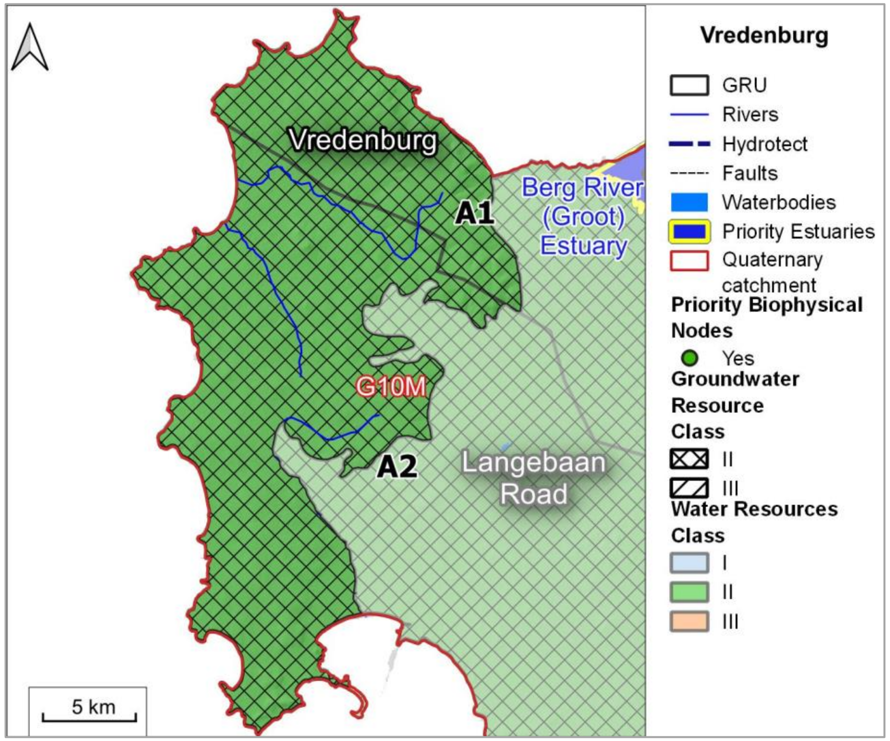
The GRU is considered to have a Groundwater Availability Present Status Category of 'B', indicating an **unstressed or slightly stressed** aquifer, and a Groundwater Quality Present Status of 'C', indicating **moderate levels of localised contamination, but little or no negative impacts apparent**.

Recharge Volume (M m³/a)	Groundwater Use (M m³/a)	Stress Index	Groundwater Availability Present Status Category	Groundwater Quality Present Status Category
9.95	0.77	0.08	B	C

5.3.11. Vredenburg GRU

<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Vredenburg</th></tr>
<tr><th>Main Towns: Vredenburg, Paternoster and Saldanha</th></tr>
<tr><th>Total Area (km^2): 376.68</th></tr>
<tr><td>GRU Boundary Description</td><td>The Vredenburg GRU is bound by the Cape Granite Suite outcrop and its contact with the Springfontyn Formation on its eastern edge. A combination of an interpolated extent of Cape Granite Suite outcrops and the Bok River was used as the GRUs south-eastern boarder, with the Atlantic, Saldanha Bay, and St Helena Bay coastlines forming the northern, western, and southern extent.</td></tr>
<tr><td>Resource Unit</td><td>Fractured and Intergranular Basement Aquifer</td></tr>
<tr><td>Quaternary Catchments</td><td>G10M</td></tr>
<tr><td>Description</td><td>The West Coast region is formed by basement Malmesbury Group and various plutons of the Cape Granite Suite, overlain by the Sandveld Group which is laterally continuous over large areas, and also reaches significant thicknesses.

</td></tr>
</table>

GRU	GRU Name: Vredenburg
	Main Towns: Vredenburg, Paternoster and Saldanha
	Total Area (km^2): 376.68
Surface Water System	Several ephemeral streams emanate from the Cape Granite Suite hills after heavy rain. All rivers follow topography, flowing from the higher lying areas in the east to the coast in the west.
Water Resource Classes & RQOs	The GRU falls within the Langebaan (A2) and Berg Estuary (A1) which both have a Water Resource Class of II and Groundwater Class II. There are no EWR sites within this IUA nor any priority biophysical nodes.



Recharge

An estimated recharge of **7.43 M m^3/a** was determined from first-order recharge calculations using the Map-Centric Simulation method (see **Section 4.2.3**), and was selected as the estimated recharge value for the Aquifer Stress (**Section 4.6.1.2**) assessments. The average recharge rate equates to **19.75 mm/a** based on the total GRU area. Additional recharge estimations are available in literature (See **Section 4.2.3**).

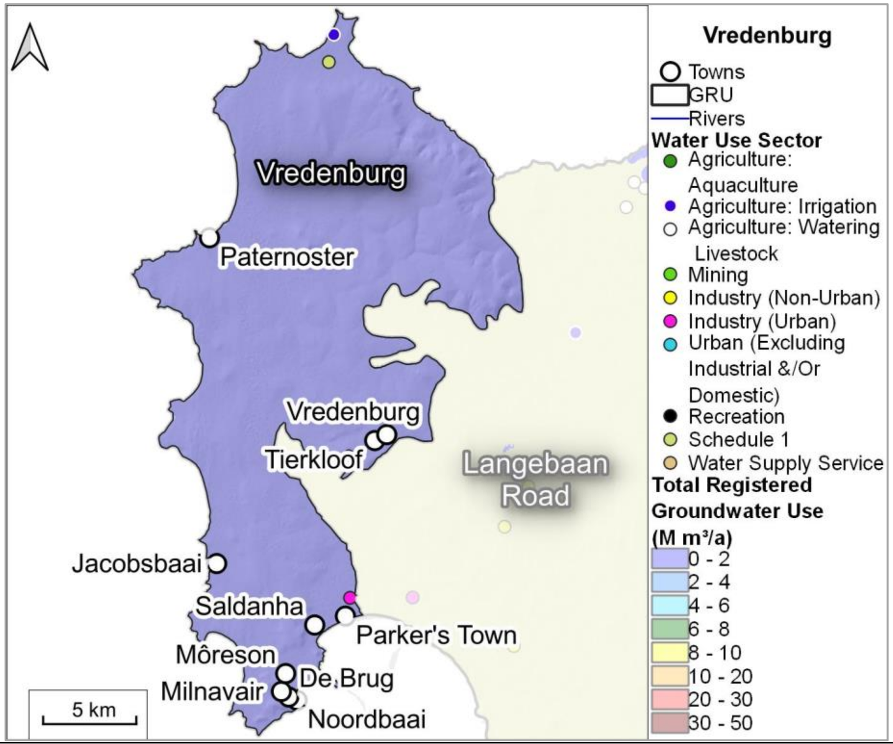
Method	Area (km^2)	Recharge Volume (M m^3/a)	Average Recharge Rate (mm/a)
Map Centric Simulation Method	376.18	7.43	19.75

GRU	
GRU	**GRU Name: Vredenburg**
	Main Towns: Vredenburg, Paternoster and Saldanha
	Total Area (km²): 376.68

Groundwater Use

There are 6 registered groundwater users in this GRU with a combined groundwater use of **1.16 M m³/a**. Major groundwater use sectors include: Urban (excluding industrial or domestic volume), Agriculture (irrigation) and Industry (Urban) which comprise of 65.4%, 21.8% and 12.8% respectively of total groundwater use volume per annum (see **Section 4.3.3** for details).

RU	Water Use Sector	No. of Users	Total Volume (M m³/a)
Fractured and Intergranular Basement	Industry (Urban)	1	0.15
Primary / Intergranular Aquifers	Agriculture: Irrigation	1	0.25
	Schedule 1	1	0.0002
	Urban (Excluding industrial and/or domestic)	3	0.76
Total		**6**	**1.16**



<table>
<tr><th rowspan="3">GRU</th><th>GRU Name: Vredenburg</th></tr>
<tr><th>Main Towns: Vredenburg, Paternoster and Saldanha</th></tr>
<tr><th>Total Area (km^2): 376.68</th></tr>
<tr><td>Discharge</td><td>Groundwater’s contribution to baseflow is minimal / unknown due to discharge to estuaries and the ocean not being included (DWAF 2008b). This will however be further investigated in Step 4 (i.e., EWR and BHN Reserve determination).
<table>
<tr><th>RU</th><th>Sum of Baseflow per component (M m^3/a)</th></tr>
<tr><td>Primary / Intergranular Aquifers</td><td>0.00</td></tr>
<tr><td>Fractured and Intergranular Basement</td><td>0.00</td></tr>
<tr><td>Total</td><td>0.00</td></tr>
</table>
</td></tr>
<tr><td>Water Quality</td><td>No water quality data</td></tr>
<tr><td>Aquifer Stress</td><td>The GRU is considered to have a Groundwater Availability Present Status Category of ‘B’, indicating an unstressed or slightly stressed aquifer, and the Groundwater Quality Present Status is unknown due to limited data availability.
<table>
<tr><th>Recharge Volume
(M m^3/a)</th><th>Groundwater Use
(M m^3/a)</th><th>Stress Index</th><th>Groundwater Present Status Category (after WRC, 2007)</th><th>Final Groundwater Quality Present Status Category</th></tr>
<tr><td>7.43</td><td>1.16</td><td>0.16</td><td>B</td><td>N/A</td></tr>
</table>
</td></tr>
</table>

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APPENDIX A: Recharge

Appendix A-1: First-Order Recharge Estimations

Table A-1-1 First-order aquifer-specific recharge estimation per RU for Primary / Intergranular Aquifers outlined in Section 4.2.1: Fixed Percentage of MAP method; 2) GRAII Spatial Distribution modified method; 3) Empirical Rainfall-Recharge Relationship method; and 4) Map-Centric Simulation method.

GRU	RU	Recharge Volume (M m^3/a)			
		Fixed % MAP	GRAII (modified)	Empirical Rainfall-Recharge	Map Centric
Primary / Intergranular Aquifers					
Cape Flats	Primary/Intergranular Aquifer	10.01	26.97	26.98	20.48
	Fractured and Intergranular Aquifer	0.02	0.07	0.03	0.04
Atlantis	Primary/Intergranular Aquifer	4.26	11.95	9.58	6.16
	Fractured and Intergranular Basement Aquifer	0.01	0.01	0.01	0.01
Yzerfontein	Primary/Intergranular Aquifer	4.73	10.75	10.53	8.83
	Fractured and Intergranular Basement Aquifer	0.16	0.46	0.22	0.37
Elandsfontein	Primary/Intergranular Aquifer	7.51	15.06	16.81	15.12
	Fractured and Intergranular Basement Aquifer	0.20	0.51	0.28	0.35
Langebaan Road	Primary/Intergranular Aquifer	10.04	19.65	17.32	22.44
	Fractured and Intergranular Basement Aquifer	0.33	0.95	0.43	0.84
Adamboerskraal	Primary/Intergranular Aquifer	7.36	12.88	13.03	21.60
	Fractured and Intergranular Basement Aquifer	0.01	0.01	0.01	0.01
Total		44.63	99.27	95.23	96.26

Table A-1-2 First-order aquifer-specific recharge estimation per RU for Fractured Table Mountain Group Aquifers outlined in Section 4.2.1: Fixed Percentage of MAP method; 2) GRAII Spatial Distribution modified method; 3) Empirical Rainfall-Recharge Relationship method; and 4) Map-Centric Simulation method.

GRU	RU	Recharge Volume (M m³/a)			
		Fixed % MAP	GRAII (modified)	Empirical Rainfall-Recharge	Map Centric
Fractured Table Mountain Group Aquifers					
Cape Peninsula	Primary/Intergranular Aquifer	1.98	8.70	6.56	1.85
	Peninsula Aquifer	22.47	24.22	16.08	8.32
	Fractured and Intergranular Other	0.00	1.46	0.00	0.32
	Fractured and Intergranular Basement Aquifer	0.40	1.95	0.92	0.50
Steenbras-Nuweberg	Primary/Intergranular Aquifer	0.12	0.46	0.64	0.19
	Nardouw Aquifer	7.44	22.81	15.37	7.91
	Peninsula Aquifer	13.24	22.81	19.22	6.05
	Fractured and Intergranular Other	0.00	11.63	0.00	3.40
	Fractured and Intergranular Basement Aquifer	0.16	1.04	0.44	0.42
Drakensteinberge	Primary/Intergranular Aquifer	0.02	0.06	0.15	0.03
	Nardouw Aquifer	0.99	2.27	1.95	1.48
	Peninsula Aquifer	46.06	72.89	81.38	23.26
	Fractured and Intergranular Other	0.00	6.34	0.00	2.28
	Fractured and Intergranular Basement Aquifer	0.00	0.00	0.00	0.00
Wemmershoek	Primary/Intergranular Aquifer	0.79	3.76	3.64	2.17
	Nardouw Aquifer	1.49	4.28	2.67	2.06
	Peninsula Aquifer	36.43	54.58	44.29	19.03
	Fractured and Intergranular Other	0.00	7.34	0.00	3.29
	Fractured and Intergranular Basement Aquifer	0.29	1.92	1.00	0.29
Voëlvlei-Slanghoek	Primary/Intergranular Aquifer	0.15	0.99	0.79	0.30
	Nardouw Aquifer	1.85	2.79	2.98	1.67
	Peninsula Aquifer	21.21	19.29	19.60	9.82
	Fractured and Intergranular Other	0.00	4.97	0.00	2.31

GRU	RU	Recharge Volume (M m^3/a)			
		Fixed % MAP	GRAII (modified)	Empirical Rainfall-Recharge	Map Centric
	Fractured and Intergranular Basement Aquifer	0.00	0.00	0.00	0.00
Witsenberg	Primary/Intergranular Aquifer	0.00	0.00	0.00	0.00
	Peninsula Aquifer	5.11	2.68	4.12	2.55
	Fractured and Intergranular Other	0.00	0.29	0.00	0.23
	Fractured and Intergranular Basement Aquifer	0.00	0.00	0.00	0.00
Groot Winterhoek	Primary/Intergranular Aquifer	0.00	0.00	0.00	0.00
	Nardouw Aquifer	7.24	11.53	8.56	7.64
	Peninsula Aquifer	26.58	21.65	21.94	11.57
	Fractured and Intergranular Other	0.00	7.15	0.00	3.28
	Fractured and Intergranular Basement Aquifer	0.00	0.00	0.00	0.00
Piketberg	Primary/Intergranular Aquifer	0.13	0.26	0.29	0.30
	Nardouw Aquifer	1.52	0.97	1.35	2.22
	Peninsula Aquifer	17.99	7.20	8.52	13.39
	Fractured and Intergranular Other	0.00	2.20	0.00	4.42
	Fractured and Intergranular Basement Aquifer	0.00	0.00	0.00	0.00
Total		213.66	330.50	262.45	142.56

Table A-1-3 First-order aquifer-specific recharge estimation per RU for Fractured and Intergranular Basement Aquifers outlined in Section 4.2.1: Fixed Percentage of MAP method; 2) GRAII Spatial Distribution modified method; 3) Empirical Rainfall-Recharge Relationship method; and 4) Map-Centric Simulation method.

GRU	RU	Recharge Volume (M m³/a)			
		Fixed % MAP	GRAII (modified)	Empirical Rainfall-Recharge	Map Centric
Fractured and Intergranular Basement Aquifer Basement					
Cape Town Rim	Primary/Intergranular Aquifer	7.14	20.02	23.43	12.51
	Peninsula Aquifer	0.01	0.01	0.01	0.01
	Fractured and Intergranular Other	0.00	0.02	0.00	0.02
	Fractured and Intergranular Basement Aquifer	2.66	9.16	5.62	6.05
Stellenbosch-Helderberg	Primary/Intergranular Aquifer	9.98	32.32	39.45	22.08
	Peninsula Aquifer	7.51	8.84	10.00	4.50
	Fractured and Intergranular Other	0.00	0.13	0.00	0.06
	Fractured and Intergranular Basement Aquifer	5.00	21.04	12.69	14.89
Paarl-Franschhoek	Primary/Intergranular Aquifer	8.55	39.55	37.56	19.01
	Nardouw Aquifer	0.00	0.00	0.00	0.00
	Peninsula Aquifer	2.04	2.38	1.92	1.11
	Fractured and Intergranular Other	0.00	0.05	0.00	0.03
	Fractured and Intergranular Basement Aquifer	3.50	18.77	9.38	6.46
Malmesbury	Primary/Intergranular Aquifer	13.15	24.97	30.62	20.31
	Peninsula Aquifer	0.39	0.12	0.25	0.14
	Fractured and Intergranular Other	0.00	0.02	0.00	0.02
	Fractured and Intergranular Basement Aquifer	14.08	32.04	21.16	32.18
Wellington	Primary/Intergranular Aquifer	7.10	14.68	20.45	14.14
	Peninsula Aquifer	0.64	0.42	0.49	0.25
	Fractured and Intergranular Other	0.00	0.12	0.00	0.11
	Fractured and Intergranular Basement Aquifer	12.58	32.19	21.45	24.99
Tulbagh	Primary/Intergranular Aquifer	3.21	7.28	10.25	5.32

GRU	RU	Recharge Volume (M m³/a)			
		Fixed % MAP	GRAII (modified)	Empirical Rainfall-Recharge	Map Centric
	Peninsula Aquifer	0.00	0.00	0.00	0.00
	Fractured and Intergranular Basement Aquifer	2.73	7.46	4.86	5.55
Eendekuil Basin	Primary/Intergranular Aquifer	3.69	5.51	9.69	4.17
	Peninsula Aquifer	0.04	0.01	0.02	0.02
	Fractured and Intergranular Other	0.00	0.03	0.00	0.08
	Fractured and Intergranular Basement Aquifer	8.84	10.92	12.41	17.62
Middle-Lower Berg	Primary/Intergranular Aquifer	8.54	11.40	17.50	18.46
	Peninsula Aquifer	0.15	0.04	0.09	0.06
	Fractured and Intergranular Other	0.00	0.01	0.00	0.02
	Fractured and Intergranular Basement Aquifer	9.69	10.65	12.96	23.95
Northern Swartland	Primary/Intergranular Aquifer	9.77	15.65	21.66	15.60
	Fractured and Intergranular Basement Aquifer	7.39	10.71	10.26	16.25
Darling	Primary/Intergranular Aquifer	1.47	3.16	3.31	1.81
	Fractured and Intergranular Basement Aquifer	4.37	12.00	6.11	8.15
Vredenburg	Primary/Intergranular Aquifer	1.64	2.74	2.22	3.14
	Fractured and Intergranular Basement Aquifer	1.43	2.64	1.22	4.29
Total		157.27	357.06	347.03	303.35

APPENDIX B: Water Use

Appendix B-1: Water Use for the Berg Catchment

Table B-1-1 Total groundwater use per RU per water use sector, as registered in WARMS, for Primary / Intergranular Aquifers.

GRU	RU	Water Use Sector	No. of Users	Total Volume (M m³/a)
Primary / Intergranular Aquifers				
Cape Flats	Primary / Intergranular Aquifers	Agriculture: Irrigation	50	4.08
		Agriculture: Watering livestock	2	0.05
		Industry (Non-urban)	2	1.05
		Industry (Urban)	31	0.97
		Mining	1	0.39
		Schedule 1	1	0
		Urban (Excluding industrial and/or domestic)	3	0.02
		Water Supply Service	5	20.09
Atlantis	Primary / Intergranular Aquifers	Agriculture: Irrigation	9	0.16
		Agriculture: Watering livestock	6	0.33
		Industry (Non-urban)	1	0.04
		Industry (Urban)	7	5.87
		Mining	1	0.37
Yzerfontein	Primary / Intergranular Aquifers	Water Supply Service	1	0.26
Elandsfontein	Primary / Intergranular Aquifers (Upper)	Agriculture: Irrigation	1	0.16
		Industry (Urban)	1	0.01
		Mining	1	0.70
	Primary / Intergranular Aquifers (Lower)	Agriculture: Irrigation	1	0.22
Langebaan Road	Primary / Intergranular Aquifers (Upper)	Agriculture: Irrigation	9	0.71
		Agriculture: Watering livestock	2	0.02
		Industry (Non-urban)	4	0.01
		Industry (Urban)	1	0.04
	Primary / Intergranular Aquifers (Lower)	Agriculture: Irrigation	6	0.87
		Agriculture: Watering livestock	8	0.08
		Water Supply service	3	6.87
Adamboerskraal	Primary / Intergranular Aquifers	Agriculture: Irrigation	11	1.34
		Industry (Urban)	1	0.79

Table B-1-2 Total groundwater use per RU per water use sector as registered in WARMS for Fractured Table Mountain Group Aquifers.

GRU	RU	Water Use Sector	No. of Users	Total Volume (M m³/a)
Fractured Table Mountain Group Aquifers				
Cape Peninsula	Fractured Table Mountain Group	Agriculture: Aquaculture	1	0.01
	Peninsula Aquifer	Agriculture: Irrigation	1	0.02
		Agriculture: Watering livestock	1	0.01
		Industry (Urban)	1	0.01
	Primary / Intergranular Aquifers	Agriculture: Irrigation	2	0.02
		Industry (Urban)	2	0.003
Steenbras-Nuweberg	Fractured Table Mountain Group **(Nardouw)**	Water Supply service	1	9.13
Drakensteinberge	Fractured Table Mountain Group **(Nardouw)**	None		
	Fractured Table Mountain Group **(Peninsula)**	Agriculture: Irrigation	2	0.05
Wemmershoek	Fractured Table Mountain Group **(Nardouw)**	Agriculture: Irrigation	2	0.01
		Industry (Urban)	2	0.08
	Fractured Table Mountain Group **(Peninsula)**	Agriculture: Irrigation	10	0.43
	Primary / Intergranular Aquifers	Agriculture: Aquaculture	1	0.30
Voëlvlei-Slanghoek	Fractured Table Mountain Group	Agriculture: Irrigation	2	0.04
		Agriculture: Watering livestock	1	0.10
Witsenberg	Fractured Table Mountain Group	Agriculture: Irrigation	3	0.08
Groot Winterhoek	Fractured Table Mountain Group **(Nardouw)**	Agriculture: Irrigation	7	1.21
	Fractured Table Mountain Group **(Peninsula)**	Agriculture: Irrigation	3	0.18
		Industry (Non-urban)	1	0.01
Piketberg	Fractured Table Mountain Group **(Nardouw)**	Agriculture: Irrigation	5	0.44
	Fractured Table Mountain Group **(Peninsula)**	Agriculture: Irrigation	41	5.02
		Industry (Non-urban)	2	0.056
		Water Supply Service	3	0.07
	Primary / Intergranular Aquifers	Agriculture: Irrigation	1	0.002

Table B-1-3 Total groundwater use per RU per water use sector as registered in WARMS for Fractured and Intergranular Basement Aquifers.

GRU	RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Fractured and Intergranular Basement				
Cape Town Rim	Fractured and Intergranular Basement	Agriculture: Irrigation	6	0.07
		Industry (Non-urban)	2	0.02
		Industry (Urban)	9	0.26
		Schedule 1	3	0.004
		Urban (Excluding industrial and/or domestic)	1	0.01
		Water Supply service	9	0.36
	Fractured Table Mountain Group (Peninsula)	Agriculture: Irrigation	12	0.49
		Agriculture: Watering Livestock	1	0.03
		Industry (Urban)	1	0.03
		Water Supply service	1	0.03
	Primary / Intergranular Aquifers	Agriculture: Aquaculture	1	0.004
		Agriculture: Irrigation	22	1.82
		Agriculture: Watering Livestock	3	0.06
		Industry (Urban)	9	0.20
		Industry (Non-urban)	70	2.37
		Schedule 1	7	0.02
		Urban (Excluding industrial and/or domestic)	3	0.02
		Water Supply service	9	0.31
Stellenbosch-Helderberg	Fractured and Intergranular Basement	Agriculture: Aquaculture	3	0.001
		Agriculture: Irrigation	35	0.87
		Industry (Non-urban)	8	0.05
		Industry (Urban)	11	0.27
		Schedule 1	3	0.003
		Water Supply service	2	3.50
	Primary / Intergranular Aquifers	Agriculture: Irrigation	38	1.06
		Agriculture: Watering Livestock	1	0.01
		Industry (Non-urban)	11	0.11
		Industry (Urban)	41	0.71
		Recreation	1	0.02
		Schedule 1	4	0.03
		Water Supply service	5	2.16

GRU	RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
Paarl-Franschhoek	Fractured and Intergranular Basement	Agriculture: Aquaculture	1	0.22
		Agriculture: Irrigation	33	0.90
		Agriculture: Watering livestock	3	0.10
		Industry (Non-urban)	16	0.32
		Industry (Urban)	7	0.17
		Schedule 1	1	0.01
		Water Supply service	1	0.004
	Fractured Table Mountain Group (Peninsula)	Agriculture: Irrigation	1	0.07
	Primary / Intergranular Aquifers	Agriculture: Irrigation	140	5.04
		Agriculture: Watering Livestock	7	0.08
		Industry (Non-urban)	5	0.11
		Industry (Urban)	34	1.31
		Schedule 1	9	0.06
		Urban (Excluding industrial and/or domestic)	1	0.01
		Water Supply service	9	1.44
Malmesbury	Fractured and Intergranular Basement	Agriculture: Irrigation	78	5.44
		Agriculture: Watering livestock	18	0.67
		Industry (Non-urban)	2	0.002
		Industry (Urban)	19	1.44
		Mining	1	0.003
		Schedule 1	4	0.01
		Water Supply service	2	0.01
	Primary / Intergranular Aquifers	Agriculture: Aquaculture	1	0.01
		Agriculture: Irrigation	63	4.51
		Agriculture: Watering livestock	28	1.84
		Industry (Non-urban)	2	0.13
		Industry (Urban)	20	0.39
		Urban (Excluding industrial and/or domestic)	1	0.02
		Water Supply service	6	0.27
Wellington	Fractured and Intergranular Basement	Agriculture: Aquaculture	1	0.16
		Agriculture: Irrigation	70	3.08
		Agriculture: Watering livestock	5	0.26
		Industry (Non-urban)	2	0.00

GRU	RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
		Industry (Urban)	11	0.12
		Recreation	1	0.00
		Schedule 1	6	0.01
		Water Supply service	3	0.04
	Primary / Intergranular Aquifers	Agriculture: Watering livestock	14	0.63
		Industry (Non-urban)	1	0.06
		Industry (Urban)	3	0.12
Tulbagh	Fractured and Intergranular Basement	Agriculture: Irrigation	30	2.00
		Industry (Non-urban)	1	0.0004
		Schedule 1	1	0.001
		Water Supply service	2	0.01
	Primary / Intergranular Aquifers	Agriculture: Irrigation	38	1.69
		Agriculture: Watering Livestock	2	0.01
		Industry (Non-urban)	3	0.01
		Industry (Urban)	2	0.04
		Schedule 1	1	0.001
		Water Supply service	1	0.01
Eendekuil Basin	Fractured and Intergranular Basement	Agriculture: Irrigation	19	1.52
		Agriculture: Watering livestock	3	0.06
		Industry (Urban)	3	0.01
	Primary / Intergranular Aquifers	Agriculture: Irrigation	7	0.26
		Water Supply service	1	3.00
Middle-Lower Berg	Fractured and Intergranular Basement	Agriculture: Irrigation	5	0.09
		Industry (Urban)	1	0.0003
		Water Supply service	1	0.06
	Primary / Intergranular Aquifers	Agriculture: Irrigation	25	2.08
Northern Swartland	Fractured and Intergranular Basement	Agriculture: Irrigation	3	0.65
	Primary / Intergranular Aquifers	Agriculture: Irrigation	6	0.65
		Agriculture: Watering livestock	5	0.16
		Industry (Urban)	5	0.34
Darling	Fractured and Intergranular Basement	Agriculture: Irrigation	5	0.71
		Agriculture: Watering livestock	3	0.05
		Industry (Urban)	1	0.01
Vredenberg	Fractured and Intergranular Basement	Industry (Urban)	1	0.15

GRU	RU	Water Use Sector	No. of Users	Total Volume (M m^3/a)
	Primary / Intergranular Aquifers	Agriculture: Irrigation	1	0.25
		Schedule 1	1	0.0002
		Urban (Excluding industrial and/or domestic)	3	0.76

APPENDIX C: Discharge

Appendix C-1: First-Order Discharge Estimations

Table C-1-1 Summary of estimated discharge per GRU per RU for Primary / Intergranular Aquifers as outlined in Section 4.4

GRU	RU	Sum of Baseflow per component M m^3/a
Primary / Intergranular Aquifers		
Cape Flats	Primary / Intergranular	2.69
	Fractured and Intergranular Basement	0.01
Atlantis	Primary / Intergranular	0.20
	Fractured and Intergranular Basement	0.00
Yzerfontein	Primary / Intergranular	0.18
	Fractured and Intergranular Basement	0.01
Elandsfontein	Primary / Intergranular	0.00
	Fractured and Intergranular Basement	0.0005
Langebaan Road	Primary / Intergranular	0.00
	Fractured and Intergranular Basement	0.00
Adamboerskraal	Primary / Intergranular	0.00
	Fractured and Intergranular Basement	0.00
Total		**3.08**

Table C-1-2 Summary of estimated discharge per GRU per RU for Fractured Table Mountain Group Aquifers as outlined in Section 4.4

GRU	RU	Sum of Baseflow per component M m^3/a
Fractured Table Mountain Group Aquifers		
Cape Peninsula	Primary / Intergranular Aquifers	1.98
	Peninsula Aquifer	3.97E-03
	Fractured and Intergranular Other	0.01
	Fractured and Intergranular Basement	1.04
Steenbras-Nuweberg	Primary / Intergranular Aquifers	0.08
	Nardouw Aquifer	3.94
	Peninsula Aquifer	2.31
	Fractured and Intergranular Other	1.37
	Fractured and Intergranular Basement	0.24
Drakensteinberge	Primary / Intergranular Aquifers	3.45E-03
	Nardouw Aquifer	0.40
	Peninsula Aquifer	6.57
	Fractured and Intergranular Other	0.58
	Fractured and Intergranular Basement	0.00
Wemmershoek	Primary / Intergranular Aquifers	0.95
	Nardouw Aquifer	0.80
	Peninsula Aquifer	6.84
	Fractured and Intergranular Other	1.21
	Fractured and Intergranular Basement	0.13
Voëlvlei-Slanghoek	Primary / Intergranular Aquifers	0.12
	Nardouw Aquifer	0.54
	Peninsula Aquifer	2.79
	Fractured and Intergranular Other	0.74
	Fractured and Intergranular Basement	1.86E-08
Witsenberg	Primary / Intergranular Aquifers	0.00
	Peninsula Aquifer	0.85
	Fractured and Intergranular Other	0.08
	Fractured and Intergranular Basement	0.00
Grootwinterhoek	Primary / Intergranular Aquifers	3.12E-04
	Nardouw Aquifer	2.85
	Peninsula Aquifer	3.74
	Fractured and Intergranular Other	1.02
	Fractured and Intergranular Basement	2.61E-06
Piketberg	Primary / Intergranular Aquifers	0.00
	Nardouw Aquifer	0.00
	Peninsula Aquifer	0.07
	Fractured and Intergranular Other	0.05
	Fractured and Intergranular Basement	0.00
Total		**42.53**

Table C-1-3 Summary of estimated discharge per GRU per RU for Fractured and Intergranular Basement as outlined in Section 4.4

GRU	RU	Sum of Baseflow per component M m^3/a
Fractured and Intergranular Basement		
Cape Town Rim	Primary / Intergranular Aquifers	4.66
	Peninsula Aquifer	3.97E-03
	Fractured and Intergranular Other	0.01
	Fractured and Intergranular Basement	1.05
Stellenbosch-Helderberg	Primary / Intergranular Aquifers	3.88
	Peninsula Aquifer	1.03
	Fractured and Intergranular Other	0.02
	Fractured and Intergranular Basement	2.67
Paarl-Franschhoek	Primary / Intergranular Aquifers	3.47
	Nardouw Aquifer	0.00
	Peninsula Aquifer	0.31
	Fractured and Intergranular Other	0.01
	Fractured and Intergranular Basement	0.94
Malmesbury	Primary / Intergranular Aquifers	4.49
	Peninsula Aquifer	0.03
	Fractured and Intergranular Other	4.59E-03
	Fractured and Intergranular Basement	7.30
Wellington	Primary / Intergranular Aquifers	2.82
	Peninsula Aquifer	0.06
	Fractured and Intergranular Other	0.03
	Fractured and Intergranular Basement	5.03
Tulbagh	Primary / Intergranular Aquifers	1.78
	Peninsula Aquifer	0.00
	Fractured and Intergranular Basement	1.86
Eendekuil Basin	Primary / Intergranular Aquifers	0.96
	Peninsula Aquifer	4.13E-03
	Fractured and Intergranular Other	0.02
	Fractured and Intergranular Basement	3.55
Middle-Lower Berg	Primary / Intergranular Aquifers	0.73
	Peninsula Aquifer	0.01
	Fractured and Intergranular Other	4.22E-03
	Fractured and Intergranular Basement	2.82
Northern Swartland	Primary / Intergranular Aquifers	2.86E-03
	Fractured and Intergranular Basement	0.02
Darling	Primary / Intergranular Aquifers	2.08E-03
	Fractured and Intergranular Basement	0.08
Vredenberg	Primary / Intergranular Aquifers	0.00
	Fractured and Intergranular Basement	0.00
Total		**49.66**

APPENDIX D: Water Quality

Appendix D-1: Threshold baseline concentrations

Table D-1 **Threshold baseline concentrations established per parameter, per GRU, calculated using data from representative boreholes. Dashes indicate GRUs where no baseline concentration could be calculated due to lack of data from the selected borehole or the whole GRU.**

GRU	Repres-entative Borehole	Sulphate (mg/l)	EC (mS/m)	pH	Ammonia (mg/l)	Nitrate + nitrite (mg/l)	Fluoride (mg/l)	Ortho-phosphate (mg/l)	Dissolved Aluminium (mg/l)	Dissolved Arsenic (mg/l)	Dissolved Chromium (mg/l)	Dissolved Iron (mg/l)	Dissolved Lead (mg/l)	Dissolved Manganese (mg/l)	Dissolved Mercury (mg/l)
Primary / Intergranular Aquifers															
Adamboerskraal	93313	52.20	499.10	7.00	0.19	0.10	0.31	0.24	-	-	-	-	-	-	-
Atlantis	91733	24.70	99.74	7.73	1.16	0.05	1.16	0.10	-	-	-	-	-	-	-
Cape Flats	88847	44.40	113.72	8.30	0.08	8.35	0.26	0.03	0.500	0.054	-3	2.918	0.255	-7	-1
Elandsfontein	93871	12.90	49.10	7.49	0.14	4.62	0.24	0.19	-	-	-	-	-	-	-
Langebaan Road	93873	25.18	155.60	8.41	0.14	0.25	0.70	0.04	0.091	0.085	0.010	0.014	0.063	-6	0.029
Yzerfontein	89820	109.04	111.70	7.97	0.11	0.51	0.44	0.05	0.026	0.061	-5	0.118	0.034	-1	-
Fractured Table Mountain Group Aquifers															
Cape Peninsula	96073	12.20	25.80	6.96	0.02	0.07	0.26	1.02	-	-	-	-	-	-	-
Steenbras-Nuweberg (Peninsula)	H8A1	1.49	14.00	7.18	0.12	1.05	0.28	0.32	0.012	-3	-7	7.755	-7	0.527	-5
Steenbras-Nuweberg (Nardouw)	H1A3b	6.50	1-	5.91	2.88	0.20	0.50	0.20	0.040	0.010	0.020	0.024	0.010	0.025	-5
Wemmershoek	W7D1	3.45	9.27	8.26	0.45	0.53	0.16	0.05	-1	-1	-1	0.539	-1	0.714	-1
Fractured and Intergranular Basement Aquifers															
Cape Town Rim	96211	8.50	105.10	7.78	0.02	0.28	0.14	0.01	-	-	-	-	-	-	-
Darling	94570	96.10	192.00	6.80	0.02	0.83	0.15	0.01	-	-	-	-	-	-	-
Eendekuil Basin	96167	52.60	205.00	8.20	0.02	0.84	0.94	0.01	-	-	-	-	-	-	-
Malmesbury	89665	172.57	1549.90	7.15	0.10	503.08	0.26	0.10	0.033	0.025	-7	0.014	-8	0.677	-
Middle-Lower Berg	96095	342.80	841.00	7.63	0.02	6.16	0.57	0.01	-	-	-	-	-	-	-
Northern Swartland	96144	114.70	532.00	7.59	0.02	0.87	0.72	0.01	-	-	-	-	-	-	-
Paarl-Franschhoek	96019	2.00	14.40	7.04	0.06	0.76	0.25	0.10	-	-	-	-	-	-	-
Stellenbosch-Helderberg (Tygerberg Formation)	96029	10.20	197.00	7.08	0.04	0.02	2.35	0.01	-	-	-	-	-	-	-

GRU	Repres-entative Borehole	Sulphate (mg/l)	EC (mS/m)	pH	Ammonia (mg/l)	Nitrate + nitrite (mg/l)	Fluoride (mg/l)	Ortho-phosphate (mg/l)	Dissolved Aluminium (mg/l)	Dissolved Arsenic (mg/l)	Dissolved Chromium (mg/l)	Dissolved Iron (mg/l)	Dissolved Lead (mg/l)	Dissolved Manganese (mg/l)	Dissolved Mercury (mg/l)
Stellenbosch-Helderberg (Cape Granite Suite)	**96033**	14.80	68.40	7.00	0.04	0.24	1.25	0.01	-	-	-	-	-	-	-
Tulbagh	**89812**	142.75	370.98	8.28	0.10	0.02	0.80	0.02	-	-	-	-	-	-	-
Wellington	**96016**	118.00	202.00	7.56	0.14	1.39	1.09	0.01	-	-	-	-	-	-	-

Appendix D-2: Groundwater Quality Summary per GRU

Table D-2: Summary of threshold baseline concentrations, summary statistics, water types and water quality classes per GRU for Primary Intergranular Aquifers, Fractured Table Mountain Group Aquifers, and Fractured and Intergranular Basement Aquifers.

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Primary / Intergranular Aquifers										
Adamboerskraal	Sulphate (mg/l)	52.20	52.20	1125.90	371.35	153.65	Na-Cl	E	C	B
	Electrical conductivity (mS/m)	499.10	499.10	4548.00	1655.58	787.6		E		
	pH	7.00	6.50	7.33	6.86	6.8		B		
	Ammonia (mg/l)	0.19	0.12	0.62	0.28	0.185		B		
	Nitrate + nitrite (mg/l)	0.10	0.02	0.10	0.04	0.02		-		
	Fluoride (mg/l)	0.31	0.14	0.50	0.31	0.305		B		
	Orthophosphate (mg/l)	0.24	0.04	0.24	0.10	0.056		-		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Atlantis	Sulphate (mg/l)	24.70	2.00	355.70	39.01	19.8	Na-Cl, Ca-Mg,Cl, Ca-HCO3, Ca-Na-HCO3, Ca-SO4	C	B	C
	Electrical conductivity (mS/m)	99.74	38.10	1122.70	125.54	92.2		C		
	pH	7.73	2.60	8.35	7.42	7.59		B		
	Ammonia (mg/l)	1.16	0.02	1.22	0.14	0.05		A		
	Nitrate + nitrite (mg/l)	0.05	0.02	2.19	0.12	0.02		C		
	Fluoride (mg/l)	1.16	0.05	1.33	0.27	0.16		A		
	Orthophosphate (mg/l)	0.10	-	1.30	0.08	0.022		A		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Cape Flats	Sulphate (mg/l)	44.40	2.00	326.00	52.17	45.4	Na-Cl, Ca-Mg-Cl, Ca-HCO3, Ca-SO4	D	A	D
	Electrical conductivity (mS/m)	113.72	13.00	578.00	87.43	88.85		A		
	pH	8.30	5.07	8.55	7.79	7.84		A		
	Ammonia (mg/l)	0.08	0.02	31.89	0.72	0.059		C		
	Nitrate + nitrite (mg/l)	8.35	0.02	23.20	2.75	1.12		A		
	Fluoride (mg/l)	0.26	0.05	3.05	0.17	0.15		A		
	Orthophosphate (mg/l)	0.03	-	1.35	0.03	0.01		A		
	Dissolved Aluminium (mg/l)	0.500	0.015	1.070	0.499	0.5		A		
	Dissolved Arsenic (mg/l)	0.054	0.002	0.139	0.051	0.05		A		
	Dissolved Chromium (mg/l)	0.003	0.001	0.063	0.004	0.003		A		
	Dissolved Iron (mg/l)	2.918	0.006	22.99	1.113	0.65		A		
	Dissolved Lead (mg/l)	0.255	0.002	0.856	0.065	0.025		A		
	Dissolved Manganese (mg/l)	0.007	0.001	0.033	0.005	0.004		A		
	Dissolved Mercury (mg/l)	0.001	0.001	14.013	0.048	0.001		A		
Elandsfontein	Sulphate (mg/l)	12.90	12.10	29.20	15.68	12.1	Na-Cl, Ca-Mg-Cl	B	A	B
	Electrical conductivity (mS/m)	49.10	45.50	101.90	58.98	49.1		B		
	pH	7.49	7.17	7.60	7.39	7.35		B		
	Ammonia (mg/l)	0.14	0.04	0.14	0.10	0.12		A		
	Nitrate + nitrite (mg/l)	4.62	0.15	4.62	1.65	1.51		A		
	Fluoride (mg/l)	0.24	0.17	0.82	0.32	0.19		B		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
	Orthophosphate (mg/l)	0.19	0.01	0.30	0.17	0.185		B		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
	Sulphate (mg/l)	25.18	0.60	1149.50	103.48	56.1		C		
	Electrical conductivity (mS/m)	155.60	59.50	2365.20	261.62	166.3		C		
	pH	8.41	6.77	8.75	8.01	8.1		A		
	Ammonia (mg/l)	0.14	-	0.55	0.05	0.025		A		
	Nitrate + nitrite (mg/l)	0.25	0.02	25.34	1.42	0.1055		B		
	Fluoride (mg/l)	0.70	0.22	2.55	0.86	0.81		B		
	Orthophosphate (mg/l)	0.04	-	0.24	0.04	0.025		B		
Langebaan Road	Dissolved Aluminium (mg/l)	0.091	0.001	0.099	0.035	0.03	Na-Cl, Ca-Mg-Cl	-	B	B
	Dissolved Arsenic (mg/l)	0.085	0.002	0.103	0.035	0.027		-		
	Dissolved Chromium (mg/l)	0.010	0.000	0.021	0.004	0.003		-		
	Dissolved Iron (mg/l)	0.014	0.001	0.031	0.008	0.006		A		
	Dissolved Lead (mg/l)	0.063	0.000	0.063	0.026	0.027		-		
	Dissolved Manganese (mg/l)	0.006	0.001	0.024	0.003	0.001		-		
	Dissolved Mercury (mg/l)	0.029	0.010	0.029	0.020	0.019		-		
	Sulphate (mg/l)	109.04	2.00	277.90	51.61	40.128		A		
Yzerfontein	Electrical conductivity (mS/m)	111.70	35.20	588.00	127.01	104.1	Na-Cl, Ca-Mg-Cl	C	B	A
	pH	7.97	1.00	8.76	7.21	7.235		A		
	Ammonia (mg/l)	0.11	0.02	1.16	0.08	0.042		A		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
	Nitrate + nitrite (mg/l)	0.51	0.01	4.18	0.24	0.087		A		
	Fluoride (mg/l)	0.44	0.03	0.88	0.23	0.2		A		
	Orthophosphate (mg/l)	0.05	-	0.81	0.11	0.058		D		
	Dissolved Aluminium (mg/l)	0.026	0.019	0.026	0.023	0.023		-		
	Dissolved Arsenic (mg/l)	0.061	0.002	0.064	0.033	0.033		-		
	Dissolved Chromium (mg/l)	0.005	0.003	0.005	0.004	0.004		-		
	Dissolved Iron (mg/l)	0.118	0.020	0.123	0.072	0.072		-		
	Dissolved Lead (mg/l)	0.034	0.002	0.036	0.019	0.019		-		
	Dissolved Manganese (mg/l)	0.001	0.001	0.001	0.001	0.001		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Fractured Table Mountain Group Aquifers										
Cape Peninsula	Sulphate (mg/l)	12.20	12.20	107.40	64.75	72.2	Na-Cl, Ca-Mg-Cl, Ca-HCO3	F	D	B
	Electrical conductivity (mS/m)	25.80	25.80	119.00	78.52	89.8		F		
	pH	6.96	6.54	7.57	7.07	7.1		D		
	Ammonia (mg/l)	0.02	0.02	2.51	0.34	0.02		B		
	Nitrate + nitrite (mg/l)	0.07	0.02	10.89	3.67	0.32		E		
	Fluoride (mg/l)	0.26	0.05	0.33	0.16	0.15		A		
	Orthophosphate (mg/l)	1.02	0.01	1.08	0.21	0.016		A		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
	Sulphate (mg/l)	6.50	0.40	17.70	3.66	3.35		A	B	B

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
Steenbras-Nuweberg (Nardouw)	Electrical conductivity (mS/m)	10.0	2.00	24.20	10.60	9	Na-Cl, Ca-Mg-Cl, Ca-Na-HCO3	B		
	pH	5.91	4.63	8.61	5.75	5.57		B		
	Ammonia (mg/l)	2.88	0.01	12.22	0.64	0.1		A		
	Nitrate + nitrite (mg/l)	0.20	-	3.66	0.30	0.2		A		
	Fluoride (mg/l)	0.50	0.05	0.50	0.21	0.1		-		
	Orthophosphate (mg/l)	0.20	-	0.20	0.10	0.1		-		
	Dissolved Aluminium (mg/l)	0.040	0.001	0.074	0.024	0.012		A		
	Dissolved Arsenic (mg/l)	0.010	0.001	0.040	0.006	0.003		A		
	Dissolved Chromium (mg/l)	0.020	0.001	0.020	0.010	0.007		-		
	Dissolved Iron (mg/l)	0.024	0.024	5.266	0.363	0.024		A		
	Dissolved Lead (mg/l)	0.010	0.001	0.040	0.008	0.007		A		
	Dissolved Manganese (mg/l)	0.025	0.019	0.700	0.063	0.019		A		
	Dissolved Mercury (mg/l)	0.005	0.001	0.005	0.005	0.005		-		
Steenbras-Nuweberg (Peninsula)	Sulphate (mg/l)	1.49	0.20	61.00	6.25	4.2	Na-Cl, Ca-Mg-Cl, Ca-HCO3, Ca-Na-HCO3	E	D	B
	Electrical conductivity (mS/m)	14.00	2.47	38.00	14.14	13		D		
	pH	7.18	4.87	9.35	7.01	6.8		C		
	Ammonia (mg/l)	0.12	0.00	12.00	0.42	0.1		C		
	Nitrate + nitrite (mg/l)	1.05	0.00	1.20	0.12	0.1		A		
	Fluoride (mg/l)	0.28	0.10	0.76	0.40	0.5		C		
	Orthophosphate (mg/l)	0.32	0.00	0.97	0.15	0.1		A		
	Dissolved Aluminium (mg/l)	0.012	0.001	0.080	0.040	0.04		A		
	Dissolved Arsenic (mg/l)	0.003	0.001	0.010	0.007	0.01		-		
	Dissolved Chromium (mg/l)	0.007	0.007	0.020	0.015	0.02		-		
	Dissolved Iron (mg/l)	7.755	0.004	12.06	4.998	2.153		A		
	Dissolved Lead (mg/l)	0.007	0.001	0.010	0.008	0.01		-		
	Dissolved Manganese (mg/l)	0.527	0.006	3.162	0.625	0.387		B		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
	Dissolved Mercury (mg/l)	0.005	0.001	0.005	0.004	0.005		-		
Wemmershoek	Sulphate (mg/l)	3.45	0.20	20.90	2.77	0.72	Na-Cl, Ca-HCO3, Ca-Na-HCO3	A	A	A
	Electrical conductivity (mS/m)	9.27	4.66	16.00	8.74	8.1		C		
	pH	8.26	6.40	10.01	7.58	7.3		A		
	Ammonia (mg/l)	0.45	0.01	0.66	0.13	0.05		A		
	Nitrate + nitrite (mg/l)	0.53	0.00	1.27	0.13	0.018		A		
	Fluoride (mg/l)	0.16	0.05	0.39	0.17	0.11		A		
	Orthophosphate (mg/l)	0.05	0.02	0.43	0.06	0.012		A		
	Dissolved Aluminium (mg/l)	0.001	0.001	0.008	0.003	0.001		A		
	Dissolved Arsenic (mg/l)	0.001	0.001	0.001	0.001	0.001		-		
	Dissolved Chromium (mg/l)	0.001	0.001	0.001	0.001	0.001		A		
	Dissolved Iron (mg/l)	0.539	0.006	0.827	0.457	0.539		A		
	Dissolved Lead (mg/l)	0.001	0.001	0.001	0.001	0.001		-		
	Dissolved Manganese (mg/l)	0.714	0.001	0.714	0.240	0.003286		-		
	Dissolved Mercury (mg/l)	0.001	0.001	0.001	0.001	0.001		-		
Fractured and Intergranular Basin										
Cape Town Rim	Sulphate (mg/l)	8.50	5.50	350.00	60.92	34.1	Na-Cl, Ca-Mg-Cl	F	C	C
	Electrical conductivity (mS/m)	105.10	21.00	659.00	150.69	92		B		
	pH	7.78	7.00	8.62	7.51	7.47		A		
	Ammonia (mg/l)	0.02	0.02	0.75	0.06	0.02		A		
	Nitrate + nitrite (mg/l)	0.28	0.02	6.57	0.92	0.13		B		
	Fluoride (mg/l)	0.14	0.12	2.60	0.45	0.27		F		
	Orthophosphate (mg/l)	0.01	0.003	0.13	0.02	0.01		D		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Darling	Sulphate (mg/l)	96.10	10.70	542.20	150.67	96.1	Na-Cl	C	D	C
	Electrical conductivity (mS/m)	192.00	108.60	1100.00	459.57	281.6		D		
	pH	6.80	6.70	7.86	7.22	7.2		E		
	Ammonia (mg/l)	0.02	0.02	0.08	0.03	0.02		B		
	Nitrate + nitrite (mg/l)	0.83	0.02	4.16	1.19	0.83		C		
	Fluoride (mg/l)	0.15	0.10	1.50	0.66	0.56		E		
	Orthophosphate (mg/l)	0.01	0.003	0.02	0.01	0.003		B		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Eendekuil Basin	Sulphate (mg/l)	52.60	7.30	219.00	91.19	79.55	Na-Cl, Ca-Mg-Cl, Ca-SO4	E	C	C
	Electrical conductivity (mS/m)	205.00	42.10	583.00	286.01	233		D		
	pH	8.20	7.86	8.45	8.14	8.135		C		
	Ammonia (mg/l)	0.02	0.02	0.05	0.02	0.02		A		
	Nitrate + nitrite (mg/l)	0.84	0.04	5.39	1.38	0.8545		C		
	Fluoride (mg/l)	0.94	0.20	1.87	0.85	1.005		D		
	Orthophosphate (mg/l)	0.01	0.01	0.02	0.01	0.0065		A		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Malmesbury	Sulphate (mg/l)	172.57	1.50	360.70	63.47	33.3	Na-Cl, Ca-Mg-Cl, Ca-SO4	A	A	B
	Electrical conductivity (mS/m)	1549.90	29.66	2110.00	220.90	107.9		A		
	pH	7.15	1.00	8.60	7.38	7.644		D		
	Ammonia (mg/l)	0.10	0.00	1.27	0.05	0.025		A		
	Nitrate + nitrite (mg/l)	503.08	0.02	589.68	20.16	0.562		A		
	Fluoride (mg/l)	0.26	0.03	2.94	0.50	0.375		C		
	Orthophosphate (mg/l)	0.10	0.00	14.00	0.12	0.022		A		
	Dissolved Aluminium (mg/l)	0.033	0.001	0.139	0.025	0.018		A		
	Dissolved Arsenic (mg/l)	0.025	0.002	0.103	0.034	0.025		A		
	Dissolved Chromium (mg/l)	0.007	0.003	0.026	0.004	0.003		A		
	Dissolved Iron (mg/l)	0.014	0.002	1.892	0.031	0.003		A		
	Dissolved Lead (mg/l)	0.008	0.008	0.063	0.024	0.008		A		
	Dissolved Manganese (mg/l)	0.677	0.001	1.190	0.073	0.001		A		
	Dissolved Mercury (mg/l)	0.00	0.008	0.075	0.021	0.019		A		
Middle-Lower Berg	Sulphate (mg/l)	342.80	3.52	799.60	216.13	196.9	Na-Cl	A	C	C
	Electrical conductivity (mS/m)	841.00	20.68	1212.00	601.50	636		A		
	pH	7.63	3.11	8.71	7.56	7.7		D		
	Ammonia (mg/l)	0.02	0.02	1.37	0.10	0.0415		D		
	Nitrate + nitrite (mg/l)	6.16	0.02	24.96	3.72	1.237		A		
	Fluoride (mg/l)	0.57	0.17	2.22	0.69	0.6725		D		
	Orthophosphate (mg/l)	0.01	0.00	0.13	0.02	0.0125		E		
	Dissolved Aluminium (mg/l)	0.00	0.01	0.028	0.019	0.019		-		
	Dissolved Arsenic (mg/l)	0.00	0.002	0.025	0.0135	0.0135		-		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
	Dissolved Chromium (mg/l)	0.00	0.002	0.012	0.007	0.007		-		
	Dissolved Iron (mg/l)	0.00	0.002	0.021	0.0115	0.0115		-		
	Dissolved Lead (mg/l)	0.00	0.002	0.008	0.005	0.005		-		
	Dissolved Manganese (mg/l)	0.00	0.001	0.001	0.001	0.001		-		
	Dissolved Mercury (mg/l)	0.00						-		
Northern Swartland	Sulphate (mg/l)	114.70	7.90	484.70	140.03	114.7	Na-Cl, Ca-Mg-Cl	C	C	C
	Electrical conductivity (mS/m)	532.00	49.70	1175.50	457.35	400		B		
	pH	7.59	5.55	8.13	7.52	7.7		D		
	Ammonia (mg/l)	0.02	0.02	0.52	0.06	0.02		B		
	Nitrate + nitrite (mg/l)	0.87	0.02	21.53	3.48	0.962		D		
	Fluoride (mg/l)	0.72	0.15	1.25	0.63	0.7		C		
	Orthophosphate (mg/l)	0.01	0.00	0.11	0.02	0.014		D		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Paarl-Franschoek	Sulphate (mg/l)	2.00	2.00	2.00	2.00	2	Na-Cl	-	n/a	n/a
	Electrical conductivity (mS/m)	14.40	14.40	14.40	-	-		-		
	pH	7.04	7.04	7.04	-	-		-		
	Ammonia (mg/l)	0.06	0.06	0.06	-	-		-		
	Nitrate + nitrite (mg/l)	0.76	0.76	0.76	-	-		-		
	Fluoride (mg/l)	0.25	0.25	0.25	-	-		-		
	Orthophosphate (mg/l)	0.10	0.10	0.10	-	-		-		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Stellenbosch-Helderberg (Tygerberg)	Sulphate (mg/l)	10.20	7.70	338.40	111.00	73.05	Na-Cl, Ca-Mg-Cl	E	D	C
	Electrical conductivity (mS/m)	197.00	32.70	885.00	289.10	203.00		D		
	pH	7.08	6.72	7.18	6.96	6.98		B		
	Ammonia (mg/l)	0.04	0.02	0.09	0.05	0.05		D		
	Nitrate + nitrite (mg/l)	0.02	0.02	5.61	1.25	0.21		E		
	Fluoride (mg/l)	2.35	0.05	2.61	1.10	0.67		B		
	Orthophosphate (mg/l)	0.02	0.007	0.078	0.02	0.009		D		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Stellenbosch-Helderberg (Cape Granite Suite)	Sulphate (mg/l)	14.80	2.00	289.80	35.00	5.9	Na-Cl	B	D	C
	Electrical conductivity (mS/m)	68.40	17.60	197.00	62.10	48.9		B		
	pH	7.00	6.41	7.48	6.90	7		C		
	Ammonia (mg/l)	0.04	0.04	0.11	0.10	0.05		E		
	Nitrate + nitrite (mg/l)	0.24	0.02	8.34	1.80	0.94		E		
	Fluoride (mg/l)	1.25	0.16	2.46	0.80	0.41		B		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
	Orthophosphate (mg/l)	0.01						F		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Tulbagh	Sulphate (mg/l)	142.75	5.00	150.00	77.50	77.5	Na-Cl	-	n/a	n/a
	Electrical conductivity (mS/m)	370.98	9.60	390.00	199.80	199.8		-		
	pH	8.28	7.23	8.34	7.79	7.785		-		
	Ammonia (mg/l)	0.10	0.02	0.11	0.06	0.0635		-		
	Nitrate + nitrite (mg/l)	0.02	0.02	0.02	0.02	0.02		-		
	Fluoride (mg/l)	0.80	0.39	0.82	0.61	0.605		-		
	Orthophosphate (mg/l)	0.02	0.01	0.02	0.01	0.0125		-		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		
Wellington	Sulphate (mg/l)	118.00	4.30	118.00	42.20	4.3	Na-Cl	-	B	B
	Electrical conductivity (mS/m)	202.00	25.60	202.00	85.77	29.7		-		
	pH	7.56	7.03	7.56	7.33	7.4		-		
	Ammonia (mg/l)	0.14	0.05	0.21	0.13	0.142		B		

GRU	Parameter	Baseline concentration	Minimum concentration	Maximum concentration	Average concentration	Median concentration	Water types	Parameter Specific Water Quality Categories	GRU Water Quality Category	Adjusted Water Quality Category
	Nitrate + nitrite (mg/l)	1.39	1.26	1.39	1.31	1.278		-		
	Fluoride (mg/l)	1.09	0.22	1.09	0.52	0.26		-		
	Orthophosphate (mg/l)	0.01	0.01	0.14	0.05	0.011		B		
	Dissolved Aluminium (mg/l)	-	-	-	-	-		-		
	Dissolved Arsenic (mg/l)	-	-	-	-	-		-		
	Dissolved Chromium (mg/l)	-	-	-	-	-		-		
	Dissolved Iron (mg/l)	-	-	-	-	-		-		
	Dissolved Lead (mg/l)	-	-	-	-	-		-		
	Dissolved Manganese (mg/l)	-	-	-	-	-		-		
	Dissolved Mercury (mg/l)	-	-	-	-	-		-		