Black Mountain Mining Prospecting Rights Application:

Geohydrological Specialist Study:

GROOT KOLK AREA

Report Prepared for

EIMS ENVIRONMENTAL IMPACT MANAGEMENT SERVICES

Report Number 549553/GROOT KOLK

Report Prepared by

srk consulting

July 2019

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EIMS

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SRK Project Number 549553/GROOT KOLK

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Executive Summary

Environmental Impact Management Services (Proprietary) Limited (EIMS) appointed SRK Consulting (South Africa) (Pty) Ltd (SRK) to undertake a Geohydrological Desktop Specialist study as part of a basic assessment report (BAR) in support of a Mining Prospecting Rights Application.

Summary of principal objectives

The aim of this assessment is to assess the baseline groundwater conditions for the aquifer system/s within the Groot Kolk Area and to highlight possible risks to the groundwater environment accordingly (from a desktop perspective). The scope of work comprises a desk study in which potentially sensitive geohydrological features are highlighted, to investigate the potential impact on these (if any) and to develop management plans to prevent / mitigate any potential impacts.

Outline of work programme

EIMS appointed SRK on 12 June 2019 to conduct a desktop geohydrological assessment on five areas where exploration drilling is planned. The Groot Kolk Area, the focus of this report, is one of the five areas.

Focus on results

From the desktop study and information provided to SRK, by EIMS, the following are concluded for the Groot Kolk Area:

- Although the majority of the area is classed as a Minor Aquifer System with variable water quality and low expected yields, there are existing groundwater users for which boreholes could be the only water source. It is therefore critical that existing groundwater users be taken into account and that their boreholes are not negatively affected in any way.
- Any negative impact on groundwater and/or groundwater users, whether factual or perceived (complaints from surrounding borehole users) can have a significant financial and reputational impact on the exploration programme and subsequent mining.
- It is not possible to accurately predict the aquifers that will be penetrated when drilling 400 m or more and it is therefore important that support by a geohydrologist is provided before and during the drilling activities.
- Due to the lack of available information, such as hydrocensus information, exact drilling positions, drilling depths and drilling processes, only a basic sensitivity map could be compiled at this stage, incorporating areas covered by quaternary deposits (e.g. sands) and surface water / pans. This information was taken from available geological and topographical maps.

Potential impacts have been identified as:

- Degradation of aquifers;
- Impacts on existing groundwater users; and
- Impacts on surface water features (e.g. streams, rivers, wetlands, saltpans) – which may be recharged by groundwater.

Proposed mitigation measures include:

- Detailed hydrocensus (to include surface water features);

- Once the exact drilling positions are known and the hydrocensus completed, the geohydrological report must be updated and must include an assessment of potential aquifers that could be penetrated by the drilling and whether mixing the water of these aquifers can lead to degradation of any of the aquifers penetrated.

Assumptions, uncertainties and gaps in knowledge

Assumptions: SRK assumes that the main purpose of this desktop study is to provide a broad overview of what has been documented for this specific area in terms of the geohydrology. SRK further assumed that the planned exploration has not yet been publicised or discussed with the local municipalities, local farming unions, or any other private or public sector body. SRK therefore did not make contact with any private or public body in terms of the gathering of site specific data. SRK further assumes that a public participation process will be followed whereby existing groundwater users will be consulted.

Limitations: The potential impacts of any drilling activity on the groundwater regime will vary from site to site, even over short distances due to changes in geology and receptors. As no recent hydrocensus across the entire exploration area has been conducted, SRK did not have access to, for example, positions of existing boreholes, dependency on groundwater, specific water quality, depth to groundwater levels and borehole depths. The sensitivity map and groundwater management plan, as presented in this report, must be seen as working documents that must be improved as more information becomes available.

Gaps: Based on the information presented to SRK, by EIMS, the following information gaps have been identified:

- Exact drilling positions and drilling depths;
- On-site storage and handling of any potentially hazardous materials / substances on the drilling site, e.g. fuels (diesel, petrol, paraffin, etc.), oils and cleaning chemicals;
- Detailed hydrocensus within the areas where exploration drilling will take place – the hydrocensus must be completed by a geohydrologist / geohydrological technician who has experience in the collection of geosite data, as prescribed by the Department of Human Settlement, Water and Sanitation (DHSWS).
- Detailed scientific reports (geological and geohydrological) of the exploration area (if any) – sourcing these reports will require open conversations with private and public bodies, in which the purpose of the exploration programme and exploration areas will have to be revealed.

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Disclaimer

The opinions expressed in this Report have been based on the information obtained by SRK Consulting (South Africa) (Pty) Ltd (SRK) from various sources such as the Department of Human Settlement, Water and Sanitation (DHSWS), the National Groundwater Archive (NGA) and others listed under References. SRK has exercised due care in reviewing the obtained information. Whilst SRK has compared the available data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the available data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

List of Abbreviations

DWS	-	Department of Water and Sanitation (before 30 May 2019)
DHSWS	-	Department of Human Settlement, Water and Sanitation (after 30 May 2019)
NEMA	–	National Environmental Management Act
NWA	–	National Water Act
MPRDA		Mineral and Petroleum Resources Development Act
WMA		Water Management Area
EWR	-	Ecological Water Requirements
GRU	-	Groundwater Resource Units
GIA	-	Groundwater Impact Assessment
BAR	-	Basic Assessment Report
EMPR	-	Environmental Management Program
EIA	-	Environmental Impact Assessment
GRA2	-	Groundwater Resource Assessment Phase 2
AGEP	-	Average Groundwater Exploitation Potential
SANS	-	South African National Standard
NGA	-	National Groundwater Archive
m amsl	-	metres above mean sea level
m bgl	-	metres below ground level
L/s	-	litres per second
mg/L	-	milligrams per litre
EC	-	Electrical Conductivity
GPS	-	Global Positioning System
GIS	-	Geographic Information Systems

1 Introduction

Environmental Impact Management Services (Proprietary) Limited (EIMS) appointed SRK Consulting (South Africa) (Pty) Ltd (SRK) to undertake a Geohydrological Desktop Study as part of a basic assessment report (BAR) in support of a Mining Prospecting Rights Application, GROOT KOLK AREA.

1.1 Scope of Work and Terms of Reference

The aim of this assessment was to assess the baseline groundwater conditions for the aquifer system/s within the Groot Kolk Area and to supply an indication of possible risks to the groundwater environment accordingly. The scope of work comprises a desk study in which potentially sensitive geohydrological features are highlighted, to investigate the potential impact on these (if any) and to develop management plans to prevent / mitigate any potential impacts. No fieldwork or site visit(s) were to be undertaken.

1.2 Legislative and Policy Framework

As per EIMS's request, the geohydrological desktop study is to satisfy the requirements of the NEMA EIA Regulations and the NWA WUL Applications, as well as the relevant MPRDA regulations. The **NWA**, Chapter 3, Part 4 states the following "*The person who owns, controls, occupies or uses the land in question is responsible for taking measures to prevent pollution of water resources*". This includes groundwater. The **MPRDA**, Part IV: Pollution Control and Waste Management Regulation states that the groundwater investigations may include an assessment of "(*iv) the vulnerability and existing potential use of the groundwater resource within the zone that could potentially be affected by the residue facility".* In terms of this report (focussing only on exploration and not mining itself) SRK will replace the term "residue facility" with "exploration activities".

1.3 Statement of SRK Independence

Neither SRK nor any of the authors of this Report have any material present or contingent interest in the outcome of this Report, nor do they have any pecuniary or other interest that could be reasonably regarded as being capable of affecting their independence or that of SRK. SRK has no beneficial interest in the outcome of the assessment which is capable of affecting its independence.

1.4 Summary of Specialist Expertise

Gert Nel is a partner in SRK, qualified **Principal Geohydrologist** and registered Professional Natural Scientist **(Pr. Sci. Nat.)** with over 26 years' of experience in the water and waste fields. Gert started off the first eight years of his career with the South African Department of Water Affairs (DWA) and was involved in geohydrological mapping, water supply and the permitting of solid waste facilities. He then joined the private sector where he continued his involvement in the water and waste fields, but also conducted geohydrological risk assessments for private industries and mines.

Eunice Goossens is a **Principal Hydrogeologist**, registered as a Professional Natural Scientist **(Pr. Sci. Nat.)**. Eunice has 20 years' experience in geohydrological investigations, and started her career at Department of Water Affairs (DWA) and was involved in groundwater supply investigation as well as geohydrological research projects. She joined the private sector and continued her career in groundwater management, groundwater resource development and evaluation, Geophysical investigations, Sanitation Groundwater Protocol Application, Groundwater database management and processing, GIS applications / mapping and Landsat & Aerial photo Interpretation.

Connan Hempel is a **Senior Geologist** and registered Professional Natural Scientist (**Pr. Sci. Nat**.) with over 20 years' experience in academic training, mining and exploration. Connan started the first ten years of his career as a Geology Lecturer at the Nelson Mandela Metropolitan University Department of Geosciences. He later joined Anglo American where he worked as a Senior Production Geologist. Prior to joining SRK Consulting, he also worked for Elitheni Coal as a Senior Exploration & Mining Geologist.

2 Project Work

2.1 Topographical Information

The topography of the Groot Kolk Area is depicted in **Map 1**, **Appendix 1**. The area is located approximately 50 kilometres west of the town of Kenhardt, Northern Cape, South Africa. It covers seven farms, over an area of 30 150.5 Ha (301.51 km^2). Surface drainage is towards the north-east with altitudes around 900 m amsl in the south-west and west, lowering to 860 m amsl in the north-east. Multiple non-perennial streams originate in the area flowing north-east, joining the perennial Tuinsrivier.

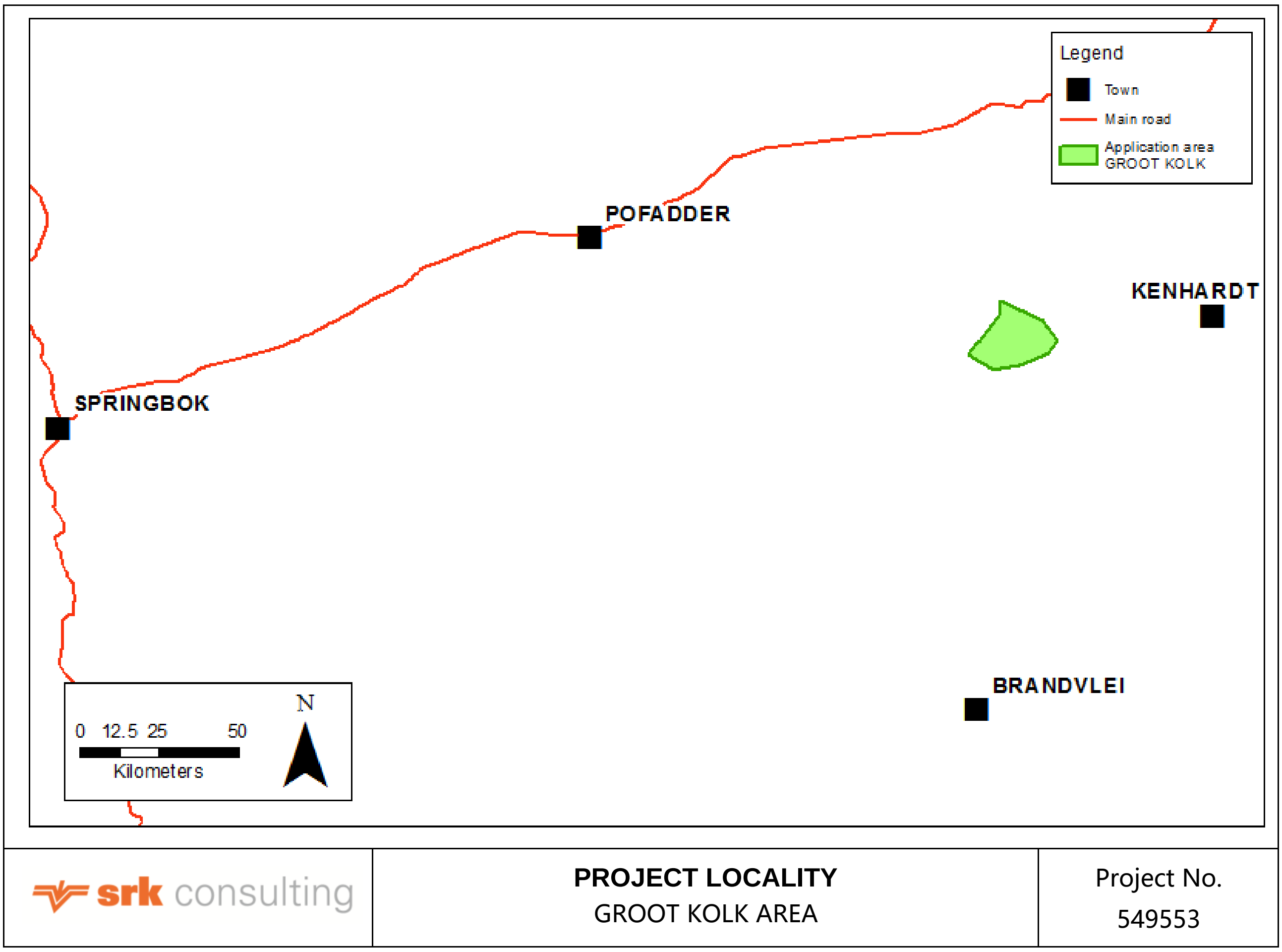

Figure 2-1: Project Locality

2.2 Geology

The terrain consists of flat lying plains with Cenozoic and Karoo-aged sediments overlying Namaquan granite gneiss and meta sediments. The majority of the Groot Kolk area comprises diamictite, tillite, subordinate sandstone, mudstone and dolomitic limestone of the Dwyka Group. Sand, red brown sandy soil and alluvium (along drainages) occur in the northern and north-eastern parts. Two fault zones are mapped in the north-eastern parts of the area, striking east-west. Refer to **Map 2** in **Appendix 1**.

2.3 Hydrogeology

The following key information sources were consulted:

- Vegter, J.R., Seymour A., 1995. Groundwater Resources of the Republic of South Africa – Two Map sheets and explanatory brochure. DWAF).
- Parsons, R., Conrad, J., WRC Report No KV 116/98, "Explanatory Notes for the Aquifer Classification Map of South Africa".
- Groundwater Resource Assessment Phase 2 (GRA 2), DWS, 2003
- Department of Water and Sanitation, South Africa, October 2016. Determination of Ecological Water Requirements for Surface water and Groundwater in the Lower Orange WMA. Groundwater EWR report.
- Department of Water Affairs and Forestry. Hydrogeological Map Series of the Republic of South Africa. Completed in 2002".

According to Vegter and Seymore (1995), the majority of the area can be considered having a low groundwater potential of 10 – 20%. These percentages indicate the probability of drilling a successful borehole (yield > 2 L/s). According to the GRA 2, the expected average groundwater exploitation potential (AGEP) in the Groot Kolk area is < 2500 m^3/km^2/annum.

Based on the Aquifer Classification Map (Vegter), the area is classified a Minor Aquifer Region, with moderately yielding aquifers of variable water quality.

The Groot Kolk Area falls entirely within the Lower Orange WMA (see Figure 2-2). The EWR report of 2016 covers the Lower Orange WMA and from this report the following information is deemed relevant to the Groot Kolk Area:

- The Groot Kolk Area have an estimated 30 – 60 % dependency of groundwater (i.e. domestic use, irrigation, stock watering, bulk supply, mining).
- Groot Kolk Area falls within the D53D Quaternary Catchments and can, according to the EWR report, described as "metamorphic terrain with poor groundwater quality".

Refer to **Figure 2-2** (the insert) for the positioning of the Groot Kolk Area relevant to the quaternary catchments. The expected electrical conductivity (EC) of the area is 300 – 1000 mS/m, but improves towards the north-eastern parts with expected ECs in the range 70 – 300 mS/m. **Map 3a** in **Appendix 1** shows the expected EC's for the area.

2.3.1 Groundwater Flow Directions

In the absence of field measurements (water level data) and accurate elevations of boreholes, no accurate groundwater contour map can be compiled. If one assumes that the groundwater table will follow the topography and surface drainage directions, then the inferred groundwater flow is depicted in **Map 3b**, **Appendix 1**.

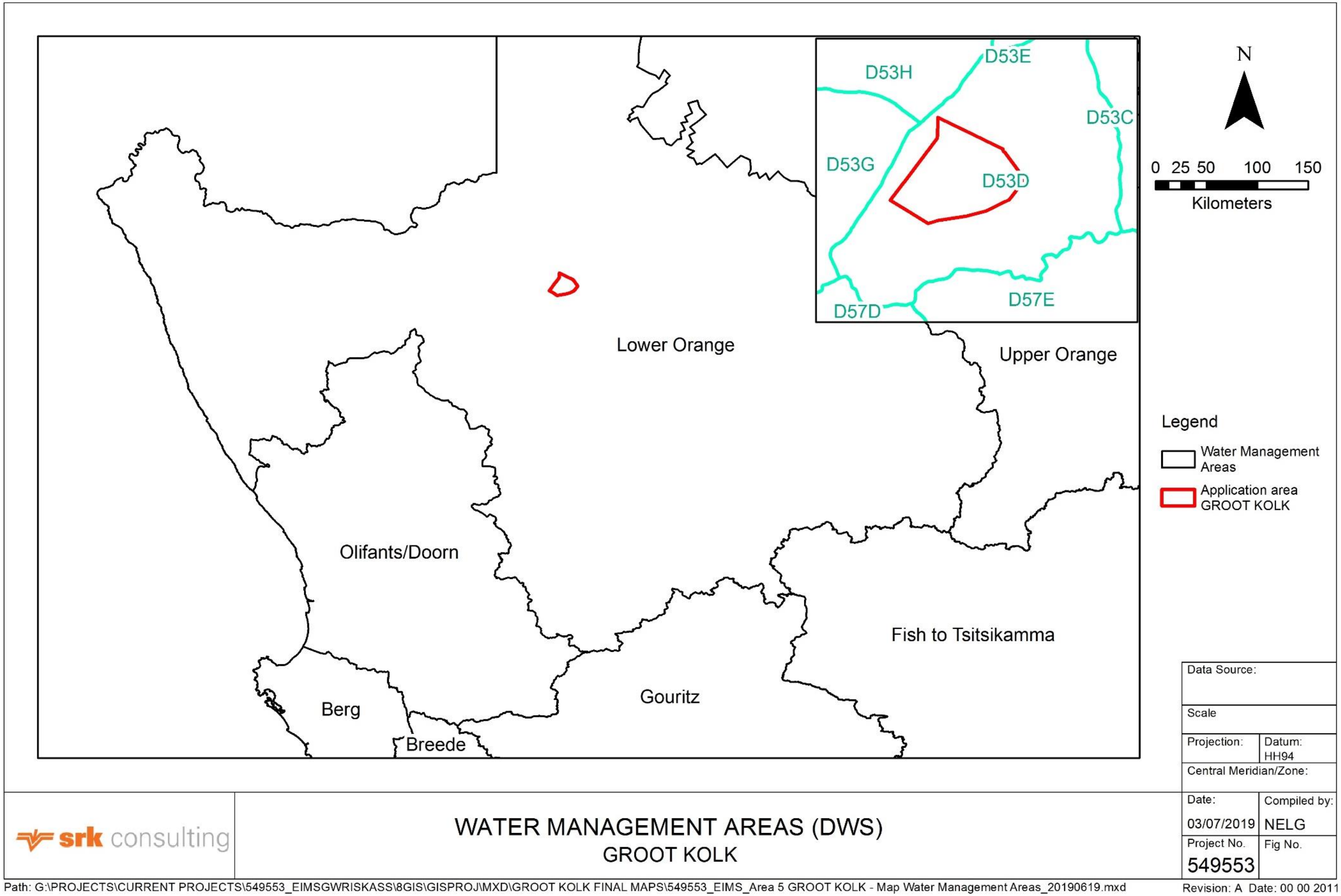

Figure 2-2: Water Management Areas (as per the DWS classification) – Quaternary Catchments inclusion

2.4 Receiving Environment

For the purpose of the geohydrological desktop assessment, and considering that no fieldwork has been conducted, the receiving environment of the Groot Kolk Area is considered to be:

- Existing groundwater users (via boreholes and springs, where applicable);
- Future groundwater users (via boreholes and springs, where applicable); and
- Groundwater, as a natural resource that falls under the protection of the National Water Act.

In the absence of sufficient data, aspects relating to groundwater recharge have not been taken into account. These include:

- Natural groundwater recharge areas (groundwater catchments); and
- Areas where managed aquifer recharge (artificial recharge) could be considered.

Due to insufficient data, the following receiving environments have also been excluded:

- Wetlands (if there are any in the area) that are groundwater fed - not all wetlands are partially or fully dependent on groundwater for sustainability, but due consideration must be given when boreholes are drilled within 500 m of a wetland, regardless whether the boreholes are for exploration, monitoring or water supply.

- Streams or rivers that are dependent on groundwater inflow – in many cases the base of streams and rivers sits below the groundwater table and are therefore experiencing lateral recharge from groundwater. Groundwater can therefore sustain the baseflow of a river or stream in cases where the water table (or perched water level) is located higher (in terms of elevation, i.e. metres above sea level) than the base of the river or stream.

Information provided to SRK, by EIMS, indicates that the farms listed in **Table 2-1** will be targeted for the exploration programme (Ref: Black Mountain Prospecting Work Programme).

Table 2-1: List of Properties that form part of the planned Exploration

Nr.	Registered Land Description	Magisterial District	Extent (Ha)	Title Deed/Diagram Deed	SG Code
1	Farm De Tuin Noord 161 Portion 0 RE	Kenhardt Rd	3316,574775	T57793/2016CTN	C03600000000016100000
2	Farm De Tuin Noord 161 Portion 4	Kenhardt Rd	3322,791447	T57792/2016CTN	C03600000000016100004
3	Farm De Tuin Zuid 163 Portion 0 RE	Kenhardt Rd	3471,292509	T24554/1971CTN	C03600000000016300000
4	Farm Groot Kolk 190 Portion 0 RE	Kenhardt Rd	4565,285821	T67338/2007CTN	C03600000000019000000
5	Farm Groot Kolk 190 Portion 1	Kenhardt Rd	4629,074162	T55618/1996	C03600000000019000001
6	Farm Annex Groot Kolk 191 Portion 0 RE	Kenhardt Rd	5322,130701	T1681/1987CTN	C03600000000019100000
7	Farm Annex Groot Kolk 191 Portion 1	Kenhardt Rd	5523,361777	T23349/1986	C03600000000019100001
	TOTAL AREA (HA)		**30 150,5**		

2.4.1 Existing Groundwater Users

To capture all existing groundwater users a hydrocensus[1] will be required. The National Groundwater Archive (NGA) data for this specific area is outdated and the data can therefore not be used to accurately determine how many existing groundwater users there are, and what the water is used for.

Existing borehole information

A data search on the NGA[2] revealed 42 existing boreholes, of which:

- 13 boreholes had water level data – the average groundwater level was 21.56 m bgl[3];
- 13 boreholes had recorded yields - the average yield being 2.42 L/s and the maximum recorded yield 11.36 L/s;
- 42 boreholes had recorded boreholes depths – the average depth being 56 m bgl and the deepest 96 m bgl (refer to **Map 4** for a plot of the NGA dataset); and
- 13 boreholes had recorded water strike depths – the average strike depth being 35 m bgl and the maximum strike depth 61 m bgl.

The data that was obtained from the NGA however dates back to 1944, with the most recent data being from 1984. Although this data provides some information on the use of groundwater at the time, it does not necessarily reflect the current number of boreholes and current use. As GPS (Global Positioning System) technology was not readily available prior to the 1980's the coordinates of the boreholes are not deemed very accurate and would have to be field-verified. This information will have to be obtained by means of a hydrocensus across the entire area. Error! Not a valid bookmark self-reference. provides the borehole information as recorded on the NGA. A plot of the **NGA data** is presented by **Map 4**, **Appendix 1**.

Table 2-2: NGA Dataset

Site ID No.	Other No.	Latitude	Longitude	Date established	Depth [m bgl]	Groundwater level [m bgl]	Reported Yield [L/s]	Waterstrike depth [m bgl]
2920BC00054	110253	-29.48649	20.58953	22-Jun-71	60.96			
2920BC00052	110254	-29.48648	20.58953	24-Jun-71	61.26			
2920BC00050	142930/4	-29.48647	20.58953	23-May-83	57			
2920BC00048	142928/1	-29.48646	20.58953	18-May-83	41			
2920BC00049	142929/9	-29.48646	20.58954	19-May-83	36			
2920BC00051	142931/2	-29.48646	20.58955	24-May-83	54			
2920BC00053	110255	-29.48646	20.58956	25-Jun-71	46.02	22.55	0.43	41.15
2920BC00055	119110/5	-29.48646	20.58957	07-Feb-74	46	5.00	0.12	15
2920BC00011	144570/8	-29.46704	20.63259		72			
2920BC00009	144571/6	-29.46703	20.63259		66			
2920BC00008	144568/5	-29.46702	20.63259		96			
2920BC00010	144569/3	-29.46702	20.63260		96			
2920BC00013	144549/9	-29.46702	20.63261	20-Jun-84	46	6.60	2.33	38
2920BC00017	120280/9	-29.45037	20.61593	06-Feb-75	45.7			
2920BC00015	120283/3	-29.45036	20.61593	12-Feb-75	40.8			
2920BC00014	120284/1	-29.45035	20.61593	13-Feb-75	47.3	24.70	4.39	39.6
2920BC00016	120282/5	-29.45035	20.61594	10-Feb-75	77.4			
2920BC00012	144548/1	-29.45035	20.64926	18-Jun-84	46	10.00	6.40	30
2920BC00021	31150	-29.42676	20.54926	16-Sep-44	48.76			
2920BC00019	31283	-29.42675	20.54926	21-Oct-44	23.77			
2920BC00018	31245	-29.42674	20.54926	10-Oct-44	36.57			
2920BC00020	31284	-29.42674	20.54927	14-Dec-44	50.59			

[1] Hydrocensus – field survey to capture all existing boreholes, springs and dugholes.
[2] Maintained by the DHSWS
[3] Bgl = below ground level

Site ID No.	Other No.	Latitude	Longitude	Date established	Depth [m bgl]	Groundwater level [m bgl]	Reported Yield [L/s]	Waterstrike depth [m bgl]
2920BC00022	31200	-29.42674	20.54928	20-Sep-44	70.1			
2920BC00026	119158/7	-29.38368	20.61593	20-May-74	65			
2920BC00061	83892	-29.37813	20.67732	17-Oct-62	35.05	13.72	1.42	25.3
2920BC00060	87986	-29.36704	20.66593	20-Jun-64	90.22	35.66	0.13	45.11
2920BC00058	31273	-29.36703	20.66593	18-Jan-45	79.55	36.57	0.11	60.96
2920BC00056	105110	-29.36702	20.66593	25-Jun-69	52.42			
2920BC00057		-29.36702	20.66594	05-Feb-45	44.19	9.14	0.23	13.71
2920BC00059	105357	-29.36702	20.66595	20-Oct-67	63.7	39.62	2.13	46.32
2920BC00038	119154/5	-29.35874	20.63259	16-May-74	41	27.00	0.22	30
2920BC00036	119169/2	-29.35873	20.63259	19-Jun-74	67			
2920BC00034	119165/0	-29.35872	20.63259	13-Jun-74	74			
2920BC00032	119162/6	-29.35871	20.63259	30-May-74	37			
2920BC00030	119160/0	-29.35870	20.63259	27-May-74	53			
2920BC00028	119151/1	-29.35869	20.63259	07-May-74	59			
2920BC00027	123684/0	-29.35868	20.63259	25-May-76	60			
2920BC00029	119153/7	-29.35868	20.63260	14-May-74	77			
2920BC00031	119161/8	-29.35868	20.63261	28-May-74	31			
2920BC00033	119164/2	-29.35868	20.63262	07-Jun-74	77			
2920BC00035	84073	-29.35868	20.63263	28-Nov-62	60.96	36.57	2.13	48.76
2920BC00037	123687/4	-29.35868	20.63264	22-Jun-76	30	13.10	11.36	23.6

2.4.2 Future Groundwater Users

The drivers for future groundwater development usually include the following:

- Existing boreholes that dry up;
- Increase in groundwater demand (e.g. population growth, economic growth, agricultural growth);
- Insecurity of bulk water supplies;
- Surface water shortages (as result of global warming, increased demand); and
- Prolonged droughts.

From a desktop study it is not possible to determine the future demand on groundwater, as the existing use and growth factors have to be taken into account.

2.4.3 Groundwater as Natural Resource

Groundwater falls under the protection of the National Water Act, and may not be polluted.

2.5 Consideration of related/significant aspect management plans in the area

SRK is not aware of any specific aspect management plans in the Groot Kolk Area, besides the regulations previously discussed.

2.6 Spatial Sensitivity Mapping

According to UNEP-WCMC. (2018),

Sensitivity mapping provides a visual representation of risks, and assets which may be exposed to them. Multiple environmental sensitivity mapping approaches exist, with methods and uses varying based on stakeholders' values, drivers of change, data availability, and the technical capacity of the users. Sensitivity mapping is often carried out using geographic information systems (GIS) technology. The amount and/or type of data used to produce a sensitivity map will affect and limit its potential uses. Nevertheless, environmental sensitivity mapping can have a wide variety of applications. These include but are not limited to:

- *Helping decision-makers understand where protection of valuable environmental assets is needed, which could aid the development of protected area networks;*
- *Informing governmental and private sector spatial planning at the project level, targeting activities to the locations where they will have the lowest impact;*
- *Supporting all stages of impact management, including prevention, mitigation, preparedness, operations, relief, recovery and integration of lessons learned;*
- *Aiding situational awareness and response strategy development for responders and decision makers during an incident.*

In the case of the Groot Kolk Area and in order to create a spatial sensitive map, the following are deemed of key importance:

- Exploration methods:
  - Drilling positions and drilling methods;
  - The processes that will be followed during the exploration phase; and
  - Implementation and auditing of the groundwater management plan.
- Receiving environment (for the purpose of this report, specifically groundwater):
  - Areas overlain with sand / alluvial deposits (quarternary deposits) – these are highly permeable and contamination may migrate rapidly[4] towards groundwater and surface water;
  - Fault zones – these could constitute major aquifer systems; and
  - Proximity of surface water features such as wetlands, streams, rivers and earth dams.

<u>Drilling Positions, Drilling depths and Exploration Processes</u>

Exact drilling positions: According to Black Mountain: "*it is not possible to give details of the drilling program before the surveys and surface work phase 1 is completed. The targeting of all drilling activities will be dependent on the results obtained during the preceding phases of prospecting, namely the geological mapping and geophysical surveying and as such it is currently not possible to include a finalized surface plan showing the intended location, extent and depth of boreholes to be completed."*

Drilling depths and drilling methods: According to Black Mountain*: The initial planned invasive exploration activities will consist of diamond drill boreholes drilled <u>to appropriate depths</u> to target any anomalies identified during Phases 2 & 3 of the non-invasive portion of the prospecting work plan. Percussion Rotary Air Blast (RAB) or Reverse Circulation (RC) drilling <u>may be carried out</u> for pre-collaring of diamond drill boreholes or for obtaining samples if significant depth of cover is encountered over particular targets. No bulk sampling work is to be carried out during this prospecting program.*

According to Black Mountain, the planned phases detailed in **Table 2-3** below will be used to investigate the prospecting area.

[4] The migration of a pollution plume is dependent on (1) the viscosity of the pollutant, (2) pathway medium, (3) the volume of pollutant and (4) hydraulic head.

Table 2-3: Planned Activities for the Exploration

Phase	Activity (what are the activities that are planned to achieve optimal prospecting)	Skill(s) required (refers to the competent personnel that will be employed to achieve the required results)	Timeframe (in months) for the activity)
1	**Non-Invasive Prospecting** Desktop Study: Literature Survey / Review	Geologist	Month 1-12
2	**Non-Invasive Prospecting** Regional Airborne Geophysical Survey	Geophysicist / Geologist / field crew	Month 6-12
3	**Non-Invasive Prospecting** Ground Geophysical Survey and Geological Field Mapping	Geologist & field crew	Month 12-24
4	**Invasive Prospecting** Exploration Boreholes (6 RAB holes – 2400m; 4 DD holes – 2000m)	Geologist / drill rig team / field crew / laboratory technicians	Month 24-34
5	**Non-Invasive Prospecting** Compilation, interpretation and modeling of data	Geologist / Geophysicist	Month 34-36
6	**Non-Invasive Prospecting** Detailed Ground Geophysical Survey on individual positively mineralized targets to define possible extent	Geophysicist / Geologist / field crew	Month 36-42
7	**Invasive Prospecting** Boreholes to confirm continuity of mineralization & potential deposit size (20 DD holes – 8000m)	Geologist / drill rig team / field crew / laboratory technicians	Month 42-48
8	**Invasive Prospecting** Resource definition drilling (40 DD holes – 16000m)	Geologist / drill rig team / field crew / laboratory technicians	Month 48-60
9	**Non-Invasive Prospecting** Analytical Desktop Pre-Feasibility Study	Economic Geologist / Mining Geologist	Month 54-60

From the available information gathered during SRK's desktop assessment of the geology, geohydrology, NGA data and information provided by EIMS, the potentially **groundwater sensitive** areas have been restricted to:

- Areas covered by quaternary deposits (e.g. alluvial sands);
- Faults; and
- Existing boreholes.

Other sensitive areas that can be linked to groundwater include:

- Surface water features (e.g. rivers); and
- Salt Pans

The sensitivity map for the Groot Kolk Area is shown in **Appendix 1**, **Map 5** and shows the areas that have been mapped on the geological map series as quaternary deposits. Mapped rivers and saltpans are also shown. A buffer zone of 150 m from mapped rivers / streams is also drawn. The distance of 150 m has been taken from the DWS document "Groundwater Protocol for the Protection of Aquifers from On-site Sanitation". Although the current exploration activities do not involve the installation of on-site sanitation systems, in SRK's professional opinion, the protocol guidelines can be applied for this project[5].

A hydrocensus of the targeted areas (farms) will provide key information pertaining to specific areas where existing boreholes, springs, rivers, streams and wetlands (groundwater fed) are situated. The spatial sensitivity map can then be updated.

2.7 Identification, description and assessment of potential impacts

From Table 2-3, the "invasive Prospecting" works (Phases 4, 7 and 8) will include Diamond Drilling with possible Percussion Rotary Air Blast (RAB) or Reverse Circulation (RC) for pre-collaring of diamond drill boreholes.

Aquifers are vulnerable to degradation during and following exploration drilling in the following ways:

- Exploration boreholes left open may lead to the inflow of contaminated run-off from the surface;
- Aquifers of good water quality may be connected to aquifers with poor and/or unacceptable water quality via the drilling processes;
- Aquifers with useable quantities of water may be connected to leakage zones / unsaturated zones; and
- Groundwater wastage can occur during drilling, negatively affecting nearby boreholes (groundwater users).

Waterways, such as streams, springs and rivers are also vulnerable to negative impact from exploration drilling activities. These negative impacts may manifest via contaminated groundwater, where the groundwater table is present at a higher altitude than the base of the river or stream and groundwater therefore feeds the stream or river. Drainage of contaminated water from the drilling processes may enter rivers, streams or springs directly. Contaminated drilling spoils that are left on the surface may be washed into rivers, streams or springs during rains.

[5] The "safe distance" between any exploration borehole and the relevant (nearest) receptors will have to be determined and adjusted once the exact drilling positions are known

3 Possible Impacts and Mitigation Measures

The aim of this section is to make a preliminary assessment of any potential groundwater impacts that are likely to arise as a result of the proposed **prospecting activities**. It must be kept in mind that no details of the prospecting / exploration activities were available at the time of writing this report. Where reference is made to possible pollution / contamination, it refers to any contamination that can result from the invasive work, i.e. drilling. This may include, but is not limited to, on-site spills (e.g. fuels and oils), sanitation, litter and mixing of poor water quality with good water quality.

EIMS provided SRK with an evaluation format to be used in the reporting of possible impacts, the severity of the impacts and mitigation measures during the exploration phases. Based on the various evaluation criteria, the following potential impacts have been identified:

- **Potential Impact 1**: **Degradation of aquifers** (see Table 3-1)
- **Potential Impact 2: Impact on existing groundwater users** (see Table 3-2)
- **Potential Impact 3**: **Degradation of surface water** (that could be linked to groundwater) (see Table 3-3)

In assessing the potential impacts, and considering mitigation measures, SRK assumed that the drilling positions cannot be moved by a distance > 1 km as the drilling will be target specific and not random.

3.1 Potential Impact 1: Degradation of Aquifers

Terms used:

- **Mitigation:** To reduce the risk of the drilling activities having a negative impact on the aquifer system or various aquifer systems (to be determined) a detailed geohydrological assessment would be required for the exploration area, and could have to be adapted for every drilling position. A qualified geohydrologist must form part of the exploration project team, to provide the necessary input and scientific support in terms of preventing / mitigating degradation of aquifers. The areas where the faults are mapped, must receive a high level of attention from a geohydrological point of view.
- **Pre-mitigation**: Refers to drilling in the absence of a detailed geohydrological impact assessment and no on-site geohydrological drilling control.
- **Post Mitigation**: Assumes that the proposed mitigation measures have been put in place.
- **Alternative 1**: In this case there is no alternative to drilling and therefore Alternative 1 = No Alternative.

Table 3-1: Potential Impact 1 - Degradation of Aquifers

Impact Name	**Degradation of aquifers**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	2
Extent	3	3	Reversibility	3	2
Duration	4	2	Probability	3	3
Environmental Risk (Pre-mitigation)					-10.50
Mitigation Measures					
Detailed geohydrological assessment of expected aquifers and support during drilling phases, especially where drilling will occur near or in the fault zones – input to the EMP					
Environmental Risk (Post-mitigation)					-6.75
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					3
High: Issue has received an intense meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					3
High: Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1.83
Final Significance					-12.38

3.2 Potential Impact 2: Impact on Local Groundwater Users

Terms used:

- **Mitigation:** To reduce the risk of the drilling activities having a negative impact on any existing groundwater user (i.e. boreholes) a detailed hydrocensus, followed by a geohydrological assessment would be required for the exploration area. The geohydrological report must include a risk assessment (source-pathway-receptor) of every drill site with nearby boreholes / springs in mind. A qualified geohydrologist must form part of the exploration project team, to provide the necessary input and scientific support in terms of preventing / mitigating impacts on nearby groundwater users.
- **Pre-mitigation**: Refers to drilling in the absence of a hydrocensus, absence of a detailed geohydrological report and no on-site geohydrological drilling control.
- **Post Mitigation**: Assumes that the proposed mitigation measures have been put in place.
- **Alternative 1**: In this case there is no alternative to drilling and therefore Alternative 1 = No Alternative.

Table 3-2: Potential Impact 2: Impact on Local Groundwater Users

Impact Name	**Impact on local GW users**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	2
Extent	3	3	Reversibility	3	2
Duration	2	2	Probability	3	2
Environmental Risk (Pre-mitigation)					-9.00
Mitigation Measures					
Detailed hydrocensus, detailed geohydrological assessment and geohydrological support during drilling phases – input to the EMP					
Environmental Risk (Post-mitigation)					-4.50
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					3
High: Issue has received an intense meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					3
High: Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1.83
Final Significance					-8.25

3.3 Potential Impact 3: Degradation of Surface Water (linked to groundwater)

Terms used:

- **Mitigation:** To reduce the risk of the drilling activities having a negative impact on any nearby surface water that may be linked to groundwater (e.g. wetlands that are sustained by groundwater, streams / rivers that are partly recharged by groundwater), the detailed geohydrological report must include a risk assessment (source-pathway-receptor) of every drill site with nearby surface water features in mind. The drilling must also be overseen by a qualified geohydrologist, who will also brief the drilling contractor on the possible risks to the receptors so that the drilling contractor can have a contingency plan in place
- **Pre-mitigation**: Refers to drilling in the absence of a hydrocensus (which must also detect surface water features), absence of a detailed geohydrological impact assessment and no on-site geohydrological drilling control.
- **Post Mitigation**: Assumes that the proposed mitigation measures have been put in place.
- **Alternative 1**: In this case there is no alternative to drilling and therefore Alternative 1 = No Alternative.

Table 3-3: Potential Impact on Surface Water Sources

Impact Name	**Degredation of surface water**				
Alternative	**Alternative 1**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature	-1	-1	Magnitude	4	2
Extent	3	3	Reversibility	3	2
Duration	3	2	Probability	2	2
Environmental Risk (Pre-mitigation)					-6.50
Mitigation Measures					
Detailed hydrocensus, including capturing surface water and risk assessment report – as input to EMP					
Environmental Risk (Post-mitigation)					-4.50
Degree of confidence in impact prediction:					Low
Impact Prioritisation					
Public Response					3
High: Issue has received an intense meaningful and justifiable public response					
Cumulative Impacts					2
Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.					
Degree of potential irreplaceable loss of resources					1
Low: Where the impact is unlikely to result in irreplaceable loss of resources.					
Prioritisation Factor					1.50
Final Significance					-6.75

4 Geohydrological Management Plan

The desktop study has highlighted potential risks and impacts that the invasive phases of the exploration (i.e. drilling) could cause. As the details of the drilling processes, drilling depths and drilling positions are not known at this stage, the potential risks that have been highlighted in this report is generic of nature and applies to exploration drilling in general.

The geohydrological management plan (GMP) cannot be finalised at a desk study phase as the identified risks and potential impacts are site specific and currently the final drilling positions have not been finalised yet. A GMP can be compiled for the Groot Kolk Area once a hydrocensus has been completed, also taking cognisance of the specific drilling positions and potential receptors.

Site specific information / instructions that will ultimately have to be included in the final GMP and overseen by an experienced and qualified geohydrologist (Pr. Sci. Nat. registered) must include:

- A description of the expected geological formations that will be penetrated and the expected aquifer characteristics associated with each geological formation – depth of the borehole will dictate the potential risks;
- Position/s of the fault zones must be determined and the impact calculated should any of the exploration boreholes penetrate the faults – unless the faults / fault zones are specifically targeted for the mineral exploration, they must be avoided as far as possible;
- Expected water qualities of each aquifer (associated with the different geological formations) that will be penetrated – depth of the exploration borehole will dictate the potential risks;
- An assessment of the potential degradation of the aquifers should variable water qualities mix;
- Surrounding groundwater users and the protection thereof: positions of boreholes, depths, abstraction rates, water quality and dependency of the owner of his/her borehole.

The following mitigation measures should be implemented as standard during the prospecting phase in order to limit the impact on groundwater resources:

- Ensure vehicles and equipment are in good working order.
- Place oil traps under stationary machinery, only re-fuel machines at fuelling station, construct structures to trap fuel spills at a fuelling station, immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only.
- Ensure that good housekeeping rules are applied.
- A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.
- Implement and follow water saving procedures and methodologies.
- If boreholes are to be drilled to supply water for the staff or drilling processes;
  - Ensure the location of the borehole/s is selected to prevent a negative effect on the groundwater levels of existing boreholes.
  - Ensure the abstraction from the borehole/s is determined scientifically to prevent over abstraction.
  - Liaise with potentially affected groundwater water users and monitor any potential impact.

    - The distance between a planned exploration drill hole and a privately owned borehole is important to note, as it also affects the distance (pathway) that any potential pollutant must migrate to reach the borehole

- Monitoring of the groundwater quality during and after activities are completed.
- Portable chemical toilets must be used during the exploration phase.
- Mud pits (if to be used) must be lined and properly covered with impermeable material after completion of exploration boreholes
- Cap and seal all exploration boreholes to prevent surface water from entering the borehole.

It is not currently known whether groundwater from boreholes is considered to be utilised during the prospecting phase. It is anticipated that water will be brought onto site and trucked to the identified drill sites.

During exploration drilling the following information must be recorded and reported on:

a) Aquifer type;

b) Depths to first water strike;

c) Depths to deeper water zones;

d) Salinity of water strike zones (EC measurement with field probe);

e) Strike yields;

f) Standing water level (allow several hours after completion); and

g) Hole completion details (e.g. cement / bentonite plug, backfill material, bore cap, bore number and coordinates).

5 Conclusions

From the desktop study and information provided to SRK by EIMS, the following are concluded for the Groot Kolk Area:

- Although the majority of the area is being classed as a Minor Aquifer System with variable water quality and low expected yields, there are existing groundwater users for which boreholes could be their only water source. It is therefore critical that existing groundwater users be taken into account and that their boreholes are not negatively affected in any way.
- Any negative impact on groundwater and/or groundwater users, whether factual or perceived (complaints from surrounding borehole users) can have a significant financial and reputational impact on the exploration programme and subsequent mining.
- It is not possible to accurately predict the aquifers that will be penetrated when drilling 400 m or more and it is therefore important that support by a geohydrologist is provided before and during the drilling activities.
- Due to the lack of information, such as hydrocensus information, exact drilling positions and drilling depths, a very basic sensitivity map could be compiled at this stage, incorporating areas covered by quaternary deposits (e.g. sands) and surface water / pans. This information was taken from available geological and topographical maps.

6 Assumptions, uncertainties and gaps in knowledge

6.1 Assumptions

SRK assumes that the main purpose of this desktop study is to provide a broad overview of what has been documented for this specific area in terms of the geohydrology. SRK further assumed that the planned exploration has not yet been publicised or discussed with the local municipalities, local farming unions, or any other private or public sector body. SRK did therefore not make contact with any private or public body in terms of the gathering of site specific data. The information on which the desktop study is based, is therefore mainly the available information from the Department of Human Settlement, Water and Sanitation, on a national scale, and published reports that we could source. SRK further assumes that a public participation process will be followed whereby existing groundwater users will be included.

6.2 Limitations

The potential impacts of any drilling activity on the groundwater regime will vary from site to site, even over short distances due to changes in geology and receptors. As no recent hydrocensus across the entire exploration area has been conducted, SRK did not have access to, for example, positions of existing boreholes, dependency on groundwater, specific water quality, depth to groundwater levels and borehole depths. The sensitivity map and groundwater management plan, as presented in this report, must be seen as working documents that must be improved as more information becomes available.

6.3 Gaps

Based on the information presented to SRK, by EIMS, the following information gaps have been identified:

- Exact drilling positions and drilling depths;
- Storage and handling of any potentially hazardous materials / substances on the drilling site, e.g. fuels (diesel, petrol, paraffin, etc.), oils and cleaning chemicals;
- Detailed hydrocensus within the areas where exploration drilling will take place – the hydrocensus must be completed by a geohydrologist / geohydrological technician who has experience in the collection of geosite data, as prescribed by the DWS.
- Detailed scientific reports (geological and geohydrological) of the exploration area (if any) – sourcing these reports will require open conversations with private and public bodies, in which the purpose of the exploration programme and exploration areas will have to be revealed.

A **detailed geohydrological assessment** is required prior to any invasive exploration work (e.g. drilling).

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

8 References

Department of Water Affairs. (February 2006). *Groundwater Resources Assessment Phase II, Project No. 3003-150.*

Department of Water Affairs. (March 2003). *A Protocol to manage the potential of groundwater contamination from on site sanitation, 2nd Ed.*

Department of Water Affairs. (March 2006). *A guideline for the assessment, planning and management of groundwater resources in South Africa.*

Directorate Catchment Management, DWA, GIS and Cartographic: Helena Fourie. (n.d.). *1: 2 000 000 Water Management areas of the Republic of South Africa.*

P.H. Macey, H. S. (2011). *The Geology of the Loeriesfontein Area, Explanation Sheet 3018.*

Appendix 1: Maps

Map 1 - Topography

Map 2 – Geology

Map 3a – EC

Map 3b – Groundwater Flow Directions

Map 4 – NGA Data

Map 5 – Sensitivity Map

SRK Report Distribution Record

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