MISGUNST AAN DE GOURITZ RIVIER FARM PORTION 30/257: PHASE 1 REPORT ON GROUNDWATER FEASIBILITY

APRIL 2024

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DECLARATION OF THE INDEPENDENCE OF THE SPECIALIST

I **Wiekus du Plessis** as the appointed Specialist hereby declare/affirm the correctness of the Phase 1 risk assessment study conducted considering that it is based on field-gathered as well as open-source desk-top based data, and that:

- In terms of the general requirement to be independent:
  - other than fair remuneration for work performed in terms of this application, have no business, financial, personal or other interest in the prospecting application and that there are no circumstances that may compromise my objectivity; or

- In terms of the remainder of the general requirements for a specialist, have throughout this risk assessment process met all of the requirements;

- I have no undisclosed material information that has or may have the potential to influence the decision of the DMR or the objectivity of any Report, plan or document prepared or to be prepared as part of the application; and

- I am aware that a false declaration is an offence.

April 30, 2024

Signature of the Specialist: Date:

Groundwater Complete CC
Name of company:

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LIST OF ABBREVIATIONS

ABBREVIATION		MEANING
mbs	-	Meters below surface
mamsl	-	Meters above mean sea level
m^2/d	-	Meter squared per day
l/s	-	Liters per second
km	-	Kilometre
ha	-	Hectare
DWS	-	Department of Water & Sanitation
I&APs	-	Interested & affected persons
MAP	-	Mean annual precipitation
WULA	-	Water Use License Application
mm/a	-	Millimetres per year
GQM	-	Groundwater Quality Management

MISGUNST AAN DE GOURITZ RIVIER FARM PORTION 30/257: PHASE 1 REPORT ON GROUNDWATER FEASIBILITY, APRIL 2024

EXECUTIVE SUMMARY:

Groundwater Complete compiled this geohydrological report for Portion 30/257 of Farm Misgunst aan de Gouritz Rivier (hereinafter referred to only as “the property”). The technical report is required as input to the “Application for Environmental Authorisation” process as one of the technical studies.

One part of the application is to investigate and describe the groundwater environment and more specifically confirm the potential of groundwater to supply the property with water for mainly domestic use. The property is not serviced by the local municipality, and it is therefore the owner’s responsibility to supply their own water. A borehole was consequently drilled on the property in April 2024 and its position is indicated on Figure 1-1. The main objective of this report is therefore to:

- Characterise the geology, geohydrology and related aspects such as climate and rainfall around the property;
- Provide details of the borehole, its estimated yield and water quality;
- Discuss the groundwater characteristics of the catchment and the potential impact of the proposed abstraction on the regional and local groundwater environment; and Comment on the suitability of the borehole for the intended use.

The geohydrological environment can be summarised as follows:

- The proposed water use is mainly domestic and only for a single household. An average volume of **1 500 l/d** is required for this purpose, while the Fransmanshoek Conservancy requires an additional **50 000 l** to be stored on the property for firefighting. This water use is classified by the DWS as Schedule 1, for which no formal registration or licensing is required.
- The northern and southern borders of the property are respectively ±400 and 700 m away from the high-water mark, with surface elevations on the property varying from approximately 75 to 90 mamsl.
- The property is situated within a predominantly winter rainfall region that receives ±60% of its annual rainfall during the autumn and winter months from March to August. The average rainfall for the larger study area was calculated to be in the order of 450 mm/a, while the evaporation is ±1 860 mm/a.
- Groundwater recharge in the property area underlain by dune sand is expected to be in the region of 25% of the MAP or 112,5 mm/a.
- The annual volume of recharge to the property area alone is estimated to be approximately 9 700 m^3/a. The intended groundwater abstraction is approximately 1.5 m^3/day (±550 m^3/a), which represents approximately 6% of the recharge to the property.
- The entire surface of the property area is covered by coastal dune sand, followed by quartzitic sandstone of the Skurweberg Formation, Cape Supergroup.

- The static groundwater level depth measured at the position of the tested borehole is 51.6 mbs.
- Analysis of the pumping test data determined that the transmissivity around the borehole is approximately 7.4 m^2/d.
- Though the borehole should **theoretically be capable of yielding 1.3 l/s (4 680 l/h) for a 24-hours pumping cycle**, it is not advisable to pump the borehole continuously at a rate higher than the tested rate of 0.3 l/s – because of aquifer heterogeneity and the uncertainty as to how the water level will react. Therefore:
    - **It can safely be stated that the borehole can be equipped to pump at 2 000 l/h for limited periods such as for firefighting**.
    - **We recommend that the borehole be pumped at a rate of 0.3 l/s to fulfil the regular domestic water requirements.**
- The maximum theoretical radius of influence, when pumping at 0.3 l/s for 24-hours, was estimated to be in the order of 130 m.
- Groundwater from the borehole has an EC value of approximately 382 mS/m, which exceeds the maximum value of 170 mS/m allowed in drinking water (SANS 241:2015).
- Being of too high salinity to use for long-term consumption, groundwater from the borehole will only be used for domestic purposes such as washing, baths/showers and sanitation (toilets), which are by far the highest consumer areas in a household.

Based on the results of a short duration pumping test that was conducted, the borehole is more than capable of fulfilling the domestic water requirements. Furthermore, the basic groundwater impact assessment concluded that impacts from the proposed groundwater abstraction on potential nearby users are expected to be negligible. Groundwater Complete therefore has no objection against the proposed groundwater abstraction.

1 INTRODUCTION AND BACKGROUND

Groundwater Complete compiled this geohydrological report for Portion 30/257 of Farm Misgunst aan de Gouritz Rivier (hereinafter referred to only as “the property”). The technical report is required as input to the “Application for Environmental Authorisation” process as one of the technical studies – the Phase 1 groundwater report.

One part of the application is to investigate and describe the groundwater environment and more specifically confirm the potential of groundwater to supply the property with water for mainly domestic use. The property is not serviced by running water from the local municipality, and it is therefore the owner’s responsibility to supply their own water. A borehole was consequently drilled on the property in April 2024 and its position is indicated on Figure 1-1. The main objectives of this report are therefore to:

- Characterise the geology, geohydrology and related aspects such as climate and rainfall around the property;
- Provide details of the borehole, its estimated yield and water quality;
- Discuss the groundwater characteristics of the catchment and the potential impact of the proposed abstraction on the regional and local groundwater environment; and
- Comment on the suitability of the borehole for the intended use.

The property is situated approximately one kilometre south of the small coastal town of Vleesbaai in the Western Cape Province. A map showing the location of the property as well as the said borehole is provided in Figure 1-1.

As mentioned, the proposed water use is mainly domestic and only for a single household. An average volume of **1 500 l/d** is required for this purpose according to the engineering services report, while the same report specifies an additional **50 000 l** to be stored on the property for firefighting. This water use is classified by the DWS as Schedule 1, for which no formal registration or licensing is required.

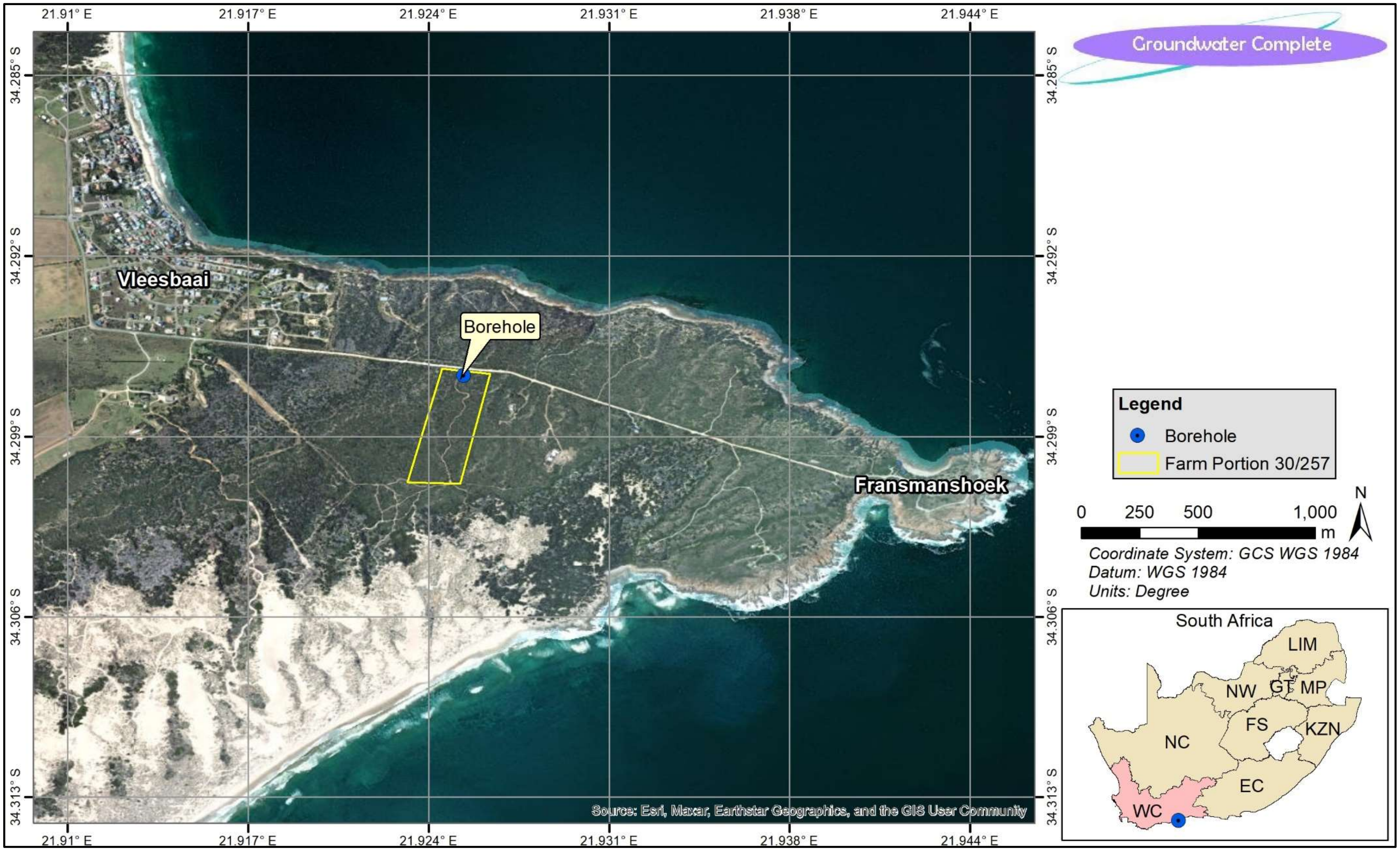

Figure 1-1: Locality map showing the property and newly drilled borehole

2 GEOGRAPHICAL SETTING

2.1 SURFACE TOPOGRAPHY AND WATER COURSES

The larger study area is situated in the fynbos biome region of the Western Cape Province, South Africa. The property is situated near the coast on a small peninsula called Fransmanshoek. The northern and southern borders of the property are respectively ±400 and 700 m away from the high-water mark, with surface elevations on the property varying from approximately 75 to 90 mamsl. The borehole is situated at ±78 mamsl. A contour map of the property is presented in Figure 2-1.

Due to the porous nature of the sandy surface cover (remnant dunes), water in the study area does not flow overland. The water seeps into the dune sand at high rates and does not create runoff or drainage lines. As a result, no water courses are present in or near the property.

2.2 CLIMATIC CONDITIONS

Climatic data in the form of monthly rainfall and evaporation figures was obtained from the H9E003 and K1E001 DWS rainfall stations. The property is situated within a predominantly winter rainfall region that receives ±60% of its annual rainfall during the autumn and winter months from March to August (Figure 2-2). The average rainfall for the larger study area was calculated to be in the order of 450 mm/a, while the evaporation is ±1 860 mm/a. Note that evaporation far exceeds rainfall, and the area therefore experiences an environmental moisture deficit when considering the annual figures (Figure 2-2).

Average daily temperatures vary from approximately 21 ^{0}C in the winter to ±24 ^{0}C in the summer, while the average nightly temperatures vary from ±10 ^{0}C in the winter to approximately 15 ^{0}C in the summer (Figure 2-3).

Figure 2-1: Surface elevations around the property

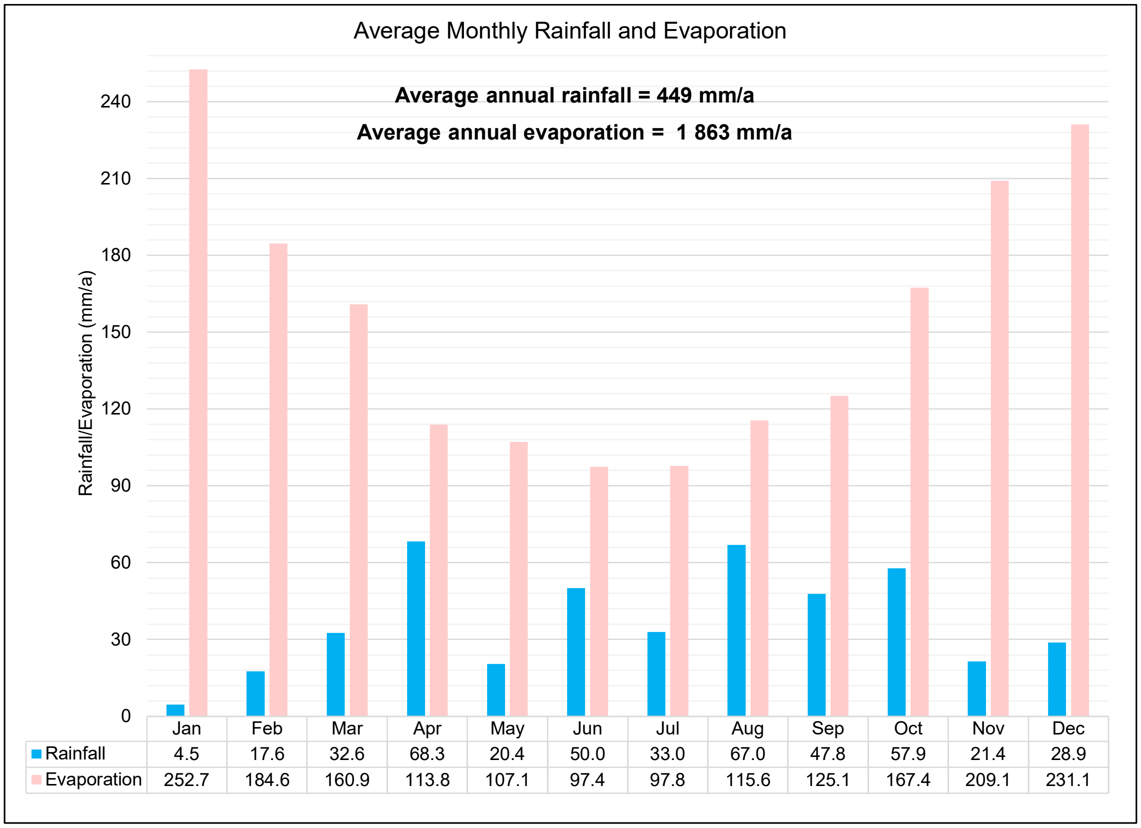

Figure 2-2: Average Monthly Rainfall for the Vleesbaai area (DWS, 2024)

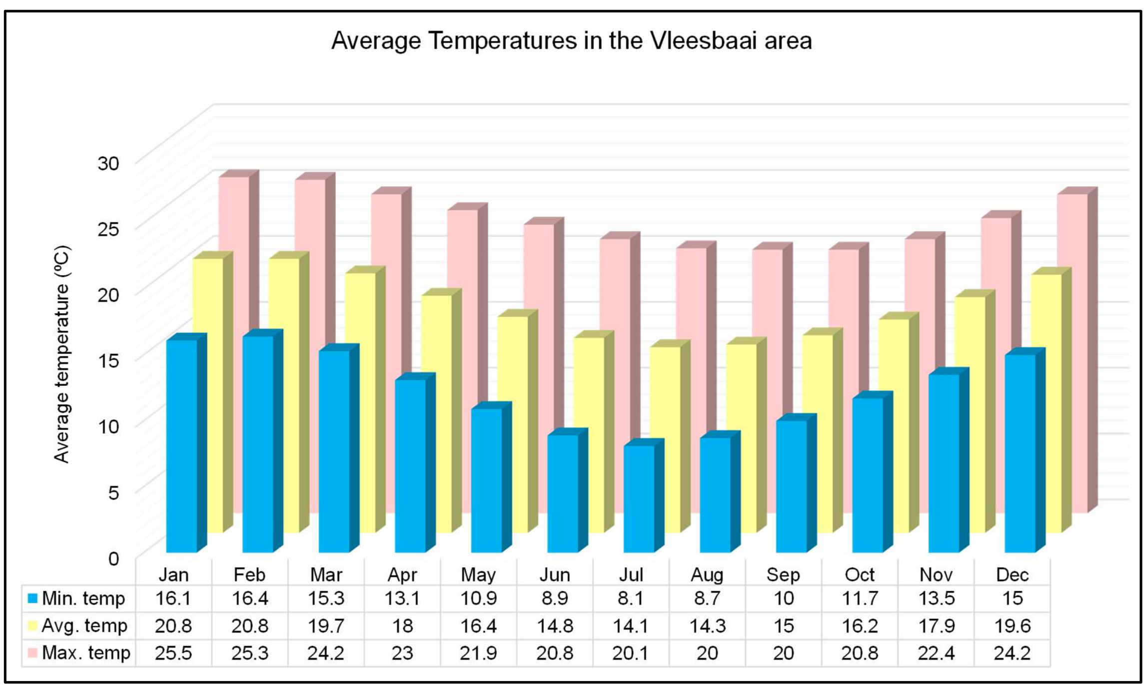

Figure 2-3: Average monthly temperatures for the Vleesbaai area *(en.climate-data.org, 2019)*

3 METHODOLOGY

3.1 DESK STUDY

No historical groundwater reports could be found for the immediate study area. Drilling results were obtained for boreholes in the Springerbaai-Vleesbaai area, but limited information could be used in this study. Groundwater Complete did, however, conduct similar studies for projects in the immediate area, and information and experience obtained from these studies were used (where applicable) to compile this report.

Important information was also obtained through the geological logging of the one borehole situated on the property as well as information from its drilling report.

3.2 SITING AND DRILLING OF BOREHOLE

There is only one borehole situated on the property and its position is indicated on Figure 1-1. The most salient borehole information is provided in Table 4-1, while photographs taken of the borehole on the 25th of April 2024 as well as the drill chips are provided in Appendix A. The borehole was drilled in April 2024 to a depth of 102 m and a simplified borehole log is provided in Table 3-1. The inner diameter of the borehole is 165 mm, and 100 m of 125 mm UPVC casing was installed. Fractures were intersected between 53 – 60 mbs and 85 – 93 mbs, and the final blow yield was estimated at between 7 000 and 9 000 l/h.

Table 3-1: Simplified borehole log

Depth from	Depth to	Description
0	24	Unconsolidated dune sand
24	102	Quartzitic sandstone

3.3 AQUIFER TESTING

The borehole was tested (i.e. pump/aquifer test) with a mobile submersible pump on the 25th of April 2024 by Groundwater Complete. The pump test was conducted for four hours after which recovery was measured. Note that a mere 1 500 l/d of groundwater is required for domestic use by a single household. This water use is classified by the DWS as Schedule 1, for which no formal registration or licensing is required. Other Schedule 1 water uses also recognised by the department include:

- Small gardening (but not for commercial purposes);
- Watering of livestock (excluding feedlots) that graze on that land (within the carrying capacity of that property);
- Storing and using run-off water from a roof (rainwater harvesting);
- In emergencies, e.g. fire-fighting; and
- Recreation, e.g. swimming, angling, etc.

Being a Schedule 1 water use, no aquifer testing is required by the DWS. Nonetheless, the pump test was conducted to determine aquifer parameters, which were in turn used to determine whether the borehole could fulfil the domestic water requirements. A manual dip meter was used in conjunction with an automatic data logger to measure the water level. The FC program (fracture characterisation program) was used to analyse the data collected during the aquifer test. The aquifer test and results are discussed in detail in Section 4.3.

3.4 GROUNDWATER RECHARGE CALCULATIONS

According to the groundwater recharge map of South Africa *(Vegter, 1995)*, recharge to the larger study area is expected to be in the order of 14 mm/a, or ±3% of the MAP. However, recharge to the sandy dune primary aquifer underlying the property area is expected to be among some of the highest in the country. A study conducted by Van Tonder & Xu (Table 3-2) estimated that coastal dunes of this kind may receive between 20 to 30% recharge. This high recharge (in a South African context at least) is made possible by the moderate climate and highly permeable nature of the thick sandy dune cover. The water table is relatively deep and out of reach of most vegetation, which further supports the estimation of a high effective recharge percentage.

Groundwater modelling of well fields in similar dunes directly west of Still Bay were calibrated on 30% effective recharge *(Dennis, 2008)*.

Groundwater recharge in the property area underlain by dune sand is therefore expected to be in the region of 25% of the MAP or 112,5 mm/a.

Table 3-2: Typical recharge to different aquifer host rocks ***(Van Tonder & Xu, 2001)***

Geology	% Recharge (soil cover <5m)	% Recharge (soil cover >5 m)
Sandstone, mudstone, siltstone	5	2
Hard Rock (granite, gneiss etc.)	7	4
Dolomite	12	8
Calcrete	9	5
Alluvial sand	20	15
Coastal sand	30	20
Alluvium	12	8

3.5 GROUNDWATER RESERVE DETERMINATION

A rapid reserve determination was conducted for the Misgunst area based on information from the DWS. The following assumptions were made in terms of groundwater use and surface area:

- The most significant ''use'' of groundwater at the property will be the water pumped from the borehole for domestic use; and
- There will be very limited seepage water returning to the groundwater.

The property has a surface area of ±86 188 m^2 or 8.6 ha, and forms part of the K10A quaternary catchment in the Gouritz water management area. The general authorised groundwater use for this catchment is 75 m^3/ha/year.

Table 3-3: Most salient parameters relevant to Catchment K10A *(Groundwater Resource Directed Measures, 2005)*

Description	*Unit*	Value	Comment
Catchment Area	*km^2*	177.5	GRDM, 2005
Property Area	*ha*	8.6	None
General Authorised Use (GA)	*m^3/ha/a*	75	GRDM, 2005
General Authorised Use (GA)	*m^3/a*	645	Calculated for property area
Mean Annual Rainfall	*mm/a*	450	Figure 2-2
Effective Annual Recharge	*mm/a*	112.5	Recharge depth per year
Annual Recharge Volume	*m^3/a*	9 696	Recharge volume to property per year
Groundwater Use	*m^3/a*	550	1 500 l/d x 365 days
Groundwater use as % of GA	*%*	85	Less than general authorised use
Groundwater use as % of Recharge	*%*	6	Small percentage of recharge

No major groundwater abstraction occurs in the direct vicinity of the property, and nearby properties rely mostly on harvested rainwater. Thus, the groundwater in the area is a resource that goes mostly unutilised.

The annual volume of recharge to the property area alone is estimated to be approximately 9 700 m^3/a. The intended groundwater abstraction is approximately 1.5 m^3/day (±550 m^3/a), which represents approximately 6% of the estimated recharge to the property.

The Department of Water and Sanitation (DWS) categorises the water use licence applications in three categories based on the amount of recharge that is used by the applicant in relation to the specified property area:

- Category A: Small scale abstractions (<60% recharge on property);
- Category B: Medium scale abstractions (60-100% recharge on property); and
- Category C: Large scale abstractions (>100% recharge on property)

Based on the rapid reserve determination conducted for the property area, the proposed water use falls within **Category A**, i.e. small-scale. As mentioned previously, this is also considered to be a Schedule 1 water use according to DWS guidelines. **Taking into consideration the very few users that rely on groundwater and relatively small volume planned for abstraction, the effect of the planned groundwater use is expected to be negligible.**

4 PREVAILING GROUNDWATER CONDITIONS

4.1 GEOLOGY

Geological information provided in this report was interpreted from the 1:250 000 scale geological map of the larger study area (Figure 4-2) and confirmed at the position of the borehole through the description of drill chips that were displayed by the drilling contractor. A photograph that was taken of this material during the pumping test is provided in Appendix A.

The property is underlain by Cape Supergroup sedimentary rocks. The Cape Supergroup rocks outcrop along large parts of the southern coast of South Africa except where it is overlain by quaternary and other younger sediments (such as the Strandveld sediments). The entire surface of the property area is covered by coastal dune sand. Below the dune sand a few meters of sandstone and interlayered calcrete of the Strandveld Formation (of the Bredasdorp Group) occurs. The basement of the younger formations is formed by the Skurweberg Formation of the Table Mountain Group (Cape Supergroup). The Skurweberg Formation consists of thick-bedded, medium- to coarse-grained, cross-bedded, white-weathering, quartzitic sandstone with subordinate calcareous sandstone. A simplified north-south sectional sketch of the lithologies underlying the property based on actual surface elevations (but not drawn to scale) is provided in Figure 4-1.

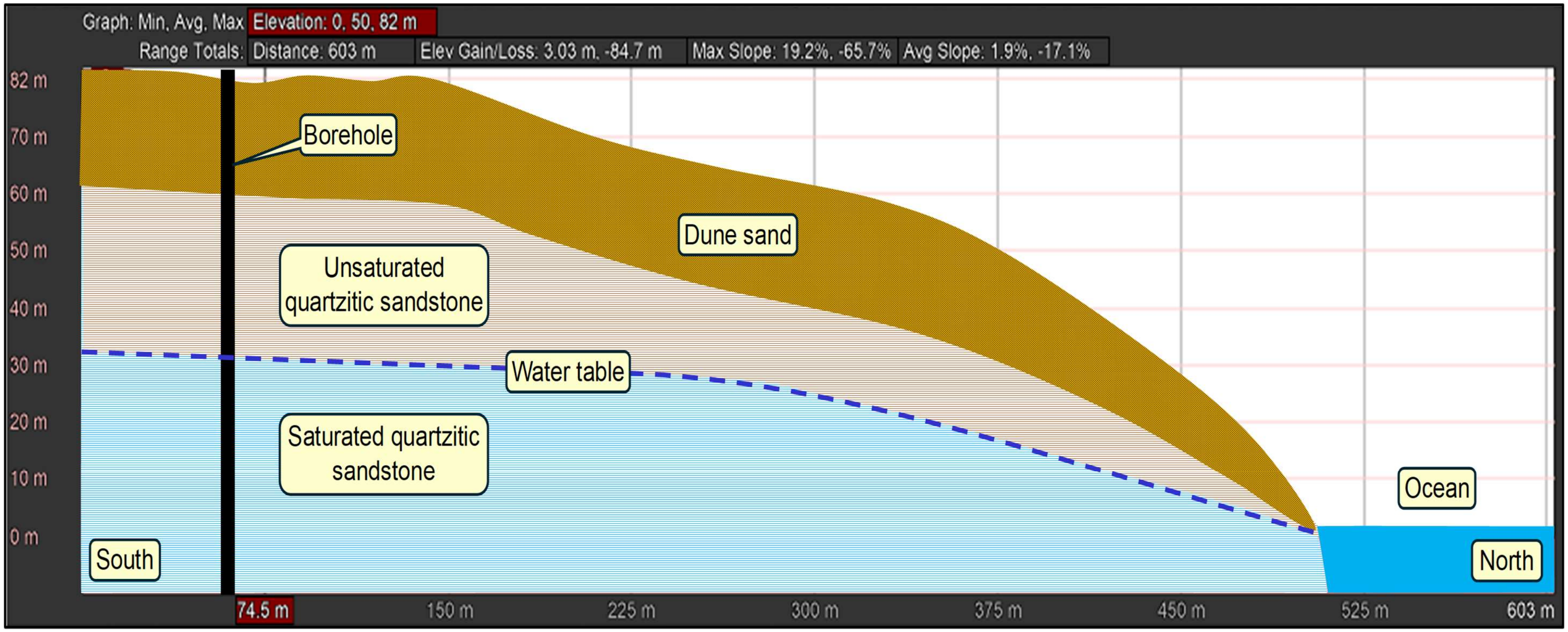

Figure 4-1: South to north sectional sketch indicating geological and groundwater relationship concepts below the property

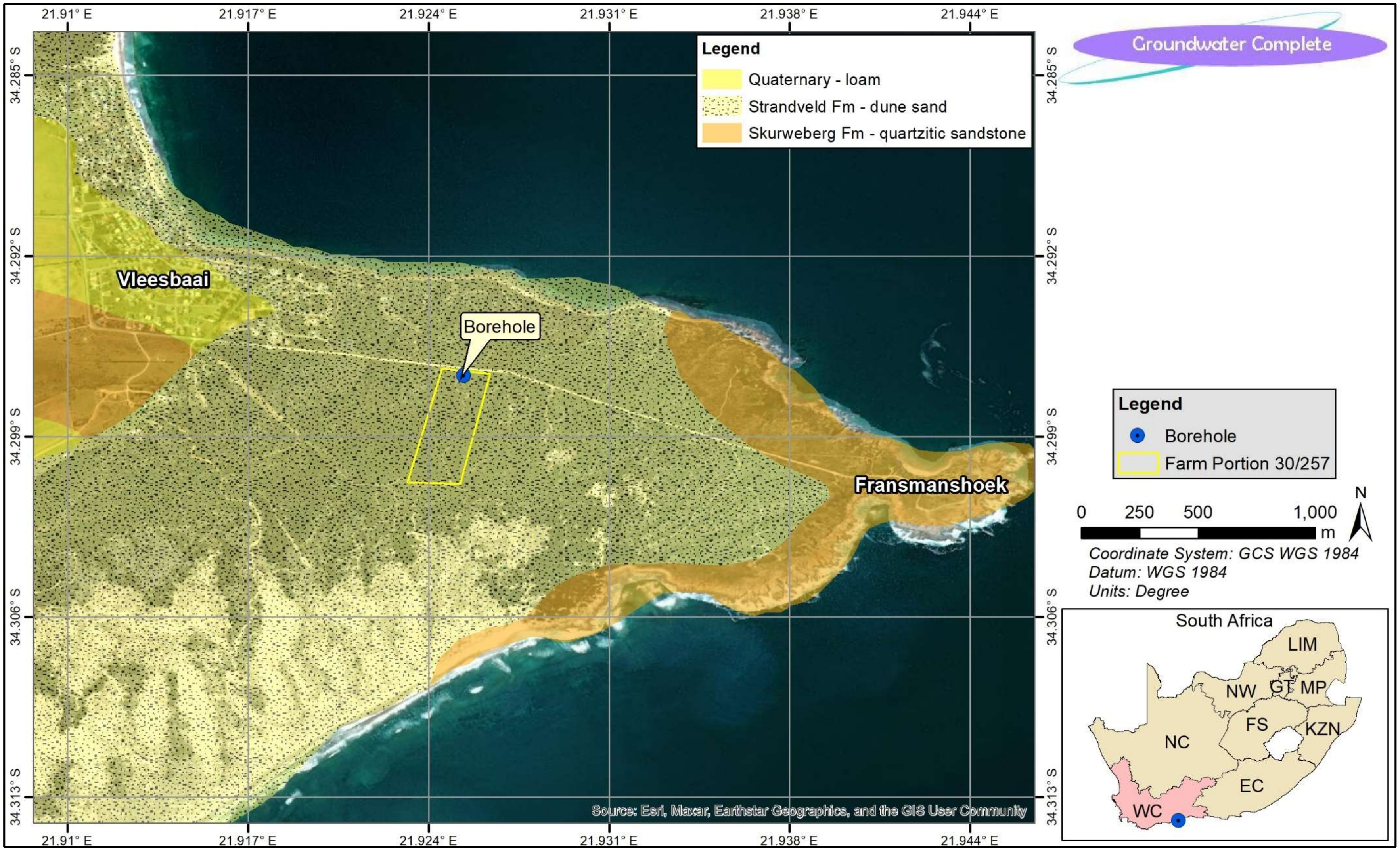

Figure 4-2: Geological map of the larger study area (1:250 000)

4.2 HYDROGEOLOGY

4.2.1 UNSATURATED ZONE

The unsaturated zone refers to the portion of the geological/soil profile that is situated above the static groundwater elevation or water table. Based on our knowledge of the local geology, the unsaturated zone is predominantly composed of unconsolidated sand at surface followed by interlayered calcrete and sandstone.

The unsaturated zone affects both the quality and quantity of the underlying groundwater. The type of material forming the unsaturated zone as well as the permeability and texture thereof will significantly influence aquifer recharge as well as the mass transport of surface contamination to the underlying aquifer(s). Factors like ion exchange, retardation, bio-degradation and dispersion all play a role in the unsaturated zone.

The thickness of the unsaturated zone is determined by subtracting the static water level elevation in the study area from the surface elevation, or simply by measuring the depth of the groundwater level below surface. The thickness of the unsaturated zone is just over 50 m at the borehole position and reduces northwards to zero at the ocean shore.

4.2.2 SATURATED ZONE

The saturated zone, as the name suggests, is the portion of the geological/soil profile that is situated below the static groundwater elevation or water table. The depth to the saturated zone is therefore equal to the thickness of the unsaturated zone, which can range between ±50 m and pinch down to 0 m at the ocean shore.

The saturated zone is important as it forms the groundwater zone or system on which groundwater users rely for their water supply. Based on drill chips that were still available on the property at the time of the aquifer test and the regional geological map (Figure 4-2), the saturated zone is most likely to consist of quartzitic sandstone of the Skurweberg Formation (Table Mountain Group).

4.2.3 TRANSMISSIVITY AND STORATIVITY OF THE AQUIFER

An aquifer test in the form of a constant rate pumping or discharge test was conducted on the borehole to calculate representative aquifer parameters (transmissivity or hydraulic conductivity), which were then applied to estimate the borehole yield.

The aquifer parameters and borehole yield estimation are discussed in Section 4.3.

4.3 BOREHOLE YIELD ESTIMATION AND RADIUS OF INFLUENCE

A constant rate pumping test was conducted by Groundwater Complete on the 25th of April 2024. The test was conducted for a 4-hours period, which is considered sufficient given:

- The low intended groundwater abstraction/use of approximately 1 500 l/d; and
- The good groundwater recharge to the property area.

Borehole-specific information is provided in Table 4-1, while the pumping test information is summarised in Table 4-2. A photograph was taken of the borehole during the pumping test and is provided in Appendix A.

Table 4-1: Summary of tested borehole

Coordinates *(WGS 84)*			Depth (m)	Water strike/s (mbs)	*SWL (mbs)	Pump depth (m)	Available drawdown (m)
South	East	Elevation (mamsl)					
-34.2963	21.9250	78	102	53 – 60 85 – 93	51.61	60	8.39

**SWL – static water level in meters below surface (mbs) prior to testing.*

Table 4-2: Summary of constant rate pumping and recovery tests

Test type	Duration	Pumping rate	Water level
	min	*l/s*	*mbs*
Pump	240	0.3	52.39
Recovery	50	0	52.02

As mentioned previously, DWS does not require a pumping test for the proposed Schedule 1 water use. Nonetheless, the test was conducted to determine aquifer parameters, which were in turn used to determine whether the borehole could fulfil the domestic water requirements – though not according to full SANS 10299-4:2003 guidelines.

4.3.1 BACKGROUND AND THEORY TO AQUIFER TESTING

An aquifer test (more commonly referred to as a pump test) is conducted to determine aquifer parameters, especially transmissivity or hydraulic conductivity. The test basically involves the abstraction of groundwater from a borehole by means of a pump (submersible- or mono pump) at a known rate. Measurements of the decreasing water level within the borehole are taken at predetermined intervals, which are generally short at the start of the test and increase as the test progresses. After the test has been completed and the pump has been shut down, measurements are again taken of the water level as it starts to recover/rise in the borehole (i.e. recovery test).

The borehole on the property was tested in the manner described above and the pump test data was analysed with the Fracture Characterisation (FC) Program software package, which offers a wide range of mathematical equations/solutions for the calculation of aquifer parameters. The time-water level data collected during the constant rate pump test is plotted on a log-linear graph. A straight line or curve (depending on equation used) can then be fitted to the different flow stages on the graph (process known as curve matching) and the aquifer transmissivity and storativity are calculated in accordance with the preselected analytical equation. Aquifer parameters provided in this report were calculated with the *Cooper-Jacob (1946)* equation.

It is important to note that the abovementioned equation for pump test analysis was designed for pump test interpretation in a primary porosity aquifer environment with the following assumptions:

- The aquifer is a homogeneous medium;
- Of infinite extent;
- No recharge is considered; and
- An observation borehole is used for water level recording at a distance from the pumped borehole.

Although few of these assumptions apply to the tested borehole, the methods/equations could still be used as long as the assumptions and 'shortcomings' are recognized and taken into consideration – the FC Program was developed specifically for this purpose.

4.3.2 BOREHOLE YIELD ESTIMATION

Analysis of the data determined that the transmissivity around the borehole is approximately 7.4 m^2/d (Figure 4-3). An accurate storage coefficient value cannot be obtained through conventional pumping test analysis, and a value of 0.001 was used in the borehole yield calculations. This value is considered to be quite conservative for the underlying secondary fractured rock aquifer hosted within the sedimentary rocks (mainly quartzitic sandstone) of the Skurweberg Formation, Cape Supergroup.

After the pumping test had been completed, the recovery of the borehole was also measured (i.e. recovery test). This is another way to determine the aquifer parameters. The recovery behaviour can be viewed in Figure 4-4. A transmissivity of approximately 36 m^2/d was calculated from the recovery data. This value is significantly higher than what was calculated from the pump test data, however, the more conservative transmissivity indicated by the pump test is considered more appropriate and was used in the calculations.

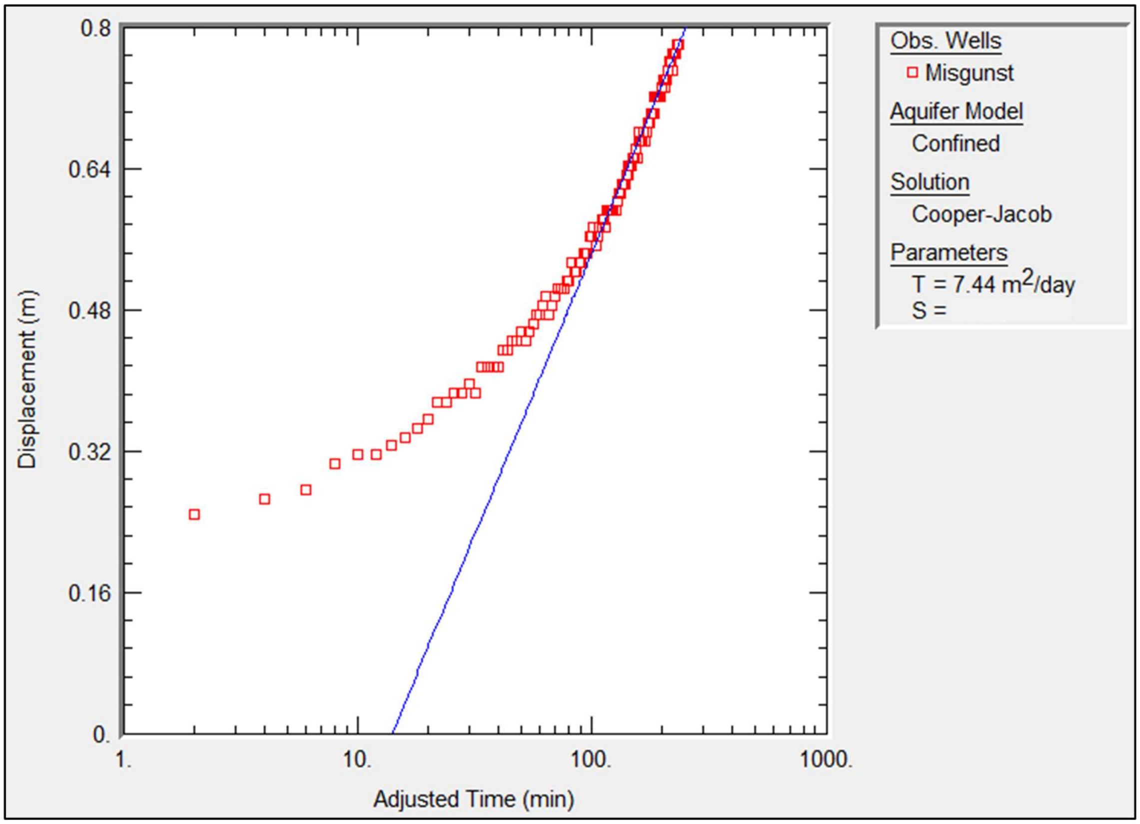

Figure 4-3: Analysis of the pump test data (time vs. drawdown) using the Cooper-Jacob equation

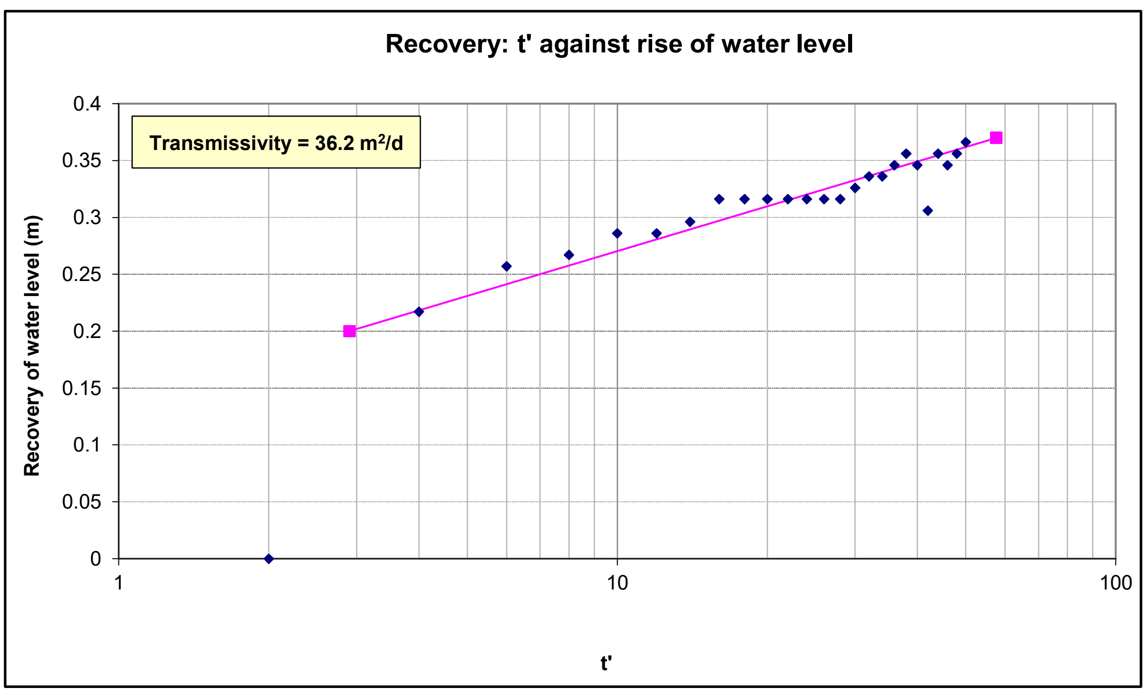

Figure 4-4: Analysis of the recovery test data

The *Cooper-Jacob* equation was applied to calculate the estimated yield and requires the following input data:

- Aquifer transmissivity = 7.4 m^2/d;
- Storage coefficient = 0.001;
- Pumping duration = 365 days;
- Observation distance from pumping well = 0.05 m; and
- Available drawdown = 40 m.

Note in Table 4-1 that water strikes/fractures were intersected at depths of between 53 – 60 mbs and 85 – 93 mbs, and the available drawdown value used in the calculations therefore represents the distance between the static groundwater level and deepest fracture position, minus one meter.

If this data is then applied to the FC analysis program, the borehole yield is estimated for four aquifer scenarios, namely:

- An open aquifer system that is not restricted by any boundaries (never found in practice);
- An aquifer bounded by a single no-flow boundary, e.g. an impervious geological structure;
- An aquifer restricted by two no-flow boundaries; and
- A closed aquifer system (absolute worst-case scenario).

Because of the highly heterogeneous nature of the fractured rock aquifer environment, it is recommended that the average yield calculated for the four aquifer scenarios be used. Rates provided in Table 4-3 are indicated as litres per second for a 24-hours pumping cycle. An average groundwater abstraction rate of 1.3 l/s (±112 m^3/d) was estimated for the tested borehole for a 24-hours pumping cycle.

Table 4-3: Estimated borehole yields (l/s)

No boundaries	1 Boundary	2 Boundaries	Closed	Average recommended
2.5	1.3	0.8	0.6	**1.3**

Though the borehole should **theoretically be capable of yielding 1.3 l/s (4 680 l/h) for a 24-hours pumping cycle**, it is not advisable to pump the borehole continuously at a rate higher than the tested rate of 0.3 l/s – because of aquifer heterogeneity and the uncertainty as to how the water level will react. Therefore:

- **It can safely be stated that the borehole can be equipped to pump at 2 000 l/h for limited periods such as for firefighting**.
- **We recommend that the borehole be pumped at a rate of 0.3 l/s to fulfil the regular domestic water requirements.**

4.3.3 RADIUS OF INFLUENCE ESTIMATION

The area that is expected to be affected by the recommended groundwater abstraction is referred to as the “radius of influence” and was estimated using the Cooper Jacob equation. The maximum theoretical radius of influence, when pumping at 0.3 l/s for 24-hours, was estimated to be in the order of 130 m. The estimated radius of influence is presented in Figure 4-7, which also shows the predicted groundwater level drawdown at various distances away from the borehole, e.g.:

Distance from borehole (m)	Estimated drawdown (m)
30	0.8
60	0.4
90	0.2
130	0

4.4 GROUNDWATER QUALITY

Groundwater Complete tested the electrical conductivity (EC) of water from the tested borehole using a handheld EC-meter in the field. This test provides a good indication of the general salinity of the groundwater. Groundwater from the borehole has an EC value of approximately 380 mS/m, which exceeds the maximum value of 170 mS/m allowed in drinking water (SANS 241:2015).

High salinity groundwater close to the coast is a common occurrence, not necessarily because of saltwater intrusion, but rather through the leaching of salts from the unsaturated zone that constantly receives saline ocean water spray. Saltwater intrusion at the position of the borehole is unlikely at the recommended pumping rates since the water table in the borehole is more than 30 m above sea level.

A groundwater sample was collected during the pumping test, which was sent to a SANAS accredited laboratory to be analysed for a wide range of physical and chemical parameters. The results were received on the 6th of May 2024 and are presented in Table 4-4. The test certificate as received from the laboratory is included in Appendix B.

Table 4-4: Results of physical and chemical groundwater analysis

BH	pH	EC mS/m	TDS mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	MALK mg/l	Cl mg/l
SANS 241:2015	*≥ 5 to ≤ 9.7*	*≤ 170*	*≤ 1 200*	*-*	*-*	*≤ 200*	*-*	*-*	*≤ 300*
BH01	7.6	**417.0**	**2333.0**	76.3	68.6	**706.0**	16.2	367.0	**926.0**

BH	SO_4 mg/l	NO_3 mg/l	F mg/l	Al mg/l	Fe mg/l	Mn mg/l	NH_4 mg/l	PO_4 mg/l	Thard mg/l
SANS 241:2015	*≤ 500*	*≤ 11*	*≤ 1.5*	*≤ 0.3*	*≤ 2*	*≤ 0.4*	*≤ 1.5*	*-*	*-*
BH01	226.0	**12.2**	**1.910**	0.007	<0.004	<0.001	0.051	<0.009	473.0

Notes: ***Red*** *= Parameter concentration exceeds drinking water limit (SANS 241:2015)*

No potential sources of groundwater contamination occur nearby, and the groundwater quality measured in April 2024 is therefore representative of the ambient or natural environment. Several analytes/parameters exceed their respective drinking water limits, most notably sodium and chloride (Table 4-4). The aquifer host rock (i.e. quartzitic sandstone) is known for being mostly inert and is not expected to affect or alter the groundwater chemistry quite to such an extent.

Analytical chemical diagrams in the form of Expanded Durov and Stiff diagrams are provided in Figure 4-5 and Figure 4-6 respectively and are widely used to characterise the groundwater chemistry. From these diagrams it is clear that the groundwater chemistry is dominated by sodium cations and chloride anions – the same as for ocean water. As mentioned previously, ocean water spray is believed to be responsible for the high concentrations of sodium and chloride in the groundwater, rather than any surface sources or interaction between the groundwater and aquifer host rock.

The drinking water limits for both nitrate and fluoride were also exceeded due to processes and interactions between the groundwater and natural environment.

Although the groundwater should preferably not be used for drinking water purposes, it is still fully suitable for domestic purposes such as washing, baths/showers and sanitation (toilets) as well as for emergency requirements such as firefighting.

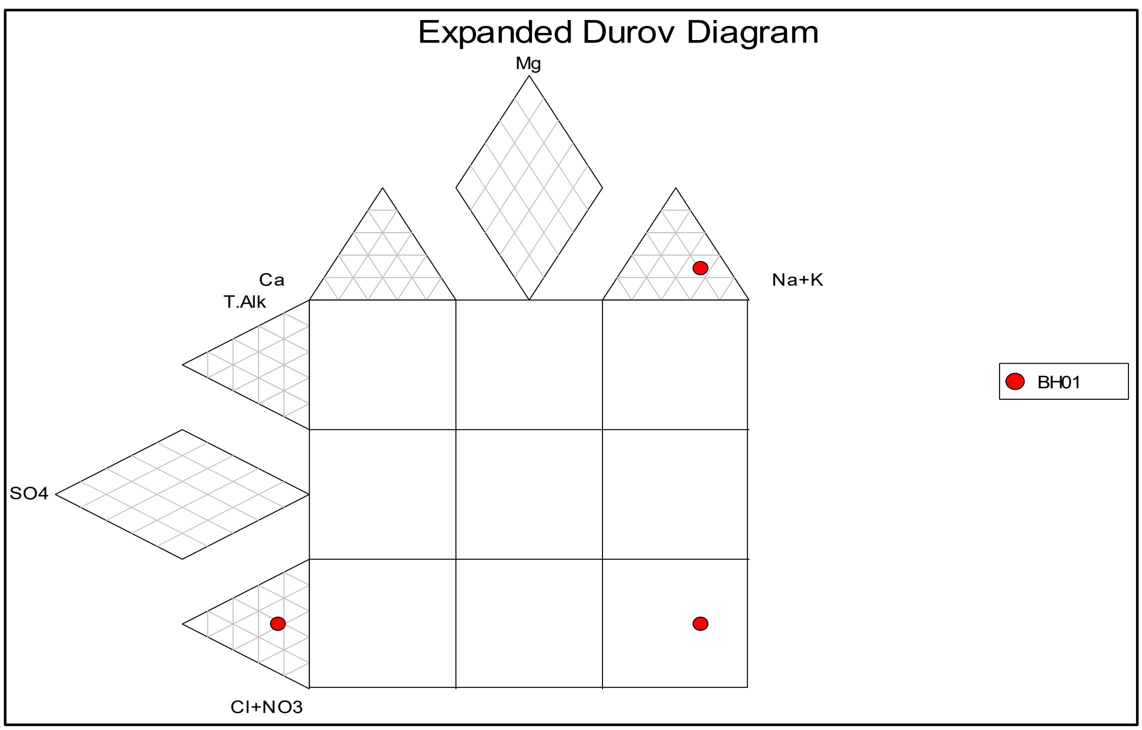

Figure 4-5: Expanded Durov diagram of groundwater chemistry

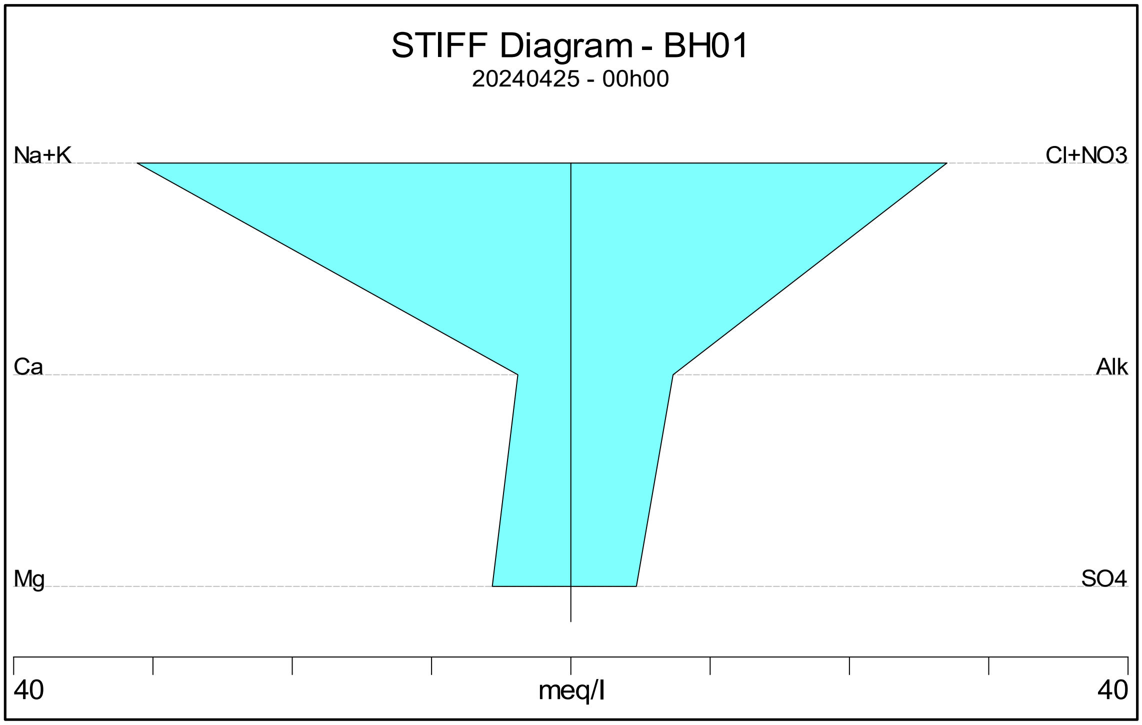

Figure 4-6: Stiff diagram of groundwater chemistry

4.5 GROUNDWATER USES

As mentioned, groundwater will be used for domestic water requirements at the property. The property is situated within a nature reserve in which no extensive gardening or agricultural practices is allowed. Being of too high salinity to use for long-term consumption, groundwater from the borehole will only be used for domestic purposes such as washing, baths/showers and sanitation (toilets), which are by far the highest consumer areas in a household.

The yield from the borehole is deemed more than capable of providing water for the abovementioned purposes.

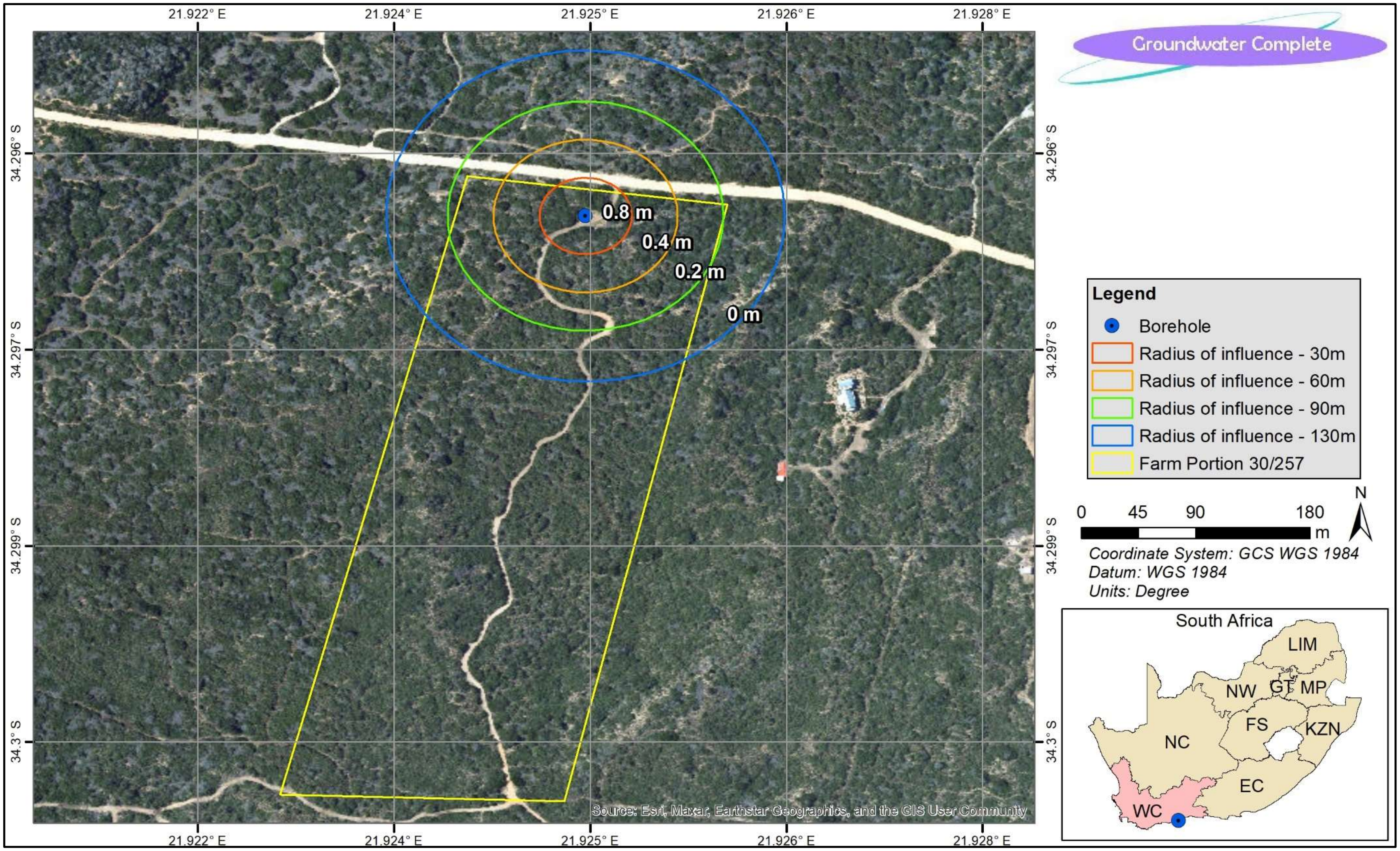

Figure 4-7: Estimated radius of influence and groundwater drawdown

5 AQUIFER CHARACTERISATION

5.1 AQUIFER CLASSIFICATION

Geological maps, borehole drilling results and experience gained from other studies conducted in similar geohydrological environments suggest that the most likely aquifer to exist in this area is a secondary fractured rock aquifer. For the purpose of this study an aquifer is defined as a geological formation or group of formations that can yield groundwater in economically useable quantities. Aquifer classification according to the Parsons Classification system is summarised in Table 5-1.

The secondary fractured rock aquifer system is hosted within the sedimentary rocks of the Cape Supergroup. Groundwater yields, although heterogeneous, generally vary between 0.1 and 0.5 l/s. This aquifer system usually displays semi-confined or confined characteristics with piezometric heads often significantly higher than the water-bearing fracture position. Fractures may occur in any of the co-existing host rocks due to different tectonic, structural and genetic processes. **According to the Parsons Classification system, the aquifer could be regarded as a minor aquifer system, but also a sole aquifer system where users are dependent on groundwater for their livelihood.**

Table 5-1: Parsons Aquifer Classification *(Parsons, 1995)*

Sole Aquifer System	An aquifer that is used to supply 50% or more of domestic water for a given area, and for which there is no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality are immaterial.
Major Aquifer System	Highly permeable formation, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (less than 150 mS/m).
Minor Aquifer System	These can be fractured or potentially fractured rocks that do not have a primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large volumes of water, they are important both for local suppliers and in supplying base flow for rivers.
Non-Aquifer System	These are formations with negligible permeability that are generally regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, groundwater flow through such rocks, although impermeable, does take place, and needs to be considered when assessing the risk associated with persistent pollutants.
Special Aquifer System	An aquifer designated as such by the Minister of Water Affairs, after due process.

5.2 GROUNDWATER VULNERABILITY

The *Groundwater Vulnerability Classification System* used in this study was developed as a first order assessment tool to aid in the determination of an aquifer's vulnerability/susceptibility to groundwater contamination. This system incorporates the well-known and widely used *Parsons Aquifer Classification System* as well as drinking water quality guidelines as stated by the Department of Water and Sanitation. This system is especially useful in situations where limited groundwater related information is available and is explained in Table 5-2 and Table 5-4. The study area achieved a score of 4 (Table 5-3) and the underlying aquifer can therefore be regarded as having a low vulnerability.

Table 5-2: Groundwater vulnerability classification system

Rating	***4***	***3***	***2***	***1***
Depth to groundwater level	0 – 3 m	3 – 6 m	6 – 10 m	>10 m
Groundwater quality *(Domestic WQG*)*	Excellent (TDS < 450 mg/l)	Good (TDS > 450 < 1 000 mg/l)	Marginal (TDS > 1 000 < 2 400 mg/l)	Poor (TDS > 2 400 mg/l)
Aquifer type *(Parsons Aquifer Classification)*	Sole aquifer system	Major aquifer system	Minor aquifer system	Non-aquifer system

** WQG = Water Quality Guideline.*

Table 5-3: Groundwater vulnerability rating for study area

	Rating
Depth to groundwater level	1
Groundwater quality	1
Aquifer type	2
Total score:	**4**

Table 5-4: Explanation of groundwater vulnerability rating

Vulnerability	**Rating**
Low vulnerability	≤ 4
Medium vulnerability	> 4 ≤ 8
High vulnerability	≥ 9

5.3 AQUIFER PROTECTION CLASSIFICATION

In 1995 Roger Parsons prepared a report for the Water Research Commission and the Department of Water and Sanitation titled, "*A South African Aquifer System Management Classification*". Amongst other things, he described how the need or importance to protect groundwater led to the development of a Groundwater Quality Management classification system, or GQM. The level of protection (GQM) depends on the aquifer classification (Section 5.1) and groundwater vulnerability (Section 5.2), which are multiplied to obtain a score of between 0 and 18.

The fractured rock aquifer underlying the study area scored a GQM rating of 2, which means that it requires a low level of protection (Table 5-5).

Table 5-5: Groundwater Quality Management classification rating

Aquifer Classification		Groundwater vulnerability		Misgunst GQM	
Aquifer system	**Points**	**Class**	**Points**	**Index**	**Level of protection**
Sole	6	High	3	<1	Limited
Major	4			1 - 3	Low
Minor	2	Medium	2	3 – 6	Medium
Non-aquifer	0	Low	1	6 – 10	High
Special	0 - 6			>10	Strictly no degradation

6 IMPACT ASSESSMENT

6.1 IMPACTS ON GROUNDWATER QUANTITY

Groundwater will regularly be extracted from the borehole on the property. The pumping test provided an estimated yield for the aquifer system. If the recommended yield is not exceeded, the abstraction should have no lasting adverse impact/s on the groundwater.

6.2 GROUNDWATER MANAGEMENT

The following guidelines can be followed to ensure that the aquifer is not overstressed or abused:

- Use water only at the recommended yield (i.e. abstraction rate) as not to over-exploit or stress the aquifer.
- When the reservoir is full and the water is not being used, switch off the pump and let the water level recover.
- Fit the borehole with an appropriately sized pump. Solar pumps are usually low yielding pumps, which will work well with the low pumping rate recommended for the borehole.
- Fit the reservoir with a level switch to stop pumping when the reservoir reaches a certain level.

6.3 SUMMARY

Impacts on the groundwater quantity are expected to be negligible due to the low pumping rate recommended for the borehole.

7 CONCLUSIONS AND RECOMMENDATIONS

The geohydrological environment can be summarised as follows:

- The proposed water use is mainly domestic and only for a single household. An average volume of **1 500 l/d** is required for this purpose, while the Fransmanshoek Conservancy requires an additional **50 000 l** to be stored on the property for firefighting. This water use is classified by the DWS as Schedule 1, for which no formal registration or licensing is required.
- The northern and southern borders of the property are respectively ±400 and 700 m away from the high-water mark, with surface elevations on the property varying from approximately 75 to 90 mamsl.
- The property is situated within a predominantly winter rainfall region that receives ±60% of its annual rainfall during the autumn and winter months from March to August. The average rainfall for the larger study area was calculated to be in the order of 450 mm/a, while the evaporation is ±1 860 mm/a.
- Groundwater recharge in the property area underlain by dune sand is expected to be in the region of 25% of the MAP or 112,5 mm/a.
- The annual volume of recharge to the property area alone is estimated to be approximately 9 700 m^3/a. The intended groundwater abstraction is approximately 1.5 m^3/day (±550 m^3/a), which represents approximately 6% of the recharge to the property.
- The entire surface of the property area is covered by coastal dune sand, followed by quartzitic sandstone of the Skurweberg Formation, Cape Supergroup.
- The static groundwater level depth measured at the position of the tested borehole is 51.6 mbs.
- Analysis of the pumping test data determined that the transmissivity around the borehole is approximately 7.4 m^2/d.
- Though the borehole should **theoretically be capable of yielding 1.3 l/s (4 680 l/h) for a 24-hours pumping cycle**, it is not advisable to pump the borehole continuously at a rate higher than the tested rate of 0.3 l/s – because of aquifer heterogeneity and the uncertainty as to how the water level will react. Therefore:
    - **It can safely be stated that the borehole can be equipped to pump at 2 000 l/h for limited periods such as for firefighting**.
    - **We recommend that the borehole be pumped at a rate of 0.3 l/s to fulfil the regular domestic water requirements.**
- The maximum theoretical radius of influence, when pumping at 0.3 l/s for 24-hours, was estimated to be in the order of 130 m.
- Groundwater from the borehole has an EC value of approximately 382 mS/m, which exceeds the maximum value of 170 mS/m allowed in drinking water (SANS 241:2015).

- Being of too high salinity to use for long-term consumption, groundwater from the borehole will only be used for domestic purposes such as washing, baths/showers and sanitation (toilets), which are by far the highest consumer areas in a household.

Based on the results of a short duration pumping test that was conducted, the borehole is more than capable of fulfilling the domestic water requirements. Furthermore, the basic groundwater impact assessment concluded that impacts from the proposed groundwater abstraction on potential nearby users are expected to be negligible. Groundwater Complete therefore has no objection against the proposed groundwater abstraction.

8 REFERENCES

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9 APPENDIX A: FIELD PHOTOGRAPHS

Photo 1: One-meter interval drill chips displayed by drilling contractor

Photo 2: Pumping test conducted on 25 April 2024

10 APPENDIX B: GROUNDWATER ANALYSIS CERTIFICATE

aquatico Laboratories (Pty). Ltd.

ilac-MRA sanas Testing Laboratory T0685

Test Report **Page 1 of 1**

Client:	Groundwater Complete	**Date of report:**	06 May 2024
Address:	Plot 9, Riversdale , 6670	**Date accepted:**	30 April 2024
Report no:	183625	**Date completed:**	06 May 2024
Project:	Plot 30	**Date received:**	30 April 2024

Lab no:					70928
Date sampled:					25-Apr-24
Aquatico sampled:					No
Sample type:					Water
Locality description:					FBH1
		Analyses	**Unit**	**Method**	
A	AQL	pH @ 25°C	pH	ALM 20	7.56
A	AQL	Electrical conductivity (EC) @ 25°C	mS/m	ALM 20	417
A	AQL	Total dissolved solids (TDS)	mg/l	ALM 26	2333
A	AQL	Total Alkalinity	mg $CaCO_3$/l	ALM 01	367
A	AQL	Chloride (Cl)	mg/l	ALM 02	926
A	AQL	Sulphate (SO_4)	mg/l	ALM 03	226
A	AQL	Nitrate (NO_3) as N	mg/l	ALM 06	12.2
A	AQL	Total oxidised nitrogen as N	mg/l	ALM 06	12.2
A	AQL	Ammonium (NH_4) as N	mg/l	ALM 05	0.051
A	AQL	Orthophosphate (PO_4) as P	mg/l	ALM 12	<0.009
A	AQL	Fluoride (F)	mg/l	ALM 08	1.91
A	AQL	Calcium (Ca)	mg/l	ALM 30	76.3
A	AQL	Magnesium (Mg)	mg/l	ALM 30	68.6
A	AQL	Sodium (Na)	mg/l	ALM 30	706
A	AQL	Potassium (K)	mg/l	ALM 30	16.2
A	AQL	Aluminium (Al)	mg/l	ALM 31	0.007
A	AQL	Iron (Fe)	mg/l	ALM 31	<0.004
A	AQL	Manganese (Mn)	mg/l	ALM 31	<0.001
A	AQL	Total hardness	mg $CaCO_3$/l	ALM 26	473

A = Accredited N = Non accredited Sub = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternative test report ; Results relate only to the items received and tested ; Results reported against the limit of detection; Results marked 'Non SANAS Accredited' in this report are not included in the SANAS Schedule of Accreditation for this laboratory; Uncertainty of measurement available on request for all methods included in the SANAS Schedule of Accreditation; The report shall not be reproduced except in full without approval of the laboratory

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Director Laboratory Services

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