Borehole Yield and Quality Testing at Portion 63 of Farm 918, Strand, Western Cape.

REPORT:
GEOSS Report No: 2023/06-16

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23 June 2023

EXECUTIVE SUMMARY

GEOSS South Africa (Pty) Ltd was appointed by Heloïse Groenewald from GNEC Environmental Consultants to conduct a camera log, and yield and groundwater quality testing of two boreholes at Portion 63 of Farm 918, Strand, Western Cape. The boreholes were tested by ATS under the management and supervision of GEOSS from 30 May to 3 June 2023. This included a Step Test, CDT and Recovery Test at each borehole. It is recommended that groundwater abstraction can occur within the below-mentioned parameters from the tested boreholes. Aquifer over-abstraction is unlikely to occur if these rates are adhered to and if the boreholes are managed through long-term monitoring data.

Borehole Details				
Borehole Name	**Latitude (DD)**	**Longitude (DD)**	**Borehole Depth (m)**	**Inner Diameter (mm)**
HP_BH3	-34.11870	18.88440	114.2	160
HP_BH4	-34.11934	18.88464	36.2	110
Abstraction Recommendations				
Borehole Name	**Abstraction rate (L/s)**	**Abstraction Duration (hrs)**	**Recovery Duration (hrs)**	**Possible Volume Abstracted (L/d)**
HP_BH3	0.2	24	0	17 280
HP_BH4	0.85	24	0	73 440
			TOTAL	**90 720**
Pump Installation Details				
Borehole Name	**Pump Installation Depth (mbgl)**	**Critical Water Level (mbgl)**	**Dynamic Water Level (mbgl)***	**Rest Water Level (mbgl)**
HP_BH3	68	67	50	21.49
HP_BH4	33	32	21	19.45

* Typical water level expected during long-term production

Please note that HP_BH4 was not tested to its full capacity due to access to the borehole being limited as HP_BH4 is situated on a slope. This prevented the safe installation of larger testing equipment.

Through long-term water level monitoring data, the abstraction volumes can be optimised by adjusting the abstraction rate, if required. This can be achieved by means of a gate valve. 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, the groundwater from HP_BH3 and HP_BH4 is of poor quality for potable supply. The total dissolved solids and electrical conductivity of both boreholes are elevated into the category of marginal. This is related to the elevated concentrations of sodium and chloride,

which exceed the aesthetic limits of the SANS 241-1:2015 drinking water guidelines. The turbidity of HP_BH3 is elevated to the category of marginal. This is related to the high concentration of iron in the borehole. Additionally, the iron, fluoride and manganese concentrations of HP_BH3 exceeds the chronic health limit of the SANS 241-1:2015 drinking water guidelines. Iron biofouling is likely to occur in the borehole if the borehole is not managed optimally. This will result in the clogging of the borehole as well as the abstraction infrastructure. Additionally, HP_BH4 has an E.coli content in the groundwater that exceeds the acute health limit of the SANS 241-1:2015 drinking water guidelines. As such, groundwater from both of these boreholes should not be consumed prior to treatment.

To address the potential for iron to clog the borehole (HP_BH3) 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 17 280 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 minimised decreasing the amount of iron precipitation inside the boreholes and pumps.

To facilitate monitoring and informed management of a borehole, it is recommended to equip boreholes 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 legal compliance with regard to the use of 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
DWA	Department of Water Affairs (pre- 1994)
DWAF	Department of Water Affairs and Forestry (1994 – 2009)
DWS	Department of Water and Sanitation (2009 – ….)
ID	inner diameter
L/s	litres per second
L/d	litres per day
m^2/d	meters squared per day
m	metres
mbgl	metres below ground level
RWL	rest water level below ground level
T	Transmissivity

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).

Dynamic water level: the stabilised water level in the borehole during production over long periods of time.

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.

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.

Suggested citation for this report:

GEOSS (2023). Borehole Yield and Quality Testing at Portion 63 of Farm 918, Strand, Western Cape. Report Number: 2023/09-16. GEOSS South Africa (Pty) Ltd. Stellenbosch, South Africa.

Cover photo:

Rig set up at HP_BH3

GEOSS project number:

2021_07–4450 Phase G

Reviewed by:

Reuben Lazarus (22 June 2023) & Dale Barrow (23 June 2023)

1. INTRODUCTION

GEOSS South Africa (Pty) Ltd was appointed by Heloïse Groenewald from GNEC Environmental Consultants to conduct a camera log, and yield and water quality testing of two boreholes at Portion 63 of Farm 918, Strand, Western Cape. The boreholes that were tested are displayed in **Figure 1**.

The boreholes were tested by ATS under the management and supervision of GEOSS from 30 May to 3 June 2023, details of this are presented in this report. The boreholes' details are presented in **Table 1** below and spatially in **Figure 2**. No drilling logs were made available, however; estimations of the boreholes' construction are presented in **Appendix A**. Camera logs of both boreholes were conducted to determine the construction of the boreholes and these are presented in **Appendix B**. The geological setting of the area and the camera logging suggests that HP_BH3 is drilled into the fractured shales of the Tygerberg Formation (EDt) and HP_BH4 is drilled into the overlying alluvium (**Figure 3**).

Table 1: Borehole Details

Borehole	Latitude (DD-WGS84)	Longitude (DD-WGS84)	Depth (m)
HP_BH3	-34.118704º	18.884398º	114.2
HP_BH4	-33.119343º	18.884644º	36.15

Figure 1: (Left) HP_BH3 before testing, (Right) HP_BH4 during testing.

2. YIELD TESTING

2.1 Methodology

The yield testing was undertaken by ATS under the management and supervision of GEOSS from 30 May to 3 June 2023 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 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 (CDT) 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 the commencement of the yield test). Raw data and measurements taken during the yield tests are presented in **Appendix C.**

Figure 2: Borehole Locality Map

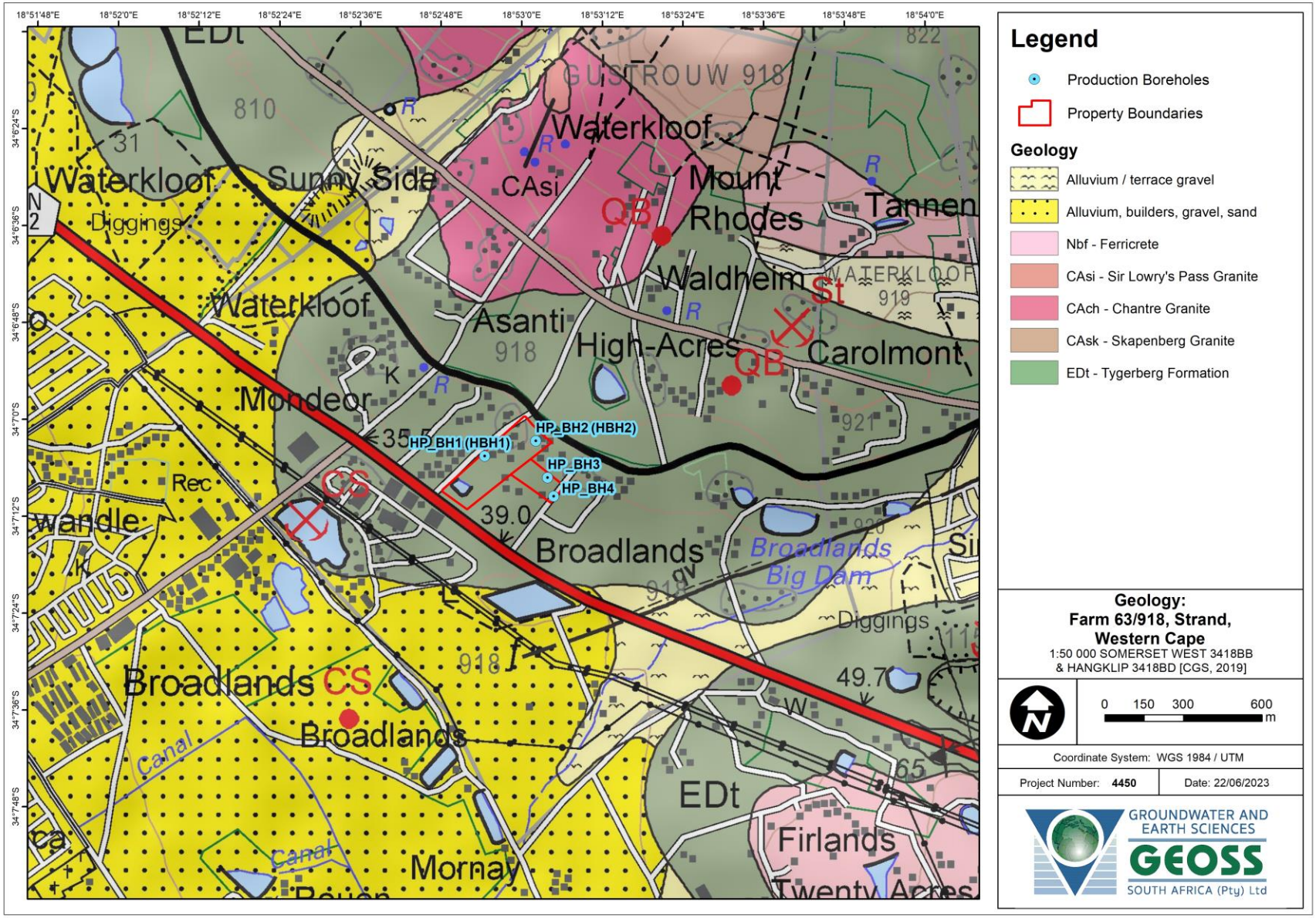

Figure 3: Geological Map with Property Boundary and Tested Borehole Positions (1:50 000 Geological Map Series, 3418BB Somerset West & 3418BD Hangklip)(CGS, 2019).

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 HP_BH3 this was 48 m, based on an inflection point observed during the step test. For HP_BH4 this was 13 m, based on the maximum pump installation depth. 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 and microbial analyses.

2.2 Yield Testing at HP_BH3

The yield testing was conducted between the 30th of May and 1st of June 2023. The borehole was measured to a depth of 114.2 meters below ground level (mbgl). The test pump was installed at a depth of 99.2 mbgl. The rest water level (RWL) at the start of the test was 21.49 mbgl.

During the step test, the water level was drawn down to pump inlet at the end of the 3rd step at a rate of 1.03 L/s (3 708 L/hour). **Figure 4** shows the time-series drawdown for the Step Test.

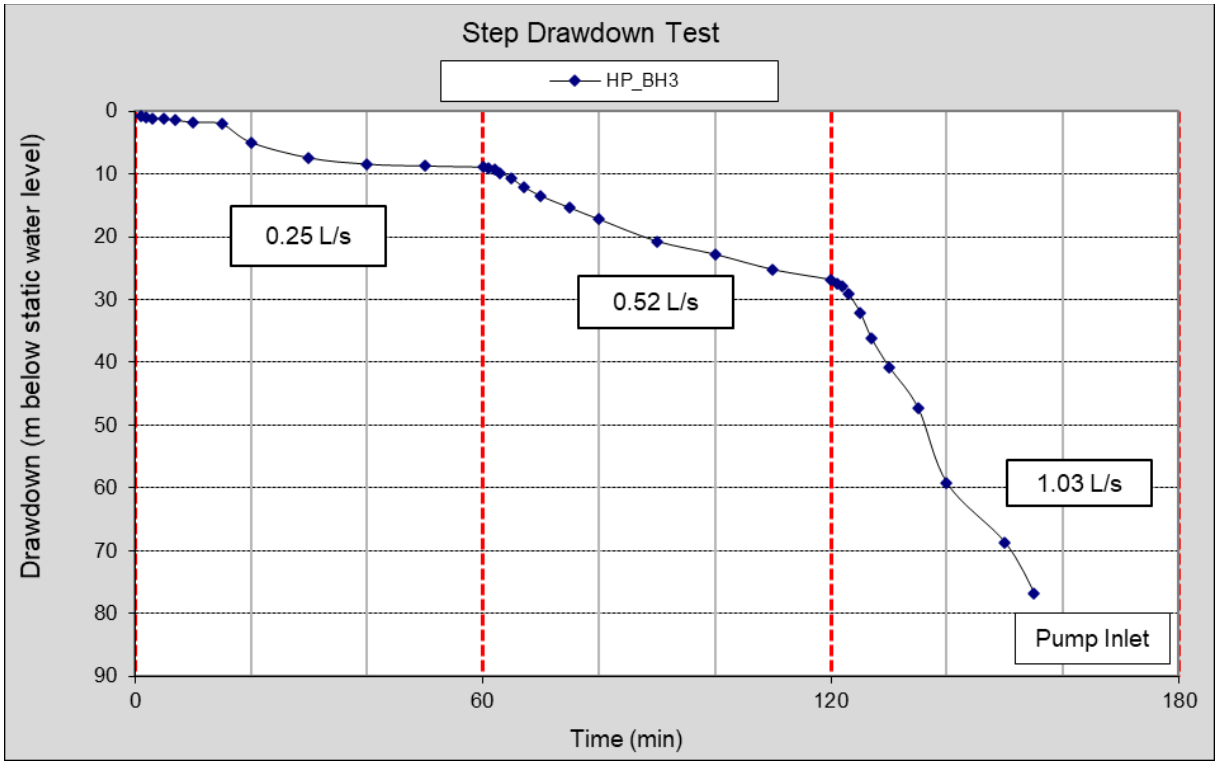

Figure 4: Step Test drawdown data for HP_BH3.

The water level was left to recover overnight before starting the CDT. The water level at the start of the CDT was 21.49 mbgl. Based on the results of the Step Test, the planned 24-hour CDT was conducted at a rate of 0.42 L/s (1 512 L/hour). At the end of the 24-hour period, the water level had drawn down 48.77 meters below the rest water level (70.26 mbgl).

The semi-log plot of the drawdown from the CDT is presented in **Figure 5**. The available drawdown (AD) is indicated with the horizontal red line at 48 m, which was selected based on an inflection point observed during the testing.

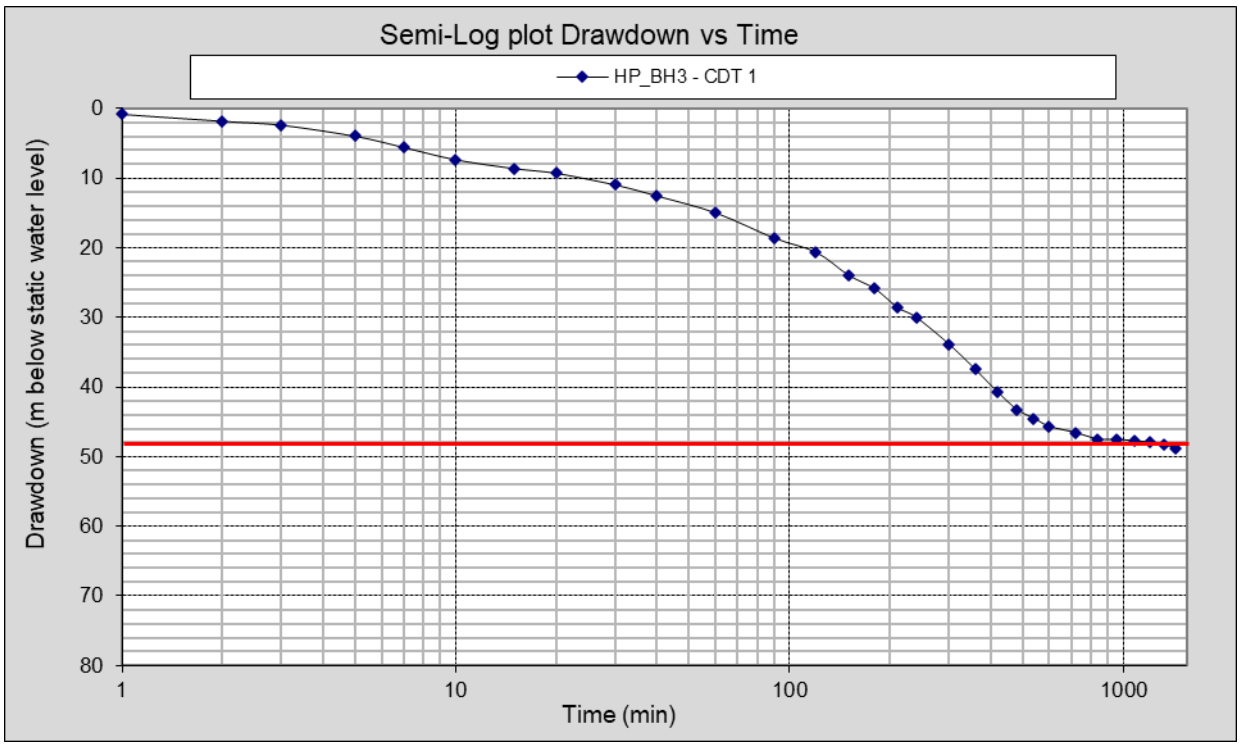

Figure 5: Semi-Log Plot of drawdown during the CDT of HP_BH3 (0.42 L/s).

The recovery of the water level was monitored after the 24-hour CDT and is presented in **Figure 6**. The recovery was very fast, reaching 96.1% in 2 hours.

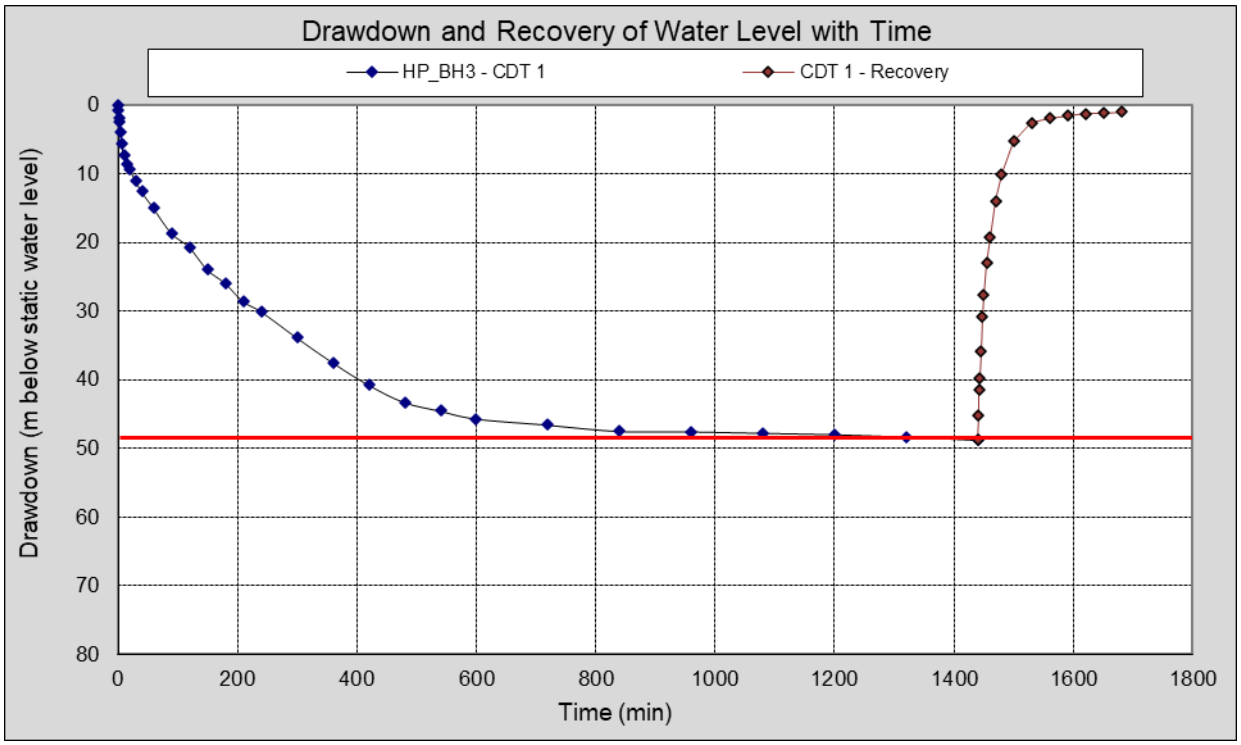

Figure 6: Time-series drawdown and recovery for HP_BH3 (0.42 L/s).

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 0.2 L/s (720 L/hour) for 24 hours per day. The assessments were based on an available drawdown (AD) of 48 meters below the RWL of the CDT, 69.5 mbgl.

Table 2: Yield Determination - HP_BH3

HP_BH3			
Method	**Sustainable Yield (L/s)**	**Late *T (m^2/d)**	***AD used (m)**
Basic FC	0.22	1.3	48.0
Cooper-Jacob	0.18	1.6	48.0
FC Non-Linear	0.20	1	48.0
Barker	0.19		48.0
Average Q_sust (L/s)	**0.20**		
Recommended Abstraction			
Abstraction Rate (L/s)	**Abstraction Duration (hours)**		**Recovery Duration (hours)**
0.2	24		0

**AD- Available Drawdown*

** T – Transmissivity*

2.3 Yield Testing at HP_BH4

The yield testing was conducted between the 1st and 3rd of June 2023. The borehole was measured to a depth of 36.15 meters below ground level (mbgl). Due to the limited access to the borehole, the largest pump that could be installed for testing was limited to a flow rate of 0.9 L/s. The test pump was installed at a depth of 33 mbgl. The rest water level (RWL) at the start of the test was 19.45 mbgl.

During the step test, the water level was drawn down 0.2 meters (19.65 mbgl) at the end of the 4th step at a rate of 0.9 L/s (3 240 L/hour). **Figure 7** shows the time-series drawdown for the Step Test.

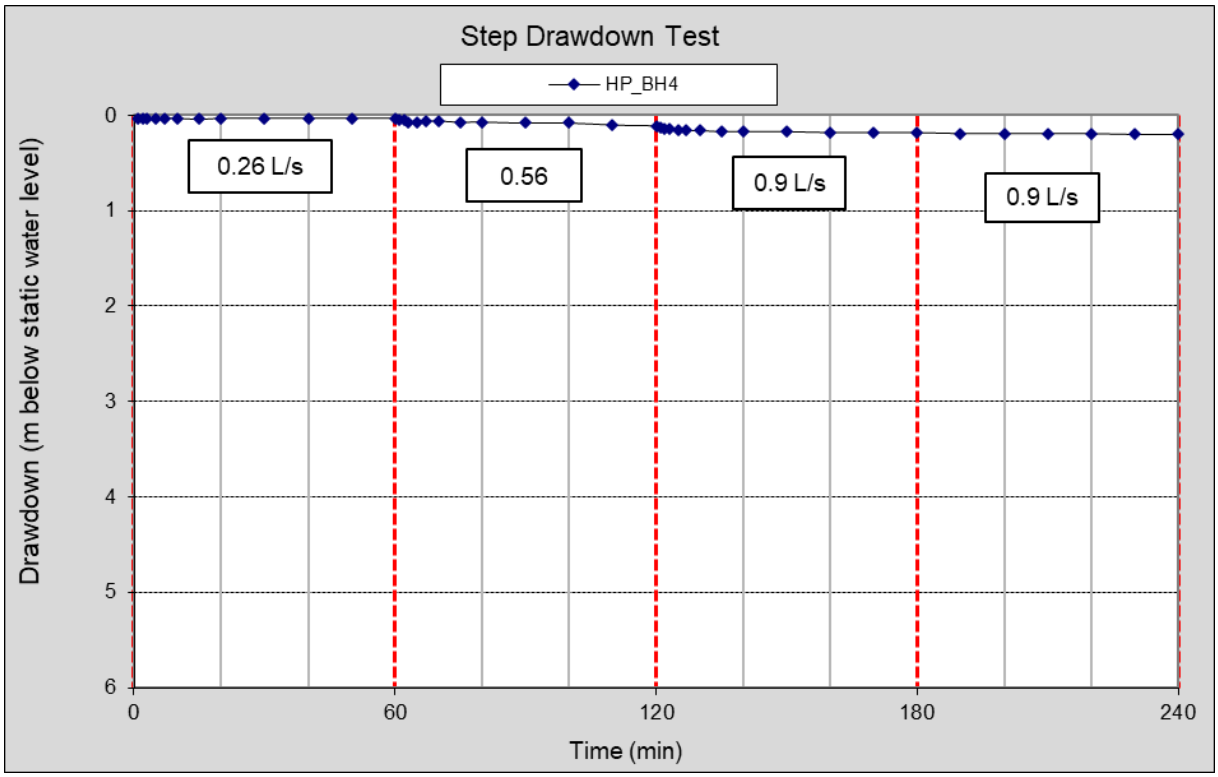

Figure 7: Step Test drawdown data for HP_BH3.

The water level was left to recover overnight before starting the CDT. The water level at the start of the CDT was 19.45 mbgl. Based on the results of the Step Test, the planned 24-hour CDT was conducted at a rate of 0.86 L/s (3 096 L/hour). At the end of the 24-hour period, the water level had drawn down 0.29 meters below the rest water level (19.74 mbgl).

The semi-log plot of the drawdown from the CDT is presented in **Figure 8**.

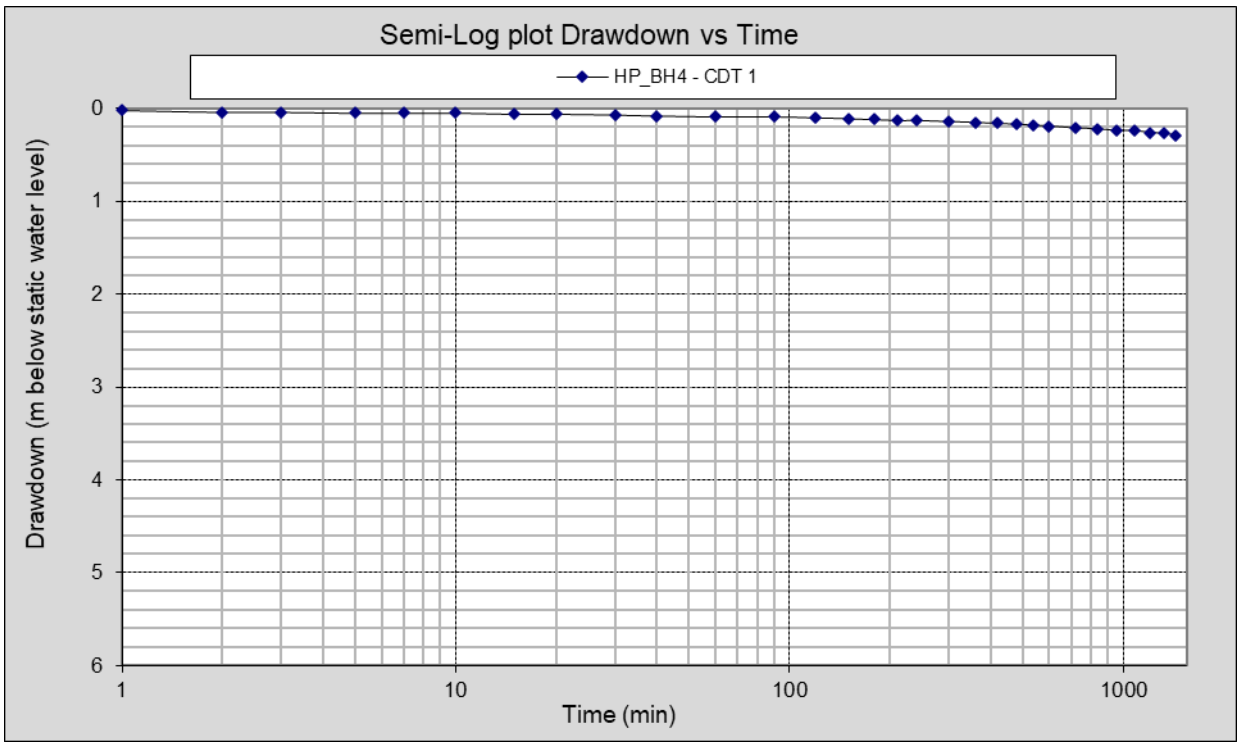

Figure 8: Semi-Log Plot of drawdown during the CDT of HP_BH4 (0.86 L/s).

The recovery of the water level was monitored after the 24-hour CDT and is presented in **Figure 9**. The recovery was fast, reaching 96.6 % after 20 minutes.

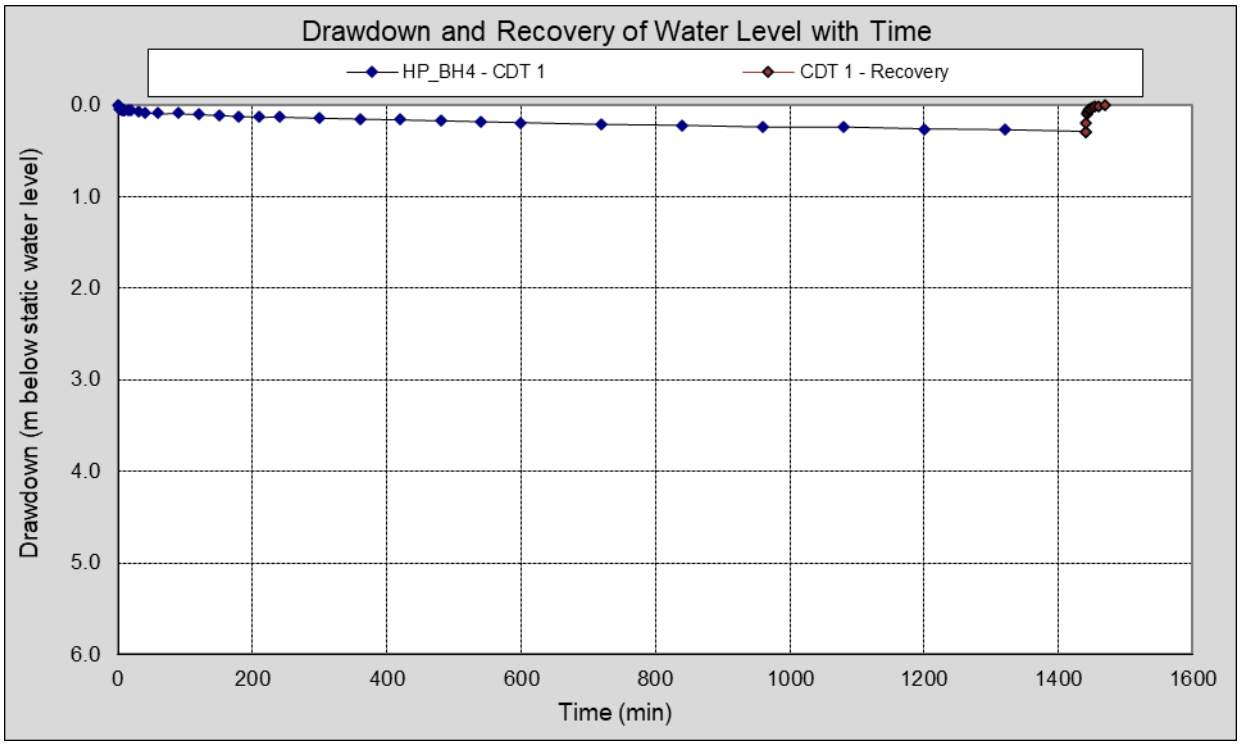

Figure 9: Time-series drawdown and recovery for HP_BH4 (0.86 L/s).

Several methods were used to assess the yield test data as presented in **Table 3**. It is recommended that the borehole can be abstracted from at a rate of up to 0.85 L/s (3 060 L/hour) for 24 hours per day. The assessments were based on an available drawdown (AD) of 13 meters below the RWL of the CDT, 32.5 mbgl.

Table 3: Yield Determination - HP_BH4

HP_BH4			
Method	**Sustainable Yield (L/s)**	**Late *T (m^2/d)**	***AD used (m)**
Basic FC	2.35	54.6	13.0
Cooper-Jacob	2.38	43.8	13.0
FC Non-Linear	1.43	156	13.0
Barker	1.78		13.0
Average Q_sust (L/s)	**1.98**		
Recommended Abstraction			
Abstraction Rate (L/s)	**Abstraction Duration (hours)**		**Recovery Duration (hours)**
0.85	24		0

**AD- Available Drawdown*

** T – Transmissivity*

3. WATER QUALITY ANALYSIS

Groundwater samples were collected from the boreholes at the end of the yield tests and submitted for inorganic chemical and microbial analyses to a SANAS accredited laboratory (Vinlab) in the Western Cape. The certificate of analysis for the samples are presented in **Appendix D**. The chemistry results obtained for the boreholes have been classified according to the SANS241-1: 2015 standards for domestic water **(Table 4). Table 6** presents the water chemistry analysis results, colour coded according to the SANS241-1: 2015 drinking water assessment standards.

Table 4: Classification table for specific limits

Acute Health	Chronic Health	Aesthetic	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 been classified according to the DWAF (1998) standards for domestic water. **Table 5** enables an evaluation of the water quality with regards to the various parameters measured (DWAF, 1998). **Table 7** presents the water chemistry analysis results colour coded according to the DWAF drinking water assessment standards.

Table 5: Classification table for the groundwater results (DWAF, 1998)

Blue	**(Class 0)**	**Ideal water quality** - suitable for lifetime use.
Green	**(Class I)**	**Good water quality** - suitable for use, rare instances of negative effects.
Yellow	**(Class II)**	**Marginal water quality** - conditionally acceptable. Negative effects may occur.
Red	**(Class III)**	**Poor water quality** - unsuitable for use without treatment. Chronic effects may occur.
Purple	**(Class IV)**	**Dangerous water quality** - totally unsuitable for use. Acute effects may occur.

Table 6: Production boreholes' results classified according the SANS241-1:2015

Analyses	HP_BH3	HP_BH4	SANS 241-1:2015
Date and Time Sampled	01/06/2023 07:50	03/06/2023 07:30	
pH (at 25 °C)	6.7	6.0	5.0 ≤ Operational ≤ 9.7
Conductivity (mS/m) (at 25 °C)	181.6	208.0	Aesthetic ≤170
Total Dissolved Solids (mg/L)	1231.25	1410.24	Aesthetic ≤1200
Turbidity (NTU)	125.0	1.58	Operational≤1 Aesthetic ≤5
Colour (mg/L as Pt)	21.0	<15	Aesthetic ≤15
Sodium (mg/L as Na)	259	255	Aesthetic ≤200
Potassium (mg/L as K)	7	7	N/A
Magnesium (mg/L as Mg)	33	66	N/A
Calcium (mg/L as Ca)	43	30	N/A
Chloride (mg/L as Cl)	503.21	589.93	Aesthetic ≤300
Sulphate (mg/L as SO_4)	30.33	61.43	Aesthetic ≤250 Acute ≤500
Nitrate & Nitrite Nitrogen (as a ratio)	0.10	0.26	≤1 Acute Health
Nitrate Nitrogen (mg/L as N)	<1.0	2.46	Acute Health ≤11
Nitrite Nitrogen (mg/L as N)	<0.05	<0.05	Acute Health ≤0.9
Ammonia Nitrogen (mg/L as N)	<0.15	<0.15	Aesthetic ≤1.5
Total Alkalinity (mg/L as $CaCO_3$)	78.8	38.1	N/A
Total Hardness (mg/L as $CaCO_3$)	242.8	345.6	N/A
Fluoride (mg/L as F)	3.5	0.36	Chronic Health ≤1.5
Aluminium (mg/L as Al)	0.416	0.07	Operational ≤0.3
Total Chromium (mg/L as Cr)	0.006	0.004	Chronic Health ≤0.05
Manganese (mg/L as Mn)	0.51	0.012	Aesthetic ≤0.1 Chronic ≤0.4
Iron (mg/L as Fe)	11.885	0.052	Aesthetic ≤0.3 Chronic ≤2
Nickel (mg/L as Ni)	<0.008	<0.008	Chronic Health ≤0.07
Copper (mg/L as Cu)	0.002	0.004	Chronic Health ≤2
Zinc (mg/L as Zn)	0.116	0.009	Aesthetic ≤5
Arsenic (mg/L as As)	<0.01	<0.01	Chronic Health ≤0.01
Selenium (mg/L as Se)	<0.008	<0.008	Chronic Health ≤0.04
Cadmium (mg/L as Cd)	0.003	0.002	Chronic Health ≤0.003
Antimony (mg/L as Sb)	<0.013	<0.013	Chronic Health ≤0.02
Mercury (mg/L as Hg)	<0.001	<0.001	Chronic Health ≤0.006
Lead (mg/L as Pb)	<0.008	<0.008	Chronic Health ≤0.01
Uranium (mg/L as U)	<0.028	<0.028	Chronic Health ≤0.03
Cyanide (mg/L as CN^-)	<0.01	<0.01	Acute Health ≤0.2
Total Organic Carbon (mg/L as C)	1.3	1.35	N/A
E.coli (count per 100 ml)	nd	1	Not Det. Acute Health-1
Total Coliform Bacteria (count per 100 ml)	nd	3	Not Det.≤10 Operational
Heterotrophic Plate Count (count per ml)	nd	400	≤1000 Operational
Charge Balance Error %	1.1	-1.3	≥-5 - ≤5 Acceptable

Table 7: Classified production boreholes' results according to DWAF 1998.

	HP_BH3	HP_BH4	DWA (1998) Drinking Water Assessment Guide				
			Class 0	Class I	Class II	Class III	Class IV
			Ideal	Good	Marginal	Poor	Dangerous
Date and Time Sampled	01/06/2023 07:50	03/06/2023 07:30					
pH	6.7	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)	181.6	208.0	<70	70-150	150-370	370-520	>520
Turbidity (NTU)	125.0	1.58	<0.1	0.1-1	1.0-20	20-50	>50
	mg/L						
Total Dissolved Solids	1231.25	1410.24	<450	450-1000	1000-2400	2400-3400	>3400
Sodium (as Na)	259	255	<100	100-200	200-400	400-1000	>1000
Potassium (as K)	7	7	<25	25-50	50-100	100-500	>500
Magnesium (as Mg)	33	66	<70	70-100	100-200	200-400	>400
Calcium (as Ca)	43	30	<80	80-150	150-300	>300	
Chloride (as Cl)	503.21	589.93	<100	100-200	200-600	600-1200	>1200
Sulphate (as SO_4)	30.33	61.43	<200	200-400	400-600	600-1000	>1000
Nitrate & Nitrite (as a ratio)	0.1	0.26	<6	6.0-10	10.0-20	20-40	>40
Fluoride (as F)	**3.50**	0.36	<0.7	0.7-1.0	1.0-1.5	1.5-3.5	>3.5
Manganese (as Mn)	0.51	0.012	<0.1	0.1-0.4	0.4-4	4.0-10.0	>10
Iron (as Fe)	11.885	0.052	<0.5	0.5-1.0	1.0-5.0	5.0-10.0	>10
Copper (as Cu)	0.002	0.004	<1	1-1.3	1.3-2	2.0-15	>15
Zinc (as Zn)	0.116	0.009	<20	>20			
Arsenic (as As)	<0.01	<0.01	<0.010	0.01-0.05	0.05-0.2	0.2-2.0	>2.0
Cadmium (as Cd)	0.003	0.002	<0.003	0.003-0.005	0.005-0.020	0.020-0.050	>0.050
Hardness (as $CaCO_3$)	242.800	345.6	<200	200-300	300-600	>600	
	counts/100 mL						
Faecal coliforms	nd	1	0	0-1	1.0-10	10-100	>100
Total coliforms	nd	3	0	0-10	10-100	100-1000	>1000
Charge Balance Error %	1.1	-1.3	≥-5 - ≤5 Acceptable				

From the chemical results presented in **Table 6** and **Table 7**, the groundwater from HP_BH3 and HP_BH4 is of poor quality for potable supply. The total dissolved solids and electrical conductivity of both boreholes are elevated into the category of marginal. This is related to the elevated concentrations of sodium and chloride, which exceed the aesthetic limits of the SANS 241-1:2015 drinking water guidelines. The turbidity of HP_BH3 is elevated to the category of marginal. This is related to the high concentration of iron in the borehole. Additionally, the iron, fluoride and manganese concentrations of HP_BH3 exceeds the chronic health limit of the SANS 241-1:2015 drinking water guidelines. Iron biofouling is likely to occur in the borehole if the borehole is not managed optimally. This will result in the clogging of the borehole as well as the abstraction infrastructure. Additionally, HP_BH4 has an E.coli content in the groundwater that exceeds the acute health limit of the SANS 241-1:2015 drinking water guidelines. As such, groundwater from both of these boreholes should not be consumed prior to treatment.

A number of chemical diagrams have been plotted for the groundwater sample and these are useful for chemical characterisation of the water and illustrates the similarities and differences in the water types. The chemistry of the samples has been plotted on a tri-linear diagram known as a Piper diagram. This diagram indicates the distribution of cations and anions in separate triangles and then a combination of the chemistry in the central diamond. From **Figure 10**, (central diamond) the tested borehole groundwater samples are similar and are classified as a Sodium & Potassium/Chloride hydrofacies, typical of the Tygerberg formation that form the bedrock in the area.

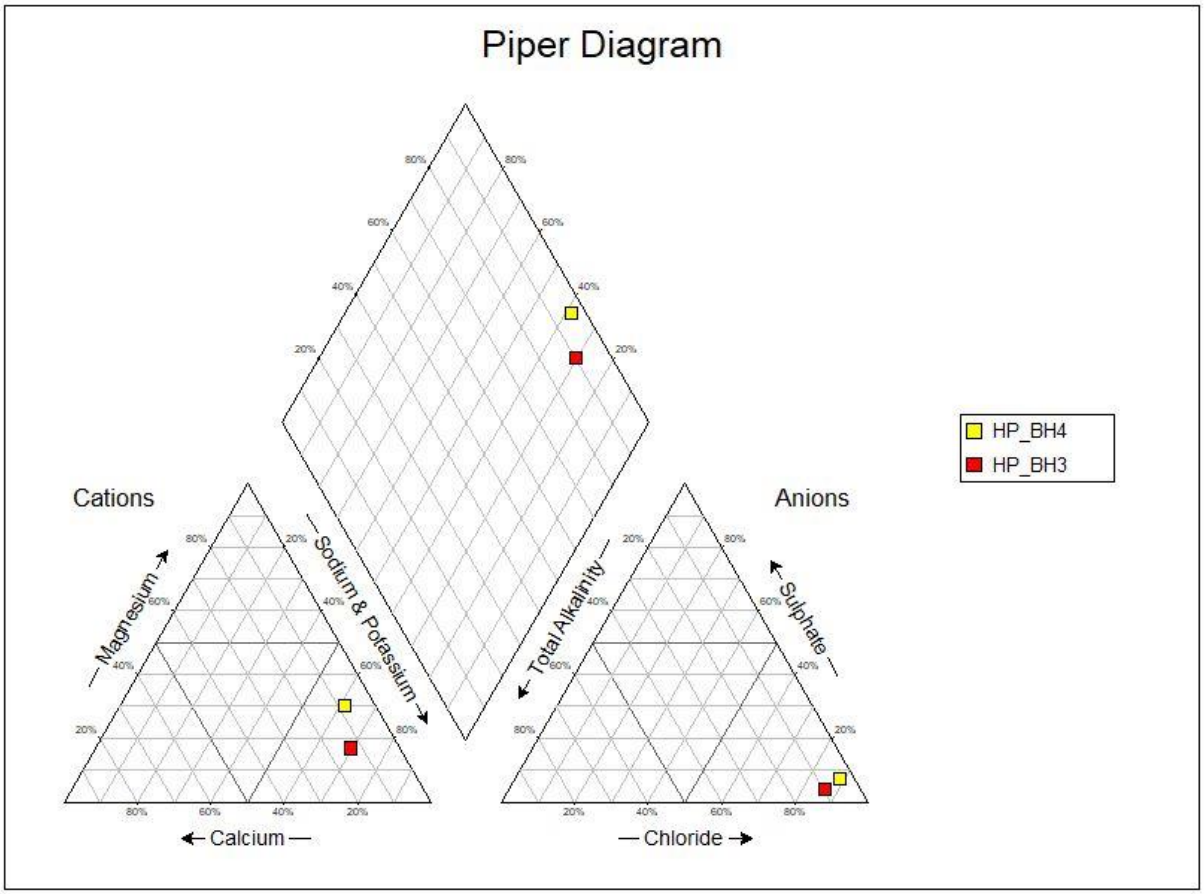

Figure 10: Piper diagram of the groundwater sample.

The Sodium Adsorption Ratio (SAR) of the groundwater is plotted in **Figure 11**. HP_BH3 and HP_BH4 are both plotted as S2/C3, thus classified as medium risk in terms of sodium adsorption and high risk in terms of salinity hazard. This graph is typically applicable to irrigation, however is dependent on soil texture and crop type.

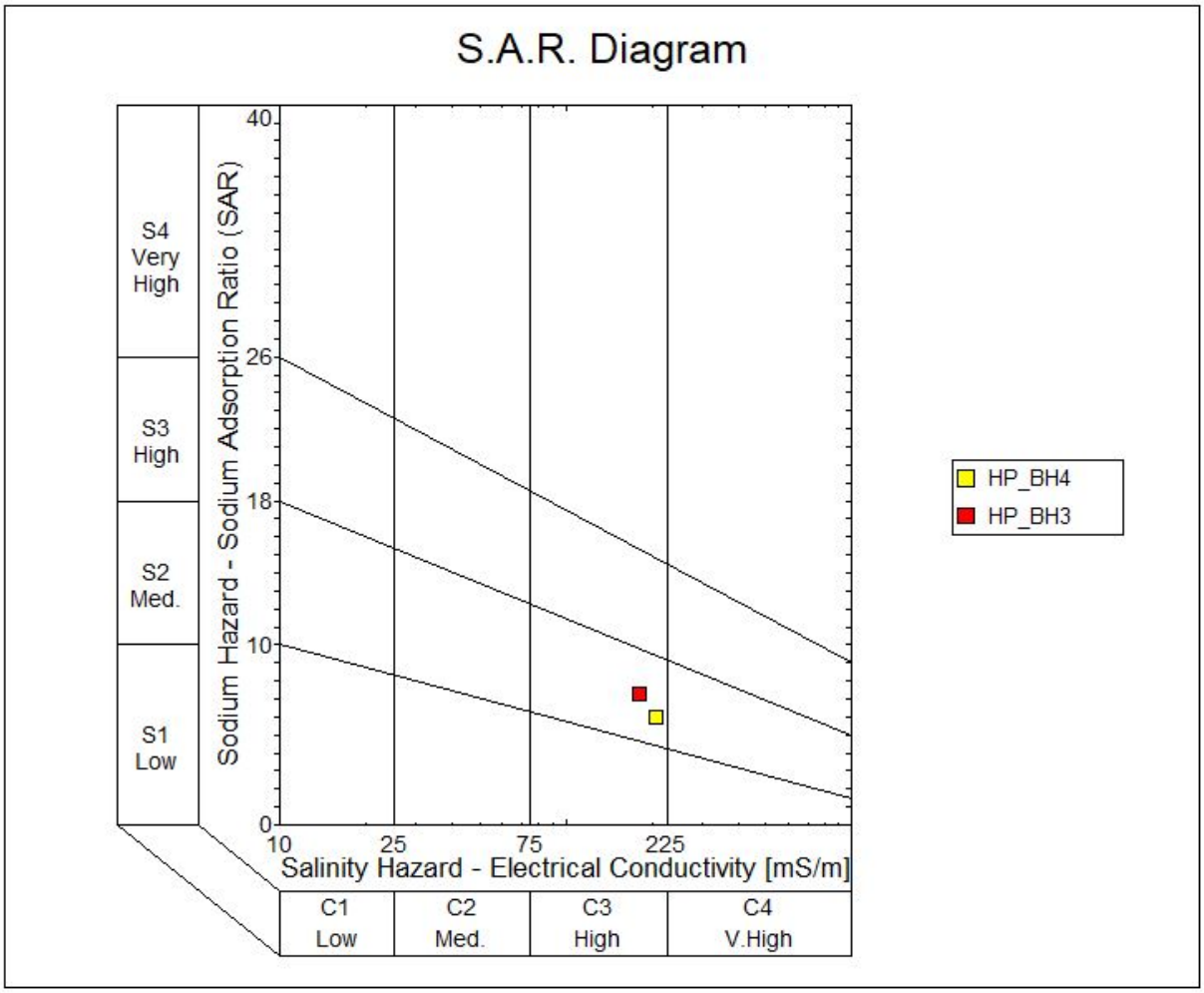

Figure 11: SAR diagram of the groundwater sample.

4. RECOMMENDATIONS

Based on the information obtained from the yield tests, the abstraction recommendations for the boreholes are presented in **Table 8**. 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 possible through making small changes to the abstraction rates and duration, should the dynamic water level's drawdown be less or more than expected as per **Table 8**. Both of these points are best managed through long term monitoring data.

Table 8: Borehole Abstraction Recommendations

Borehole Details				
Borehole Name	**Latitude (DD)**	**Longitude (DD)**	**Borehole Depth (m)**	**Inner Diameter (mm)**
HP_BH3	-34.11870	18.88440	114.2	160
HP_BH4	-34.11934	18.88464	36.2	110
Abstraction Recommendations				
Borehole Name	**Abstraction rate (L/s)**	**Abstraction Duration (hrs)**	**Recovery Duration (hrs)**	**Possible Volume Abstracted (L/d)**
HP_BH3	0.2	24	0	17 280
HP_BH4	0.85	24	0	73 440
			TOTAL	**90 720**
Pump Installation Details				
Borehole Name	**Pump Installation Depth (mbgl)**	**Critical Water Level (mbgl)**	**Dynamic Water Level (mbgl)***	**Rest Water Level (mbgl)**
HP_BH3	68	67	50	21.49
HP_BH4	33	32	21	19.45

* Typical water level expected during long-term production

For borehole HP_BH3 it is recommended that abstraction can occur at a rate of up to 0.2 L/s for up to 24 hours per day. A pump suitable to deliver the recommended rate should be installed at a depth of 68 mbgl. It is anticipated that abstraction at the recommended rate will cause the water level to drop to a depth of approximately 50 mbgl – this is referred to as the dynamic water level. During abstraction, a maximum level cut off switch should be installed to 67 mbgl to ensure the groundwater level does not drop to the pump inlet.

For borehole HP_BH4 it is recommended that abstraction can occur at a rate of up to 0.85 L/s for up to 24 hours per day. A pump suitable to deliver the recommended rate should be installed at a depth of 33 mbgl. It is anticipated that abstraction at the recommended rate will cause the water level to drop to a depth of approximately 21 mbgl – this is referred to as the dynamic water

level. During abstraction, a maximum level cut off switch should be installed to 32 mbgl to ensure the groundwater level does not drop to the pump inlet.

Please note that HP_BH4 was not tested to its full capacity due to access to the borehole being limited as HP_BH4 is situated on a slope and in cased in a brick block, refer to **Figure 12**. This prevented the safe installation of larger testing equipment. It is assumed that the borehole could deliver a larger volume, should the area around the borehole be levelled out to allow access to the borehole.

Figure 12: Borehole testing set up a few meters away from the HP_BH4.

From the laboratory results, the groundwater from HP_BH3 and HP_BH4 is of poor quality for potable supply. The total dissolved solids and electrical conductivity of both boreholes are elevated into the category of marginal. This is related to the elevated concentrations of sodium and chloride, which exceed the aesthetic limits of the SANS 241-1:2015 drinking water guidelines. The turbidity of HP_BH3 is elevated to the category of marginal. This is related to the high concentration of iron in the borehole. Additionally, the iron, fluoride and manganese concentrations of HP_BH3 exceeds the chronic health limit of the SANS 241-1:2015 drinking water guidelines. Iron biofouling is likely to occur in the borehole if the borehole is not managed optimally. This will result in the clogging of the borehole as well as the abstraction infrastructure. Additionally, HP_BH4 has an E.coli content in the groundwater that exceeds the acute health limit of the SANS 241-1:2015 drinking water guidelines. As such, groundwater from both of these boreholes should not be consumed prior to treatment.

To address the potential for iron to clog the borehole (HP_BH3) and abstraction infrastructure, it is recommended to maintain a constant and continuous pumping schedule. Thus, should a daily volume of less than 17 280 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 minimised, 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 boreholes are equipped with gate valves. 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 a borehole, it is highly recommended that boreholes 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 of the borehole. Legal compliance with regard to the use of groundwater also needs to be addressed with the Department of Water and Sanitation.

5. REFERENCES

Barker, J.A., (1988) A Generalised Radial Flow Model for Hydraulic Tests in Fractured Rock. Water Resources Research, Vol. 24, No. 10 Pages 1796 – 1804.

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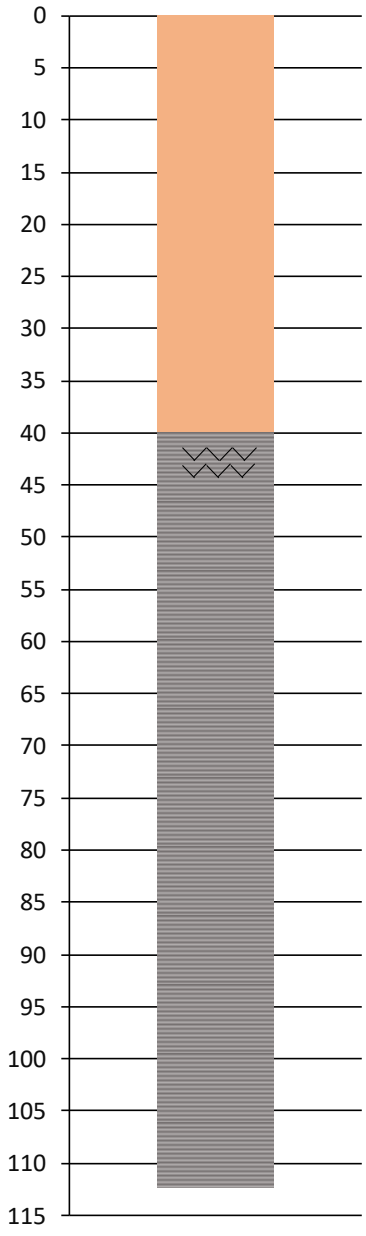
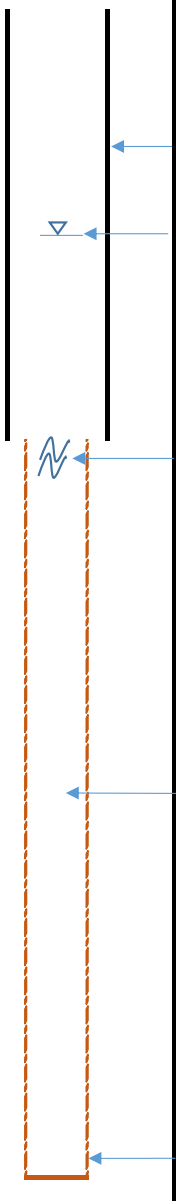
6. APPENDIX A: ESTIMATED BOREHOLE LOG

Log of Borehole No.: HP_BH3

Location:	Lwandwe	**Latitude:**	-34.118704
Date:	22/06/2023	**Longitude:**	18.884398
Client:	GNEC	**Ground Elevation:**	57 mamsl

Lithological Description	Lithology Symbol & Depth (m)	Borehole Construction	Description & water strike
Expected: Alluvium **Unknow Geology** Expected: Tygerberg Fm. shales (fractured)			160 mm (ID) Steel casing (0 mbgl - 41.71 mbgl) Water level (21.46 mbgl) Water Strike (42.46 mbgl & 44.56 mbgl) Open hole (41.71 mbgl - 112.26 mbgl) EOH (112.26 mbgl)

Drilled By:	Unknown	**Remarks:**	None of the estimated information included here is collected from the drilling records, but comes from the published 1:50 000 Geological Map of the area and measurements made during testing and camera logging
Drill Method:	Unknown		
Logged By:	Not logged, estimated from available data		

Log of Borehole No.: HP_BH4

Location:	Lwandwe	**Latitude:**	-34.119343
Date:	22/06/2023	**Longitude:**	18.884644
Client:	GNEC	**Ground Elevation:**	53 mamsl

Lithological Description	Lithology Symbol & Depth (m)	Borehole Construction	Description & water strike
Unknow Geology Expected: Alluvium	0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34		110 mm (ID) uPVC casing (0 mbgl - 33.65 mbgl) (no slots observed) Water level (19.04 mbgl) EOH (33.65 mbgl)

Drilled By:	Unknown	**Remarks:**	None of the estimated information included here is collected from the drilling records, but comes from the published 1:50 000 Geological Map of the area and measurements made during testing and camera logging
Drill Method:	Unknown		
Logged By:	Not logged, estimated from available data		

7. APPENDIX B: CAMERA LOGGING

HP_BH3 Camera Logging – 30 May 2023	
	The water level at the time of the camera log was 21.46 mbgl
	The end of the borehole casing was observed at 41.71 mbgl
	A fracture was observed at 42.46 mbgl

	A fracture was observed at 44.56 mbgl
	No deeper fractures could be observed in the borehole, however; based on the yield testing results, it is evident that deeper fractures exist. The end of the borehole was measures at 112.26 mbgl.

HP_BH4 Camera Logging – 30 May 2023	
	The water level at the time of the camera log was 19.04 mbgl
	uPVC casing joint appears to be in a good condition. Casing slots could not be observed in the borehole.
	The end of the borehole was measures at 33.65 mbgl

8. APPENDIX C: 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/WL	Static water level
µS/cm	Microsiemens per centimeter

BOREHOLE TEST RECORD

CONSULTANT:	GEOSS
DISTRICT:	SOMERSET WEST
PROVINCE:	WESTERN CAPE
FARM / VILLAGE NAME :	RHINO HPC
DATE TESTED:	30-05-2023

PR0JECT #	P2815
TEAM MEMBERS	

BOREHOLE LOCATION & ACCESS INFORMATION:		
BOREHOLE COORDINATES		**COMMENTS ON ACCESS IF ANY:**
LATITUDE (SOUTH):	S34 07 07.2	
LONGITUDE (EAST):	E18 53 04.0	

BOREHOLE NO:	**BH03**
TRANSMISSIVITY VALUE:	
TYPE INSTALLATION:	**NEW BOREHOLE**
BOREHOLE DEPTH: (mbgl)	**114.2**

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:**	AVN
Date sample taken	01-06-2023		If sample courier, to where:		**DATA CHECKED BY:**	AVN
Time sample taken	07H50					

DESCRIPTION:	**UNIT**	**QTY**		**UNIT**	**QTY**
STRAIGHTNESS TEST:	**NO**	0	BOREHOLE DEPTH AFTER TEST:	**M**	114.04
VERTICALLY TEST:	**NO**	0	BOREHOLE WATER LEVEL AFTER TEST: (mbch)	**M**	21.81
CASING DETECTION:	**NO**	RUST	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**	50
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:** _____

BOREHOLE TEST CONTROL SHEET **Groundwater Solutions t/a AB PUMPS**							
Borehole number:		BH03		Old / Alternative number:			
Contractor:		ATS		Supervisor:			
Operator:				Rig number & Type rig:			
EXISTING EQUIPMENT							
Type pump	**Depth**	**Condition**	**Drive unit**	**Condition**	**Pump house**	**Condition**	**Remarks**
TESTING EQUIPMENT							
Pump type		**Depth installed (m)**		**Date & time (started)**		**Date & time (completed)**	
BP16		99.20		30-05-2023 13H00		30-05-2023 20H10	
MULTI-RATE OR STEPTEST DETAILS							
STEP		**DURATION (MIN)**		**RECOVERY (MIN)**		**YIELD (L/S)**	**DRAWDOWN (m)**
1		60				0.23 l/s	8.93
2		60				0.52 l/s	26.84
3		40		210		1.03 l/s	76.73
4						l/s	
5						l/s	
6						l/s	
7						l/s	
8						l/s	
Calibration:						l/s	
TOTAL:		160		210		l/s	
COMMENT:							
CONSTANT RATE DISCHARGE TEST							
Pump type		**Depth installed (m)**		**Date & time (started)**		**Date & time (completed)**	
BP16		99.20		31-05-2023 08H00		01-06-2023 12H00	
Yield l/s		**Drawdown (m)**		**Duration (min)**		**Recovery (min)**	
0.42		48.77		1440		240	
Total: (Multi-rate and Constant Discharge rate)				1600		450	
COMMENT:							
		Borehole number		**Duration (min) CONSTANT**		**Drawdown (m)**	**Hand/logger** **Distance (m)**
Observation Hole 1							0
Observation Hole 2							0
Observation Hole 3							0
Observation Hole 4							
Observation Hole 5							
GENERAL							
ESTABLISHMENT		From:		To:			
Site Move		From project#		To #:	P2815	Travelling km:	26
		Village	Borehole no	Village	Borehole no		
				RHINO HPC	BH03		
Maintenance:		Work time hr		Parts repaired/ replaced		Travelling km	
After test measurements		Water level	21.81	Borehole depth	114.04	Casing depth m	RUST
Water level before installing test pump: (mbch)				21.49			
Depth before installing test pump:				114.20			
Testpump Installed		**Once** /Twice /More		Reason:			
Installed Testpump		**<10 l/s** / >10ls/s		Reason:			
Was existing equipment re-installed:				No:	If not where was it left:		
GPS Unit number:							
EC Unit number:							
Remarks:							
Signed Contractor:				Signed Consultant:			

FORM 5 E
STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P2815	Coordinates: SOUTH:	S34 07 07.2	PROVINCE:	WESTERN CAPE
BOREHOLE NO:	BH03	EAST:	E18 53 04.0	DISTRICT:	SOMERSET WEST
ALT BH NO:	0			SITE NAME:	RHINO HPC
ALT BH NO:	0				
BOREHOLE DEPTH (m)	114.20	DATUM LEVEL ABOVE CASING (m):	0.98	EXISTING PUMP:	0
WATER LEVEL (mbdl):	22.47	CASING HEIGHT: (magl):	0.00	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	99.20	DIAM PUMP INLET (mm):	170.00	PUMP TYPE:	BP16

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM 248		DISCHARGE RATE 2			RPM 318		DISCHARGE RATE 3			RPM 567	
DATE: 30-05-2023		TIME: 13H00			DATE: 30-05-2023		TIME: 14H00			DATE: 30-05-2023		TIME: 15H00		
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	0.70		**1**		**1**	9.16		**1**		**1**	27.37		**1**	72.23
2	0.95		**2**		**2**	9.35	0.41	**2**		**2**	27.85		**2**	68.70
3	1.14		**3**		**3**	9.80	0.52	**3**		**3**	29.06	0.75	**3**	66.21
5	1.28		**5**		**5**	10.75		**5**		**5**	32.06		**5**	61.70
7	1.43		**7**		**7**	12.04	0.54	**7**		**7**	36.25	1.03	**7**	54.78
10	1.78	0.24	**10**		**10**	13.52	0.52	**10**		**10**	40.74		**10**	48.84
15	2.05	0.22	**15**		**15**	15.41		**15**		**15**	47.32	1.15	**15**	40.14
20	4.96		**20**		**20**	17.22	0.53	**20**		**20**	59.29	1.03	**20**	36.50
30	7.44	0.25	**30**		**30**	20.72		**30**		**30**	68.71		**30**	23.89
40	8.46	0.24	**40**		**40**	22.80	0.51	**40**		**40**	76.73		**40**	16.53
50	8.74		**50**		**50**	25.23	0.52	**50**			76.73	0.55	**50**	9.48
60	8.93	0.23	**60**		**60**	26.84		**60**			76.73	0.50	**60**	5.76
70			**70**		**70**			**70**			76.73	0.48	**70**	3.44
80			**80**		**80**			**80**					**80**	2.59
90			**90**		**90**			**90**					**90**	1.88
100			**100**		**100**			**100**					**100**	1.40
110			**110**		**110**			**110**					**110**	1.03
120			**120**		**120**			**120**					**120**	0.75
pH			**150**		**pH**			**150**		**pH**			**150**	0.34
TEMP	18.40	°C	**180**		**TEMP**	20.40	°C	**180**		**TEMP**		°C	**180**	0.06
EC	2	µS/cm	**210**		**EC**	2	µS/cm	**210**		**EC**		µS/cm	**210**	0.00

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE:		TIME:			DATE:		TIME:			DATE:		TIME:		
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			**1**		**1**			**1**		**1**			**1**	
2			**2**		**2**			**2**		**2**			**2**	
3			**3**		**3**			**3**		**3**			**3**	
5			**5**		**5**			**5**		**5**			**5**	
7			**7**		**7**			**7**		**7**			**7**	
10			**10**		**10**			**10**		**10**			**10**	
15			**15**		**15**			**15**		**15**			**15**	
20			**20**		**20**			**20**		**20**			**20**	
30			**30**		**30**			**30**		**30**			**30**	
40			**40**		**40**			**40**		**40**			**40**	
50			**50**		**50**			**50**		**50**			**50**	
60			**60**		**60**			**60**		**60**			**60**	
70			**70**		**70**			**70**		**70**			**70**	
80			**80**		**80**			**80**		**80**			**80**	
90			**90**		**90**			**90**		**90**			**90**	
100			**100**		**100**			**100**		**100**			**100**	
110			**110**		**110**			**110**		**110**			**110**	
120			**120**		**120**			**120**		**120**			**120**	
pH			**150**		**pH**			**150**		**pH**			**150**	
TEMP		°C	**180**		**TEMP**		°C	**180**		**TEMP**		°C	**180**	
EC		µS/cm	**210**		**EC**		µS/cm	**210**		**EC**		µS/cm	**210**	
			240					**240**					**240**	
			300					**300**					**300**	
			360					**360**					**360**	

S/W/L:(mbch) 21.49

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P2815	Coordinates: SOUTH:	S34 07 07.2	PROVINCE:	WESTERN CAPE
BOREHOLE NO:	BH03	EAST:	E18 53 04.0	DISTRICT:	SOMERSET WEST
ALT BH NO:	0			SITE NAME:	RHINO HPC
ALT BH NO:	0				
BOREHOLE DEPTH:	114.20	DATUM LEVEL ABOVE CASING (m):	0.98	EXISTING PUMP:	0
WATER LEVEL (mbdl):	22.47	CASING HEIGHT: (magl):	0.00	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	99.20	DIAM PUMP INLET(mm):	170	PUMP TYPE:	BP16

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				**TEST COMPLETED**					
DATE:	31-05-2023	TIME:	08H00	DATE:		TIME:		TYPE OF PUMP:	BP16

					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3	
					NR:			NR:			NR:	
DISCHARGE BOREHOLE					Distance(m);			Distance(m);			Distance(m);	
TIME	DRAW	YIELD	TIME	RECOVERY	TIME:	Drawdown	Recovery	TIME:	Drawdown	Recovery	TIME:	Drawdown
(MIN)	DOWN (M)	(L/S)	MIN	(M)	(min)	m	(m)	(min)	(m)		(min)	(m)
1	0.80		**1**	45.27	**1**			**1**			**1**	
2	1.79		**2**	41.42	**2**			**2**			**2**	
3	2.36		**3**	39.70	**3**			**3**			**3**	
5	3.96	0.34	**5**	35.84	**5**			**5**			**5**	
7	5.58		**7**	30.80	**7**			**7**			**7**	
10	7.33	0.43	**10**	27.66	**10**			**10**			**10**	
15	8.60		**15**	23.00	**15**			**15**			**15**	
20	9.28	0.40	**20**	19.27	**20**			**20**			**20**	
30	10.95		**30**	13.94	**30**			**30**			**30**	
40	12.53	0.42	**40**	10.02	**40**			**40**			**40**	
60	14.97		**60**	5.24	**60**			**60**			**60**	
90	18.60	0.41	**90**	2.59	**90**			**90**			**90**	
120	20.64	0.40	**120**	1.90	**120**			**120**			**120**	
150	23.92	0.43	**150**	1.49	**150**			**150**			**150**	
180	25.88	0.42	**180**	1.26	**180**			**180**			**180**	
210	28.54	0.40	**210**	1.12	**210**			**210**			**210**	
240	30.02	0.43	**240**	1.00	**240**			**240**			**240**	
300	33.83	0.44	**300**		**300**			**300**			**300**	
360	37.46	0.41	**360**		**360**			**360**			**360**	
420	40.73	0.40	**420**		**420**			**420**			**420**	
480	43.25	0.40	**480**		**480**			**480**			**480**	
540	44.51	0.43	**540**		**540**			**540**			**540**	
600	45.66	0.42	**600**		**600**			**600**			**600**	
720	46.56	0.40	**720**		**720**			**720**			**720**	
840	47.48	0.43	**840**		**840**			**840**			**840**	
960	47.53	0.40	**960**		**960**			**960**			**960**	
1080	47.74	0.45	**1080**		**1080**			**1080**			**1080**	
1200	47.93	0.44	**1200**		**1200**			**1200**			**1200**	
1320	48.27	0.42	**1320**		**1320**			**1320**			**1320**	
1440	48.77		**1440**		**1440**			**1440**			**1440**	
1560			**1560**		**1560**			**1560**			**1560**	
1680			**1680**		**1680**			**1680**			**1680**	
1800			**1800**		**1800**			**1800**			**1800**	
1920			**1920**		**1920**			**1920**			**1920**	
2040			**2040**		**2040**			**2040**			**2040**	
2160			**2160**		**2160**			**2160**			**2160**	
2280			**2280**		**2280**			**2280**			**2280**	
2400			**2400**		**2400**			**2400**			**2400**	
2520			**2520**		**2520**			**2520**			**2520**	
2640			**2640**		**2640**			**2640**			**2640**	
2760			**2760**		**2760**			**2760**			**2760**	
2880			**2880**		**2880**			**2880**			**2880**	
3000			**3000**		**3000**			**3000**			**3000**	
3120			**3120**		**3120**			**3120**			**3120**	
3240			**3240**		**3240**			**3240**			**3240**	
3360			**3360**		**3360**			**3360**			**3360**	
3480			**3480**		**3480**			**3480**			**3480**	
3600			**3600**		**3600**			**3600**			**3600**	
3720			**3720**		**3720**			**3720**			**3720**	
3840			**3840**		**3840**			**3840**			**3840**	
3960			**3960**		**3960**			**3960**			**3960**	
4080			**4080**		**4080**			**4080**			**4080**	
4200			**4200**		**4200**			**4200**			**4200**	
4320			**4320**		**4320**			**4320**			**4320**	
Total time pumped(min):				1440		**W/L**			**W/L**			**W/L**
Average yield (l/s):				0.42								

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/WL	Static water level
µS/cm	Microsiemens per centimeter

BOREHOLE TEST RECORD

CONSULTANT:	GEOSS
DISTRICT:	SOMERSET WEST
PROVINCE:	WESTERN CAPE
FARM / VILLAGE NAME :	RHINO HPC
DATE TESTED:	01-06-2023

PR0JECT #	P2815
TEAM MEMBERS	

BOREHOLE LOCATION & ACCESS INFORMATION:		
BOREHOLE COORDINATES		**COMMENTS ON ACCESS IF ANY:**
LATITUDE (SOUTH):	S34.11935	
LONGITUDE (EAST):	E18.88464	

BOREHOLE NO:	**BH04**
TRANSMISSIVITY VALUE:	
TYPE INSTALLATION:	**NEW BOREHOLE**
BOREHOLE DEPTH: (mbgl)	**36.15**

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:**	AVN
Date sample taken	03-06-2023		If sample courier, to where:		**DATA CHECKED BY:**	AVN
Time sample taken	07H30					

DESCRIPTION:	**UNIT**	**QTY**		**UNIT**	**QTY**
STRAIGHTNESS TEST:	**NO**	0	BOREHOLE DEPTH AFTER TEST:	**M**	36.15
VERTICALLY TEST:	**NO**	0	BOREHOLE WATER LEVEL AFTER TEST: (mbch)	**M**	19.53
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**	30
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:** _____

BOREHOLE TEST CONTROL SHEET **Groundwater Solutions t/a AB PUMPS**							
Borehole number:		BH04		Old / Alternative number:			
Contractor:		ATS		Supervisor:			
Operator:				Rig number & Type rig:			
EXISTING EQUIPMENT							
Type pump	**Depth**	**Condition**	**Drive unit**	**Condition**	**Pump house**	**Condition**	**Remarks**
TESTING EQUIPMENT							
Pump type		**Depth installed (m)**		**Date & time (started)**		**Date & time (completed)**	
Submersible		33.00		01-06-2023 15H05			
MULTI-RATE OR STEPTEST DETAILS							
STEP		**DURATION (MIN)**		**RECOVERY (MIN)**		**YIELD (L/S)**	**DRAWDOWN (m)**
1		60				0.26 l/s	0.03
2		60				0.56 l/s	0.11
3		120		5		0.90 l/s	0.20
4						l/s	
5						l/s	
6						l/s	
7						l/s	
8						l/s	
Calibration:						l/s	
TOTAL:		240		5		l/s	
COMMENT:							
CONSTANT RATE DISCHARGE TEST							
Pump type		**Depth installed (m)**		**Date & time (started)**		**Date & time (completed)**	
Submersible		33.00		02-06-2023 08H02		03-06-2023 08H30	
Yield l/s		**Drawdown (m)**		**Duration (min)**		**Recovery (min)**	
0.86		0.29		1440		30	
Total: (Multi-rate and Constant Discharge rate)				1680		35	
COMMENT:							
		Borehole number		**Duration (min) CONSTANT**		**Drawdown (m)**	**Hand/logger**
Observation Hole 1							0
Observation Hole 2							0
Observation Hole 3							0
Observation Hole 4							
Observation Hole 5							
GENERAL							
ESTABLISHMENT		From:		To:			
Site Move		From project#		To #:	P2815	Travelling km:	0.74
		Village	Borehole no	Village	Borehole no		
				RHINO HPC	BH04		
Maintenance:		Work time hr		Parts repaired/ replaced		Travelling km	
After test measurements		Water level	19.53	Borehole depth	36.15	Casing depth m	UPVC
Water level before installing test pump: (mbch)				19.51			
Depth before installing test pump:				36.15			
Testpump Installed		**Once** /Twice /More		Reason:			
Installed Testpump		**<10 l/s** / >10ls/s		Reason:			
Was existing equipment re-installed:				No:	If not where was it left:		
GPS Unit number:							
EC Unit number:							
Remarks:							
Signed Contractor:				Signed Consultant:			

FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P2815	Coordinates: SOUTH:	S34.11935	PROVINCE:	WESTERN CAPE
BOREHOLE NO:	BH04	EAST:	E18.88464	DISTRICT:	SOMERSET WEST
ALT BH NO:	0			SITE NAME:	RHINO HPC
ALT BH NO:	0				
BOREHOLE DEPTH (m)	36.15	DATUM LEVEL ABOVE CASING (m):	1.93	EXISTING PUMP:	0
WATER LEVEL (mbdl):	21.38	CASING HEIGHT: (magl):	MAIN BOREH	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	33.00	DIAM PUMP INLET (mm):	127.00	PUMP TYPE:	Submersible

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2			RPM		DISCHARGE RATE 3			RPM	
DATE:	01-06-2023	TIME:	15H05		DATE:	01-06-2023	TIME:	16H05		DATE:	01-06-2023	TIME:	17H05	
TIME	DRAW	YIELD	TIME	RECOVERY	TIME	DRAW	YIELD	TIME	RECOVERY	TIME	DRAW	YIELD	TIME	RECOVERY
(MIN)	DOWN (M)	(L/S)	(MIN)	(M)	(MIN)	DOWN (M)	(L/S)	(MIN)	(M)	(MIN)	DOWN (M)	(L/S)	(MIN)	(M)
1	0.03		**1**		**1**	0.05	0.48	**1**		**1**	0.13		**1**	0.08
2	0.03		**2**		**2**	0.05		**2**		**2**	0.14	0.90	**2**	0.03
3	0.04	0.23	**3**		**3**	0.07	0.56	**3**		**3**	0.14		**3**	0.01
5	0.03		**5**		**5**	0.07		**5**		**5**	0.15	0.92	**5**	0.00
7	0.03	0.22	**7**		**7**	0.06	0.55	**7**		**7**	0.16	0.89	**7**	
10	0.03		**10**		**10**	0.06	0.55	**10**		**10**	0.16		**10**	
15	0.04	0.21	**15**		**15**	0.07		**15**		**15**	0.17	0.90	**15**	
20	0.03		**20**		**20**	0.07	0.52	**20**		**20**	0.17		**20**	
30	0.03	0.20	**30**		**30**	0.08		**30**		**30**	0.17	0.90	**30**	
40	0.03		**40**		**40**	0.08	0.54	**40**		**40**	0.18	0.91	**40**	
50	0.03	0.20	**50**		**50**	0.10	0.56	**50**		**50**	0.18		**50**	
60	0.03		**60**		**60**	0.11		**60**		**60**	0.18	0.92	**60**	
70			**70**		**70**			**70**		**70**	0.19	0.89	**70**	
80			**80**		**80**			**80**		**80**	0.19	0.90	**80**	
90			**90**		**90**			**90**		**90**	0.18	0.88	**90**	
100			**100**		**100**			**100**		**100**	0.19	0.91	**100**	
110			**110**		**110**			**110**		**110**	0.20	0.90	**110**	
120			**120**		**120**			**120**		**120**	0.20		**120**	
pH			**150**		**pH**			**150**		**pH**			**150**	
TEMP	19.00	°C	**180**		**TEMP**	21.70	°C	**180**		**TEMP**	24.80	°C	**180**	
EC	2250	µS/cm	**210**		**EC**	1984	µS/cm	**210**		**EC**	1935	µS/cm	**210**	

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE:		TIME:			DATE:		TIME:			DATE:		TIME:		
TIME	DRAW	YIELD	TIME	RECOVERY	TIME	DRAW	YIELD	TIME	RECOVERY	TIME	DRAW	YIELD	TIME	RECOVERY
(MIN)	DOWN (M)	(L/S)	(MIN)	(M)	(MIN)	DOWN (M)	(L/S)	(MIN)	(M)	(MIN)	DOWN (M)	(L/S)	(MIN)	(M)
1			**1**		**1**			**1**		**1**			**1**	
2			**2**		**2**			**2**		**2**			**2**	
3			**3**		**3**			**3**		**3**			**3**	
5			**5**		**5**			**5**		**5**			**5**	
7			**7**		**7**			**7**		**7**			**7**	
10			**10**		**10**			**10**		**10**			**10**	
15			**15**		**15**			**15**		**15**			**15**	
20			**20**		**20**			**20**		**20**			**20**	
30			**30**		**30**			**30**		**30**			**30**	
40			**40**		**40**			**40**		**40**			**40**	
50			**50**		**50**			**50**		**50**			**50**	
60			**60**		**60**			**60**		**60**			**60**	
70			**70**		**70**			**70**		**70**			**70**	
80			**80**		**80**			**80**		**80**			**80**	
90			**90**		**90**			**90**		**90**			**90**	
100			**100**		**100**			**100**		**100**			**100**	
110			**110**		**110**			**110**		**110**			**110**	
120			**120**		**120**			**120**		**120**			**120**	
pH			**150**		**pH**			**150**		**pH**			**150**	
TEMP		°C	**180**		**TEMP**		°C	**180**		**TEMP**		°C	**180**	
EC		µS/cm	**210**		**EC**		µS/cm	**210**		**EC**		µS/cm	**210**	
			240					**240**					**240**	
			300					**300**					**300**	
			360					**360**					**360**	

S/W/L:(mbch) 19.51

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P2815	Coordinates: SOUTH:	S34.11935	PROVINCE:	WESTERN CAPE
BOREHOLE NO:	BH04	EAST:	E18.88464	DISTRICT:	SOMERSET WEST
ALT BH NO:	0			SITE NAME:	RHINO HPC
ALT BH NO:	0				
BOREHOLE DEPTH:	36.15	DATUM LEVEL ABOVE CASING (m):	1.93	EXISTING PUMP:	0
WATER LEVEL (mbdl):	21.38	CASING HEIGHT: (magl):	MAIN BOR	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	33.00	DIAM PUMP INLET(mm):	127	PUMP TYPE:	Submersible

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				**TEST COMPLETED**								
DATE:	02-06-2023	TIME:	08H00	DATE:		TIME:		TYPE OF PUMP:				Submersible
				OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3		
				NR:			NR:			NR:		
	DISCHARGE BOREHOLE			Distance(m);			Distance(m);			Distance(m);		
TIME	DRAW	YIELD	TIME	RECOVERY	TIME:	Drawdown	Recovery	TIME:	Drawdown	Recovery	TIME:	Drawdown
(MIN)	DOWN (M)	(L/S)	MIN	(M)	(min)	m	(m)	(min)	(m)		(min)	(m)
1	0.02		**1**	0.19	**1**			**1**			**1**	
2	0.04	0.85	**2**	0.10	**2**			**2**			**2**	
3	0.04		**3**	0.08	**3**			**3**			**3**	
5	0.05	0.86	**5**	0.05	**5**			**5**			**5**	
7	0.05		**7**	0.04	**7**			**7**			**7**	
10	0.05	0.85	**10**	0.03	**10**			**10**			**10**	
15	0.06		**15**	0.02	**15**			**15**			**15**	
20	0.06	0.80	**20**	0.01	**20**			**20**			**20**	
30	0.07		**30**	0.00	**30**			**30**			**30**	
40	0.08	0.86	**40**		**40**			**40**			**40**	
60	0.09	0.87	**60**		**60**			**60**			**60**	
90	0.09	0.86	**90**		**90**			**90**			**90**	
120	0.10		**120**		**120**			**120**			**120**	
150	0.11	0.85	**150**		**150**			**150**			**150**	
180	0.12		**180**		**180**			**180**			**180**	
210	0.13	0.85	**210**		**210**			**210**			**210**	
240	0.13	0.86	**240**		**240**			**240**			**240**	
300	0.14		**300**		**300**			**300**			**300**	
360	0.15	0.85	**360**		**360**			**360**			**360**	
420	0.16		**420**		**420**			**420**			**420**	
480	0.17	0.85	**480**		**480**			**480**			**480**	
540	0.18		**540**		**540**			**540**			**540**	
600	0.19	0.86	**600**		**600**			**600**			**600**	
720	0.21	0.87	**720**		**720**			**720**			**720**	
840	0.22		**840**		**840**			**840**			**840**	
960	0.24	0.87	**960**		**960**			**960**			**960**	
1080	0.24	0.85	**1080**		**1080**			**1080**			**1080**	
1200	0.26	0.87	**1200**		**1200**			**1200**			**1200**	
1320	0.27	0.86	**1320**		**1320**			**1320**			**1320**	
1440	0.29		**1440**		**1440**			**1440**			**1440**	
1560			**1560**		**1560**			**1560**			**1560**	
1680			**1680**		**1680**			**1680**			**1680**	
1800			**1800**		**1800**			**1800**			**1800**	
1920			**1920**		**1920**			**1920**			**1920**	
2040			**2040**		**2040**			**2040**			**2040**	
2160			**2160**		**2160**			**2160**			**2160**	
2280			**2280**		**2280**			**2280**			**2280**	
2400			**2400**		**2400**			**2400**			**2400**	
2520			**2520**		**2520**			**2520**			**2520**	
2640			**2640**		**2640**			**2640**			**2640**	
2760			**2760**		**2760**			**2760**			**2760**	
2880			**2880**		**2880**			**2880**			**2880**	
3000			**3000**		**3000**			**3000**			**3000**	
3120			**3120**		**3120**			**3120**			**3120**	
3240			**3240**		**3240**			**3240**			**3240**	
3360			**3360**		**3360**			**3360**			**3360**	
3480			**3480**		**3480**			**3480**			**3480**	
3600			**3600**		**3600**			**3600**			**3600**	
3720			**3720**		**3720**			**3720**			**3720**	
3840			**3840**		**3840**			**3840**			**3840**	
3960			**3960**		**3960**			**3960**			**3960**	
4080			**4080**		**4080**			**4080**			**4080**	
4200			**4200**		**4200**			**4200**			**4200**	
4320			**4320**		**4320**			**4320**			**4320**	
Total time pumped(min):				1440		**W/L**			**W/L**			**W/L**
Average yield (l/s):				0.86								

9. APPENDIX D: WATER QUALITY

vinlab H2O
Your partner in quality water analysis

Distillery Road
Stellenbosch
Tel 021-8828866/7
info@vinlab.com
www.vinlab.com
2023-06-08

TEST REPORT

Water

Geoss South Africa (Pty) Ltd

Attn: Alison McDuling

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

@VinlabSA

Sample Details					
SampleID	W38911				
Water Type	Drinking Water				
Water Source	Borehole				
Sample Temperature					
Description	4450PhG_HP_BH3				
Batch Number	4450PhG_HP_BH3				
PO Number	4450PhG				
Date Received	2023-06-06				
Condition	Good				

Water - Routine	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
pH@25C (Water)		VIN-05-MW01	^^^	>= 5 to <= 9.7	6.71				
Conductivity@25C (Water)	mS/m	VIN-05-MW02	^	<= 170	181.6				
Turbidity (Water)*	ntu			<= 5	125				
Total dissolved solids (Water)*	mg/L			<= 1200	1231.25				
Free Chlorine (Water)*	mg/L			<= 5	<0.02				
Ammonia (NH4) as N (Water)	mg/L	VIN-05-MW08	2.5%	<= 1.5	<0.15				
Nitrate as N (Water)	mg/L	VIN-05-MW08	10%	<= 11	<1.00				
Nitrite as N (Water)	mg/L	VIN-05-MW08	10%	<= 0.9	<0.05				
Chloride (Cl-) - Water	mg/L	VIN-05-MW08	2.73%	<= 300	503.21				
Sulphates (SO4) - Water	mg/L	VIN-05-MW08	7.56%	<= 500	30.33				
Fluoride (F) - Water	mg/L	VIN-05-MW08	9.74%	<= 1.5	3.50				
Alkalinity as CaCO3 (Water)*	mg/L				78.80				
Colour (Water)*	mg/L Pt-Co			<= 15	21				
Total Organic Carbon (Water)*	mg/L			<=10	1.30				
Date Tested					2023-06-06				

Water - Metals	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
Calcium (Ca) - Water	mg/L	VIN-05-MW43	14.60%		43				

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

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

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2023-06-08

TEST REPORT

Water

Geoss South Africa (Pty) Ltd

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Magnesium (Mg) - Water	mg/L	VIN-05-MW43	8.49%		33				
Sodium (Na) - Water	mg/L	VIN-05-MW43	11.45%	<= 200	259				
Potassium (K) - Water	mg/L	VIN-05-MW43	9.42%		7				
Zinc (Zn) - Water	mg/L	VIN-05-MW43	19.40%	<= 5	0.116				
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	156				
Cadmium (Cd) Water	µg/L	VIN-05-MW43	12.26%	<= 3	3				
Chromium (Cr) - Water	µg/L	VIN-05-MW43	13.03%	<= 50	6				
Copper (Cu) - Water	µg/L	VIN-05-MW43	11.57%	<= 2000	2				
Iron (Fe) - Water	µg/L	VIN-05-MW43	12.49%	<= 2000	11885				
Lead (Pb) - Water	µg/L	VIN-05-MW43	16.32%	<= 10	<8				
Manganese (Mn) - Water	µg/L	VIN-05-MW43	12.44%	<= 400	510				
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	416				
Cyanide (CN) - Water*	µg/L			<= 200	<10.0				
Mercury (Hg) - Water*	µg/L			<= 6	<1.0				
Barium (Ba) Water	µg/L	VIN-05-MW43	14.09%	<= 700	33				
Uranium (U) - Water*	µg/L			<= 30	<28				
Date Tested					2023-06-07				

Water - Micro

	Unit	Method	Uncertainty	Limits	Results	Results	Results	Results	Results
Total Coliforms (Water)	cfu/100mL	VIN-05-MW09		<= 10	nd				
E-Coli (Water)	cfu/100mL	VIN-05-MW09		not detected	nd				
Heterotrophic plate count*	cfu/mL			<= 1000	nd				
Date Tested					2023-06-06				

Comments

W38911
Two Samples received,

Ion balance = 0.4%

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

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

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AEFourie

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

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^^ - COD. LR = ±16mg/L, MR = ±48mg/L, HR = ±477mg/L
^^^ - pH ± 0.1

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2023-06-12

TEST REPORT

Water

Geoss South Africa (Pty) Ltd

Attn: Alison McDuling

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Sample Details					
SampleID	W38912				
Water Type	Drinking Water				
Water Source					
Sample Temperature					
Description	4450PhG_HP_BH4				
Batch Number	4450PhG_HP_BH4				
PO Number	4450PhG				
Date Received	2023-06-06				
Condition	Good				

Water - Routine									
	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
pH@25C (Water)		VIN-05-MW01	^^^	>= 5 to <= 9.7	5.97				
Conductivity@25C (Water)	mS/m	VIN-05-MW02	^	<= 170	208				
Turbidity (Water)*	ntu			<= 5	1.58				
Total dissolved solids (Water)*	mg/L			<= 1200	1410.24				
Free Chlorine (Water)*	mg/L			<= 5	<0.02				
Ammonia (NH4) as N (Water)	mg/L	VIN-05-MW08	2.5%	<= 1.5	<0.15				
Nitrate as N (Water)	mg/L	VIN-05-MW08	10%	<= 11	2.46				
Nitrite as N (Water)	mg/L	VIN-05-MW08	10%	<= 0.9	<0.05				
Chloride (Cl-) - Water	mg/L	VIN-05-MW08	2.73%	<= 300	589.93				
Sulphates (SO4) - Water	mg/L	VIN-05-MW08	7.56%	<= 500	61.43				
Fluoride (F) - Water	mg/L	VIN-05-MW08	9.74%	<= 1.5	0.36				
Alkalinity as CaCO3 (Water)*	mg/L				38.10				
Colour (Water)*	mg/L Pt-Co			<= 15	<15				
Total Organic Carbon (Water)*	mg/L			<=10	1.35				
Date Tested					2023-06-06				

Water - Metals									
	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
Calcium (Ca) - Water	mg/L	VIN-05-MW43	14.60%		30				

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^^ - COD, LR = ±16mg/L, MR = ±48mg/L, HR = ±477mg/L
^^^ - pH ± 0.1

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TEST REPORT

Water

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Magnesium (Mg) - Water	mg/L	VIN-05-MW43	8.49%		66				
Sodium (Na) - Water	mg/L	VIN-05-MW43	11.45%	<= 200	255				
Potassium (K) - Water	mg/L	VIN-05-MW43	9.42%		7				
Zinc (Zn) - Water	mg/L	VIN-05-MW43	19.40%	<= 5	0.009				
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	44				
Cadmium (Cd) Water	µg/L	VIN-05-MW43	12.26%	<= 3	2				
Chromium (Cr) - Water	µg/L	VIN-05-MW43	13.03%	<= 50	4				
Copper (Cu) - Water	µg/L	VIN-05-MW43	11.57%	<= 2000	4				
Iron (Fe) - Water	µg/L	VIN-05-MW43	12.49%	<= 2000	52				
Lead (Pb) - Water	µg/L	VIN-05-MW43	16.32%	<= 10	<8				
Manganese (Mn) - Water	µg/L	VIN-05-MW43	12.44%	<= 400	12				
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	70				
Cyanide (CN) - Water*	µg/L			<= 200	<10.0				
Mercury (Hg) - Water*	µg/L			<= 6	<1.0				
Barium (Ba) Water	µg/L	VIN-05-MW43	14.09%	<= 700	81				
Uranium (U) - Water*	µg/L			<= 30	<28				
Date Tested					2023-06-07				

Water - Micro

	Unit	Method	Uncertainty	Limits	Results	Results	Results	Results	Results
Total Coliforms (Water)	cfu/100mL	VIN-05-MW09		<= 10	3				
E-Coli (Water)	cfu/100mL	VIN-05-MW09		not detected	1				
Heterotrophic plate count*	cfu/mL			<= 1000	400				
Date Tested					2023-06-06				

Comments

W38912
Two Samples received,

Ion balance = 1.4%

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Water

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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

Kalinke Rossouw
Laboratory Technician
VIN-05-M01, M02, M04, M05, M08, M10,
M28,M40, MW01, MW02, MW03, MW04,
MW08,MW09,MW10,MW12,MW13,MW1
4, MW43, VIN-05-M42, M44, M45, M46,
M48, M49, M50, M51, M52, M53, M54,
M55

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

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^^^ - pH ± 0.1

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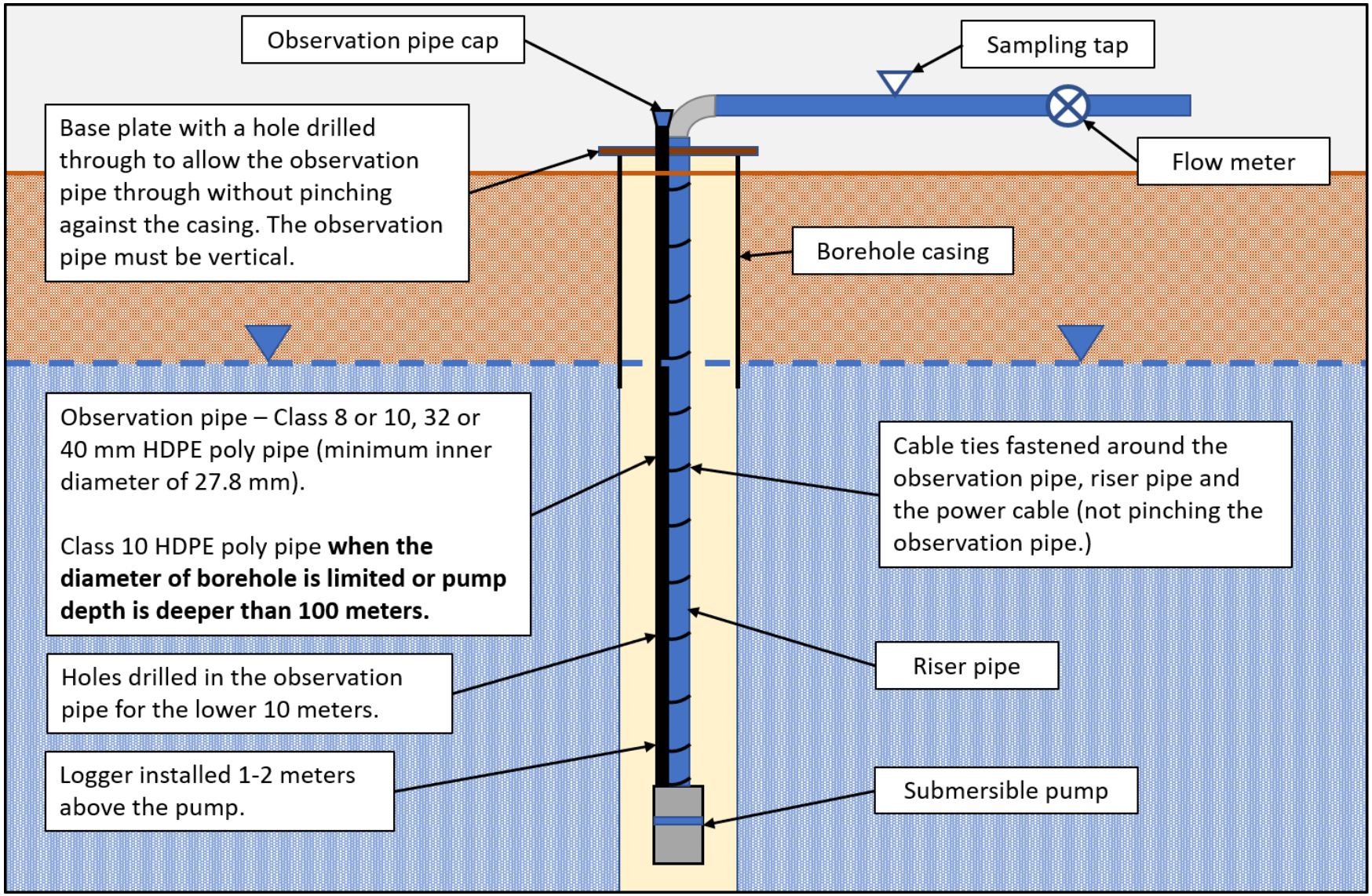
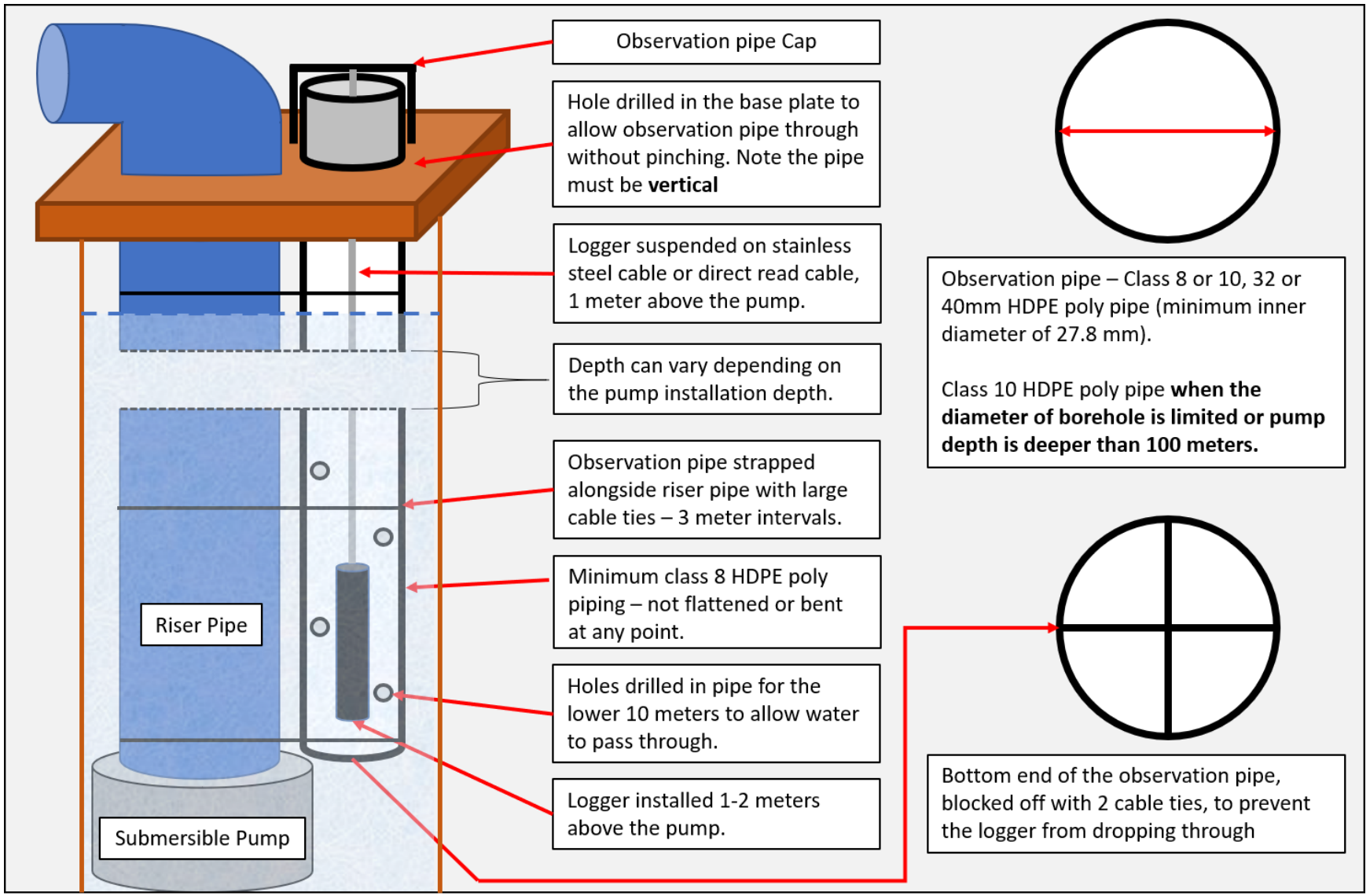
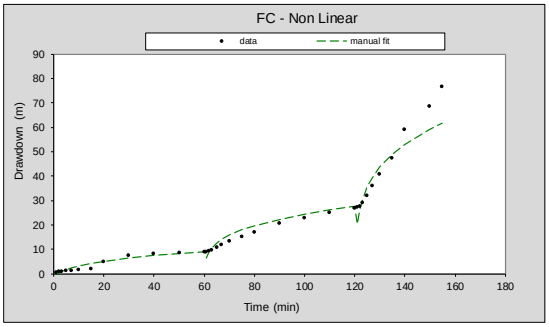
10. APPENDIX E: MONITORING INFRASTRUCTURE DIAGRAM


Observation pipe cap
Sampling tap
Base plate with a hole drilled through to allow the observation pipe through without pinching against the casing. The observation pipe must be vertical.
Flow meter
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

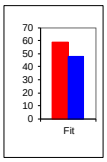
11. APPENDIX F : YIELD TEST DATA ANALYSIS

HP_BH3



FC - Non Linear Method to estimate Q_Sust

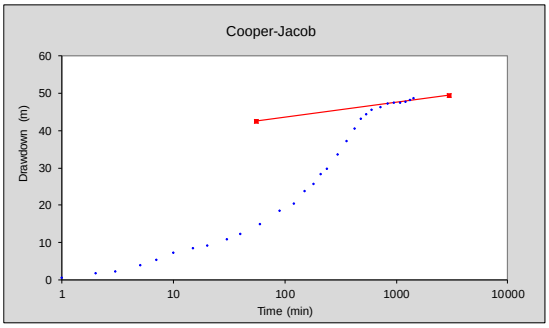
skin effect	Non-Darcian loss		Darcian loss		
A	C	p	B	n	e
0.00E+00	0.00E+00	2.00E+00	5.50E-02	1.00E+00	1.33E+00



Extrapolation
Ext_pol time (min)
1051200

Q (L/s)	Drawdown (m)
0.2	58.66

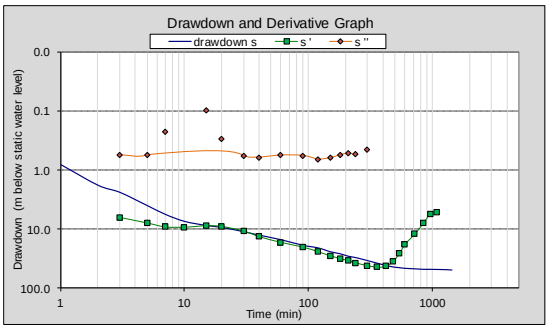
Available drawdown (m) =		48	
No boundaries	1 no-flow	2 no-flow	Closed
0.2	0.1	0.1	0.0
Q_Sust (L/s)=	0.20	std.dev =	0.07
Boundaries selected	0.00		



Cooper-Jacob method

$T(m^2/d)$ =	1.6	r_o (m)=	0.1
S =	4.40E-10	Q (l/s) =	0.42

	No boundaries	1 no-flow	2 no-flow	Closed
Q_sust	0.34	0.17	0.11	0.08
Avg. Q_sust =		0.18	std. dev =	0.11
Boundaries selected		0 - closed		

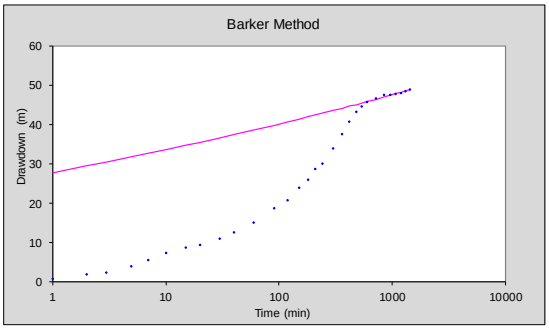


FC method

Extrapolation time in years	2	1051200	Extrapol.time in minutes	
Effective borehole radius (r_e)	34.6906933	34.69069331	Est. r_e	From r(e) sheet
Q (l/s) from pumping test	0.42	9.54322E-06	S-late	Change r_e
s_a (available drawdown), sigma_s	**48**	0	Sigma_s from risk	
Annual effective recharge (mm)	0	48	s_available w orking draw dow n(m)	
t(end) and s(end) of pumping test	1440	48.77	End time and draw dow n of test	
Average maximum derivative	**5.14**	43.21270295	Estimate of average of max deriv	
Average second derivative	**0.45**	-0.12272914	Estimate of average second deriv	
Derivative at radial flow period	9.59827687	9.598276871	Read from derivative graph	
T-early[m^2/d]		0.691864184	Aqui. thick (m)	60
T and S estimates	**T-late [m^2/d]**	**1.291965759**	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) =	65.33	80.05	94.77	138.92
Q_sust (l/s) =	0.31	0.25	0.21	0.15
Average Q_sust (l/s) =	0.22			
with standard deviation=	0.07			
Boundaries selected	0 - closed			

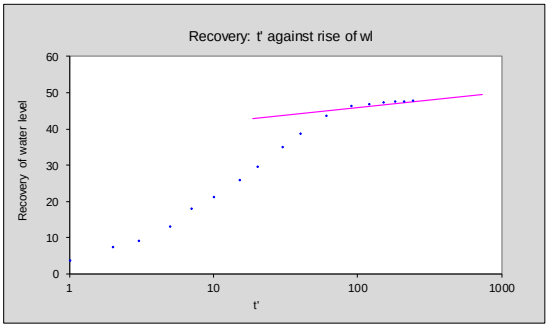


Barker method

	K_f [m/d]	S_f [1/m]	b	n	N
Fit Parameters	148.60	1.00E-07	0.03	1.89	0.0550

	No boundaries	1 no-flow	2 no-flow	Closed
sWell(Extrapol.time)	76.62	106.06	120.77	135.49
Q_sust	0.26	0.19	0.17	0.15

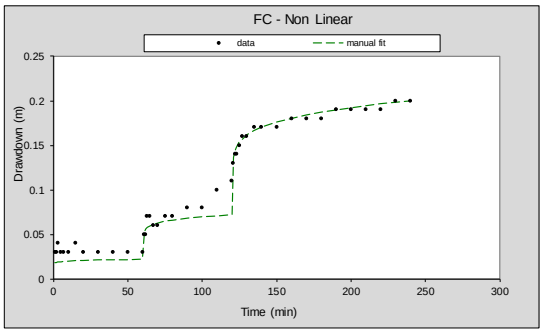
Fractal n = 1.89	Average Q-sust (l/s)=	0.19	std. dev =	0.05
	Boundaries selected	0 - closed		



Recovery

T [m2/d]	1.6
CDT Duration	1440
Recovery Duration	240
Max % Recovery	97.9

HP_BH4

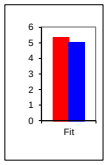


FC - Non Linear Method to estimate Q_Sust

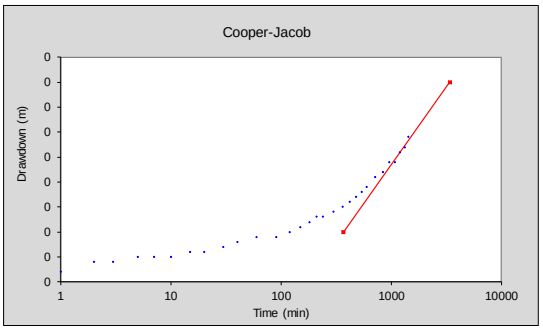
skin effect	Non-Darcian loss		Darcian loss		
A	C	p	B	n	e
8.03E-04	5.30E-07	2.68E+00	0.00E+00	1.00E+00	5.00E+00

Extrapolation
Ext_pol time (min)
1051200

Q (L/s)	Drawdown (m)
2.4	5.33



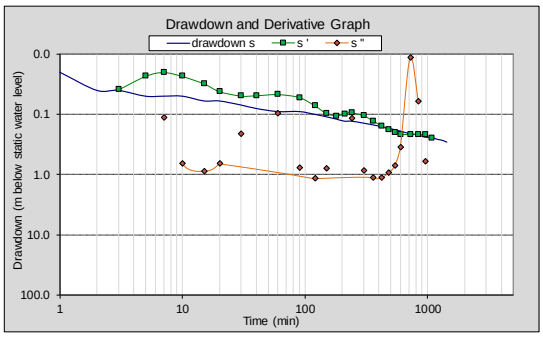
Available drawdown (m) =		5		
No boundaries	1 no-flow		2 no-flow	Closed
2.4	1.2		0.8	0.4
Q_Sust (L/s)=	0.73		std.dev =	0.86
Boundaries selected	0 - closed			



Cooper-Jacob method

T(m²/d) =	43.8	r_e (m)=	0.1
S =	1.20E+03	Q (l/s) =	0.86

	No boundaries	1 no-flow	2 no-flow	Closed
Q_sust	3.67	1.83	1.21	0.92
Avg. Q_sust =		0.92	std. dev =	1.23
Boundaries selected		closed		

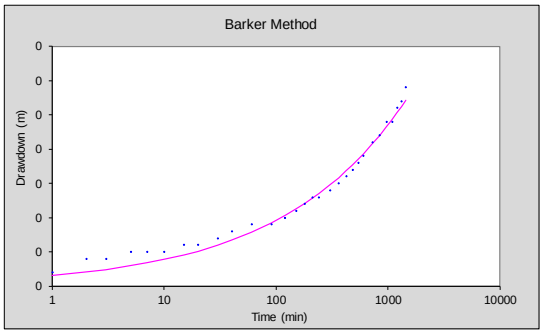


FC method

Extrapolation time in years	2	1051200	Extrapol.time in minutes	
Effective borehole radius (r_e)	51.6368433	51.6368433	Est. r_e	From r(e) sheet
Q (l/s) from pumping test	0.86	0.00417131	S-late	Change r_e
s_a (available drawdown), sigma_s	**5**	0	Sigma_s from risk	
Annual effective recharge (mm)	0	5	s_available working drawdown(m)	
t(end) and s(end) of pumping test	1440	0.29	End time and drawdown of test	
Average maximum derivative	**0.249**	0.24919123	Estimate of average of max deriv	
Average second derivative	**0.61**	0.10895905	Estimate of average second deriv	
Derivative at radial flow period	0.03425067	0.03425067	Read from derivative graph	
T-early[m²/d]		397.00344	Aqui. thick (m)	60
T and S estimates	**T-late [m²/d]**	**54.6089639**	Est. S-late	0.0033
	S-late	0.00417131		

BASIC SOLUTION

	No boundaries	1 no-flow	2 no-flow	Closed no-flow
sWell (Extrapol.time) =	3.50	4.22	4.93	7.07
Q_sust (l/s) =	1.23	1.02	0.87	0.61
Average Q_sust (l/s) =	**0.90**			
with standard deviation=	0.26			
Boundaries selected	0 - closed			

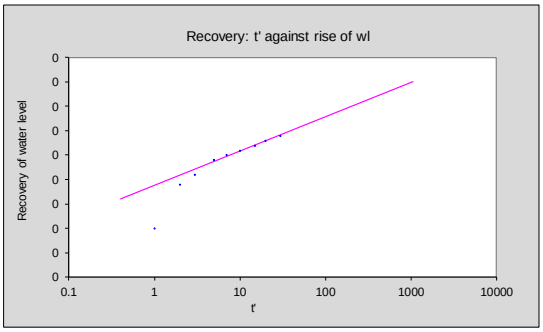


Barker method

	K_r [m/d]	S_r [1/m]	b	n	N
Fit Parameters	1707.40	2.00E-03	5.08	1.22	0.3900

	No boundaries	1 no-flow	2 no-flow	Closed
sWell(Extrapol.time)	3.55	4.98	5.69	6.41
Q_sust	1.21	0.86	0.76	0.67

Fractal n = 1.22	Average Q-sust (l/s)=	0.85	std. dev =	0.24
	Boundaries selected	0 - closed		



Recovery

T [m2/d]	194.1
CDT Duration	1440
Recovery Duration	30
Max % Recovery	100

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