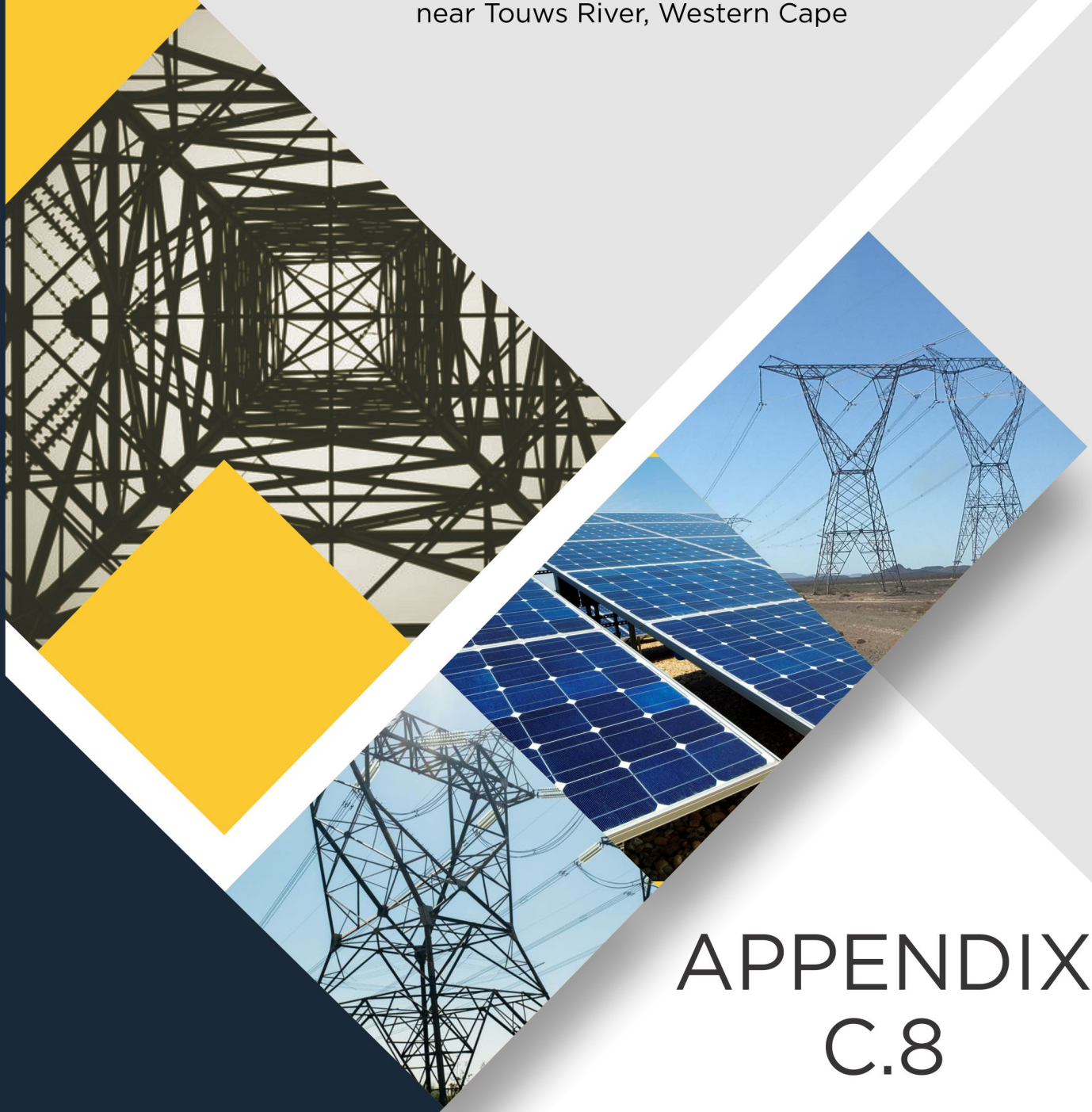
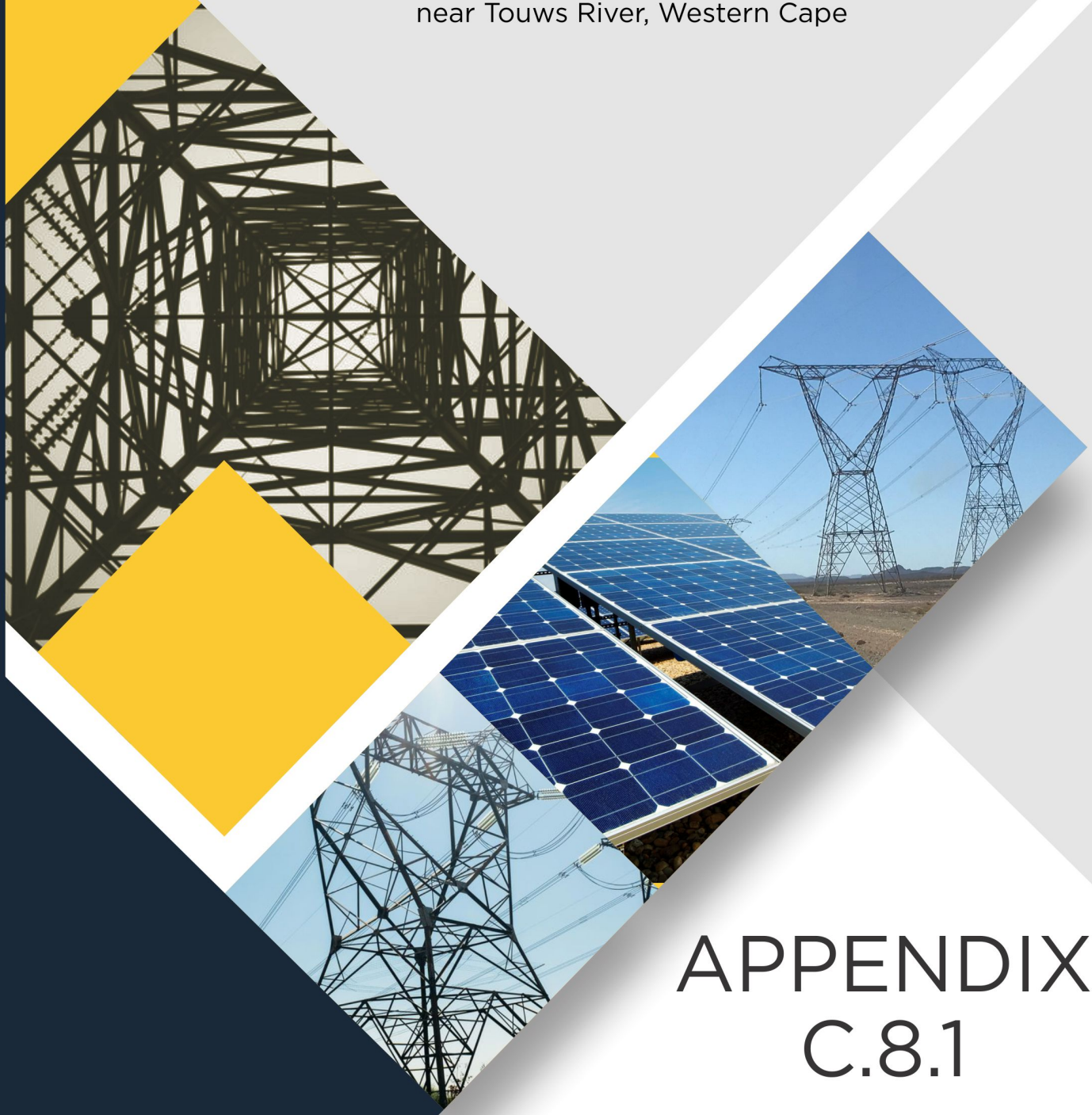
Basic Assessment for the Proposed Development of Electrical Grid Infrastructure to support the proposed nine 175 MW Solar Photovoltaic Facilities and associated Infrastructure (i.e. Witte Wall PV 1, Witte Wall PV 2, Grootfontein PV 1, Grootfontein PV 2, Grootfontein PV 3, Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3, and Hoek Doornen PV 4), near Touws River, Western Cape



APPENDIX C.8

Geohydrology Assessment

Basic Assessment for the Proposed Development of Electrical Grid Infrastructure to support the proposed nine 175 MW Solar Photovoltaic Facilities and associated Infrastructure (i.e. Witte Wall PV 1, Witte Wall PV 2, Grootfontein PV 1, Grootfontein PV 2, Grootfontein PV 3, Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3, and Hoek Doornen PV 4), near Touws River, Western Cape



APPENDIX C.8.1

Geohydrology Assessment for Witte Wall

GROUNDWATER SPECIALIST ASSESSMENT:

Basic Groundwater Assessment for the Proposed Development of the two 175 MW Solar Photovoltaic Facilities and associated Electrical Grid Infrastructure at Witte Wall Farm (i.e. Witte Wall PV 1 and Witte Wall PV 2), near Touws River, Western Cape

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Report prepared for:	*Report prepared by:*
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30 October 2020

Executive Summary

GEOSS South Arica (Pty) Ltd was appointed by the Council for Scientific and Industrial Research (CSIR) to complete a basic groundwater assessment for the proposed development of two 175 MW solar photovoltaic (PV) facilities and associated electrical grid infrastructure, near Touws River in the Western Cape. This geohydrological assessment includes a **desktop review** of groundwater characteristics and users in the area, with the aim of determining the potential for groundwater to be used for panel cleaning, as well as risk to nearby groundwater users, in both the construction and operational phases.

The area of interest receives most of its rainfall during the winter months with an average of 197 mm per year with increased evaporation rates during the summer months. The regional geological setting consists of sedimentary deposits underlain by five distinct geological formations which directly correlate with the regional geohydrological characterization. According to the regional scale groundwater map the greater portion of the study area hosts a “fractured” aquifer (i.e. fractures within the bedrock constitute an aquifer) with borehole yields being in the range of 0.1 – 0.5 L/s. The regional groundwater quality, using Electrical Conductivity (EC) as an indicator, is “moderate to poor” (EC of 70 – 1 000 mS/m). Data sources for the area indicates that the EC varies from 118 mS/m to a maximum of 1 377 mS/m. The DRASTIC groundwater vulnerability rating methodology (Department of Water Affairs and Forestry, 2005) indicates that the larger study area can be classified as having a “low” groundwater vulnerability rating.

The potential impacts of the proposed development on groundwater are:

- Accidental oil spillages or fuel leakages;
- Over-abstraction of groundwater; and
- Groundwater contamination due solar panel cleaning agents.

These issues can be easily managed and potential groundwater impacts completely mitigated if appropriate measures are implemented.

The author considers groundwater to be a viable source for use during the construction phase and operational phase. Prior to use, all boreholes being used should be tested to ensure their yield and quality meets necessary requirements. Furthermore, any abstraction boreholes should be equipped with water level and water quality monitoring infrastructure; as well as a flow meter, prior to use. Water use authorisation must also be addressed. The planned groundwater use is likely to fall within the General Authorization (GA) (based on anticipated volumes) so the groundwater use need only be registered (assuming the water use meets the relevant GA requirements).

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List of Abbreviations

BH	Borehole
CGS	Council for Geoscience
DHSWS	Department of Human Settlements, Water and Sanitation
DWA	Department of Water Affairs (used to be Department of Water Affairs and Forestry)
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	electrical conductivity
GIS	Geographic Information System
L/s	litres per second
m	metres
mbch	meters below collar height
mbgl	metres below ground level
mm	millimetre
mS/m	milli-Siemens per metre
NGA	National Groundwater Archive
WARMS	Water Authorisation and Registration Management System

Glossary

Definitions	
Aquifer	A geological formation, which has structures or textures that hold water or permit appreciable water movement through them [from National Water Act (Act No. 36 of 1998)].
Borehole	Includes a well, excavation, or any other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer [from National Water Act (Act No. 36 of 1998)].
DRASTIC	An acronym for a groundwater vulnerability assessment methodology: D = depth to groundwater / R = recharge / A = aquifer media type / S = soil type / T = topography / I = impact of the unsaturated zone / C = hydraulic conductivity. The methodology uses a rating and weighting approach and was developed by the Environmental Protection Agency (USA)
Electrical Conductivity	The ability of groundwater to conduct electrical current, due to the presence of charged ionic species in solution (Freeze and Cherry, 1979).
Fractured aquifer	Fissured and fractured bedrock resulting from decompression and/or tectonic action. Groundwater occurs predominantly within fissures and fractures.
Groundwater	Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.
Inferred	Where a geological contact or fault is believed to exist however is not confirmed.
Intergranular aquifer	Generally unconsolidated but occasionally semi-consolidated aquifers. Groundwater occurs within intergranular interstices in porous medium. Typically occur as alluvial deposits along river terraces.
Intergranular and fractured aquifers	Largely medium to coarse grained granite, weathered to varying thicknesses, with groundwater contained in intergranular interstices in the saturated zone, and in jointed and occasionally fractured bedrock.
Vulnerability	The tendency or likelihood for contaminants to reach a specified position in the ground-water system after introduction at some location above the uppermost aquifer (National Research Council, 1993).

Groundwater Specialist Assessment

This report serves as the Groundwater Specialist Assessment prepared as part of the Basic Assessments (BAs) for the proposed development of two 175 MW Solar Photovoltaic (PV) Facilities and associated Electrical Grid Infrastructure (Specifically Witte Wall PV 1 and Witte Wall PV 2), near Touws River, Western Cape.

1. Introduction

GEOSS South Arica (Pty) Ltd was appointed by the Council for Scientific and Industrial Research (CSIR) to complete a basic groundwater assessment for the proposed project (**Map 1**). This geohydrological assessment includes a desktop review of groundwater characteristics and users in the area, with the aim of determining the potential for groundwater to be used for construction and operational purposes, including panel cleaning, as well as risk to nearby groundwater users.

The study area can be divided into three separate farms namely Witte Wall, Grootfontein and Hoek Doornen. The total water requirement is estimated to be 5 million to 8 million litres per year during operation per project (i.e. per Witte Wall PV 1 and Witte Wall PV 2). At the time of writing this report the amount of groundwater to be used during construction was uncertain, however in this report it has been assumed that groundwater will be used during this phase. In terms of groundwater quality, optimally the water should be of drinking water quality. The groundwater might have to be treated to make it suitable for the intended use.

This report outlines the work completed to assess the likelihood of using groundwater for the Witte Wall PV 1 and Witte Wall PV 2 developments (**Map 2**), including the potential impact the development may have on groundwater resources in the area.

1.1. Scope, Purpose and Objectives of this Specialist Report

The scope of work is to provide groundwater specialist services, including the tasks outlined below:

- Desktop assessment for groundwater to be used for construction and operational purposes for each proposed project, including solar panel cleaning.
- Assessment of the impact on geohydrological resources as a result of the proposed development.
- Provide recommendations to minimize or mitigate impacts.
- Confirm what type of authorisation is required to make use of the ground water.

The results of the investigation are presented in this report along with the data analysis and interpretation.

1.2. Details of Specialist

This specialist assessment has been undertaken by Charl Muller of GEOSS South Africa. Charl Muller is registered with the South African Council for Natural and Scientific Professions (SACNASP), with Registration Number 123456 in the field of Hydrogeology. A curriculum vitae is included in **Appendix B** of this specialist assessment.

1.3. Terms of Reference

The procedure adopted for this study involved a **desktop study** of all available data and databases. The study involved obtaining and reviewing all relevant data to the proposed projects. This included analysing data from the National Groundwater Archive (NGA), Water Authorisation and Registration Management System (WARMS) and GEOSS's internal database, as well as groundwater yield, groundwater chemistry and geological maps of the area. A site visit was not carried out as the study was desktop based.

2. Approach and Methodology

The specialist study was completed as follows:

Task 1: Obtain all relevant data to the proposed projects (i.e. obtain data from the NGA and associated groundwater use databases, e.g. WARMS, GEOSS internal database). Obtain any data from local Department of Water and Sanitation (DWS) [now operating as the Department of Human Settlements, Water and Sanitation (DHSWS)] monitoring boreholes. Obtain relevant geological maps and geohydrological maps. Obtain relevant groundwater reports. Compile a project Geographic Information System (GIS).

Task 2: Analyse the data, using geohydrological methods and address the questions raised in the project objectives.

Task 3: Document the results in a report.

The report is also required to comply with the Assessment Protocols that were published on 20 March 2020, in Government Gazette 43110, Government Notice (GN) 320 (i.e. Part A, which provides the Site Sensitivity Verification Requirements where a Specialist Assessment is required but no specific Assessment Protocol has been prescribed). There is no specific Assessment Protocol devised for Geohydrology or Groundwater Assessments. Therefore, the report needs to comply with Appendix 6 of the 2014 National Environmental Management Act (Act 107 of 1998, as amended) Environmental Impact Assessment (EIA) Regulations.

2.1. Information Sources

The following information sources were used in this study:

Data / Information	Source	Date	Type	Description
Geological Map	Council for Geosciences	2009	Spatial	1:1 000 000 scale Geological Map series of South Africa
Geological Map	Council for Geosciences	1991	Spatial	1:250 000 scale Geological Map Series of 3320 Ladismith
Geological Map	Council for Geosciences	2001	Spatial	1:250 000 scale Geological Map Series of 3319 Worcester
Geological Map	Council for Geosciences	1973	Spatial	1:250 000 scale Geological Map Series of 3218 Clanwilliam
Geological Map	Council for Geosciences	1983	Spatial	1:250 000 scale Geological Map Series of 3218 Sutherland
Groundwater recharge and vulnerability mapping	GWD Conference Bloemfontein	2007	Spatial	A National scale approach to groundwater recharge and vulnerability mapping
Hydrogeological map series	Department of Water Affairs and Forestry	2002	Spatial	Hydrogeological map series of the republic of South Africa
NGA Database	NGA	27 October	Database and Spatial	Spatial delineation of NGA registered boreholes

Data / Information	Source	Date	Type	Description
		2020		
WARMS Database	Water use Authorization & Registration Management System	June 2019	Database and Spatial	Spatial delineation of WARMS registered boreholes
GEOSS Database	GEOSS South Africa	2015	Report	Consulting report from a neighbouring property.
Climatology and Geohydrology	2009	Cape Farm Mapper	Database	SA Atlas of Climatology and Geohydrology; obtained from Western Cape Government Agriculture

2.2. Assumptions, Knowledge Gaps and Limitations

The following assumptions and limitations apply:

- A limitation experienced during this investigation was that no site visit was carried out, and therefore no hydrocensus could be undertaken. Despite this, this desktop study is considered suitable to meet the objectives of the study
- The geohydrological assessment is based on previous studies and available literature for the study area. Regional scale GIS datasets based on 1: 500 000 and previous hydrogeological work completed have been assumed to be correct.
- No drill records or yield test data exists for production or wind pump boreholes to clarify yields and geological logs.
- The acquisition of accurate groundwater levels proved to be difficult, therefore data was limited to information obtained from local parties. Nonetheless these limitations have not negatively impacted the conclusions of the project.
- The NGA data is available at a local scale, although is known to sometimes contain false information.

The information obtained was sufficient to provide comprehensive geohydrological characterization of the regional setting.

It must be noted that there are no areas on site that should be avoided from a groundwater sensitivity perspective.

2.3. Consultation Processes Undertaken

No site visit was undertaken; however, involved land owners were contacted (if possible) to gather as much information on existing boreholes surrounding the proposed development.

3. Description of Project Aspects relevant to the Geohydrological Assessment

As mentioned above, the Project Applicant intends to make use of existing boreholes to source groundwater (if available and if suitable) for the construction and operational phases (i.e. cleaning of panels). As a result, water pipelines may need to be constructed in order to transfer groundwater from existing boreholes or they may be transported by trucks from the boreholes to the sites. Groundwater will need to be stored on site in suitable containers or reservoir tanks during the construction and operational phases. The process required to ensure use of the groundwater in terms of the National Water Act is also addressed in this study. As noted in the BA Reports, if groundwater is not suitable, then the water will be trucked in from the municipality.

Generally, groundwater can be impacted negatively in two manners, namely:

- Over-abstraction (where groundwater abstraction exceeds recharge rates) which can result in the alteration of groundwater flow directions and gradients.

- Quality deterioration (i.e. from anthropogenic activities negatively impacting groundwater quality).

There is currently limited groundwater abstraction taking place in relation to the size of the study area (based on regional datasets). Groundwater is mostly used for drinking, agricultural purposes and livestock watering. The low rainfall and high evapotranspiration rates within the study area are a limiting factor for the recharge of the aquifer underlying the study area.

The groundwater requirement for the project can be met by using the existing boreholes. However, agreements will have to be put in place with the current land owners for the use of groundwater. These agreements will have to be legally valid documents and the necessary endorsements will be required from the DHSWS. If no such agreements can be put in place, then additional boreholes will need to be drilled on the relevant farm portions/developments, followed by yield and water quality testing, and then authorization from DHSWS to use the groundwater will be required. The groundwater will need to be stored in water tanks on site. The groundwater required for the construction and operational phase per project will be very low.

4. Baseline Environmental Description (Witte Wall PV 1 and Witte Wall PV 2)

4.1. General Description

The nearest town to the centroid of the study area (Witte Wall PV 1 and Witte Wall PV 2) is Touws River, approximately 40 km to the south. The Witte Wall farm landscape is arid with transported sands occurring widely along plains with shales and sandstones dominating the mountainous areas.

4.2. Project Specific Description (Witte Wall PV 1 and Witte Wall PV 2 - PV Facility, Electrical Grid Infrastructure and Associated Infrastructure)

The Witte Wall Farm experiences a semi-arid climate, with most of the rainfall occurring during the winter months. **Figure 1** shows the monthly average air temperature and rainfall distribution and **Figure 2** shows the monthly median rainfall and evaporation distribution for the Witte Wall Farm (Schulze, 2009). The long term (1950 – 2000) mean annual precipitation for the Witte Wall Farm is 197 mm/a. The rainfall does not exceed evaporation during the winter rainy season.

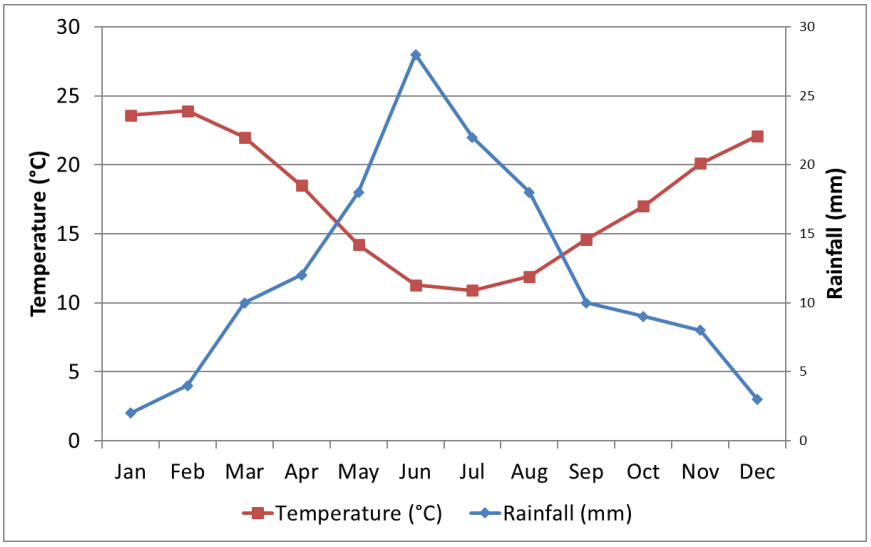

Figure 1: Monthly average air temperature and rainfall distribution for the Witte Wall Farm (Schulze, 2009).

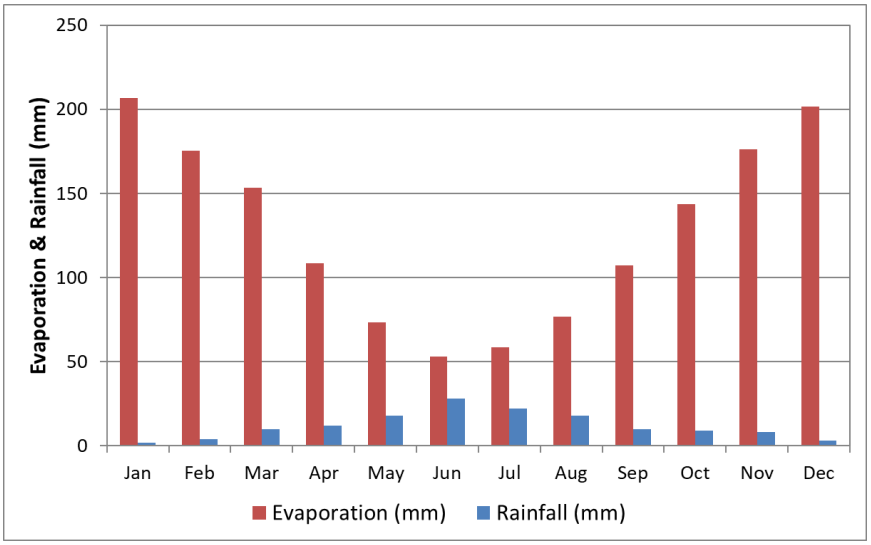

Figure 2: Monthly average rainfall and evaporation distribution for the Witte Wall Farm (Schulze, 2009).

4.3. Regional Geology

The Geological Survey of South Africa (now the Council for Geoscience) has mapped the area at 1:1M scale (South Africa). The geological setting is shown in **Map 3**. The main geology of the area is listed in **Table 1**.

Table 1: Geological formation within the study area.

Symbol	Formation	Group	Lithology
N-Qg	n/a - Quaternary Age		Alluvium and terrace gravel.
PA-Ng	Grahamstown Formation	n/a	High-level terrace gravel, silcrete, ferricrete.
Pak	Abrahamskraal Formation	Beaufort Group	Mudstone, siltstone, sandstone and thin chert beds.
Pk	Kookfontein Formation	Ecca Group	Shale, siltstone, subordinate sandstone.
Ps	Skoorsteenberg Formation		Mudrock and siltstone, sandstone
Pt	Tierberg Formation		Dark-grey shale and siltstone.
Ppw	1. Collingham Formation 2. Whitehill Formation 3. Prince Albert Formations		1. Siltstone, chert and sandstone with thin interbedded shale and yellow weathering mudstone/tuff. 2. Dark-grey shale, light-grey weathering with cherty siltstone beds 3. Dark-grey shale with reddish-brown-weathering siltstone.
C-Pd	Dwyka Formation		Tillite, diamictite, and subsidiary shale.
Cl	n/a	Witteberg Group	Mudrock, micaceous shale, siltstone, quartzose and arkosic sandstone, diamictite.
Dw			Reddish to white quartz arenite, red to brown thin-bedded sandstone, minor micaceous red or purple siltstone and shale, rhythmite

The Witte Wall Farm Portions is underlain by the Grahamstown Formation deposits which comprises of high-level terrace gravel, silcrete and ferricrete. This is most likely underlain by (in order of youngest to oldest):

- dark-grey shale and siltstone (the Tierberg Formation)
- siltstone, chert and sandstone with thin interbedded shale and yellow weathering mudstone/tuff (the Collingham Formation)
- dark-grey shale, light-grey weathering with cherty siltstone beds (the Whitehill Formation)
- dark-grey shale with reddish-brown-weathering siltstone (the Prince Albert Formation)
- tillite, diamictite, and subsidiary shale (the Dwyka Formation)

The proposed development is located just south of two faults trending from north-east towards the south-west. These faults are prominent in the Kookfontein, Skoorsteenberg and Grahamstown Formations resulting in fracturing of the bedrock (**Map 3**). Whereas, to the south of the Witte Wall Farm portion is a mapped Dolerite Dyke (Kf). These faults and dyke structures are good target zones if further groundwater development is going to take place.

4.4. Regional Hydrogeology

The regional aquifer directly underlying the Witte Wall Farm portion is classified by the Department of Water Affairs and Forestry (DWAF) (DWAF, 2002) as a fractured aquifer with an average yield potential of 0.1 – 0.5 L/s (**Map 4**). A fractured aquifer describes an aquifer where groundwater only occurs in narrow fractures within the bedrock.

Based on the DWAF (2002) mapping of the regional groundwater quality, as indicated by electrical conductivity (EC), the majority of the farm portion is in the range of 70 – 300 mS/m with the southern corner of the portion in the range of 300 – 1 000 mS/m. This is considered to be “moderate to poor” quality for water (**Map 5**) with respect to drinking water standards.

Both these classifications are based on regional datasets, and therefore only provide an indication of conditions to be expected.

4.4.1. NGA Database

A desktop assessment was initially carried out around the property to determine if there were any groundwater users in the area. The NGA database provides data on borehole positions, groundwater chemistry and yield, where available. The NGA indicated there is one borehole located within the Witte Wall Farm portion and eight boreholes surrounding the portion (**Map 6**). A total of 9 NGA sites could be identified and are summarized in **Table 2**.

Table 2: Summary of NGA borehole.

NGA Label	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	Yield (L/s)	EC (mS/m)	Depth (m)	Lithology
3319BB00012	-33.1274	19.91708			673	36.6	Tillite
3320AA00009	-33.1117	20.02777	14		118	80	Shale
3319BB00013	-33.0838	19.9518	9.15		333	36.6	Tillite
3320AA00010	-33.0656	20.08249	3	0.25	286	80	Shale
3320AA00023	-33.0656	20.0825		0.25	286	80	Shale
3319BB00011	-33.0647	19.87847		0.63	398	12.2	Tillite
3319BB00004	-33.0344	19.88263	6.1		432	36.6	Tillite
3319BB00005	-33.0161	19.87097	7.63		1192	36.6	Sandstone & Shale
3319BB00003	-33.0099	19.98597	10.68		496	67.1	Sandstone & Shale

The NGA registered site (3319BB00003) located on the Witte Wall Farm portion indicates a shallow drill depth of 67 m, drilled into sandstone and shale, with a relatively deep-water level of 10.68 mbgl and a poor EC of 496 mS/m.

Overall, the NGA sites indicate a relatively shallow drill depth (12 – 80 m), drilled into varying lithologies of tillite, shale and sandstone. Yields are low, ranging from 0.25 to 0.63 l/s and EC's are moderate to poor ranging from 118 to 1192 mS/m.

4.4.2. WARMS Database

There are 4 registered boreholes (WARMS site) located within a search radius of 1 km around the Witte Wall Farm portion boundary, as shown on **Map 6**. The information is summarised in **Table 3**. This groundwater use is registered to neighbouring farm portions.

Table 3: Summary of WARMS borehole details.

WARMS no.	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Registered Volume (m^3/a)	Status
22137787	-33.0718	19.9709	27375	Registered
22138090	-33.079	19.9597	27375	Registered
22124933	-33.1047	20.0114	7300	Complete
22138697	-33.0404	20.1098	2190	Registered

4.4.3. Witte Wall Boreholes

A representative of the Witte Wall Farm, was contacted regarding groundwater use from boreholes on the Witte Wall farm portion, shown on Map 6. These boreholes are summarised in Table 4 below.

Table 4 – Summary of Witte Wall Boreholes.

Borehole Name	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Comment
WW_1	-32.995951	19.980220	Only used for domestic use and livestock watering. Airlift yield of 4 500 L/h. Depth between 80 and 100 m.
WW_2	-32.996100	19.980193	Only used for domestic use and livestock watering. Airlift yield of 4 500 L/h. Depth between 80 and 100 m.
WW_3	-32.996183	19.980102	Only used for domestic use and livestock watering. Airlift yield of 4 500 L/h. Depth between 80 and 100 m.
WW_4	-33.010868	19.986994	Only used for domestic use and livestock watering. Airlift yield of 6 500 L/h. Depth between 80 and 100 m.
WW_5	-33.009423	20.023950	Only used for domestic use and livestock watering. Airlift yield of 6 000 L/h. Depth between 80 and 100 m.

From the information provided it is clear that the boreholes are relatively high yielding (airlift yields) for the area. The water is mainly used for domestic use and livestock watering. The status and condition of these boreholes will need to be accessed during the hydrocensus.

4.4.4. Grootfontein Boreholes

A representative of the Grootfontein Farm, was contacted regarding groundwater use from boreholes on his farm, shown on **Map 6**. These boreholes are summarised in **Table 5**.

Table 5: Summary of Grootfontein Boreholes.

Borehole Name	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Comment
GF_1	-32.9448	19.94878	Brackish water used only for drinking water and gardening.
GF_2	-32.9439	19.94818	Used for drinking water. Low yielding.
GF_3	-32.9386	19.95211	Reportedly strong borehole, pumped at 6000 L/h from time to time. Has not been pumped for years
GF_4	-32.9375	19.95276	Reportedly strong borehole, pumped at 4000 L/h from time to time. Has not been pumped for years
GF_5	-32.9398	19.94759	Old borehole, water level at 1.5 mbgl. Has not been pumped in last 25 years.
GF_6	-32.9737	19.95309	Used for livestock watering.

From the information supplied it is clear that the water is brackish and is mostly used for domestic use. Two of the boreholes indicate relatively high yields for the area of 4 000 to 6 000 L/h. The status and condition of these boreholes will need to be accessed during the hydrocensus.

4.4.5. GEOSS Database

A search of GEOSS's internal database of previous projects conducted in the area indicated a total of 18 boreholes surrounding the Witte Wall Farm portion (**Map 6**). The results are summarised in **Table 6**.

From GEOSS's internal database, it is clear that groundwater quality is poor (ranging from 169 to 1377 mS/m) with low yields ranging from 0.5 to 1.47 L/s. Water levels range from shallow (1.00 mbgl) to relatively deep (8.80 mbgl).

Table 6: Summary of GEOSS's internal database borehole details.

ID no.	WL (mbgl)	Yield (L/s)	EC (mS/m)	TDS (mg/L)	pH
GD_1	8.215	-	-	-	-
GD_2	8.8	1.47	478.2	3102	7.09
GD_3	-	-	-	-	-
GD_4	-	-	-	-	-
GD_5	6.4	-	356.5	2400	7.25
GD_6	8.62	-	305.7	2082	7.76
GD_7	4.24	-	1377.5	9263	7.33
GD_8	1.09	0.5	169.5	1114	8.87
GD_9	1.00	-	299.8	1917	8.04
GD_10	1.47	-	287.32	-	-
GD_11	1.03	-	435.94	-	
GD_12	-	-	405.4	2821	7.88
GD_13	-	-	-	-	-
GD_14	-	-	305	1918	7.86
GD_15	-	-	-	-	-
GD_16	8.10	-	215.9	1398	8.33
GD_17	-	-	-	-	-
GD_18	-	-	-	-	-

4.4.6. Kareekolk Borehole

The Kareekolk Farm contains the access road to the Hoek Doornen and Witte Wall Farm portions delineated for the proposed solar development. Mr Leon Theunissen (owner of Kareekolk Farm) indicated the possible use of his dam water for construction and operations, including solar panel cleaning. It was established that this dam (**Figure 3**) is filled with borehole water supplied by the KK_1 borehole, shown on **Map 6** and summarised in **Table 7**. This borehole, reportedly, can pump up to 40 000 L/h for 9 hours per day. Quality at this stage is unknown. The preliminary findings for the determination of the existing lawful use, for this borehole, indicates a lawful use of 2694 m3/a (~0.08L/s). This is not enough to supplement the required amount of water of 5 to 8 million litres per year per project (~0.5 L/s). This will require a General Authorisation to make use of this volume of water.

Table 7: Kareekolk Borehole Summary.

Borehole Label	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Reported Yield (L/s)	Quality
KK_1	-32.9836030	19.938373	11.1	Unknown

Figure 3: Dam located on Kareekolk Farm.

4.5. Geohydrological Characterisation (Aquifer Vulnerability) - Witte Wall PV 1 and Witte Wall PV 2

The Witte Wall Farm portion overlies a fractured aquifer that possesses water bearing properties due to fracturing. Several methods have been developed to classify an aquifer's vulnerability. The DRASTIC method has been applied to this study.

4.5.1. Aquifer Vulnerability (DRASTIC)

Groundwater vulnerability can be defined as the "tendency for contaminants to reach a specified position in the groundwater system after introduction at some location" (Vrba and Zaporozec, 1994). Key physical parameters which determine groundwater vulnerability include lithology, thickness, effective porosity, groundwater flow direction, age and residence time of water. Generally, the residence time of a contaminant in groundwater and the distance that it travels in the aquifer are considered important measures of vulnerability.

There are two main groups of methods for assessing groundwater vulnerability, namely:

- Index or subjective rating methods, and
- Statistical or process-based methods.

The "index or subjective rating method" is relatively easily addressed within a GIS framework. The cell-based layer approach facilitates the assignment of ratings and weights and rapid achievement of a final result of relative groundwater vulnerability. This approach also means that the algorithm can easily be repeated as new or more detailed data sets are obtained or if ratings and weightings need to be adjusted as a result of a sensitivity analysis for example. The most well-known "index or subjective rating method" is the "DRASTIC" method (Aller et al., 1987). The DRASTIC method of Aller et al. (1987) uses the typical overlay technique often applied in subjective rating methods. The DRASTIC approach is based on four major assumptions:

- The contaminant is introduced at ground surface;
- The contaminant is flushed into the groundwater by precipitation;
- The contaminant has the mobility of water; and
- The area evaluated using DRASTIC is 40.5 ha or larger.

The implication of these assumptions is that DRASTIC should not be used for contaminants that do not have the mobility of water or for point assessment (such as storage tanks). In addition, groundwater conditions in South Africa are dominated by secondary/fracture-controlled flow conditions. The DRASTIC method does not consider local preferential flow paths of fractured aquifer systems particularly well. The DRASTIC method takes into account the following factors:

D	=	depth to groundwater	(5)
R	=	recharge	(4)
A	=	aquifer media	(3)
S	=	soil type	(2)
T	=	topography	(1)
I	=	impact of the vadose zone	(5)
C	=	conductivity (hydraulic)	(3)

The number indicated in parenthesis at the end of each factor description is the weighting or relative importance at that factor.

Groundwater vulnerability maps developed using the DRASTIC method have been produced in many parts of the world. In spite of the widespread use of DRASTIC, the effectiveness of the method has been met with mixed success due to hydrogeological heterogeneity and the many assumptions that need to be made in determining groundwater vulnerability. In addition, the use of a generic vulnerability map only gives a broad indication of relative vulnerability and in many instances detailed scale, contaminant specific vulnerability assessments are required. From the assumptions outlined by Aller et al. (1987), DRASTIC can only be applied to non-point source pollution, as DRASTIC is inaccurate in point source assessments.

As part of the Groundwater Resources Assessment Project (DWAF, 2005), numerous data sets were produced and this enabled the mapping of groundwater vulnerability at the national scale on a 1 km by 1 km cell (pixel) size basis (Conrad and Munch, 2007). This national scale map indicates the relative vulnerability of groundwater resources throughout the country and provides project planners a clear idea of what level of groundwater protection is required.

A national scale map of groundwater vulnerability has been completed for South Africa (DWAF, 2005). The groundwater vulnerability for the study area is shown in **Map 7**. The development area on the Witte Wall Farm portion has a **very low** groundwater vulnerability.

4.6. Strategic Water Source Areas

Strategic Water Source Areas (SWSAs) are defined as “areas of land that either: (a) supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or (b) have high groundwater recharge and where the groundwater forms a nationally important resource; or (c) areas that meet both criteria (a) and (b)” (Le Maitre et al., 2018:1 in DEFF, 2019: Page 61). Thirty-seven groundwater SWSAs have been identified in South Africa and are considered to be strategically important at a national level for water and economic security (Le Maitre et al. 2018 in DEFF, 2019: Page 61). The total area for groundwater SWSAs extends approximately 104 000 km2, and covers approximately 9% of the land surface of South Africa (Le Maitre et al. 2018, in DEFF 2019: Page 61).

According to the Solar PV Theme on the National Web-based Environmental Screening Tool, there are no SWSAs on the Witte Wall Farm. Refer to Figure 4 below.

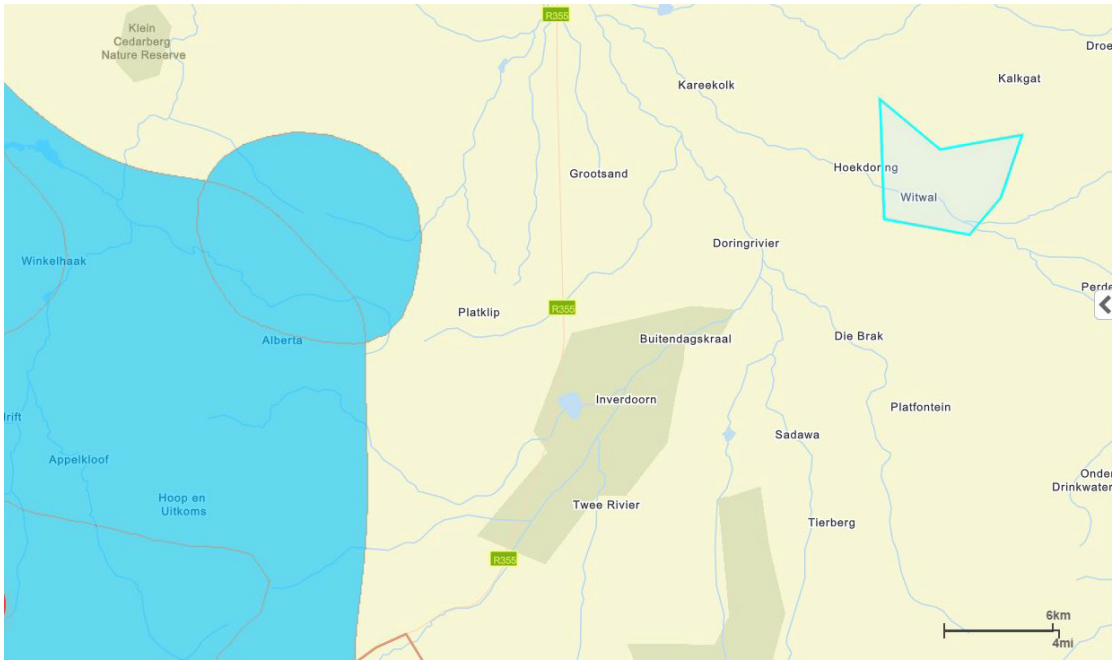

Figure 4: SWSAs from the National DEFF Screening Tool (DEFF, 2020).

5. Issues, Risks and Impacts (Witte Wall PV 1 and Witte Wall PV 2)

5.1. Identification of Potential Impacts/Risks

The following potential impacts on groundwater of the proposed project activities are as follows:

- Lowering of the groundwater level due to abstraction (5 to 8 million litres per year per PV project);
- Potential impact on groundwater quality as a result of accidental oil spillages or fuel leakages during the construction, operational and decommissioning phases; and
- Potential impact on groundwater quality as a result of cleaning agents used for cleaning the solar panels.

Any construction activities such as the excavation and installation of foundations and piling (narrow diameter holes for foundation purposes) will have minimal to no impact on the groundwater of the site or region, as the groundwater level is approximately 3 – 8 mbgl.

The potential impacts identified during the BA are:

Construction Phase

- Potential lowering of the groundwater level; and
- Potential impact on groundwater quality as a result of accidental oil spillages or fuel leakages.

Operational Phase

- Potential lowering of the groundwater level; and
- Potential impact on groundwater quality as a result of using cleaning agents for cleaning the solar panels.

Decommissioning Phase

- None

Cumulative Impacts

- Due to the large spatial extent and low water demand in the study area, including other groundwater users within a 30 km radius, the cumulative impact is regarded as insignificant.
- It is assumed that not all 9 PV facilities will be constructed at the same time, hence the requirements will not be 8 million litres * 9 per year per PV project, allowing for sufficient recharge.

No indirect impacts are identified.

In terms of the no-go alternative, if the proposed Witte Wall PV 1 and Witte Wall PV 2 projects do not go ahead, there will be no need to use approximately 5 – 8 million litres per year of ground water per project. However, as noted above, there is a low water demand in the study area and a large spatial extent; and the impacts relating to the use of ground water is not considered as highly significant.

6. Impact Assessment - Witte Wall PV 1 and Witte Wall PV 2

6.1. Potential Impacts during the Construction Phase

It must be noted that the impacts provided below are the same for both the Witte Wall PV 1 and Witte Wall PV 2 projects, as well as the Electrical Grid Infrastructure.

6.1.1. Impact 1: Groundwater impact as a result of over-abstraction abstraction

This impact is only applicable during the construction and operational phases. At the peak requirement of 8 million litres per year per project (Witte Wall PV 1 and Witte Wall PV 2 requires 0.25 L/s each ~ 0.5 L/s) the proposed groundwater abstraction is within the yield potential of the underlying aquifer (0.1 – 0.5 L/s).

The status of this impact is rated as negative with a local spatial extent and a long-term duration (i.e. for the life of the project). The consequence and probability of the impact is respectively rated as substantial and unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated low. The significance of the impact without the implementation of mitigation measures is rated as moderate. With effective implementation of prevention / mitigation actions (i.e. to adhere to the borehole's safe yield and to monitor water levels and flow), the impact of the proposed abstraction on groundwater is predicted to be of low significance.

6.1.2. Impact 2: Potential Impact on Groundwater Quality as a result of Accidental Oil Spillages or Fuel Leakages

If there is an accidental oil spill or fuel leakage during the construction phase, then the low permeability of the unsaturated zone will provide significant attenuation capacity. The status of this impact (for the construction phase) is rated as negative with a site-specific spatial extent and short-term duration. The consequence and probability of the impact is respectively rated as slight and extremely unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated as low. The significance of the impact without the implementation of mitigation measures is rated as very low.

A precautionary approach must be implemented and reasonable measures must be undertaken to prevent oil spillages and fuel leakages from occurring. During the construction phase, vehicles must be regularly serviced and maintained to check and ensure there are no leakages. Any engines that stand in one place for an excessive length of time must have drip trays. Diesel fuel storage tanks, if required, should be above ground on an impermeable concrete surface in a bunded area. Construction vehicles and equipment should also be refuelled on an impermeable surface. A designated area should be established at the construction site camp for this purpose, if off-site refuelling is not possible. If spillages occur, they should be contained and removed as rapidly as possible, with correct disposal procedures of the spilled material, and reported. Proof of disposal (waste disposal slips or waybills) should be obtained and retained on file for auditing purposes.

With effective implementation of these prevention / mitigation actions, the impact of the project on groundwater as a consequence of accidental oil spillages and fuel leakages is predicted to be of very low significance.

6.1.2.1. Impact Summary Tables: Construction Phase

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
CONSTRUCTION PHASE						
Lowering of groundwater levels as a result of over-abstraction	***Status***	*Negative*	*Moderate*	*Adhere to the borehole's safe yield and to monitor water levels and flow.* *Boreholes must be correctly yield tested according to the National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes). This includes a Step Test, Constant Discharge Test and recovery monitoring.*	*Low*	*High*
	Spatial Extent	*Local*				
	Duration	*Long Term*				
	Consequence	*Substantial*				
	Probability	*Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				
Accidental oil spillage / fuel leakage	***Status***	*Negative*	*Very Low*	*Vehicles must be regularly serviced and maintained to check and ensure there are no leakages. Any engines that stand in one place for an excessive length of time must have drip trays. Diesel fuel storage tanks, if required, should be above ground on an impermeable surface in a bunded area. Vehicles and equipment should also be refuelled on an impermeable surface. A designated area should be established at the construction site camp for this purpose, if off-site refuelling is not possible. If spillages occur, they should be contained and removed as rapidly as possible, with correct disposal procedures of the spilled material, as reported. Proof of disposal (waste disposal slips or waybills) should be obtained and retained on file for auditing purposes.*	*Very Low*	*High*
	Spatial Extent	*Site Specific*				
	Duration	*Short Term*				
	Consequence	*Slight*				
	Probability	*Extremely Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

6.2. Potential Impacts during the Operational Phase - Witte Wall PV 1 and Witte Wall PV 2

It must be noted that the impacts provided below are the same for both the Witte Wall PV 1 and Witte Wall PV 2 projects. The power lines do not have any operational water usage and thus not considered to have an impact on the groundwater.

6.2.1. Impact 1: Groundwater impact as a result of over-abstraction abstraction

This impact is only applicable during the construction and operational phases. At the peak requirement of 8 million litres per year per project (Witte Wall PV 1 and Witte Wall PV 2 requires 0.25 L/s each ~ 0.5 L/s) the proposed groundwater abstraction is within the yield potential of the underlying aquifer (0.1 – 0.5 L/s).

The status of this impact is rated as negative with a local spatial extent and a long-term duration (i.e. for the life of the project). The consequence and probability of the impact is respectively rated as substantial and unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated low. The significance of the impact without the implementation of mitigation measures is rated as moderate. With effective implementation of prevention / mitigation actions (i.e. to adhere to the borehole's safe yield and to monitor water levels and flow), the impact of the proposed abstraction on groundwater is predicted to be of low significance.

Impact 2: Potential impact on groundwater quality as a result of using cleaning agents

The low permeability of the unsaturated zone will provide significant attenuation capacity. The status of this impact (for the operational phase) is rated as negative with a site-specific spatial extent and long-term duration (i.e. for the life of the project). The consequence and probability of the impact is respectively rated as slight and extremely unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated as low. The significance of the impact without the implementation of mitigation measures is rated as very low. Recommended mitigation includes using an environmentally safe cleaning agent that breakdown naturally and do not cause adverse effects.

6.2.1.1. Impact Summary Tables: Operational Phase

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
OPERATIONAL PHASE						
Lowering of groundwater levels as a result of over-abstraction	***Status***	*Negative*	*Moderate*	*Adhere to the borehole's safe yield and to monitor water levels and flow.* *Boreholes must be correctly yield tested according to the National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes). This includes a Step Test, Constant Discharge Test and recovery monitoring.*	*Low*	*High*
	Spatial Extent	*Local*				
	Duration	*Long Term*				
	Consequence	*Substantial*				
	Probability	*Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				
Potential impact on groundwater quality as a result of using cleaning agents	***Status***	*Negative*	*Very Low*	*Use environmentally safe cleaning agents that breakdown naturally and do not cause adverse effects.*	*Very Low*	*High*
	Spatial Extent	*Site Specific*				
	Duration	*Long Term*				
	Consequence	*Slight*				
	Probability	*Extremely Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

7. Impact Assessment Summary - Witte Wall PV 1 and Witte Wall PV 2

The overall impact significance findings, following the implementation of the proposed mitigation measures are shown in the **Table 8**.

Table 8: Overall Impact Significance (Post Mitigation)

Phase	**Overall Impact Significance**
Construction	Low-Very Low
Operational	Low-Very Low
Decommissioning	None
Nature of Impact	**Overall Impact Significance**
Cumulative - Construction	Insignificant
Cumulative - Operational	Insignificant
Cumulative - Decommissioning	None

8. Legislative and Permit Requirements

The National Water Act (Act 36 of 1998) (NWA) is administered by the DWS and is the main legislation for managing water resources in South Africa. The purpose of the NWA is to provide a framework for the equitable allocation and sustainable management of water resources. Both surface and groundwater sources are redefined by the Act as national resources which cannot be owned by any individual, and rights to which are not automatically coupled to land rights, but for which prospective users must apply for authorization and register as users. The NWA also provides for measures to prevent, control and remedy the pollution of surface and groundwater sources.

The Witte Wall PV 1 and PV 2 development areas are located within quaternary catchment E22E which forms part of the Olifants Catchment in Western Cape. The General Authorisation (GA) Limit for the taking of groundwater in this quaternary catchment is 45 m^3/ha/a (published on 2 September 2016, in Government Gazette 40243, Government Notice (GN) 538 (i.e. Revision of General authorisation for the taking and storing of water). The Witte Wall Farm portion is approximately 3 646 ha; equating to 164 070 m^3/a. The allowable abstraction under the GA is capped at 40 000 m^3/a. This equates to approximately 1.27 L/s (continuous abstraction) for the entire Witte Wall Farm portion. The proposed groundwater use for each project is less than this (peak usage is 0.5 L/s annually for both Witte Wall PV1 and Witte Wall PV2 projects) and will thus fall within the GA. Only a registration process will have to be followed for the groundwater use; i.e. Section 39 of the NWA is applicable. Although the assessed development footprint is 1010 ha, (and each PV Facility will have an estimated footprint of 260 ha within the assessed development footprint), the total farm portion is 3 646 ha and it is the total farm area that is used for the GA calculation. If other water uses in terms of Section 21 of the NWA is applicable to the farm portion, this will need to be incorporated in the registration process.

9. Environmental Management Programme Inputs

Certain measures need to be put in place to ensure that the groundwater of local and regional aquifers is not significantly negatively impacted by the proposed projects. The following aspects are considered to be applicable to the Witte Wall PV 1 and Witte Wall PV 2 Facilities, Electrical Grid Infrastructure and Associated Infrastructure.

9.1. Accidental oil spillage / fuel leakages

- All vehicles and other equipment (generators etc.) must be regularly serviced to ensure they do not spill oil. Vehicles should be refuelled on paved (impervious) areas, optimally off-site. If liquid product is being transported it must be ensured this does not spill during transit.

- Emergency measures and plans must be put in place and rehearsed in order to prepare for accidental spillage.
- Diesel fuel storage tanks, if require, must be above ground on a concrete surface in a bunded area.
- Engines that stand in one place for an excessive length of time must have drip trays.
- Vehicle and washing areas must also be on paved surfaces and the by-products removed to an evaporative storage area or a hazardous waste disposal site (if the material is hazardous).

9.2. Groundwater abstraction (if groundwater is to be used)

- The production boreholes that are to be used should be yield tested prior to use (according to SANS10299) so that the correct pump sizes and installation depths can be determined.
- The planned production boreholes should also be sampled and chemically and microbiologically analysed by a SANAS accredited laboratory.
- Once the boreholes are in use they should be equipped with:
    - Observation pipes - so that the water levels can be measured (either manually or by data loggers);
    - Flow meters – to assess how much water is used and thereby all authorisations in place for use of the water are adhered to; and
    - Sampling tap – to enable annual sampling to ensure the groundwater is safe for continued use – especially if it is to be used as drinking water.

9.3. Cleaning agents used solar panel cleaning

- Environmentally safe cleaning agents that breakdown naturally must be used for cleaning the panels. No chemical that that could cause adverse effects to the natural environment should be allowed.

10. Final Specialist Statement and Authorisation Recommendation

The allowable general abstraction volume for the Witte Wall Farm Portion is 40 000 m^3/year (1.27 L/s). The entire development is estimated to require 5 to 8 million litres per year per PV project (0.25 L/s per project ~ total of 0.5 L/s). Therefore, the amount of water required for the Witte Wall PV 1 and Witte Wall PV 2 developments falls within the abstraction volume allowed under GA. Only a registration process will have to be followed for the groundwater use; i.e. Section 39 of the NWA is applicable. Although the Witte Wall PV 1 and Witte Wall PV 2 assessed development footprint is approximately 1010 ha, (and each PV Facility will have an estimated footprint of 260 ha within the assessed development footprint), the total farm portion is 3 646 ha and it is the total farm area that is used for the GA calculation.

It is recommended that a site visit and hydrocensus be undertaken during the design and planning phase (after environmental authorisation is issued, should it be granted) to quantify the number of potential boreholes that could be used for abstraction, as well as, their proximity to the development and other nearby groundwater sources and users. Groundwater quality sampling is also recommended to determine whether the quality of the water meets the quality recommendations for the cleaning of solar panels, and for other purposes during the construction and operational phases.

10.1. Statement and Reasoned Opinion

It is the opinion of this specialist that the proposed activity be allowed to proceed. No impacts of significance could be identified and therefore does not pose any risk to the geohydrological conditions on site. It is imperative that proper yield testing and quality analysis of groundwater be undertaken should it be considered for use.

10.2. EA Condition Recommendations

A site visit and hydrocensus conducted by groundwater specialist should be undertaken to determine the number of groundwater users and abstraction points. This must include water level recording and groundwater sampling of potential boreholes to be used for the development.

11. References

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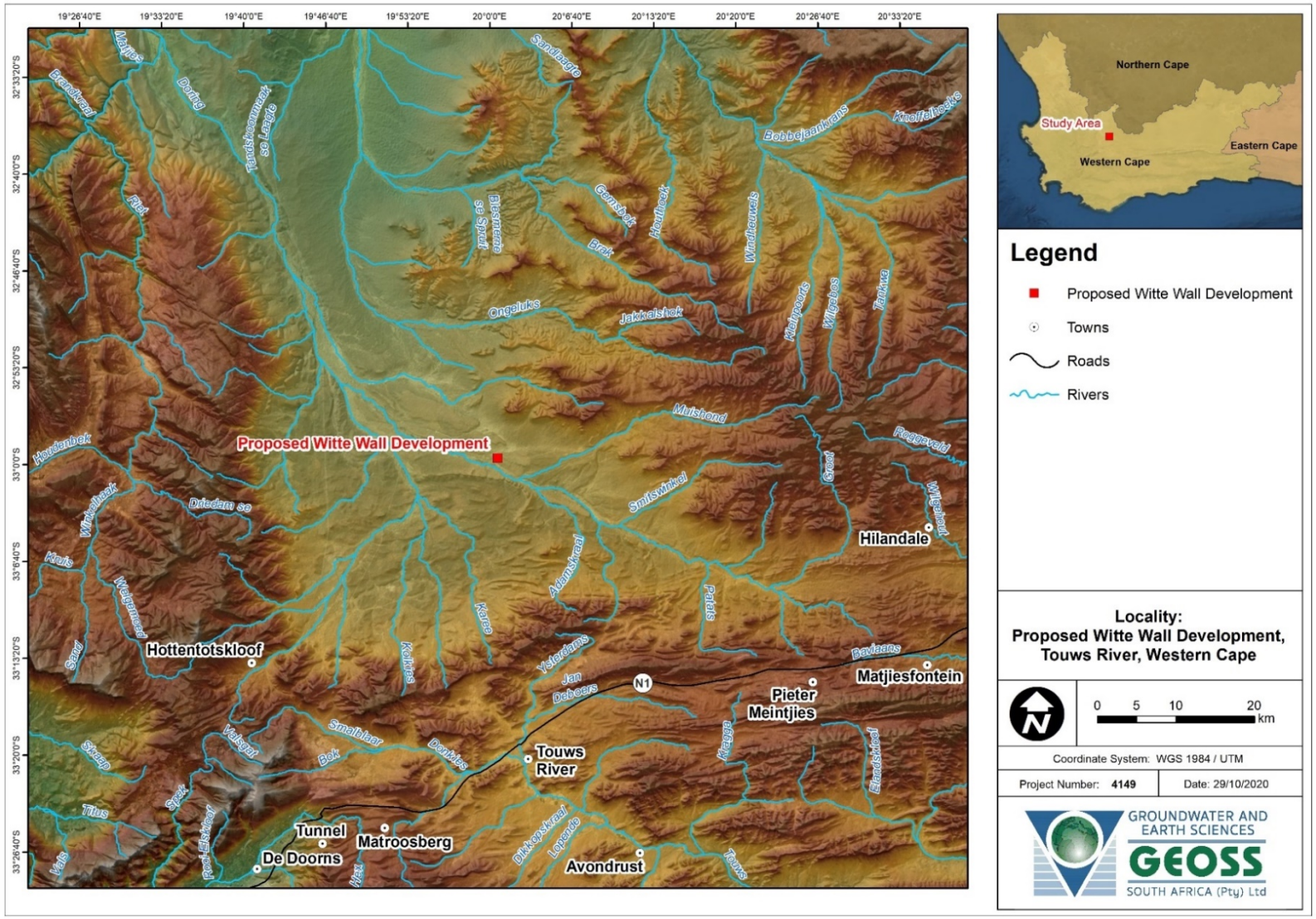
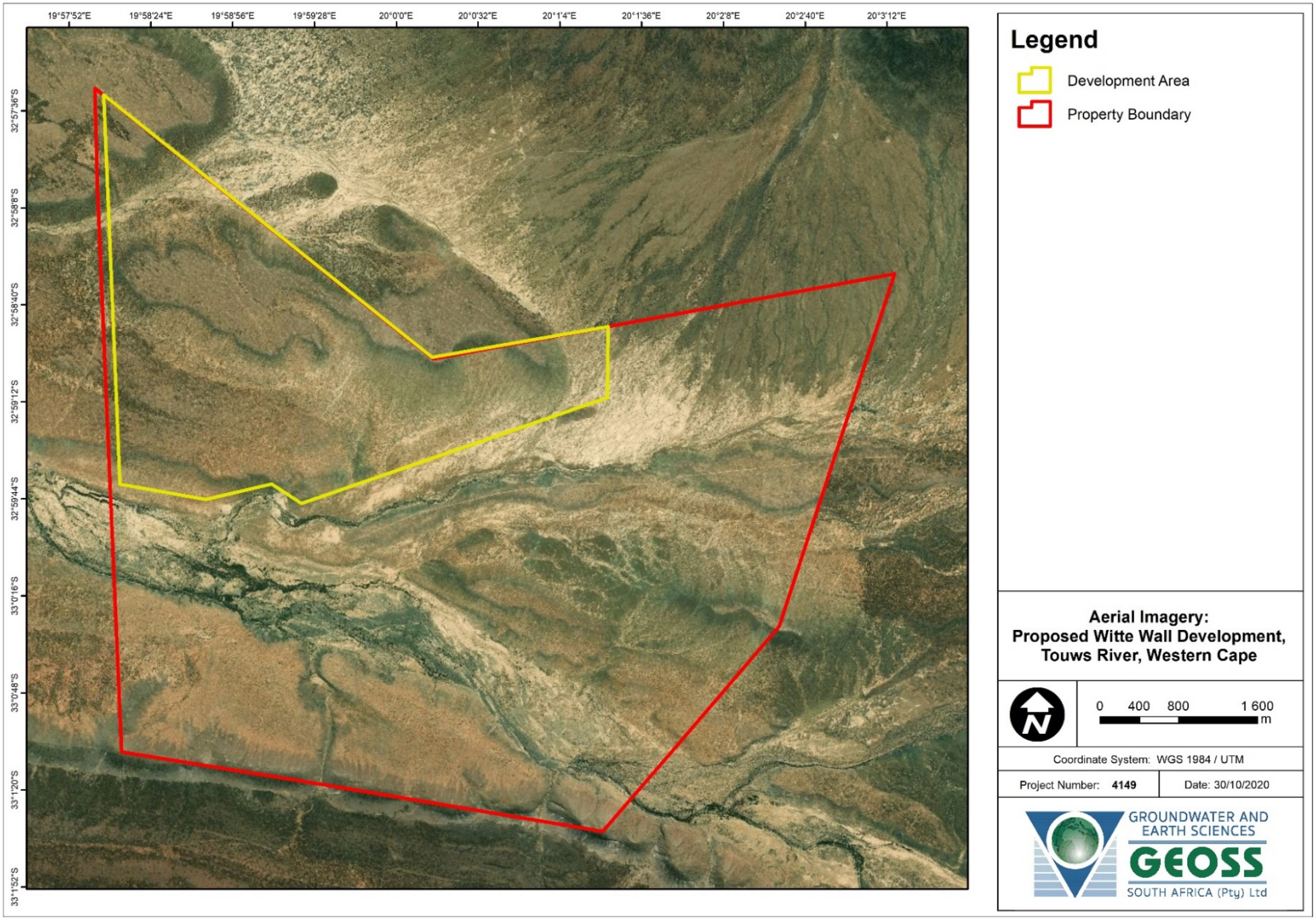
WRC, 2012. A Groundwater Planning Toolkit for the Main Karoo Basin: Identifying and quantifying groundwater development options incorporating the concept of wellfield yields and aquifer firm yields. WRC Report No. 1763/1/11, Pretoria, South Africa.

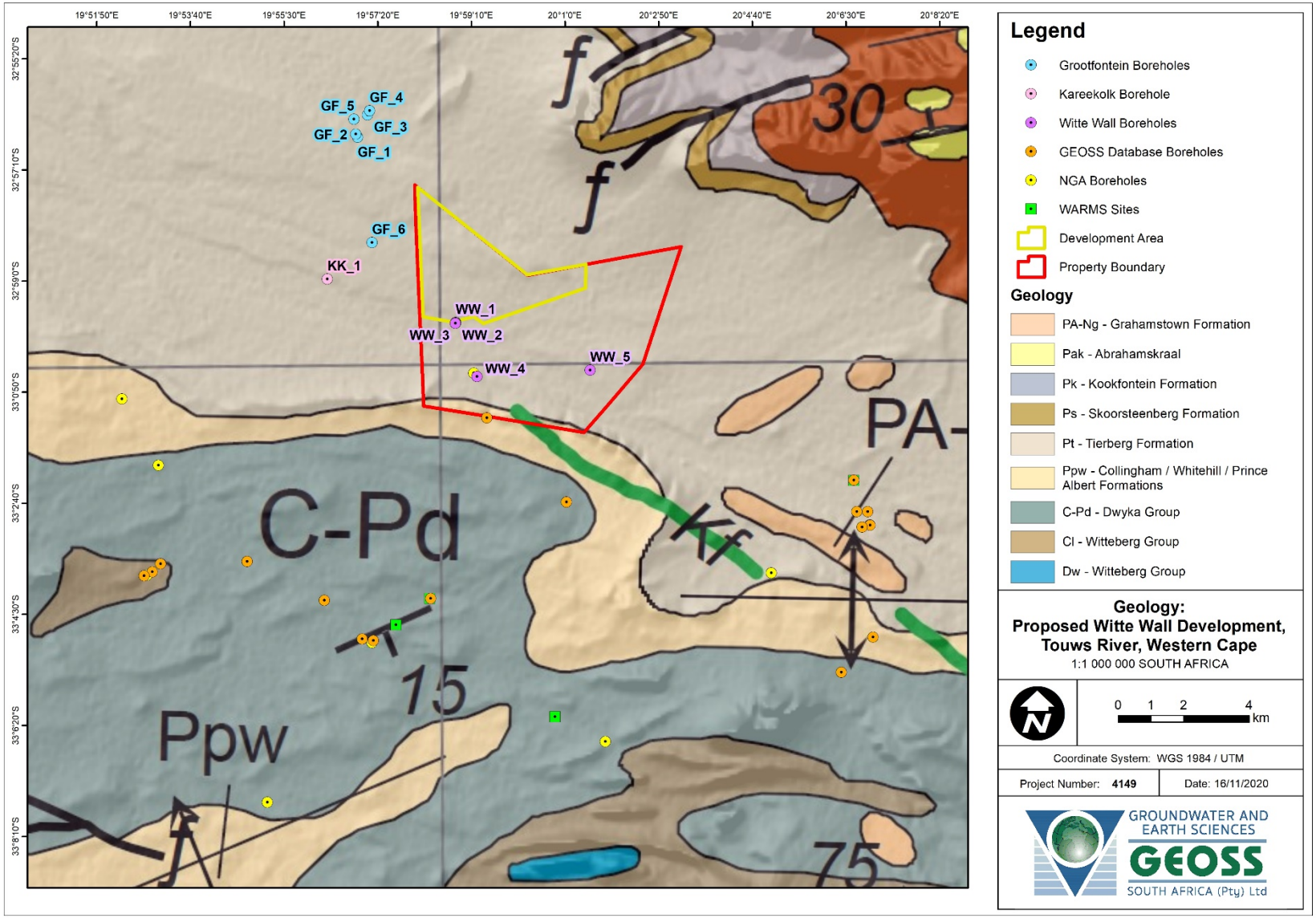
Appendix A - Maps



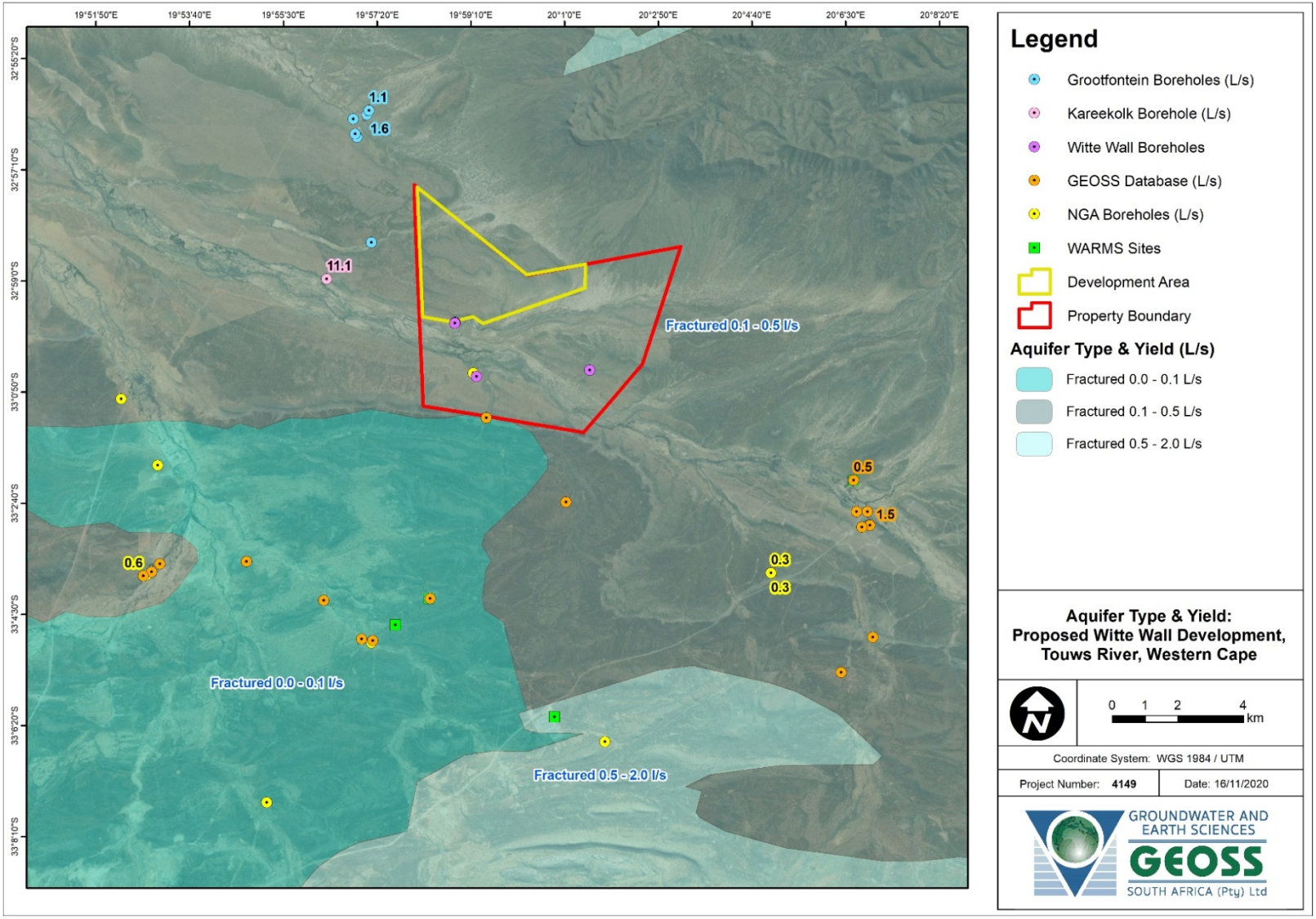
Map 1: Locality of the proposed development of two 175 MW solar PV facilities and associated electrical grid infrastructure, Touws River, Western Cape.



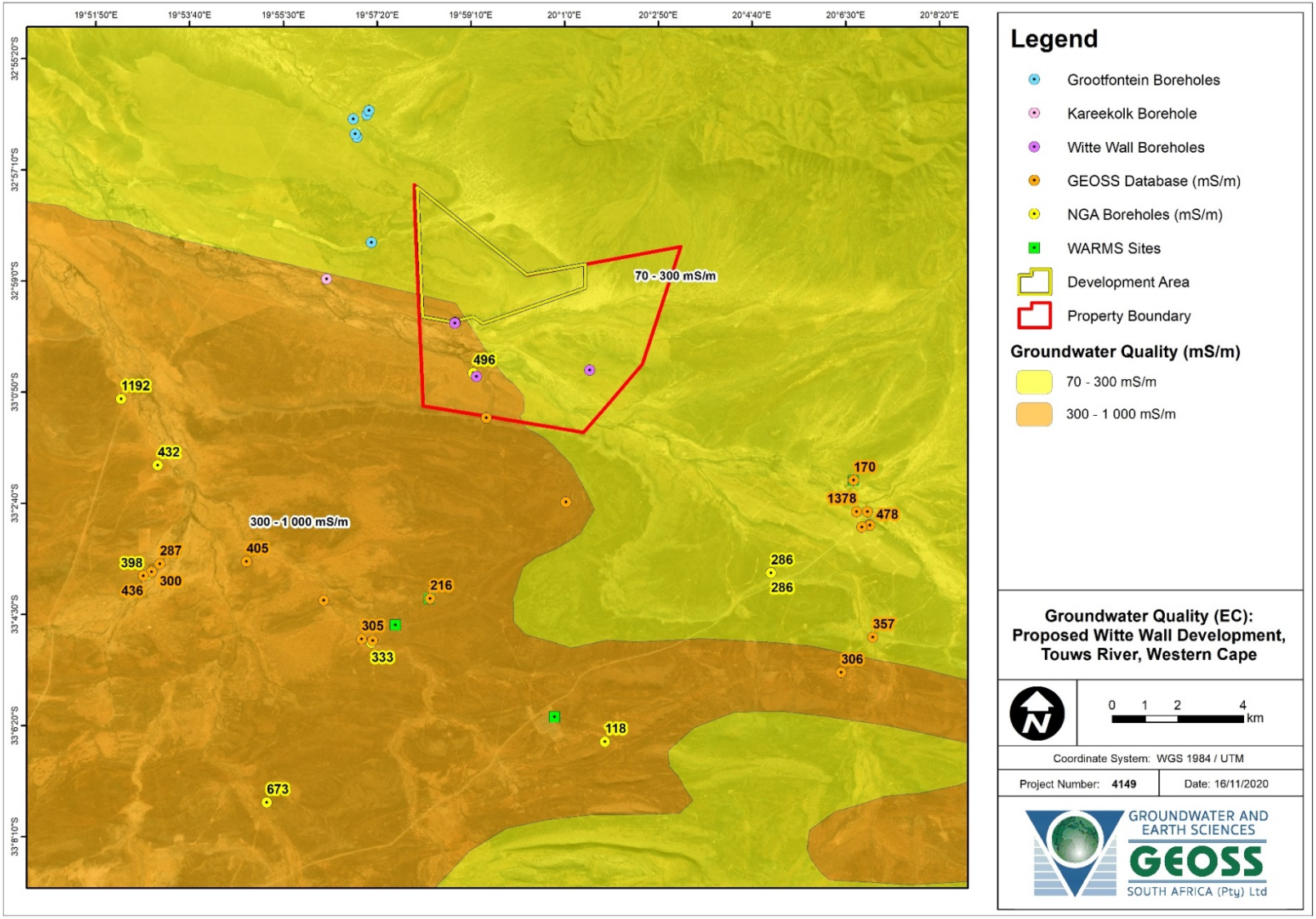
Map 2: Aerial view delineating the Witte Wall Farm portion and proposed Witte Wall PV 1 and Witte Wall PV 2 development assessed area (Note that each PV Facility will cover an estimated area of 260 ha).



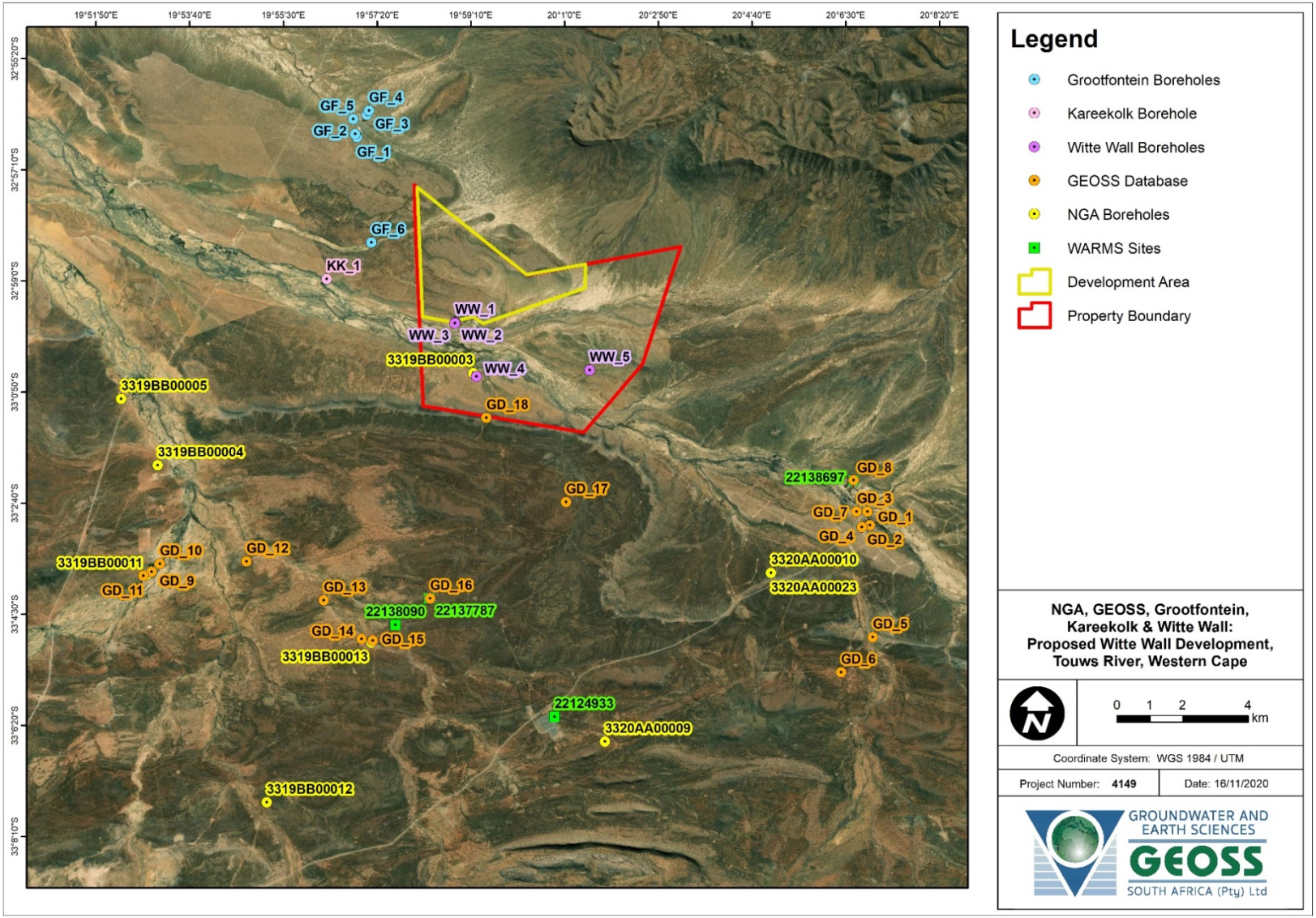
Map 3: Geological setting of the study area (CGS (2019) map: 1:1 00 000 scale South Africa).



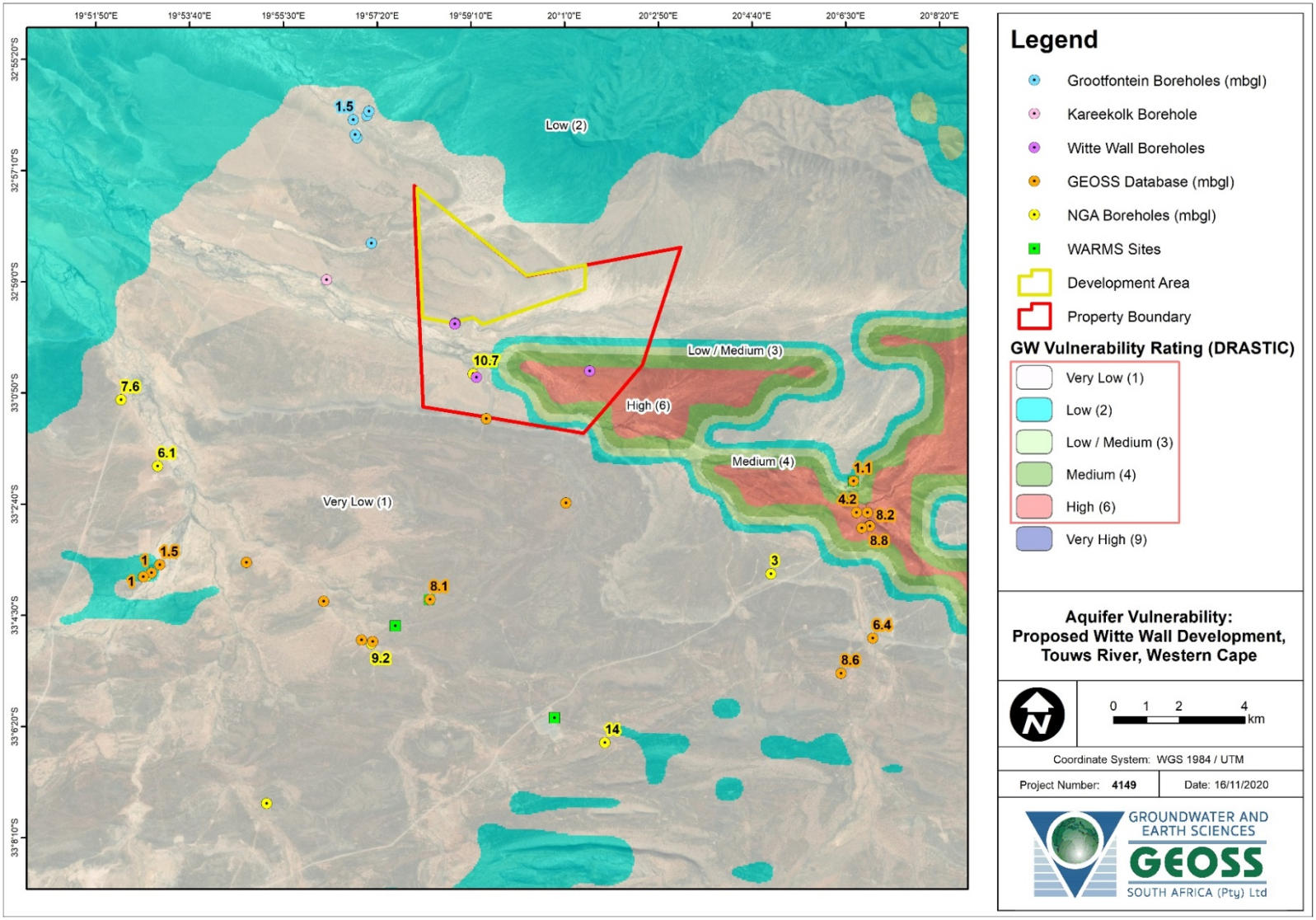
Map 4: Regional aquifer yield (DWAF, 2002) and borehole yields (L/s).



Map 5: Regional groundwater quality (mS/m) from DWAF (2002) and borehole groundwater quality (EC in mS/m).



Map 6: NGA, WARMS, Witte Wall, Grootfontein, Kareekolk and GEOSS internal database boreholes.



Map 7: Vulnerability rating (DWAF, 2005) and groundwater depths (mbgl).

Appendix B - Specialist Expertise

GENERAL

Nationality:	South African and Namibian
Profession:	Geohydrologist
Specialization:	Groundwater exploration, development, sampling and monitoring.
Position in firm:	Geohydrologist at GEOSS - Geohydrological and Spatial Solutions International (Pty) Ltd
Date commenced:	16th October 2017
Year of birth & ID #:	1991 – 9105216400083
Language skills:	English (good – speaking, reading and writing) Afrikaans (good - speaking, reading and writing).

KEY SKILLS

- Groundwater sampling, soil sampling, field measurements, borehole logging, data logging for groundwater monitoring, borehole depth and water level measurements, augering for piezometer installation, groundwater geophysics and conducting hydrocensus studies.

RELEVANT EXPERIENCE

- Numerous groundwater exploration - this includes aerial photo interpretation, resistivity, magnetic and electromagnetic geophysical surveys for borehole siting purposes, data analysis and interpretation and hydrogeological conceptualization, development, monitoring and management projects.
- Extensive satellite image data processing (including geo-referencing) for the Validation and Verification projects within the Breede-Overberg Catchment Management Agency.
- Smaller projects involving borehole siting's (aerial photo interpretation, geological mapping, geophysical profiling).
- Projects involving drilling supervision and pumping test supervision with associated data interpretation (FC Method) and writing of geohydrological reports.
- Groundwater and groundwater quality monitoring projects involving appropriate sampling, measurements, data analysis and reporting.
- Numerous Groundwater Impact Assessments

EDUCATIONAL AND PROFESSIONAL STATUS

Qualifications

2017	MEng (Geotechnical Engineering):	University of the Free State, South Africa
2015	BSc Hon – Earth Science Degree:	University of the Stellenbosch, South Africa
2014	BSc - Earth Science Degree:	University of the Stellenbosch, South Africa

Memberships

- Groundwater Division of the Geological Society of South Africa – Member No. 6080/16
- South African Council for National Scientific Professions (SACNASP) Mem. No. 123456

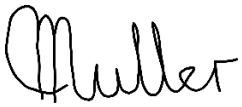
EMPLOYMENT RECORD

October 2017 to March 2019:	GEOSS – Geohydrological and Spatial Solutions International (Pty) Ltd, Stellenbosch
March 2019 to present	GEOSS SOUTH AFRICA (Pty) Ltd

Appendix C - Specialist Statement of Independence

I, **Charl Muller**, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist: 

Name of Company: **GEOSS South Africa Pty Ltd**

Date: **30 October 2020**

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Basic Assessments for the Proposed Development of two 175 MW Solar Photovoltaic Facilities and associated Electrical Grid Infrastructure (i.e. Witte Wall 1 and Witte Wall 2), near Touws River, Western Cape

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	GEOSS SOUTH AFRICA (PTY) LTD			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	100 %
Specialist name:	Charl Muller			
Specialist Qualifications:	BSc Hons (Earth Sciences) AND MEng (Civil Engineering)			
Professional affiliation/registration:	SACNASP Reg. no: 123456			
Physical address:	Unit 12, Technostell Building, 9 Quantum St, Techno Park, Stellenbosch, 7600			
Postal address:	P.O. Box 12412, Die Boord, Stellenbosch			
Postal code:	7613	Cell:	079824 6157	
Telephone:	021 880 1079	Fax:	086 605 1121	
E-mail:	cmuller@geoss.co.za			

2. DECLARATION BY THE SPECIALIST

I, Charl Muller, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

GEOSS SOUTH AFRICA (PTY) LTD

Name of Company:

30 | October | 2020

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Charl Muller, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

GEOSS SOUTH AFRICA (PTY) LTD

Name of Company

30/October/2020.

Date

Signature of the Commissioner of Oaths

Date

STASIE BEVELVOERDER
STELLENBOSCH
2020 -10- 30
STELLENBOSCH
STATION COMMANDER
SOUTH AFRICAN POLICE SERVICE

Appendix D: Site Sensitivity Verification

It is important to note that there are no dedicated Geohydrology or Groundwater themes on the National Web-based Environmental Screening Tool (Screening Tool) (as at October 2020), therefore the environmental sensitivity of the proposed project area as identified by the Screening Tool is not applicable. Therefore, no site sensitivity verification report is required. Furthermore, there is no dedicated assessment protocol prescribed for Geohydrology or Groundwater. Therefore, the specialist assessment has been undertaken in compliance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014. All relevant desktop information, consultation with landowners, and previous assessments undertaken by the author in the study area have been taken into consideration in this assessment.

Appendix E: Impact Assessment Methodology

The following impact assessment has been used in this assessment.

The impact assessment includes:

- *the nature, significance and consequences of the impact and risk;*
- *the extent and duration of the impact and risk;*
- *the probability of the impact and risk occurring;*
- *the degree to which impacts and risks can be mitigated;*
- *the degree to which the impacts and risks can be reversed; and*
- *the degree to which the impacts and risks can cause loss of irreplaceable resources.*

As per the DEFFT Guideline 5: Assessment of Alternatives and Impacts, the following methodology is applied to the prediction and assessment of impacts and risks. Potential impacts and risks have been rated in terms of the direct, indirect and cumulative:

- *Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.*
- *Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.*
- *Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.*

The impact assessment methodology includes the following aspects:

- *Nature of impact/risk - The type of effect that a proposed activity will have on the environment.*

- *Status - Whether the impact/risk on the overall environment will be:*
    - *Positive - environment overall will benefit from the impact/risk;*
    - *Negative - environment overall will be adversely affected by the impact/risk; or*
    - *Neutral - environment overall not be affected.*

- *Spatial extent – The size of the area that will be affected by the impact/risk:*
    - *Site specific;*
    - *Local (<10 km from site);*
    - *Regional (<100 km of site);*
    - *National; or*
    - *International (e.g. Greenhouse Gas emissions or migrant birds).*

- *Duration – The timeframe during which the impact/risk will be experienced:*
    - *Very short term (instantaneous);*
    - *Short term (less than 1 year);*
    - *Medium term (1 to 10 years);*
    - *Long term (the impact will cease after the operational life of the activity (i.e. the impact or risk will occur for the project duration)); or*
    - *Permanent (mitigation will not occur in such a way or in such a time span that the impact can be considered transient (i.e. the impact will occur beyond the project decommissioning)).*

- *Consequence – The anticipated consequence of the risk/impact:*
    - *Extreme (extreme alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they permanently cease);*
    - *Severe (severe alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);*
    - *Substantial (substantial alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);*
    - *Moderate (notable alteration of natural systems, patterns or processes, i.e. where the environment continues to function but in a modified manner); or*
    - *Slight (negligible alteration of natural systems, patterns or processes, i.e. where no natural systems/environmental functions, patterns, or processes are affected).*

- *Reversibility of the Impacts - the extent to which the impacts/risks are reversible assuming that the project has reached the end of its life cycle (decommissioning phase):*
    - *High reversibility of impacts (impact is highly reversible at end of project life i.e. this is the most favourable assessment for the environment);*
    - *Moderate reversibility of impacts;*
    - *Low reversibility of impacts; or*
    - *Impacts are non-reversible (impact is permanent, i.e. this is the least favourable assessment for the environment).*

- *Irreplaceability of Receiving Environment/Resource Loss caused by impacts/risks – the degree to which the impact causes irreplaceable loss of resources assuming that the project has reached the end of its life cycle (decommissioning phase):*
    - *High irreplaceability of resources (project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment);*
    - *Moderate irreplaceability of resources;*
    - *Low irreplaceability of resources; or*
    - *Resources are replaceable (the affected resource is easy to replace/rehabilitate, i.e. this is the most favourable assessment for the environment).*

Using the criteria above, the impacts have been further assessed in terms of the following:

- *Probability – The probability of the impact/risk occurring:*
    - *Extremely unlikely (little to no chance of occurring);*
    - *Very unlikely (<30% chance of occurring);*
    - *Unlikely (30-50% chance of occurring)*
    - *Likely (51 – 90% chance of occurring); or*
    - *Very Likely (>90% chance of occurring regardless of prevention measures).*

To determine the significance of the identified impact/risk, the consequence is multiplied by probability (qualitatively as shown in Figure 1).

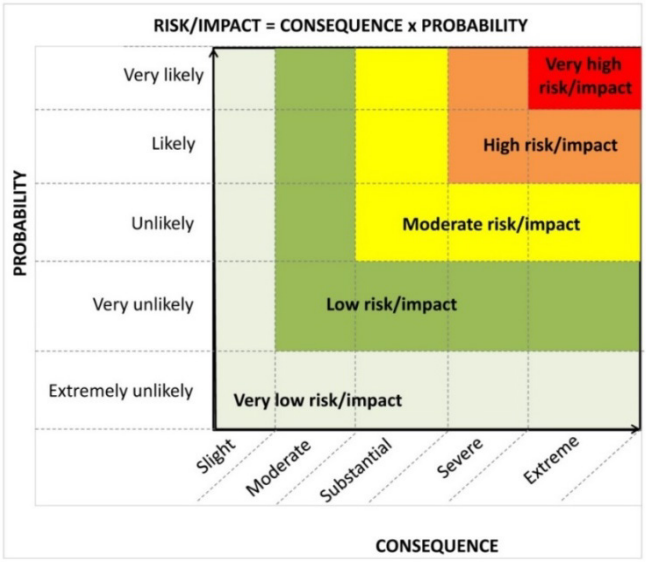


Figure 1. Guide to assessing risk/impact significance as a result of consequence and probability.

- *Significance – Will the impact cause a notable alteration of the environment?*
    - *Very low (the risk/impact may result in very minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making);*
    - *Low (the risk/impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making);*
    - *Moderate (the risk/impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures, and will only have an influence on the decision-making if not mitigated);*
    - *High (the risk/impact will result in major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making); and*
    - *Very high (the risk/impact will result in very major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making (i.e. the project cannot be authorised unless major changes to the engineering design are carried out to reduce the significance rating)).*

With the implementation of mitigation measures, the residual impacts/risks are ranked as follows in terms of significance:

- *Very low = 5;*
- *Low = 4;*
- *Moderate = 3;*
- *High = 2; and*
- *Very high = 1.*

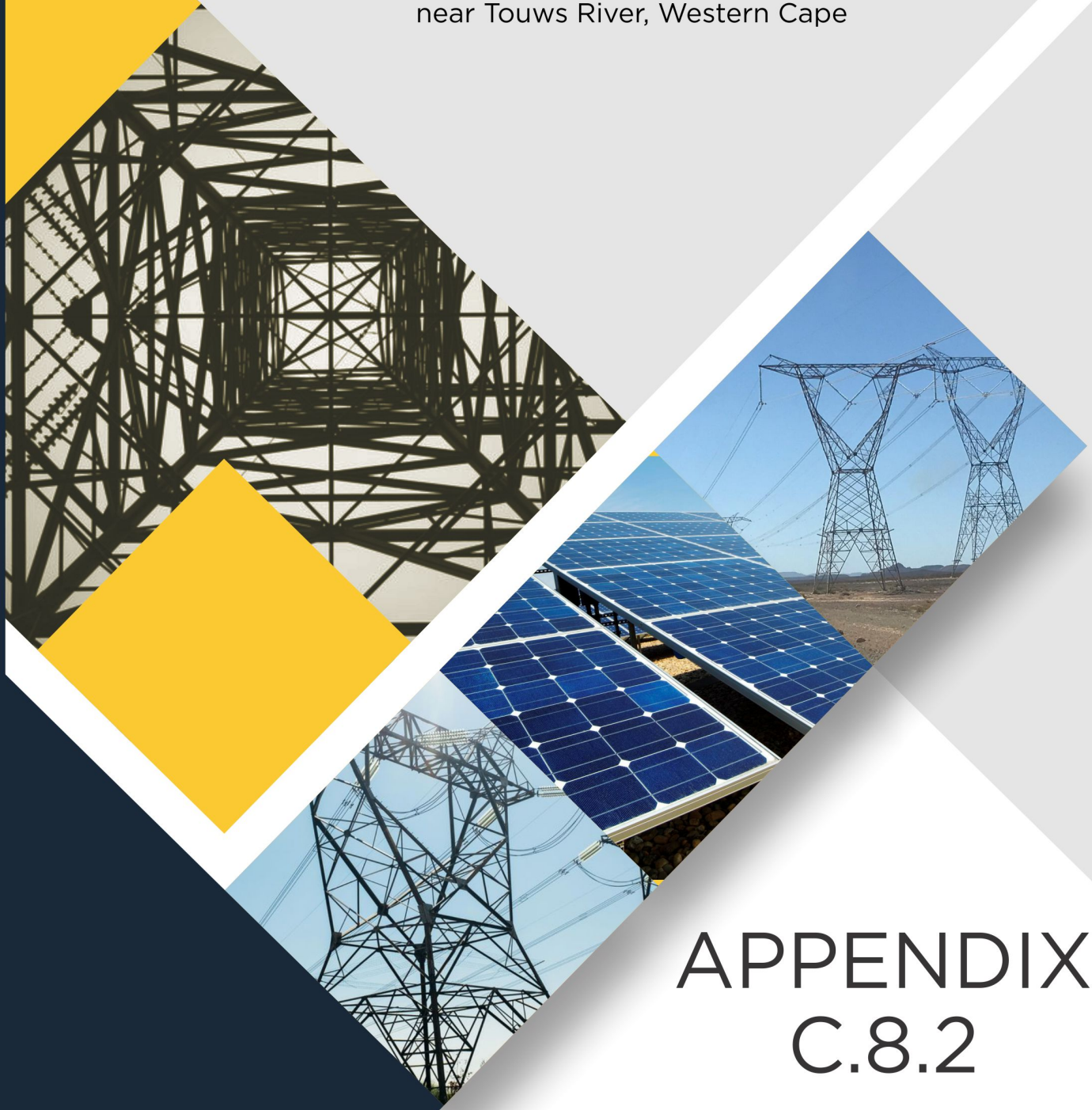
Confidence – The degree of confidence in predictions based on available information and specialist knowledge:

- *Low;*
- *Medium; or*
- *High.*

Appendix F: Compliance with the Appendix 6 of the 2014 EIA Regulations (as amended)

Requirements of Appendix 6 (Specialist Reports) of Government Notice R326 (Environmental Impact Assessment (EIA) Regulations of 2014, as amended)	***Section where this has been addressed in the Specialist Report***
1. (1) A specialist report prepared in terms of these Regulations must contain - *a) details of -* *i. the specialist who prepared the report; and* *ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;*	*Section 1.2 and Appendix B*
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	*Appendix C*
c) an indication of the scope of, and the purpose for which, the report was prepared;	*Section 1*
(cA) an indication of the quality and age of base data used for the specialist report;	*Section 2*
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	*Section 4*
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	*Not Applicable (Desktop Study undertaken)*
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	*Section 2 and Section 4*
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	*Section 4 and Maps*
g) an identification of any areas to be avoided, including buffers;	*Not Applicable*
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	*Section 4 and Maps*
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	*Section 2.2*
j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	*Section 5 and Section 6*
k) any mitigation measures for inclusion in the EMPr;	*Section 6 and Section 7*
l) any conditions for inclusion in the environmental authorisation;	*Section 10*
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	*Section 7*
n) a reasoned opinion- *i. whether the proposed activity, activities or portions thereof should be authorised;* *(iA) regarding the acceptability of the proposed activity or activities; and* *ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;*	*Section 10*
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	*Section 2.3*
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	*Not Applicable at this stage*
q) any other information requested by the competent authority.	*Not Applicable*
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	*Not Applicable at this stage, refer to the BA Report*

Basic Assessment for the Proposed Development of Electrical Grid Infrastructure to support the proposed nine 175 MW Solar Photovoltaic Facilities and associated Infrastructure (i.e. Witte Wall PV 1, Witte Wall PV 2, Grootfontein PV 1, Grootfontein PV 2, Grootfontein PV 3, Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3, and Hoek Doornen PV 4), near Touws River, Western Cape



APPENDIX C.8.2

Geohydrology Assessment for Grootfontein

GROUNDWATER SPECIALIST ASSESSMENT:

Basic Groundwater Assessment for the Proposed Development of three 175 MW Solar Photovoltaic Facilities and associated Electrical Grid Infrastructure at Grootfontein Farm (i.e. Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3), near Touws River, Western Cape

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Report prepared for:	*Report prepared by:*
CSIR – Environmental Management Services P O Box 320 Stellenbosch 7599 South Africa	Charl Muller GEOSS South Africa (Pty) Ltd P.O. Box 12412 Die Boord, Stellenbosch 7613 South Africa Stellenbosch 7600 South Africa

30 October 2020

Executive Summary

GEOSS South Arica (Pty) Ltd was appointed by the Council for Scientific and Industrial Research (CSIR) to complete a basic groundwater assessment for the proposed development of three 175 MW solar photovoltaic (PV) facilities and associated electrical grid infrastructure, near Touws River in the Western Cape. This geohydrological assessment includes a **desktop review** of groundwater characteristics and users in the area, with the aim of determining the potential for groundwater to be used for panel cleaning, as well as risk to nearby groundwater users, in both the construction and operational phases.

The area of interest receives most of its rainfall during the winter months with an average of 197 mm per year with increased evaporation rates during the summer months. The regional geological setting consists of sedimentary deposits underlain by five distinct geological formations which directly correlate with the regional geohydrological characterization. According to the regional scale groundwater map the greater portion of the study area hosts a “fractured” aquifer (i.e. fractures within the bedrock constitute an aquifer) with borehole yields being in the range of 0.1 – 0.5 L/s. The regional groundwater quality, using Electrical Conductivity (EC) as an indicator, is “moderate to poor” (EC of 70 – 1 000 mS/m). Data sources for the area indicates that the EC varies from 118 mS/m to a maximum of 1 377 mS/m. The DRASTIC groundwater vulnerability rating methodology (Department of Water Affairs and Forestry, 2005) indicates that the larger study area can be classified as having a “low” groundwater vulnerability rating.

The potential impacts of the proposed development on groundwater are:

- Accidental oil spillages or fuel leakages;
- Over-abstraction of groundwater; and
- Groundwater contamination due solar panel cleaning agents.

These issues can be easily managed and potential groundwater impacts completely mitigated if appropriate measures are implemented.

The author considers groundwater to be a viable source for use during the construction phase and operational phase. Prior to use, all boreholes being used should be tested to ensure their yield and quality meets necessary requirements. Furthermore, any abstraction boreholes should be equipped with water level and water quality monitoring infrastructure; as well as a flow meter, prior to use. Water use authorisation must also be addressed. The planned groundwater use is likely to fall within the General Authorization (GA) (based on anticipated volumes) so the groundwater use need only be registered (assuming the water use meets the relevant GA requirements).

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List of Abbreviations

BH	Borehole
CGS	Council for Geoscience
DHSWS	Department of Human Settlements, Water and Sanitation
DWA	Department of Water Affairs (used to be Department of Water Affairs and Forestry)
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	electrical conductivity
GIS	Geographic Information System
L/s	litres per second
m	metres
mbch	meters below collar height
mbgl	metres below ground level
mm	millimetre
mS/m	milli-Siemens per metre
NGA	National Groundwater Archive
WARMS	Water Authorisation and Registration Management System

Glossary

Definitions	
Aquifer	A geological formation, which has structures or textures that hold water or permit appreciable water movement through them [from National Water Act (Act No. 36 of 1998)].
Borehole	Includes a well, excavation, or any other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer [from National Water Act (Act No. 36 of 1998)].
DRASTIC	An acronym for a groundwater vulnerability assessment methodology: D = depth to groundwater / R = recharge / A = aquifer media type / S = soil type / T = topography / I = impact of the unsaturated zone / C = hydraulic conductivity. The methodology uses a rating and weighting approach and was developed by the Environmental Protection Agency (USA)
Electrical Conductivity	The ability of groundwater to conduct electrical current, due to the presence of charged ionic species in solution (Freeze and Cherry, 1979).
Fractured aquifer	Fissured and fractured bedrock resulting from decompression and/or tectonic action. Groundwater occurs predominantly within fissures and fractures.
Groundwater	Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.
Inferred	Where a geological contact or fault is believed to exist however is not confirmed.
Intergranular aquifer	Generally unconsolidated but occasionally semi-consolidated aquifers. Groundwater occurs within intergranular interstices in porous medium. Typically occur as alluvial deposits along river terraces.
Intergranular and fractured aquifers	Largely medium to coarse grained granite, weathered to varying thicknesses, with groundwater contained in intergranular interstices in the saturated zone, and in jointed and occasionally fractured bedrock.
Vulnerability	The tendency or likelihood for contaminants to reach a specified position in the ground-water system after introduction at some location above the uppermost aquifer (National Research Council, 1993).

Groundwater Specialist Assessment

This report serves as the Groundwater Specialist Assessment prepared as part of the Basic Assessments (BAs) for the proposed development of three 175 MW Solar Photovoltaic (PV) Facilities and associated Electrical Grid Infrastructure (Specifically Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3), near Touws River, Western Cape.

1. Introduction

GEOSS South Arica (Pty) Ltd was appointed by the Council for Scientific and Industrial Research (CSIR) to complete a basic groundwater assessment for the proposed project (**Map 1**). This geohydrological assessment includes a desktop review of groundwater characteristics and users in the area, with the aim of determining the potential for groundwater to be used for construction and operational purposes, including panel cleaning, as well as risk to nearby groundwater users.

The study area can be divided into three separate farms namely Witte Wall, Grootfontein and Hoek Doornen. The total water requirement is estimated to be 5 million to 8 million litres per year during operation per project (i.e. per Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3). At the time of writing this report the amount of groundwater to be used during construction was uncertain, however in this report it has been assumed that groundwater will be used during this phase. In terms of groundwater quality, optimally the water should be of drinking water quality. The groundwater might have to be treated to make it suitable for the intended use.

This report outlines the work completed to assess the likelihood of using groundwater for the Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 developments (**Map 2**), including the potential impact the development may have on groundwater resources in the area.

1.1. Scope, Purpose and Objectives of this Specialist Report

The scope of work is to provide groundwater specialist services, including the tasks outlined below:

- Desktop assessment for groundwater to be used for construction and operational purposes for each proposed project, including solar panel cleaning.
- Assessment of the impact on geohydrological resources as a result of the proposed development.
- Provide recommendations to minimize or mitigate impacts.
- Confirm what type of authorisation is required to make use of the groundwater.

The results of the investigation are presented in this report along with the data analysis and interpretation.

1.2. Details of Specialist

This specialist assessment has been undertaken by Charl Muller of GEOSS South Africa. Charl Muller is registered with the South African Council for Natural and Scientific Professions (SACNASP), with Registration Number 123456 in the field of Hydrogeology. A curriculum vitae is included in **Appendix B** of this specialist assessment.

1.3. Terms of Reference

The procedure adopted for this study involved a **desktop study** of all available data and databases. The study involved obtaining and reviewing all relevant data to the proposed projects. This included analysing data from the National Groundwater Archive (NGA), Water Authorisation and Registration Management System (WARMS) and GEOSS's internal database, as well as groundwater yield, groundwater chemistry and geological maps of the area. A site visit was not carried out as the study was desktop based.

2. Approach and Methodology

The specialist study was completed as follows:

Task 1: Obtain all relevant data to the proposed projects (i.e. obtain data from NGA and associated groundwater use databases, e.g. WARMS, GEOSS internal database). Obtain any data from local Department of Water and Sanitation (DWS) [now operating as the Department of Human Settlements, Water and Sanitation (DHSWS)] monitoring boreholes. Obtain relevant geological maps and geohydrological maps. Obtain relevant groundwater reports. Compile a project Geographic Information System (GIS).

Task 2: Analyse the data, using geohydrological methods and address the questions raised in the project objectives.

Task 3: Document the results in a report.

The report is also required to comply with the Assessment Protocols that were published on 20 March 2020, in Government Gazette 43110, Government Notice (GN) 320 (i.e. Part A, which provides the Site Sensitivity Verification Requirements where a Specialist Assessment is required but no specific Assessment Protocol has been prescribed). There is no specific Assessment Protocol devised for Geohydrology or Groundwater Assessments. Therefore, the report needs to comply with Appendix 6 of the 2014 National Environmental Management Act (Act 107 of 1998, as amended) Environmental Impact Assessment (EIA) Regulations.

2.1. Information Sources

The following information sources were used in this study:

Data / Information	Source	Date	Type	Description
Geological Map	Council for Geosciences	2009	Spatial	1:1 000 000 scale Geological Map series of South Africa
Geological Map	Council for Geosciences	1991	Spatial	1:250 000 scale Geological Map Series of 3320 Ladismith
Geological Map	Council for Geosciences	2001	Spatial	1:250 000 scale Geological Map Series of 3319 Worcester
Geological Map	Council for Geosciences	1973	Spatial	1:250 000 scale Geological Map Series of 3218 Clanwilliam
Geological Map	Council for Geosciences	1983	Spatial	1:250 000 scale Geological Map Series of 3218 Sutherland
GEOSS Database	GEOSS South Africa	2015	Report	Consulting report from a neighbouring property.
Climatology and Geohydrology	Cape Farm Mapper	2009	Database	SA Atlas of Climatology and Geohydrology; obtained from Western Cape Government Agriculture
Groundwater recharge and vulnerability mapping	GWD Conference Bloemfontein	2007	Spatial	A National scale approach to groundwater recharge and vulnerability mapping

Data / Information	Source	Date	Type	Description
Hydrogeological map series	Department of Water Affairs and Forestry	2002	Spatial	Hydrogeological map series of the republic of South Africa
NGA Database	NGA	27 October 2020	Database and Spatial	Spatial delineation of NGA registered boreholes
WARMS Database	Water use Authorization & Registration Management System	June 2019	Database and Spatial	Spatial delineation of WARMS registered boreholes

2.2. Assumptions, Knowledge Gaps and Limitations

The following assumptions and limitations apply:

- A limitation experienced during this investigation was that no site visit was carried out, and therefore no hydrocensus could be undertaken. Despite this, this desktop study is considered suitable to meet the objectives of the study
- The geohydrological assessment is based on previous studies and available literature for the study area. Regional scale GIS datasets based on 1: 500 000 and previous hydrogeological work completed have been assumed to be correct.
- No drill records or yield test data exists for production or wind pump boreholes to clarify yields and geological logs.
- The acquisition of accurate groundwater levels proved to be difficult, therefore data was limited to information obtained from local parties. Nonetheless these limitations have not negatively impacted the conclusions of the project.
- The NGA data is available at a local scale, although is known to sometimes contain false information.

The information obtained was sufficient to provide comprehensive geohydrological characterization of the regional setting.

It must be noted that there are no areas on site that should be avoided from a groundwater sensitivity perspective.

2.3. Consultation Processes Undertaken

No site visit was undertaken; however, involved land owners were contacted (if possible) to gather as much information on existing boreholes surrounding the proposed development.

3. Description of Project Aspects relevant to the Geohydrological Assessment

As mentioned above, the Project Applicant intends to make use of existing boreholes to source groundwater (if available and if suitable) for the construction and operational phases (i.e. cleaning of panels). As a result, water pipelines may need to be constructed in order to transfer groundwater from existing boreholes or they may be transported by trucks from the boreholes to the sites. Groundwater will need to be stored on site in suitable containers or reservoir tanks during the construction and operational phases. The process required to ensure use of the groundwater in terms of the National Water Act is also addressed in this study. As noted in the BA Reports, if groundwater is not suitable, then the water will be trucked in from the municipality.

Generally, groundwater can be impacted negatively in two manners, namely:

- Over-abstraction (where groundwater abstraction exceeds recharge rates) which can result in the alteration of groundwater flow directions and gradients.
- Quality deterioration (i.e. from anthropogenic activities negatively impacting groundwater quality).

There is currently limited groundwater abstraction taking place in relation to the size of the study area (based on regional datasets). Groundwater is mostly used for drinking, agricultural purposes and livestock watering. The low rainfall and high evapotranspiration rates within the study area are a limiting factor for the recharge of the aquifer underlying the study area.

The groundwater requirement for the project can be met by using the existing boreholes. However, agreements will have to be put in place with the current land owners for the use of groundwater. These agreements will have to be legally valid documents and the necessary endorsements will be required from the DHSWS. If no such agreements can be put in place, then additional boreholes will need to be drilled on the relevant farm portions/developments, followed by yield and water quality testing, and then authorization from DHSWS to use the groundwater will be required. The groundwater will need to be stored in water tanks on site. The groundwater required for the construction and operational phase per project will be very low.

4. Baseline Environmental Description (Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3)

4.1. General Description

The nearest town to the centroid of the study area (Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3) is Touws River, approximately 40 km to the south. The Grootfontein farm landscape is arid with transported sands occurring widely along plains with shales and sandstones dominating the mountainous areas.

4.2. Project Specific Description (Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 - PV Facilities, Electrical Grid Infrastructure and Associated Infrastructure)

The Grootfontein Farm experiences a semi-arid climate, with most of the rainfall occurring during the winter months. **Figure 1** shows the monthly average air temperature and rainfall distribution and **Figure 2** shows the monthly median rainfall and evaporation distribution for the Grootfontein Farm (Schulze, 2009). The long term (1950 – 2000) mean annual precipitation for the Grootfontein Farm is 197 mm/a. The rainfall does not exceed evaporation during the winter rainy season.

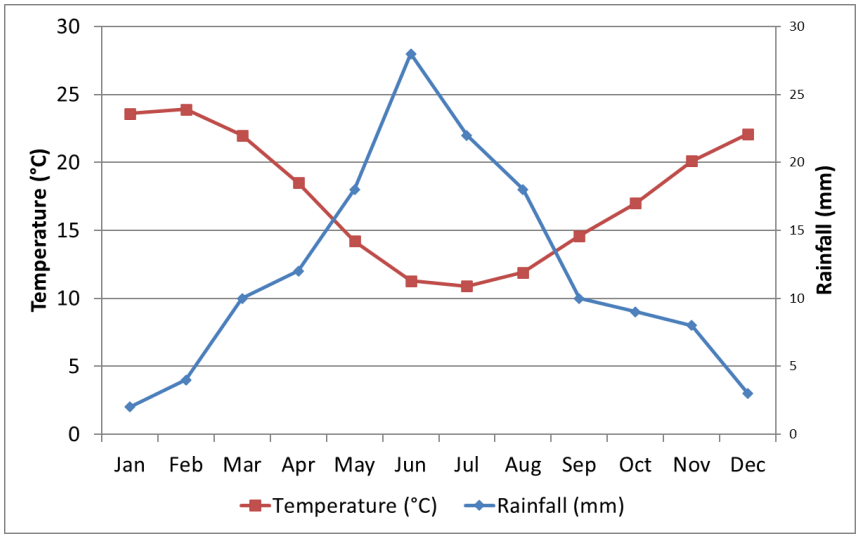

Figure 1: Monthly average air temperature and rainfall distribution for the Grootfontein Farm (Schulze, 2009).

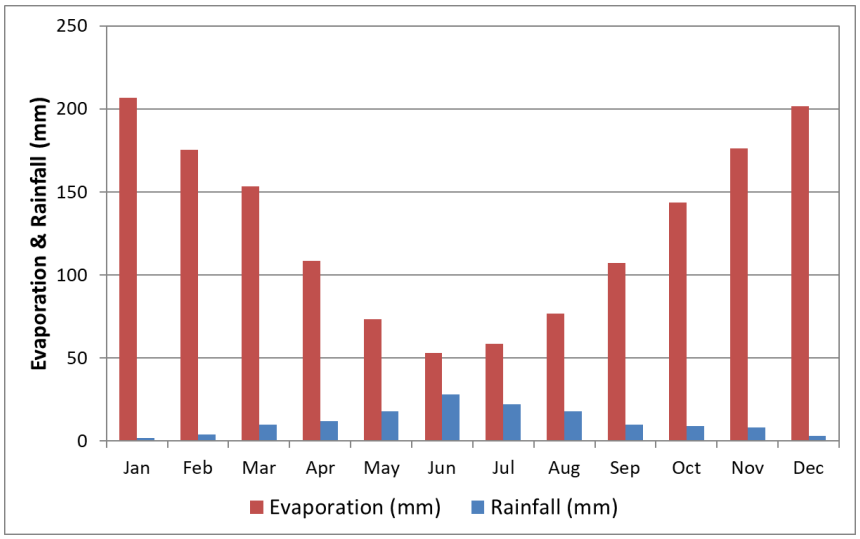

Figure 2: Monthly average rainfall and evaporation distribution for the Grootfontein Farm (Schulze, 2009).

4.3. Regional Geology

The Geological Survey of South Africa (now the Council for Geoscience) has mapped the area at 1:1M scale (South Africa). The geological setting is shown in **Map 3**. The main geology of the area is listed in **Table 1**.

Table 1: Geological formation within the study area.

Symbol	Formation	Group	Lithology
N-Qg	n/a - Quaternary Age		Alluvium and terrace gravel.
PA-Ng	Grahamstown Formation	n/a	High-level terrace gravel, silcrete, ferricrete.
Pak	Abrahamskraal Formation	Beaufort Group	Mudstone, siltstone, sandstone and thin chert beds.
Pk	Kookfontein Formation	Ecca Group	Shale, siltstone, subordinate sandstone.
Ps	Skoorsteenberg Formation		Mudrock and siltstone, sandstone
Pt	Tierberg Formation		Dark-grey shale and siltstone.
Ppw	1. Collingham Formation 2. Whitehill Formation 3. Prince Albert Formations		1. Siltstone, chert and sandstone with thin interbedded shale and yellow weathering mudstone/tuff. 2. Dark-grey shale, light-grey weathering with cherty siltstone beds 3. Dark-grey shale with reddish-brown-weathering siltstone.
C-Pd	Dwyka Formation		Tillite, diamictite, and subsidiary shale.
Cl	n/a	Witteberg Group	Mudrock, micaceous shale, siltstone, quartzose and arkosic sandstone, diamictite.
Dw			Reddish to white quartz arenite, red to brown thin-bedded sandstone, minor micaceous red or purple siltstone and shale, rhythmite

The Grootfontein Farm Portions is underlain by the Grahamstown Formation deposits which comprises of high-level terrace gravel, silcrete and ferricrete. This is most likely underlain by (in order of youngest to oldest):

- dark-grey shale and siltstone (the Tierberg Formation)
- siltstone, chert and sandstone with thin interbedded shale and yellow weathering mudstone/tuff (the Collingham Formation)
- dark-grey shale, light-grey weathering with cherty siltstone beds (the Whitehill Formation)
- dark-grey shale with reddish-brown-weathering siltstone (the Prince Albert Formation)
- tillite, diamictite, and subsidiary shale (the Dwyka Formation)

The proposed development is located east of two faults trending from north-east towards the south-west. These faults are prominent in the Kookfontein, Skoorsteenberg and Grahamstown Formations resulting in fracturing of the bedrock (**Map 3**). Whereas, to the southeast of the Grootfontein Farm portion is a mapped Dolerite Dyke (Kf). These faults and dyke structures are good target zones if further groundwater development is going to take place.

4.4. Regional Hydrogeology

The regional aquifer directly underlying the Grootfontein Farm portion is classified by the Department of Water Affairs and Forestry (DWAF) (DWAF, 2002) as a fractured aquifer with an average yield potential of 0.1 – 0.5 L/s (**Map 4**). A fractured aquifer describes an aquifer where groundwater only occurs in narrow fractures within the bedrock.

Based on the DWAF (2002) mapping of the regional groundwater quality, as indicated by electrical conductivity (EC), the majority of the farm portion is in the range of 70 – 300 mS/m, whereas towards

the southern corner of the portion the quality ranges from 300 – 1 000 mS/m. This is considered to be "moderate to poor" quality for water (**Map 5**) with respect to drinking water standards.

Both these classifications are based on regional datasets, and therefore only provide an indication of conditions to be expected.

4.4.1. NGA Database

A desktop assessment was initially carried out around the property to determine if there were any groundwater users in the area. The NGA database provides data on borehole positions, groundwater chemistry and yield, where available. The NGA indicated there are nine boreholes surrounding the farm portion (**Map 6**). The NGA sites are summarized in **Table 2**.

Table 2: Summary of NGA borehole.

NGA Label	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	Yield (L/s)	EC (mS/m)	Depth (m)	Lithology
3319BB00012	-33.1274	19.91708			673	36.6	Tillite
3320AA00009	-33.1117	20.02777	14		118	80	Shale
3319BB00013	-33.0838	19.9518	9.15		333	36.6	Tillite
3320AA00010	-33.0656	20.08249	3	0.25	286	80	Shale
3320AA00023	-33.0656	20.0825		0.25	286	80	Shale
3319BB00011	-33.0647	19.87847		0.63	398	12.2	Tillite
3319BB00004	-33.0344	19.88263	6.1		432	36.6	Tillite
3319BB00005	-33.0161	19.87097	7.63		1192	36.6	Sandstone & Shale
3319BB00003	-33.0099	19.98597	10.68		496	67.1	Sandstone & Shale

Overall, the NGA sites indicate a relatively shallow drill depth (12 – 80 m), drilled into varying lithologies of tillite, shale and sandstone. Yields are low, ranging from 0.25 to 0.63 l/s and EC's are moderate to poor ranging from 118 to 1192 mS/m.

4.4.2. WARMS Database

There are 4 registered boreholes (WARMS site) located within a search radius of 1 km around the Grootfontein Farm portion boundary, as shown on **Map 6**. The information is summarised in **Table 3**. This groundwater use is registered to neighbouring farm portions.

Table 3: Summary of WARMS borehole details.

WARMS no.	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Registered Volume (m^3/a)	Status
22137787	-33.0718	19.9709	27375	Registered
22138090	-33.079	19.9597	27375	Registered
22124933	-33.1047	20.0114	7300	Complete
22138697	-33.0404	20.1098	2190	Registered

4.4.3. Witte Wall Boreholes

A representative of the Witte Wall Farm, was contacted regarding groundwater use from boreholes on the Witte Wall farm portion, shown on **Map 6**. These boreholes are summarised in **Table 4**.

Table 4 – Summary of Witte Wall Boreholes.

Borehole Name	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Comment
WW_1	-32.995951	19.980220	Only used for domestic use and livestock watering. Airlift yield of 4 500 L/h. Depth between 80 and 100 m.
WW_2	-32.996100	19.980193	Only used for domestic use and livestock watering. Airlift yield of 4 500 L/h. Depth between 80 and 100 m.
WW_3	-32.996183	19.980102	Only used for domestic use and livestock watering. Airlift yield of 4 500 L/h. Depth between 80 and 100 m.
WW_4	-33.010868	19.986994	Only used for domestic use and livestock watering. Airlift yield of 6 500 L/h. Depth between 80 and 100 m.
WW_5	-33.009423	20.023950	Only used for domestic use and livestock watering. Airlift yield of 6 000 L/h. Depth between 80 and 100 m.

From the information provided it is clear that the boreholes are relatively high yielding (airlift yields) for the area. The water is mainly used for domestic use and livestock watering. The status and condition of these boreholes will need to be accessed during the hydrocensus.

4.4.4. Grootfontein Boreholes

A representative of Grootfontein Farm, was contacted regarding groundwater use from boreholes on his farm, shown on **Map 6**. These boreholes are summarised in **Table 5**.

Table 5: Summary of Grootfontein Boreholes.

Borehole Name	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Comment
GF_1	-32.9448	19.94878	Brackish water used only for drinking water and gardening.
GF_2	-32.9439	19.94818	Used for drinking water. Low yielding.
GF_3	-32.9386	19.95211	Reportedly strong borehole, pumped at 6000 L/h from time to time. Has not been pumped for years
GF_4	-32.9375	19.95276	Reportedly strong borehole, pumped at 4000 L/h from time to time. Has not been pumped for years
GF_5	-32.9398	19.94759	Old borehole, water level at 1.5 mbgl. Has not been pumped in last 25 years.
GF_6	-32.9737	19.95309	Used for livestock watering.

Overall, the boreholes are located in close proximity to the Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 developments. Information on these boreholes are somewhat limited, however, the boreholes are believed to be brackish with two boreholes (GF_3 and GF_4) indicating yields of 4 000 to 6 000 L/h. The status and condition of these boreholes will need to be accessed during the hydrocensus.

4.4.5. GEOSS Database

A search of GEOSS's internal database of previous projects conducted in the area indicated a total of 18 boreholes surrounding the Grootfontein Farm portion (**Map 6**). The results are summarised in **Table 6**.

From GEOSS's internal database, it is clear that groundwater quality is poor (ranging from 169 to 1377 mS/m) with low yields ranging from 0.5 to 1.47 L/s. Water levels range from shallow (1.00 mbgl) to relatively deep (8.80 mbgl).

Table 6: Summary of GEOSS's internal database borehole details.

ID no.	WL (mbgl)	Yield (L/s)	EC (mS/m)	TDS (mg/L)	pH
GD_1	8.215	-	-	-	-
GD_2	8.8	1.47	478.2	3102	7.09
GD_3	-	-	-	-	-
GD_4	-	-	-	-	-
GD_5	6.4	-	356.5	2400	7.25
GD_6	8.62	-	305.7	2082	7.76
GD_7	4.24	-	1377.5	9263	7.33
GD_8	1.09	0.5	169.5	1114	8.87
GD_9	1.00		299.8	1917	8.04
GD_10	1.47		287.32	-	-
GD_11	1.03		435.94	-	
GD_12	-		405.4	2821	7.88
GD_13	-		-	-	-
GD_14	-		305	1918	7.86
GD_15	-		-	-	-
GD_16	8.10		215.9	1398	8.33
GD_17	-		-	-	-
GD_18	-		-	-	-

4.4.6. Kareekolk Borehole

The Kareekolk Farm contains the access road to the Hoek Doornen and Witte Wall Farm portions delineated for the proposed solar development. Mr Leon Theunissen (owner of Kareekolk Farm) indicated the possible use of his dam water for construction and operations, including solar panel cleaning. It was established that this dam (**Figure 3**) is filled with borehole water supplied by the KK_1 borehole, shown on **Map 6** and summarised in **Table 7**. This borehole, reportedly, can pump up to 40 000 L/h for 9 hours per day. Quality at this stage is unknown. The preliminary findings for the determination of the existing lawful use, for this borehole, indicates a lawful use of 2694 m3/a (~0.08L/s). This is not enough to supplement the required amount of water of 5 to 8 million litres per year per project (~0.25 L/s). This will require a General Authorisation to make use of this volume of water.

Table 7: Kareekolk Borehole Summary.

Borehole Label	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Reported Yield (L/s)	Quality
KK_1	-32.9836030	19.938373	11.1	Unknown

Figure 3: Dam located on Kareekolk Farm.

4.5. Geohydrological Characterisation (Aquifer Vulnerability)

The Grootfontein Farm portion overlies a fractured aquifer that possesses water bearing properties due to fracturing. Several methods have been developed to classify an aquifer's vulnerability. The DRASTIC method has been applied to this study.

4.5.1. Aquifer Vulnerability (DRASTIC)

Groundwater vulnerability can be defined as the "tendency for contaminants to reach a specified position in the groundwater system after introduction at some location" (Vrba and Zaporozec, 1994). Key physical parameters which determine groundwater vulnerability include lithology, thickness, effective porosity, groundwater flow direction, age and residence time of water. Generally, the residence time of a contaminant in groundwater and the distance that it travels in the aquifer are considered important measures of vulnerability.

There are two main groups of methods for assessing groundwater vulnerability, namely:

- Index or subjective rating methods, and
- Statistical or process-based methods.

The "index or subjective rating method" is relatively easily addressed within a GIS framework. The cell-based layer approach facilitates the assignment of ratings and weights and rapid achievement of a final result of relative groundwater vulnerability. This approach also means that the algorithm can easily be repeated as new or more detailed data sets are obtained or if ratings and weightings need to be adjusted as a result of a sensitivity analysis for example. The most well-known "index or subjective rating method" is the "DRASTIC" method (Aller et al., 1987). The DRASTIC method of Aller et al. (1987) uses the typical overlay technique often applied in subjective rating methods. The DRASTIC approach is based on four major assumptions:

- The contaminant is introduced at ground surface;
- The contaminant is flushed into the groundwater by precipitation;
- The contaminant has the mobility of water; and
- The area evaluated using DRASTIC is 40.5 ha or larger.

The implication of these assumptions is that DRASTIC should not be used for contaminants that do not have the mobility of water or for point assessment (such as storage tanks). In addition, groundwater conditions in South Africa are dominated by secondary/fracture-controlled flow conditions. The DRASTIC method does not consider local preferential flow paths of fractured aquifer systems particularly well. The DRASTIC method takes into account the following factors:

D	=	depth to groundwater	(5)
R	=	recharge	(4)
A	=	aquifer media	(3)
S	=	soil type	(2)
T	=	topography	(1)
I	=	impact of the vadose zone	(5)
C	=	conductivity (hydraulic)	(3)

The number indicated in parenthesis at the end of each factor description is the weighting or relative importance at that factor.

Groundwater vulnerability maps developed using the DRASTIC method have been produced in many parts of the world. In spite of the widespread use of DRASTIC, the effectiveness of the method has been met with mixed success due to hydrogeological heterogeneity and the many assumptions that need to be made in determining groundwater vulnerability. In addition, the use of a generic vulnerability map only gives a broad indication of relative vulnerability and in many instances detailed scale, contaminant specific vulnerability assessments are required. From the assumptions outlined by Aller et al. (1987), DRASTIC can only be applied to non-point source pollution, as DRASTIC is inaccurate in point source assessments.

As part of the Groundwater Resources Assessment Project (DWAF, 2005), numerous data sets were produced and this enabled the mapping of groundwater vulnerability at the national scale on a 1 km by 1 km cell (pixel) size basis (Conrad and Munch, 2007). This national scale map indicates the relative vulnerability of groundwater resources throughout the country and provides project planners a clear idea of what level of groundwater protection is required.

A national scale map of groundwater vulnerability has been completed for South Africa (DWAF, 2005). The groundwater vulnerability for the study area is shown in **Map 7**. The development area on the Grootfontein Farm portion has a **very low** groundwater vulnerability.

4.6. Strategic Water Source Areas

Strategic Water Source Areas (SWSAs) are defined as “areas of land that either: (a) supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or (b) have high groundwater recharge and where the groundwater forms a nationally important resource; or (c) areas that meet both criteria (a) and (b)” (Le Maitre et al., 2018:1 in DEFF, 2019: Page 61). Thirty-seven groundwater SWSAs have been identified in South Africa and are considered to be strategically important at a national level for water and economic security (Le Maitre et al. 2018 in DEFF, 2019: Page 61). The total area for groundwater SWSAs extends approximately 104 000 km2, and covers approximately 9% of the land surface of South Africa (Le Maitre et al. 2018, in DEFF 2019: Page 61).

According to the Solar PV Theme on the National Web-based Environmental Screening Tool, there are no SWSAs on the Grootfontein Farm. Refer to Figure 4 below.

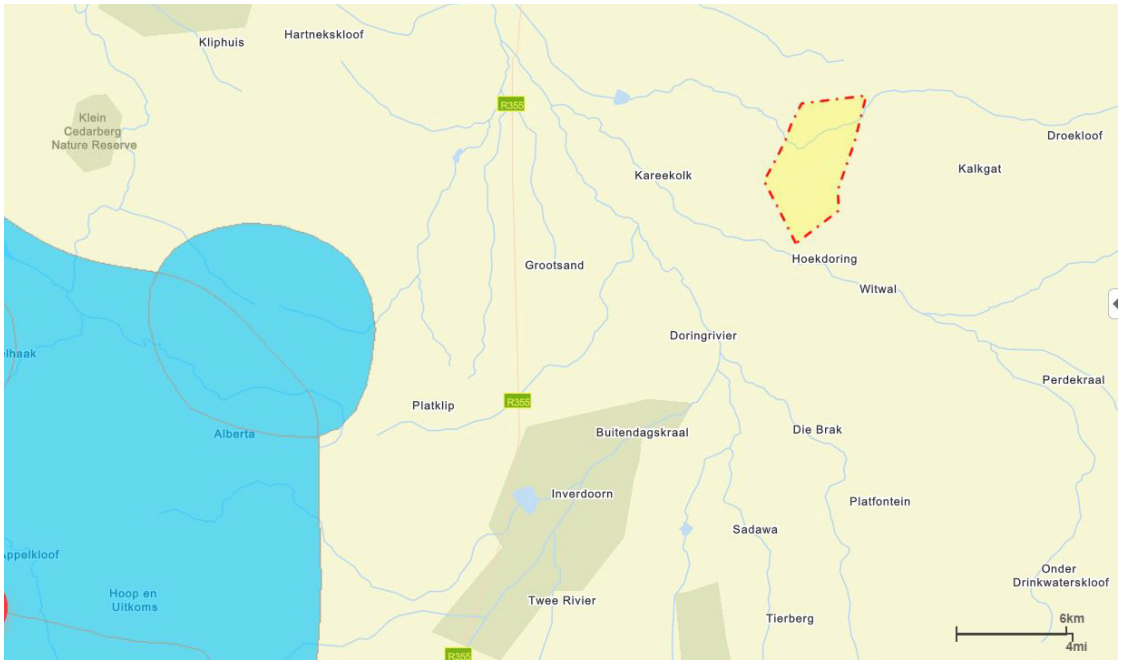

Figure 4: SWSAs from the National DEFF Screening Tool (DEFF, 2020).

5. Issues, Risks and Impacts (Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3)

5.1. Identification of Potential Impacts/Risks

The following potential impacts on groundwater of the proposed project activities are as follows:

- Lowering of the groundwater level due to abstraction (5 to 8 million litres per PV project per year);
- Potential impact on groundwater quality as a result of accidental oil spillages or fuel leakages during the construction, operational and decommissioning phases; and
- Potential impact on groundwater quality as a result of cleaning agents used for cleaning the solar panels.

Any construction activities such as the excavation and installation of foundations and piling (narrow diameter holes for foundation purposes) will have minimal to no impact on the groundwater of the site or region, as the groundwater level is approximately 3 – 8 mbgl.

The potential impacts identified during the BA are:

Construction Phase

- Potential lowering of the groundwater level; and
- Potential impact on groundwater quality as a result of accidental oil spillages or fuel leakages.

Operational Phase

- Potential lowering of the groundwater level; and

- Potential impact on groundwater quality as a result of using cleaning agents for cleaning the solar panels.

Decommissioning Phase

- None

Cumulative Impacts

- Due to the large spatial extent and low water demand in the study area, including other groundwater users within a 30 km radius, the cumulative impact is regarded as insignificant.
- It is assumed that not all 9 PV facilities will be constructed at the same time, hence the requirements will not be 8 million litres * 9 per year per PV project, allowing for sufficient recharge.

No indirect impacts are identified.

In terms of the no-go alternative, if the proposed Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 projects do not go ahead, there will be no need to use approximately 5 – 8 million litres per year of ground water per project. However, as noted above, there is a low water demand in the study area and a large spatial extent; and the impacts relating to the use of ground water is not considered as highly significant.

6. Impact Assessment - Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3

6.1. Potential Impacts during the Construction Phase

It must be noted that the impacts provided below are the same for all three the Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 projects, as well as the Electrical Grid Infrastructure.

6.1.1. Impact 1: Groundwater impact as a result of over-abstraction abstraction

This impact is only applicable during the construction and operational phases. At the peak requirement of 8 million litres per year per project (Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 requires 0.25 L/s each ~ 0.75 L/s) the proposed groundwater abstraction is higher than the yield potential of the underlying aquifer (0.1 – 0.5 L/s).

The status of this impact is rated as negative with a local spatial extent and a long-term duration (i.e. for the life of the project). The consequence and probability of the impact is respectively rated as substantial and likely. The reversibility of the impact is rated as high and the irreplaceability is rated low. The significance of the impact without the implementation of mitigation measures is rated as moderate. With effective implementation of prevention / mitigation actions (i.e. to adhere to the borehole's safe yield and to monitor water levels and flow), the impact of the proposed abstraction on groundwater is predicted to be of low significance.

6.1.2. Impact 2: Potential Impact on Groundwater Quality as a result of Accidental Oil Spillages or Fuel Leakages

If there is an accidental oil spill or fuel leakage during the construction phase, then the low permeability of the unsaturated zone will provide significant attenuation capacity. The status of this

impact (for the construction phase) is rated as negative with a site-specific spatial extent and short-term duration (i.e. for the life of the facility). The consequence and probability of the impact is respectively rated as slight and extremely unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated as low. The significance of the impact without the implementation of mitigation measures is rated as very low.

A precautionary approach must be implemented and reasonable measures must be undertaken to prevent oil spillages and fuel leakages from occurring. During the construction phase, vehicles must be regularly serviced and maintained to check and ensure there are no leakages. Any engines that stand in one place for an excessive length of time must have drip trays. Diesel fuel storage tanks, if required, should be above ground on an impermeable concrete surface in a bunded area. Construction vehicles and equipment should also be refuelled on an impermeable surface. A designated area should be established at the construction site camp for this purpose, if off-site refuelling is not possible. If spillages occur, they should be contained and removed as rapidly as possible, with correct disposal procedures of the spilled material, and reported. Proof of disposal (waste disposal slips or waybills) should be obtained and retained on file for auditing purposes.

With effective implementation of these prevention / mitigation actions, the impact of the project on groundwater as a consequence of accidental oil spillages and fuel leakages is predicted to be of very low significance.

6.1.2.1. Impact Summary Tables: Construction Phase

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
CONSTRUCTION PHASE						
Lowering of groundwater levels as a result of over-abstraction	***Status***	*Negative*	*Moderate*	*Adhere to the borehole's safe yield and to monitor water levels and flow.* *Boreholes must be correctly yield tested according to the National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes). This includes a Step Test, Constant Discharge Test and recovery monitoring.*	*Low*	*High*
	Spatial Extent	*Local*				
	Duration	*Long Term*				
	Consequence	*Substantial*				
	Probability	*Likely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				
Accidental oil spillage / fuel leakage	***Status***	*Negative*	*Very Low*	*Vehicles must be regularly serviced and maintained to check and ensure there are no leakages. Any engines that stand in one place for an excessive length of time must have drip trays. Diesel fuel storage tanks, if required, should be above ground on an impermeable surface in a bunded area. Vehicles and equipment should also be refuelled on an impermeable surface. A designated area should be established at the construction site camp for this purpose, if off-site refuelling is not possible. If spillages occur, they should be contained and removed as rapidly as possible, with correct disposal procedures of the spilled material, as reported. Proof of disposal (waste disposal slips or waybills) should be obtained and retained on file for auditing purposes*	*Very Low*	*High*
	Spatial Extent	*Site Specific*				
	Duration	*Short Term*				
	Consequence	*Slight*				
	Probability	*Extremely Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

6.2. Potential Impacts during the Operational Phase - Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3

It must be noted that the impacts provided below are the same for all three the Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 projects. The power lines do not have any operational water usage and thus not considered to have an impact on the groundwater.

6.2.1. Impact 1: Groundwater impact as a result of over-abstraction abstraction

This impact is only applicable during the construction and operational phases. At the peak requirement of 8 million litres per year per project (Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 requires 0.25 L/s each ~ 0.75 L/s) the proposed groundwater abstraction is higher than the yield potential of the underlying aquifer (0.1 – 0.5 L/s).

The status of this impact is rated as negative with a local spatial extent and a long-term duration (i.e. for the life of the project). The consequence and probability of the impact is respectively rated as substantial and likely. The reversibility of the impact is rated as high and the irreplaceability is rated low. The significance of the impact without the implementation of mitigation measures is rated as moderate. With effective implementation of prevention / mitigation actions (i.e. to adhere to the borehole's safe yield and to monitor water levels and flow), the impact of the proposed abstraction on groundwater is predicted to be of low significance.

Impact 2: Potential impact on groundwater quality as a result of using cleaning agents

The low permeability of the unsaturated zone will provide significant attenuation capacity. The status of this impact (for the operational phase) is rated as negative with a site-specific spatial extent and long-term duration (i.e. for the life of the project). The consequence and probability of the impact is respectively rated as slight and extremely unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated as low. The significance of the impact without the implementation of mitigation measures is rated as very low. Recommended mitigation includes using an environmentally safe cleaning agent that breakdown naturally and do not cause adverse effects.

6.2.1.1. Impact Summary Tables: Operational Phase

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
OPERATIONAL PHASE						
Lowering of groundwater levels as a result of over-abstraction	***Status***	*Negative*	*Moderate*	*Adhere to the borehole's safe yield and to monitor water levels and flow.* *Boreholes must be correctly yield tested according to the National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes). This includes a Step Test, Constant Discharge Test and recovery monitoring.*	*Low*	*High*
	Spatial Extent	*Local*				
	Duration	*Long Term*				
	Consequence	*Substantial*				
	Probability	*Likely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				
Potential impact on groundwater quality as a result of using cleaning agents	***Status***	*Negative*	*Very Low*	*Use environmentally safe cleaning agents that breakdown naturally and do not cause adverse effects.*	*Very Low*	*High*
	Spatial Extent	*Site Specific*				
	Duration	*Long Term*				
	Consequence	*Slight*				
	Probability	*Extremely Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

7. Impact Assessment Summary - Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3

The overall impact significance findings, following the implementation of the proposed mitigation measures are shown in the **Table 8**.

Table 8: Overall Impact Significance (Post Mitigation)

Phase	**Overall Impact Significance**
Construction	Low-Very Low
Operational	Low-Very Low
Decommissioning	None
Nature of Impact	**Overall Impact Significance**
Cumulative - Construction	Insignificant
Cumulative - Operational	Insignificant
Cumulative - Decommissioning	None

8. Legislative and Permit Requirements

The National Water Act (Act 36 of 1998) (NWA) is administered by the DWS and is the main legislation for managing water resources in South Africa. The purpose of the NWA is to provide a framework for the equitable allocation and sustainable management of water resources. Both surface and groundwater sources are redefined by the Act as national resources which cannot be owned by any individual, and rights to which are not automatically coupled to land rights, but for which prospective users must apply for authorization and register as users. The NWA also provides for measures to prevent, control and remedy the pollution of surface and groundwater sources.

The Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 development areas are located within quaternary catchment E22E which forms part of the Olifants Catchment in Western Cape. The groundwater General Authorisation (GA) for this catchment is 45 m^3/ha/a (published on 2 September 2016, in Government Gazette 40243, Government Notice (GN) 538 (i.e. Revision of General authorisation for the taking and storing of water). The Grootfontein Farm portions are approximately 1611 hectares (north portion) and 1147 hectares (south portion); equating to 72 495 m^3/a and 51 615 m^3/a respectively. The allowable abstraction under the GA is capped at 40 000 m^3/a per farm portion. This equates to approximately 1.27 L/s (continuous abstraction) per Grootfontein Farm portion. The proposed groundwater use for each project is less than this (peak usage is 0.75 L/s annually all three Grootfontein PV projects) and will thus fall within the GA. Only a registration process will have to be followed for the groundwater use; i.e. Section 39 of the NWA is applicable. Although the assessed development footprint is 1230 ha, (and each PV Facility will have an estimated footprint of 260 ha within the assessed development footprint), the total farm portions are 1611 and 1147 ha respectively and it is the total farm portion area that is used for the GA calculation. If other water uses in terms of Section 21 of the NWA is applicable to the farm portion, this will need to be incorporated in the registration process.

9. Environmental Management Programme Inputs - Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3

Certain measures need to be put in place to ensure that the groundwater of local and regional aquifers is not significantly negatively impacted by the proposed projects. The following aspects are considered to be applicable to the Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 Facilities, Electrical Grid Infrastructure and Associated Infrastructure.

9.1. Accidental oil spillage / fuel leakages

- All vehicles and other equipment (generators etc.) must be regularly serviced to ensure they do not spill oil. Vehicles should be refuelled on paved (impervious) areas, optimally off-site. If liquid product is being transported it must be ensured this does not spill during transit.
- Emergency measures and plans must be put in place and rehearsed in order to prepare for accidental spillage.
- Diesel fuel storage tanks, if required, must be above ground on a concrete surface in a bunded area.
- Engines that stand in one place for an excessive length of time must have drip trays.
- Vehicle and washing areas must also be on paved surfaces and the by-products removed to an evaporative storage area or a hazardous waste disposal site (if the material is hazardous).

9.2. Groundwater abstraction (if groundwater is to be used)

- The production boreholes that are to be used should be yield tested prior to use (according to SANS10299) so that the correct pump sizes and installation depths can be determined.
- The planned production boreholes should also be sampled and chemically and microbiologically analysed by a SANAS accredited laboratory.
- Once the boreholes are in use they should be equipped with:
    - Observation pipes - so that the water levels can be measured (either manually or by data loggers);
    - Flow meters – to assess how much water is used and thereby all authorisations in place for use of the water are adhered to; and
    - Sampling tap – to enable annual sampling to ensure the groundwater is safe for continued use – especially if it is to be used as drinking water.

9.3. Cleaning agents used solar panel cleaning

- Environmentally safe cleaning agents that breakdown naturally must be used for cleaning the panels. No chemical that that could cause adverse effects to the natural environment should be allowed.

10. Final Specialist Statement and Authorisation Recommendation

The allowable general abstraction volume per Grootfontein Farm Portion is 40 000 m^3/year (1.27 L/s). The entire development is estimated to require 5 to 8 million litres per year per PV project (0.25 L/s per project ~ total of 0.75 L/s). Therefore, the amount of water required for the Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 falls within the abstraction volume allowed under GA. Only a registration process will have to be followed for the groundwater use; i.e. Section 39 of the NWA is applicable. Although the Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 assessed development footprint is approximately 1230 ha (and each PV Facility will have an estimated footprint of 260 ha within the assessed development footprint), the total farm portions are 1611 and 1147 ha respectively and it is the total farm portion area that is used for the GA calculation.

It is recommended that site visit and hydrocensus be undertaken during the design and planning phase (after environmental authorisation is issued, should it be granted) to quantify the number of potential boreholes that could be used for abstraction, as well as, their proximity to the development and other nearby groundwater sources and users. Groundwater quality sampling is also recommended to determine whether the quality of the water meets the quality recommendations for the cleaning of solar panels.

10.1.Statement and Reasoned Opinion

It is the opinion of this specialist that the proposed activity be allowed to proceed. No impacts of significance could be identified and therefore does not pose any risk to the geohydrological conditions on site. It is imperative that proper yield testing and quality analysis of groundwater be undertaken should it be considered for use.

10.2.EA Condition Recommendations

A site visit and hydrocensus conducted by groundwater specialist should be undertaken to determine the number of groundwater users and abstraction points. This must include water level recording and groundwater sampling of potential boreholes to be used for the development.

11. References

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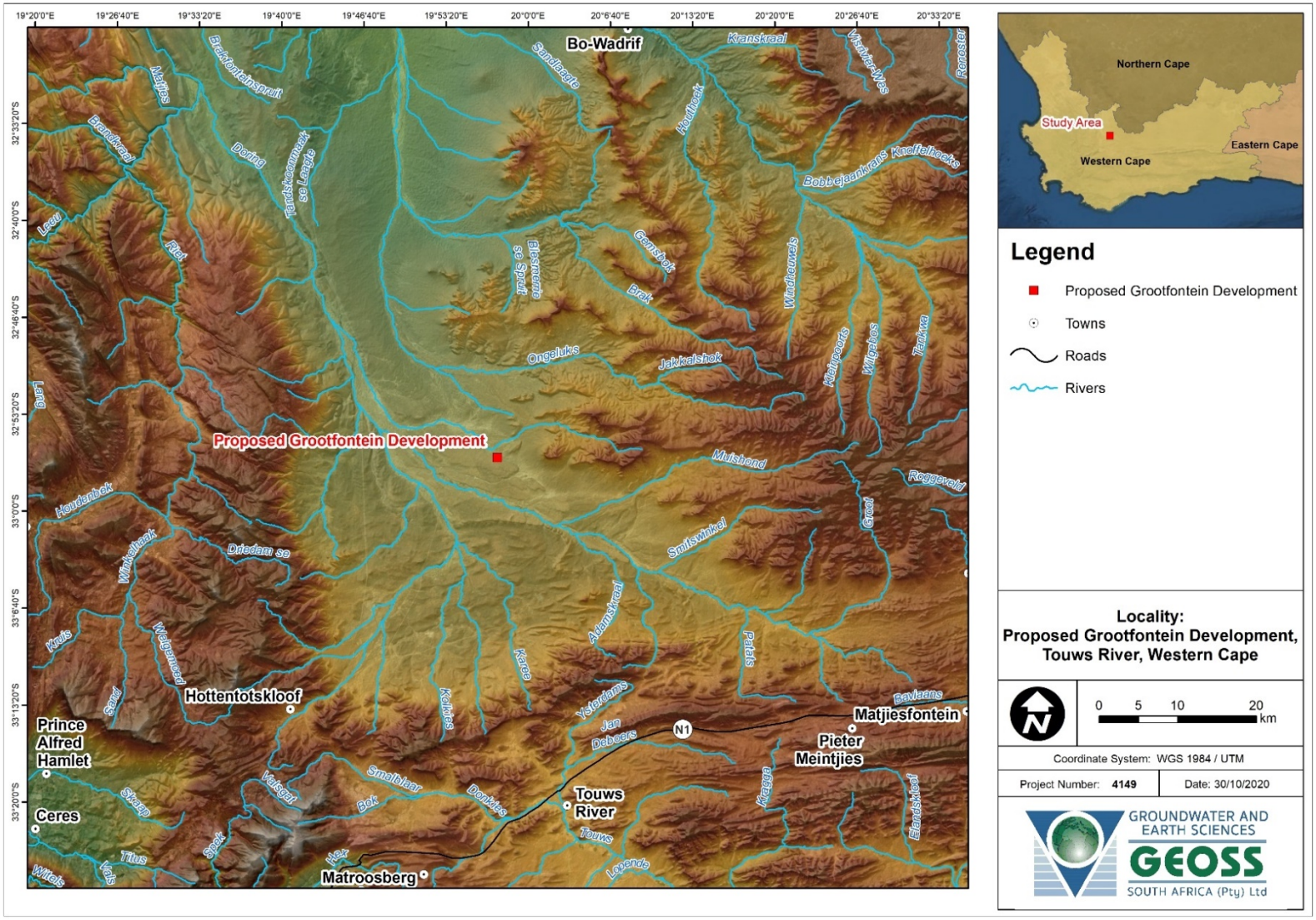
Parsons R., and Conrad, J., (1993). South African aquifer system management classification'; WRC Report No: KV 77/95; Author: Mr. Parsons R; Date Published: 12 January 1993.

Schulze, R. E., 2009. SA Atlas of Climatology and Geohydrology; obtained from Western Cape Government Agriculture - http://gis.elsenburg.com/apps/cfm/: Long term median rainfall per month (1950-2000).

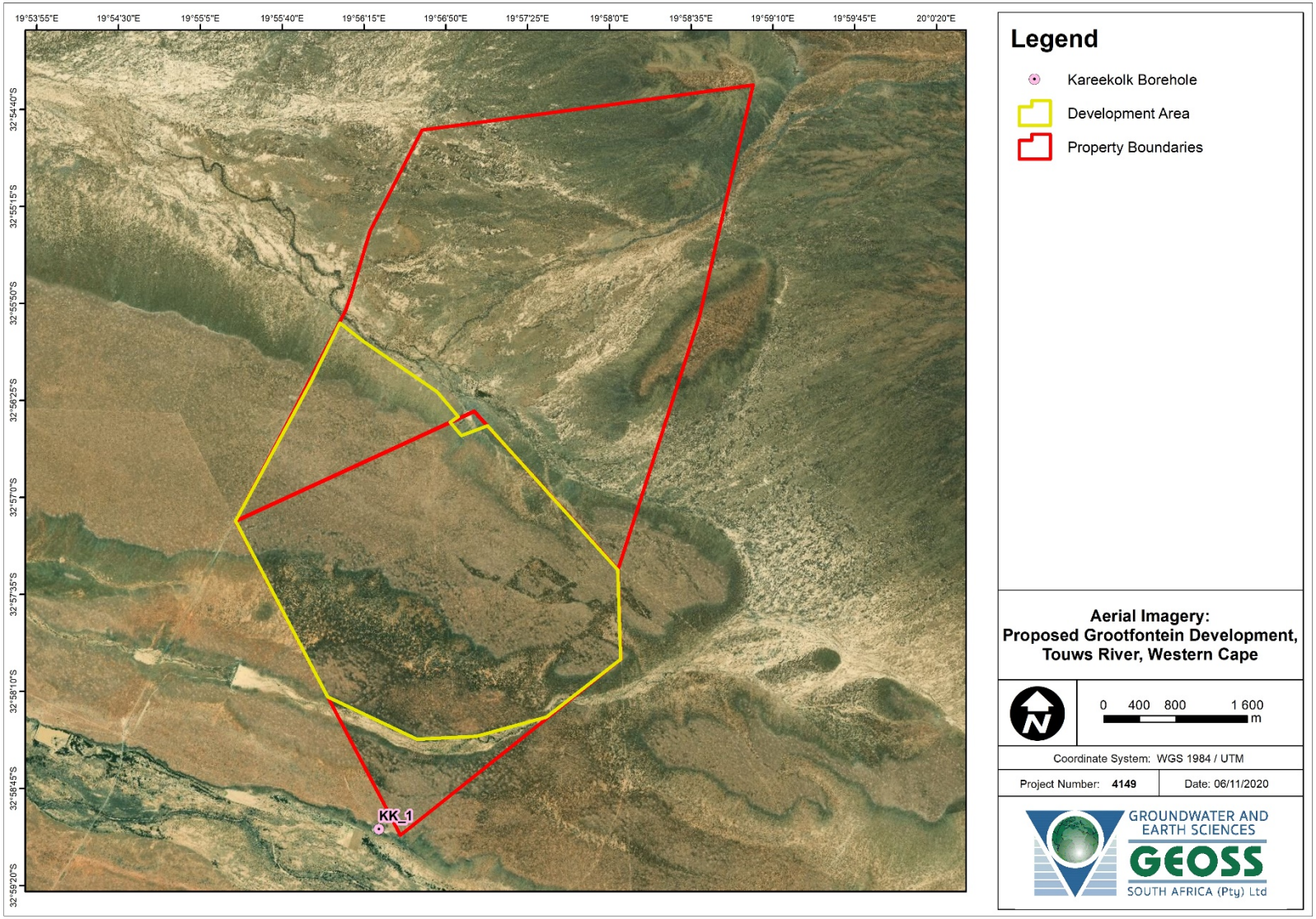
Vrba, J. and A. Zaporozec (eds.) 1994. Guidebook on Mapping Groundwater Vulnerability. Verlag Heinz Heise, Hannover, Germany, International Contributions to Hydrogeology, Vol. 16, 131 pp. Conrad and Munch, 2007

WRC, 2012. A Groundwater Planning Toolkit for the Main Karoo Basin: Identifying and quantifying groundwater development options incorporating the concept of wellfield yields and aquifer firm yields. WRC Report No. 1763/1/11, Pretoria, South Africa.

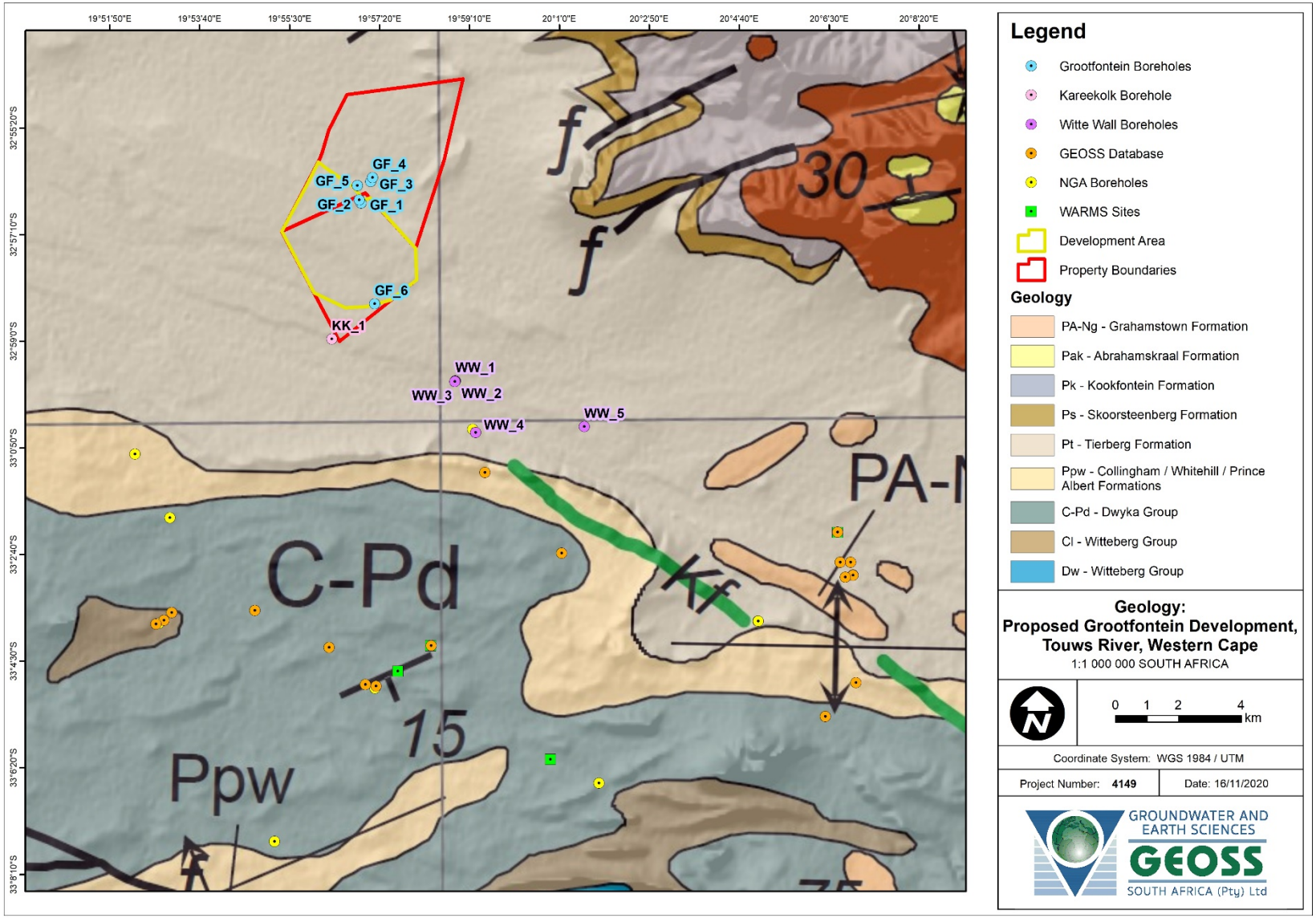
Appendix A - Maps



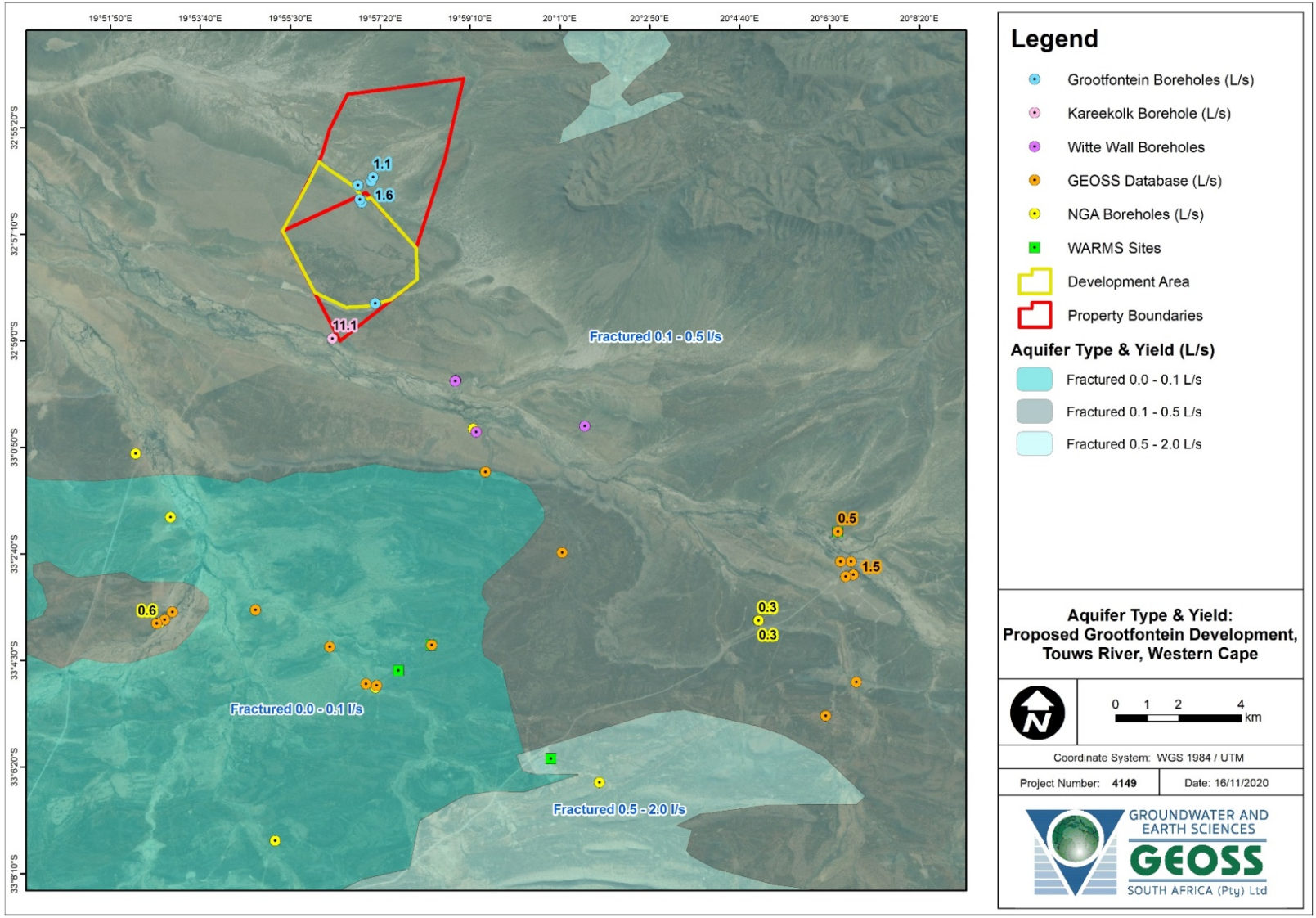
Map 1: Locality of the proposed development of three 175 MW solar PV facilities and associated electrical grid infrastructure, Touws River, Western Cape.



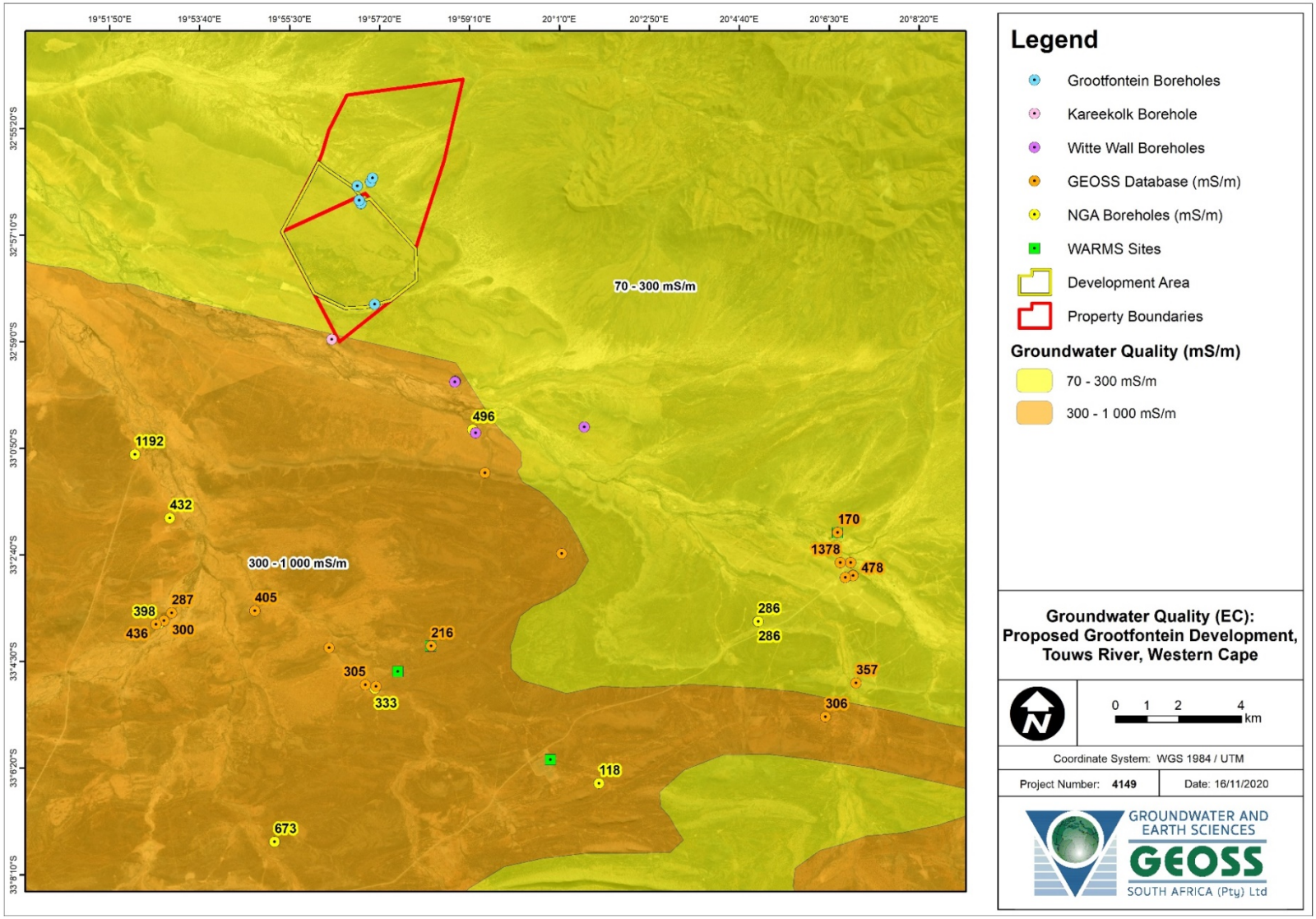
Map 2: Aerial view delineating the Grootfontein Farm portions and proposed Grootfontein PV 1, Grootfontein PV 2 and Grootfontein PV 3 development assessed area (Note that each PV Facility will cover an estimated area of 260 ha).



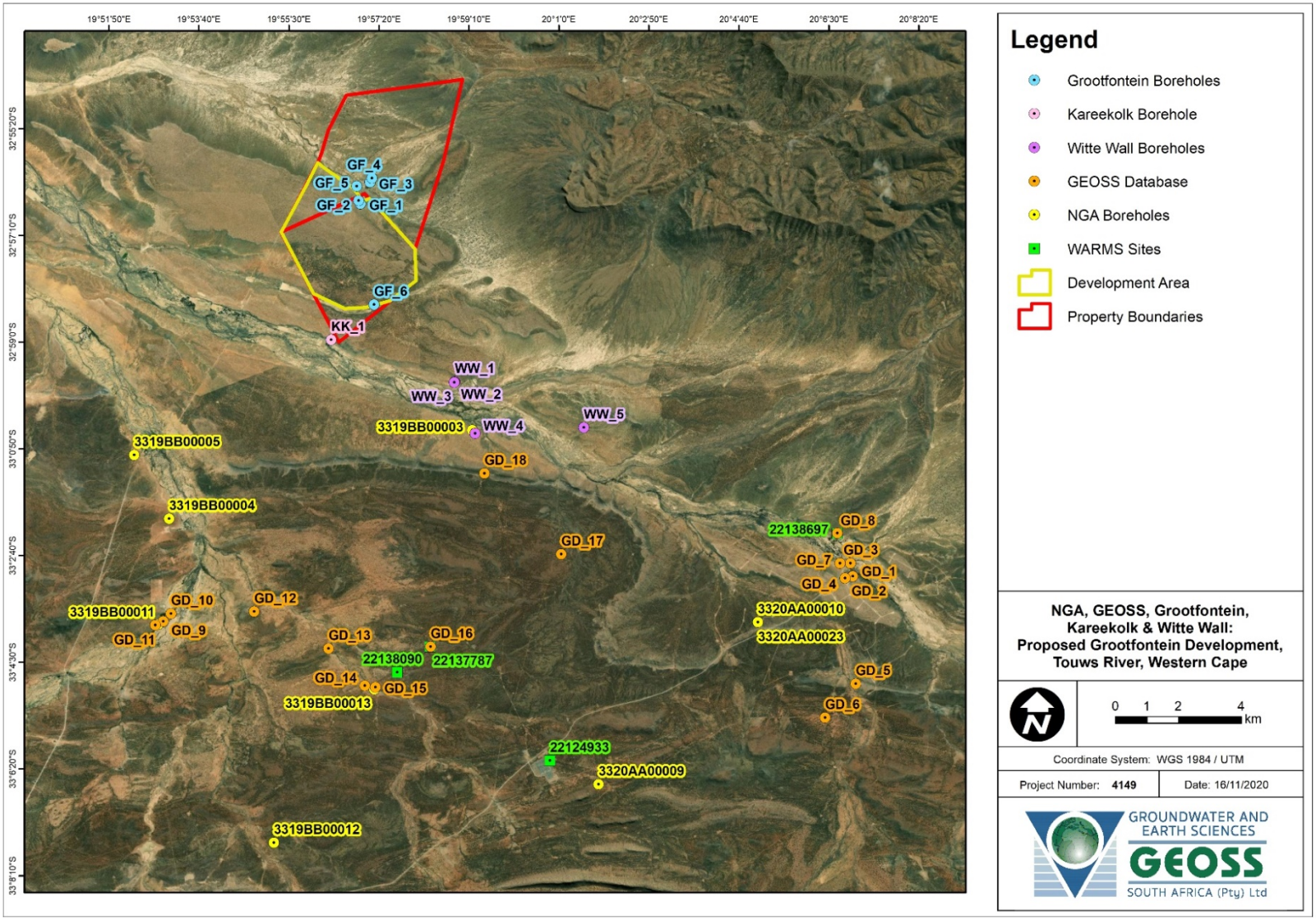
Map 3: Geological setting of the study area (CGS (2019) map: 1:1 00 000 scale South Africa).



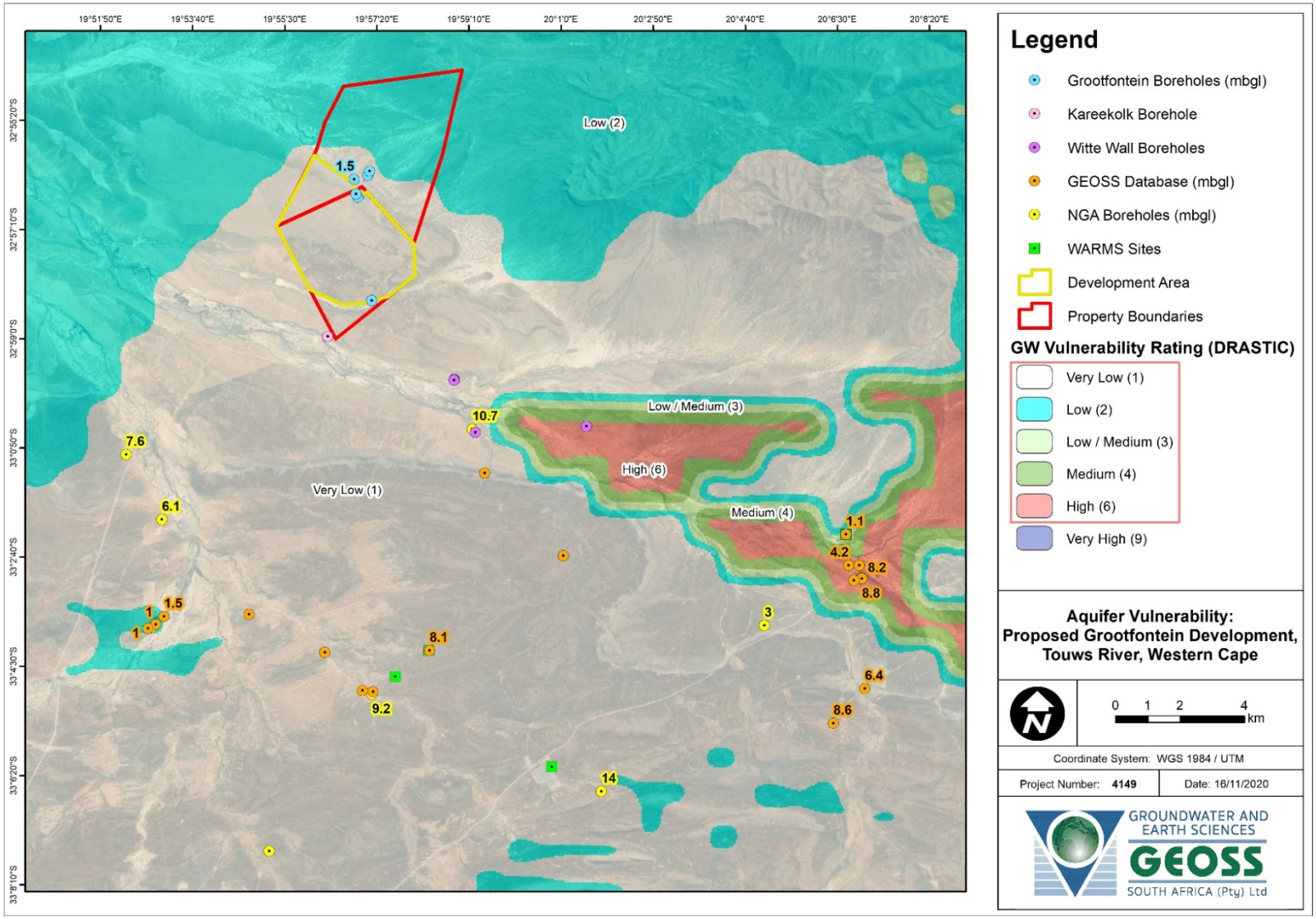
Map 4: Regional aquifer yield (DWAF, 2002) and borehole yields (L/s).



Map 5: Regional groundwater quality (mS/m) from DWAF (2002) and borehole groundwater quality (EC in mS/m).



Map 6: NGA, WARMS, Grootfontein, Witte Wall and Kareekolk and GEOSS internal database boreholes.



Map 7: Vulnerability rating (DWAF, 2005) and groundwater depths (mbgl).

Appendix B - Specialist Expertise

GENERAL

Nationality:	South African and Namibian
Profession:	Geohydrologist
Specialization:	Groundwater exploration, development, sampling and monitoring.
Position in firm:	Geohydrologist at GEOSS - Geohydrological and Spatial Solutions International (Pty) Ltd
Date commenced:	16th October 2017
Year of birth & ID #:	1991 – 9105216400083
Language skills:	English (good – speaking, reading and writing) Afrikaans (good - speaking, reading and writing).

KEY SKILLS

- Groundwater sampling, soil sampling, field measurements, borehole logging, data logging for groundwater monitoring, borehole depth and water level measurements, augering for piezometer installation, groundwater geophysics and conducting hydrocensus studies.

RELEVANT EXPERIENCE

- Numerous groundwater exploration - this includes aerial photo interpretation, resistivity, magnetic and electromagnetic geophysical surveys for borehole siting purposes, data analysis and interpretation and hydrogeological conceptualization, development, monitoring and management projects.
- Extensive satellite image data processing (including geo-referencing) for the Validation and Verification projects within the Breede-Overberg Catchment Management Agency.
- Smaller projects involving borehole sitings (aerial photo interpretation, geological mapping, geophysical profiling).
- Projects involving drilling supervision and pumping test supervision with associated data interpretation (FC Method) and writing of geohydrological reports.
- Groundwater and groundwater quality monitoring projects involving appropriate sampling, measurements, data analysis and reporting.
- Numerous Groundwater Impact Assessments

EDUCATIONAL AND PROFESSIONAL STATUS

Qualifications

2017	MEng (Geotechnical Engineering):	University of the Free State, South Africa
2015	BSc Hon – Earth Science Degree:	University of the Stellenbosch, South Africa
2014	BSc - Earth Science Degree:	University of the Stellenbosch, South Africa

Memberships

- Groundwater Division of the Geological Society of South Africa – Member No. 6080/16
- South African Council for National Scientific Professions (SACNASP) Mem. No. 123456

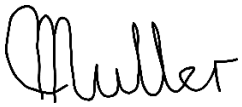
EMPLOYMENT RECORD

October 2017 to March 2019:	GEOSS – Geohydrological and Spatial Solutions International (Pty) Ltd, Stellenbosch
March 2019 to present	GEOSS SOUTH AFRICA (Pty) Ltd

Appendix C - Specialist Statement of Independence

I, **Charl Muller**, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist: 

Name of Company: **GEOSS South Africa Pty Ltd**

Date: **30 October 2020**

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Basic Assessments for the Proposed Development of three 175 MW Solar Photovoltaic Facilities and associated Electrical Grid Infrastructure (i.e. Grootfontein 1; Grootfontein 2; and Grootfontein 3), near Touws River, Western Cape

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	GEOSS SOUTH AFRICA (PTY) LTD			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	100 %
Specialist name:	Charl Muller			
Specialist Qualifications:	BSc Hons (Earth Sciences) AND MEng (Civil Engineering)			
Professional affiliation/registration:	SACNASP Reg. no. 123456			
Physical address:	Unit 12, Technostell Building, 9 Quantum Street, Techno Park, Stellenbosch, 7600			
Postal address:	P.O Box 12412, Die Boord, Stellenbosch			
Postal code:	7613	Cell:	079 824 6157	
Telephone:	021 880 1079	Fax:	086 605 1121	
E-mail:	cmuller@geoss.co.za			

2. DECLARATION BY THE SPECIALIST

I, Charl Muller, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

GEOSS SOUTH AFRICA (PTY) LTD

Name of Company:

30/October/2020

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Charl Muller, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

GEOSS SOUTH AFRICA (PTY) LTD

Name of Company

30 / October / 2020

Date

Signature of the Commissioner of Oaths

Date

STASIE BEVELVOERDER
STELLENBOSCH
2020 -10- 30
STELLENBOSCH
STATION COMMANDER
SOUTH AFRICAN POLICE SERVICE

Appendix D: Site Sensitivity Verification

It is important to note that there are no dedicated Geohydrology or Groundwater themes on the National Web-based Environmental Screening Tool (Screening Tool) (as at October 2020), therefore the environmental sensitivity of the proposed project area as identified by the Screening Tool is not applicable. Therefore, no site sensitivity verification report is required. Furthermore, there is no dedicated assessment protocol prescribed for Geohydrology or Groundwater. Therefore, the specialist assessment has been undertaken in compliance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014. All relevant desktop information, consultation with landowners, and previous assessments undertaken by the author in the study area have been taken into consideration in this assessment.

Appendix E: Impact Assessment Methodology

The following impact assessment has been used in this assessment.

The impact assessment includes:

- *the nature, significance and consequences of the impact and risk;*
- *the extent and duration of the impact and risk;*
- *the probability of the impact and risk occurring;*
- *the degree to which impacts and risks can be mitigated;*
- *the degree to which the impacts and risks can be reversed; and*
- *the degree to which the impacts and risks can cause loss of irreplaceable resources.*

As per the DEFFT Guideline 5: Assessment of Alternatives and Impacts, the following methodology is applied to the prediction and assessment of impacts and risks. Potential impacts and risks have been rated in terms of the direct, indirect and cumulative:

- *Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.*
- *Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.*
- *Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.*

The impact assessment methodology includes the following aspects:

- *Nature of impact/risk - The type of effect that a proposed activity will have on the environment.*

- *Status - Whether the impact/risk on the overall environment will be:*
    - *Positive - environment overall will benefit from the impact/risk;*
    - *Negative - environment overall will be adversely affected by the impact/risk; or*
    - *Neutral - environment overall not be affected.*

- *Spatial extent – The size of the area that will be affected by the impact/risk:*
    - *Site specific;*
    - *Local (<10 km from site);*
    - *Regional (<100 km of site);*
    - *National; or*
    - *International (e.g. Greenhouse Gas emissions or migrant birds).*

- *Duration – The timeframe during which the impact/risk will be experienced:*
    - *Very short term (instantaneous);*
    - *Short term (less than 1 year);*
    - *Medium term (1 to 10 years);*
    - *Long term (the impact will cease after the operational life of the activity (i.e. the impact or risk will occur for the project duration)); or*
    - *Permanent (mitigation will not occur in such a way or in such a time span that the impact can be considered transient (i.e. the impact will occur beyond the project decommissioning)).*

- *Consequence – The anticipated consequence of the risk/impact:*
    - *Extreme (extreme alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they permanently cease);*
    - *Severe (severe alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);*

- *Substantial (substantial alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);*
- *Moderate (notable alteration of natural systems, patterns or processes, i.e. where the environment continues to function but in a modified manner); or*
- *Slight (negligible alteration of natural systems, patterns or processes, i.e. where no natural systems/environmental functions, patterns, or processes are affected).*

- *Reversibility of the Impacts - the extent to which the impacts/risks are reversible assuming that the project has reached the end of its life cycle (decommissioning phase):*
  - *High reversibility of impacts (impact is highly reversible at end of project life i.e. this is the most favourable assessment for the environment);*
  - *Moderate reversibility of impacts;*
  - *Low reversibility of impacts; or*
  - *Impacts are non-reversible (impact is permanent, i.e. this is the least favourable assessment for the environment).*

- *Irreplaceability of Receiving Environment/Resource Loss caused by impacts/risks – the degree to which the impact causes irreplaceable loss of resources assuming that the project has reached the end of its life cycle (decommissioning phase):*
  - *High irreplaceability of resources (project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment);*
  - *Moderate irreplaceability of resources;*
  - *Low irreplaceability of resources; or*
  - *Resources are replaceable (the affected resource is easy to replace/rehabilitate, i.e. this is the most favourable assessment for the environment).*

Using the criteria above, the impacts have been further assessed in terms of the following:

- *Probability – The probability of the impact/risk occurring:*
  - *Extremely unlikely (little to no chance of occurring);*
  - *Very unlikely (<30% chance of occurring);*
  - *Unlikely (30-50% chance of occurring)*
  - *Likely (51 – 90% chance of occurring); or*
  - *Very Likely (>90% chance of occurring regardless of prevention measures).*

To determine the significance of the identified impact/risk, the consequence is multiplied by probability (qualitatively as shown in Figure 1).

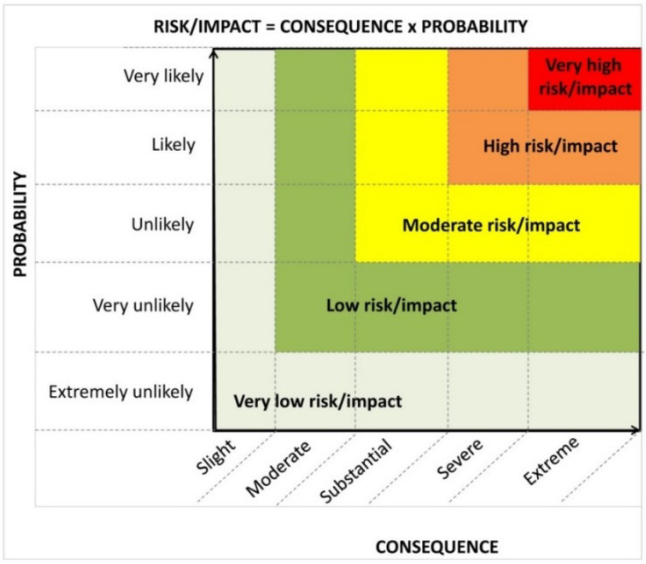


Figure 1. Guide to assessing risk/impact significance as a result of consequence and probability.

- *Significance – Will the impact cause a notable alteration of the environment?*
    - *Very low (the risk/impact may result in very minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making);*
    - *Low (the risk/impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making);*
    - *Moderate (the risk/impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures, and will only have an influence on the decision-making if not mitigated);*
    - *High (the risk/impact will result in major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making); and*
    - *Very high (the risk/impact will result in very major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making (i.e. the project cannot be authorised unless major changes to the engineering design are carried out to reduce the significance rating)).*

With the implementation of mitigation measures, the residual impacts/risks are ranked as follows in terms of significance:

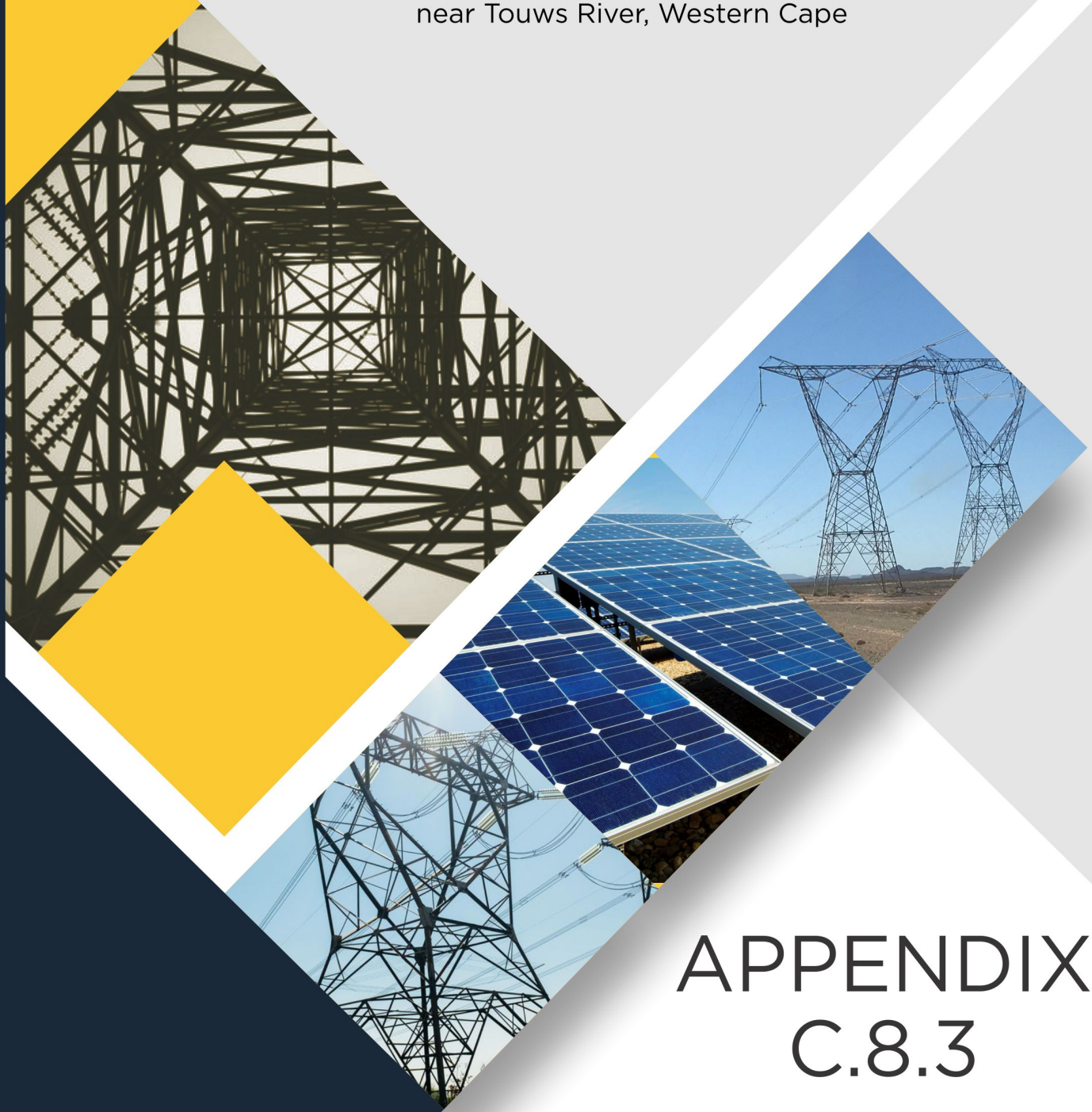
- *Very low = 5;*
- *Low = 4;*
- *Moderate = 3;*
- *High = 2; and*
- *Very high = 1.*

Confidence – The degree of confidence in predictions based on available information and specialist knowledge:
- *Low;*
- *Medium; or*
- *High.*

Appendix F: Compliance with the Appendix 6 of the 2014 EIA Regulations (as amended)

Requirements of Appendix 6 (Specialist Reports) of Government Notice R326 (Environmental Impact Assessment (EIA) Regulations of 2014, as amended)	***Section where this has been addressed in the Specialist Report***
1. (1) A specialist report prepared in terms of these Regulations must contain - *a) details of -* *i. the specialist who prepared the report; and* *ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;*	*Section 1.2 and Appendix B*
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	*Appendix C*
c) an indication of the scope of, and the purpose for which, the report was prepared;	*Section 1*
(cA) an indication of the quality and age of base data used for the specialist report;	*Section 2*
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	*Section 4*
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	*Not Applicable (Desktop Study undertaken)*
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	*Section 2 and Section 4*
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	*Section 4 and Maps*
g) an identification of any areas to be avoided, including buffers;	*Not Applicable*
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	*Section 4 and Maps*
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	*Section 2.2*
j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	*Section 5 and Section 6*
k) any mitigation measures for inclusion in the EMPr;	*Section 6 and Section 7*
l) any conditions for inclusion in the environmental authorisation;	*Section 10*
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	*Section 7*
n) a reasoned opinion- *i. whether the proposed activity, activities or portions thereof should be authorised;* *(iA) regarding the acceptability of the proposed activity or activities; and* *ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;*	*Section 10*
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	*Section 2.3*
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	*Not Applicable at this stage*
q) any other information requested by the competent authority.	*Not Applicable*
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	*Not Applicable*

Basic Assessment for the Proposed Development of Electrical Grid Infrastructure to support the proposed nine 175 MW Solar Photovoltaic Facilities and associated Infrastructure (i.e. Witte Wall PV 1, Witte Wall PV 2, Grootfontein PV 1, Grootfontein PV 2, Grootfontein PV 3, Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3, and Hoek Doornen PV 4), near Touws River, Western Cape



APPENDIX C.8.3

Geohydrology Assessment for Hoek Doornen

GROUNDWATER SPECIALIST ASSESSMENT:

Basic Groundwater Assessment for the Proposed Development of four 175 MW Solar Photovoltaic Facilities and associated Electrical Grid Infrastructure at Hoek Doornen Farm (i.e. Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4), near Touws River, Western Cape

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Report prepared for:	*Report prepared by:*
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30 October 2020

Executive Summary

GEOSS South Arica (Pty) Ltd was appointed by the Council for Scientific and Industrial Research (CSIR) to complete a basic groundwater assessment for the proposed development of four 175 MW solar photovoltaic (PV) facilities and associated electrical grid infrastructure, near Touws River in the Western Cape. This geohydrological assessment includes a **desktop review** of groundwater characteristics and users in the area, with the aim of determining the potential for groundwater to be used for panel cleaning, as well as risk to nearby groundwater users, in both the construction and operational phases.

The area of interest receives most of its rainfall during the winter months with an average of 197 mm per year with increased evaporation rates during the summer months. The regional geological setting consists of sedimentary deposits underlain by five distinct geological formations which directly correlate with the regional geohydrological characterization. According to the regional scale groundwater map the greater portion of the study area hosts a “fractured” aquifer (i.e. fractures within the bedrock constitute an aquifer) with borehole yields being in the range of 0.1 – 0.5 L/s. The regional groundwater quality, using Electrical Conductivity (EC) as an indicator, is “moderate to poor” (EC of 70 – 1 000 mS/m). Data sources for the area indicates that the EC varies from 118 mS/m to a maximum of 1 377 mS/m. The DRASTIC groundwater vulnerability rating methodology (Department of Water Affairs and Forestry, 2005) indicates that the larger study area can be classified as having a “low” groundwater vulnerability rating.

The potential impacts of the proposed development on groundwater are:

- Accidental oil spillages or fuel leakages;
- Over-abstraction of groundwater; and
- Groundwater contamination due solar panel cleaning agents.

These issues can be easily managed and potential groundwater impacts completely mitigated if appropriate measures are implemented.

The author considers groundwater to be a viable source for use during the construction phase and operational phase. Prior to use, all boreholes being used should be tested to ensure their yield and quality meets necessary requirements. Furthermore, any abstraction boreholes should be equipped with water level and water quality monitoring infrastructure; as well as a flow meter, prior to use. Water use authorisation must also be addressed. The planned groundwater use is likely to fall within the General Authorization (GA) (based on anticipated volumes) so the groundwater use need only be registered (assuming the water use meets the relevant GA requirements).

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List of Abbreviations

BH	Borehole
CGS	Council for Geoscience
DHSWS	Department of Human Settlements, Water and Sanitation
DWA	Department of Water Affairs (used to be Department of Water Affairs and Forestry)
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	electrical conductivity
GIS	Geographic Information System
L/s	litres per second
m	metres
mbch	meters below collar height
mbgl	metres below ground level
mm	millimetre
mS/m	milli-Siemens per metre
NGA	National Groundwater Archive
WARMS	Water Authorisation and Registration Management System

Glossary

Definitions	
Aquifer	A geological formation, which has structures or textures that hold water or permit appreciable water movement through them [from National Water Act (Act No. 36 of 1998)].
Borehole	Includes a well, excavation, or any other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer [from National Water Act (Act No. 36 of 1998)].
DRASTIC	An acronym for a groundwater vulnerability assessment methodology: D = depth to groundwater / R = recharge / A = aquifer media type / S = soil type / T = topography / I = impact of the unsaturated zone / C = hydraulic conductivity. The methodology uses a rating and weighting approach and was developed by the Environmental Protection Agency (USA)
Electrical Conductivity	The ability of groundwater to conduct electrical current, due to the presence of charged ionic species in solution (Freeze and Cherry, 1979).
Fractured aquifer	Fissured and fractured bedrock resulting from decompression and/or tectonic action. Groundwater occurs predominantly within fissures and fractures.
Groundwater	Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.
Inferred	Where a geological contact or fault is believed to exist however is not confirmed.
Intergranular aquifer	Generally unconsolidated but occasionally semi-consolidated aquifers. Groundwater occurs within intergranular interstices in porous medium. Typically occur as alluvial deposits along river terraces.
Intergranular and fractured aquifers	Largely medium to coarse grained granite, weathered to varying thicknesses, with groundwater contained in intergranular interstices in the saturated zone, and in jointed and occasionally fractured bedrock.
Vulnerability	The tendency or likelihood for contaminants to reach a specified position in the ground-water system after introduction at some location above the uppermost aquifer (National Research Council, 1993).

Groundwater Specialist Assessment

This report serves as the Groundwater Specialist Assessment prepared as part of the Basic Assessments (BAs) for the proposed development of four 175 MW Solar Photovoltaic (PV) Facilities and associated Electrical Grid Infrastructure (Specifically Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4), near Touws River, Western Cape.

1. Introduction

GEOSS South Arica (Pty) Ltd was appointed by the Council for Scientific and Industrial Research (CSIR) to complete a basic groundwater assessment for the proposed project (**Map 1**). This geohydrological assessment includes a desktop review of groundwater characteristics and users in the area, with the aim of determining the potential for groundwater to be used for construction and operational purposes, including panel cleaning, as well as risk to nearby groundwater users.

The study area can be divided into three separate farms namely Witte Wall, Grootfontein and Hoek Doornen. The total water requirement is estimated to be 5 million to 8 million litres per year during operation per project (i.e. per Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4). At the time of writing this report the amount of groundwater to be used during construction was uncertain, however in this report it has been assumed that groundwater will be used during this phase. In terms of groundwater quality, optimally the water should be of drinking water quality. The groundwater might have to be treated to make it suitable for the intended use.

This report outlines the work completed to assess the likelihood of using groundwater for the Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 developments (**Map 2**), including the potential impact the development may have on groundwater resources in the area.

1.1. Scope, Purpose and Objectives of this Specialist Report

The scope of work is to provide groundwater specialist services, including the tasks outlined below:

- Desktop assessment for groundwater to be used for construction and operational purposes for each proposed project, including solar panel cleaning.
- Assessment of the impact on geohydrological resources as a result of the proposed development.
- Provide recommendations to minimize or mitigate impacts.
- Confirm what type of authorisation is required to make use of the groundwater.

The results of the investigation are presented in this report along with the data analysis and interpretation.

1.2. Details of Specialist

This specialist assessment has been undertaken by Charl Muller of GEOSS South Africa. Charl Muller is registered with the South African Council for Natural and Scientific Professions (SACNASP), with Registration Number 123456 in the field of Hydrogeology. A curriculum vitae is included in **Appendix B** of this specialist assessment.

1.3. Terms of Reference

The procedure adopted for this study involved a **desktop study** of all available data and databases. The study involved obtaining and reviewing all relevant data to the proposed projects. This included analysing data from the National Groundwater Archive (NGA), Water Authorisation and Registration Management System (WARMS) and GEOSS's internal database, as well as groundwater yield, groundwater chemistry and geological maps of the area. A site visit was not carried out as the study was desktop based.

2. Approach and Methodology

The specialist study was completed as follows:

Task 1: Obtain all relevant data to the proposed projects (i.e. obtain data from the NGA and associated groundwater use databases, e.g. WARMS, GEOSS internal database). Obtain any data from local Department of Water and Sanitation (DWS) [now operating as the Department of Human Settlements, Water and Sanitation (DHSWS)] monitoring boreholes. Obtain relevant geological maps and geohydrological maps. Obtain relevant groundwater reports. Compile a project Geographic Information System (GIS).

Task 2: Analyse the data, using geohydrological methods and address the questions raised in the project objectives.

Task 3: Document the results in a report.

The report is also required to comply with the Assessment Protocols that were published on 20 March 2020, in Government Gazette 43110, Government Notice (GN) 320 (i.e. Part A, which provides the Site Sensitivity Verification Requirements where a Specialist Assessment is required but no specific Assessment Protocol has been prescribed). There is no specific Assessment Protocol devised for Geohydrology or Groundwater Assessments. Therefore, the report needs to comply with Appendix 6 of the 2014 National Environmental Management Act (Act 107 of 1998, as amended) Environmental Impact Assessment (EIA) Regulations.

2.1. Information Sources

The following information sources were used in this study:

Data / Information	Source	Date	Type	Description
Geological Map	Council for Geosciences	2009	Spatial	1:1 000 000 scale Geological Map series of South Africa
Geological Map	Council for Geosciences	1991	Spatial	1:250 000 scale Geological Map Series of 3320 Ladismith
Geological Map	Council for Geosciences	2001	Spatial	1:250 000 scale Geological Map Series of 3319 Worcester
Geological Map	Council for Geosciences	1973	Spatial	1:250 000 scale Geological Map Series of 3218 Clanwilliam
Geological Map	Council for Geosciences	1983	Spatial	1:250 000 scale Geological Map Series of 3218 Sutherland
Groundwater recharge and vulnerability mapping	GWD Conference Bloemfontein	2007	Spatial	A National scale approach to groundwater recharge and vulnerability mapping
Hydrogeological map series	Department of Water Affairs and Forestry	2002	Spatial	Hydrogeological map series of the republic of South Africa
NGA Database	NGA	27 October 2020	Database and Spatial	Spatial delineation of NGA registered boreholes

Data / Information	Source	Date	Type	Description
WARMS Database	Water use Authorization & Registration Management System	June 2019	Database and Spatial	Spatial delineation of WARMS registered boreholes
GEOSS Database	GEOSS South Africa	2015	Report	Consulting report from a neighbouring property.
Climatology and Geohydrology	2009	Cape Farm Mapper	Database	SA Atlas of Climatology and Geohydrology; obtained from Western Cape Government Agriculture

2.2. Assumptions, Knowledge Gaps and Limitations

The following assumptions and limitations apply:

- A limitation experienced during this investigation was that no site visit was carried out, and therefore no hydrocensus could be undertaken. Despite this, this desktop study is considered suitable to meet the objectives of the study
- The geohydrological assessment is based on previous studies and available literature for the study area. Regional scale GIS datasets based on 1: 500 000 and previous hydrogeological work completed have been assumed to be correct.
- No drill records or yield test data exists for production or wind pump boreholes to clarify yields and geological logs.
- The acquisition of accurate groundwater levels proved to be difficult, therefore data was limited to information obtained from local parties. Nonetheless these limitations have not negatively impacted the conclusions of the project.
- The NGA data is available at a local scale, although is known to sometimes contain false information.

The information obtained was sufficient to provide comprehensive geohydrological characterization of the regional setting.

It must be noted that there are no areas on site that should be avoided from a groundwater sensitivity perspective.

2.3. Consultation Processes Undertaken

No site visit was undertaken; however, involved land owners were contacted (if possible) to gather as much information on existing boreholes surrounding the proposed development.

3. Description of Project Aspects relevant to the Geohydrological Assessment

As mentioned above, the Project Applicant intends to make use of existing boreholes to source groundwater (if available and if suitable) for the construction and operational phases (i.e. cleaning of panels). As a result, water pipelines may need to be constructed in order to transfer groundwater from existing boreholes or they may be transported by trucks from the boreholes to the sites. Groundwater will need to be stored on site in suitable containers or reservoir tanks during the construction and operational phases. The process required to ensure use of the groundwater in terms of the National Water Act is also addressed in this study. As noted in the BA Reports, if groundwater is not suitable, then the water will be trucked in from the municipality.

Generally, groundwater can be impacted negatively in two manners, namely:

- Over-abstraction (where groundwater abstraction exceeds recharge rates) which can result in the alteration of groundwater flow directions and gradients.

- Quality deterioration (i.e. from anthropogenic activities negatively impacting groundwater quality).

There is currently limited groundwater abstraction taking place in relation to the size of the study area (based on regional datasets). Groundwater is mostly used for drinking, agricultural purposes and livestock watering. The low rainfall and high evapotranspiration rates within the study area are a limiting factor for the recharge of the aquifer underlying the study area.

The groundwater requirement for the project can be met by using the existing boreholes. However, agreements will have to be put in place with the current land owners for the use of groundwater. These agreements will have to be legally valid documents and the necessary endorsements will be required from the DHSWS. If no such agreements can be put in place, then additional boreholes will need to be drilled on the relevant farm portions/developments, followed by yield and water quality testing, and then authorization from DHSWS to use the groundwater will be required. The groundwater will need to be stored in water tanks on site. The groundwater required for the construction and operational phase per project will be very low.

4. Baseline Environmental Description (Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4)

4.1. General Description

The nearest town to the centroid of the study area (Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4) is Touws River, approximately 40 km to the south. The Hoek Doornen farm landscape is arid with transported sands occurring widely along plains with shales and sandstones dominating the mountainous areas.

4.2. Project Specific Description (Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 - PV Facilities, Electrical Grid Infrastructure and Associated Infrastructure)

The Hoek Doornen Farm experiences a semi-arid climate, with most of the rainfall occurring during the winter months. **Figure 1** shows the monthly average air temperature and rainfall distribution and **Figure 2** shows the monthly median rainfall and evaporation distribution for the Hoek Doornen Farm (Schulze, 2009). The long term (1950 – 2000) mean annual precipitation for the Hoek Doornen Farm is 197 mm/a. The rainfall does not exceed evaporation during the winter rainy season.

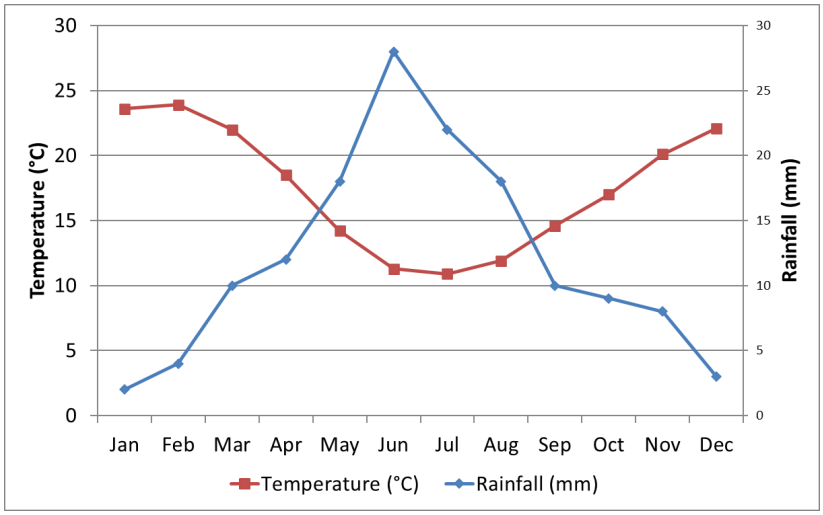

Figure 1: Monthly average air temperature and rainfall distribution for the Hoek Doornen Farm (Schulze, 2009).

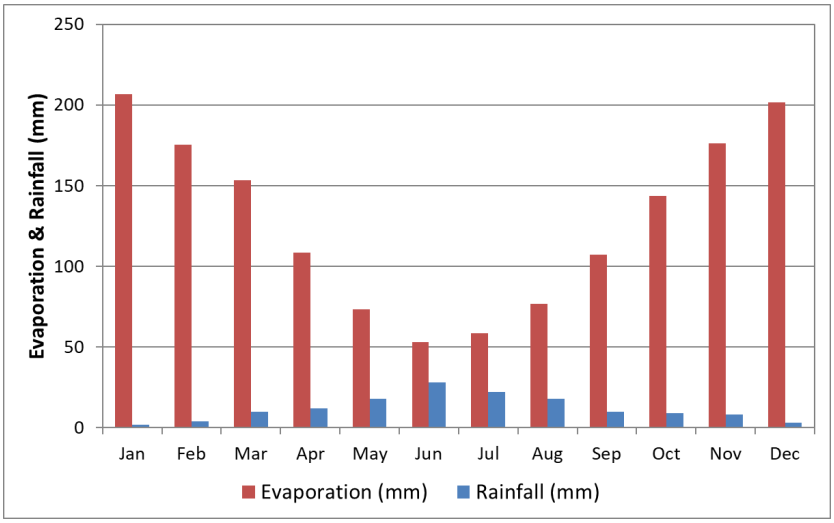

Figure 2: Monthly average rainfall and evaporation distribution for the Hoek Doornen Farm (Schulze, 2009).

4.3. Regional Geology

The Geological Survey of South Africa (now the Council for Geoscience) has mapped the area at 1:1M scale (South Africa). The geological setting is shown in **Map 3**. The main geology of the area is listed in **Table 1**.

Table 1: Geological formation within the study area.

Symbol	Formation	Group	Lithology
N-Qg	n/a - Quaternary Age		Alluvium and terrace gravel.
PA-Ng	Grahamstown Formation	n/a	High-level terrace gravel, silcrete, ferricrete.
Pak	Abrahamskraal Formation	Beaufort Group	Mudstone, siltstone, sandstone and thin chert beds.
Pk	Kookfontein Formation	Ecca Group	Shale, siltstone, subordinate sandstone.
Ps	Skoorsteenberg Formation		Mudrock and siltstone, sandstone
Pt	Tierberg Formation		Dark-grey shale and siltstone.
Ppw	1. Collingham Formation 2. Whitehill Formation 3. Prince Albert Formations		1. Siltstone, chert and sandstone with thin interbedded shale and yellow weathering mudstone/tuff. 2. Dark-grey shale, light-grey weathering with cherty siltstone beds 3. Dark-grey shale with reddish-brown-weathering siltstone.
C-Pd	Dwyka Formation		Tillite, diamictite, and subsidiary shale.
Cl	n/a	Witteberg Group	Mudrock, micaceous shale, siltstone, quartzose and arkosic sandstone, diamictite.
Dw			Reddish to white quartz arenite, red to brown thin-bedded sandstone, minor micaceous red or purple siltstone and shale, rhythmite

The Hoek Doornen Farm Portion is underlain by the Grahamstown Formation deposits which comprises of high-level terrace gravel, silcrete and ferricrete. This is most likely underlain by (in order of youngest to oldest):

- dark-grey shale and siltstone (the Tierberg Formation)
- siltstone, chert and sandstone with thin interbedded shale and yellow weathering mudstone/tuff (the Collingham Formation)
- dark-grey shale, light-grey weathering with cherty siltstone beds (the Whitehill Formation)
- dark-grey shale with reddish-brown-weathering siltstone (the Prince Albert Formation)
- tillite, diamictite, and subsidiary shale (the Dwyka Formation)

The proposed development is located southwest of two faults trending from north-east towards the south-west. These faults are prominent in the Kookfontein, Skoorsteenberg and Grahamstown Formations resulting in fracturing of the bedrock (**Map 3**). Whereas, to the southeast of the Hoek Doornen Farm portion is a mapped Dolerite Dyke (Kf). These faults and dyke structures are good target zones if further groundwater development is going to take place.

4.4. Regional Hydrogeology

The regional aquifer directly underlying the Hoek Doornen Farm portion is classified by the Department of Water Affairs and Forestry (DWAF) (DWAF, 2002) as a fractured aquifer with an average yield potential of 0.1 – 0.5 L/s (**Map 4**). A fractured aquifer describes an aquifer where groundwater only occurs in narrow fractures within the bedrock.

Based on the DWAF (2002) mapping of the regional groundwater quality, as indicated by electrical conductivity (EC), the majority of the farm portion is in the range of 300 – 1 000 mS/m with the northern corner of the portion in the range of 70 – 300 mS/m. This is considered to be "moderate to poor" quality for water (**Map 5**) with respect to drinking water standards.

Both these classifications are based on regional datasets, and therefore only provide an indication of conditions to be expected.

4.4.1. NGA Database

A desktop assessment was initially carried out around the property to determine if there were any groundwater users in the area. The NGA database provides data on borehole positions, groundwater chemistry and yield, where available. The NGA indicated there are nine boreholes surrounding the Hoek Doornen portion (**Map 6**) These NGA sites are summarized in **Table 2**.

Table 2: Summary of NGA borehole.

NGA Label	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	Yield (L/s)	EC (mS/m)	Depth (m)	Lithology
3319BB00012	-33.1274	19.91708			673	36.6	Tillite
3320AA00009	-33.1117	20.02777	14		118	80	Shale
3319BB00013	-33.0838	19.9518	9.15		333	36.6	Tillite
3320AA00010	-33.0656	20.08249	3	0.25	286	80	Shale
3320AA00023	-33.0656	20.0825		0.25	286	80	Shale
3319BB00011	-33.0647	19.87847		0.63	398	12.2	Tillite
3319BB00004	-33.0344	19.88263	6.1		432	36.6	Tillite
3319BB00005	-33.0161	19.87097	7.63		1192	36.6	Sandstone & Shale
3319BB00003	-33.0099	19.98597	10.68		496	67.1	Sandstone & Shale

Overall, the NGA sites indicate a relatively shallow drill depth (12 – 80 m), drilled into varying lithologies of tillite, shale and sandstone. Yields are low, ranging from 0.25 to 0.63 l/s and EC's are moderate to poor ranging from 118 to 1192 mS/m.

4.4.2. WARMS Database

There are 4 registered boreholes (WARMS site) located within a search radius of 1 km around the Hoek Doornen Farm portion boundary, as shown on **Map 6**. The information is summarised in **Table 3**. This groundwater use is registered to neighbouring farm portions.

Table 3: Summary of WARMS borehole details.

WARMS no.	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Registered Volume (m^3/a)	Status
22137787	-33.0718	19.9709	27375	Registered
22138090	-33.079	19.9597	27375	Registered
22124933	-33.1047	20.0114	7300	Complete
22138697	-33.0404	20.1098	2190	Registered

4.4.3. Witte Wall Boreholes

A representative of the Witte Wall Farm, was contacted regarding groundwater use from boreholes on the Witte Wall farm portion, shown on **Map 6**. These boreholes are summarised in **Table 4**.

Table 4 – Summary of Witte Wall Boreholes.

Borehole Name	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Comment
WW_1	-32.995951	19.980220	Only used for domestic use and livestock watering. Airlift yield of 4 500 L/h. Depth between 80 and 100 m.
WW_2	-32.996100	19.980193	Only used for domestic use and livestock watering. Airlift yield of 4 500 L/h. Depth between 80 and 100 m.
WW_3	-32.996183	19.980102	Only used for domestic use and livestock watering. Airlift yield of 4 500 L/h. Depth between 80 and 100 m.
WW_4	-33.010868	19.986994	Only used for domestic use and livestock watering. Airlift yield of 6 500 L/h. Depth between 80 and 100 m.
WW_5	-33.009423	20.023950	Only used for domestic use and livestock watering. Airlift yield of 6 000 L/h. Depth between 80 and 100 m.

From the information provided it is clear that the boreholes are relatively high yielding (airlift yields) for the area. The water is mainly used for domestic use and livestock watering. The status and condition of these boreholes will need to be accessed during the hydrocensus.

4.4.4. Grootfontein Boreholes

A representative of Grootfontein Farm, was contacted regarding groundwater use from boreholes on his farm, shown on **Map 6**. These boreholes are summarised in **Table 5**.

Table 5: Summary of Grootfontein Boreholes.

Borehole Name	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Comment
GF_1	-32.9448	19.94878	Brackish water used only for drinking water and gardening.
GF_2	-32.9439	19.94818	Used for drinking water. Low yielding.
GF_3	-32.9386	19.95211	Reportedly strong borehole, pumped at 6000 L/h from time to time. Has not been pumped for years
GF_4	-32.9375	19.95276	Reportedly strong borehole, pumped at 4000 L/h from time to time. Has not been pumped for years
GF_5	-32.9398	19.94759	Old borehole, water level at 1.5 mbgl. Has not been pumped in last 25 years.
GF_6	-32.9737	19.95309	Used for livestock watering.

From the information supplied it is clear that the water is brackish and is mostly used for domestic use. Two of the boreholes indicate relatively high yield for the area of 4 000 to 6 000 L/h. The status and condition of these boreholes will need to be accessed during the hydrocensus.

4.4.5. GEOSS Database

A search of GEOSS's internal database of previous projects conducted in the area indicated a total of 18 boreholes surrounding the Hoek Doornen Farm portion (**Map 6**). The results are summarised in **Table 6**.

From GEOSS's internal database, it is clear that groundwater quality is poor (ranging from 169 to 1377 mS/m) with low yields ranging from 0.5 to 1.47 L/s. Water levels range from shallow (1.00 mbgl) to relatively deep (8.80 mbgl).

Table 6: Summary of GEOSS's internal database borehole details.

ID no.	WL (mbgl)	Yield (L/s)	EC (mS/m)	TDS (mg/L)	pH
GD_1	8.215	-	-	-	-
GD_2	8.8	1.47	478.2	3102	7.09
GD_3	-	-	-	-	-
GD_4	-	-	-	-	-
GD_5	6.4	-	356.5	2400	7.25
GD_6	8.62	-	305.7	2082	7.76
GD_7	4.24	-	1377.5	9263	7.33
GD_8	1.09	0.5	169.5	1114	8.87
GD_9	1.00		299.8	1917	8.04
GD_10	1.47		287.32	-	-
GD_11	1.03		435.94	-	
GD_12	-		405.4	2821	7.88
GD_13	-		-	-	-
GD_14	-		305	1918	7.86
GD_15	-		-	-	-
GD_16	8.10		215.9	1398	8.33
GD_17	-		-	-	-
GD_18	-		-	-	-

4.4.6. Kareekolk Borehole

The Kareekolk Farm contains the access road to the Hoek Doornen and Witte Wall Farm portions delineated for the proposed solar development. Mr Leon Theunissen (owner of Kareekolk Farm) indicated the possible use of his dam water for construction and operations, including solar panel cleaning. It was established that this dam (**Figure 3**) is filled with borehole water supplied by the KK_1 borehole, shown on **Map 6** and summarised in **Table 7**. This borehole, reportedly, is pumped at a high rate of 40 000 L/h for 9 hours per day. Quality at this stage is unknown. The preliminary findings for the determination of the existing lawful use, for this borehole, indicates a lawful use of 2694 m3/a (~0.08L/s). This is not enough to supplement the required amount of water of 5 to 8 million litres per year per project (~1.0 L/s). This will require a General Authorisation to make use of this volume of water.

Table 7: Kareekolk Borehole Summary.

Borehole Label	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Reported Yield (L/s)	Quality
KK_1	-32.9836030	19.938373	11.1	Unknown

Figure 3: Dam located on Kareekolk Farm.

4.5. Geohydrological Characterisation (Aquifer Vulnerability) - Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4

The Hoek Doornen Farm portion overlies a fractured aquifer that possesses water bearing properties due to fracturing. Several methods have been developed to classify an aquifer's vulnerability. The DRASTIC method has been applied to this study.

4.5.1. Aquifer Vulnerability (DRASTIC)

Groundwater vulnerability can be defined as the "tendency for contaminants to reach a specified position in the groundwater system after introduction at some location" (Vrba and Zaporozec, 1994). Key physical parameters which determine groundwater vulnerability include lithology, thickness, effective porosity, groundwater flow direction, age and residence time of water. Generally, the residence time of a contaminant in groundwater and the distance that it travels in the aquifer are considered important measures of vulnerability.

There are two main groups of methods for assessing groundwater vulnerability, namely:

- Index or subjective rating methods, and
- Statistical or process-based methods.

The “index or subjective rating method” is relatively easily addressed within a GIS framework. The cell-based layer approach facilitates the assignment of ratings and weights and rapid achievement of a final result of relative groundwater vulnerability. This approach also means that the algorithm can easily be repeated as new or more detailed data sets are obtained or if ratings and weightings need to be adjusted as a result of a sensitivity analysis for example. The most well-known “index or subjective rating method” is the “DRASTIC” method (Aller et al., 1987). The DRASTIC method of Aller et al. (1987) uses the typical overlay technique often applied in subjective rating methods. The DRASTIC approach is based on four major assumptions:

- The contaminant is introduced at ground surface;
- The contaminant is flushed into the groundwater by precipitation;
- The contaminant has the mobility of water; and
- The area evaluated using DRASTIC is 40.5 ha or larger.

The implication of these assumptions is that DRASTIC should not be used for contaminants that do not have the mobility of water or for point assessment (such as storage tanks). In addition, groundwater conditions in South Africa are dominated by secondary/fracture-controlled flow conditions. The DRASTIC method does not consider local preferential flow paths of fractured aquifer systems particularly well. The DRASTIC method takes into account the following factors:

D	=	depth to groundwater	(5)
R	=	recharge	(4)
A	=	aquifer media	(3)
S	=	soil type	(2)
T	=	topography	(1)
I	=	impact of the vadose zone	(5)
C	=	conductivity (hydraulic)	(3)

The number indicated in parenthesis at the end of each factor description is the weighting or relative importance at that factor.

Groundwater vulnerability maps developed using the DRASTIC method have been produced in many parts of the world. In spite of the widespread use of DRASTIC, the effectiveness of the method has been met with mixed success due to hydrogeological heterogeneity and the many assumptions that need to be made in determining groundwater vulnerability. In addition, the use of a generic vulnerability map only gives a broad indication of relative vulnerability and in many instances detailed scale, contaminant specific vulnerability assessments are required. From the assumptions outlined by Aller et al. (1987), DRASTIC can only be applied to non-point source pollution, as DRASTIC is inaccurate in point source assessments.

As part of the Groundwater Resources Assessment Project (DWAF, 2005), numerous data sets were produced and this enabled the mapping of groundwater vulnerability at the national scale on a 1 km by 1 km cell (pixel) size basis (Conrad and Munch, 2007). This national scale map indicates the relative vulnerability of groundwater resources throughout the country and provides project planners a clear idea of what level of groundwater protection is required.

A national scale map of groundwater vulnerability has been completed for South Africa (DWAF, 2005). The groundwater vulnerability for the study area is shown in **Map 7**. The development area on the Hoek Doornen portion has a **very low** groundwater vulnerability.

4.6. Strategic Water Source Areas

Strategic Water Source Areas (SWSAs) are defined as “areas of land that either: (a) supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or (b) have high groundwater recharge and where the groundwater forms a nationally important resource; or (c) areas that meet both criteria (a) and (b)” (Le Maitre et al., 2018:1 in DEFF, 2019: Page 61). Thirty-seven groundwater SWSAs have been identified in South Africa and are considered to be strategically important at a national level for water and economic security (Le Maitre et al. 2018 in DEFF, 2019: Page 61). The total area for groundwater SWSAs extends approximately 104 000 km^2, and covers approximately 9% of the land surface of South Africa (Le Maitre et al. 2018, in DEFF 2019: Page 61).

According to the Solar PV Theme on the National Web-based Environmental Screening Tool, there are no SWSAs on the Hoek Doornen Farm. Refer to Figure 4 below.

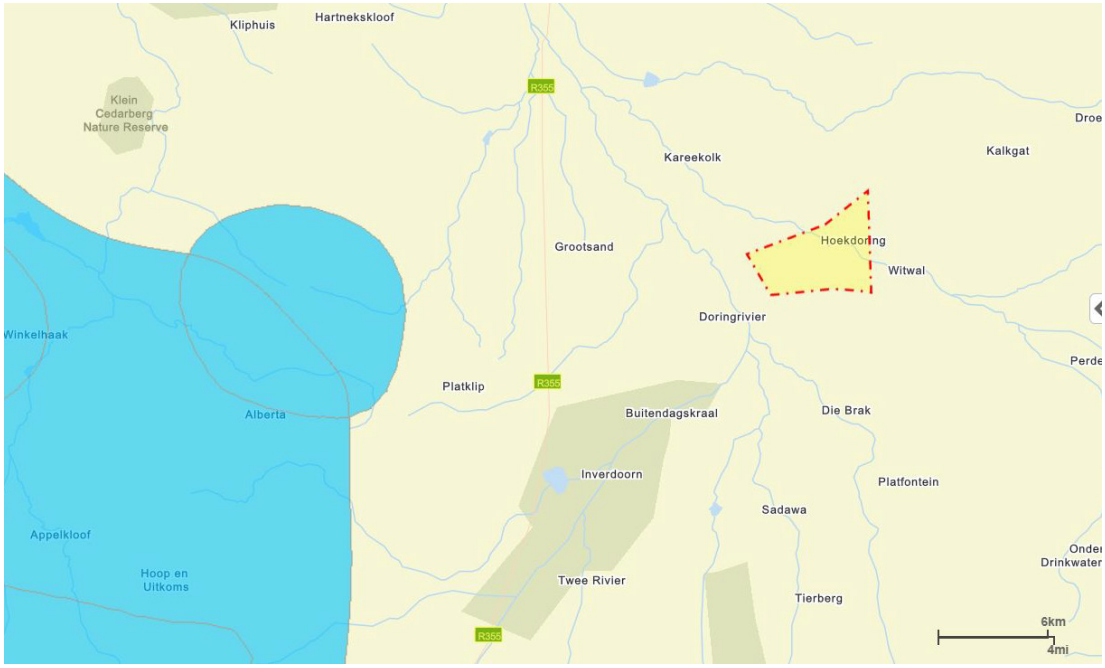

Figure 4: SWSAs from the National DEFF Screening Tool (DEFF, 2020).

5. Issues, Risks and Impacts (Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4)

5.1. Identification of Potential Impacts/Risks

The following potential impacts on groundwater of the proposed project activities are as follows:

- Lowering of the groundwater level due to abstraction (5 to 8 million litres per year per PV project);
- Potential impact on groundwater quality as a result of accidental oil spillages or fuel leakages during the construction, operational and decommissioning phases; and
- Potential impact on groundwater quality as a result of cleaning agents used for cleaning the solar panels.

Any construction activities such as the excavation and installation of foundations and piling (narrow diameter holes for foundation purposes) will have minimal to no impact on the groundwater of the site or region, as the groundwater level is approximately 3 – 8 mbgl.

The potential impacts identified during the BA are:

Construction Phase

- Potential lowering of the groundwater level; and
- Potential impact on groundwater quality as a result of accidental oil spillages or fuel leakages.

Operational Phase

- Potential lowering of the groundwater level; and
- Potential impact on groundwater quality as a result of using cleaning agents for cleaning the solar panels.

Decommissioning Phase

- None

Cumulative Impacts

- Due to the large spatial extent and low water demand in the study area, including other groundwater users within a 30 km radius, the cumulative impact is regarded as insignificant.
- It is assumed that not all 9 PV facilities will be constructed at the same time, hence the requirements will not be 8 million litres * 9 per year per PV project, allowing for sufficient recharge.

No indirect impacts are identified.

In terms of the no-go alternative, if the proposed Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 projects do not go ahead, there will be no need to use approximately 5 – 8 million litres per year of ground water per project. However, as noted above, there is a low water demand in the study area and a large spatial extent; and the impacts relating to the use of ground water is not considered as highly significant.

6. Impact Assessment - Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4

It must be noted that the impacts provided below are the same for all the Hoek Doornen PV 1, Hoek Doornen PV2, Hoek Doornen PV 3 and Hoek Doornen PV 4 projects, as well as the Electrical Grid Infrastructure.

6.1. Potential Impacts during the Construction Phase

6.1.1. Impact 1: Groundwater impact as a result of over-abstraction abstraction

This impact is only applicable during the construction and operational phases. At the peak requirement of 8 million litres per year per project (Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 requires 0.25 L/s each ~ 1.0 L/s) the proposed groundwater abstraction is higher than the yield potential of the underlying aquifer (0.1 – 0.5 L/s).

The status of this impact is rated as negative with a local spatial extent and a long-term duration (i.e. for the life of the project). The consequence and probability of the impact is respectively rated as substantial and unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated low. The significance of the impact without the implementation of mitigation measures is rated as moderate. With effective implementation of prevention / mitigation actions (i.e. to adhere to the borehole's safe yield and to monitor water levels and flow), the impact of the proposed abstraction on groundwater is predicted to be of low significance.

6.1.2. Impact 2: Potential Impact on Groundwater Quality as a result of Accidental Oil Spillages or Fuel Leakages

If there is an accidental oil spill or fuel leakage during the construction phase, then the low permeability of the unsaturated zone will provide significant attenuation capacity. The status of this impact (for the construction phase) is rated as negative with a site-specific spatial extent and short-term duration (i.e. for the life of the facility). The consequence and probability of the impact is respectively rated as slight and extremely unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated as low. The significance of the impact without the implementation of mitigation measures is rated as very low.

A precautionary approach must be implemented and reasonable measures must be undertaken to prevent oil spillages and fuel leakages from occurring. During the construction phase, vehicles must be regularly serviced and maintained to check and ensure there are no leakages. Any engines that stand in one place for an excessive length of time must have drip trays. Diesel fuel storage tanks, if required, should be above ground on an impermeable concrete surface in a bunded area. Construction vehicles and equipment should also be refuelled on an impermeable surface. A designated area should be established at the construction site camp for this purpose, if off-site refuelling is not possible. If spillages occur, they should be contained and removed as rapidly as possible, with correct disposal procedures of the spilled material, and reported. Proof of disposal (waste disposal slips or waybills) should be obtained and retained on file for auditing purposes.

With effective implementation of these prevention / mitigation actions, the impact of the project on groundwater as a consequence of accidental oil spillages and fuel leakages is predicted to be of very low significance.

6.1.2.1. Impact Summary Tables: Construction Phase

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
CONSTRUCTION PHASE						
Lowering of groundwater levels as a result of over-abstraction	***Status***	*Negative*	*Moderate*	*Adhere to the borehole's safe yield and to monitor water levels and flow.* *Boreholes must be correctly yield tested according to the National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes). This includes a Step Test, Constant Discharge Test and recovery monitoring.*	*Low*	*High*
	Spatial Extent	*Local*				
	Duration	*Long Term*				
	Consequence	*Substantial*				
	Probability	*Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				
Accidental oil spillage / fuel leakage	***Status***	*Negative*	*Very Low*	*Vehicles must be regularly serviced and maintained to check and ensure there are no leakages. Any engines that stand in one place for an excessive length of time must have drip trays. Diesel fuel storage tanks, if required, should be above ground on an impermeable surface in a bunded area. Vehicles and equipment should also be refuelled on an impermeable surface. A designated area should be established at the construction site camp for this purpose, if off-site refuelling is not possible. If spillages occur, they should be contained and removed as rapidly as possible, with correct disposal procedures of the spilled material, as reported. Proof of disposal (waste disposal slips or waybills) should be obtained and retained on file for auditing purposes*	*Very Low*	*High*
	Spatial Extent	*Site Specific*				
	Duration	*Short Term*				
	Consequence	*Slight*				
	Probability	*Extremely Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

6.2. Potential Impacts during the Operational Phase - Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4

It must be noted that the impacts provided below are the same for both the Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 projects. The power lines do not have any operational water usage and thus not considered to have an impact on the groundwater.

6.2.1. Impact 1: Groundwater impact as a result of over-abstraction abstraction

This impact is only applicable during the construction and operational phases. At the peak requirement of 8 million litres per year per project (Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 requires 0.25 L/s each ~ 1.0 L/s) the proposed groundwater abstraction is higher than the yield potential of the underlying aquifer (0.1 – 0.5 L/s).

The status of this impact is rated as negative with a local spatial extent and a long-term duration (i.e. for the life of the project). The consequence and probability of the impact is respectively rated as substantial and unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated low. The significance of the impact without the implementation of mitigation measures is rated as moderate. With effective implementation of prevention / mitigation actions (i.e. to adhere to the borehole's safe yield and to monitor water levels and flow), the impact of the proposed abstraction on groundwater is predicted to be of low significance.

Impact 2: Potential impact on groundwater quality as a result of using cleaning agents

The low permeability of the unsaturated zone will provide significant attenuation capacity. The status of this impact (for the operational phase) is rated as negative with a site-specific spatial extent and long-term duration (i.e. for the life of the project). The consequence and probability of the impact is respectively rated as slight and extremely unlikely. The reversibility of the impact is rated as high and the irreplaceability is rated as low. The significance of the impact without the implementation of mitigation measures is rated as very low. Recommended mitigation includes using an environmentally safe cleaning agent that breakdown naturally and do not cause adverse effects.

6.2.1.1. Impact Summary Tables: Operational Phase

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
OPERATIONAL PHASE						
Lowering of groundwater levels as a result of over-abstraction	***Status***	*Negative*	*Moderate*	*Adhere to the borehole's safe yield and to monitor water levels and flow.* *Boreholes must be correctly yield tested according to the National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes). This includes a Step Test, Constant Discharge Test and recovery monitoring.*	*Low*	*High*
	Spatial Extent	*Local*				
	Duration	*Long Term*				
	Consequence	*Substantial*				
	Probability	*Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				
Potential impact on groundwater quality as a result of using cleaning agents	***Status***	*Negative*	*Very Low*	*Use environmentally safe cleaning agents that breakdown naturally and do not cause adverse effects.*	*Very Low*	*High*
	Spatial Extent	*Site Specific*				
	Duration	*Long Term*				
	Consequence	*Slight*				
	Probability	*Extremely Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

7. Impact Assessment Summary - Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4

The overall impact significance findings, following the implementation of the proposed mitigation measures are shown in the **Table 8**.

Table 8: Overall Impact Significance (Post Mitigation)

Phase	**Overall Impact Significance**
Construction	Low-Very Low
Operational	Low-Very Low
Decommissioning	None
Nature of Impact	**Overall Impact Significance**
Cumulative - Construction	Insignificant
Cumulative - Operational	Insignificant
Cumulative - Decommissioning	None

8. Legislative and Permit Requirements

The National Water Act (Act 36 of 1998) (NWA) is administered by the DWS and is the main legislation for managing water resources in South Africa. The purpose of the NWA is to provide a framework for the equitable allocation and sustainable management of water resources. Both surface and groundwater sources are redefined by the Act as national resources which cannot be owned by any individual, and rights to which are not automatically coupled to land rights, but for which prospective users must apply for authorization and register as users. The NWA also provides for measures to prevent, control and remedy the pollution of surface and groundwater sources.

The Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 development areas are located within quaternary catchment E22E which forms part of the Olifants Catchment in Western Cape. The General Authorisation (GA) Limit for the taking of groundwater in this quaternary catchment is 45 m^3/ha/a (published on 2 September 2016, in Government Gazette 40243, Government Notice (GN) 538 (i.e. Revision of General authorisation for the taking and storing of water). The Hoek Doornen Farm portion is 2 372 hectares; equating to 106 740 m^3/a. The allowable abstraction under the GA is capped at 40 000 m^3/a. This equates to approximately 1.27 L/s (continuous abstraction) for the entire Hoek Doornen Farm portion. The proposed groundwater use for each project is less than this (peak usage is 1.0 L/s annually for all 4 Hoek Doornen PV projects) and will thus fall within the GA. Only a registration process will have to be followed for the groundwater use; i.e. Section 39 of the NWA is applicable. Although the assessed development footprint is 1910 ha, (and each PV Facility will have an estimated footprint of 260 ha within the assessed development footprint), the total farm portion is 2 372 ha and it's the total farm area that is used for the GA calculation. If other water uses in terms of Section 21 of the NWA is applicable to the farm portion, this will need to be incorporated in the registration process.

9. Environmental Management Programme Inputs

Certain measures need to be put in place to ensure that the l groundwater of local and regional aquifers is not significantly negatively impacted by the proposed projects. The following aspects are considered to be applicable to the Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 Facilities, Electrical Grid Infrastructure and Associated Infrastructure.

9.1. Accidental oil spillage / fuel leakages

- All vehicles and other equipment (generators etc.) must be regularly serviced to ensure they do not spill oil. Vehicles should be refuelled on paved (impervious) areas, optimally off-site. If liquid product is being transported it must be ensured this does not spill during transit.
- Emergency measures and plans must be put in place and rehearsed in order to prepare for accidental spillage.
- Diesel fuel storage tanks, if required, must be above ground on a concrete surface in a bunded area.
- Engines that stand in one place for an excessive length of time must have drip trays.
- Vehicle and washing areas must also be on paved surfaces and the by-products removed to an evaporative storage area or a hazardous waste disposal site (if the material is hazardous).

9.2. Groundwater abstraction (if groundwater is to be used)

- The production boreholes that are to be used should be yield tested prior to use (according to SANS10299) so that the correct pump sizes and installation depths can be determined.
- The planned production boreholes should also be sampled and chemically and microbiologically analysed by a SANAS accredited laboratory.
- Once the boreholes are in use they should be equipped with:
    - Observation pipes - so that the water levels can be measured (either manually or by data loggers);
    - Flow meters – to assess how much water is used and thereby all authorisations in place for use of the water are adhered to; and
    - Sampling tap – to enable annual sampling to ensure the groundwater is safe for continued use – especially if it is to be used as drinking water.

9.3. Cleaning agents used solar panel cleaning

- Environmentally safe cleaning agents that breakdown naturally must be used for cleaning the panels. No chemical that that could cause adverse effects to the natural environment should be allowed.

10. Final Specialist Statement and Authorisation Recommendation

The allowable general abstraction volume for the Hoek Doornen Farm Portion is 40 000 m^3/year (1.27 L/s). The entire development is estimated to require 5 to 8 million litres per year per PV project (0.25 L/s per project ~ total 1.0 L/s). Therefore, the amount of water required for the Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 developments falls within the abstraction volume allowed under GA. Only a registration process will have to be followed for the groundwater use; i.e. Section 39 of the NWA is applicable. Although the Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 assessed development footprint is approximately 1910 ha, (and each PV Facility will have an estimated footprint of 260 ha within the assessed development footprint), the total farm portion is 2 372 ha and it is the total farm area that is used for the GA calculation.

It is recommended that site visit and hydrocensus be undertaken to quantify the number of potential boreholes that could be used for abstraction, as well as, their proximity to the development and other nearby groundwater sources and users. Groundwater quality sampling is also recommended to determine whether the quality of the water meets the quality recommendations for the cleaning of solar panels, and for other purposes during the construction and operational phases.

10.1.Statement and Reasoned Opinion

It is the opinion of this specialist that the proposed activity be allowed to proceed. No impacts of significance could be identified and therefore does not pose any risk to the geohydrological conditions on site. It is imperative that proper yield testing and quality analysis of groundwater be undertaken should it be considered for use.

10.2.EA Condition Recommendations

A site visit and hydrocensus conducted by groundwater specialist should be undertaken to determine the number of groundwater users and abstraction points. This must include water level recording and groundwater sampling of potential boreholes to be used for the development.

11. References

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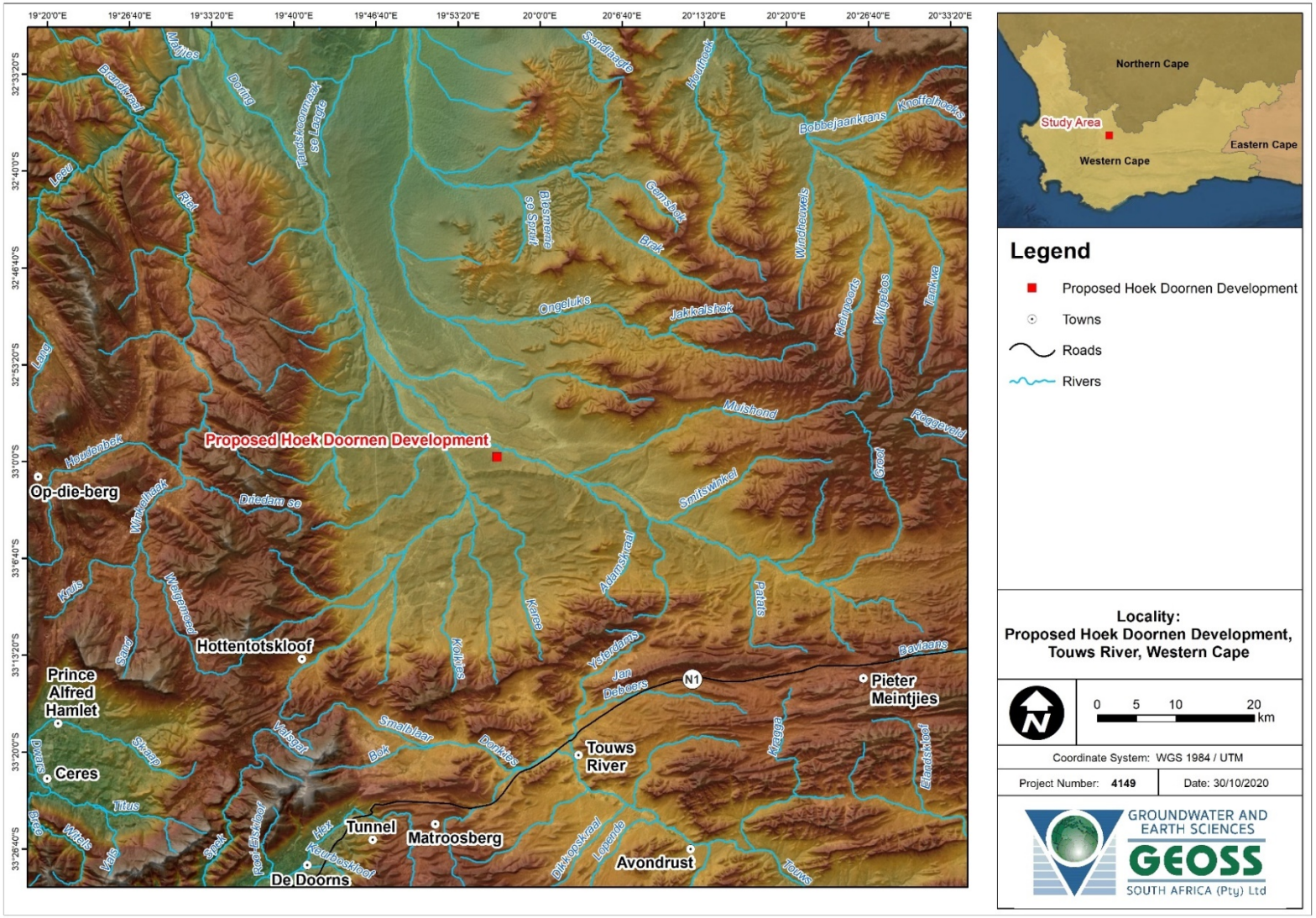
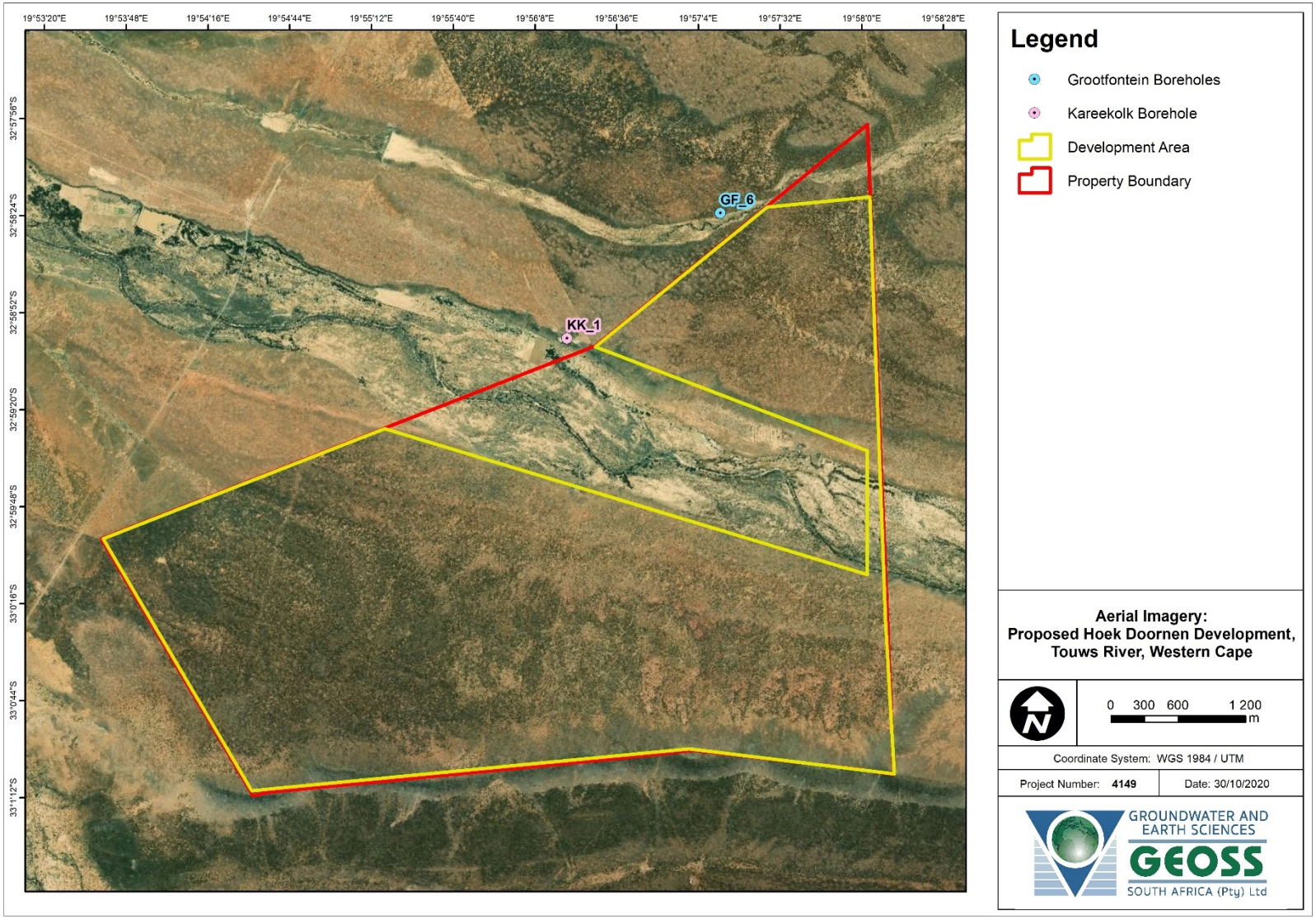
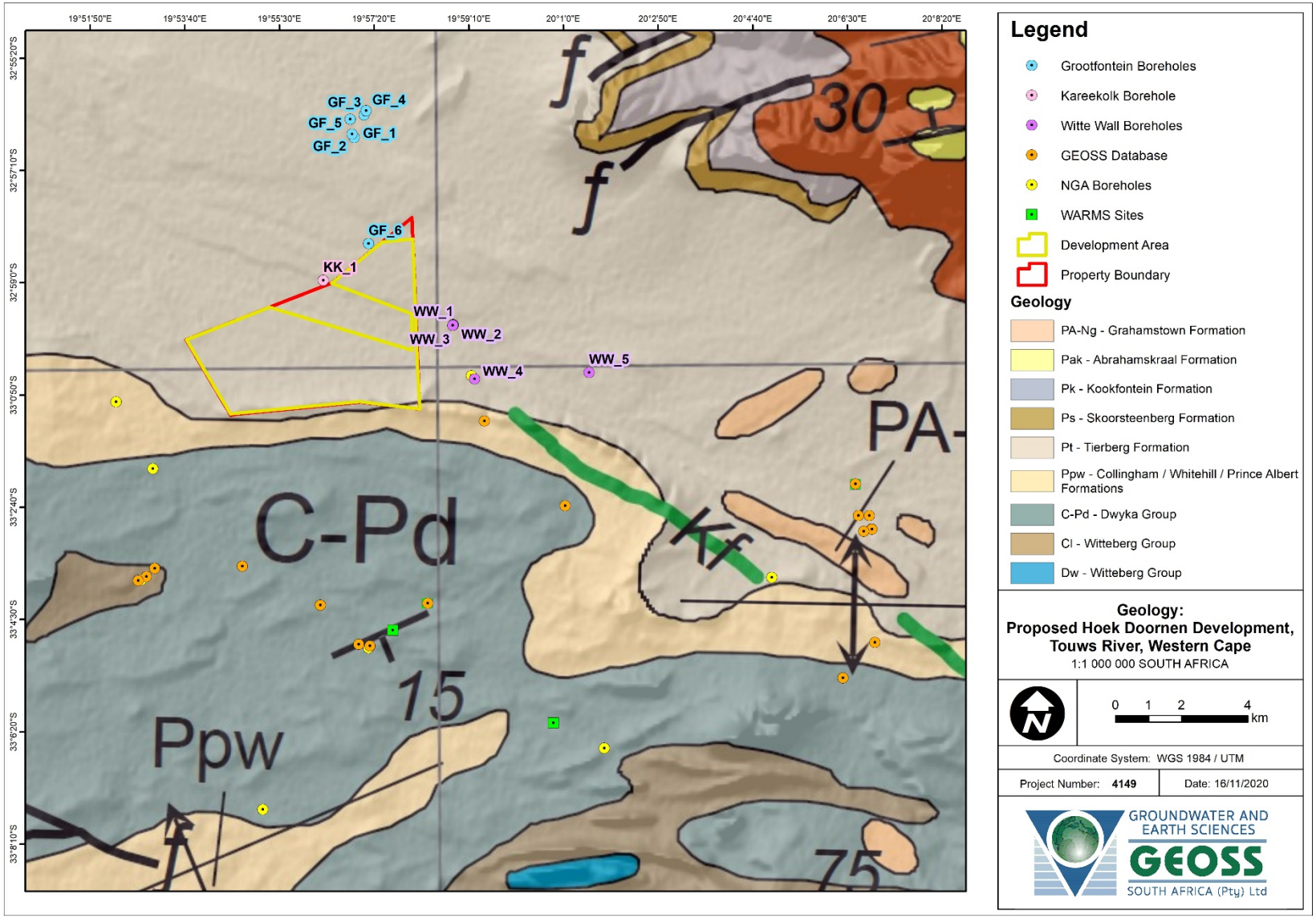
Appendix A - Maps



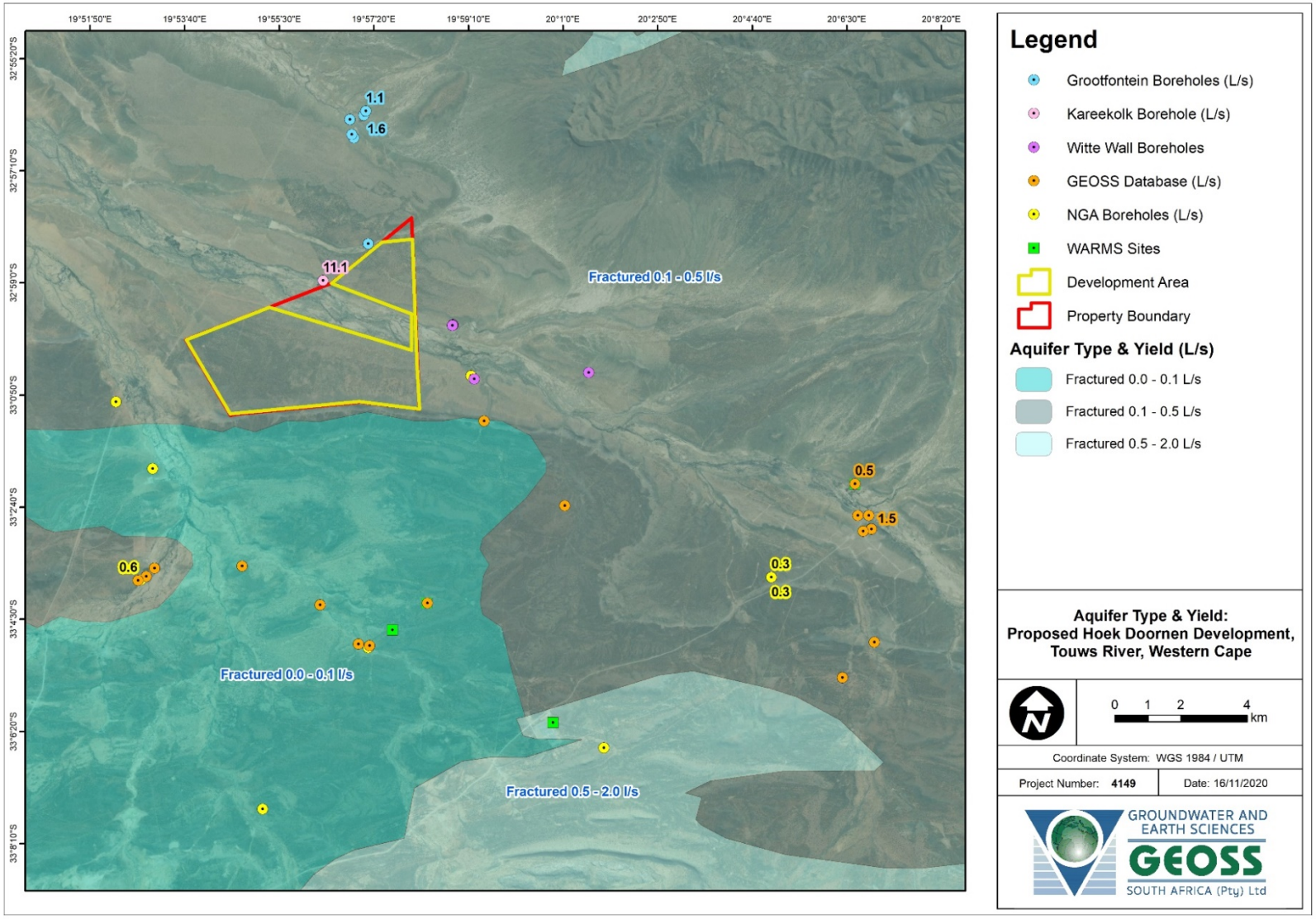
Map 1: Locality of the proposed development of four 175 MW solar PV facilities and associated electrical grid infrastructure, Touws River, Western Cape.



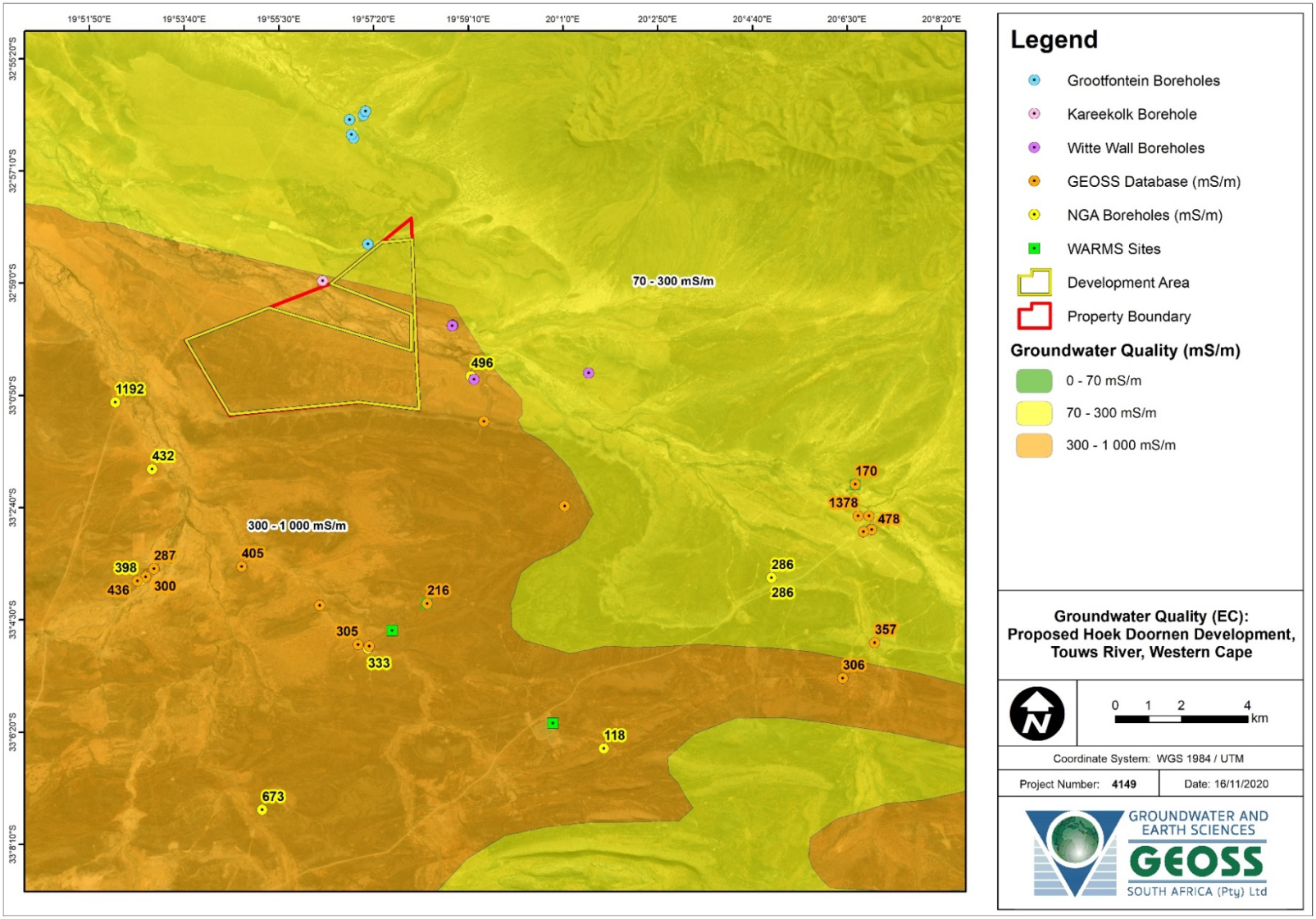
Map 2: Aerial view delineating the Hoek Doornen Wall Farm portion and proposed Hoek Doornen PV 1, Hoek Doornen PV 2, Hoek Doornen PV 3 and Hoek Doornen PV 4 development assessed area (Note that each PV Facility will cover an estimated area of 260 ha).



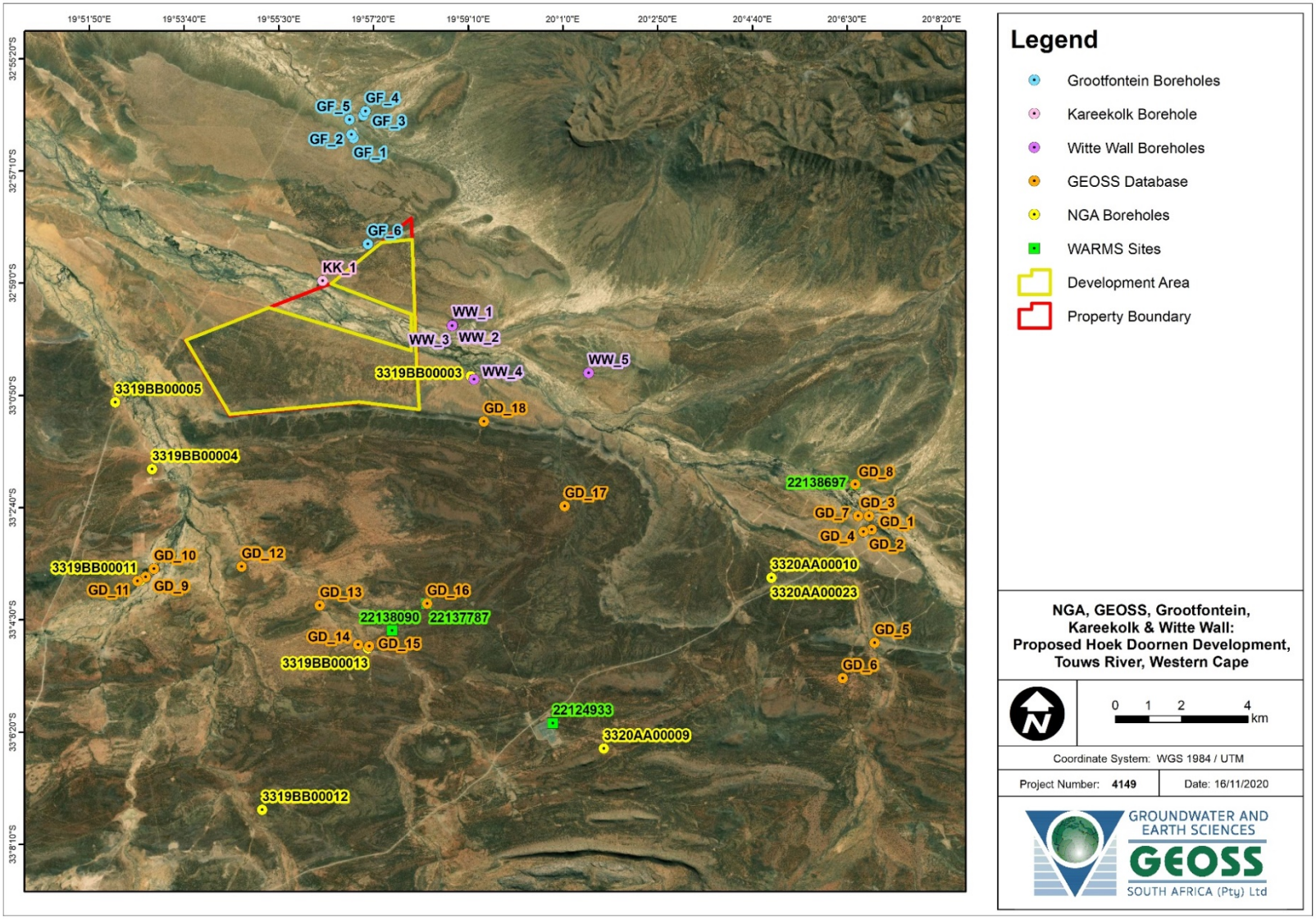
Map 3: Geological setting of the study area (CGS (2019) map: 1:1 00 000 scale South Africa).



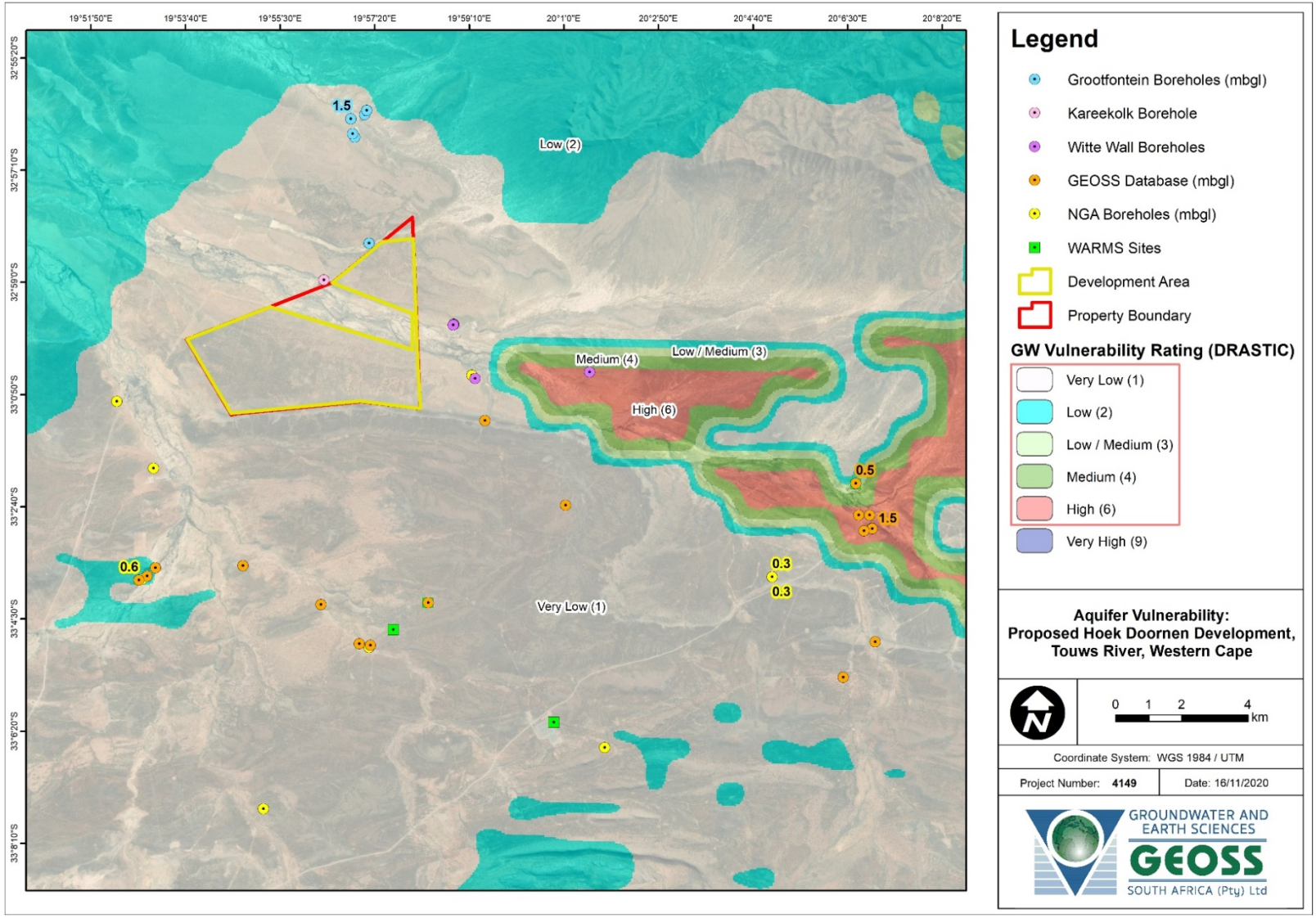
Map 4: Regional aquifer yield (DWAF, 2002) and borehole yields (L/s).



Map 5: Regional groundwater quality (mS/m) from DWAF (2002) and borehole groundwater quality (EC in mS/m).



Map 6: NGA, WARMS, Grootfontein, Witte Wall and Kareekolk and GEOSS internal database boreholes.



Map 7: Vulnerability rating (DWAF, 2005) and groundwater depths (mbgl).

Appendix B - Specialist Expertise

GENERAL

Nationality:	South African and Namibian
Profession:	Geohydrologist
Specialization:	Groundwater exploration, development, sampling and monitoring.
Position in firm:	Geohydrologist at GEOSS - Geohydrological and Spatial Solutions International (Pty) Ltd
Date commenced:	16th October 2017
Year of birth & ID #:	1991 – 9105216400083
Language skills:	English (good – speaking, reading and writing) Afrikaans (good - speaking, reading and writing).

KEY SKILLS

- Groundwater sampling, soil sampling, field measurements, borehole logging, data logging for groundwater monitoring, borehole depth and water level measurements, augering for piezometer installation, groundwater geophysics and conducting hydrocensus studies.

RELEVANT EXPERIENCE

- Numerous groundwater exploration - this includes aerial photo interpretation, resistivity, magnetic and electromagnetic geophysical surveys for borehole siting purposes, data analysis and interpretation and hydrogeological conceptualization, development, monitoring and management projects.
- Extensive satellite image data processing (including geo-referencing) for the Validation and Verification projects within the Breede-Overberg Catchment Management Agency.
- Smaller projects involving borehole sitings (aerial photo interpretation, geological mapping, geophysical profiling).
- Projects involving drilling supervision and pumping test supervision with associated data interpretation (FC Method) and writing of geohydrological reports.
- Groundwater and groundwater quality monitoring projects involving appropriate sampling, measurements, data analysis and reporting.
- Numerous Groundwater Impact Assessments

EDUCATIONAL AND PROFESSIONAL STATUS

Qualifications

2017	MEng (Geotechnical Engineering):	University of the Free State, South Africa
2015	BSc Hon – Earth Science Degree:	University of the Stellenbosch, South Africa
2014	BSc - Earth Science Degree:	University of the Stellenbosch, South Africa

Memberships

- Groundwater Division of the Geological Society of South Africa – Member No. 6080/16
- South African Council for National Scientific Professions (SACNASP) Mem. No. 123456

EMPLOYMENT RECORD

October 2017 to March 2019:	GEOSS – Geohydrological and Spatial Solutions International (Pty) Ltd, Stellenbosch
March 2019 to present	GEOSS SOUTH AFRICA (Pty) Ltd

Appendix C - Specialist Statement of Independence

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Basic Assessments for the Proposed Development of four 175 MW Solar Photovoltaic Facilities and associated Electrical Grid Infrastructure (i.e. Hoek Doornen 1; Hoek Doornen 2; Hoek Doornen 3; and Hoek Doornen 4), near Touws River, Western Cape

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

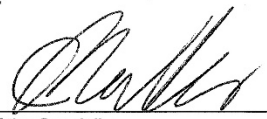
1. SPECIALIST INFORMATION

Specialist Company Name:	GEOSS SOUTH AFRICA (PTY) LTD			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	100%
Specialist name:	Charl Muller			
Specialist Qualifications:	BSc Hons (Earth Science) AND MEng (Civil Engineering)			
Professional affiliation/registration:	SACNASP Reg. no. 123456			
Physical address:	Unit 12, Technostell Building, 9 Quantum st, Techno Park, Stellenbosch 7600			
Postal address:	P.O. Box 12412, Die Boord, Stellenbosch			
Postal code:	7613	Cell:	079824 6157	
Telephone:	021 850 1079	Fax:	086 605 1121	
E-mail:				

2. DECLARATION BY THE SPECIALIST

I, Charl Muller, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.



Signature of the Specialist

GEOSS SOUTH AFRICA (PTY) LTD

Name of Company:

30 / October / 2020

Date

3. **UNDERTAKING UNDER OATH/ AFFIRMATION**

I, Charl Muller, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

GEOSS SOUTH AFRICA (PTY) LTD

Name of Company

30/ October /2020

Date

Signature of the Commissioner of Oaths

Date

STASIE BEVELVOERDER
STELLENBOSCH
2020 -10- 30
STELLENBOSCH
STATION COMMANDER
SOUTH AFRICAN POLICE SERVICE

Appendix D: Site Sensitivity Verification

It is important to note that there are no dedicated Geohydrology or Groundwater themes on the National Web-based Environmental Screening Tool (Screening Tool) (as at October 2020), therefore the environmental sensitivity of the proposed project area as identified by the Screening Tool is not applicable. Therefore, no site sensitivity verification report is required. Furthermore, there is no dedicated assessment protocol prescribed for Geohydrology or Groundwater. Therefore, the specialist assessment has been undertaken in compliance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014. All relevant desktop information, consultation with landowners, and previous assessments undertaken by the author in the study area have been taken into consideration in this assessment.

Appendix E: Impact Assessment Methodology

The following impact assessment has been used in this assessment.

The impact assessment includes:

- *the nature, significance and consequences of the impact and risk;*
- *the extent and duration of the impact and risk;*
- *the probability of the impact and risk occurring;*
- *the degree to which impacts and risks can be mitigated;*
- *the degree to which the impacts and risks can be reversed; and*
- *the degree to which the impacts and risks can cause loss of irreplaceable resources.*

As per the DEFF Guideline 5: Assessment of Alternatives and Impacts, the following methodology is applied to the prediction and assessment of impacts and risks. Potential impacts and risks have been rated in terms of the direct, indirect and cumulative:

- *Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.*
- *Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.*
- *Cumulative impacts are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.*

The impact assessment methodology includes the following aspects:

- *Nature of impact/risk - The type of effect that a proposed activity will have on the environment.*

- *Status - Whether the impact/risk on the overall environment will be:*
    - *Positive - environment overall will benefit from the impact/risk;*
    - *Negative - environment overall will be adversely affected by the impact/risk; or*
    - *Neutral - environment overall not be affected.*

- *Spatial extent – The size of the area that will be affected by the impact/risk:*
    - *Site specific;*
    - *Local (<10 km from site);*
    - *Regional (<100 km of site);*
    - *National; or*
    - *International (e.g. Greenhouse Gas emissions or migrant birds).*

- *Duration – The timeframe during which the impact/risk will be experienced:*
    - *Very short term (instantaneous);*
    - *Short term (less than 1 year);*
    - *Medium term (1 to 10 years);*
    - *Long term (the impact will cease after the operational life of the activity (i.e. the impact or risk will occur for the project duration)); or*
    - *Permanent (mitigation will not occur in such a way or in such a time span that the impact can be considered transient (i.e. the impact will occur beyond the project decommissioning)).*

- *Consequence – The anticipated consequence of the risk/impact:*
    - *Extreme (extreme alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they permanently cease);*
    - *Severe (severe alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);*

- *Substantial (substantial alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);*
- *Moderate (notable alteration of natural systems, patterns or processes, i.e. where the environment continues to function but in a modified manner); or*
- *Slight (negligible alteration of natural systems, patterns or processes, i.e. where no natural systems/environmental functions, patterns, or processes are affected).*

- *Reversibility of the Impacts - the extent to which the impacts/risks are reversible assuming that the project has reached the end of its life cycle (decommissioning phase):*
  - *High reversibility of impacts (impact is highly reversible at end of project life i.e. this is the most favourable assessment for the environment);*
  - *Moderate reversibility of impacts;*
  - *Low reversibility of impacts; or*
  - *Impacts are non-reversible (impact is permanent, i.e. this is the least favourable assessment for the environment).*

- *Irreplaceability of Receiving Environment/Resource Loss caused by impacts/risks – the degree to which the impact causes irreplaceable loss of resources assuming that the project has reached the end of its life cycle (decommissioning phase):*
  - *High irreplaceability of resources (project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment);*
  - *Moderate irreplaceability of resources;*
  - *Low irreplaceability of resources; or*
  - *Resources are replaceable (the affected resource is easy to replace/rehabilitate, i.e. this is the most favourable assessment for the environment).*

Using the criteria above, the impacts have been further assessed in terms of the following:

- *Probability – The probability of the impact/risk occurring:*
  - *Extremely unlikely (little to no chance of occurring);*
  - *Very unlikely (<30% chance of occurring);*
  - *Unlikely (30-50% chance of occurring)*
  - *Likely (51 – 90% chance of occurring); or*
  - *Very Likely (>90% chance of occurring regardless of prevention measures).*

To determine the significance of the identified impact/risk, the consequence is multiplied by probability (qualitatively as shown in Figure 1).

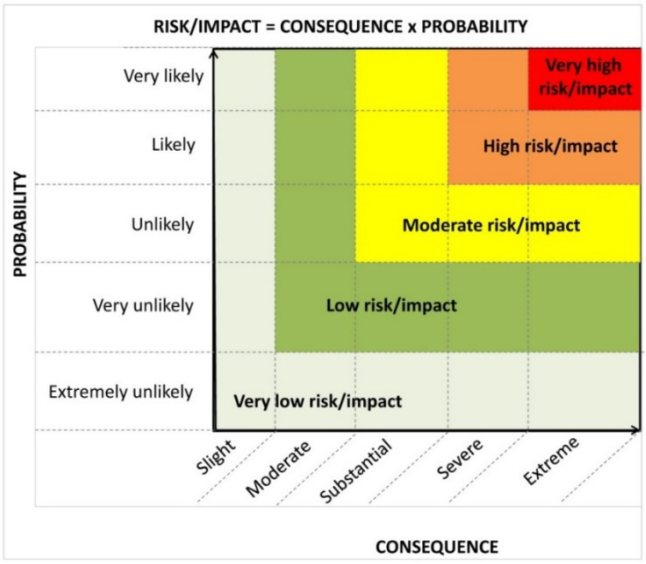


Figure 1. Guide to assessing risk/impact significance as a result of consequence and probability.

- *Significance – Will the impact cause a notable alteration of the environment?*
    - *Very low (the risk/impact may result in very minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making);*
    - *Low (the risk/impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making);*
    - *Moderate (the risk/impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures, and will only have an influence on the decision-making if not mitigated);*
    - *High (the risk/impact will result in major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making); and*
    - *Very high (the risk/impact will result in very major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making (i.e. the project cannot be authorised unless major changes to the engineering design are carried out to reduce the significance rating)).*

With the implementation of mitigation measures, the residual impacts/risks are ranked as follows in terms of significance:

- *Very low = 5;*
- *Low = 4;*
- *Moderate = 3;*
- *High = 2; and*
- *Very high = 1.*

Confidence – The degree of confidence in predictions based on available information and specialist knowledge:
- *Low;*
- *Medium; or*
- *High.*

Appendix F: Compliance with the Appendix 6 of the 2014 EIA Regulations (as amended)

Requirements of Appendix 6 (Specialist Reports) of Government Notice R326 (Environmental Impact Assessment (EIA) Regulations of 2014, as amended)	***Section where this has been addressed in the Specialist Report***
1. (1) A specialist report prepared in terms of these Regulations must contain - *a) details of -* *i. the specialist who prepared the report; and* *ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;*	*Section 1.2 and Appendix B*
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	*Appendix C*
c) an indication of the scope of, and the purpose for which, the report was prepared;	*Section 1*
(cA) an indication of the quality and age of base data used for the specialist report;	*Section 2*
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	*Section 4*
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	*Not Applicable (Desktop Study undertaken)*
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	*Section 2 and Section 4*
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	*Section 4 and Maps*
g) an identification of any areas to be avoided, including buffers;	*Not Applicable*
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	*Section 4 and Maps*
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	*Section 2.2*
j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	*Section 5 and Section 6*
k) any mitigation measures for inclusion in the EMPr;	*Section 6 and Section 7*
l) any conditions for inclusion in the environmental authorisation;	*Section 10*
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	*Section 7*
n) a reasoned opinion- *i. whether the proposed activity, activities or portions thereof should be authorised;* *(iA) regarding the acceptability of the proposed activity or activities; and* *ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;*	*Section 10*
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	*Section 2.3*
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	*Not Applicable at this stage*
q) any other information requested by the competent authority.	*Not Applicable*
(2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	*Not Applicable*