



water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

REDELINGHUYS GROUNDWATER PESTICIDE CONTAMINATION INVESTIGATION

JUNE 2024



**REFERENCE NO:
GH4397**

FINAL VERSION

CLIENT:
Breede-Olifants CMA

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VERIFICATION

TITLE: REDELINGHUYS GROUNDWATER PESTICIDE CONTAMINATION INVESTIGATION				
REPORT REFERENCE: GH4397		DATE: 18/06/2024		VERSION: FINAL
COMPILED BY: SUB-DIRECTORATE GEOHYDROLOGY		COMMISSIONED BY: BREEDE-OLIFANTS CMA		
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NOTATION AND TERMS

CGS: Council for Geoscience

DoA: Department of Agriculture

DWS: Department of Water and Sanitation

EC: Electrical Conductivity

GIS: Geographical Information System

GRAII: Groundwater Resource Assessment (Phase II)

GRU: Groundwater Resource Unit

ha: Hectare

Km²: Square kilometre

m³/a: metres cubed per annum

MAP: Mean Annual Precipitation

Mbc: Meter Below Collar

Max: Maximum

Min: Minimum

mm: Millimetre

mm/a: Millimetres per annum

mS/m: milliSiemens per meter

NGA: National Groundwater Archive

SANS: South African National Standard

SAWS: South African Weather Services

TWQR: Target Water Quality Range (Department of Water Affairs and Forestry, 1996)

Aquifer: strata or a group of interconnected strata comprising saturated earth material capable of conducting groundwater and of yielding usable quantities of groundwater to borehole(s) and / or springs (a supply rate of 0.1 l/s is considered a usable quantity)

Borehole: Includes a well, excavation, or any other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer

Fault: A zone of displacement in rock formations resulting from forces of tension or compression in the earth's crust.

Fractured aquifer: An aquifer that owes its water-bearing properties to fracturing caused by folding and faulting.

Fitness-for-use: Water quality is such that it meets the requirements for a particular use. The five major groups of water users are recognised as domestic, agricultural, industrial, recreational or environmental users.

Groundwater Resource Unit: A groundwater body that has been delineated or grouped into a single significant water resource based on one or more characteristics that are similar across that unit; also referred to as a groundwater unit.

Hydrocensus or water census: is a task that involves gathering information on water features, water supply sources and sources of potential water pollution in a particular site or area.

Primary aquifer: An aquifer in which groundwater moves through the original interstices of the geological formation.

Recharge: The addition of water to the zone of saturation, either by the downward percolation of precipitation or surface water and/or the lateral migration of groundwater from adjacent aquifers.

Storativity: The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

Transmissivity: The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It is expressed as the product of the average hydraulic conductivity and thickness of the saturated portion of an aquifer.

EXECUTIVE SUMMARY

The Department of Water and Sanitation Breede-Olifants Catchment Management Agency (CMA) received an investigatory report compiled by the Department of Environmental Affairs and Development Planning regarding the alleged illegal disposal of pesticides. Subsequently the CMA conducted their own site investigation and drafted a site investigation report and requested the Sub-Directorate Geohydrology to conduct a groundwater investigation within a 4km radius of the alleged pesticide dumping site.

As a result of the hydrocensus conducted, samples were collected in accordance with best practises and sent to the laboratory for analysis of macro and trace elements and pesticides. The laboratory results illustrate elevated concentration of macro elements and in-situ parameters when measured against TWQR for domestic and irrigation use such as Cl, TDS, EC, pH, NO₃+NO₂, Na and SO₄. However based on historic data from the Sandveld Geodatabase these elevated concentration are natural conditions of the groundwater except for NO₂+NO₃ of which could be due to possible excessive use of fertilizer, concentration of cattle, sanitation infrastructure. The elevated levels of Mn could be due to the geological composition of the TMG sandstones which discharge into the primary aquifer groundwater during recharge processes.

The laboratory results of the pesticides illustrated concentrations below international drinking water standard thresholds.

It is recommended that precaution should be taken to sample the groundwater and test for the relevant constituents at an accredited laboratory to ensure the groundwater meets the "Fitness for use" i.e. The South African Water Quality Guidelines.

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1. INTRODUCTION

The Department of Water and Sanitation Breede-Olifants Catchment Management Agency (CMA) received an investigatory report (Van Wyk, 2023) compiled by the Department of Environmental Affairs and Development Planning regarding the alleged illegal disposal of pesticides. Subsequently the CMA conducted their own site investigation and drafted a site investigation report (Nakin, 2023) and requested the Sub-Directorate Geohydrology to conduct a groundwater investigation within a 4km radius of the alleged pesticide dumping site. The groundwater investigation was conducted in December 2023 and the scope of work is highlighted in section 2.

2. SCOPE OF WORK

2.1 Phase1: Review of existing data

The desktop review of existing data consisted of:

- Extracting available information from the National Groundwater Archives,
- Internal Geodatabase excel spreadsheet data,
- Literature review
- Council for Geoscience (CGS) 1:250 000 geological map series Clanwilliam 3218 and 1: 1 000 000 geological structures,
- Sandveld monitoring geosite data i.e. water levels, in-situ parameters, macro and trace hydrochemistry,
- Surveyor general 1:50 000 topocadastral map and Digital Elevation Model 20m resolution,
- Aquifer vulnerability shapefiles
- Google Earth satellite imagery,
- Groundwater use data,
- 1: 500 000 Vegter map series spatial data i.e. electrical conductivity, recharge estimated, yield potential

2.2 Phase 2: Assessment of groundwater resources

- Hydrocensus
- Groundwater sampling protocol
- Groundwater quality
- Groundwater levels
- Laboratory results

3. BACKGROUND AND REVIEW OF EXISTING DATA

3.1 Site location

The town of Redelinghuys is located ~26km Southeast from the town of Elands Bay within the quaternary drainage region G30E of the Olifants-Doorn Water Management Area (see Figure 1). The property Brainwave Agri of the alleged pesticide contamination is on the corner of Smit and Krige Street, Redelinghuys.

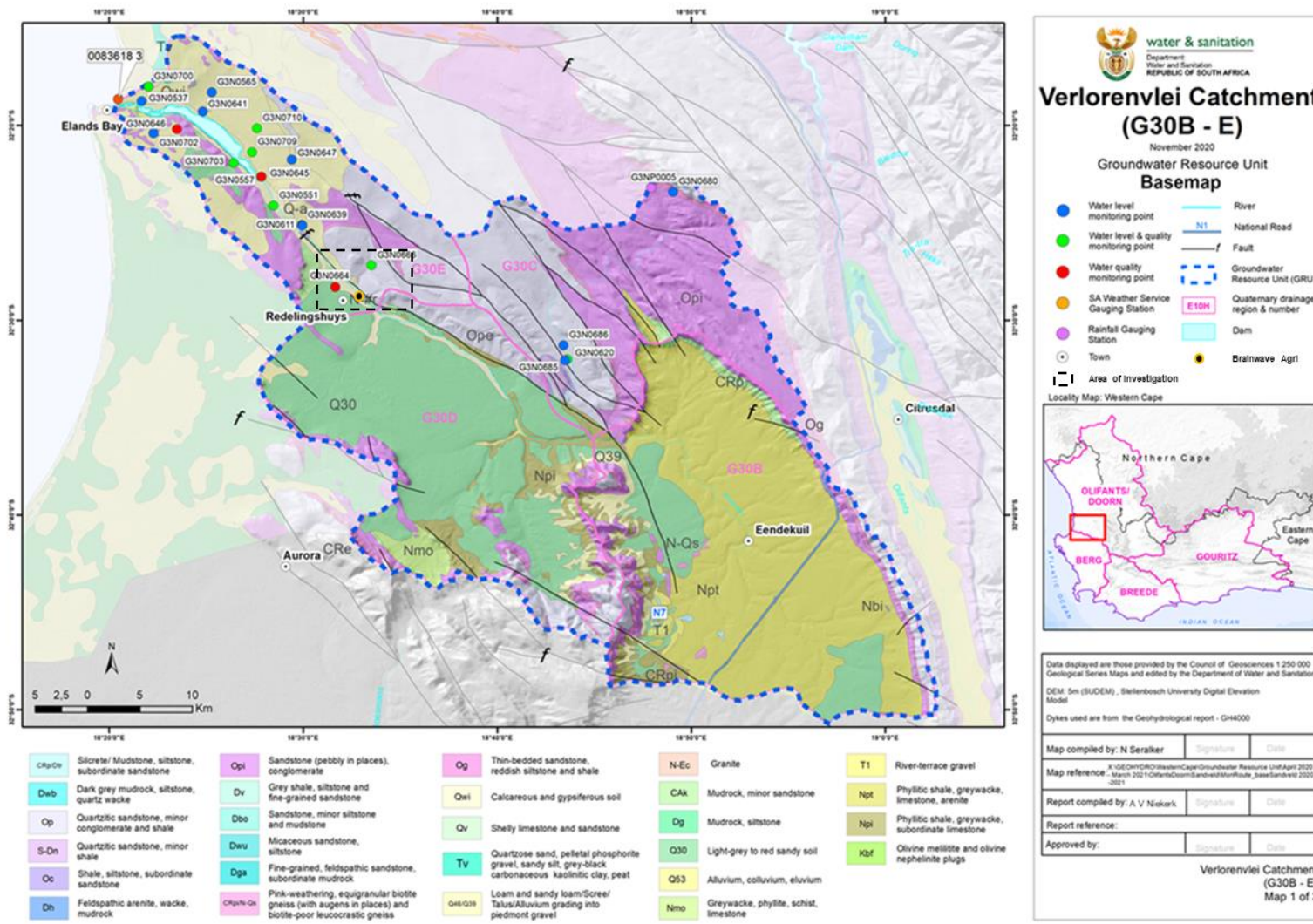


Figure 1 Locality map of Verlorenvlei catchment groundwater monitoring network and Redelinghuys area of pesticide investigation

3.2 Topography and Drainage

The town of Redelinghuys is located in the low lying flood plain area adjacent to the Verloren River where the general elevation is at 15 mamsl. North-East of the town is a higher lying area with a trig beacon elevation of 351.9 known as Bakenskop as per the 1:50 000 topographical map. The general drainage occurs mainly via the Verloren River and towards the Verlorenvlei in a North Westerly direction.

3.3 Rainfall and Climate

Based on a 23 year period of SAWS rainfall for Elands Bay, 230mm mean rainfall per annum occurs with an increasing linear slope (see Figure 2). The climate is classified as a semi-arid climate according to the Koppen climate classification (1980-2016), with hot dry summers and cold wet winters. The long term annual mean rainfall and evaporation totals are 284mm and 2396.40mm respectively. (see Figure 3).

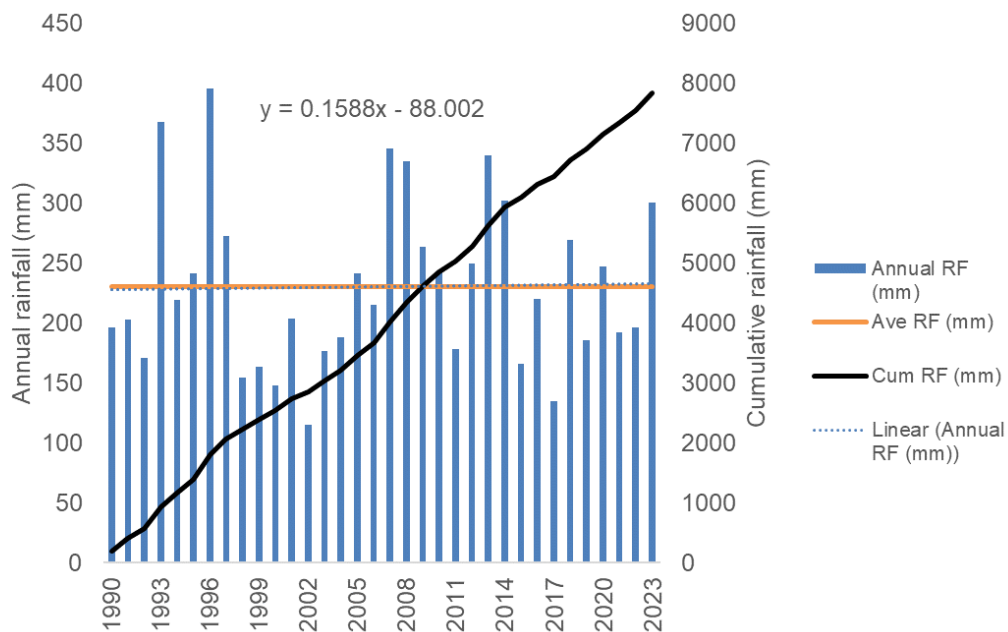


Figure 2 SAWS Elands Bay yearly rainfall

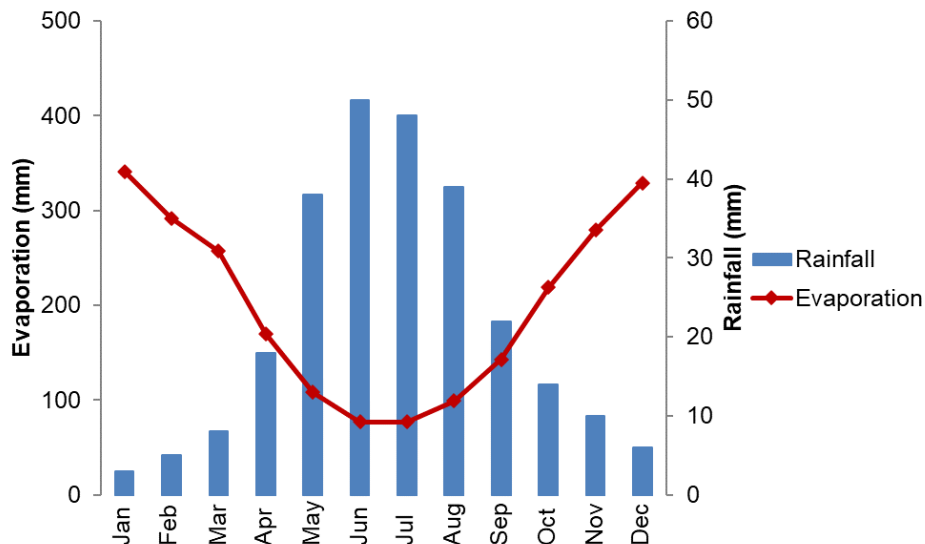


Figure 3 Redelinhuys long term monthly evaporation vs rainfall mean totals (Schulze, 2009)

3.4 Geology

The Geology of the town of Redelinhuys is of Ordovician Era, Namibian Era and Cambrian Period and is represented by the Tertiary and Quaternary formations such as alluvium and sandy loam soils, Table Mountain Group and Klipheuwel Group (see Table 1). The local area consists of the Peninsula Formation characterized by quartzitic sandstone, minor conglomerate and shale, and the Populiersbos Formation which consist of red and purple conglomerate, sandstone and shale with dewatering structures. (Johnson et al, 2006). The most prominent geological structure is the NW trending Redelinhuys fault whereby the Peninsula Formation of the North East portion of the fault moved downward against the Populiersbos Formation of the South west side of the fault (Meyer, 1986 & see Figure 4).

Table 1 Stratigraphy of Redelinhuys

Era/Period	Group	Formation
Cenozoic		Tertiary and Quaternary
Ordovician	Table Mountain Group	Peninsula
Cambrian	Klipheuwel	Populierbos

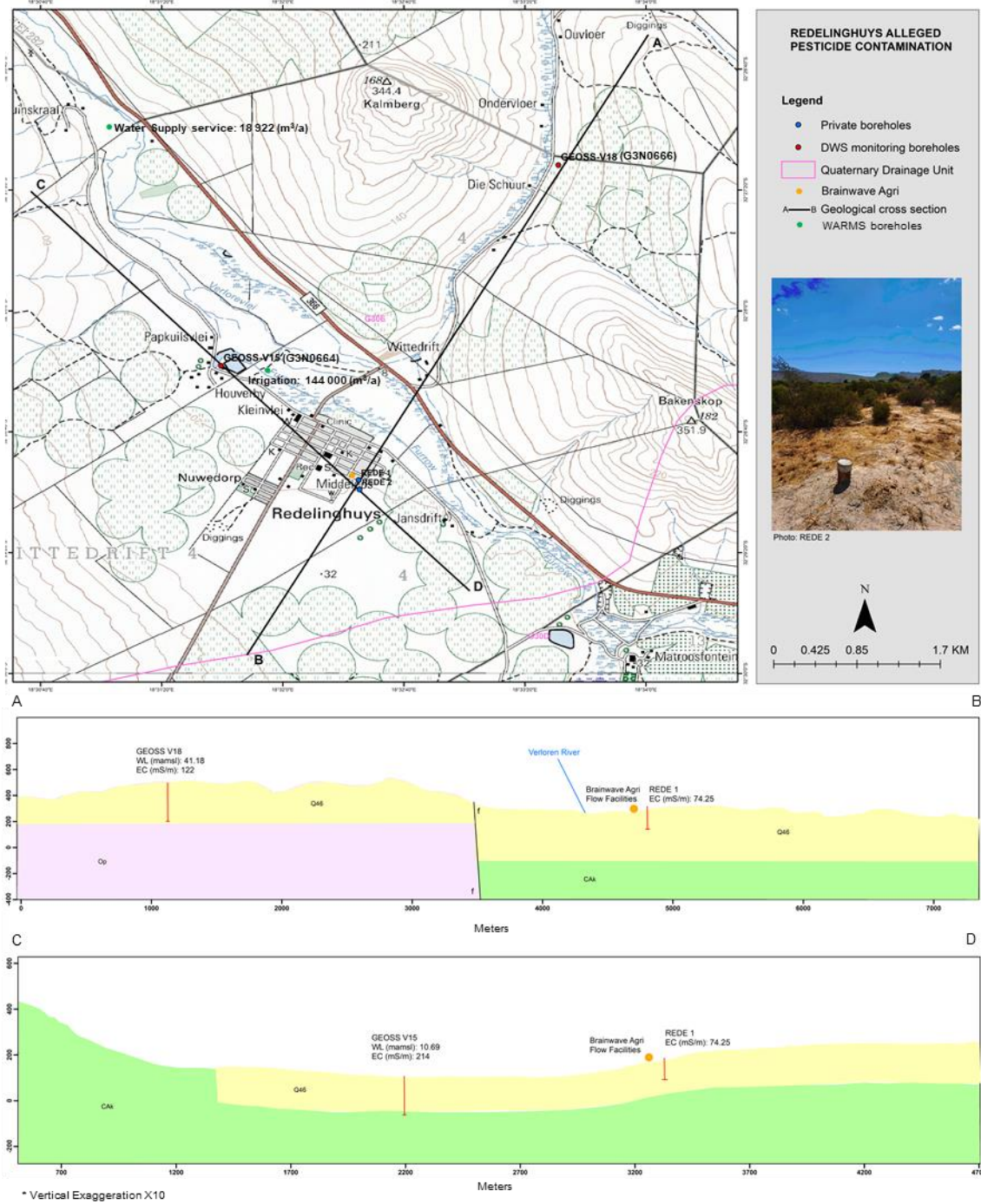


Figure 4 Geological cross section at Redelinghuys

3.5 Hydrogeology

3.5.1 Hydrogeological units

Based on the 1:250 000 CGS Geological Map Series Clanwilliam 3218, DWS Sandveld monitoring geodatabase and field observations the aquifers associated with the area are quaternary/tertiary sediments known as the primary aquifers and fractured sandstone, conglomeritic and shale rocks known as the secondary aquifers. The NW trending fault which occurs North of the town of Redelinghuys may serve as a preferential flow path for groundwater with possible high transmissivity values.

3.5.2 Groundwater flow and hydraulic gradients

Based on the regional scale, DWS Sandveld monitoring geodatabase water level data, topography, geological structures such as faults and dykes the groundwater flow direction is from the North East high lying areas to a South West direction toward the Verlorenvlei. Whereas the local scale of Redelinghuys the groundwater flow direction is from North West to South East at a gradient of 0.004m and from North East to South west at a gradient of 0.009m.

3.5.3 Groundwater recharge

In general localized recharge is low (3-5% of MAP) due to low mean annual rainfall of 230mm. However recent research has established that recharge toward of the Verlorenvlei catchment predominately occur in higher lying areas i.e. Piketberg mountain ranges whereby the fractured TMG outcrops receive high rainfall events (~800mm/a) of which is then fed into the low lying areas within the catchment (Miller et al., 2018). Studies have shown recharge values to range from 0.7-25.12% of MAP within the Verlorenvlei catchment.

3.5.4 Aquifer characteristics

The alluvial deposits or primary aquifer are estimated to reach depths of ~36m due to the construction detail of private borehole REDE 2, whereby the solid casing extended to a depth of 36m (see Table 3). Typical drilling practises would be to case off the unconsolidated material when the target geological Formation is the secondary Formations below i.e. Klipheuwel Group. Furthermore typical primary aquifer characteristics can be seen in Table 2.

Table 2 Typical Primary aquifer characteristic (Jolly, 1992):

Aquifer material	Fluvial deposits ranging from fine sand to sandy gravel
Aquifer volume	34 X 10 ⁶ m ³
Groundwater conditions	unconfined to semi-unconfined (leaky aquifer)
Saturated thickness	15m
Groundwater storage	7 X 10 ⁶ m ³
Transmissivity	350-500 m ² /day
Permeability	20 m/day
Specific yield	0.17
Pumped yield	1-12 l/s (B.O.Y 0.1-2.5 l/s)
Quality	70 mS/m

The secondary aquifers of the TMG, Peninsula Formation are known to be highly fractured and are major water bearing aquifers. Thickness of the Peninsula Formation has been documented as ranging 900-1800m (De Beer, 2003). DWS monitoring borehole (G47864) drilled into the Peninsula Fm and fault zone has a blow out yield of 5 l/s.

The Klipheuwel Group is regarded as a non-high yielding geological formation and has no water strikes recorded in the Populiersbos Formation during Departmental exploration drilling.

The Redelinghuys fault could serve as a major preferential pathway contributing to recharge into the Verlorevlei Catchment. Boreholes drilled into fault structures are known to yield very high blow out yields (25-100 l/s) and transmissivities ranging 1 000-10 000 m²/d (Nel, 2005)

3.5.5 Aquifer Vulnerability

The vulnerability of the Redelinghuys area aquifers is demarcated as moderate according to the DWS mapping shapefiles. However, it should be further noted that the aquifer in close proximity indicate shallow water levels ranging from 5.11-6.47 (mbc) measured during the site investigation (see Table 3).

3.5.6 Groundwater quality

Previous studies (Jolly, 1992 ; Nel, 2005 ; Miller et al, 2018) and existing DWS Sandveld monitoring geodatabase has illustrated that in general (using EC as an indicator) the groundwater quality is of good quality (32-146mS/m) in the primary aquifer. The Peninsula Fm is also known for good quality groundwater however tend to consist of high concentration of iron and manganese due to the geological composition. The Populiersbos Fm is known to consist of poorer groundwater quality due to the shale characteristics of the geology and slow groundwater flow properties. These coastal aquifers are also characteristic of Na-Cl type groundwater.

4. ASSESSMENT OF GROUNDWATER RESOURCES

4.1 Hydrocensus

A hydrocensus was conducted on the property of Ms Burger and 1 well point (REDE 1) was located of which was used for gardening (see Table 4 and Appendix I). All basic hydrocensus information was captured on site such as field parameters of EC, pH and Temperature. Water level could not be measured due to no conduit pipe being installed. Furthermore a second property was visited of which was owned by Mr Smit where 1 borehole (REDE 2) was located and all hydrocensus information was captured as seen in Table 4 and Appendix I GEOSS V15 and 18 are existing DWS monitoring boreholes with long term monitoring data available.

Table 3 Redelinghuys hydrocensus

Date: 14-12-2023																	
Site ID	Latitude	Longitude	Elevation (mamsl)	WL (m)	EC (mS/m)	pH	Temperature	BH depth (m)	Equipment	Owner	Collar height (m)	Drilling company	Water strikes (m)	Casing Diameter (mm)	Casing depth (m)	Comments	Use
REDE 2	-32.483	18.54038	9	6.47	74	7.88	22.4	35.45	None, open hole	Hugo Smit	0.34	Torque Projects Pty Ltd	51 ; 68 ; 96	177	36	Borehole depth was drilled to 100m - possible obstruction or borehole collapsed at 35.45m	Not in use
REDE 1	-32.482	18.5403	9		75.25	4.56	21.2	9	1.13 kw well point pump / Jetcom 102m,06-3.8m ³ /h;DAB -brand or manufacture	Elmarie Burger							Gardening
GEOSS V15	-32.472	18.52697	14	5.11	261	7.05			Submersible pump	Sebulon Boerdery; Bestuurders Tobie van Zyl & seun Danie	0.7			210		PVC casing ; Borehole is pumped into nearby dam	Irrigation
GEOSS V18	-32.453	18.55792	42	5.35	122	5.5		20	None, open hole	Dirk Van Zyl	0.25			200		PVC casing ; artesian borehole ; impacted by abstraction nearby	Not in use

*No data 

4.2 Groundwater sampling protocol

The groundwater samples were taken in line with best practise methods as stipulated in the WRC, 2017 groundwater sampling manual.

Site REDE 1 and GEOSS V15 was sampled at the outflow pipe after allowing the outflow for ~30min whilst constantly measuring the EC, pH and Temperature to ensure these parameters were constant and ensuring a representative sample was taken. Site REDE 2 and GEOSS V18 were open holes and was therefore sampled with stainless steel specific depth bailers at depths of 34m and 18m respectively. Groundwater samples were taken for macro and trace elements and pesticides and kept in cool storage and transported to Integral Laboratories for analysis.

4.3 Groundwater quality

Borehole GEOSS V18:

The EC of borehole GEOSS V18 range from 96-148 mS/m with an average of 120 mS/m over an average period of 10 years. The EC time series plot seen in Figure 5 illustrate a seasonal trend with higher EC during lower rainfall periods and lower EC during higher rainfall periods and a decreasing linear slope.

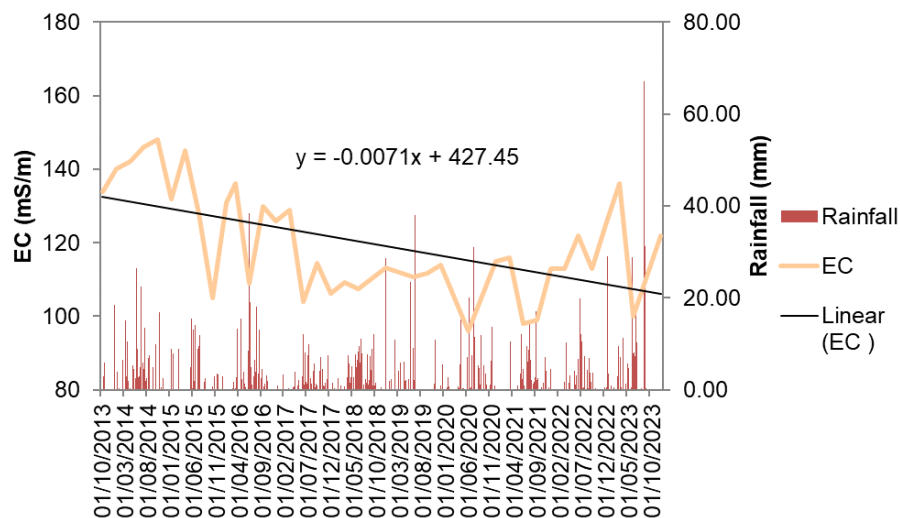


Figure 5 GEOSS V18 time series EC verse rainfall graph

The pH of borehole GEOSS V18 range from 4.69-6.78 with an average of 5.42 over an average period of 10 years. The pH time series plot seen in Figure 6 illustrate seasonal variations and tend to respond to high rainfall events, and a slight decreasing linear slope can also be observed.

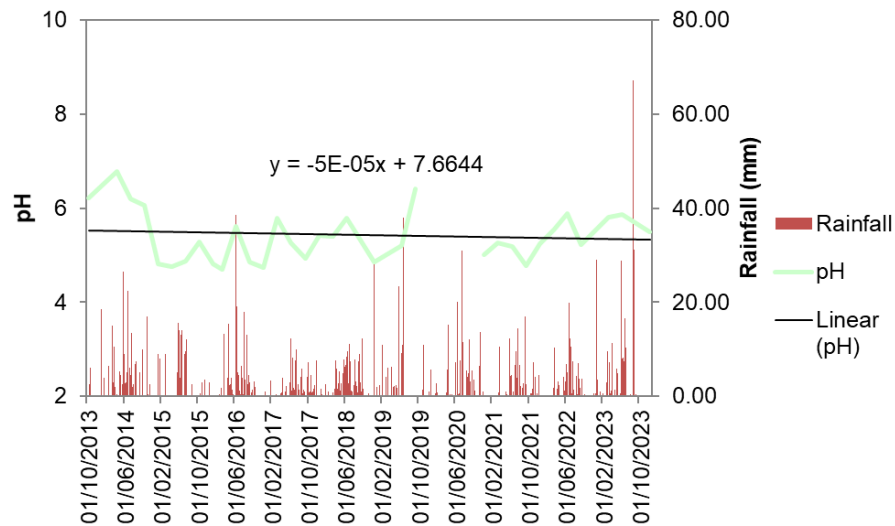


Figure 6 GEOSS V18 time series pH verses rainfall graph

Borehole GEOSS V15:

The EC of borehole GEOSS V15 range from 198-335 mS/m with an average of 273 mS/m over an average period of 10 years. The EC time series plot seen in Figure 7 illustrate a declining trend and linear slope.

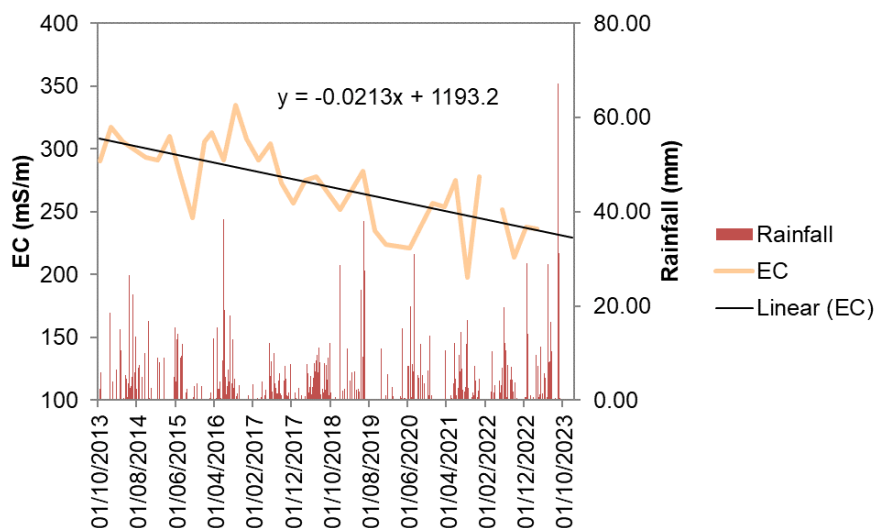


Figure 7 GEOSS V15 time series EC verses rainfall graph

The pH of borehole GEOSS V15 range from 5.06-7.85 with an average of 6.56 over an average period of 10 years. The pH time series plot seen in Figure 8 illustrate seasonal variations and tend to respond to high rainfall events, and a slight increasing linear slope can also be observed. The lowest pH (5.06) was also recorded for this borehole after the low rainfall season in 2022.

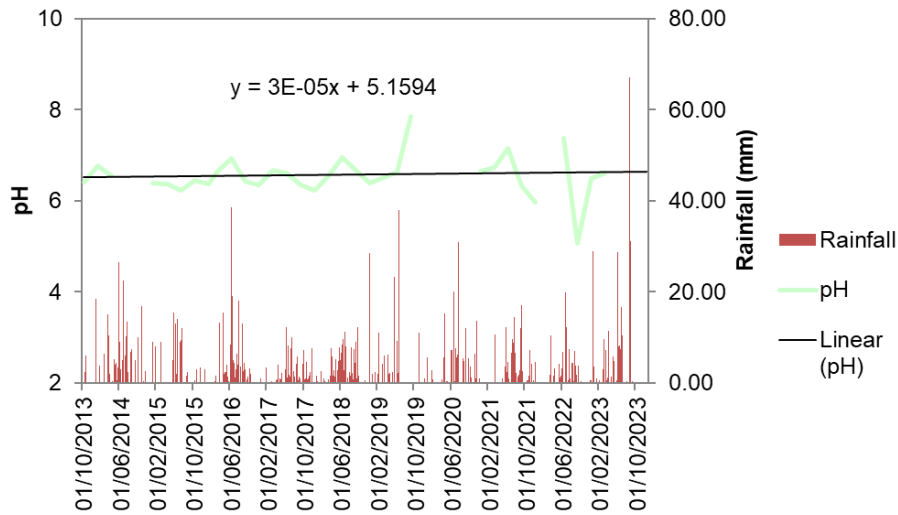


Figure 8 GEOSS V15 time series pH verses rainfall graph

The Piper diagram in Figure 9 below illustrate the typical geochemical facies of the Sodium Chloride (Na-Cl) groundwater type that can be expected for the primary aquifers of the Sandveld coastal region.

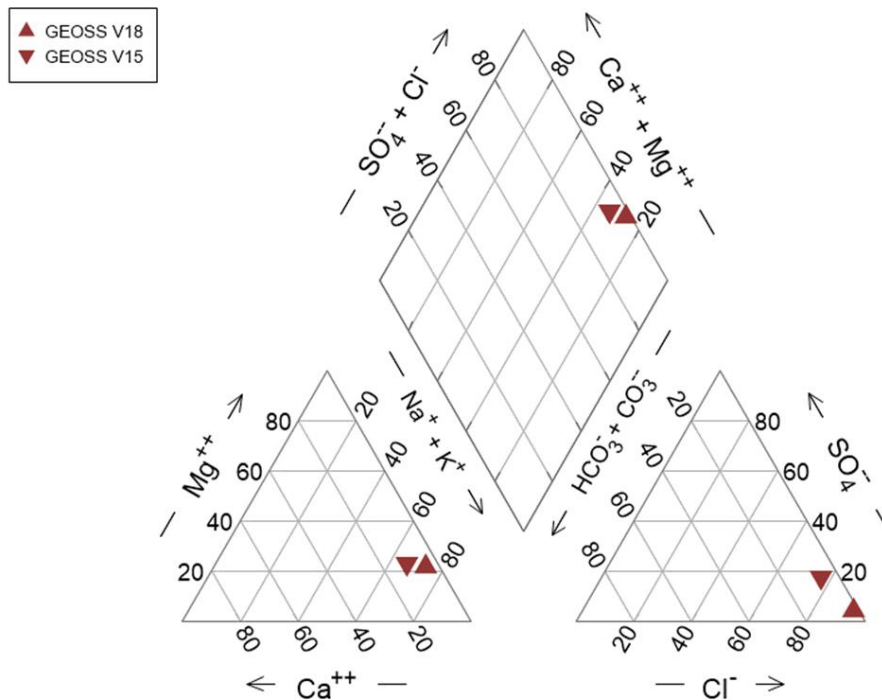


Figure 9 Piper diagram illustrating the groundwater type

4.4 Groundwater levels

Borehole GEOSS V18:

Borehole GEOSS V18 has artesian conditions possibly due to the fault structure located in a north easterly direction. The variation in water level is due to the impact of a production borehole located in close proximity ~15m. The water levels are drawn down and recover after period of no abstraction from the production borehole. These water levels can therefore be seen as stable with no definitive trend (see Figure 10).

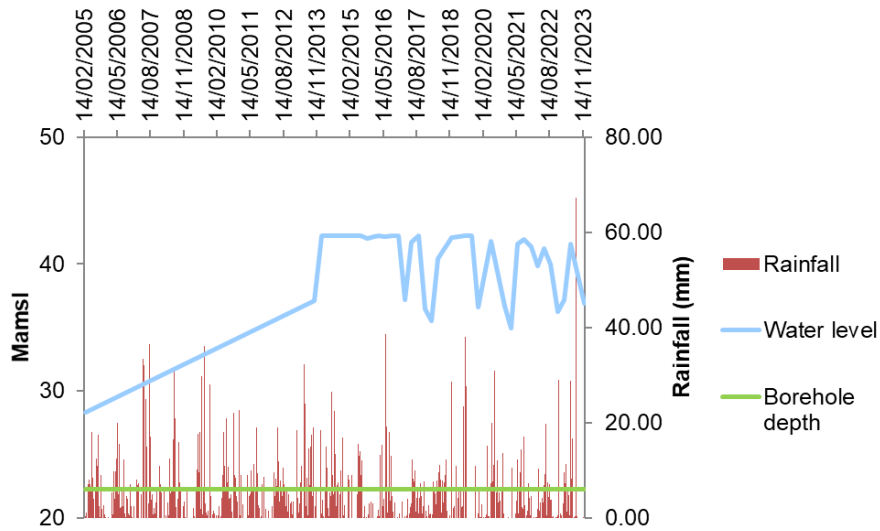


Figure 10 GEOSS V18 water level versus rainfall graph

Borehole GEOSS V15:

The variation in water level of Borehole GEOSS V15 is due to the impact of abstraction. The water levels are drawn down and recover after period of no abstraction from the production borehole. These water levels can therefore be seen as stable with no definitive trend (see Figure 11).

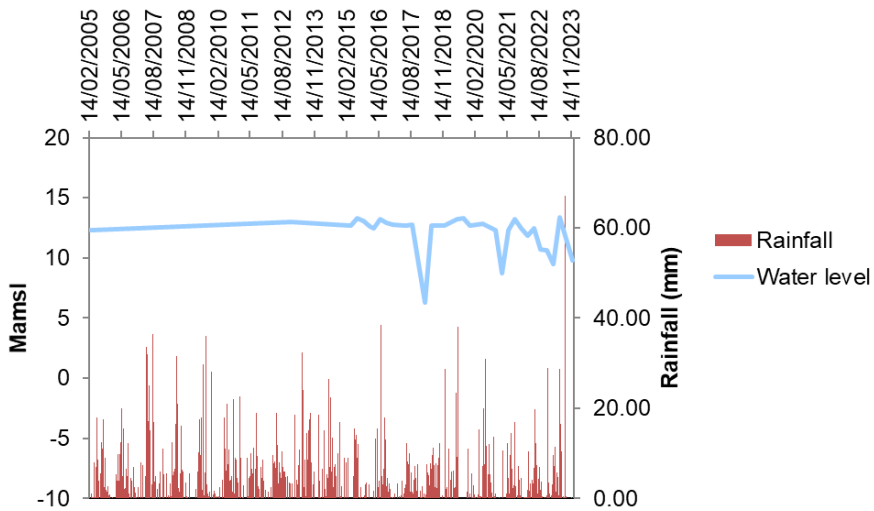


Figure 11 GEOSS V15 water level versus rainfall graph

4.5 Laboratory results

Borehole GEOSS V18:

In terms of the TWQR for macro elements the groundwater is non-compliant for elements such as Chloride (Cl), Total Dissolved Solids (TDS), Electrical Conductivity (EC), pH, Nitrate Nitrite (NO₃+NO₂), Sodium (Na). The groundwater would need to be treated before it can be consumed or blended with surface water before it is used in an irrigation scheme.

The TWQR for the trace elements are non complaint due to an elevated concentration of Manganese (Mn). The groundwater would need to be treated before it can be consumed or blended with surface water or aerated before it is used in an irrigation scheme.

Table 4 Borehole GEOSS V18 Macro elements:

TWQR Domestic use (mg/l)	0-32	0-100	0-450	0-70	6-9	0-1	0-50	0-30	0-1	0-6	0-100	*	0-200	*	*	*
TWQR Irrigation (mg/l)		100	260	40	6.5-8.4	2	*	*	*	*	70	*	*	*	*	*
Sample date	Ca (mg/l)	Cl (mg/l)	TDS (mg/l)	EC (mS/m)	pH	F (mg/l)	K (mg/l)	Mg (mg/l)	NH ₄ (mg/l)	NO ₃ +NO ₂ (mg/l)	Na (mg/l)	PO ₄ (mg/l)	SO ₄ (mg/l)	Si (mg/l)	TAL (mg/l)	HCO ₃ (mg/l)
14/12/2024	8.56	287	804.00	120	5.22	0.09	3.3	24.8	0.1	16.5	176	0.46	21	5.81	10	3.42

* No Threshold

Table 5 Borehole GEOSS V18 Trace elements:

TWQR Domestic use (mg/l)	0-0.15	0-0.01	*	*	*	0-0.005	*	0-0.05	0-1	0-0.1	0-0.05	*	*	0-0.01	*	*	0-0.1	0-3	*
TWQR Irrigation (mg/l)	0-5	0.1	0.5	*	0.1	0.01	0.05	0.1	0.2	5	0.02	0.01	0.2	0.2	*	*	0.1	1	*
Sample date	Al (mg/l)	As (mg/l)	B (mg/l)	Ba (mS/m)	Be (mg/l)	Cd (mg/l)	Co (mg/l)	Cr (mg/l)	Cu (mg/l)	Fe (mg/l)	Mn (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb (mg/l)	Sr (mg/l)	Ti (mg/l)	V (mg/l)	Zn (mg/l)	Zr (mg/l)
14/12/2024	0.017	0.005	0.108	0.05	0.005	0.001	0.005	0.005	0.02	0.02	0.151	0.02	0.005	0.003	0.114	0.0134	0.005	0.05	0.004

* No Threshold

Borehole GEOSS V15:

In terms of the TWQR for macro elements the groundwater is non-compliant for elements such as Cl, TDS, EC, Magnesium (Mg), NO3+NO2, Na and Sulphate (SO4). The groundwater would need to be treated before it can be consumed or blended with surface water before it is used in an irrigation scheme.

The TWQR for the trace elements are non complaint due to a slightly elevated concentration of Mn for irrigation. The groundwater would need to be blended with surface water or aerated before it is used in an irrigation scheme.

Borehole GEOSS V15:

Table 6 Borehole GEOSS V 15 Macro elements:

TWQR Domestic use (mg/l)	0-32	0-100	0-450	0-70	6-9	0-1	0-50	0-30	0-1	0-6	0-100	*	0-200	*	*	*
TWQR Irrigation (mg/l)		100	260	40	6.5-8.4	2	*	*	*	*	70	*	*	*	*	*
Sample date	Ca (mg/l)	Cl (mg/l)	TDS (mg/l)	EC (mS/m)	pH	F (mg/l)	K (mg/l)	Mg (mg/l)	NH4 (mg/l)	NO3+NO2 (mg/l)	Na (mg/l)	PO4 (mg/l)	SO4 (mg/l)	Si (mg/l)	TAL (mg/l)	HCO3 (mg/l)
14/12/2024	52.3	679	1728	258	6.76	0.06	23	63.7	0.11	15.3	379	0.68	214	1.14	53	64.7

* No Threshold

Table 7 Borehole GEOSS V15 Trace elements:

TWQR Domestic use (mg/l)	0-0.15	0-0.01	*	*	*	0-0.005	*	0-0.05	0-1	0-0.1	0-0.05	*	*	0-0.01	*	*	0-0.1	0-3	*
TWQR Irrigation (mg/l)	0-5	0.1	0.5	*	0.1	0.01	0.05	0.1	0.2	5	0.02	0.01	0.2	0.2	*	*	0.1	1	*
Sample date	Al (mg/l)	As (mg/l)	B (mg/l)	Ba (mS/m)	Be (mg/l)	Cd (mg/l)	Co (mg/l)	Cr (mg/l)	Cu (mg/l)	Fe (mg/l)	Mn (mg/l)	Mo (mg/l)	Ni (mg/l)	Pb (mg/l)	Sr (mg/l)	Ti (mg/l)	V (mg/l)	Zn (mg/l)	Zr (mg/l)
14/12/2024	0.01	0.005	0.541	0.1	0.005	0.001	0.005	0.005	0.02	0.02	0.0301	0.02	0.005	0.003	0.409	0.0459	0.005	0.05	0.004

* No Threshold

Based on the lab results obtained from Integral Laboratories the detection of 106 pesticides analysed are well below international drinking water standards illustrated in Table 8.

Table 8 Summary of international standards for pesticides in drinking water (mg/l) after London et al 2005 verses lab results

Type of Standard:	USEPA							Lab Results: 14/12/2023					
	MCL standard	Child advisories			Adult advisories		Advisory at 10-4 cancer risk	Australian	WHO	GEOSS V18	GEOSS V15	REDE 1	REDE 2
		1 day	10 day	Longer term	Longer term	DWEL							
Pesticide													
Chlordecone										0	0	0	0
Propazine		1	1	0.5	2	0.7	0.01		0.05	0.00001	0.00001	0.00001	0.00001
2,4,6-Trichlorophenol										0.0002	0.0002	0.0002	0.0002
2,4-DB										0.00002	0.00002	0.00002	0.00002
2,4-DDE										0.0002	0.0002	0.0002	0.0002
2,4-DDE										0.0002	0.0002	0.0002	0.0002
2,4-DDT										0.0002	0.0002	0.0002	0.0002
4,4-DDD										0.0002	0.0002	0.0002	0.0002
4,4-DDE										0.0002	0.0002	0.0002	0.0002
4,4-DDT										0.0002	0.0002	0.0002	0.0002
Alachlor	0.002	0.1	0.1			0.4		0.04	0.002	0.02	0.00001	0.00001	0.00001
Aldicarb	0.003	0.01	0.01			0.035	0.007		0.001	0.01	0.00002	0.00002	0.00002
Aldicarb Sulfone	0.003	0.01	0.01			0.035	0.007				0.00002	0.00002	0.00002
Aldicarb Sulfoxide	0	0.01	0.01			0.035	0.007				0.00002	0.00002	0.00002
Aldrin			0.0003	0.0003	0.0003	0.001		0.0003	0.0003	0.00003	0.0002	0.0002	0.0002
Aldrin & Dieldrin (combined)											0.00002	0.00002	0.00002
Ametryn		9	9	0.9	3	0.3	0.06		0.05		0.0002	0.0002	0.0002
Amicarbazone											0.0005	0.0005	0.0005
Atrazine	0.003	0.1	0.1	0.05	0.2	0.2	0.003		0.02	0.002	0.0005	0.0005	0.0005
Azinphos-ethyl											0.0001	0.0001	0.0001
Azinphos-methyl											0.0001	0.0001	0.0001
Bentazone											0.000005	0.000005	0.000005
Bromacil		5	5	3	9	5	0.09		0.3		0.000005	0.000005	0.000005
Carbendazime											0.00002	0.00002	0.00002
Carbofuran	0.04	0.05	0.05	0.05	0.2	0.2	0.04		0.01	0.007	0.00001	0.00001	0.00001
Chlordane	0.002	0.06	0.06			0.002		0.003	0.001	0.0002	0.0002	0.0002	0.0002
Chlordane (Trans _ Gamma)											0.0002	0.0002	0.0002
Chlorotoluron		0.03	0.03	0.03	0.1	0.1	0.02		0.03		0.00001	0.00001	0.00001
Chlorpyrifos											0.0002	0.0002	0.0002
Clofibric Acid											0.00001	0.00001	0.00001
Clopyralid											0.0002	0.0002	0.0002
Cyanazine										0.0006	0.00002	0.00002	0.00002
DDT & Metabolites											0.0002	0.0002	0.0002
DEET (Diethyltoluamide)											0.0002	0.0002	0.0002
Diazinon		0.02	0.02	0.005	0.02	0.003	0.0006		0.003		0.0002	0.0002	0.0002
Dicamba											0.0002	0.0002	0.0002
Dichlorprop										0.1	0.00002	0.00002	0.00002
Dichlorvos											0.00002	0.00002	0.00002
Dieldrin		0.0005	0.0005	0.0005	0.002	0.002		0.0002	0.0003	0.00003	0.0002	0.0002	0.0002
Dimethoate										0.006	0.00001	0.00001	0.00001
Dinoseb											0.00001	0.00001	0.00001
Diuron											0.0002	0.0002	0.0002
Endosulphan (Alpha)											0.0002	0.0002	0.0002
Endosulphan (Beta)											0.0002	0.0002	0.0002
Endothall	0.1	0.8	0.8	0.2	0.2	0.7	0.1		0.1		0.0002	0.0002	0.0002
Endrin										0.0006	0.0002	0.0002	0.0002
Ethion											0.00001	0.00001	0.00001
Ethoprop											0.0002	0.0002	0.0002
Fenoprop										0.009	0.00005	0.00005	0.00005
Fenthion											0.00005	0.00005	0.00005
Fluazifop											0.00005	0.00005	0.00005
Glyphosate		20	20	1	1	4	0.7		1		0.0001	0.0001	0.0001
Haloxifop											0.00001	0.00001	0.00001
HCH _ Alpha											0.0002	0.0002	0.0002
HCH _ Beta											0.0002	0.0002	0.0002
HCH _ Delta											0.0002	0.0002	0.0002
HCH _ Epsilon											0.0002	0.0002	0.0002
HCH _ Gamma											0.0002	0.0002	0.0002
Heptachlor	0.0004	0.01	0.01	0.005	0.005	0.02		0.0008	0.0003	0.00003	0.00002	0.00002	0.00002
Heptachlor Epoxide (cis & trans)	0.0002	0.01	0.01	0.0001	0.0001	0.0004		0.0004	0.0003	0.00003	0.00002	0.00002	0.00002
Imidacloprid											0.00002	0.00002	0.00002
Isodrin											0.0002	0.0002	0.0002
Isoproturon										0.009	0.000005	0.000005	0.000005
Malathion		0.2	0.2	0.2	0.8	0.8	0.1				0.00001	0.00001	0.00001
MCPA			0.1	0.1	0.4	0.02	0.004			0.002	0.00005	0.00005	0.00005
MCPB											0.00005	0.00005	0.00005
Mecoprop										0.001	0.00005	0.00005	0.00005
Methoxychlor	0.04	0.05	0.05	0.05	0.2	0.2	0.04		0.3	0.02	0.0002	0.0002	0.0002
Metolachlor		2	2	2	5	3.5	0.07		0.3	0.01	0.00005	0.00005	0.00005
Molinate										0.006	0.00001	0.00001	0.00001
Pendimethalin										0.02	0.0002	0.0002	0.0002
Picloram	0.5	20	20	0.7	2	2	0.5		0.3		0.0002	0.0002	0.0002
Pinmicarb											0.00002	0.00002	0.00002
Prometon		0.2	0.2	0.2	0.5	0.5	0.1				0.00005	0.00005	0.00005
Prometryn											0.00002	0.00002	0.00002
Propoxur											0.0002	0.0002	0.0002
Simazine	0.004	0.004	0.07	0.07	0.07	0.2	0.004		0.02	0.002	0.000005	0.000005	0.000005
Tebuthiuron		3	3	0.7	2	2	0.5				0.0002	0.0002	0.0002
Terbutylazine											0.00002	0.00002	0.00002
Terbutryn											0.00005	0.00005	0.00005
Triclopyr											0.0001	0.0001	0.0001
Trifluralin		0.08	0.08	0.08	0.3	0.3	0.005	0.5	0.05	0.02	0.0005	0.0005	0.0005
Mirex											0.0002	0.0002	0.0002
Parathion-ethyl											0.00005	0.00005	0.00005
Parathion-methyl											0.00005	0.00005	0.00005

*MCL: Maximum contaminant level

*DWEL: Drinking water equivalent level

5. CONCLUSIONS AND RECOMMENDATIONS

The laboratory results illustrate elevated concentration of macro elements and in-situ parameters such as Cl, TDS, EC, pH, NO₃+NO₂, Na and SO₄. However based on historic data illustrated in section 4.2 and Appendix II all these elevated concentration are natural conditions of the groundwater except for NO₂+NO₃ of which could be due to possible over use of fertilizer, concentration of cattle, sanitation infrastructure. The elevated levels of Mn could be due to the geological composition of the TMG sandstones which discharge into the primary aquifer groundwater during recharge processes.

The laboratory results of the pesticides illustrated concentrations below international drinking water standard thresholds.

It is recommended that in the event the localized groundwater is to be used for drinking water or irrigation, precaution should be taken to sample the groundwater and test for the relevant constituents at an accredited laboratory to ensure the groundwater meets the “Fitness for use” or relevant thresholds recommended in guidelines i.e. The South African Water Quality Guidelines.

6. REFERENCES

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7. APPENDIX I – FIELDWORK PHOTOS



(a) Well point infrastructure



(b) 1.13kw well point pump



(c) Well point irrigation inflow and outflow network



(b) Well point outflow sampling point

Figure 12 REDE 1 (well point site)



(a) Borehole photo taken in direction of Kalmberg



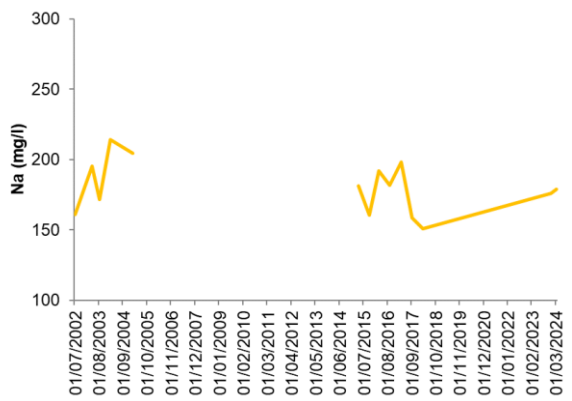
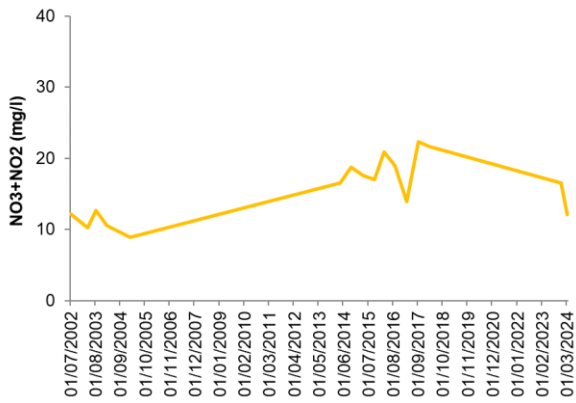
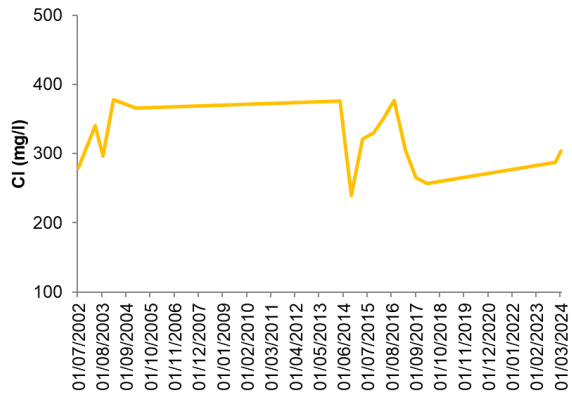
(a) Measuring borehole depth



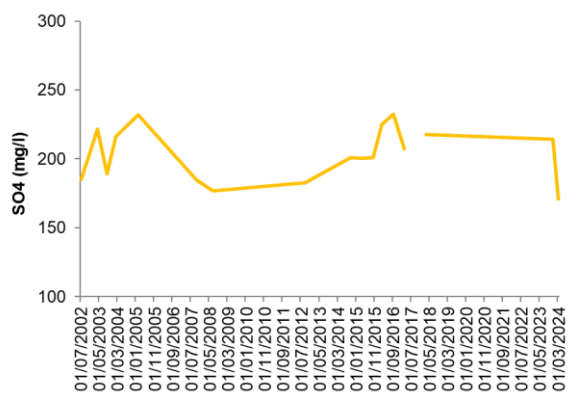
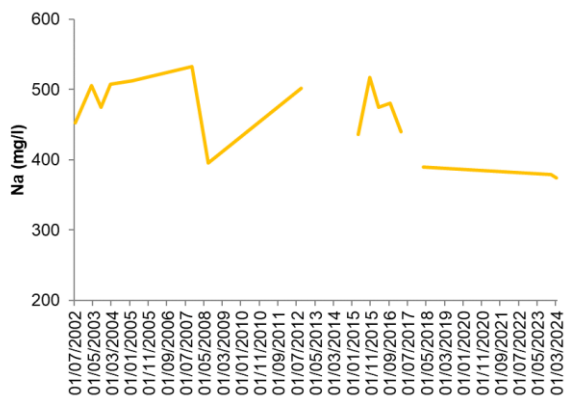
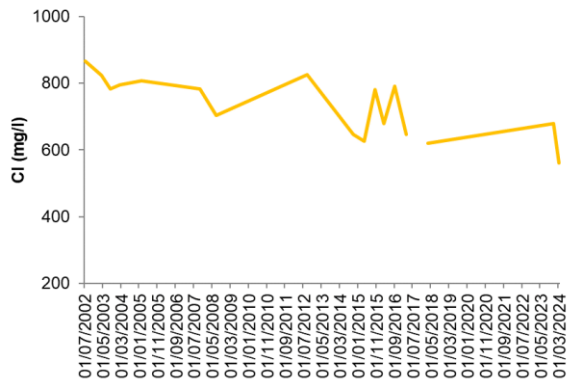
(a) Measuring water level

Figure 13 REDE 2 (borehole site)


8. APPENDIX II – HISTORIC MACRO ELEMENT DATA
GEOSS V18 borehole:



GEOSS V 15 borehole




9. APPENDIX III – MACRO AND TRACE ELEMENT LABORATORY CERTIFICATES OF ANALYSIS



**INTEGRAL
LABORATORIES**

Integral Laboratories (Pty) Ltd
No 1 Zandevyk Park, Sandringham Close Paarl, 7848
Tel: 021 863 1238 Fax: 086 635 8874
Email: westerncape@integralabs.co.za



sanas
Testing Laboratory

T0417

Certificate Of Analysis

Company: Department of Water and Sanitation (Bellville) Address: Berg-Olifants WMA Bellville-Spectrum Building Bellville South Africa Contact: Ashton Van Niekerk	Service Request Number: PW-2023-42326 Date of Certificate: 14-March-2024 Date Completed: 14-March-2024 Date of Sampling: 14-December-2023 Date of Receipt at Lab: 21-December-2023
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Sample Identification:		GEOSS-V16				
Sample Number:	Sampling Time:	Sample Condition:	Remark:			
PW-23-140382	16:34 pm		GEOSS-V16			
Chemical	Method	Unit	Limit	Result	Analysis Date	
Zirconium as Zr	M16	µg/L		<4.00	2024-03-14	
Physical / Aesthetic Parameters		Method	Unit	Limit	Result	Analysis Date
Alkalinity - Total as CaCO3		M7	mg/L		63.0	2023-12-29
Bicarbonate as HCO3-		M42	mg/L		64.7	2023-12-29
Electrical Conductivity @ 25°C		M4	mS/m		268	2023-12-29
pH @ 25°C		M6	pH units		6.76	2023-12-29
Total Dissolved Solids		Calc	mg/L		1728	2024-03-14
Chemistry (Macro) Parameters		Method	Unit	Limit	Result	Analysis Date
Ammonium (NH4)		M44	mg/L		0.11	2024-01-10
Calcium as Ca		M18	mg/L		62.3	2024-01-05
Chloride as Cl-		M44	mg/L		679	2024-01-10
Fluoride as F-		M44	mg/L		0.06	2024-01-16
Magnesium as Mg		M18	mg/L		63.7	2024-01-05
Nitrate + Nitrite (NO3-N + NO2-N)		Calc	mg/L		16.3	2024-03-14
Nitrate as Nitrogen		M44	mg/L		15.24908	2024-01-17
Nitrite as N		M44	mg/L		0.06442	2024-01-17
Orthophosphate as P		M44	mg/L		0.68	2024-01-10
Potassium as K		M18	mg/L		23.0	2024-01-05
Sodium as Na		M18	mg/L		379	2024-01-05
Sulphate as SO4²-		M44	mg/L		214	2024-01-10
Zinc as Zn		M16	mg/L		<0.06	2024-01-11
Chemistry (Micro) Parameters		Method	Unit	Limit	Result	Analysis Date
Aluminium as Al		M16	µg/L		<10.0	2024-03-14
Arsenic as As		M16	µg/L		<6.00	2024-01-10
Barium as Ba		M16	µg/L		100	2024-01-10
Beryllium as Be		M16	µg/L		<6.00	2024-01-10
Boron as B		M16	µg/L		641	2024-01-10

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Certificate Of Analysis

Company:	Department of Water and Sanitation (Bellville)	Service Request Number:	PW-2023-42326
Address:	Berg-Olifants WMA	Date of Certificate:	14-March-2024
	Bellville-Spectrum Building	Date Completed:	14-March-2024
	Bellville	Date of Sampling:	14-December-2023
	South Africa	Date of Receipt at Lab:	21-December-2023
Contact:	Ashton Van Niekerk		

Chemistry (Micro) Parameters	Method	Unit	Limit	Result	Analysis Date
Cadmium as Cd	M16	µg/L		<1.00	2024-01-10
Chromium as Cr	M16	µg/L		<6.00	2024-01-10
Cobalt as Co	M16	µg/L		<6.00	2024-01-10
Copper as Cu	M16	µg/L		<20.0	2024-01-10
Iron as Fe	M16	µg/L		<20.0	2024-01-10
Lead as Pb	M16	µg/L		<3.00	2024-01-10
Manganese as Mn	M16	µg/L		30.1	2024-01-10
Molybdenum as Mo	M16	µg/L		<20.0	2024-01-11
Nickel as Ni	M16	µg/L		<6.00	2024-01-11
Silicon as Si	M44	mg/L		1.14	2024-01-10
Strontium as Sr	M16	µg/L		409	2024-01-11
Titanium as Ti	M16	µg/L		46.9	2024-01-11
Vanadium as V	M16	µg/L		<6.00	2024-01-11
Zinc as Zn	M16	mg/L		<0.06	2024-01-11

Certificate Of Analysis

Company:	Department of Water and Sanitation (Bellville)	Service Request Number:	PW-2023-42326
Address:	Berg-Olifants WMA	Date of Certificate:	14-March-2024
	Belville-Spectrum Building	Date Completed:	14-March-2024
	Belville	Date of Sampling:	14-December-2023
	South Africa	Date of Receipt at Lab:	21-December-2023
Contact:	Achton Van Niekerk		

Sample Identification: GEOSS-V18					
Sample Number:	PW-23-140383	Sampling Time:	13:43 pm	Sample Condition:	Remark: GEOSS-V18
Chemical	Method	Unit	Limit	Result	Analysis Date
Zirconium as Zr ⁺	M16	µg/L		<4.00	2024-03-14
Physical / Aesthetic Parameters					
Method	Unit	Limit	Result	Analysis Date	
Alkalinity - Total as CaCO ₃	M7	mg/L		<10.0	2023-12-29
Bicarbonate as HCO ₃ ⁻	M42	mg/L		3.42	2023-12-29
Electrical Conductivity @ 25°C	M4	mS/m		120	2023-12-29
pH @ 25°C	M6	pH units		6.22	2023-12-29
Total Dissolved Solids	Calc	mg/L		804	2024-03-14
Chemistry (Macro) Parameters					
Method	Unit	Limit	Result	Analysis Date	
Ammonium (NH ₄)	M44	mg/L		<0.10	2024-01-10
Calcium as Ca	M18	mg/L		8.66	2024-01-05
Chloride as Cl ⁻	M44	mg/L		287	2024-01-10
Fluoride as F ⁻	M44	mg/L		0.09	2024-01-16
Magnesium as Mg	M18	mg/L		24.8	2024-01-05
Nitrate + Nitrite (NO ₃ -N + NO ₂ -N)	Calc			16.6	2024-03-14
Nitrate as Nitrogen	M44	mg/L		16.63904	2024-01-17
Nitrite as N	M44	mg/L		<0.06	2024-01-17
Orthophosphate as P	M44	mg/L		0.46	2024-01-10
Potassium as K	M18	mg/L		3.30	2024-01-05
Sodium as Na	M18	mg/L		176	2024-01-05
Sulphate as SO ₄ ²⁻	M44	mg/L		21.0	2024-01-10
Zinc as Zn	M16	mg/L		<0.06	2024-01-11
Chemistry (Micro) Parameters					
Method	Unit	Limit	Result	Analysis Date	
Aluminium as Al	M16	µg/L		17.0	2024-03-14
Arsenic as As	M16	µg/L		<6.00	2024-01-10
Barium as Ba	M16	µg/L		<60.0	2024-01-10
Beryllium as Be	M16	µg/L		<6.00	2024-01-10
Boron as B	M16	µg/L		108	2024-01-10

Certificate Of Analysis

Company:	Department of Water and Sanitation (Belville)	Service Request Number:	PW-2023-42326
Address:	Berg-Olifants WMA	Date of Certificate:	14-March-2024
	Belville-Spectrum Building	Date Completed:	14-March-2024
	Belville	Date of Sampling:	14-December-2023
	South Africa	Date of Receipt at Lab:	21-December-2023
Contact:	Ashton Van Niekerk		

Chemistry (Micro) Parameters	Method	Unit	Limit	Result	Analysis Date
Cadmium as Cd	M16	µg/L		<1.00	2024-01-10
Chromium as Cr	M16	µg/L		<6.00	2024-01-10
Cobalt as Co	M16	µg/L		<6.00	2024-01-10
Copper as Cu	M16	µg/L		<20.0	2024-01-10
Iron as Fe	M16	µg/L		<20.0	2024-01-10
Lead as Pb	M16	µg/L		<3.00	2024-01-10
Manganese as Mn	M16	µg/L		161	2024-01-10
Molybdenum as Mo	M16	µg/L		<20.0	2024-01-11
Nickel as Ni	M16	µg/L		<6.00	2024-01-11
Silicon as Si	M44	mg/L		6.81	2024-01-10
Strontium as Sr	M16	µg/L		114	2024-01-11
Titanium as Ti	M16	µg/L		13.4	2024-01-11
Vanadium as V	M16	µg/L		<6.00	2024-01-11
Zinc as Zn	M16	mg/L		<0.06	2024-01-11

10. APPENDIX IV – PESTICIDE LABORATORY CERTIFICATES OF ANALYSIS



Integral Laboratories (Pty) Ltd
 No 1 Zandwyk Park, Sandringham Close Paarl, 7646
 Tel: 021 863 1238 Fax: 086 635 8874
 Email: westerncape@integralabs.co.za

Amended Certificate Of Analysis

Company:	Department of Water and Sanitation (Belville)	Service Request Number:	PW-2023-42321-A
Address:	Berg-Olifants WMA	Date of Certificate:	03-April-2024
	Belville-Spectrum Building	Date Completed:	27-March-2024
	Belville	Date of Sampling:	14-December-2023
	South Africa	Date of Receipt at Lab:	21-December-2023
Contact:	Ashton Van Niekerk		

Sample Identification:		REDE2 (ODWMA)					
Sample Number:	PW-23-140279	Sampling Time:	16:03 PM	Sample Condition:	Chilled	Remark:	
Chemical	Method	Unit	Limit	Result	Analysis Date		
Chlordecone		µg/L		0	2024-03-26		
Propazine	M176	µg/L		<-0.010	2024-03-21		
Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date		
2,4,6-Trichlorophenol	M176	µg/L		<-0.200	2024-03-21		
2,4-DB	M176	µg/L		<-0.020	2024-03-21		
2,4-DDD	M176	µg/L		<-0.200	2024-03-26		
2,4-DDE	M176	µg/L		<-0.200	2024-01-05		
2,4-DDT	M176	µg/L		<-0.200	2024-01-05		
4,4-DDD	M176	µg/L		<-0.200	2024-01-05		
4,4-DDE	M176	µg/L		<-0.200	2024-01-05		
4,4-DDT	M176	µg/L		<-0.200	2024-01-05		
Alachlor	M176	µg/L		<-0.010	2024-03-21		
Aldicarb	M176	µg/L		<-0.020	2024-03-21		
Aldicarb Sulfone	M176	µg/L		<-0.020	2024-03-21		
Aldicarb Sulfoxide	M176	µg/L		<-0.020	2024-03-21		
Aldrin	M176	µg/L		<-0.200	2024-01-05		
Aldrin & Dieldrin (combined)	M176	µg/L		<-0.020	2024-01-05		
Ametryn	M176	µg/L		<-0.200	2024-03-21		
Anicarbazono	M176	µg/L		<-0.60	2024-03-21		
Atrazine	M177	µg/L		<-0.600	2024-03-21		
Azinphos-ethyl	M176	µg/L		<-0.100	2024-03-21		
Azinphos-methyl	M176	µg/L		<-0.100	2024-03-21		
Bentazone	M176	µg/L		<-0.006	2024-03-21		
Bromacil	M176	µg/L		<-0.006	2024-03-21		
Carbendazime	M176	µg/L		<-0.020	2024-03-21		
Carbofuran	M176	µg/L		<-0.010	2024-03-21		
Chlordane	M176	µg/L		<-0.200	2024-03-26		
Chlordane (Trans_Gamma)	M176	µg/L		<-0.200	2024-03-26		
Chlorotoluron	M176	µg/L		<-0.010	2024-03-21		

INTEGRAL LABORATORIES

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 Email: westerncape@integrallabs.co.za

Amended Certificate Of Analysis

Company:	Department of Water and Sanitation (Bellville)	Service Request Number:	PW-2023-42321-A
Address:	Berg-Olifants WMA	Date of Certificate:	03-April-2024
	Bellville-Spectrum Building	Date Completed:	27-March-2024
	Bellville	Date of Sampling:	14-December-2023
	South Africa	Date of Receipt at Lab:	21-December-2023
Contact:	Ashton Van Niekerk		

Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date
Chlorpyrifos	M177	µg/L		<0.200	2024-03-21
Clofibric Acid	M176	µg/L		<0.010	2024-03-21
Clopyralid	M176	µg/L		<0.200	2024-03-21
Cyflazifop	M176	µg/L		<0.020	2024-03-21
DDT & Metabolites	M176	µg/L		<0.200	2024-03-26
DEET (Diethyltoluamide)	M176	µg/L		<0.200	2024-03-26
Diazinon	M176	µg/L		<0.200	2024-01-05
Dicamba	M176	µg/L		<0.200	2024-03-21
Dichlorprop	M176	µg/L		<0.020	2024-03-21
Dichlorvos	M176	µg/L		<0.020	2024-03-21
Dieldrin	M176	µg/L		<0.200	2024-01-05
Dimethoate	M176	µg/L		<0.010	2024-03-21
Dinoseb	M176	µg/L		<0.010	2024-03-27
Diuron	M176	µg/L		<0.20	2024-03-21
Endosulphan (Alpha)	M176	µg/L		<0.200	2024-01-05
Endosulphan (Beta)	M176	µg/L		<0.200	2024-01-05
Endosulf	M176	µg/L		<0.200	2024-03-21
Endrin	M176	µg/L		<0.200	2024-01-05
Ethion	M176	µg/L		<0.010	2024-03-21
Ethoprop	M176	µg/L		<0.200	2024-01-05
Fenoprop	M176	µg/L		<0.060	2024-03-21
Fenthion	M176	µg/L		<0.060	2024-03-21
Fluzifop	M176	µg/L		<0.060	2024-03-21
Glyphosate	M176	µg/L		<0.100	2024-03-21
Haloxifop	M176	µg/L		<0.010	2024-03-21
HCH _ Alpha	M176	µg/L		<0.200	2024-01-05
HCH _ Beta	M176	µg/L		<0.200	2024-01-05
HCH _ Delta	M176	µg/L		<0.200	2024-01-05
HCH _ Epsilon	M176	µg/L		<0.200	2024-01-05
HCH _ Gamma (Lindane)	M176	µg/L		<0.200	2024-01-05
Heptachlor	M176	µg/L		<0.020	2024-01-05

Amended Certificate Of Analysis

Company:	Department of Water and Sanitation (Belville)	Service Request Number:	PW-2023-42321-A
Address:	Berg-Olifants WMA Belville-Spectrum Building Belville South Africa	Date of Certificate:	03-April-2024
		Date Completed:	27-March-2024
		Date of Sampling:	14-December-2023
Contact:	Ashton Van Niekerk	Date of Receipt at Lab:	21-December-2023

Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date
Heptachlor Epoxide (cis & trans)	M176	µg/L		<0.020	2024-01-05
Imidacloprid	M176	µg/L		<0.020	2024-03-21
Isodrin	M176	µg/L		<0.200	2024-01-05
Isoproturon	M176	µg/L		<0.005	2024-03-21
Malathion	M176	µg/L		<0.010	2024-03-21
MCPA	M176	µg/L		<0.060	2024-03-21
MCPB	M176	µg/L		<0.060	2024-03-21
Mecoprop (MOPP)	M176	µg/L		<0.060	2024-03-21
Methoxychlor	M176	µg/L		<0.200	2024-01-05
Metolachlor	M177	µg/L		<0.060	2024-03-21
Molinate	M177	µg/L		<0.010	2024-03-21
Pendimethalin	M176	µg/L		<0.200	2024-03-21
Picloram	M176	µg/L		<0.100	2024-03-21
Pinmicarb	M176	µg/L		<0.020	2024-03-21
Prometon	M176	µg/L		<0.060	2024-03-21
Prometryn	M177	µg/L		<0.020	2024-03-21
Propoxur	M176	µg/L		<0.200	2024-03-21
Simazine	M176	µg/L		<0.005	2024-03-21
Tebuthiuron	M176	µg/L		<0.20	2024-03-21
Terbuthiazine	M177	µg/L		<0.020	2024-03-21
Terbutryn	M177	µg/L		<0.060	2024-03-21
Triclopyr	M176	µg/L		<0.100	2024-03-21
Trifluralin	M176	µg/L		<0.600	2024-01-05
Industrial Chemicals	Method	Unit	Limit	Result	Analysis Date
Mirex	M176	µg/L		<0.200	2024-01-05
Parathion-ethyl	M176	µg/L		<0.060	2024-03-21
Parathion-methyl	M176	µg/L		<0.060	2024-03-21

Amended Certificate Of Analysis

Company:	Department of Water and Sanitation (Belville)	Service Request Number:	PW-2023-42321-A
Address:	Berg-Olifants WMA	Date of Certificate:	03-April-2024
	Belville-Spectrum Building	Date Completed:	27-March-2024
	Belville	Date of Sampling:	14-December-2023
	South Africa	Date of Receipt at Lab:	21-December-2023
Contact:	Ashton Van Niekerk		

Sample Identification: GEOSV16 (ODWMA)							
Sample Number:	PW-23-140280	Sampling Time:	15:37 PM	Sample Condition:	Chilled	Remark:	
Chemical	Method	Unit	Limit	Result	Analysis Date		
Chlordecone		µg/L		0	2024-03-26		
Propazine	M175	µg/L		<-0.010	2024-03-21		
Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date		
2,4,6-Trichlorophenol	M175	µg/L		<-0.200	2024-03-21		
2,4-DB	M175	µg/L		<-0.020	2024-03-21		
2,4-DDD	M175	µg/L		<-0.200	2024-03-26		
2,4-DDE	M175	µg/L		<-0.200	2024-01-05		
2,4-DDT	M175	µg/L		<-0.200	2024-01-05		
4,4-DDD	M175	µg/L		<-0.200	2024-01-05		
4,4-DDE	M175	µg/L		<-0.200	2024-01-05		
4,4-DDT	M175	µg/L		<-0.200	2024-01-05		
Alachlor	M175	µg/L		<-0.010	2024-03-21		
Aldicarb	M175	µg/L		<-0.020	2024-03-21		
Aldicarb Sulfone	M175	µg/L		<-0.020	2024-03-21		
Aldicarb Sulfoxide	M175	µg/L		<-0.020	2024-03-21		
Aldrin	M175	µg/L		<-0.200	2024-01-05		
Aldrin & Dieldrin (combined)	M175	µg/L		<-0.020	2024-01-05		
Ametrifn	M175	µg/L		<-0.200	2024-03-21		
Amicarbazone	M175	µg/L		<-0.50	2024-03-21		
Atrazine	M177	µg/L		<-0.500	2024-03-21		
Azinphos-ethyl	M175	µg/L		<-0.100	2024-03-21		
Azinphos-methyl	M175	µg/L		<-0.100	2024-03-21		
Bentazone	M175	µg/L		<-0.005	2024-03-21		
Bromacil	M175	µg/L		<-0.005	2024-03-21		
Carbendazim	M175	µg/L		<-0.020	2024-03-21		
Carbofuran	M176	µg/L		<-0.010	2024-03-21		
Chlordane	M175	µg/L		<-0.200	2024-03-26		
Chlordane (Trans_ Gamma)	M176	µg/L		<-0.200	2024-03-26		
Chlorotoluron	M176	µg/L		<-0.010	2024-03-21		

Amended Certificate Of Analysis

Company:	Department of Water and Sanitation (Bellville)	Service Request Number:	PW-2023-42321-A
Address:	Berg-Olifants WMA Bellville-Spectrum Building Bellville South Africa	Date of Certificate:	03-April-2024
		Date Completed:	27-March-2024
		Date of Sampling:	14-December-2023
Contact:	Ashton Van Niekerk	Date of Receipt at Lab:	21-December-2023

Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date
Chlorpyrifos	M177	µg/L		<0.200	2024-03-21
Clofencic Acid	M176	µg/L		<0.010	2024-03-21
Clopyralid	M176	µg/L		<0.200	2024-03-21
Cyanazine	M176	µg/L		<0.020	2024-03-21
DDT & Metabolites	M176	µg/L		<0.200	2024-03-26
DEET (Diethyltoluamide)	M176	µg/L		<0.200	2024-03-26
Diazinon	M176	µg/L		<0.200	2024-01-05
Dicamba	M176	µg/L		<0.200	2024-03-21
Dichlorprop	M176	µg/L		<0.020	2024-03-21
Dichlorvos	M176	µg/L		<0.020	2024-03-21
Dieldrin	M176	µg/L		<0.200	2024-01-05
Dimethoate	M176	µg/L		<0.010	2024-03-21
Dinoseb	M176	µg/L		<0.010	2024-03-27
Diuron	M176	µg/L		<0.20	2024-03-21
Endosulphan (Alpha)	M176	µg/L		<0.200	2024-01-05
Endosulphan (Beta)	M176	µg/L		<0.200	2024-01-05
Endosulf	M176	µg/L		<0.200	2024-03-21
Endrin	M176	µg/L		<0.200	2024-01-05
Ethion	M176	µg/L		<0.010	2024-03-21
Ethoprop	M176	µg/L		<0.200	2024-01-05
Fenoprop	M176	µg/L		<0.060	2024-03-21
Fenthion	M176	µg/L		<0.060	2024-03-21
Fluzifop	M176	µg/L		<0.060	2024-03-21
Glyphosate	M176	µg/L		<0.100	2024-03-21
Haloxifop	M176	µg/L		<0.010	2024-03-21
HCH _ Alpha	M176	µg/L		<0.200	2024-01-05
HCH _ Beta	M176	µg/L		<0.200	2024-01-05
HCH _ Delta	M176	µg/L		<0.200	2024-01-05
HCH _ Epsilon	M176	µg/L		<0.200	2024-01-05
HCH _ Gamma (Lindane)	M176	µg/L		<0.200	2024-01-05
Heptachlor	M176	µg/L		<0.020	2024-01-05

INTEGRAL LABORATORIES

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Amended Certificate Of Analysis

Company:	Department of Water and Sanitation (Belville)	Service Request Number:	PW-2023-42321-A
Address:	Berg-Olifants WMA Belville-Spectrum Building Belville South Africa	Date of Certificate:	03-April-2024
		Date Completed:	27-March-2024
		Date of Sampling:	14-December-2023
Contact:	Ashton Van Niekerk	Date of Receipt at Lab:	21-December-2023

Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date
Heptachlor Epoxide (cis & trans)	M176	µg/L		<0.020	2024-01-05
Imidacloprid	M176	µg/L		<0.020	2024-03-21
Isodrin	M176	µg/L		<0.200	2024-01-05
Isoproturon	M176	µg/L		<0.005	2024-03-21
Malathion	M176	µg/L		<0.010	2024-03-21
MCPA	M176	µg/L		<0.060	2024-03-21
MCPB	M176	µg/L		<0.060	2024-03-21
Mecoprop (MCPB)	M176	µg/L		<0.060	2024-03-21
Methoxychlor	M176	µg/L		<0.200	2024-01-05
Metolachlor	M177	µg/L		<0.060	2024-03-21
Molinate	M177	µg/L		<0.010	2024-03-21
Pendimethalin	M176	µg/L		<0.200	2024-03-21
Picloram	M176	µg/L		<0.100	2024-03-21
Pinmicarb	M176	µg/L		<0.020	2024-03-21
Prometon	M176	µg/L		<0.060	2024-03-21
Prometryn	M177	µg/L		<0.020	2024-03-21
Propoxur	M176	µg/L		<0.200	2024-03-21
Simazine	M176	µg/L		<0.005	2024-03-21
Tebuthiuron	M176	µg/L		<0.20	2024-03-21
Terbutylazine	M177	µg/L		<0.020	2024-03-21
Terbutryn	M177	µg/L		<0.060	2024-03-21
Triclopyr	M176	µg/L		<0.100	2024-03-21
Trifluralin	M176	µg/L		<0.600	2024-01-05
Industrial Chemicals	Method	Unit	Limit	Result	Analysis Date
Mirex	M176	µg/L		<0.200	2024-01-05
Parathion-ethyl	M176	µg/L		<0.060	2024-03-21
Parathion-methyl	M176	µg/L		<0.060	2024-03-21

INTEGRAL LABORATORIES

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Amended Certificate Of Analysis

Company:	Department of Water and Sanitation (Belville)	Service Request Number:	PW-2023-42321-A
Address:	Berg-Olifants WMA Belville-Spectrum Building Belville South Africa	Date of Certificate:	03-April-2024
		Date Completed:	27-March-2024
		Date of Sampling:	14-December-2023
Contact:	Ashton Van Niekerk	Date of Receipt at Lab:	21-December-2023

Sample Identification: GEOSV18 (ODWMA)					
Sample Number:	PW-23-140281	Sampling Time:	13:47 PM	Sample Condition:	Chilled
				Remark:	
Chemical	Method	Unit	Limit	Result	Analysis Date
Chlordecone		µg/L		0	2024-03-26
Propazine	M175	µg/L		<0.010	2024-03-21
Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date
2,4,6-Trichlorophenol	M175	µg/L		<0.200	2024-03-21
2,4-DB	M175	µg/L		<0.020	2024-03-21
2,4-DDD	M175	µg/L		<0.200	2024-03-26
2,4-DDE	M175	µg/L		<0.200	2024-01-05
2,4-DDT	M175	µg/L		<0.200	2024-01-05
4,4-DDD	M175	µg/L		<0.200	2024-01-05
4,4-DDE	M175	µg/L		<0.200	2024-01-05
4,4-DDT	M175	µg/L		<0.200	2024-01-05
Alachlor	M175	µg/L		<0.010	2024-03-21
Aldicarb	M175	µg/L		<0.020	2024-03-21
Aldicarb Sulfone	M175	µg/L		<0.020	2024-03-21
Aldicarb Sulfoxide	M175	µg/L		<0.020	2024-03-21
Aldrin	M175	µg/L		<0.200	2024-01-05
Aldrin & Dieldrin (combined)	M175	µg/L		<0.020	2024-01-05
Ametryn	M175	µg/L		<0.200	2024-03-21
Amicarbazone	M175	µg/L		<0.60	2024-03-21
Atrazine	M177	µg/L		<0.600	2024-03-21
Azinphos-ethyl	M175	µg/L		<0.100	2024-03-21
Azinphos-methyl	M175	µg/L		<0.100	2024-03-21
Bentazone	M175	µg/L		<0.005	2024-03-21
Bromacil	M175	µg/L		<0.005	2024-03-21
Carbendazime	M175	µg/L		<0.020	2024-03-21
Carbofuran	M175	µg/L		<0.010	2024-03-21
Chlordane	M175	µg/L		<0.200	2024-03-26
Chlordane (Trans, Gamma)	M175	µg/L		<0.200	2024-03-26
Chlorotoluron	M175	µg/L		<0.010	2024-03-21

INTEGRAL LABORATORIES

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 Email: westerncape@integrallabs.co.za

Amended Certificate Of Analysis

Company:	Department of Water and Sanitation (Bellville)	Service Request Number:	PW-2023-42321-A
Address:	Berg-Olifants WMA	Date of Certificate:	03-April-2024
	Belville-Spectrum Building	Date Completed:	27-March-2024
	Belville	Date of Sampling:	14-December-2023
	South Africa	Date of Receipt at Lab:	21-December-2023
Contact:	Ashton Van Niekerk		

Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date
Chlorpyrifos	M177	µg/L		<0.200	2024-03-21
Clofencic Acid	M176	µg/L		<0.010	2024-03-21
Clopyralid	M176	µg/L		<0.200	2024-03-21
Cyanazine	M176	µg/L		<0.020	2024-03-21
DDT & Metabolites	M176	µg/L		<0.200	2024-03-26
DEET (Diethyltoluamide)	M176	µg/L		<0.200	2024-03-26
Diazinon	M176	µg/L		<0.200	2024-01-05
Dicamba	M176	µg/L		<0.200	2024-03-21
Dichlorprop	M176	µg/L		<0.020	2024-03-21
Dichlorvos	M176	µg/L		<0.020	2024-03-21
Dieldrin	M176	µg/L		<0.200	2024-01-05
Dimethoate	M176	µg/L		<0.010	2024-03-21
Dinoseb	M176	µg/L		<0.010	2024-03-21
Diuron	M176	µg/L		<0.20	2024-03-21
Endosulphan (Alpha)	M176	µg/L		<0.200	2024-01-05
Endosulphan (Beta)	M176	µg/L		<0.200	2024-01-05
Endothal	M176	µg/L		<0.200	2024-03-21
Endrin	M176	µg/L		<0.200	2024-01-05
Ethion	M176	µg/L		<0.010	2024-03-21
Ethoprop	M176	µg/L		<0.200	2024-01-05
Fenprop	M176	µg/L		<0.060	2024-03-21
Fenthion	M176	µg/L		<0.060	2024-03-21
Fluzifop	M176	µg/L		<0.060	2024-03-21
Glyphosate	M176	µg/L		<0.100	2024-03-21
Haloxifop	M176	µg/L		<0.010	2024-03-21
HCH _ Alpha	M176	µg/L		<0.200	2024-01-05
HCH _ Beta	M176	µg/L		<0.200	2024-01-05
HCH _ Delta	M176	µg/L		<0.200	2024-01-05
HCH _ Epsilon	M176	µg/L		<0.200	2024-01-05
HCH _ Gamma (Lindane)	M176	µg/L		<0.200	2024-01-05
Heptachlor	M176	µg/L		<0.020	2024-01-05

Amended Certificate Of Analysis

Company:	Department of Water and Sanitation (Bellville)	Service Request Number:	PW-2023-42321-A
Address:	Berg-Olifants WMA	Date of Certificate:	03-April-2024
	Bellville-Spectrum Building	Date Completed:	27-March-2024
	Bellville	Date of Sampling:	14-December-2023
	South Africa	Date of Receipt at Lab:	21-December-2023
Contact:	Ashton Van Niekerk		

Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date
Heptachlor Epoxide (cis & trans)	M176	µg/L		<0.020	2024-01-05
Imidacloprid	M176	µg/L		<0.020	2024-03-21
Isodrin	M176	µg/L		<0.200	2024-01-05
Isoproturon	M176	µg/L		<0.006	2024-03-21
Malathion	M176	µg/L		<0.010	2024-03-21
MCPA	M176	µg/L		<0.060	2024-03-21
MCPB	M176	µg/L		<0.060	2024-03-21
Mecoprop (MCP)	M176	µg/L		<0.060	2024-03-21
Methoxychlor	M176	µg/L		<0.200	2024-01-05
Metolachlor	M177	µg/L		<0.060	2024-03-21
Molinate	M177	µg/L		<0.010	2024-03-21
Pendimethalin	M176	µg/L		<0.200	2024-03-21
Picloram	M176	µg/L		<0.100	2024-03-21
Pirimicarb	M176	µg/L		<0.020	2024-03-21
Prometon	M176	µg/L		<0.060	2024-03-21
Prometryn	M177	µg/L		<0.020	2024-03-21
Propoxur	M176	µg/L		<0.200	2024-03-21
Simazine	M176	µg/L		<0.006	2024-03-21
Tebuthiuron	M176	µg/L		<0.20	2024-03-21
Terbutylazine	M177	µg/L		<0.020	2024-03-21
Terbutyn	M177	µg/L		<0.060	2024-03-21
Triclopyr	M176	µg/L		<0.100	2024-03-21
Trifluralin	M176	µg/L		<0.500	2024-01-05
Industrial Chemicals	Method	Unit	Limit	Result	Analysis Date
Mirex	M176	µg/L		<0.200	2024-01-05
Parathion-ethyl	M176	µg/L		<0.060	2024-03-21
Parathion-methyl	M176	µg/L		<0.060	2024-03-21

Amended Certificate Of Analysis

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Address:	Berg-Olifants WMA Belville-Spectrum Building Belville South Africa	Date of Certificate:	03-April-2024
		Date Completed:	27-March-2024
		Date of Sampling:	14-December-2023
Contact:	Ashton Van Niekerk	Date of Receipt at Lab:	21-December-2023

Sample Identification:		REDE1 (ODWMA)					
Sample Number:	PW-23-140282	Sampling Time:	14:30 PM	Sample Condition:	Chilled	Remark:	
Chemical	Method	Unit	Limit	Result	Analysis Date		
Chlordecone		µg/L		0	2024-03-26		
Propazine	M176	µg/L		<-0.010	2024-03-21		
Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date		
2,4,6-Trichlorophenol	M176	µg/L		<-0.200	2024-03-21		
2,4-DB	M176	µg/L		<-0.020	2024-03-21		
2,4-DDD	M176	µg/L		<-0.200	2024-03-26		
2,4-DDE	M176	µg/L		<-0.200	2024-01-05		
2,4-DDT	M176	µg/L		<-0.200	2024-01-05		
4,4-DDD	M176	µg/L		<-0.200	2024-01-05		
4,4-DDE	M176	µg/L		<-0.200	2024-01-05		
4,4-DDT	M176	µg/L		<-0.200	2024-01-05		
Alachlor	M176	µg/L		<-0.010	2024-03-21		
Aldicarb	M176	µg/L		<-0.020	2024-03-21		
Aldicarb Sulfone	M176	µg/L		<-0.020	2024-03-21		
Aldicarb Sulfoxide	M176	µg/L		<-0.020	2024-03-21		
Aldin	M176	µg/L		<-0.200	2024-01-05		
Aldin & Dieldrin (combined)	M176	µg/L		<-0.020	2024-01-05		
Ametrifn	M176	µg/L		<-0.200	2024-03-21		
Anicarbazon	M176	µg/L		<-0.50	2024-03-21		
Atrazine	M177	µg/L		<-0.500	2024-03-21		
Azinphos-ethyl	M176	µg/L		<-0.100	2024-03-21		
Azinphos-methyl	M176	µg/L		<-0.100	2024-03-21		
Bentazone	M176	µg/L		<-0.005	2024-03-21		
Bromacil	M176	µg/L		<-0.005	2024-03-21		
Carbendazime	M176	µg/L		<-0.020	2024-03-21		
Carbofuran	M176	µg/L		<-0.010	2024-03-21		
Chlordane	M176	µg/L		<-0.200	2024-03-26		
Chlordane (Trans_Gamma)	M176	µg/L		<-0.200	2024-03-26		
Chlorotoluron	M176	µg/L		<-0.010	2024-03-21		

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Contact:	Ashton Van Niekerk	Date of Receipt at Lab:	21-December-2023

Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date
Chlorpyrifos	M177	µg/L		<0.200	2024-03-21
Clofibric Acid	M175	µg/L		<0.010	2024-03-21
Clopyralid	M175	µg/L		<0.200	2024-03-21
Cyanazine	M175	µg/L		<0.020	2024-03-21
DDT & Metabolites	M175	µg/L		<0.200	2024-03-26
DEET (Diethyltoluamide)	M175	µg/L		<0.200	2024-03-26
Diazinon	M175	µg/L		<0.200	2024-01-05
Dicamba	M175	µg/L		<0.200	2024-03-21
Dichlorprop	M175	µg/L		<0.020	2024-03-21
Dichlorvos	M175	µg/L		<0.020	2024-03-21
Dieldrin	M175	µg/L		<0.200	2024-01-05
Dimethoate	M175	µg/L		<0.010	2024-03-21
Dinoseb	M175	µg/L		<0.010	2024-03-21
Diuron	M175	µg/L		<0.20	2024-03-21
Endosulphan (Alpha)	M175	µg/L		<0.200	2024-01-05
Endosulphan (Beta)	M175	µg/L		<0.200	2024-01-05
Endosulf	M175	µg/L		<0.200	2024-03-21
Erdin	M175	µg/L		<0.200	2024-01-05
Ethion	M175	µg/L		<0.010	2024-03-21
Ethoprop	M175	µg/L		<0.200	2024-01-05
Fenoprop	M175	µg/L		<0.050	2024-03-21
Fenthion	M175	µg/L		<0.050	2024-03-21
Fluzifop	M175	µg/L		<0.050	2024-03-21
Glyphosate	M175	µg/L		<0.100	2024-03-21
Haloxifop	M175	µg/L		<0.010	2024-03-21
HCH _Alpha	M175	µg/L		<0.200	2024-01-05
HCH _Beta	M175	µg/L		<0.200	2024-01-05
HCH _Delta	M175	µg/L		<0.200	2024-01-05
HCH _Epsilon	M175	µg/L		<0.200	2024-01-05
HCH _Gamma (Lindane)	M175	µg/L		<0.200	2024-01-05
Heptachlor	M175	µg/L		<0.020	2024-01-05

INTEGRAL LABORATORIES

Integral Laboratories (Pty) Ltd
No 1 Zandevyk Park, Sandringham Close Paarl, 7646
Tel: 021 863 1238 Fax: 086 635 8874
Email: westerncape@integrallabs.co.za

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	Belville-Spectrum Building	Date Completed:	27-March-2024
	Belville	Date of Sampling:	14-December-2023
	South Africa	Date of Receipt at Lab:	21-December-2023
Contact:	Ashton Van Niekerk		

Pesticides / Herbicides	Method	Unit	Limit	Result	Analysis Date
Heptachlor Epoxide (cis & trans)	M176	µg/L		<0.020	2024-01-05
Imidacloprid	M176	µg/L		<0.020	2024-03-21
Isodrin	M176	µg/L		<0.200	2024-01-05
Isoproturon	M176	µg/L		<0.005	2024-03-21
Malathion	M176	µg/L		<0.010	2024-03-21
MCPA	M176	µg/L		<0.060	2024-03-21
MCPB	M176	µg/L		<0.060	2024-03-21
Mecoprop (MCP)	M176	µg/L		<0.060	2024-03-21
Methoxychlor	M176	µg/L		<0.200	2024-01-05
Metolachlor	M177	µg/L		<0.060	2024-03-21
Molinate	M177	µg/L		<0.010	2024-03-21
Pendimethalin	M176	µg/L		<0.200	2024-03-21
Picloram	M176	µg/L		<0.100	2024-03-21
Pinnicarb	M176	µg/L		<0.020	2024-03-21
Prometon	M176	µg/L		<0.060	2024-03-21
Prometryn	M177	µg/L		<0.020	2024-03-21
Propoxur	M176	µg/L		<0.200	2024-03-21
Simazine	M176	µg/L		<0.005	2024-03-21
Tebuthiuron	M176	µg/L		<0.20	2024-03-21
Terbutylazine	M177	µg/L		<0.020	2024-03-21
Terbutryn	M177	µg/L		<0.060	2024-03-21
Triclopyr	M176	µg/L		<0.100	2024-03-21
Trifluralin	M176	µg/L		<0.600	2024-01-05
Industrial Chemicals	Method	Unit	Limit	Result	Analysis Date
Mirex	M176	µg/L		<0.200	2024-01-05
Parathion-ethyl	M176	µg/L		<0.060	2024-03-21
Parathion-methyl	M176	µg/L		<0.060	2024-03-21

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ODWMA

1. Sampling is outside the laboratory's scope of accreditation. Where applicable, free and total chlorine results are supplied by the sampling officer.
2. This report shall not be reproduced except in full, without written approval from the laboratory.
3. Uncertainties of Measurement, Limits of Detection, and Method Descriptions will be provided upon request.
4. The organization reports results at the 95% confidence interval with a coverage factor $k = 2$. The overlying acceptance criteria for method expanded uncertainty is $\pm 6\%$. Decision Rule - Results reflecting on the Certificate of Analysis are actual results as obtained at the time of testing, and do not include any uncertainty considerations. The Laboratory does not issue any statement of conformity, unless by prior arrangement.
5. Certificates of Analysis will be reported electronically in a protected format. The laboratory will not be responsible for any unauthorised changes made to results once reported.
6. Parameters indicated by an * are not SANAS accredited and are not included in the SANAS Schedule of Accreditation for this laboratory.
7. Parameters indicated by ** are subcontracted and are not included in the SANAS Schedule of Accreditation for this laboratory.
8. The following has reference:
 - Unless otherwise stated, ICP, HPLC, GC, GC-MS and LC-MS samples have been filtered using a 0.45µm filter prior to analysis.
9. In the absence of client specified limits, the limits reflected are based on SANS 241:2015 or General Effluent Standards, as applicable.
10. The quality and integrity of samples submitted has a direct correlation to the results reported. As such, results reflected on this report relate only to the samples as received.
11. Opinions and interpretations expressed herein are outside the scope of SANAS accreditation.



Neil van Kooten
Technical Signatory

This certificate supersedes all previous documents bearing the reference (PW-2023-42321)