Borehole Yield and Quality Testing at Elgin Free Range Chickens Agri Operations, Lottershof Farm, Caledon

Prepared by

GEOSS

15 August 2024

Executive Summary

GEOSS South Africa (Pty) Ltd was appointed by Willie Benson from Elgin Free Range Chickens Agri Operations to conduct yield and groundwater quality testing of one borehole at Lottershof farm, Caledon. The yield testing was undertaken by ATS under the management and supervision of GEOSS SA from the 30th of July to the 3rd of August 2024. This included a Step Test, CDT and Recovery Test at the borehole and sampling of the groundwater for chemical analysis. It is recommended that groundwater abstraction occur within the below-mentioned parameters from the tested borehole. Aquifer over-abstraction is unlikely to occur if these rates are adhered to and if the borehole is managed through long-term monitoring data.

Borehole Details				
Borehole Name	**Latitude (DD, WGS84)**	**Longitude (DD, WGS84)**	**Borehole Depth (m)**	**Inner Diameter (mm)**
ECA_BH1	-34.30790°	19.47264°	138.6	177
Abstraction Recommendations				
Borehole Name	**Abstraction rate (L/s)**	**Abstraction Duration (hrs)**	**Recovery Duration (hrs)**	**Possible Volume Abstracted (L/d)**
ECA_BH1	1.5	24	0	129 600
Pump Installation Details				
Borehole Name	**Pump Installation Depth (mbgl)**	**Critical Water Level (mbgl)**	**Dynamic Water Level (mbgl)***	**Rest Water Level (mbgl)**
ECA_BH1	66	63	29	8.23

* Typical water level expected during long-term production

Through long term water level monitoring data, the abstraction volumes can be optimised by adjusting the abstraction rate, if required. It is recommended that the borehole is equipped with a variable frequency drive. This enables adjustments to the flow rate to be made if required, as determined by the hydrogeological analysis of water level and flow rate monitoring data.

From the laboratory results, groundwater from ECA_BH1 is of poor quality for potable use. The primary issue is elevated turbidity, measured at 27.3 NTU, which exceeds the SANS 241-1:2015 aesthetic standard. This level of turbidity is likely due to fine sediments entering the borehole, and it causes aesthetic issues such as cloudiness in the water. Although some of the turbidity may clear up during borehole development, the presence of elevated iron (0.549 mg/L) poses additional concerns. High iron levels can lead to aesthetic problems like red staining on walls and infrastructure, and they increase the risk of iron biofouling. If not managed properly, biofouling could clog the borehole and associated abstraction infrastructure.

To address the potential for iron to clog the borehole and abstraction infrastructure, it is recommended to maintain a constant and continuous pumping schedule as much as possible. Thus, should a daily volume of less than 129 600 L/d be required, it is recommended to decrease the pumping rate and not the pumping duration. By pumping continuously instead of on a stop-start schedule, iron oxidation in the borehole is minimized, decreasing the amount of iron precipitation inside the boreholes and pumps.

To facilitate monitoring and informed management of the borehole, it is recommended to equip borehole with the following monitoring infrastructure and equipment:

- Installation of a 32 mm (inner diameter, class 10) observation pipe from the pump depth to the surface, closed at the bottom and slotted for the bottom 5 – 10 m.
- Installation of an electronic water level logger (for automated water level monitoring)
- Installation of a sampling tap (to monitor water quality)
- Installation of a flow volume meter (to monitor abstraction rates and volumes)

This report is an important document for obtaining the legal compliance with regard to the use of the groundwater with the Department of Water and Sanitation, but does not constitute a Geohydrological Assessment report in support of a WULA, which would need to incorporate information from this report.

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Abbreviations

AD	Available Drawdown
bh	Borehole
CDT	Constant Discharge Test
CGS	Council for Geoscience
DD	Decimal degree
DWA	Department of Water Affairs (pre- 1994)
DWAF	Department of Water Affairs and Forestry (1994 – 2009)
DWS	Department of Water and Sanitation (2009 – ….)
EC	Electrical Conductivity
FC	Flow Characteristic
GRF	Generalised Radial Flow
IARF	Infinite Acting Radial Flow
ID	inner diameter
L/d	litres per day
L/s	litres per second
m	metres
m^2/d	meters squared per day
mamsl	metres above mean sea level
mbch	metres below collar height
mbgl	metres below ground level
mg	milligram
mg/L	milligram per litre
mm	millimetres
nd	not detected
OD	outer diameter
RWL	rest water level below ground level
SANS	South African National Standard
T	Transmissivity
TDS	total dissolved solids
WGS84	Since the 1st January 1999, the official co-ordinate system for South Africa is based on the World Geodetic System 1984 ellipsoid, commonly known as WGS84
WL	water level
WULA	Water Use Licence Assessment

Glossary of Terms

aquifer	a geological formation, which has structures or textures that hold water or permit appreciable water movement through them [from National Water Act (Act No. 36 of 1998)].
available drawdown	available drawdown in a borehole is the difference between the rest water level or piezometric surface and the depth that the water level may drop to (typically major water baring unit, boundary inflection or pump depth).
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 [from National Water Act (Act No. 36 of 1998)].
confined aquifer	an aquifer confined between two impermeable beds
dynamic water level	the stabilised water level in the borehole during production over long periods of time.
electrical conductivity	the ability of groundwater to conduct electrical current, due to the presence of charged ionic species in solution (Freeze and Cherry, 1979).
fractured aquifer	Fissured and fractured bedrock resulting from decompression and/or tectonic action. Groundwater occurs predominantly within fissures and fractures.
groundwater	Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e., the water table marks the upper surface of groundwater systems.
intergranular aquifer	an aquifer in which groundwater is stored in and flows through open pore spaces in the unconsolidated Quaternary deposits.
rest water level	the groundwater level in a borehole not influenced by abstraction or artificial recharge.
sustainable yield	sustainable yield is defined as the rate of withdrawal that can be sustained by an aquifer without causing an unacceptable decline in the hydraulic head or deterioration in water quality in the aquifer.
transmissivity	the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient.
unconfined aquifer	an aquifer which has free water surface - which means the water table exists for this type of aquifer; primarily recharged by the infiltration of precipitation from the ground surface

SPECIALIST EXPERTISE

CURRICULUM VITAE – Reuben Lazarus

GENERAL

Nationality:	South African
Profession:	Hydrogeologist
Specialization:	Groundwater development, yield testing, geochemistry and camera logging
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Language skills:	Afrikaans (mother tongue) English (excellent)

KEY SKILLS

- Groundwater component of Catchment Management Strategies and other Groundwater Resource Directed Measures.
- Groundwater development – borehole drilling and test pumping supervision and analysis.
- Groundwater monitoring – development and analysis of groundwater level and quality data.
- Groundwater management – sustainable aquifer development and management.
- Groundwater contamination assessments – geochemical analysis.
- Writing of hydrogeological reports
- ArcMap / Geochemist's Workbench / WISH and typical software skills.

EDUCATIONAL AND PROFESSIONAL STATUS

Qualifications

2018	BSc (Geology – Environmental Geochemistry)	University of Stellenbosch, South Africa
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2019	SA remediation workshop (Enviro Workshops)

Memberships/Organisations

- South African Council for National Scientific Professions (SACNASP)- Mem. No. Pr.Sci.Nat: 120711
- Groundwater Division of the Geological Society of South Africa UID 9661/21
- Geological Society of South Africa Mem. No. 970021

EMPLOYMENT RECORD

June 2021 – present:	GEOSS South Africa (Pty) Ltd, Stellenbosch *Project Hydrogeologist: Yield and Water Quality Testing Business Unit Leader*
October 2018 – June 2021:	GEOSS South Africa (Pty) Ltd, Stellenbosch *Project Hydrogeologist*
October 2017 – October 2018:	GEOSS - Geohydrological and Spatial Solutions International (Pty) Ltd *Student Hydrogeologist*

SPECIALIST DECLARATION

I, Reuben Lazarus, as the appointed independent specialist(s) hereby declare that we:

- act/ed as the independent specialist in this application;
- regard the information contained in this report as it relates to our specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the South African National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes);
- have and will not have no vested interest in the proposed activity proceeding;
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not

Reuben Lazarus

GEOSS South Africa (Pty) Ltd

SACNSAP – Pr.Sci.Nat:

15 August 2024

1 Introduction

GEOSS South Africa (Pty) Ltd was appointed by Willie Benson from Elgin Free Range Chickens Agri Operations to conduct yield and water quality testing of one borehole at Lottershof farm, Caledon.

The borehole was tested by ATS under the management and supervision of GEOSS SA from the 30th of July to the 3rd of August 2024, details of this are presented in this report. The borehole's details are presented in **Table 1** below and spatially in **Map 1**. A borehole drill log is presented in **Appendix A.** The geological setting of the area indicates that the borehole is drilled through the sandstone of the Rietvlei formation (**Map 2**).

Table 1: Borehole Details.

Borehole	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Depth (m)
ECA_BH1	-34.30790°	19.47264°	138.6

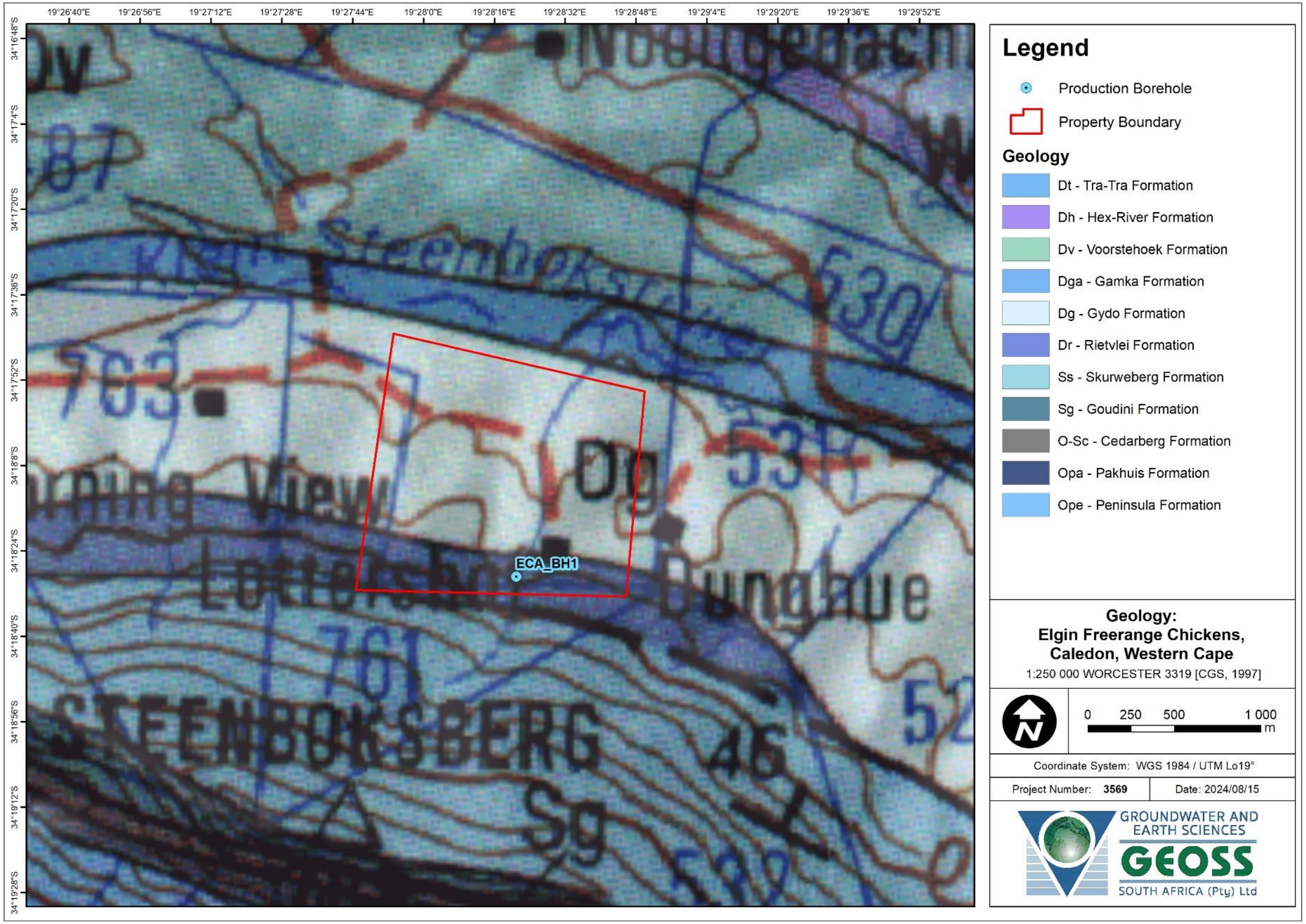
Figure 1: ECA_BH1 during (left) and after (right) testing.

2 Yield Testing

2.1 Methodology

The yield testing was undertaken by ATS under the management and supervision of GEOSS SA from the 30th of July to the 3rd of August 2024 and carried out according to the National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes). This included a Step Test, Constant Discharge Test (CDT) and recovery monitoring of the borehole. For the Step Test, a borehole is pumped at a constant rate for one-hour intervals and the flow rates are incrementally increased for each step. This test is followed by a Constant Discharge Test where the borehole is pumped at a constant rate for an extended period of time, followed by recovery monitoring. The water level drawdown is monitored at pre-determined intervals during these tests (drawdown refers to the difference in water level from the rest water level (RWL) measured before commencement of the yield test). Raw data and measurements taken during the yield tests are presented in **Appendix B**.

Map 1: Borehole Locality Map.



Map 2: Geological Map with Property Boundary and Tested Borehole Position (1:250 000 Geological Map Series, 3319 Worcester) (CGS, 1997).

The yield test data was analysed using the excel-based FC program, developed by the IGS (Institute for Groundwater Studies) in Bloemfontein. The sustainable yield of the borehole was calculated based upon long-term extrapolations of the CDT data according to (1) the Cooper-Jacob approximation of the Theis solution for confined aquifers, (2) the Barker Generalised Radial Flow Model (GRF) for hydraulic tests in fractured rock and (3) the Flow Characteristic (FC) method(s) using first and second derivative calculations. Boundary conditions are accounted for in multiplication factors to the rate of drawdown (derivatives), according to each of the above three methods. These three methods are briefly described below.

1. The Cooper-Jacob approximation of the Theis solution for confined aquifers was designed for porous media aquifers, where infinite acting radial flow (IARF) was observed during the pumping of a borehole. The application of this method to fractured aquifers was discussed by Meier et al (1998), concluding that T estimates using the Cooper-Jacob analysis gave an effective T for the fracture zone. The Cooper-Jacob analysis (and more accurately the Theis method) is therefore viable for analysing pumping test data for fractured aquifers where IARF is observed. The parameters are then used to predict theoretical long-term drawdowns.
2. The Barker GRF Model (Barker, 1988) uses fracture hydraulic conductivity, fracture storativity and flow domain to predict drawdown due to abstraction in a borehole in a fractured medium. By changing these values, a curve of drawdown predictions can be made to fit real-world data and therefore predict theoretical long-term drawdowns.
3. The FC methods are the Basic FC, the FC Inflection Point and the FC Non-Linear. The Basic FC and the FC Inflection Point methods make use of the derivatives of the drawdown data to predict theoretical long-term drawdowns and the scale-back factors are applied to selected available drawdowns. The FC Non-Linear method uses curve fitting of the Step Test data to predict theoretical long-term drawdowns. Due to the short nature of the Step Test, this method is usually not included if the other methods of analysis differ from it.

In all three methods, the available drawdown was carefully selected to ensure that the flow regime described by the analytical solution is not extrapolated beyond its applicable depth, which may easily result in an overuse of the resource. For ECA_BH1 this was 54 m (63 mbgl), based on an inflection point observed in the test data corresponding to a fracture observed during drilling. A two-year extrapolation time without recharge to the aquifer was selected as per the recommendations within the FC method program.

Water samples were collected at the end of the yield test and submitted for inorganic chemical analyses.

2.2 Yield Testing at AB_BH1

The yield testing was conducted between the 30th of July and the 3rd of August 2024. The borehole was measured to a depth of 138.6 meters below ground level (mbgl). The test pump was installed at a depth of 118.5 mbgl. The rest water level (RWL) at the start of the test was 8.23 mbgl.

During the step test, the water level was drawn down 83.86 meters below the rest water level (92.8 mbgl) during the 4th step at a rate of 25 L/s. 10 minutes into the final step the pump broke down due to sand ingress. **Figure 2** shows the time-series drawdown for the Step Test.

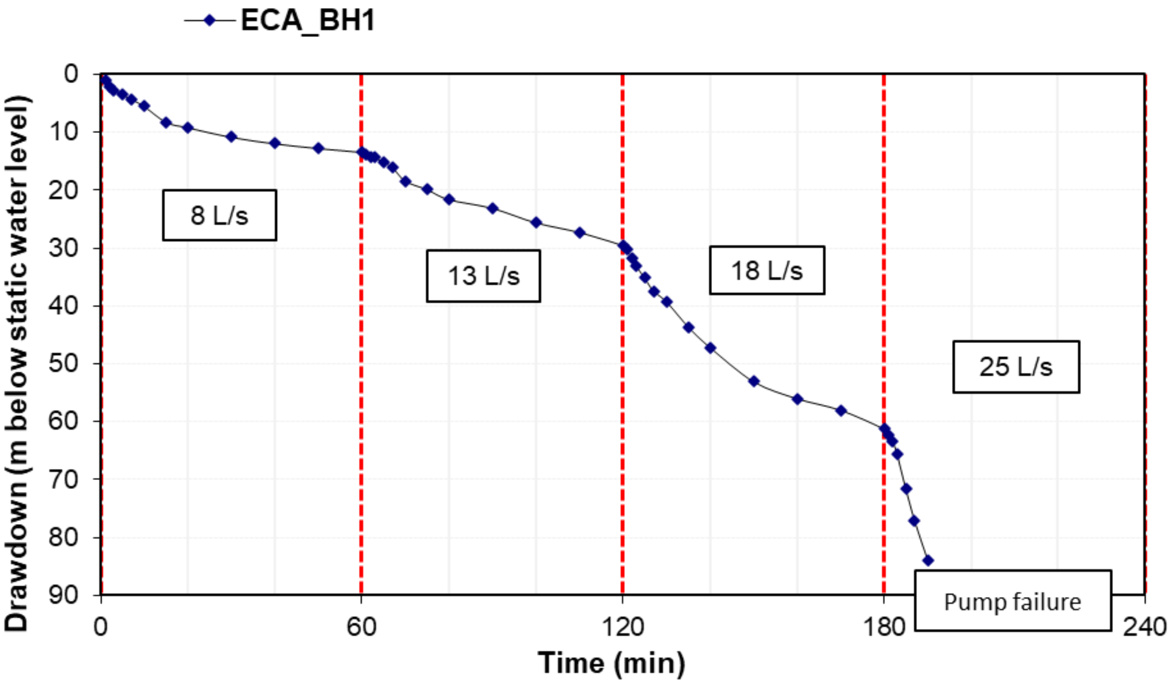


Figure 2: Step Test drawdown data for ECA_BH1.

The water level was left to recover overnight. Before starting the CDT, the water level recovered to 8.57 mbgl. Based on the results of the Step Test, the planned 24-hour CDT was conducted at a rate of 15 L/s (54 000 L/hour). After 17.7 hours, the water level had drawn down 109.12 meters below the rest water level (pump inlet). The borehole was left to recover to 12.98 mbgl, before starting a second CDT for the remaining 7 hours at 12.5 L/s. After the 7 hours, the water level had drawn down to 52.7 meters below the rest water level to 66.39 mbgl.

The semi-log plot of the drawdown from the CDT is presented in **Figure 3**. The available drawdown (AD) is indicated with the horizontal red line at 54 m.

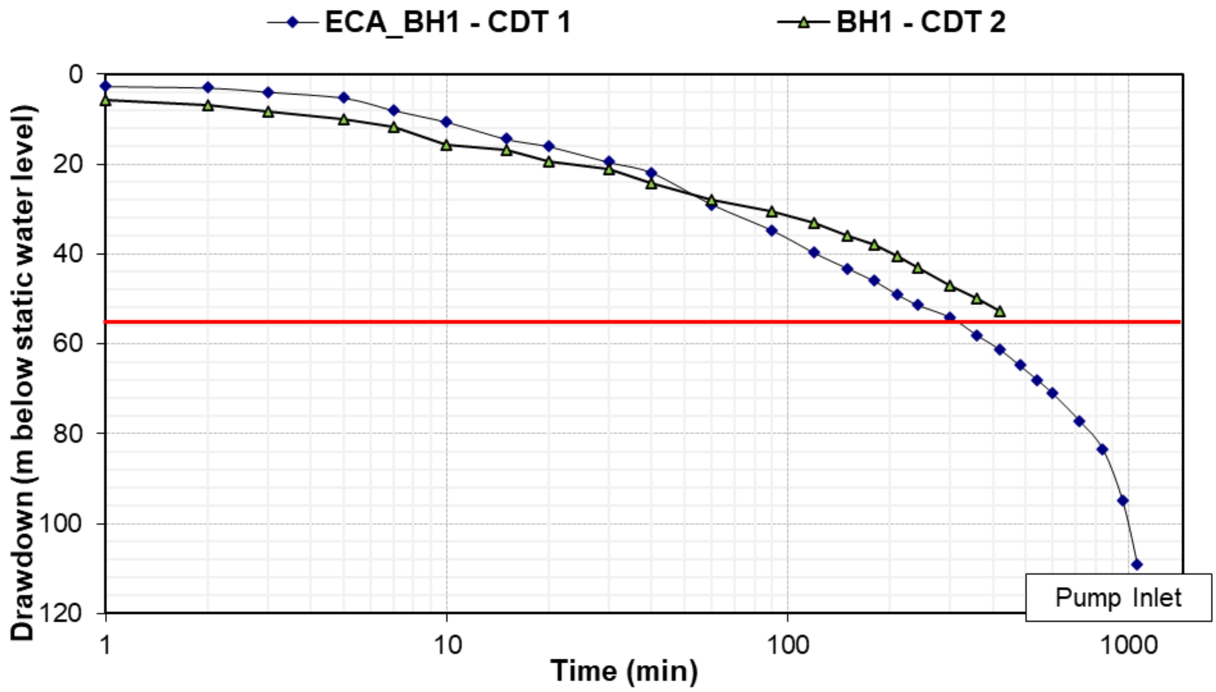


Figure 3: Semi-Log Plot of drawdown during the CDT of ECA_BH1 (CDT 1: 15 L/s, CDT 2: 12.5 L/s).

The recovery of the water level was monitored after the first CDT and is presented in **Figure 4**. The recovery was moderate, reaching 93.6% after pump time and 95.8% in 24 hours. Monitoring will be essential to determine the long-term recovery of the borehole.

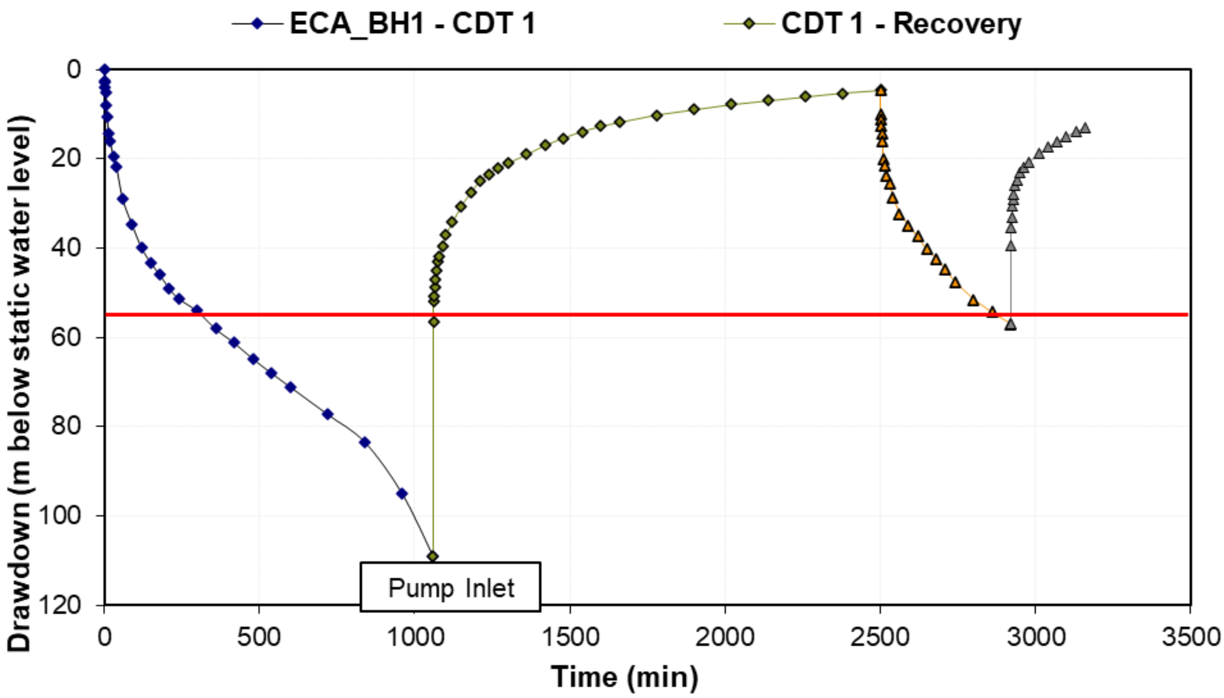


Figure 4: Time-series drawdown and recovery for ECA_BH1 (CDT 1: 15 L/s, CDT 2: 12.5 L/s).

Several methods were used to assess the yield test data as presented in **Table 2**. It is recommended that the borehole can be abstracted from at a rate of up to 1.5 L/s (5 400 L/hour) for up to 24 hours per day. The assessments were based on an available drawdown (AD) of 54 meters below the RWL of the CDT, which equates to 63 mbgl.

Table 2: Yield Determination - ECA_BH1.

ECA_BH1			
Method	**Sustainable Yield (L/s)**	**Late *T (m^2/d)**	***AD used (m)**
Basic FC	1.88	5.8	54.0
FC inflection point	1.89		58.0
Cooper-Jacob	2.19	6.1	54.0
FC Non-Linear	0.71	3	54.0
Barker	0.79		54.0
Average Q_sust (L/s)	**1.49**		
Recommended Abstraction			
Abstraction Rate (L/s)	**Abstraction Duration (hours)**		**Recovery Duration (hours)**
1.5	24		0

**AD- Available Drawdown
* T – Transmissivity

No boreholes were monitored during the testing of ECA_BH1. Transmissivity was calculated through the Theis method using the drawdown response in ECA_BH1. The transmissivity of the system was calculated at 6.1 m^2/d. A storativity value of $5x10^{-4}$ was used for the radius of influence calculation based on an average expected value of confined aquifers as report by (Todd, 1980). Based on the aquifer parameters the radius of influence was calculated for the recommended sustainable yield of the borehole. A drawdown of up to 5 meters can be expected 1 kilometre away from ECA_BH1 at the recommended sustainable rate (1.5 L/s for 24 hours per day) after 2 years of abstraction without recharge (**Figure 5**).

It must be noted that the Cooper-Jacob modelling of radius of influence is based on a homogenous, confined aquifer and therefore does not account for the heterogeneity associated with secondary aquifers (fractured rock). Thus, the radius of influence model will only provide an indication of how abstraction at AB_BH1 will impact the water level in the fracture network. This suggests that the cone of depression will not expand equivalently in all directions surrounding the borehole, but will rather propagate along the fracture network within the secondary aquifer.

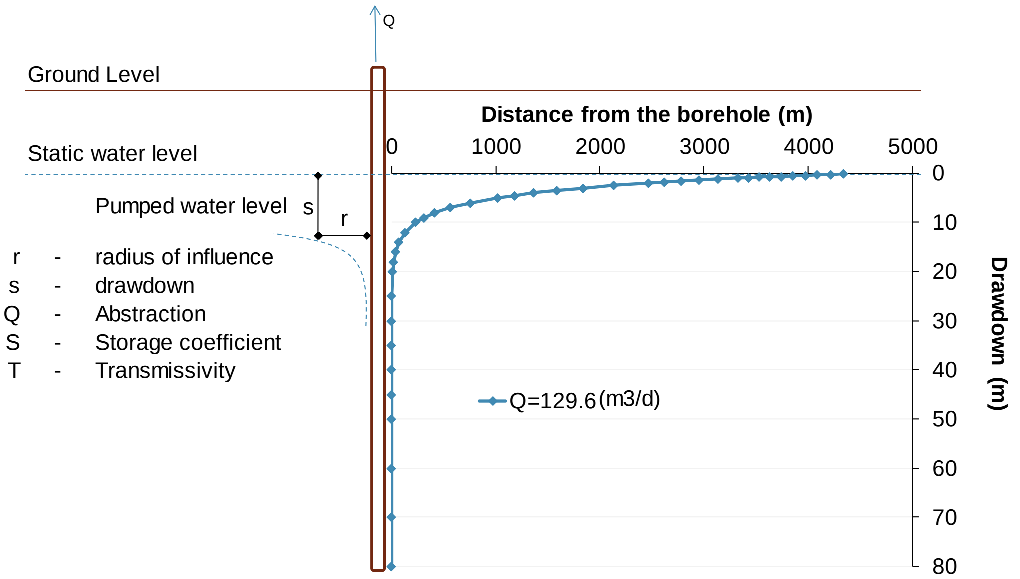


Figure 5: Radius of influence for ECA_BH1 at the recommended sustainable yield (1.5 L/s).

3 Water Quality Analysis

Groundwater samples were collected from the borehole at the end of the yield test and submitted for inorganic chemical analyses to a SANAS accredited laboratory (Vinlab) in the Western Cape. The certificate of analysis for the sample is presented in **Appendix C**. The chemistry results obtained for the borehole have been classified according to the SANS241-1: 2015 standards for domestic water (**Table 3**). **Table 5** presents the water chemistry analysis results, colour coded according to the SANS241-1: 2015 drinking water assessment standards.

Table 3: Classification table for the specific limits.

Acute Health	Aesthetic	Chronic Health	Operational	Acceptable

The limits and associated risks for domestic water as determined by the South African National Standard (SANS) 241:2015 are as follows, where:

- Health risks: parameters falling outside these limits may cause acute or chronic health problems in individuals.
- Aesthetic risks: parameters falling outside these limits indicate that water is visually, aromatically or palatably unacceptable.
- Operational risks: parameters falling outside these limits may indicate that operational procedures to ensure water quality standards are met may have failed.

The chemistry results obtained have also been classified according to the DWAF (1998) standards for domestic water. **Table 4** enables an evaluation of the water quality with regards to the various parameters measured (DWAF, 1998). **Table 6** presents the water chemistry analysis results colour coded according to the DWAF drinking water assessment standards.

Table 4: Classification table for the groundwater results (DWAF, 1998).

Class	Water quality	Description
Class 0	**Ideal**	Suitable for lifetime use.
Class I	**Good**	Suitable for use, rare instances of negative effects.
Class II	**Marginal**	Conditionally acceptable. Negative effects may occur.
Class III	**Poor**	Unsuitable for use without treatment. Chronic effects may occur.
Class IV	**Dangerous**	Totally unsuitable for use. Acute effects may occur.

From the chemical results presented in **Table 5** and **Table 6**, groundwater from ECA_BH1 is of poor quality for potable use. The primary issue is elevated turbidity, measured at 27.3 NTU, which exceeds the SANS 241-1:2015 aesthetic standard. This level of turbidity is likely due to fine sediments entering the borehole, and it causes aesthetic issues such as cloudiness in the water. Although some of the turbidity may clear up during borehole development, the presence of elevated iron (0.549 mg/L) poses additional concerns. High iron levels can lead to aesthetic problems like red staining on walls and infrastructure, and they increase the risk of iron biofouling. If not managed properly, biofouling could clog the borehole and associated abstraction infrastructure.

Table 5: Production borehole results classified according to SANS241-1:2015.

Analyses	ECA_BH1	SANS 241-1:2015
Date and Time Sampled	03/09/2024 15:00	
pH (at 25 ºC)	6.0	5.0 ≤ Operational ≤ 9.7
Conductivity (mS/m) (at 25 ºC)	28.0	Aesthetic ≤170
Total Dissolved Solids (mg/L)	189.84	Aesthetic ≤1200
Turbidity (NTU)	27.30	Operational ≤1 Aesthetic ≤5
Colour (mg/L as Pt)	<15	Aesthetic ≤15
Sodium (mg/L as Na)	37	Aesthetic ≤200
Potassium (mg/L as K)	4	N/A
Magnesium (mg/L as Mg)	4	N/A
Calcium (mg/L as Ca)	7	N/A
Chloride (mg/L as Cl)	64.43	Aesthetic ≤300
Sulphate (mg/L as SO_4)	6.86	Aesthetic ≤250 Acute ≤500
Nitrate & Nitrite Nitrogen (mg/L as N)	0.068	≤1 Acute Health
Nitrate Nitrogen (mg/L as N)	<1.00	Acute Health ≤11
Nitrite Nitrogen (mg/L as N)	<0.05	Acute Health ≤0.9
Ammonia Nitrogen (mg/L as N)	<0.15	Aesthetic ≤1.5
Total Alkalinity (mg/L as $CaCO_3$)	25.1	N/A
Total Hardness (mg/L as $CaCO_3$)	33.9	N/A
Fluoride (mg/L as F)	0.16	Chronic Health ≤1.5
Aluminium (mg/L as Al)	0.217	Operational ≤0.3
Total Chromium (mg/L as Cr)	<0.004	Chronic Health ≤0.05
Manganese (mg/L as Mn)	0.045	Aesthetic ≤0.1 Chronic ≤0.4
Iron (mg/L as Fe)	0.549	Aesthetic ≤0.3 Chronic ≤2
Nickel (mg/L as Ni)	<0.008	Chronic Health ≤0.07
Copper (mg/L as Cu)	0.005	Chronic Health ≤2
Zinc (mg/L as Zn)	0.716	Aesthetic ≤5
Arsenic (mg/L as As)	<0.010	Chronic Health ≤0.01
Selenium (mg/L as Se)	<0.008	Chronic Health ≤0.04
Cadmium (mg/L as Cd)	<0.001	Chronic Health ≤0.003
Antimony (mg/L as Sb)	<0.013	Chronic Health ≤0.02
Mercury (mg/L as Hg)	0.002	Chronic Health ≤0.006
Lead (mg/L as Pb)	<0.008	Chronic Health ≤0.01
Uranium (mg/L as U)	<0.028	Chronic Health ≤0.03
Cyanide (mg/L as CN^-)	<0.01	Acute Health ≤0.2
Total Organic Carbon (mg/L as C)	1.74	N/A
Charge Balance Error %	0.5	≥-5 - ≤5 Acceptable

.

Table 6: Classified production borehole results according to DWAF 1998.

Sample Marked:	ECA_BH1	DWAF (1998) Drinking Water Assessment Guide				
		Class 0	**Class I**	**Class II**	**Class III**	**Class IV**
		Ideal	**Good**	**Marginal**	**Poor**	**Dangerous**
Date and Time Sampled	03/09/2024 15:00					
pH	6.0	5-9.5	4.5-5 & 9.5-10	4-4.5 & 10-10.5	3-4 & 10.5-11	< 3 & >11
Conductivity (mS/m)	28.0	<70	70-150	150-370	370-520	>520
Turbidity (NTU)	**27.30**	<0.1	0.1-1	1.0-20	20-50	>50
	mg/L					
Total Dissolved Solids	189.84	<450	450-1000	1000-2400	2400-3400	>3400
Sodium (as Na)	37	<100	100-200	200-400	400-1000	>1000
Potassium (as K)	4	<25	25-50	50-100	100-500	>500
Magnesium (as Mg)	4	<70	70-100	100-200	200-400	>400
Calcium (as Ca)	7	<80	80-150	150-300	>300	
Chloride (as Cl)	64.43	<100	100-200	200-600	600-1200	>1200
Sulphate (as SO_4)	6.86	<200	200-400	400-600	600-1000	>1000
Nitrate & Nitrite (as N)	0.068	<6	6.0-10	10.0-20	20-40	>40
Fluoride (as F)	0.16	<0.7	0.7-1.0	1.0-1.5	1.5-3.5	>3.5
Manganese (as Mn)	0.045	<0.1	0.1-0.4	0.4-4	4.0-10.0	>10
Iron (as Fe)	0.549	<0.5	0.5-1.0	1.0-5.0	5.0-10.0	>10
Copper (as Cu)	0.005	<1	1-1.3	1.3-2	2.0-15	>15
Zinc (as Zn)	0.716	<20	>20			
Arsenic (as As)	<0.010	<0.010	0.01-0.05	0.05-0.2	0.2-2.0	>2.0
Cadmium (as Cd)	<0.001	<0.003	0.003-0.005	0.005-0.020	0.020-0.050	>0.050
Hardness (as $CaCO_3$)	33.900	<200	200-300	300-600	>600	
Charge Balance Error %	0.5	≥-5 - ≤5 Acceptable				

A number of chemical diagrams have been plotted for the groundwater sample and these are useful for chemical characterisation of the water and illustrate the similarities and differences in the water types. The Stiff Diagram is a graphical representation of the equivalent concentrations of the cations (positive ions) and anions (negative ions). This diagram shows concentrations of cations and anions relative to each other and direct reference can be made to specific salts in the water. From **Figure 6**, ECA_BH1 is classified as a Sodium & Potassium/Chloride hydrofacies. This is expected of groundwater hosted in the sandstone of the Rietvlei formation.

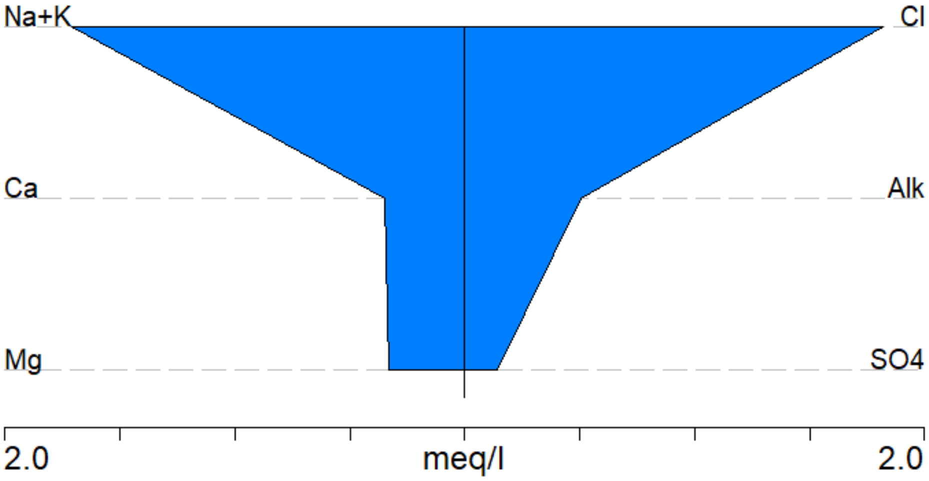


Figure 6: Stiff diagram of the groundwater sample (ECA_BH1).

The Sodium Adsorption Ratio (SAR) of the groundwater is plotted in **Figure 7**. ECA_BH1 plots as S1/C2, thus classified as low risk in terms of sodium adsorption and medium risk in terms of salinity hazard. This graph is typically applicable to irrigation, however, is dependent on soil texture and crop type.

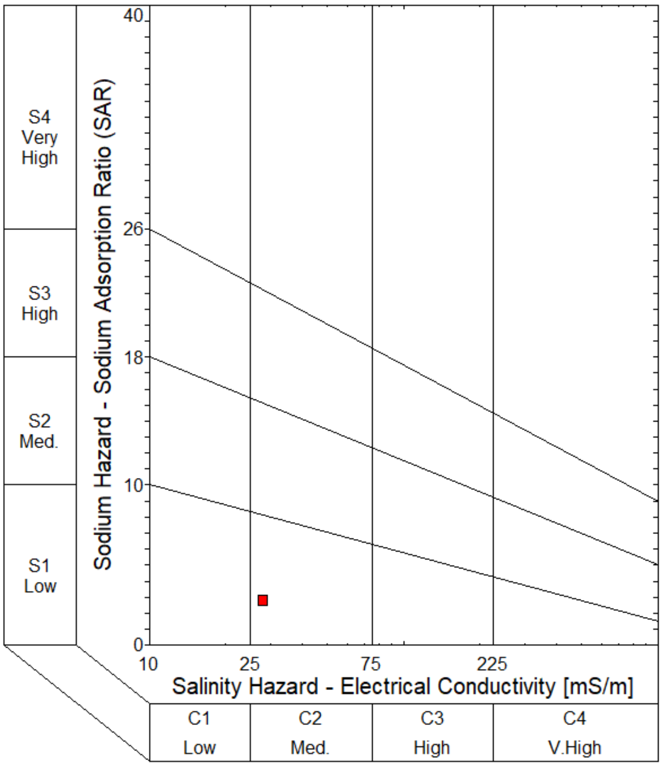


Figure 7: SAR diagram of the groundwater sample (ECA_BH1).

4 Recommendations

Based on the information obtained from the yield test, the abstraction recommendation for the borehole is presented in **Table 7**. The yield testing was conducted with a Step Test, Constant Discharge Test and Recovery Test and while this data can be analysed to estimate sustainable yields, additional drilling in the area may result in long term cumulative impacts. Optimisation of the resource is also likely through making small changes to the abstraction rate, should the dynamic water level's drawdown be less or more than expected as per **Table 7**. Both of these points are best managed through long term monitoring data.

Table 7: Borehole Abstraction Recommendations.

Borehole Details				
Borehole Name	**Latitude (DD, WGS84)**	**Longitude (DD, WGS84)**	**Borehole Depth (m)**	**Inner Diameter (mm)**
ECA_BH1	-34.30790°	19.47264°	138.6	177
Abstraction Recommendations				
Borehole Name	**Abstraction rate (L/s)**	**Abstraction Duration (hrs)**	**Recovery Duration (hrs)**	**Possible Volume Abstracted (L/d)**
ECA_BH1	1.5	24	0	129 600
Pump Installation Details				
Borehole Name	**Pump Installation Depth (mbgl)**	**Critical Water Level (mbgl)**	**Dynamic Water Level (mbgl)***	**Rest Water Level (mbgl)**
ECA_BH1	66	63	29	8.23

* Typical water level expected during long-term production

For borehole ECA_BH1 it is recommended that abstraction can occur at a rate of up to 1.5 L/s for 24 hours per day. A pump suitable to deliver the recommended rate should be installed at a depth of 66 mbgl. It is anticipated that abstraction at the recommended rate will cause the water level to drop to a depth of approximately 29 mbgl – this is referred to as the dynamic water level. During abstraction, a maximum level cut off switch should be installed to 63 mbgl to ensure the groundwater level does not drop to the pump inlet.

From the laboratory results, groundwater from ECA_BH1 is of poor quality for potable use. The primary issue is elevated turbidity, measured at 27.3 NTU, which exceeds the SANS 241-1:2015 aesthetic standard. This level of turbidity is likely due to fine sediments entering the borehole, and it causes aesthetic issues such as cloudiness in the water. Although some of the turbidity may clear up during borehole development, the presence of elevated iron (0.549 mg/L) poses additional concerns. High iron levels can lead to aesthetic problems like red staining on walls and infrastructure, and they increase the risk of iron biofouling. If not managed properly, biofouling could clog the borehole and associated abstraction infrastructure.

To address the potential for iron to clog the borehole and abstraction infrastructure, it is recommended to maintain a constant and continuous pumping schedule as much as possible. Thus, should a daily volume of less than 129 600 L/d be required, it is recommended to decrease the pumping rate and not the pumping duration. By pumping continuously instead of on a stop-start schedule, iron oxidation in the borehole is minimized, decreasing the amount of iron precipitation inside the boreholes and pumps.

Through long term water level monitoring data, the abstraction volumes can be optimised by adjusting the abstraction rate if required. It is recommended that the borehole is equipped with a variable frequency drive. This enables adjustments to the flow rate to be made if required, as determined by the hydrogeological analysis of water level and flow rate monitoring data.

As of January 2018 the Department of Water and Sanitation released a Government Gazette stating that: "All water use sector groups and individuals taking water from any water resource (surface or groundwater) regardless of the authorization type, in the Berg, Olifants and Breede Gouritz Water Management Area, shall install electronic water recording, monitoring or measuring devices to enable monitoring of abstractions, storage and use of water by existing lawful users and establish links with any monitoring or management system as well as keep records of the water used."

Therefore, to facilitate monitoring and informed management of the borehole, it is highly recommended that the borehole be equipped with the following monitoring infrastructure and equipment (diagram included in **Appendix D**):

- Installation of a 32 mm (inner diameter, class 10) observation pipe from the pump depth to the surface, closed at the bottom and slotted for the bottom 5 – 10 m.
- Installation of an electronic water level logger (for automated water level monitoring).
- Installation of a sampling tap (to monitor water quality).
- Installation of a flow volume meter (to monitor abstraction rates and volumes).

This monitoring data should be analysed by a qualified Hydrogeologist to ensure long-term sustainable use from the borehole. The legal compliance with regard to the use of the groundwater also needs to be addressed with the Department of Water and Sanitation.

5 References

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SANS (241-1:2015). Drinking water – Part 1: Microbiological, physical, aesthetic and chemical determinants.

6 Appendix A: Borehole Log

Log of Borehole No.: ECA_BH1

Location:	EFRC Agri Calendon	**Latitude:**	-34.3079
Date:	15-Aug-24	**Longitude:**	19.47264
Client:	EFRC Agri	**Ground Elevation:**	237 mamsl

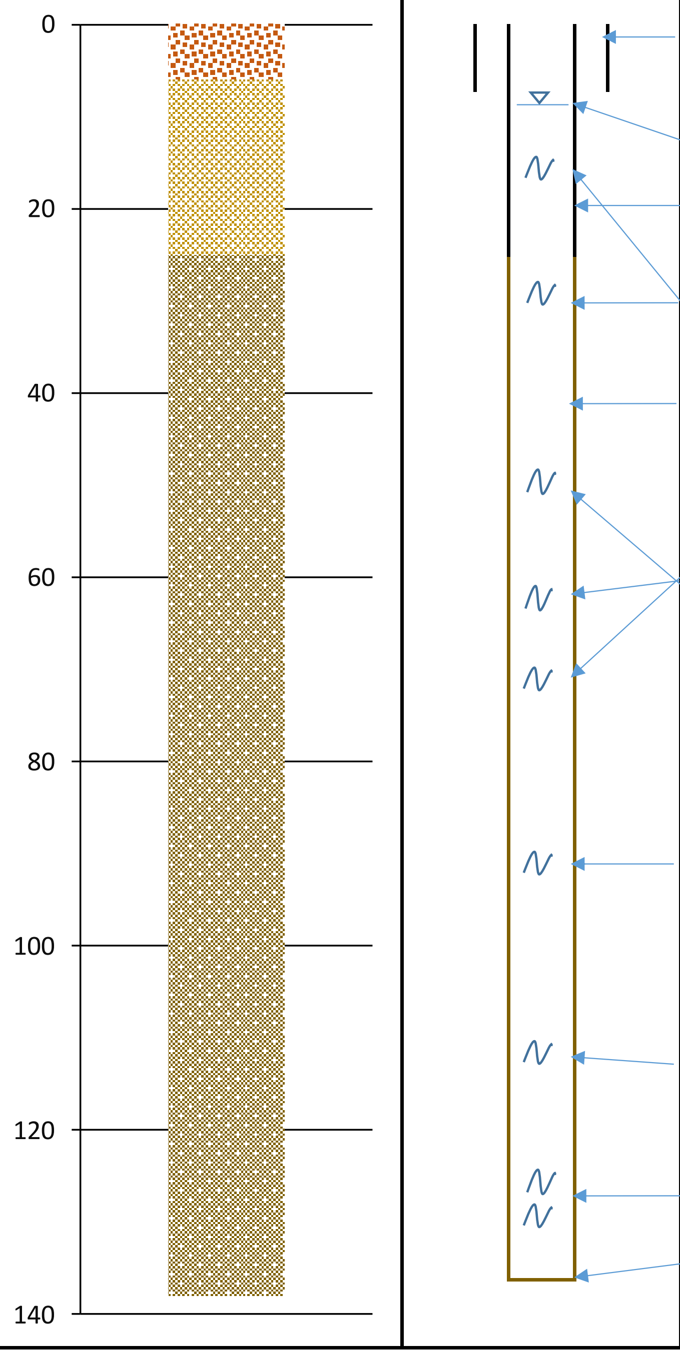
Lithological Description | **Lithology Symbol & Depth (m)** | **Borehole Construction** | **Description & water strike**

Lithological Description:

Overburden

Weathered sandstone

Sandstone



Description & water strike:

219mm Steel casing (0 -6 m)

Water level (8.97m)

177mm Steel casing (0 - 25m)

Water strike (17, 26m)

Open hole construction

Water strike (62, 70, 74m)

Water strike (93m)

Water strike (110m)

Water strike (124, 129m)

EOH (138 m)

Drilled By:	RPM Drilling	**Remarks:**	Blow yield: 60 000 L/h
Drill Method:	Air percussion		
Logged By:	RPM Drilling		

7 Appendix B: Yield Test Data

Abbreviations	
EC	Electrical conductivity
mbgl	Meters below ground level
mbch	Meters below casing height
mbdl	Meters below datum level
magl	Meters above ground level
L/S	Litres per second
RPM	Rates per minute
S/W/L	Static water level
µS/cm	Microsiemens per centimeter

ATS

BOREHOLE TEST RECORD

PR0JECT #	P2987
TEAM MEMBERS	MZIMKHULU
	ISAAC
	LUKHANYO

CONSULTANT: GEOSS
DISTRICT: OVERBERG
PROVINCE: WESTERN CAEP
FARM / VILLAGE NAME : ELGIN CHICKEN FARM
DATE TESTED: 31/07/2024

BOREHOLE LOCATION & ACCESS INFORMATION:

BOREHOLE COORDINATES

LATITUDE (SOUTH):	34.3079
LONGITUDE (EAST):	19.47264

COMMENTS ON ACCESS IF ANY:

BOREHOLE NO:	**ECA-BH1**
TRANSMISSIVITY VALUE:	
TYPE INSTALLATION:	**NEW BOREHOLE**
BOREHOLE DEPTH: (mbg	**138.6**

MAINTENANCE RECORD:		**REHABILITATION RECORD:**		**DIGITAL CAMERA LOGGING:**		**EQUIPMENT FISHING RECORD**	
Labour hours:		**Jetting hours:**		**Camera logged once:**		**Hours spent:**	
Cost of material:		**Brushing hours:**		**Camera logged twice:**			
Travelling (km):		**Airlifting hours:**		**Camera logged three times:**		**OTHER COSTS ON PROJECT:**	
		Sulphamic Acid KG's		**Camera work sent to client:**		**Courier of samples:**	
		Boresaver KG's				**Km's for delivery:**	
		Soda Ash KG's				**Cost of packaging:**	

COMMENTS:	**RECOMMENDATIONS / CORRECTIVE ACTIONS:**

SAMPLE INSTRUCTIONS :

Water sample taken	**Yes**	No	If consultant took sample, give name:		**DATA CAPTURED BY**	EC
Date sample taken	03/08/2024		If sample courier, to where:		**DATA CHECKED BY:**	AVN
Time sample taken	15H00					

DESCRIPTION:	**UNIT**	**QTY**		**UNIT**	**QTY**
STRAIGHTNESS TEST:	**NO**	0	BOREHOLE DEPTH AFTER TEST:	**M**	138.60
VERTICALLY TEST:	**NO**	0	BOREHOLE WATER LEVEL AFTER TEST: (mbch)	**M**	12.7
CASING DETECTION:	**NO**	1	SAND/GRAVEL/SILT PUMPED?	**YES/NO**	**0**
SUPPLIED NEW STEEL BOREHOLE COVER:	**NO**	0	DATA REPORTING AND RECORDING	**NO**	1
BOREHOLE MARKING	**NO**	0	SLUG TEST:	**NO**	0
SITE CLEANING & FINISHING	**NO**	1	LAYFLAT (M):	**M**	100
LOGGERS FOR WATERLEVEL MONITORING	**NO**	0	LOGGERS FOR pH AND EC:	**NO**	0

It is hereby acknowledged that upon leaving the site, all existing equipment is in an acceptable condition.

NAME: ____________________ **SIGNATURE:** ____________________

DESIGNATION: ____________________ **DATE:** ____________________

FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P2987	Coordinates: SOUTH:	34.3079	PROVINCE:	WESTERN CAEP
BOREHOLE NO:	ECA-BH1	EAST:	19.47264	DISTRICT:	OVERBERG
ALT BH NO:	0			SITE NAME:	ELGIN CHICKEN FARM
ALT BH NO:	0				
BOREHOLE DEPTH (m)	138.60	DATUM LEVEL ABOVE CASING (m):	0.32	EXISTING PUMP:	0
WATER LEVEL (mbdl):	8.94	CASING HEIGHT: (magl):	0.39	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	118.50	DIAM PUMP INLET (mm):	170.00	PUMP TYPE:	WA 110-2

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1 — 276
DATE: 31/07/2022 TIME: 12H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	1.08		**1**	
2	2.13		**2**	
3	2.83		**3**	
5	3.50		**5**	
7	4.28	6.25	**7**	
10	5.50		**10**	
15	8.25	8.02	**15**	
20	9.20	8.09	**20**	
30	10.85		**30**	
40	11.98	8.12	**40**	
50	12.77		**50**	
60	13.49	8.04	**60**	
70			**70**	
80			**80**	
90			**90**	
100			**100**	
110			**110**	
120			**120**	
pH			**150**	
TEMP	22.10	°C	**180**	
EC	288	µS/cm	**210**	

DISCHARGE RATE 2 — RPM 434
DATE: 31/07/202 TIME: 13H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	13.96		**1**	
2	14.24	10.96	**2**	
3	14.37		**3**	
5	15.12	12.52	**5**	
7	16.04		**7**	
10	18.43	13.00	**10**	
15	19.90		**15**	
20	21.62	13.04	**20**	
30	23.13	13.10	**30**	
40	25.63		**40**	
50	27.30	13.12	**50**	
60	29.57		**60**	
70			**70**	
80			**80**	
90			**90**	
100			**100**	
110			**110**	
120			**120**	
pH			**150**	
TEMP	17.80	°C	**180**	
EC	274	µS/cm	**210**	

DISCHARGE RATE 3 — RPM 618
DATE: 31/07/202 TIME: 14H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	30.22		**1**	
2	31.84		**2**	
3	33.08		**3**	
5	35.17	17.45	**5**	
7	37.43		**7**	
10	39.27	18.09	**10**	
15	43.63		**15**	
20	47.17	18.14	**20**	
30	53.07	18.11	**30**	
40	56.03		**40**	
50	58.02	18.06	**50**	
60	61.28		**60**	
70			**70**	
80			**80**	
90			**90**	
100			**100**	
110			**110**	
120			**120**	
pH			**150**	
TEMP	16.20	°C	**180**	
EC	256	µS/cm	**210**	

DISCHARGE RATE 4 — RPM
DATE: 31/07/2024 TIME: 15H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	62.30		**1**	38.96
2	63.43		**2**	28.91
3	65.62		**3**	25.89
5	71.61	21.24	**5**	25.00
7	77.02		**7**	21.24
10	83.86	22.28	**10**	19.17
15			**15**	17.67
20			**20**	16.56
30			**30**	14.49
40			**40**	12.95
50			**50**	11.57
60			**60**	10.76
70			**70**	10.03
80			**80**	9.66
90			**90**	9.28
100			**100**	8.68
110			**110**	8.16
120			**120**	7.67
pH			**150**	6.99
TEMP		°C	**180**	6.27
EC		µS/cm	**210**	
			240	
			300	
			360	

DISCHARGE RATE 5 — RPM
DATE: TIME:

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			**1**	
2			**2**	
3			**3**	
5			**5**	
7			**7**	
10			**10**	
15			**15**	
20			**20**	
30			**30**	
40			**40**	
50			**50**	
60			**60**	
70			**70**	
80			**80**	
90			**90**	
100			**100**	
110			**110**	
120			**120**	
pH			**150**	
TEMP		°C	**180**	
EC		µS/cm	**210**	
			240	
			300	
			360	

DISCHARGE RATE 6 — RPM
DATE: TIME:

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			**1**	
2			**2**	
3			**3**	
5			**5**	
7			**7**	
10			**10**	
15			**15**	
20			**20**	
30			**30**	
40			**40**	
50			**50**	
60			**60**	
70			**70**	
80			**80**	
90			**90**	
100			**100**	
110			**110**	
120			**120**	
pH			**150**	
TEMP		°C	**180**	
EC		µS/cm	**210**	
			240	
			300	
			360	

S/W/L:(mbch) 8.97

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P2987	Coordinates: SOUTH:	34.3079	PROVINCE:	WESTERN CAEP
BOREHOLE NO:	ECA-BH1	EAST:	19.47264	DISTRICT:	OVERBERG
ALT BH NO:	0			SITE NAME:	ELGIN CHICKEN FARM
ALT BH NO:	0				
BOREHOLE DEPTH:	138.60	DATUM LEVEL ABOVE CASING (m):	0.32	EXISTING PUMP:	0
WATER LEVEL (mbdl):	9.28	CASING HEIGHT: (magl):	0.39	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	118.50	DIAM PUMP INLET(mm):	170	PUMP TYPE:	WA 110-2

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				TEST COMPLETED					
DATE:	01/08/2024	TIME:	13H00	DATE:		TIME:		TYPE OF PUMP:	WA 110-2

DISCHARGE BOREHOLE					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3	
					NR:			NR:			NR:	
					Distance(m);			Distance(m);			Distance(m);	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	2.64		**1**	56.57	**1**			**1**			**1**	
2	3.00		**2**	51.91	**2**			**2**			**2**	
3	3.92		**3**	50.74	**3**			**3**			**3**	
5	5.26		**5**	48.76	**5**			**5**			**5**	
7	8.02	11.68	**7**	47.02	**7**			**7**			**7**	
10	10.63		**10**	44.98	**10**			**10**			**10**	
15	14.41	13.46	**15**	42.96	**15**			**15**			**15**	
20	16.09		**20**	41.90	**20**			**20**			**20**	
30	19.56	15.06	**30**	39.60	**30**			**30**			**30**	
40	21.20		**40**	37.02	**40**			**40**			**40**	
60	28.96	15.10	**60**	34.23	**60**			**60**			**60**	
90	34.71	15.08	**90**	30.70	**90**			**90**			**90**	
120	39.76		**120**	27.57	**120**			**120**			**120**	
150	43.21	15.02	**150**	25.08	**150**			**150**			**150**	
180	46.02		**180**	23.52	**180**			**180**			**180**	
210	49.00	15.11	**210**	22.06	**210**			**210**			**210**	
240	51.26		**240**	21.09	**240**			**240**			**240**	
300	54.08	15.03	**300**	18.95	**300**			**300**			**300**	
360	58.10	15.07	**360**	17.00	**360**			**360**			**360**	
420	61.24		**420**	15.40	**420**			**420**			**420**	
480	64.82	15.12	**480**	14.02	**480**			**480**			**480**	
540	68.00		**540**	12.88	**540**			**540**			**540**	
600	71.09	15.07	**600**	11.87	**600**			**600**			**600**	
720	77.20		**720**	10.31	**720**			**720**			**720**	
840	83.45	15.10	**840**	9.01	**840**			**840**			**840**	
960	94.98		**960**	7.87	**960**			**960**			**960**	
		12.35	**1080**	6.97	**1080**			**1080**			**1080**	
		12.19	**1200**	6.13	**1200**			**1200**			**1200**	
		11.98	**1320**	5.39	**1320**			**1320**			**1320**	
			1440	4.63	**1440**			**1440**			**1440**	
			1560		**1560**			**1560**			**1560**	
			1680		**1680**			**1680**			**1680**	
			1800		**1800**			**1800**			**1800**	
			1920		**1920**			**1920**			**1920**	
			2040		**2040**			**2040**			**2040**	
			2160		**2160**			**2160**			**2160**	
			2280		**2280**			**2280**			**2280**	
			2400		**2400**			**2400**			**2400**	
			2520		**2520**			**2520**			**2520**	
			2640		**2640**			**2640**			**2640**	
			2760		**2760**			**2760**			**2760**	
			2880		**2880**			**2880**			**2880**	
			3000		**3000**			**3000**			**3000**	
			3120		**3120**			**3120**			**3120**	
			3240		**3240**			**3240**			**3240**	
			3360		**3360**			**3360**			**3360**	
			3480		**3480**			**3480**			**3480**	
			3600		**3600**			**3600**			**3600**	
			3720		**3720**			**3720**			**3720**	
			3840		**3840**			**3840**			**3840**	
			3960		**3960**			**3960**			**3960**	
			4080		**4080**			**4080**			**4080**	
			4200		**4200**			**4200**			**4200**	
			4320		**4320**			**4320**			**4320**	
Total time pumped(min):						**W/L**			**W/L**			**W/L**
Average yield (l/s):												

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P2987	Coordinates: SOUTH:	34.3079	PROVINCE:	WESTERN CAEP
BOREHOLE NO:	ECA-BH1	EAST:	19.47264	DISTRICT:	OVERBERG
ALT BH NO:	0			SITE NAME:	ELGIN CHICKEN FARM
ALT BH NO:	0				
BOREHOLE DEPTH:	138.60	DATUM LEVEL ABOVE CASING (m):	0.32	EXISTING PUMP:	0
WATER LEVEL (mbdl):	13.69	CASING HEIGHT: (magl):	0.39	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	118.50	DIAM PUMP INLET(mm):	170	PUMP TYPE:	WA 110-2

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				TEST COMPLETED					
DATE:	03/08/2024	TIME:	08H20	DATE:		TIME:		TYPE OF PUMP:	WA 110-2

DISCHARGE BOREHOLE					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3	
					NR:			NR:			NR:	
					Distance(m);			Distance(m);			Distance(m);	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	5.74		**1**	35.02	**1**			**1**			**1**	
2	6.90		**2**	31.16	**2**			**2**			**2**	
3	8.19		**3**	28.68	**3**			**3**			**3**	
5	10.04	10.62	**5**	26.02	**5**			**5**			**5**	
7	11.63		**7**	24.74	**7**			**7**			**7**	
10	15.74	12.54	**10**	23.54	**10**			**10**			**10**	
15	17.00	12.52	**15**	21.51	**15**			**15**			**15**	
20	19.33		**20**	20.47	**20**			**20**			**20**	
30	21.03	12.50	**30**	18.73	**30**			**30**			**30**	
40	24.16		**40**	17.62	**40**			**40**			**40**	
60	27.95	12.54	**60**	16.35	**60**			**60**			**60**	
90	30.49	12.56	**90**	14.51	**90**			**90**			**90**	
120	32.98		**120**	13.00	**120**			**120**			**120**	
150	35.84	12.52	**150**	11.68	**150**			**150**			**150**	
180	38.06		**180**	10.59	**180**			**180**			**180**	
210	40.50	12.57	**210**	9.36	**210**			**210**			**210**	
240	43.12	12.56	**240**	8.61	**240**			**240**			**240**	
300	49.91	12.58	**300**		**300**			**300**			**300**	
360	49.91	12.58	**360**		**360**			**360**			**360**	
420	52.70		**420**		**420**			**420**			**420**	
			480		**480**			**480**			**480**	
			540		**540**			**540**			**540**	
			600		**600**			**600**			**600**	
			720		**720**			**720**			**720**	
			840		**840**			**840**			**840**	
			960		**960**			**960**			**960**	
			1080		**1080**			**1080**			**1080**	
			1200		**1200**			**1200**			**1200**	
			1320		**1320**			**1320**			**1320**	
			1440		**1440**			**1440**			**1440**	
			1560		**1560**			**1560**			**1560**	
			1680		**1680**			**1680**			**1680**	
			1800		**1800**			**1800**			**1800**	
			1920		**1920**			**1920**			**1920**	
			2040		**2040**			**2040**			**2040**	
			2160		**2160**			**2160**			**2160**	
			2280		**2280**			**2280**			**2280**	
			2400		**2400**			**2400**			**2400**	
			2520		**2520**			**2520**			**2520**	
			2640		**2640**			**2640**			**2640**	
			2760		**2760**			**2760**			**2760**	
			2880		**2880**			**2880**			**2880**	
			3000		**3000**			**3000**			**3000**	
			3120		**3120**			**3120**			**3120**	
			3240		**3240**			**3240**			**3240**	
			3360		**3360**			**3360**			**3360**	
			3480		**3480**			**3480**			**3480**	
			3600		**3600**			**3600**			**3600**	
			3720		**3720**			**3720**			**3720**	
			3840		**3840**			**3840**			**3840**	
			3960		**3960**			**3960**			**3960**	
			4080		**4080**			**4080**			**4080**	
			4200		**4200**			**4200**			**4200**	
			4320		**4320**			**4320**			**4320**	
Total time pumped(min):						**W/L**			**W/L**			**W/L**
Average yield (l/s):												

8 Appendix C: Water Quality

vinlab H2O
Your partner in quality water analysis

Distillery Road
Stellenbosch
Tel 021-8828866/7
info@vinlab.com
www.vinlab.com
2024-08-08

TEST REPORT

Water

Geoss South Africa (Pty) Ltd

Attn: Alison McDuling

P.O.Box 12412
Die Boord, Stellenbosch
7613
+27218801079

@VinlabSA

Sample Details					
SampleID	W54284				
Water Type	Drinking Water				
Water Source	Borehole				
Sample Temperature					
Description	ECA_BH1				
Batch Number					
PO Number	3659_L				
Date Received	2024-08-06				
Condition	Good				

Water - Routine

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
pH@25C (Water)		VIN-05-MW01	^^^	>= 5 to <= 9.7	6.01				
Conductivity@25C (Water)	mS/m	VIN-05-MW02	^	<= 170	28				
Turbidity (Water)*	ntu			<= 5	27.3				
Total dissolved solids (Water)*	mg/L			<= 1200	189.84				
Free Chlorine (Water)*	mg/L			<= 5	<0.02				
Ammonia (NH4) as N (Water)	mg/L	VIN-05-MW08	8.90%	<= 1.5	<0.15				
Nitrate as N (Water)	mg/L	VIN-05-MW08	11.00%	<= 11	<1.00				
Nitrite as N (Water)	mg/L	VIN-05-MW08	4.50%	<= 0.9	<0.05				
Chloride (Cl-) - Water	mg/L	VIN-05-MW08	10.12%	<= 300	64.43				
Sulphates (SO4) - Water	mg/L	VIN-05-MW08	7.56%	<= 500	6.86				
Fluoride (F) - Water	mg/L	VIN-05-MW08	12.30%	<= 1.5	0.16				
Alkalinity as CaCO3 (Water)*	mg/L				25.10				
Colour (Water)*	mg/L Pt-Co			<= 15	<15				
Total Organic Carbon (Water)*	mg/L			<=10	1.74				
Date Tested					2024-08-06				

Water - Metals

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
Calcium (Ca) - Water	mg/L	VIN-05-MW43	14.60%		7				
Magnesium (Mg) - Water	mg/L	VIN-05-MW43	8.49%		4				
Sodium (Na) - Water	mg/L	VIN-05-MW43	11.45%	<= 200	37				
Potassium (K) - Water	mg/L	VIN-05-MW43	9.42%		4				

Please click here for SANS241-1:2015 drinking water limits

*** Not SANAS Accredited. Results marked "Not SANAS Accredited" in this report are not included in the SANAS Scope of Accreditation for Vinlab.**

^ - Conductivity <1000mS/m = ±1mS/m , >1000mS/m = ±9mS/m
^^ - COD, LR = ±16mg/L, MR = ±48mg/L, HR = ±477mg/L
^^^ - pH ± 0.1

sanas Testing Laboratory T1131

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2024-08-08

vinlab H2O
Your partner in quality water analysis

TEST REPORT

Water

Geoss South Africa (Pty) Ltd

Attn: Alison McDuling

P.O.Box 12412
Die Boord, Stellenbosch
7613
+27218801079

@VinlabSA

Zinc (Zn) - Water	mg/L	VIN-05-MW43	19.40%	<= 5	0.716					
Antimony (Sb) - Water*	µg/L			<=20	<13.0					
Arsenic (As) - Water*	µg/L			<= 10	<10.0					
Boron (B) Water	µg/L	VIN-05-MW43	11.79%	<= 2400	13					
Cadmium (Cd) Water	µg/L	VIN-05-MW43	12.26%	<= 3	<1					
Chromium (Cr) - Water	µg/L	VIN-05-MW43	13.03%	<= 50	<4					
Copper (Cu) - Water	µg/L	VIN-05-MW43	11.57%	<= 2000	5					
Iron (Fe) - Water	µg/L	VIN-05-MW43	12.49%	<= 2000	549					
Lead (Pb) - Water	µg/L	VIN-05-MW43	16.32%	<= 10	<8					
Manganese (Mn) - Water	µg/L	VIN-05-MW43	12.44%	<= 400	45					
Nickel (Ni) - Water	µg/L	VIN-05-MW43	17.38%	<= 70	<8					
Selenium (Se) - Water*	µg/L			<= 40	<10.0					
Aluminium (Al) - Water	µg/L	VIN-05-MW43	13.49%	<= 300	217					
Cyanide (CN) - Water*	µg/L			<= 200	<10.0					
Mercury (Hg) - Water*	µg/L			<= 6	2					
Barium (Ba) Water	µg/L	VIN-05-MW43	14.09%	<= 700	29					
Uranium (U) - Water*	µg/L			<= 30	<28					
Date Tested					2024-08-06					

Comments

W54284
Ion balance = 0.5%

Adelize Fourie
Laboratory Manager (Waterlab)
VIN-05-
M01,M02,M03,M04,M05,MO8,M10,M28,
M43, MW01, MW02, MW03, MW04,
MW05, MW06, MW07, MW08/9/10,
MW12, MW13, MW14

Please click here for SANS241-1:2015 drinking water limits

*** Not SANAS Accredited. Results marked "Not SANAS Accredited" in this report are not included in the SANAS Scope of Accreditation for Vinlab.**

^ - Conductivity <1000mS/m = ±1mS/m , >1000mS/m = ±9mS/m
^^ - COD, LR = ±16mg/L, MR = ±48mg/L, HR = ±477mg/L
^^^ - pH ± 0.1

sanas Testing Laboratory T1131

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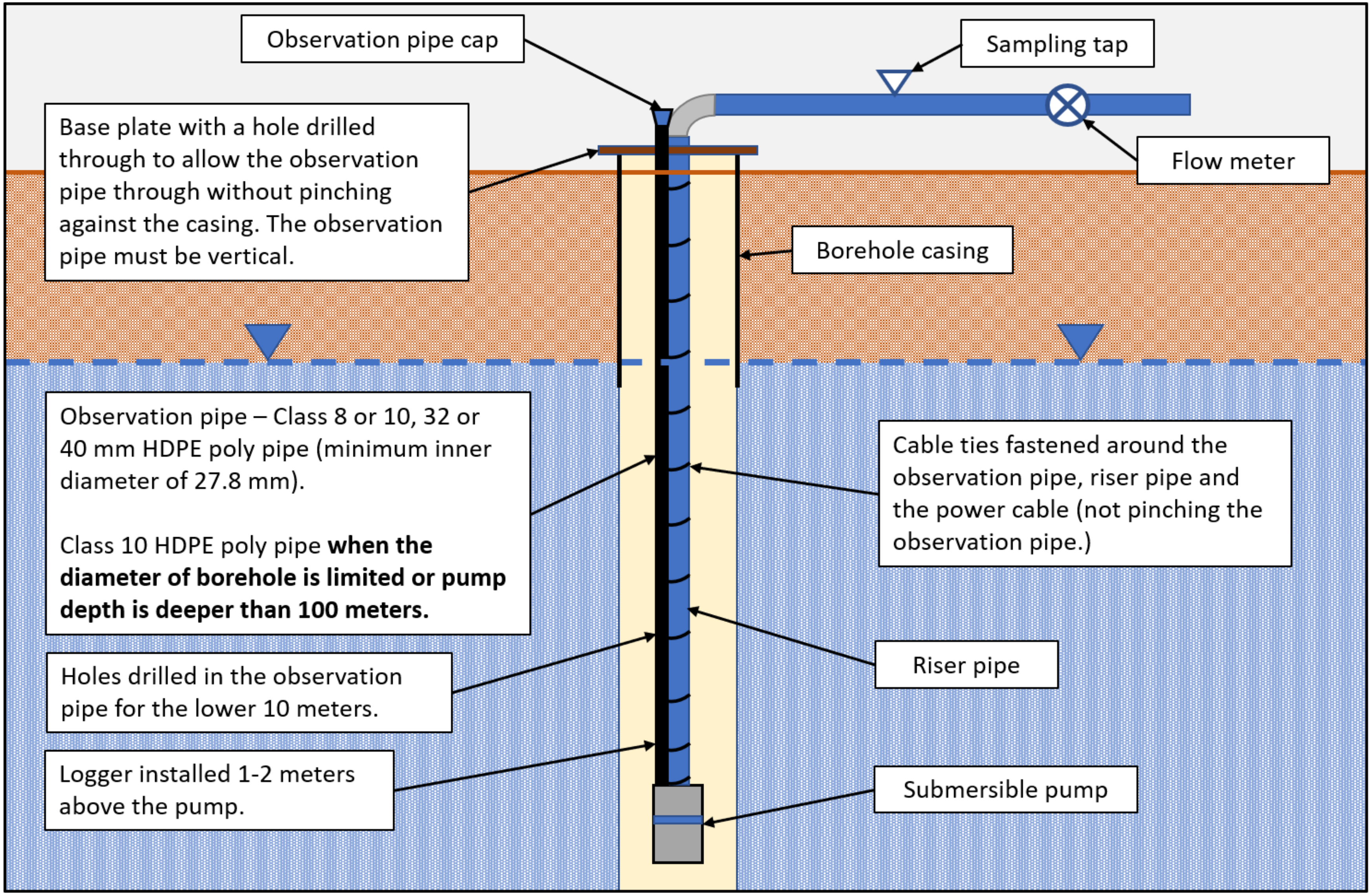
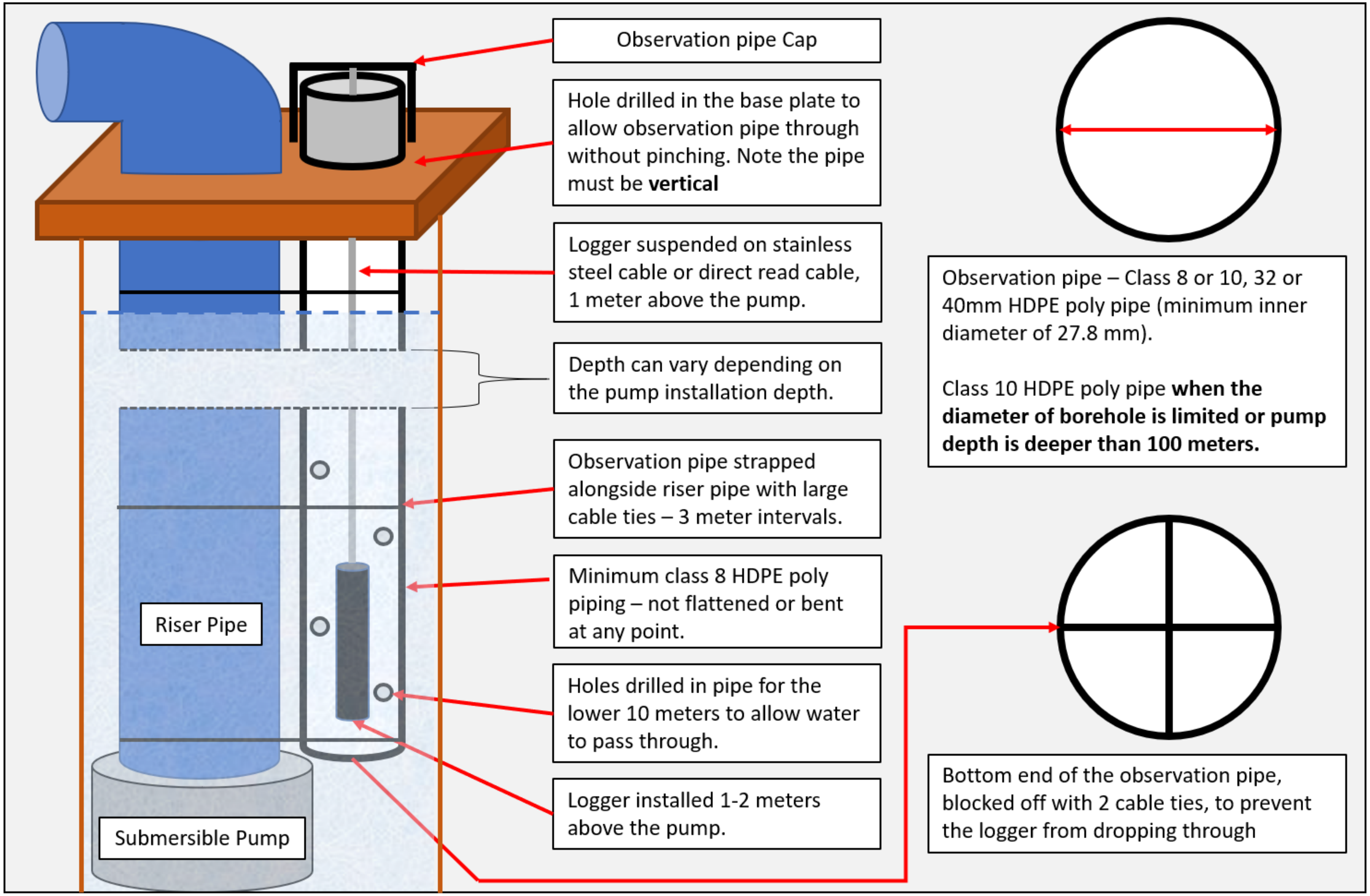
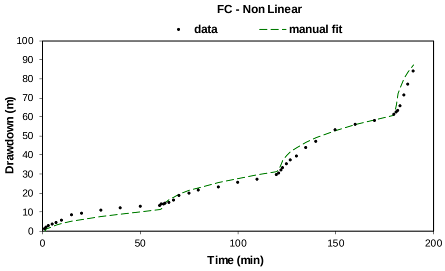
9 Appendix D: Monitoring Infrastructure Diagram


Observation pipe cap
Sampling tap
Flow meter
Base plate with a hole drilled through to allow the observation pipe through without pinching against the casing. The observation pipe must be vertical.
Borehole casing
Observation pipe – Class 8 or 10, 32 or 40 mm HDPE poly pipe (minimum inner diameter of 27.8 mm).
Class 10 HDPE poly pipe **when the diameter of borehole is limited or pump depth is deeper than 100 meters.**
Cable ties fastened around the observation pipe, riser pipe and the power cable (not pinching the observation pipe.)
Holes drilled in the observation pipe for the lower 10 meters.
Riser pipe
Logger installed 1-2 meters above the pump.
Submersible pump


Observation pipe Cap
Hole drilled in the base plate to allow observation pipe through without pinching. Note the pipe must be **vertical**
Logger suspended on stainless steel cable or direct read cable, 1 meter above the pump.
Depth can vary depending on the pump installation depth.
Observation pipe strapped alongside riser pipe with large cable ties – 3 meter intervals.
Minimum class 8 HDPE poly piping – not flattened or bent at any point.
Holes drilled in pipe for the lower 10 meters to allow water to pass through.
Logger installed 1-2 meters above the pump.
Riser Pipe
Submersible Pump
Observation pipe – Class 8 or 10, 32 or 40mm HDPE poly pipe (minimum inner diameter of 27.8 mm).
Class 10 HDPE poly pipe **when the diameter of borehole is limited or pump depth is deeper than 100 meters.**
Bottom end of the observation pipe, blocked off with 2 cable ties, to prevent the logger from dropping through

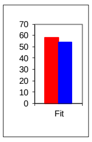
10 Appendix E: Yield Test Data Analysis

ECA_BH1



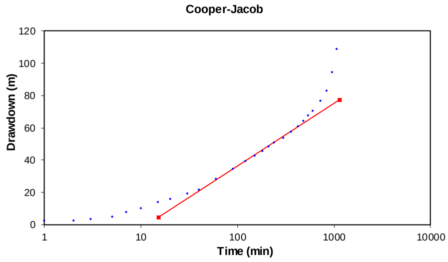
FC - Non Linear Method to estimate Q_Sust

skin effect	Non-Darcian loss		Darcian loss		
A	C	p	B	n	e
1.00E-06	2.41E-06	2.16E+00	1.00E-03	5.00E-01	1.00E+00



Extrapolation	
Ext_pol time (min)	
1051200	
Q (L/s)	Drawdown (m)
1	58.23

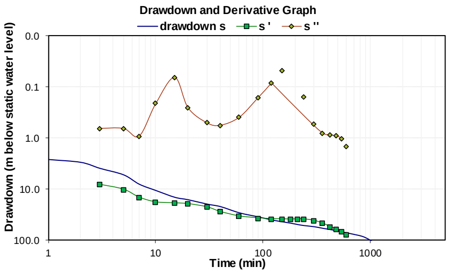
Available drawdown (m) =		54	
No boundaries	1 no-flow	2 no-flow	Closed
1.0	0.5	0.3	0.2
Q_Sust (L/s)=	0.71	std.dev = 0.36	
Boundaries selected	0 - closed		



Cooper-Jacob method

$T(m^2/d)$ =	6.1	r_e (m)=	0.1
S =	1.09E+01	Q (l/s) =	15.00

	No boundaries	1 no-flow	2 no-flow	Closed
Q_sust	4.20	2.10	1.39	1.05
Avg. Q_sust =		2.19	std. dev =	1.41
Boundaries selected	0 - closed			

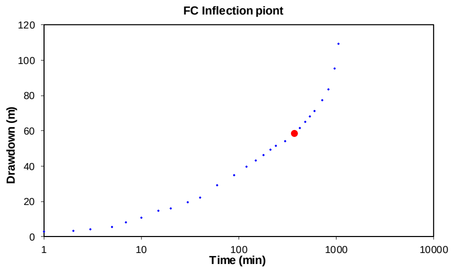


FC method

Extrapolation time in years	2	1051200	Extrapol.time in minutes	
Effective borehole radius (r_e)	43.1428199	43.14281989	Est. r_e	From r(e) sheet
Q (l/s) from pumping test	15	0.000274289	S-late	Change r_e
s_a (available drawdown), sigma_s	**54**	0	Sigma_s from risk	
Annual effective recharge (mm)	0	54	s_available working drawdown(m)	
t(end) and s(end) of pumping test	1060	109.12	End time and drawdown of test	
Average maximum derivative	**40.95**	103.3733784	Estimate of average of max deriv	
Average second derivative	**0.8**	0.095270497	Estimate of average second deriv	
Derivative at radial flow period	17.5525733	17.55257331	Read from derivative graph	
T-early[m^2/d]		13.51186494	Aqui. thick (m)	60
T and S estimates	**T-late [m^2/d]**	**5.791648352**	Est. S-late	0.0033
	S-late	0.0033		

BASIC SOLUTION

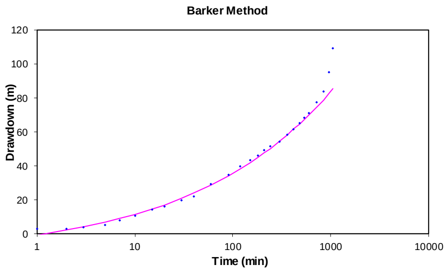
	No boundaries	1 no-flow	2 no-flow	Closed no-flow
sWell (Extrapol.time) =	235.41	358.11	480.82	848.92
Q_sust (l/s) =	3.44	2.26	1.68	0.95
Average Q_sust (l/s) =	**1.88**			
with standard deviation=	1.05			
Boundaries selected	0 - closed			



FC inflection point method

extrapolaltion time in years =	2	1051200
t(min) and s(m) at inflection point =	380	58
enter derivative value at inflection point time =	46.49	46.48555

	No boundaries	1 no-flow	2 no-flow	Closed
sWell(Extrapol.time)	218.01	378.03	538.04	1018.08
Q_sust	3.99	2.30	1.62	0.85
Average Q-sust (l/s)	**1.89**	std. dev =	0.85	
Boundaries selected	0 - closed			

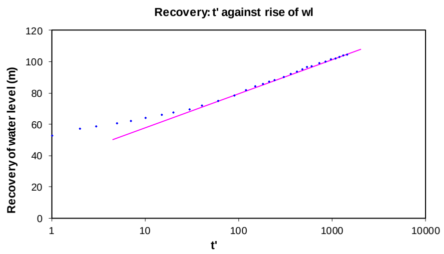


Barker method

	K_f [m/d]	S_f [1/m]	b	n	N
Fit Parameters	150.00	2.00E-03	1.19	1.40	0.3000

	No boundaries	1 no-flow	2 no-flow	Closed
sWell(Extrapol.time)	764.85	1010.25	1132.96	1255.66
Q_sust	1.06	0.80	0.71	0.65

Fractal n = 1.40	**Average Q-sust (l/s)=**	0.79	std. dev =	0.18
	Boundaries selected	0 - closed		



Recovery

T [m2/d]	10.86
CDT Duration	1060
Recovery Duration	1440
Max % Recovery	95.8

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