TRICON AGRIC SERVICES PTY LTD

UNIT 5, 1028 SAXBY ROAD, ELDORAIGNE, 0157, 012 111 9060 INFO@TRICONAGRICSERVICES.CO.ZA

GEOHYDROLOGICAL REPORT IN SUPPORT OF A WATER USE LICENSE APPLICATION FOR THEFARMS STERKFONTEIN 306 PORTION 8 KR AND BUFFELSFONTEIN 277 PORTION RE/1 KR, CONSOLIDATED AS STERKFONTEIN 843 PORTION RE KR

April 2022

PREPARED ON BEHALF OF:

ERNA MATILDA PIENAAR

VILAGAMA PRIVATE GAME LODGE CC

COMPILED BY:

NAEDINE SWARTZ & AMONÉ MOUTON

TRICON AGRIC SERVICES PTY LTD

TEL 012 111 9060

WWW.TRICONAGRICSERVICES.CO.ZA

DOCUMENT TYPE	Geohydrological Report		
ISSUE STATUS	Final		
DISTRIBUTION LIST	**Company**	**Email**	
	Tricon Agric Services	naedine@triconagricservices.co.za	
PREPARED BY:	Amoné Mouton		July 2021
	Naedine Swartz		April 2022
REVIEWED BY:	Boniswa Magwaza		April 2022

Executive Summary

Tricon Agric Services (Pty) Ltd was appointed by Erna Matilda Pienaar, from Vilagama Private Game Lodge CC ("the Client") to undertake a geohydrological specialist study in support of a water use license application (WULA) for the proposed groundwater use of 1 360.66 m3/a for the farm Sterkfontein 306 Portion 8 KR and Buffelshoek 277 Portion RE/1 KR, consolidated as Farm Sterkfontein 843 Portion RE KR ("the Site") located approximately 24 km north of Mookgophong in the Limpopo Province.

The Client is applying for a section 21 (a) taking water from a water resource, section 21 (b) storing or water, section 21 (c) impeding and diverting the flow of water in a watercourse, section 21 (g) disposing of waste in a manner which may detrimentally impact a water resource and section 21 (i) altering the beds, banks course or characteristics of a watercourse.

The Site falls within the summer rainfall region of South Africa and according to Conradie (2012). The Köppen-Geiger classification for the region is BSh which means that the area has an Arid Steppe climate and hot steppe temperatures greater than 18 ^{o}C. The mean annual rainfall distribution for Quaternary catchment A61J is 552 mm/a. Most rainfall occurs from October to April.

According to the 1:1'000'000 geological map of the Republic of South Africa and the Kingdoms of Lesotho and Swaziland (de Beer, 2019) the Rooiberg Group include the Kwaggasnek Formation, part of the Rooiberg Group, found to the south-east of the regional area consists of felsite with minor presence of pyroclastic rocks and sandstone. Formations found in the regional area from the Waterberg Group includes the Swaershoek Formation, Alma Formation, Skilpadkop Formation, Makgabeng Formation, Aasvoëlkop Formation, Sandrivier and Mogalakwena Formations. These formations all consist mostly of sedimentary rocks including sandstone, conglomerates, mudrock and siltstone. Structurally, diabase Sills and structural lineaments can be found throughout the regional area as well as on Site.

A hydro-census investigation for the Site could not be conducted due to the neighbouring boreholes being inaccessible. The data obtained was based on boreholes on Site and regional borehole data from the National Groundwater Archive (NGA) database (DWS, 2021). Based on the information obtained the average borehole depth in a 5-km radius of the Site is 57.96 meters below ground level (mbgl) and range between 7.43 – 119.40 m bgl. The static water levels recorded by the NGA database has an average of 21.43 mbgl and range between 3.66 – 40 m bgl. This may be an indication that the boreholes in the area were drilled within different aquifer systems. Regional groundwater levels range between 2.00 and 54.86 mbgl with an average groundwater level of 15.50 mbgl and show a 99% correlation between the surface elevations and the groundwater levels.

Aquifer pump testing was conducted by C.G. Waterplan for the borehole located at the house (BH 03) and lodge (BH 01) during February of 2018 at a rate of 0.78 l/s and 0.21 l/s respectively for 360 minutes.

A groundwater sample was collected from the main lodge borehole and analysed at a SANAS accredited laboratory. The sample results were compared to the SANS 241:2015 Limit for potable water as the water from this borehole will be strictly used for human consumption and domestic purposes.

Total coliforms of the water sample exceed the SANS 241:2015 Limit for portable water and hereby deeming the groundwater quality incompliant and unsuitable for human consumption. Coliforms is primarily an indicator of the general hygienic quality of water therefore may also be an indication of microbial growth in the water.

Appropriate treatment measures should be implemented to address the excessive parameter and to ensure compliance with SANS standards. It is recommended that the groundwater monitoring network programme (Section 11) be adhered to.

Groundwater Reserve Determination (GRD) was used to calculate allocable reserve in the unit of analysis, the value of 0.49 Mm3/a was determined as the allocable reserve. The proposed abstraction volume of 0.00136 Mm3/a accounts for 0.28% of the allocable groundwater resources. The scale of abstraction calculations showed that the proposed abstraction on Site falls within a Category A indicating small scale abstraction.

The borehole yields during pump testing is 0.78 l/s and 0.21 l/s for BH 01 and BH 03 respectively with an average yield of 0.5 l/s. This aquifer type is classified as minor according to Parson (1995) and has limited development potential based on the average yield of the boreholes. According to the impact rating after the implementation of mitigation measure the magnitude of the groundwater abstraction at the Site remained low.

The abstraction from the two (2) boreholes should take place according to the borehole management plan (Section 11), with weekly groundwater level and flow meter readings taken at the boreholes should be stored in a central database for analysis and interpretation. Should a negative trend in groundwater levels be identified it is recommended that the borehole abstraction is reduced to allow the borehole to recover.

It is recommended that the abstraction at production boreholes does not exceed recommended long-term sustainable yields and all monitoring and mitigation measures discuss in this document are adhered to.

List of Contents

List of Figures

List of Tables

List of Abbreviations

%	Percentage
CDT	Constant Discharge Test
DWS	Department of Water & Sanitation
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Program
GQM	Groundwater Quality Management
GRDM	Groundwater Resource Directed Measures
K	Hydraulic Conductivity
km	Kilometre
km^2	Square Kilometre
l/h	litres/hour
l/s	litres/second
mbgl	meter below ground level
m/d	Meters per day
Mm^3/a	Mega cubic meters per annum
FC method	Fracture Characterisation (FC) method
BH	Borehole
≥	Greater or equal to
<	Less than

1 Introduction

Tricon Agric Services (Pty) Ltd was appointed by Erna Matilda Pienaar, from Vilagama Private Game Lodge CC ("the Client") to undertake a geohydrological specialist study in support of a water use license application (WULA) for the proposed groundwater use of 1 360.66 m^3/annum for the farm Sterkfontein 306 Portion 8 KR and Buffelshoek 277 Portion RE/1 KR, consolidated as Farm Sterkfontein 843 Portion RE KR ("the Site"). The Site is located approximately 24 km north of Mookgophong in the Limpopo Province.

The Client is applying for a section 21 (a) taking water from a water resource; section 21 (b) storing of water; section 21 (c) impeding and diverting the flow of water in a watercourse; section 21 (g) disposing of waste in a manner which may detrimentally impact a water resource; and section 21 (i) altering the beds, banks course or characteristics of a watercourse.

There are two (2) boreholes that will strictly used for domestic purposes, one (1) at the house and the other for water supply to Vilagama lodge both located on Farm Sterkfontein 306 Portion 8 KR.

2 Scope of Work

The scope of work was adapted from the requirements for the geohydrological investigations for WULA's in accordance with the GNR 267 of March 2017 and the scale of abstraction. The purpose of this geohydrological report is to support the WUL Application for the abstraction of groundwater resources for the purposes of human consumption and domestic use.

The scope of work included the following:

- Desktop Review;
- Hydro-census;
- Aquifer Testing;
- Groundwater Sampling;
- Groundwater Reserve Determination;
- Groundwater Impact Assessment;
- Groundwater Management Plan Development; and
- Technical Report Compilation.

3 Methodology

3.1 Desktop Review

A detailed review was completed for the Site, during which all relevant data and information available in the public domain and provided by the Client for the study area was reviewed, analysed, and collated into a central database.

The information reviewed included, but was not limited to the following:

- 1:50 000 Topographic Map series 2428BC Lekkerrus (1981);
- 1:1 000 000 Geological Map of the Republic of South Africa and the Kingdoms ofLesotho and Swaziland (de Beer, 2019); and
- 1:500 000 Hydrogeological Map series 2326 Polokwane (du Toit, 2003).
- National Groundwater Archive (NGA, 2021) database of Registered Groundwater users.

3.2 Hydro-census and Registered Groundwater Users

A hydro-census investigation was not conducted for the Site within a 1.5-km radius from the point of proposed abstraction. This is due to the neighbouring boreholes being inaccessible for the purpose of the hydro-census investigation. The information obtained and presented for registered groundwater users is based on data from the NGA database (DWS, 2021).

The following information was included but not limited to:

- Geographic coordinates of the boreholes;
- Depth of boreholes;
- Static water levels; and
- Purpose of borehole i.e., irrigation, livestock watering or domestic use.

3.3 Aquifer Testing

Two abstraction boreholes on Site underwent aquifer testing, the main lodge borehole and a borehole located at the house. Aquifer tests were conducted by C.G. Waterplan in February of 2021. The results are discussed in Section 6. The aquifer testing data is shown in Appendix A.

3.4 Sampling and Chemical Analysis

A groundwater sample taken from the main lodge borehole BH 01 was analysed on the in June of 2021. The water quality results are discussed in Section 6 and the laboratory certificates are attached in Appendix B.

3.5 Groundwater Reserve Determination

A groundwater reserve determination was completed for the Site based on the Groundwater Resource Directed Measures (GRDM) methodology as per Dennis et al. (2012) and approved by the Department of Water and Sanitation (DWS).

The Site GRDM is presented in Section 7.

3.6 Groundwater Impact Assessment

The results of the hydrogeological investigations were used to complete a groundwater impact assessment for the Site. The impact assessment aimed to quantify the risks present at the Site, as well as mitigation and management measures that can be implemented to minimize the risks during the operational and closure phases of the project life cycle.

The hydrogeological impact assessment for the Site is discussed in Section 9.

3.7 Groundwater Management Plan Development

A groundwater management plan (GWMP) for the Site was developed using the results of the project tasks.

The following was included in the GWMP:

- Descriptions of the water management philosophies for the Site, which can be translated easily to company policies;
- Management strategies for groundwater, including recommended borehole abstraction schedules and possible water saving measures to be implemented at the Site;
- Performance objectives for the Site, associated with management strategies and responsible persons/departments;
- A detailed analysis of the available management options and motivations for their implementation;
- A short, medium, and long-term action plan for the GWMP's implementation at the Site;
- And control and monitoring measures to be implemented at the Site.

The Site GWMP is discussed in Section 10.

4 Geographical Setting

4.1 Topography and Drainage

The Site elevation ranges between 1 230 and 1 308 mamsl, sloping in a north-western direction towards the perennial Mmadikiri River flowing through the northern section of the Site. The Site is accessible via a secondary road that joins from R101 coming from Mookgopong.

Sterk River is located approximately 3.30 km southeast of the site and north-west Mmadikiri River intersect the Site. From the available geographic data, no wetlands or springs are identified in the vicinity of the Site. The Site topography and drainage is shown in Figure 2.

4.2 Climate

The Site falls within the summer rainfall region of South Africa and according to Conradie (2012). The Köppen-Geiger classification for the region is *BSh* which means that the area has an Arid Steppe climate and hot steppe temperatures greater than 18 ºC.

The rainfall and evaporation distribution are based on weather data for quaternary catchment A61J (Schulze & Maharaj, 2007) (Schulze & Lynch, 2007). The mean annual precipitation (MAP) and mean annual evaporation (MAE) for quaternary catchment A61J are shown in Figure 1. The distribution shows that most rainfall occurs from October to April. Quaternary catchment A61J has a MAP of 552 mm/a and a MAE of 2 221 mm/a.

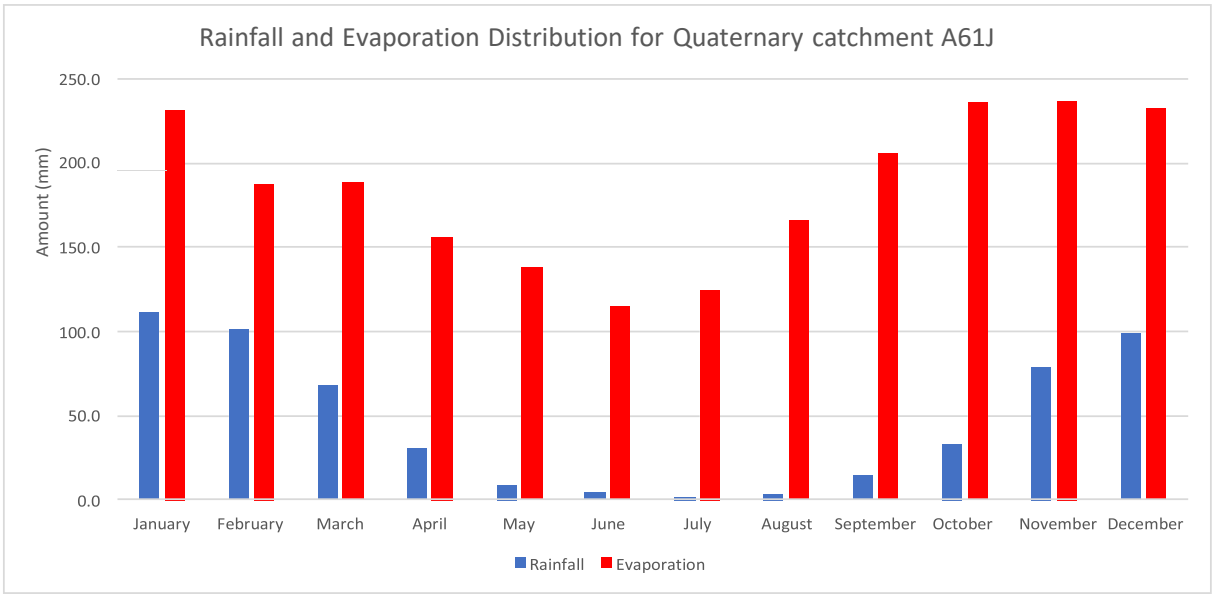

Figure 1: Mean Annual Rainfall and Evaporation Distribution.

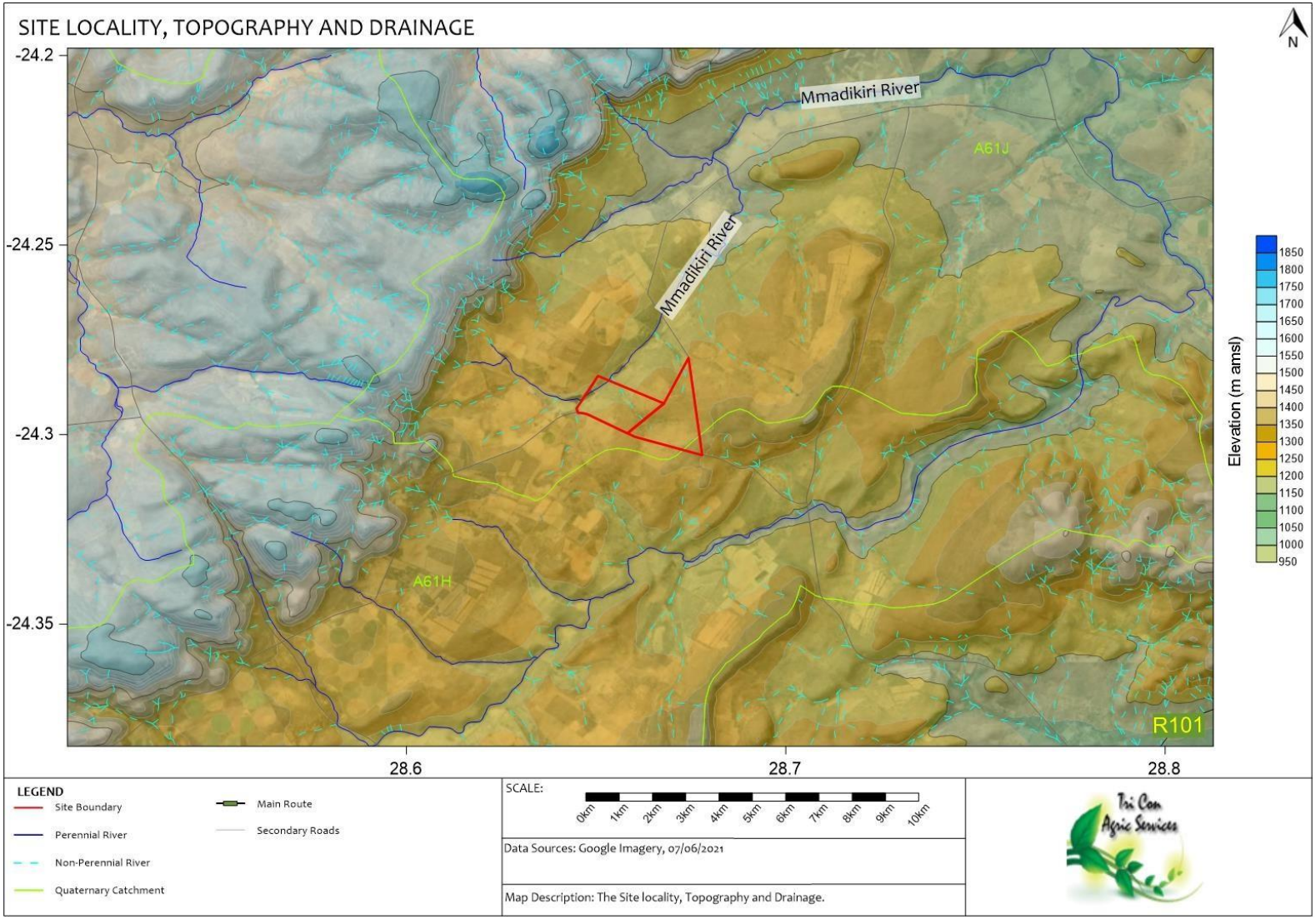

Figure 2: Site Locality, Topography and Drainage

5 Prevailing Groundwater Conditions

5.1 Geology

5.1.1 Regional Geology

According to the 1:1'000'000 geological map of the Republic of South Africa and the Kingdoms of Lesotho and Swaziland (de Beer, 2019) the regional geology is comprised of Formations from the Waterberg Group and the Rooiberg Group.

The Kwaggasnek Formation from the Rooiberg Group is the oldest formation found in the regional area. This formation can be found to the south-east of the regional area. The Kwaggasnek Formation consists of felsite with minor presence of pyroclastic rocks and sandstone (de Beer, 2019).

Formations found in the regional area from the Waterberg Group includes the Swaershoek Formation, Alma Formation, Skilpadkop Formation, Makgabeng Formation, Aasvoëlkop Formation, and Sandrivier and Mogalakwena Formations. These formations all consist mostly of sedimentary rocks including sandstone, conglomerates, mudrock and siltstone (de Beer, 2019).

Figure 3 shows the Regional Geological Setting.

5.1.2 Local Geology

The Site geology is comprised of the Makgabeng Formation, the Skilpadkop Formation, and a Diabase Sill. The Makgabeng and Skilpadkop Formations from the Waterberg Group consists of sedimentary rocks including sandstone and conglomerate. The Diabase Sill found on Site towards the southern section of the Site consist of magnesium-rich tholeiite and melanorite according to de Beer (2019).

5.1.3 Structural Geology

Diabase Sills and structural lineaments can be found throughout the regional area as well as on Site. The Diabase Sills found in the regional area consists of magnesium-rich tholeiite and melanorite (de Beer, 2019).

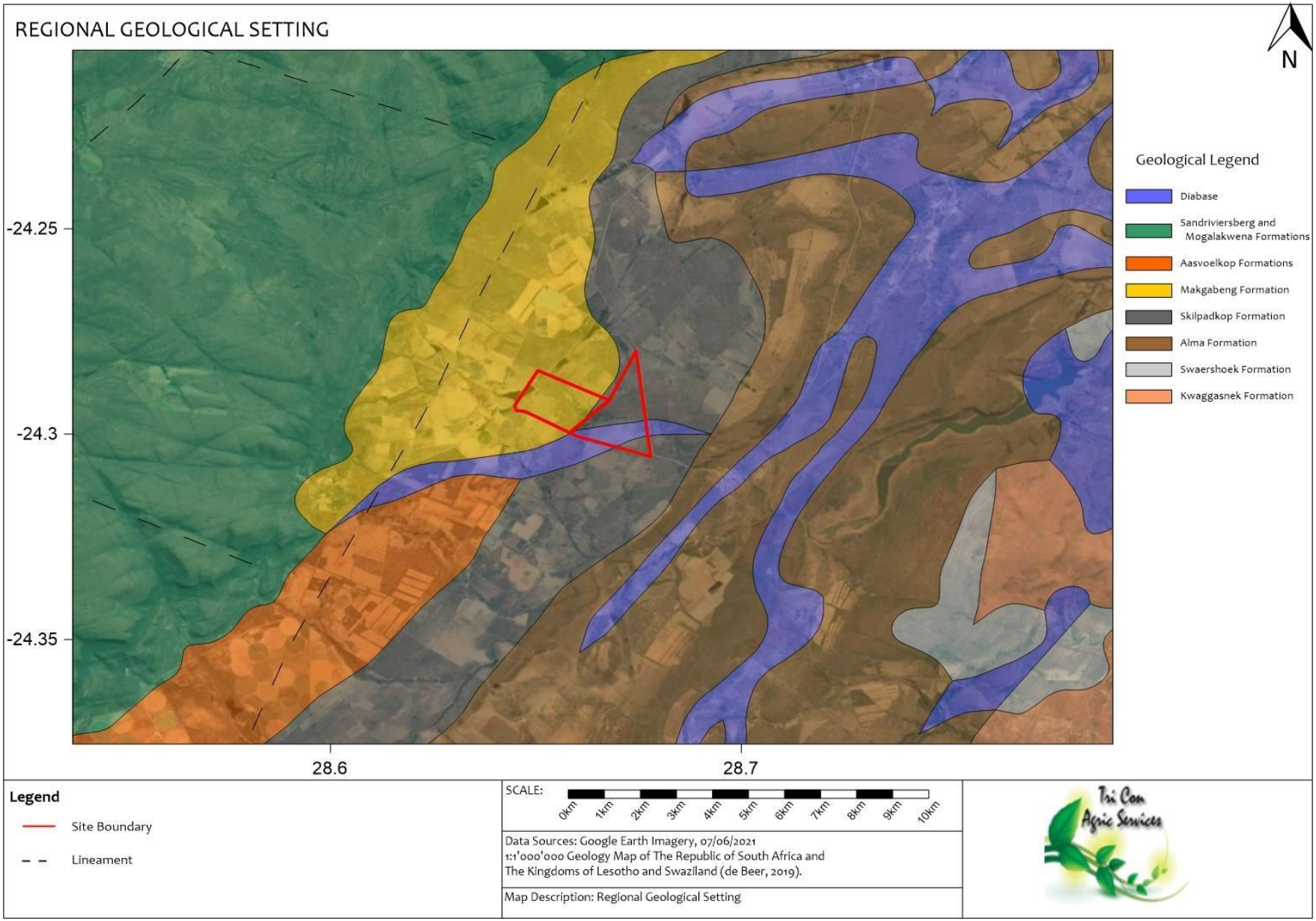

Figure 3: Regional Geological Setting.

5.2 Geohydrological Setting

5.2.1 Regional Geohydrology

According to the 1:500'000 hydrogeological map series 2326: Polokwane (du Toit, 2003), the northern section of the Site and much of the regional area to the west is underlain by fractured aquifers with typical yields ranging between 0.5 to 2.0 l/s. However, the southern section of the Site and eastern regional area is underlain by intergranular and fractured aquifers with typical yields ranging between 0.5 to 2.0 l/s.

5.2.2 Groundwater Levels

Regional groundwater levels range between 2.00 and 54.86 mbgl with an average groundwater level of 15.50 mbgl. Figure 4 shows a 99% correlation between the surface elevations and the groundwater levels. This good correlation suggests that groundwater flow takes place under semi-confined conditions and generally mimics the surface topography.

Regional groundwater contours were generated using the Bayesian Interpolation method. The general groundwater flow at the Site is in a north-west direction, as shown in Figure 5.

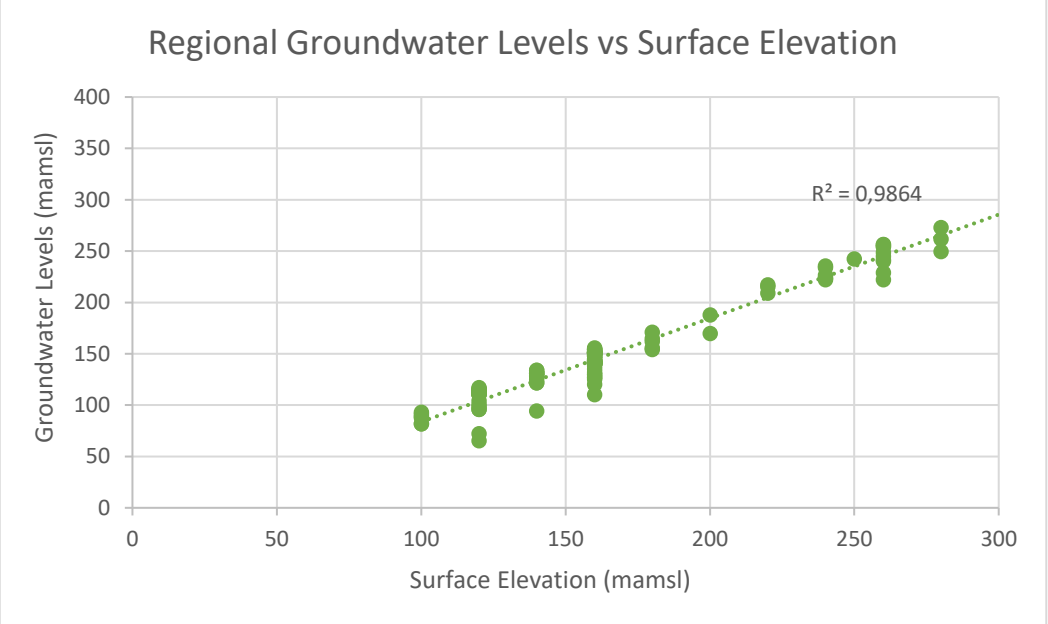

Figure 4: Regional Groundwater Level vs Surface Elevation

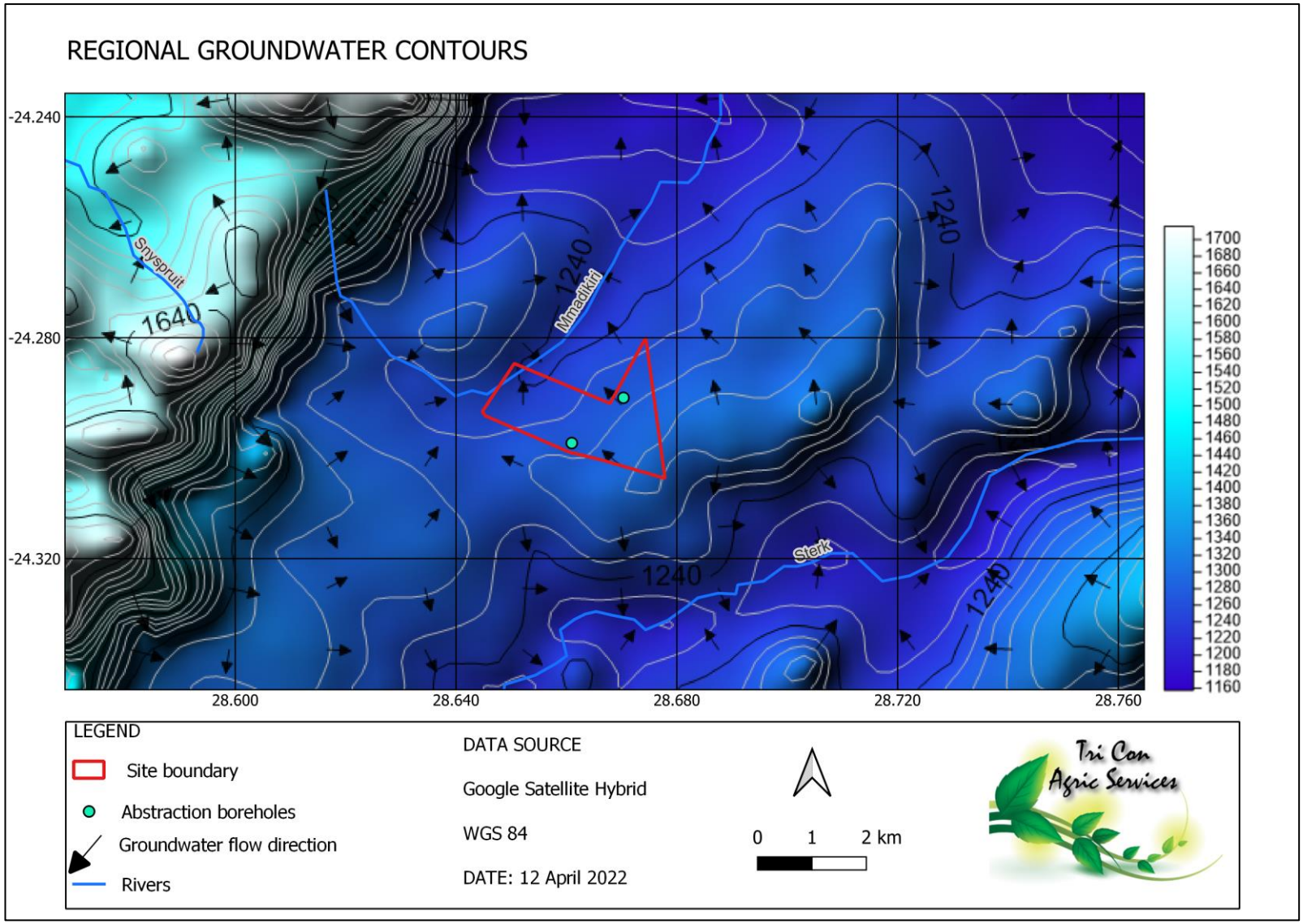

Figure 5: Regional Groundwater Contours.

6 Field Investigation

6.1 Hydro-census and Registered Groundwater Users

A hydro-census investigation form part of the specialist studies in support of the environmental impact assessment and water use license application (WULA). The investigation is conducted to identify groundwater users and assess the potential impact concerning the proposed abstraction from the Site within a 1.5 km radius from the site boundaries. A Hydro-census does not usually extent past a river or surface water body as they are usually hydraulically connected to an aquifer, acts as a groundwater pollution plume or cone of depression. The investigation generates data that will assist with information about groundwater users, purpose of abstraction, groundwater potential, quality, and quantity thereof.

In addition to a hydro-census investigation, data may also be retrieved from the National Groundwater Archive (NGA) database provided by the Department of Water and Sanitation (DWS). The groundwater database is comprised of existing registered boreholes and include a broad spectrum of borehole information.

A hydro-census investigation for the Site could not be conducted due to the inaccessibility of neighbouring boreholes. The data presented in Table 1 was based on Site boreholes and information retrieved from the NGA database within a 5 km radius of the Site. From the available hydrogeological information, the following can be concluded:

- Borehole 02 is a Site borehole and Borehole 04 to 15 are NGA boreholes.
- The average borehole depth in a 5-km radius of the Site is 57.96 meters below ground level (mbgl) and range between 7.43 – 119.40 m bgl.
- The static water levels recorded by the NGA database has an average of 21.43 mbgl and range between 3.66 – 40 m bgl. This may be an indication that the boreholes in the area were drilled within different aquifer systems.

Table 1: Site boreholes and registered groundwater users (NGA database,2021)

User	BH no.	Latitude	Longitude	Use	Depth (m)	SWL (m bgl)
Erna Pienaar (lodge)	BH 02	-	-	Domestic	59	23
Erna Pienaar (Jacob's house)	BH 03	-24.29910	28.66108	Domestic	29	18
030393	BH 04	-24.29166	28.61947	Unknown	65	31
2428BC00294	BH 05	-24.29165	28.61944	Unknown	61.26	-
2428BC00293	BH 06	-24.29166	28.61944	Unknown	65.23	-
2428BC00301	BH 07	-24.29166	28.61943	Unknown	68	6
2428BC00298	BH 08	-24.29167	28.61944	Unknown	119.40	18.80
030395	BH 09	-24.29168	28.61947	Unknown	65	40
2428BC00297	BH 10	-24.29235	28.61918	Unknown	60.96	-
030393	BH 11	-24.29234	28.61919	Unknown	65	31
2428BC00035	BH 12	-24.31105	28.62422	Unknown	7.43	-
2428BC00341	BH 13	-24.26736	28.64555	Unknown	63.40	3.66
2428BC00337	BH 14	-24.26735	28.64555	Unknown	19.81	-
2428BC00001	BH 15	-24.292339	28.61638	Unknown	-	18

6.2 Aquifer Testing

Aquifer tests were conducted by C.G. Waterplan for BH 01 and BH 03. BH 01 underwent aquifer testing on the 2nd of February 2018. The static water level at the start of the pump test was 20 meters below ground level (mbgl) with the borehole depth of 54 meters. This borehole is used for domestic purposes at the lodge. The test was conducted at a rate of 0.78 l/s for 360 minutes. The test results are summarised in Table 2.

BH 03 underwent aquifer testing on the 21st of February 2018. The static water level at the start of pump test was 18 below ground level (mbgl) with the borehole depth of 29 meters. The test was conducted at a rate of 0.21 l/s for 360 minutes. This borehole is used for domestic purposes at Jacob's house. The aquifer test certificates are presented in Appendix B.

Table 2: Aquifer Testing Summary of test conducted by C.G. Waterplan.

Borehole ID	Latitude	Longitude	Borehole Depth (m)	Static water level (m bgl)	Pump Duration (min)	Abstraction rate (l/s)
BH 01 (Main lodge borehole)	-24.29082	28.67037	54	20	360	0.78
BH 03 (Jacob's house)	-24.29910	28.66108	29	18	360	0.21

6.3 Long-term sustainable abstraction

To sustain a long-term use of groundwater Table 2 recommends the pump rate and pump cycle for each borehole. The recommended pump cycle will be sufficient to meet the client's total water demand using the main lodge borehole, BH 01.

Table 3: Recommended pump rate and pump cycle.

Borehole ID	Pump Rate (l/s)	Pump Cycle (mins/day)
BH 01	0.78	120
BH 03	0.21	60

6.4 Site Groundwater Quality

The main lodge borehole (BH 01) was sampled, and the analysis is shown in Table 4. Sample results are presented in Appendix B: Water Quality Laboratory Certificates. The sample results were compared to the SANS 241:2015 Limits for potable water as the water from this borehole is strictly used for human consumption and domestic purposes.

The following observation and recommendation were made:

- Total coliforms of the water sample exceed the SANS 241:2015 Limit. This has an operational effect on the water use, deeming the water quality in the study area incompliant with SANS 241:2015 standards for drinking water.
- Appropriate water treatment techniques should be implemented to address excessive coliforms, and to ensure that the water is compliant with SANS 241:2015 standards.

Table 4 : Groundwater quality analysis for the Site.

Sample ID	Unit	SANS 241:2015 Limit	Lodge Borehole (BH 01)
			4 June 2021
pH	pH	5 - 9.7	7.95
Electrical Conductivity	mS/m	<170	49.9
Total Dissolved Solids	mg/l	<1200	302
Ammonia as N	mg/l	<1.5	<0.009
Chloride as Cl	mg/l	<300	9.34
Fluoride as F	mg/l	<1.5	0.0163
Nitrate NO_3 as N	mg/l	<11	2.76
Nitrite NO_2 as N	mg/l	<0.9	<0.002
Phosphate PO_4	mg/l		0.03
Phosphate PO_4 as P	mg/l	<5.0	0.010
Sodium as Na	mg/l	<200	35.38
E. coli	Colonies/100 ml	Not Detected	Not Detected
Free Chlorine	mg/l	<5.0	0.09
Free Cyanide	mg/l	<0.02	<0.01
Phenols	mg/l	<0.01	<0.01
Standard Plate Count	Colonies/1 ml	<1000	670
Total Coliforms	Colonies/100 ml	<10	133
Aluminium as Al	mg/l	<0.30	<0.001
Arsenic as As	mg/l	<0.01	0.003
Boron as B	mg/l	<0.30	0.009
Barium as Ba	mg/l	-	0.279
Cadmium as Cd	mg/l	<0.003	<0.001
Copper as Cu	mg/l	<2.0	0.002
Iron as Fe	mg/l	<2.0	<0.01
Mercury as Hg	mg/l	<0.006	0.001
Manganese as Mn	mg/l	<0.4	<0.001
Nickel as Ni	mg/l	<0.07	0.001
Lead as Pb	mg/l	<0.01	<0.001
Antimony as Sb	mg/l	<0.02	0.001
Selenium as Se	mg/l	<0.04	0.002
Zink as Zn	mg/l	<5.0	0.016
Turbidity	NTU	<1.0	0.17

Red – Indicated exceedance of the SANS 241:2015 Limit.

7 Groundwater Reserve Determination

Reserve can be defined as the quantity and quality of water required to supply basic human needs with water from a resource, while protecting aquatic ecosystem to secure sustainable development and use of a water resource. To calculate the groundwater component of the reserve, the following need to be considered:

7.1 Unit of analysis delineation

The unit of analysis (UA) for the Site was taken to be the affected catchment area and can be calculated using geology and aquifer boundaries, elevation boundaries, river boundaries, etc., which represent the extent of the groundwater environment that is likely to interact with the onsite groundwater abstraction activities. The Quaternary catchment A61J has a total area of 817.6 km^2, and the total area of the unit of analysis was calculated to be 49.83 km^2.

7.2 Basic human needs

The basic human needs (BHN) reserve provides for the essential needs of individuals served by the water resource in question and includes water for drinking, food preparation and for personal hygiene. A life-line amount of 25 litres per person per day is used as a standard. According to the published DWS Government Gazette (2017), the population density for the quaternary catchment A61J is allocated as zero. The total basic human need volume from groundwater for the UA was then allocated as 0.0 Mm3/a.

7.3 Groundwater contribution to baseflow

Baseflow can be defined as a sustained low flow in rivers during dry or fair-weather conditions, but not necessarily all contributed by groundwater; includes contribution from delayed interflow and groundwater discharge. GRDM database documented a value determined by Hughes (2001) for the groundwater contribution to baseflow for quaternary catchment A61J as 7.73 Mm^3/a.

7.4 Groundwater Recharge

Groundwater recharge can be defined as "an addition of water to a groundwater reservoir or aquifer". Recharge can be expressed in various forms, e.g., as a percentage of annual rainfall, or in mm/annum.

Regional recharge values based on the Vegter recharge map shows that the regional area surrounding the Site receives 45 mm/a recharge. Based on the GRA 2 recharge map, the regional area receives 50 to 75 mm/a recharge. Recharge to groundwater was calculated using the chloride

mass balance method and groundwater chloride concentrations from the Site borehole. The calculated recharge value for the Site is 11.7% of the MAP which is 64 mm/a. According GRDM (DWS, 2018), the estimated recharge to the quaternary catchment A61J is 1.45 Mm3/a. This value will be used to represent groundwater recharge in the study area.

7.5 Existing abstraction

According to Groundwater Resource Direct Measure (DWS, 2012) the current total groundwater use in quaternary catchment A61J is 0.49 Mm3/annum. This value was used as a representative for the purpose of the current study.

7.6 Proposed Abstraction

The proposed volume applied for at the Site is 0.00136 Mm3/a, to be abstracted from the main lodge abstraction borehole on Site.

7.7 Reserve determination

The groundwater component of the reserve is the part of the groundwater resource which sustains both human needs and contributes to environmental water requirements (e.g., baseflow). The groundwater component of the reserve is calculated as per Equation 1 taken from Dennis et al. (2012).

Equation 1: Groundwater Component of the Reserve

$$Reserve\ (\%) = \frac{Basic\ Human\ Needs + Groundwater\ Contribution\ to\ Baseflow}{Recharge} \times 100\%$$

The groundwater component of the reserve was calculated as 32.5%, leaving 0.49 Mm^3/a as allocable groundwater resources. The proposed additional abstraction volume of (0.0136 Mm^3/a) accounts for 0.28% of the allocable groundwater resource, as shown in Table 5.

Table 5: Groundwater Reserve Determination.

Description	Unit	Value
Unit of Analysis Area	m2	49 830 000
Mean Annual Precipitation (MAP)	mm/a	631
Recharge to Groundwater	Mm3/a	1.45
Basic Human Need	Mm3/a	0
Groundwater Contribution to Baseflow	Mm3/a	0.471
Existing Abstraction	Mm3/a	0.49

Description	Unit	Value
Proposed Abstraction	Mm3/a	0.00136
Groundwater Reserve	%	32.5
Allocable Reserve	Mm3/a	0.49
Proposed Abstraction as % Allocable Reserve	%	0.28

7.8 Scale of Abstraction Calculations

Table 6: Scale of Abstraction Determination

Description	Unit	Value
Size of Property ($Area_{PROP}$)	m^2	4 456 774.86
Recharge (RE)	m	0.0287
Existing Use Volume (ABS_{EX})	m^3/a	0
New Use Volume (ABS_{NEW})	m^3/a	1 360.66

Recharge to Area Calculation (RE_{AREA}):

$$AREA_{PROP} \times RE = RE_{AREA}(m^3/a)$$

$$4\ 456\ 774.86 \times 0.0287 = RE_{AREA}(m^3/a)$$

$$127\ 909.43\ m^3/a = RE_{AREA}$$

Total Abstraction Calculation (ABS_{TOTAL}):

$$ABS_{EX} + ABS_{NEW} = ABS_{TOTAL}(m^3/a)$$

$$0 + 1\ 360.66 = ABS_{TOTAL}(m^3/a)$$

$$1\ 360.66\ m^3/a = ABS_{TOTAL}$$

Scale of Abstraction Calculation:

$$ABS_{SCALE} = (ABS_{TOTAL} \div RE_{AREA}) \times 100$$

$$ABS_{SCALE} = (1\ 360.66 \div 127\ 909.43) \times 100$$

$$ABS_{SCALE} = 1.06\%$$

Small scale abstraction (<60% recharge on property) Category A

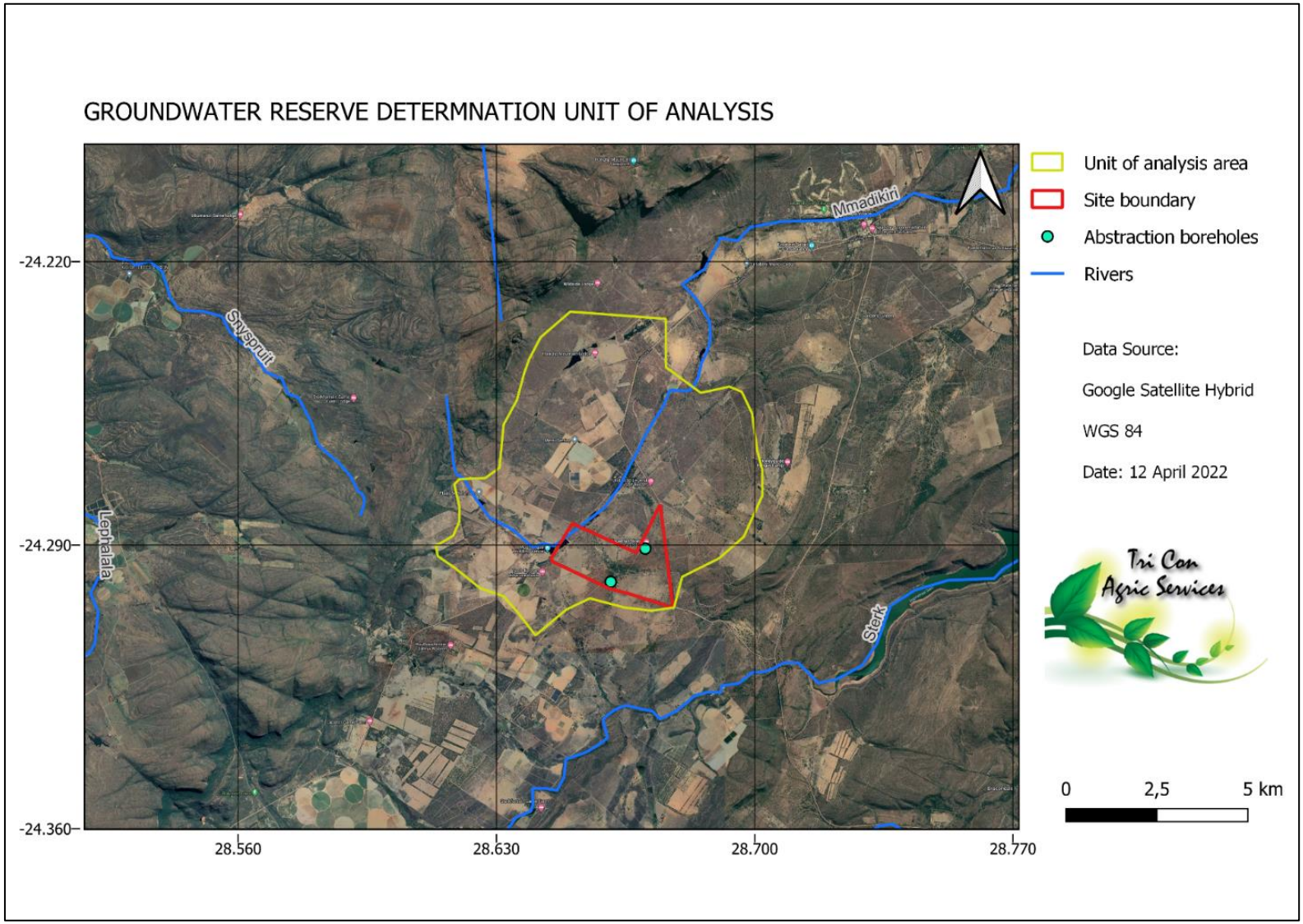

Figure 6: Groundwater Reserve Determination Unit of Analysis Area.

8 Aquifer Characterisation

8.1 Groundwater Vulnerability

The Site aquifer vulnerability was determined by making use of the DRASTIC map of South Africa obtained from the Council for Geoscience (Musekiwa & Majola, 2011:22). According to Musekiwa and Majola (2011: 4), DRASTIC is a model that can be used to evaluate the pollution potential of an area and is a useful tool when planning or can be used in the decision-making process.

The DRASTIC acronym is derived from the following parameters (Saatsaz et al., 2011:5):

- Depth of water table (D) – provides an indication of the distance and time contaminants would need to travel through the unsaturated zone into the groundwater table.
- Aquifer Recharge (R) – aids the mobilization of surface contaminants to the groundwater table.
- Aquifer media (A) – the geological units which are water bearing.
- Soil media (S) – soil type present at the Site, which may influence the travel time and concentration of contaminants reaching the groundwater table.
- Topography (T) – an indication of the amount of runoff versus infiltration of surface contaminants.
- Impact of vadose zone (I) – material found in the unsaturated zone which may slow the infiltration of contaminants.
- Hydraulic Conductivity (C) – the rate at which potential contaminants can flow into the groundwater table.

As indicated by Figure 7, the Site has a low vulnerability to contamination. The vulnerability to contamination increases to the north-west and south-east of the regional area.

8.2 Aquifer Classification

According to Parsons (1995) the aquifer classifications scheme was developed to classify the aquifer supply potential.

According to the 1:500'000 hydrogeological map series 2326: Polokwane (du Toit, 2003), the area where the main lodge borehole (BH 01) is located is underlain by intergranular and fractured aquifers with typical yields ranging between 0.5 to 2.0 l/s. Based on the aquifer testing conducted on this borehole the yield was 0.78 l/s. Jacob's house borehole BH 03 has a yield of 0.21 l/s. Table 7 provides an indication of the development potential of the aquifer based on the borehole yield.

Table 7: Aquifer Classification according to sustainable yield (After AGES, 2012).

Yield	Low	Medium	High	Very High
Range	<1 L/s	1-5 L/s	5-20 L/s	>20 L/s
Potential Use	Stock, Garden, domestic	Limited Development potential	Small Community	Large Scale Water Supply

Based on Table 7 the yield of BH 01 and BH 03 on Site can be classified as a low yielding borehole as the boreholes yield less than 1 l/s. The average yield of the boreholes is 0.5 l/s. This means that the boreholes are ideal for human consumption, stock watering, gardening, and domestic use. Parsons (1995) classifies this aquifer as a minor aquifer system.

A minor aquifer is defined by Parsons (1995: 11) as "fractured or potentially fractured rocks which do not have a high primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important for local supplies and in supplying base flow for rivers."

8.3 Aquifer Protection Classification

Aquifer system management classification and aquifer vulnerability classification systems ratings were assigned as per Table 8 in order to determine the groundwater quality management (GQM) index.

The GQM index was calculated using *Equation 2*, with the calculated level of protection being 2 (i.e., limited level of protection according to Table 9).

Equation 2: GQM Index.

$$GQM\ Index = Aquifer\ System\ Management \times Aquifer\ Vulnerability = 2 \times 1 = 2$$

Table 8: Aquifer System Management and Second Variable Classification Ratings.

Aquifer System Management Classification		
Class	**Points**	**Site Points**
Sole Source Aquifer System	6	
Major Aquifer System	4	
Minor Aquifer System	2	
Non-Aquifer System	0	2

Special Aquifer System	0-6	
Aquifer Vulnerability Classification (weathering/fracturing)		
Class	**Points**	**Site Points**
High	3	1
Medium	2	
Low	1	

Table 9: GQM Index for the Site.

GQM Index	Level of Protection	Site GQM Index
<1	Limited	2
1-3	Low Level	
3-6	Medium Level	
>6	High Level	

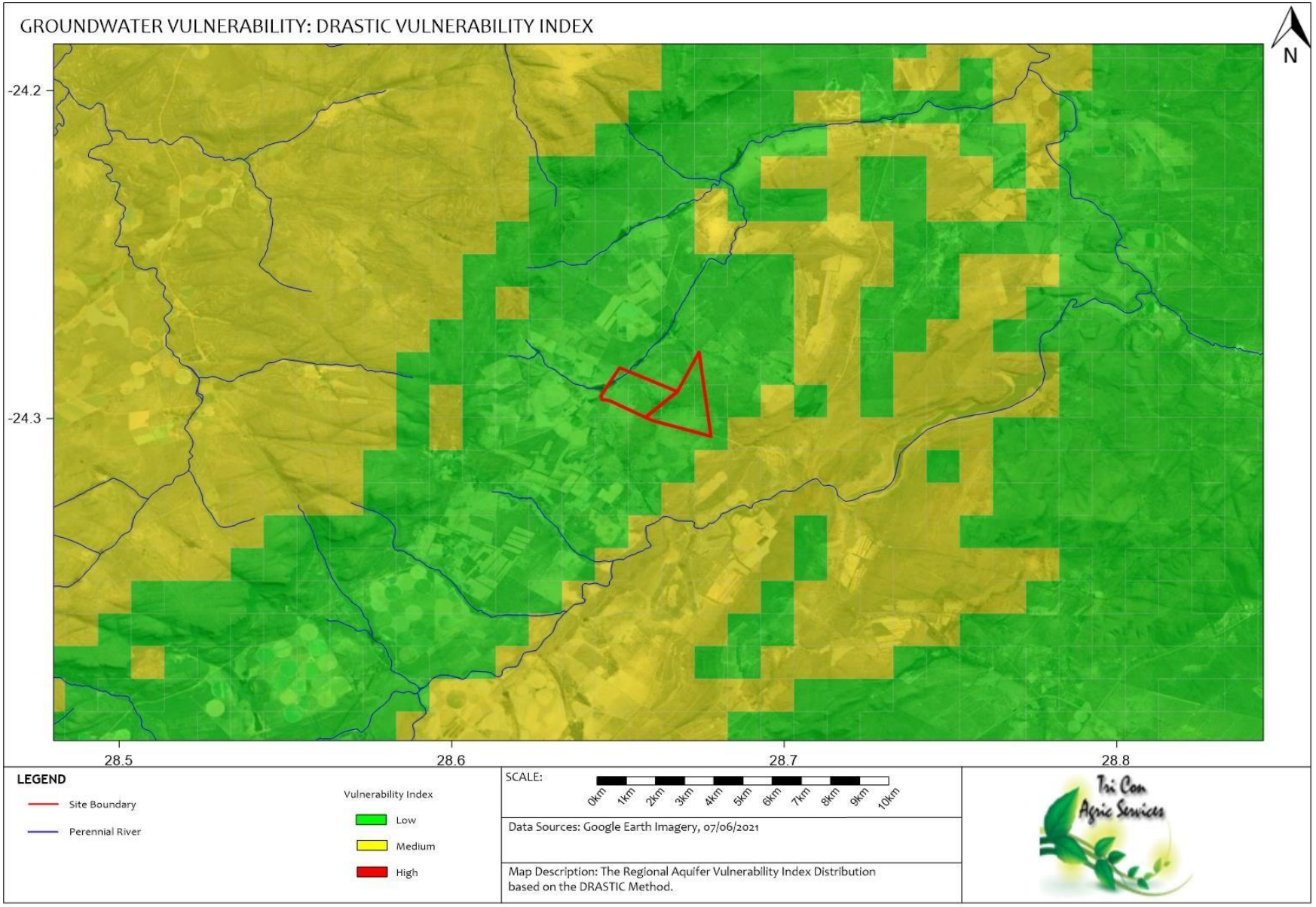

Figure 7: Groundwater Vulnerability: DRASTIC Vulnerability Index

9 Hydrogeological Impact Assessment

The impacts on the receiving environment were quantified based on the magnitude (M), duration (D), scale (S) and probability of occurrence (P), following which mitigation measures were proposed and the risk re-evaluated to take mitigation and management measures into account.

The overall risk rating (R) was calculated using the equation: R = (M + S + D) * P, where the scale of the input parameters is shown in Table 10 and the risk categories are shown in Table 11.

Table 10: Risk Ranking Parameters

Magnitude: =M	***Duration: =D***
10: Very high/do not know	5: Permanent
8: High	4: Long-term (ceases with the operational life)
6: Moderate	3: Medium-term (5-15 years)
4: Low	2: Short-term (0-5 years)
2: Minor	1: Immediate
0: Not applicable/none/negligible	0: Not applicable/none/negligible
Scale: =S	***Probability: =P***
5: International	5: Definite/do not know
4: National	4: Highly probable
3: Regional	3: Medium probability
2: Local	2: Low probability
1: Site only	1: Improbable
0: Not applicable/none/negligible	0: Not applicable/none/negligible

Table 11: Risk Classification

Significance	***Environmental Significance Points***	***Colour Code***
Neutral	0	N
Low (negative)	<30	L
Medium (negative)	30 to 60	M
High (negative)	>60	H

The hydrogeological impact assessment considered the potential impacts from groundwater abstraction from the two (2) abstraction boreholes located on Site. Due to the nature of activities at the Site, no closure or post-closure phase assessments were completed for the Site and only groundwater quantity impacts were evaluated.

The recommended pump testing yields for BH 01 and BH 03 are 0.78 l/s and 0.21 l/s, respectively.

The duration is based on the cease of the operations and occurrence of activities on the Site. The Site activities include farming and can be classified as long-term.

Table 12: Impact Rating (Prior to Mitigation/Management Measures).

Description	Impact	M	S	D	P	Risk Rating	
Groundwater Abstraction from two (2) abstraction boreholes.	Localised Aquifer Dewatering	2	2	4	2	16	Low (negative)

Groundwater abstraction from the two (2) abstraction boreholes should take place according to the borehole management plan (Section 11), with weekly groundwater level and flow meter readings taken at the boreholes and stored in a central database for analysis and interpretation.

Should a negative groundwater level trend be identified at the boreholes, it is recommended that the abstraction cycles be reduced, and the static water level monitored closely.

Following the implementation of these management measures the impact rating at the borehole remained low (Table 13).

Table 13: Impact Rating (Following Management/Mitigation Measure Implementation)

Proposed Management/Mitigation Measure	M	S	D	P	Risk Rating	
Borehole abstraction should take place according to the borehole management plan, with groundwater levels at all abstraction boreholes measured weekly.	2	2	4	2	16	low (Negative)
Flow meters should be installed at all abstraction boreholes and the readings taken weekly.						

10 Groundwater Management Plan

10.1 Objectives

Best practice guidelines should be applied at the Site to manage, prevent, and minimize the impact of groundwater abstraction on the receiving hydrogeological environment while allowing for efficient operation of the Site.

The following will be embedded in water management procedures at the site:

- Maintenance of an effective response mechanism to deal with hydrogeological issues, including unexpected events and complaints; and
- Insurance of minimal environmental impacts in terms of groundwater quantity due to groundwater abstraction.

10.2 General Approach

The key principles of the GWMP are as follows:

- Minimize the loss of the groundwater resource through effective monitoring and management of groundwater abstraction activities; and
- Measure, monitor, evaluate and update management measures continuously throughout the project lifespan.

10.3 Water Management Controls

10.3.1 Abstraction Borehole Management Plan

The following is recommended for the Site boreholes:

- The recommended abstraction rate for the boreholes should not exceed the required pumping yields;
- Water levels at the abstraction boreholes should be measured weekly and stored in a central database for interpretation and analysis;
- A flow meter should be installed at abstraction boreholes and abstraction volumes recorded weekly and stored in a central database;
- A detailed water balance should be compiled for the Site to manage water usage andidentify potential areas for re-use of water within the Site activities; and
- The monitoring results must be interpreted bi-annually by a qualified hydrogeologist and network audited annually as well to ensure compliance with regulations.

10.4 Groundwater Monitoring

10.4.1 Monitoring Network

The groundwater monitoring network design should comply with the risk-based source-pathway - receptor principle. A groundwater-monitoring network should contain monitoring positions which can assess the groundwater status at certain areas.

Both the impact on water quality and water quantity should be catered for in the monitoring system. The boreholes in the network should cover the following: potential contaminant sources, receptors, groundwater sinks (e.g., abstraction boreholes) and dewatering extents.

Groundwater monitoring should be conducted to assess the following:

- The impact of groundwater abstraction on the surrounding aquifers (if any). This will be achieved through monitoring of groundwater levels in the monitoring boreholes. If private boreholes are identified within the zone of impact on groundwater levels, these will be included in the monitoring programme;
- Groundwater abstraction volumes. This will be achieved through monitoring of groundwater levels in the monitoring boreholes as well as measuring water volumes pumped from the Site production boreholes;
- Groundwater quality trends. This will be achieved through sampling of the groundwater in the boreholes at the prescribed frequency; and
- Groundwater Monitoring should be undertaken to SABS and DWS requirement according to the schedule presented in Table 14 below.

Table 14: Monitoring Network Programme Summary.

Monitoring position	Sampling interval	Analysis	Water Quality Standards
Operational Phase			
Rainfall	Daily at the Site	N/a	N/a
All boreholes	Weekly: Abstraction volumes should be recorded	N/a	N/a
All boreholes	Weekly: measuring the depth of groundwater levels	N/a	N/a
All boreholes	Bi-Annually: sampling for waterquality analysis	Full analysis	- SANS 241:2015 Standards
		Groundwater level	- WUL Requirements

The proposed monitoring network should be comprised of all existing production boreholes at the Site.

10.4.2 Monitoring Parameters

Physical Parameters:

- Groundwater Levels; and
- Groundwater Abstraction Volumes.

Chemical Parameters:

- Field measurements:
    - pH, EC;
- Laboratory analyses:
    - Anions and cations (Ca, Mg, Na, K, NO_3, Cl, SO_4, F, Fe, Mn, Al, Hardness & Bicarbonate, Carbonate and Total Alkalinity);
    - Other parameters (pH, EC, TDS)

Laboratory analysis techniques should comply with SANS 241:2015 guidelines and it is recommended that a SANAS-accredited laboratory is used. The groundwater monitoring database should be updated monthly as information becomes available and used to analyse the information and evaluate trends noted. The database must include baseline information and background water quality and level information to make accurate observations of the impact of Site activities on the Site groundwater environment.

An annual compliance report should be compiled and submitted to the authorities for evaluation and comment. This report should be submitted annually during the active life of the Site.

11 Conclusion and Recommendations

Tricon Agric Services (Pty) Ltd was appointed by Erna Matilda Pienaar, from Vilagama Private Game Lodge CC ("the Client") to undertake a geohydrological specialist study in support of a water use license application (WULA) for the proposed groundwater use of 1 360.66 m^3/a for the farm Sterkfontein 306 Portion 8 KR and Buffelshoek 277 Portion RE/1 KR, consolidated as Farm Sterkfontein 843 Portion RE KR ("the Site"). The Site is located ~36 km north of Mookgopong in the Limpopo Province.

The Client is applying for a Section 21 (a), Section 21 (b), Section 21 (c), Section 21 (g), and Section 21 (i). Groundwater on Site will strictly be used for domestic purposes and water supply to the lodge. There are two (2) boreholes used, one (1) at the house and the other for water supply to the lodge.

The boreholes underwent aquifer testing. However, only the main lodge borehole BH 01 is utilized for production. The test results are discussed below and summarised in Table 2. The aquifer test certificates are presented by Appendix A.

- Borehole BH 01 was tested at a rate of 0.78 l/s and will be able to meet the Client's water requirement for consumption and domestic purposes.
- Borehole BH 03 was tested at a rate of 0.21 l/s.

BH 01 should not exceed the abstraction rate 0.78 l/s and pump cycle of 2 hours per day.

A Groundwater sample was collected from the main lodge borehole (BH 01) and the analysis results shown in Table 4. Sample results are presented in Appendix B: Water Quality Laboratory Certificates. The sample analysis results were compared to the SANS 241:2015 limits for potable water as the water from this borehole is strictlyto be used for human consumption and domestic purposes. The following observations and recommendation were made:

- Total coliforms of the water sample exceed the SANS 241:2015 Limit, deeming water incompliant with SANS 241:2015 standards for drinking water. Coliforms is primarily an indicator of the general hygienic quality of water and may also be an indication of microbial growth. This deems the water unfit for drinking.
- Appropriate treatment measures should be implemented to address the excessive parameter and to ensure compliance with SANS standards.

11.1 Recommendations

Groundwater Management Plan

The following is recommended for the Site boreholes:

- The recommended abstraction rate for the boreholes should not exceed the required pumping yields;
- Water levels at all the abstraction boreholes at the Site should be measured weekly and stored in a central database for interpretation and analysis;
- A flow meter should be installed at each of the abstraction boreholes and abstraction volumes recorded weekly and stored in a central database;
- A detailed water balance should be compiled for the Site in order to manage water usage and identify potential areas for re-use of water within the Site activities; and
- The monitoring results must be interpreted bi-annually by a qualified hydrogeologist and network audited annually as well to ensure compliance with regulations.

Groundwater Monitoring Plan

The groundwater monitoring network design should comply with the risk-based source-pathway - receptor principle. A groundwater-monitoring network should contain monitoring positions which can assess the groundwater status in certain areas.

Both the impact on water quality and water quantity should be catered for in the monitoring system. The boreholes in the network should cover the following: potential contaminant sources, receptors, groundwater sinks (e.g. abstraction boreholes) and dewatering extents.

Laboratory analysis techniques should comply with SANS 241:2015 guidelines, and it is recommended that a SANAS-accredited laboratory is used. The groundwater monitoring database should be updated monthly as information becomes available and used to analyse the information and evaluate trends noted. This must include baseline information and background water quality and level information in order to make accurate observations of the impact of Site activities on the Site groundwater environment.

An annual compliance report should be compiled and submitted to the authorities for evaluation and comment. This report should be submitted annually during the active life of the Site.

12 References

Conradie, D.C.U. 2012. South Africa's climatic Zones: today, tomorrow. https://researchspace.csir.co.za/dspace/handle/10204/6064 Date of access: 18 Jun. 2021.

De Beer, C.H. 2019. 1:1'000'000 Geological Map of The Republic of South Africa and The Kingdoms of Lesotho and Swaziland. Council for Geoscience.

Du Toit, W.H. 2003. Hydrogeological map series 2326: Polokwane. Department of WaterAffairs and Forestry. Pretoria, South Africa.

Musekiwa, C., Majola, K. 2011. Groundwater Vulnerability map for South Africa. Council for Geoscience report number: 2011-0063 https://www.geoscience.org.za/images/geohazard/Groundwater_vulnerability.pdf Date of access: 22Jun. 2021.

Parsons, R.P. 1995. A South African Aquifer System Management Classification. http://www.wrc.org.za/wp-content/uploads/mdocs/KV-77-95.pdf Date of access: 22 Jun. 2021.

Saatsaz, M., Eslamian, S. & Mohammandi, K. 2011. GIS DRASTIC model for groundwater vulnerability estimation of Astaneh-Kouchesfahan Plain, Northern Iran. International Journal of Water, 6(1/2):1-14.

Schulze, R.E. & Lynch, S.D. 2007. Mean Annual Precipitation (mm). http://www.sasdi.net/metaview.aspx?uuid=aae110650844f9da99d8d27e37e6c921 Date of access: 18Jun. 2021.

Schulze, R.E. & Maharaj, M. 2007. A-Pan Equivalent Reference Potential Evaporation. https://doi.org/10.15493/SARVA.BEEH.10000004 Date of access: 18 Jun. 2021.

National Groundwater Archive (NGA) database (DWS, 2021).

Appendix A: Aquifer Testing Certificates

Reg no Ck 2000/004030/23
Definate Dealers BK h/a

C.G. Waterplan

B.t.w. Reg no 4330198526
Thabo Mbeki str 112 Posbus 302
Naboomspruit 0560
Tel/Faks 014 743 1002
E- pos: cgwaterplan@gmail.com

BOORGAT TOETS SERTIFIKAAT

SOOS GETOETS OP DAG EN DATUM

KLIëNT	Vilagama
ADRES GETOETS	Naboomspruit
KONTAK BESONDERHEDE	083 259 0319 / 083 448 1924 082 553 0158

Boorgat #1

Datum getoets:	02/02/2018
Lewering:	2800 liter per uur
Boorgat diepte:	54 meter
Diepte getoets:	50 meter
Watervlak voor toets:	20 meter
Toets Beampte:	Steven
Toets tyd:	6 ure

Reg no Ck 2000/004030/23
Definate Dealers BK h/a

C.G. Waterplan

B.t.w. Reg no 4330198526
Thabo Mbeki str 112 Posbus 302
Naboomspruit 0560
Tel/Faks 014 743 1002
E- pos: cgwaterplan@gmail.com

BOORGAT TOETS SERTIFIKAAT

SOOS GETOETS OP DAG EN DATUM

KLIëNT	Vilagama
ADRES GETOETS	Naboomspruit
KONTAK BESONDERHEDE	083 259 0319 / 083 448 1924 082 553 0158

Boorgat #3

Datum getoets:	21/02/2018
Lewering:	750 liter per uur
Boorgat diepte:	29 meter
Watervlak voor toets:	18 meter
Toets Beampte:	Steven
Toets tyd:	6 ure

Appendix C: Water Quality Laboratory Certificates

UIS Analytical Services (Pty) Ltd · Reg. No. 2000/027788/07 · VAT No. 4920202969
13 Esdoring Nook, Highveld Technopark, Centurion · PO Box 8286, Centurion, 0046
Tel. +27 665 4291 · Fax. +27 12 665 4294 · info@uis-sa.co.za · www.uis-as.co.za

FINAL CERTIFICATE OF ANALYSIS

Tricon Agric Services (Pty) Ltd
1028 Saxby, Eldoraigne
Centurion

Date Required 2021-06-14

Client Provided Information:

SAMPLE 01 - 03/06/21 (QUOTE:20459)
SAMPLE 01 - 03/06/21 (QUOTE:20459)

Contact: Amone Mouton
Tel. No.: 012 111 9060
Email: geo-hydro@triconagricservices.co.za

Report Revision 0
Test Start Date: 04/06/2021
Test Complete Date: 05/07/2021

Notes
The results relate specifically to the items tested as received.
The report shall not be reproduced except in full, without the written approval of the laboratory.
[1] SANAS accredited analysis included in the SANAS Schedule of Accreditation for this laboratory.
[2] Not SANAS accredited analysis and not included in the SANAS schedule of accreditation for this laboratory.
[3] Outsourced not performed by this laboratory.
[4] Deviations: N/A unless specifically stated below.

Ricardo William Kayser
Digitally signed by Ricardo William Kayser
Date: 2021.07.05 10:06:04 +02'00'

TECHNICAL SIGNATORY: Ricardo Kayser

				Sample ID: 783012
				SAMPLE 01/03/06/2021/10 H37
				Type: Water
Analysis	Analyte	Unit	Test Method	value
Ammonia by Photometry	Ammonia as N (1)	mg/l	UIS-EA-T034a (1)	<0.009
Anions by Photometry	Chloride Cl (1)	mg/l	UIS-EA-T034 (1)	9.34
	Fluoride F (1)	mg/l	UIS-EA-T034 (1)	0.163
	Nitrate NO3 (1)	mg/l	UIS-EA-T034 (1)	12.2
	Nitrate NO3 as N (1)	mg/l	UIS-EA-T034 (1)	2.76
	Nitrite NO2 as N (1)	mg/l	UIS-EA-T034 (1)	<0.002
	Phosphate PO4 (1)	mg/l	UIS-EA-T034 (1)	0.03
	Phosphate PO4 as P (1)	mg/l	UIS-EA-T034 (1)	0.010
	Sulphate SO4 (1)	mg/l	UIS-EA-T034 (1)	3.08
Bromodichloromethane as	Bromodichloromethane as	ug/l	UIS-OS-T023 (2)	<10
Bromoform as CHBr3	Bromoform as CHBr3 (OL)	ug/l	UIS-OS-T025 (2)	<5
Calculated Total Dissolved	TDS by Summation (2)	mg/l	UIS-CP-T003 (2)	35.4
Calculated Total Dissolved Solids from EC	TDS by EC*6.5 (2)	mg/l	UIS-CP-T001 (2)	325
	TDS by EC*7 (2)	mg/l	UIS-CP-T001 (2)	350
Chloroform as CHCl3	Chloroform as CHCl3 (OL) (2)	ug/l	UIS-OS-T022 (2)	<5
Colour	Colour (2)	mg/l [Pt-Co]	UIS-EA-T036 (2)	<3
Combined NO3-as-N plus	Combined NO3-as-N plus	mg/l	UIS-CP-T013 (2)	2.8
Dibromochloromethane as	Dibromochloromethane as	ug/l	UIS-OS-T024 (2)	<2
Dissolved Elements in Water	Na (1)	mg/l	UIS-EA-T007 (1)	35.38
Electrical Conductivity	TC Temperature (2)	Deg C	UIS-EA-T001 (1)	22.2
	Tot Cond @25C (1)	mSm	UIS-EA-T001 (1)	49.9
	Total Conductivity (1)	mS/m	UIS-EA-T001 (1)	49.9
Escherichia coli	Escherichia coli (2)	Colonies/100ml	UIS-MB-T004 (2)	ND
Free Chlorine	Free Chlorine (2)	mg/l	UIS-EA-T061 (2)	0.09
Free Cyanide in water	CN (2)	mg/l	UIS-EA-T031 (2)	<0.01
Monochloramine	Monochloramine (2)	mg/l	UIS-EA-T060 (2)	0.21
pH	pH (1)		UIS-EA-T001 (1)	7.95
	pH Temperature (2)	Deg C	UIS-EA-T001 (1)	25
Phenols	Phenols (2)	mg/l	UIS-OS-T018 (2)	<0.01
Standard Plate Count	Standard Plate Count/HPC	Colonies/1ml	UIS-MB-T001 (2)	670
Total Cations in Water by ICP	Total Cr as Cr (2)	mg/l	UIS-TEA-T002 (2)	<0.05
Total Coliforms	Total Coliforms (2)	Colonies/100ml	UIS-MB-T002 (2)	133
Total Dissolved Solids	Total Dissolved Solids at	mg/l	UIS-EA-T005 (1)	302
Total Organic Carbon	Total Organic Carbon (OL)	mg/l	UIS-OS-T014 (2)	<10
Trace elements in liquids by ICP-MS	Al (2)	mg/l	UIS-AC-T100 (2)	<0.001
	As (2)	mg/l	UIS-AC-T100 (2)	0.003
	B (2)	mg/l	UIS-AC-T100 (2)	0.009
	Ba (2)	mg/l	UIS-AC-T100 (2)	0.279
	Cd (2)	mg/l	UIS-AC-T100 (2)	<0.0001
	Cu (2)	mg/l	UIS-AC-T100 (2)	0.002
	Fe (2)	mg/l	UIS-AC-T100 (2)	<0.01
	Hg (2)	mg/l	UIS-AC-T100 (2)	0.001
	Mn (2)	mg/l	UIS-AC-T100 (2)	<0.001
	Ni (2)	mg/l	UIS-AC-T100 (2)	0.001
	Pb (2)	mg/l	UIS-AC-T100 (2)	<0.001
	Sb (2)	mg/l	UIS-AC-T100 (2)	0.001
	Se (2)	mg/l	UIS-AC-T100 (2)	0.002
	U (2)	mg/l	UIS-AC-T100 (2)	0.002
	Zn (2)	mg/l	UIS-AC-T100 (2)	0.016
Turbidity	Turbidity (1)	NTU	UIS-EA-T029 (2)	0.17

AQUADOC™ Analytics cc

Reg no. CK 93/05881/23

Suite 200, P/Bag X025
Lynnwood Ridge 0040
CSIR

115 Excelsior street
MEYERSPARK
PRETORIA
South Africa

Gerrit: 082 5781152

Tel: (012) 308 6046
International: (27 12) 308 6046
Fax: (086) 608 7256
e-mail: gerrit@aquadoc.co.za

02/07/2021 JT: 11557

REPORT ON WATER ANALYSIS

Submitter: UIS Analytical Services
Address: Unit 6; Carrera House, Route 21 Corporate Park (P.O Box 8286, CENTURION, 0046)
Email: reports@uis-as.co.za
Fax: (012) 345 1004
Tel: (012) 345 1004
Attention: Petunia Moleta

Sample description: 1 x Water sample
Date received: 07/06/2021

Determination: Giardia and Cryptosporidium
Date completed: 02/07/2021
Order no: ENV 16451

Sample	Giardia /10ℓ	Cryptosporidium / 10ℓ
38273 - 783012	0	0

Method:

Giardia and Cryptosporidium: Method 9711 B.C. 22 nd Ed. 2012. EPA. Method 1623: Cryptosporidium and Giardia by filtration IMS/FA.

Remarks:

This report relates only to the samples as actually received by AQUADOC Analytics cc. This Company does not accept responsibility for any matters arising from the further use of these results.

G K Idema

1

AQUADOC™ Analytics cc
Reg no. CK 93/05881/23

Suite 200, P/Bag X025
Lynnwood Ridge 0040
CSIR

115 Excelsior street
MEYERSPARK
PRETORIA
South Africa

Gerrit: 082 5781152

Tel: (012) 308 6046
International: (27 12) 308 6046
Fax: (086) 608 7256
e-mail: gerrit@aquadoc.co.za

15/06/2021 JT: 11559

REPORT ON WATER ANALYSIS

Submitter: UIS Analytical Services
Address: Unit 6; Carrera House, Route 21 Corporate Park (P.O Box 8286, CENTURION, 0046)
Email: reports@uis-as.co.za
Fax: (012) 345 1004
Tel: (012) 345 1004
Attention: Petunia Moleta

Sample description: 1 x Water sample
Date received: 07/06/2021

Determination: Somatic coliphage
Date completed: 15/06/2021
Order no: ENV 16453

	Sample	Somatic coliphage /10mℓ
1	38273 - 783012	0

Methods:

Somatic Coliphage. SANS 10705-2/ISO 10705-2, Water quality – Detection and enumeration of bacteriophages – Part 2: Enumeration of somatic coliphages.

Remarks:

This report relates only to the samples as actually received by AQUADOC Analytics cc. This Company does not accept responsibility for any matters arising from the further use of these results.

G K Idema

1

Appendix D: Letter of Review

_____

Boniswa Magwaza Pr.Sci.Nat (131752)
Geohydrologist
BSc (Hons) Geology (University of KwaZulu-Natal)
MSc Geology and Geochemistry (University of Johannesburg)
Tricon Agric Services (Pty) Ltd
(012) 111 9060 / 071 993 9906

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Boniswa Nolwazi Magwaza

Registration Number: 131752

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Geological Science (Professional Natural Scientist)

Effective **8 September 2021** Expires **31 March 2023**

Chairperson

Chief Executive Officer

To verify this certificate scan this code