Report to SiVEST SA (PTY) LTD

Desktop Geotechnical Specialist Study for the:

PROPOSED LESAKA 1 SOLAR ENERGY FACILITY NORTHERN CAPE PROVINCE, SOUTH AFRICA

DEA Reference:	
Report Prepared by:	GaGE Consulting (Pty) Ltd
Issue Date:	6th March 2023
Version No.:	F1
GaGE Ref No.:	CSV22111/G0466

GaGE CONSULTING

Report to:	SiVEST Environmental Division 51 Wessel Road, Rivonia, 2129
Project name:	Proposed Lesaka 1 Solar Energy Facility
Report title:	Desktop Geotechnical Specialist Study
Report number:	G0466-F1

Revision	Date	Comment	Prepared by	Reviewed by
F0. FINAL	03/02/2023	Issued to client for review / distribution	DSW	SNB
F1. FINAL	06/03/2023	Issued to client for distribution	DSW	SNB

Revision Details:	Applied client's corrects

Report by:	Approved by:
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ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED LESAKA 1 SOLAR ENERGY FACILITY AND BASIC ASSESSMENTS (BA) FOR ASSOCIATED GRID CONNECTION INFRASTRUCTURE, NEAR LOERIESFONTEIN, NORTHERN CAPE PROVINCE DESKTOP GEOTECHNICAL SPECIALIST STUDY

Executive Summary

This desktop geotechnical specialist study was undertaken for the development of the 240 MW Lesaka 1 SEF and associated grid infrastructure near Loeriesfontein in the Northern Cape Province. The assessment area is underlain by rock units of Ecca Group of Karoo Supergroup and intrusive dolerite. Some geotechnical constraints have been identified, primarily shallow and outcropping bedrock which may cause excavation difficulties, localised steep slopes with thick talus and existing drainage channels with concentrated water flow. These conditions and associated constraints may be mitigated via standard engineering design and construction measures.

The assessment Lesaka 1 SEF area and grid corridor option 1 area may be divided into four (4No.) ZONEs (I, II, III and IV) where similar geotechnical conditions are anticipated. ZONE I is defined by shallow occurring bedrock covered by thin, loose transported material and varying degrees of cemented calcrete. ZONE II can be characterised by talus deposits on relatively steep slopes that is linked to ZONE III that defines the high lying outcropping bedrock of which is seemingly dolerite material. ZONE IV is confined to low lying areas that are underlain by relativity thicker alluvial deposits, identifiable by erosion paths, rills, and continuous drainage features.

Intrusive investigation may reveal additional facets once variations in the subsoil profile become apparent.

No fatal flaws or 'no-go' areas have been identified that would render any assessment areas unsuitable from a geological and geotechnical perspective. No geologically or geotechnically sensitive areas were identified within or near the assessment area. It is recommended however that areas of steeper slope gradients and drainage channels are avoided when determining the final infrastructure layout.

The proposed developments are assessed to have a "Negative Low impact - the anticipated impact will have negligible negative effects" provided that the recommended mitigation measures are implemented. The remaining mitigation measures provided minimise the impacts related to the appropriate engineering design of earthworks and site drainage, erosion control, and topsoil and spoil material management. These do not exceed civil engineering and construction best practices.

Further intrusive geotechnical investigations should be undertaken to confirm the engineering recommendations provided in this report.

From a geotechnical and geological perspective, no fatal flaws or sensitivities have been identified within or close to the Lesaka 1 SEF assessment area and the grid option 1. It is therefore recommended that the proposed activity be authorised.

NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) AND ENVIRONMENTAL IMPACT REGULATIONS, 2014 (AS AMENDED) - REQUIREMENTS FOR SPECIALIST REPORTS (APPENDIX 6

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	Section of 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;	 1.3 Appendix B
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix A
c) an indication of the scope of, and the purpose for which, the report was prepared;	1.1, 1.2
(cA) an indication of the quality and age of base data used for the specialist report;	1.4, References
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	5, 6
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Not applicable
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	1.4, Appendix C
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;	3, 6, 7
g) an identification of any areas to be avoided, including buffers;	None identified
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;	No sensitivities identified
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	2
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, (including identified alternatives on the environment) or activities;	5,6,7
k) any mitigation measures for inclusion in the EMPr;	6.1 Appendix D
l) any conditions for inclusion in the environmental authorisation;	6.1 Appendix D
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	6.1 Appendix D
n) a reasoned opinion- i. (as to) 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;	6.1, 8 6.1 Appendix D
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Not applicable
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None
q) any other information requested by the competent authority.	None
2) Where a government notice *gazetted* 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

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1. Introduction

GaGE Consulting (Pty) Ltd was appointed by SiVEST Environmental (PTY) Ltd (hereafter referred to as "SiVEST") to undertake a desktop study for the proposed Lesaka 1 Solar Energy Facility (SEF) and associated grid connection infrastructure in the Northern Cape Province, South Africa.

Enertrag South Africa (Pty) Ltd, on behalf of Lesaka 1 SEF (Pty) Ltd, has appointed SiVEST to undertake the required Environmental Impact Assessment (EIA) process and Basic Assessment (BA) process for the Lesaka 1 SEF and the associated grid connection infrastructure.

The proposed SEF will be subject to a full Environmental Impact Assessment (EIA) process in terms of the National Environmental Management Act (Act 107 of 1998) (NEMA) and EIA Regulations, 2014 (as amended). Accordingly, the EIA process as contemplated in terms of the EIA Regulations (2014, as amended) are being undertaken in respect of the proposed SEF project. The competent authority for this EIA is the national Department of Forestry, Fisheries and the Environment (DFFE).

Grid connection infrastructure for the SEF will be subject to a separate Basic Assessment (BA) Process as contemplated in terms of regulation 19 and 20 of the Environmental Impact Assessment Regulations, 2014, which is being undertaken in parallel to the EIA process.

1.1. Scope and Objectives

Assess the impacts associated with the installation of the 240 MW Lesaka 1 Solar PV Facility and the associated grid infrastructure (Grid Connection Infrastructure up to 132kV).

The following key considerations were taken into account during the desktop study:

- The geological and geotechnical conditions (ground conditions) and the influence thereof on the competency of founding of civil infrastructure and structures,
- Site topography and influence thereof on the site stability and suitability,
- The presence of geological or geomorphological features such as faults, lineaments and unstable ground,
- The presence of problem soils, geotechnical constraints, shallow groundwater conditions, and
- Geologically significant or sensitive features such as ridges, outcrops and exposures.

1.2. Terms of Reference

The terms of reference were provided by SiVEST to allow a consistent approach to the various specialist studies that are required as part of the Environmental Impact Assessment (EIA) and Basic Assessment (BA) processes being conducted in respect of the Solar Energy Facility (SEF) and associated grid connection infrastructure. This will enable comparison of environmental impacts, efficient review and collation of the specialist studies into the EIA / BA reports, in accordance with the latest requirements of the EIA Regulations, 2014 (as amended).

A detailed description of the infrastructure required for the project including layouts of the proposed development were not provided by SiVEST.

1.3. Specialist Credentials

This study has been undertaken by Duan Swart, a Professional Natural Scientist registered by the South African National Council for Natural Scientific Professions (SACNASP) registration number 137549 (Geological Science). The report was reviewed by Steven Bok, a Professional Natural Scientist registered by the SACNASP registration number 400279/07 (Geological Science). Mr Swarts CV is attached in Appendix B.

1.4. Assessment Methodology

The assessment involved a review of the following information:

i) 1:250 000 Scale Geological Map 3018 Loeriesfontein (Council for Geoscience,1986)
ii) Aerial photographs (Google Earth imagery, current and historical)
iii) Screening Report for Environmental Authorisation (national web based environmental screening tool)
iv) Literature as referenced within this report

An Environmental Impact Assessment matrix was used to quantify the impacts of the project on the receiving environment (provided by SiVEST and attached as Appendix C).

2. Assumptions and Limitations

The services performed by GaGE Consulting (Pty) Ltd were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession practising under similar conditions in the locality of the project. The interpretation of the site conditions is based on available information, experience in the general project area and professional judgement and is considered to provide sufficient confidence to meet the objectives of this specialist study. The nature of geotechnical engineering is such that conditions at variance with those described may be encountered on site. Engineering recommendations provided in this report are preliminary and must be confirmed through further intrusive investigations.

Third party information has been utilised in good faith.

A site visit was not undertaken.

3. Technical Description

3.1. Project Location and Description

The Lesaka Cluster is located approximately 35km north of the Loeriesfontein town within the Hantam Local Municipality, in the Namakwa District Municipality, in the Northern Cape Province. The Lesaka 1 SEF facility will be located on Portion 0 of Farm Kluitjies Kraal No. 264. The grid infrastructure (option 1) traverses multiple farm portions and connects the proposed SEF to Helios Main Transmission Station (MTS), which is approximately 21km to the northeast of the Project Site. The general location is shown in Figure 3-1.

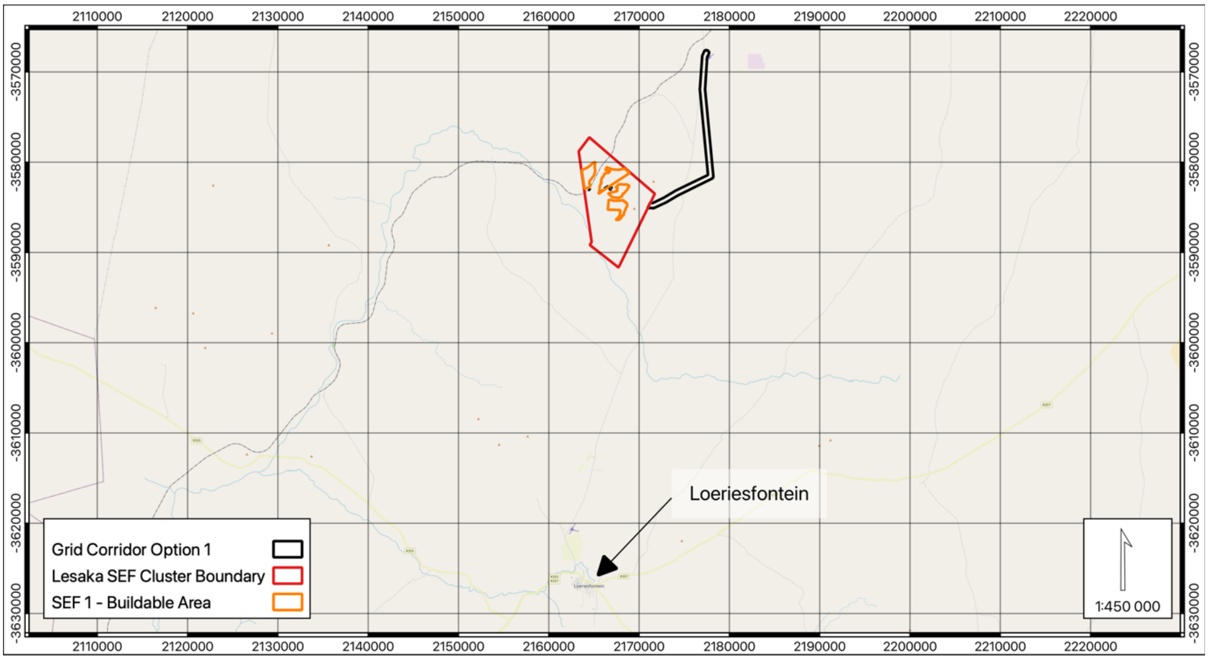


Figure 3-1 Location of the proposed Lesaka Solar PV Facility

3.1.1. SEF Infrastructure

The Lesaka SEF's will be located over one farm portion and the collective site extent is approximately 4 894.93 ha. Lesaka 1 Solar Energy Facility will compromise of several arrays of PV panels, all associated grid infrastructure, a Battery Energy Storage System (BESS), an on-site Independent Power Producer ("IPP") Substation (up to 33/132kV) and it will have a contracted capacity of up to 240 MW.

3.1.2. Grid Connection Infrastructure

A 132 kV overhead powerline (OHL) from Lesaka 1 SEF Switching Station to Lesaka 2 SEF switching station (if needed). The Grid option 1 will comprise a 132 kV OHL and shall connect the project from the onsite substation to Helios MTS, approximately 21 km northeast from the project site. The route is approximately 21 km in length and a has a corridor width of 500 m (250 m on either side) which will be assessed as shown in Figure 3-2.

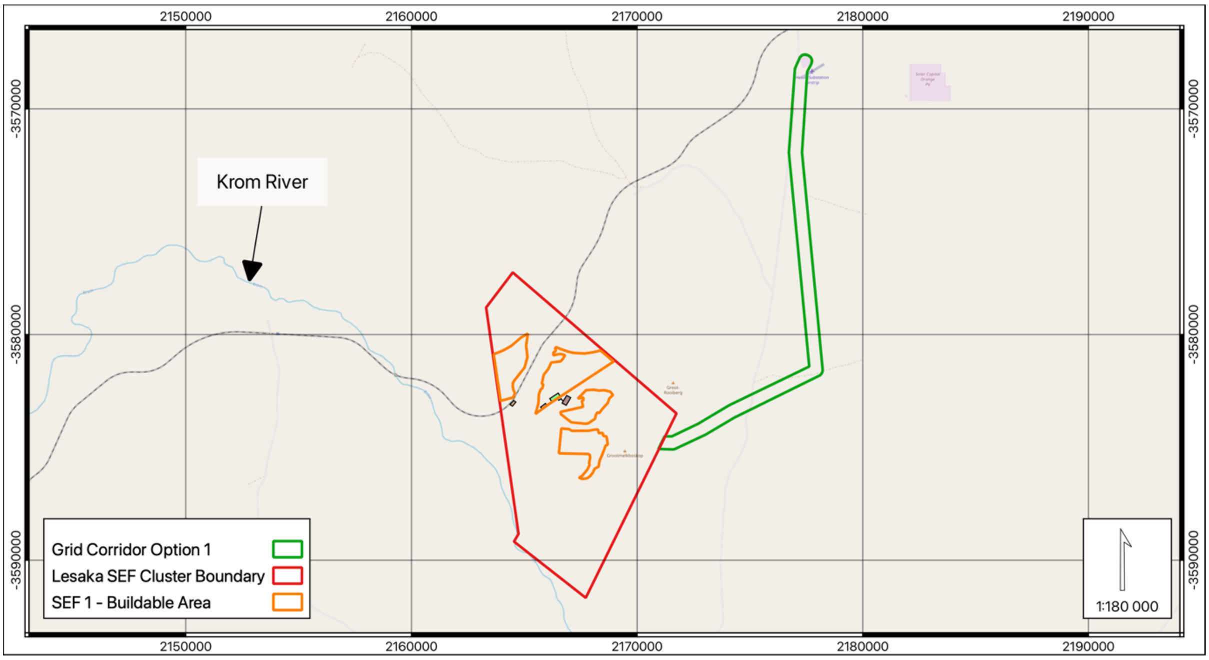


Figure 3-2 Location of the grid infrastructure

3.1.3. Solar Farm Components

The Solar Farm will comprise of the following components:

- PV modules and mounting structures (monoracial or bifacial) with fixed, single or double axis tracking mounting structures.
- Associated stormwater management infrastructure.
- Battery Energy Storage System (BESS);
- Site and internal access roads (mainly 5 m to 6 m wide and up to 20 m wide);
- Auxiliary buildings (offices, parking, etc.);
- Ablution facilities and associated infrastructure.
- Temporary laydown area during the construction phase for the construction camp and laydown area (which will be a permanent laydown area for the BESS during the operational phase);
- Infrastructure including offices, operational control centre, operation and maintenance area, ablution facilities etc.
- On-site 33 kV/132kV on-site IPP substation (facility substation);
- Grid connection infrastructure including low- and medium-voltage cabling between the project components and the facility substation (underground cabling will be used where practical (up to 33kV);
- Perimeter fencing; and,
- Rainwater and/or groundwater storage tanks and associated water transfer infrastructure.

3.1.4. Grid Connection Components

It is proposed that the Lesaka SEF Cluster will connect to the nearby Helios 132/400kV MTS through a single or double circuit 132kV OHL from the collector 132kV Switching Station. The 132kV OHL pylon structures are approximate to be up to 40m in height. The OHL will be approximately 21km in length and a corridor of a width of up to 500m should be assessed. The OHL servitude of approximately 32m in width will be placed within the authorised corridor to allow flexibility in the design of the final OHL route and for the avoidance of sensitive environmental features (where possible).

3.2. Alternatives

3.2.1. Location Alternatives

No other activity alternatives are being considered. Renewable Energy development in South Africa is highly desirable from a social, environmental and development.

3.2.2. Technology Alternatives

No other activity alternatives are being considered. Renewable Energy development in South Africa is highly desirable from a social, environmental and development point of view

3.2.3. SEF Layout Alternatives

Design and layout alternatives will be considered and assessed as part of the EIA. These include alternatives for the Substation locations and also for the construction / laydown area.

3.2.4. BA Alternatives

Two proposed Grid Connection configuration alternatives (technical) are being considered and each configuration alternative will have two layout options. These alternatives will be considered and assessed as part of the BA process and will be amended or refined to avoid identified environmental sensitivities.

3.2.5. No-Go Alternative

The 'no-go' alternative is the option of not undertaking the proposed SEF and / or grid connection infrastructure projects. Hence, if the 'no-go' option is implemented, there would be no development. This alternative would result in no environmental impacts from the proposed project on the site or the surrounding local area. It provides the baseline against which other alternatives are compared and will be considered throughout the report.

4. Legal Requirement and Guidelines

The desktop study was undertaken according to the guidelines provided by The South African Institution of Civil Engineering Site Investigation (SAICE) Code of Practice published by The Geotechnical Division of SAICE, 2010.

This report has been prepared to meet the requirements for a specialist report as provided in Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6.

5. Description of the Receiving Environment

The following description of the receiving environment is relevant to assessing the geological and geotechnical impacts.

5.1. Climate

The area surrounding Loeriesfontein is considered to have a desert climate with little rainfall all year long. The area can be classified as hot desert climate (BWk) according to the Köppen-Geiger climate classification. The average annual rainfall is 224 mm with the average maximum and minimum temperatures of 22.8°C and 9.9°C, respectively.

Climate plays a fundamental role in rock weathering and soil development. The effect of climate on the weathering processes (i.e. soil formation) in a particular area can be determined from the climatic N-value, defined by Weinert (1980). A climatic N-Value of 5 or less implies a water surplus and the dominant mode of weathering is chemical decomposition. These climatic conditions are favourable for the development of a deep residual soil profile. Where the climatic N-value is greater than 5, mechanical disintegration is the predominant mode of rock weathering. In these drier areas residual soils are typically shallow. Climatic N-values of greater than 10 imply an arid climate with a limited or absent residual soil profile.

Weinert's climatic N-value for the site was determined to be 18 to 22, which indicates a scarcity of water. Physical disintegration will dominate resulting in a thin gravelly residual soil and a shallow bedrock (unless covered with transported soils). This climate is conducive to the formation of pedogenic calcrete.

5.2. Topography and Drainage

The site topography will be discussed separately for the Lesaka 1 SEF area and Grid Corridor option 1 area.

The Lesaka 1 SEF area is generally flat with slightly undulating ground topography due to the various rills and gullies formed from erosion. The north-eastern portion of the site has flat to convex plateaus and isolated ridge lines. The Lesaka SEF cluster area consists of isolated koppies and higher lying plateaus. These have formed due to the presence of weather resistance geological units such as dolerite capping seemingly less durable shale and mudrock. The presence of the geological units results in very steep slopes adjacent to isolated koppies. The very steep sections occur in the midslope and are angled at greater than 20° (>35%). Foot slopes and plateau area are shallower and exist between 10° (1:5; 20%) to 15° (1:4; 25%) . The majority of the site area is sloped between <2° (1:20; 4%) to occasionally 5° (1:10; 10%). The locations of these are shown by the green circles in Figure 5-1. These areas will need to be consider during the evaluation of the internal access roads and grid infrastructure within the Lesaka SEF cluster.

There are two large non-perennial streams passing through the site, namely the Rooiberg River and the Klein Rooiberg River, flowing in a westerly to south westerly direction. The watershed between these two is the plateau and ridgeline in the southern portion of Lesaka 1 SEF buildable area. The site drainage is expected to occur as sheetwash into the rills and gullies, becoming concentrated flow into the various small non-perennial streams before flowing into the two large streams. The drained water will then flow into the Krom River to the west of site. The elevation of the site is between 750 m to 800 m (above mean sea level) AMSL.

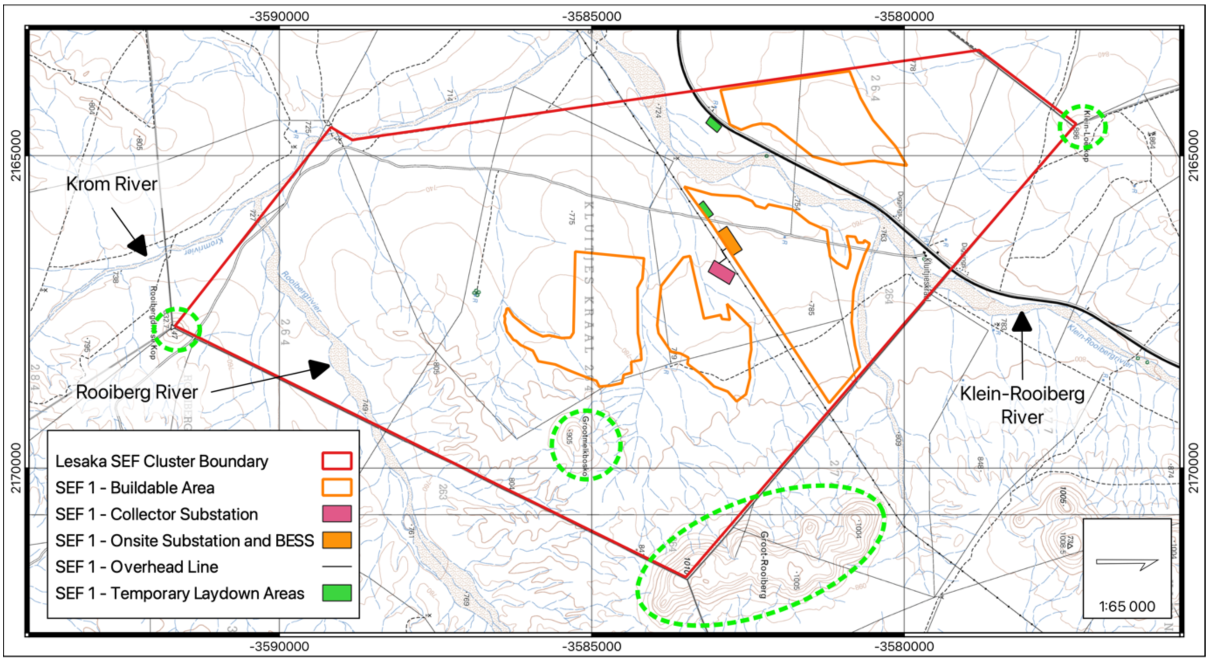


Figure 5-1 SEF site topography

The grid corridor option 1 transverse generally flat areas with slight undulations formed by erosion gullies and low-lying ridges. The entire route alignments seemingly has ground topography that is shallower than 1:10, with localised areas having very steep slopes (>1:20). The routes cross through small to large non-perennial streams and drainage direction will be variable but generally flowing in a southernly direction. The drainage will be in the form sheetwash becoming concentrated and eventually flowing into the Rooiberg River. Several isolated, small, koppies exist within the corridor routes. These are generally between 5 m to 10 m higher in elevation than the surrounding, low-lying area.

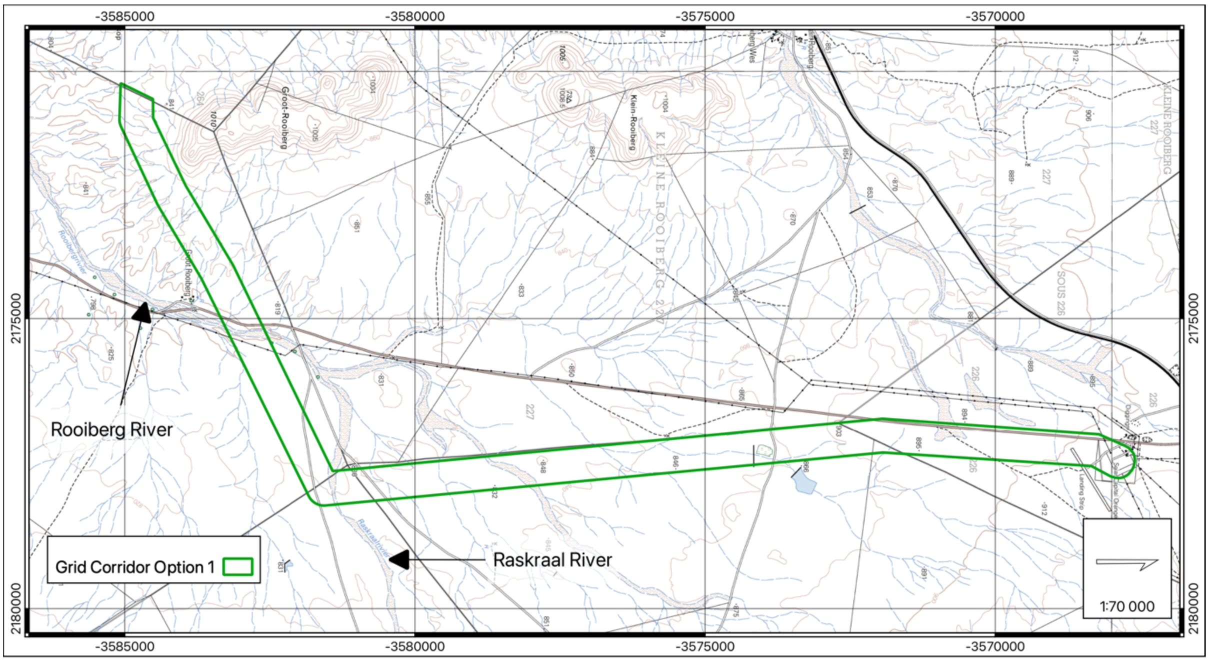


Figure 5-2 Grid Corridor topography

5.3. Seismicity

According to the Seismic Hazard Map of South Africa (SANS 10160-4, 2017), the peak ground acceleration is approximately 0.2 g for the site. The peak ground acceleration may be described as the maximum acceleration of the ground shaking during an earthquake, which has a 10% probability of being exceeded in a 50-year period.

The site is within seismic hazard Zone I as per SANS 10160-4 (2017) – regions of natural seismic activity.

5.4. Bedrock Geology

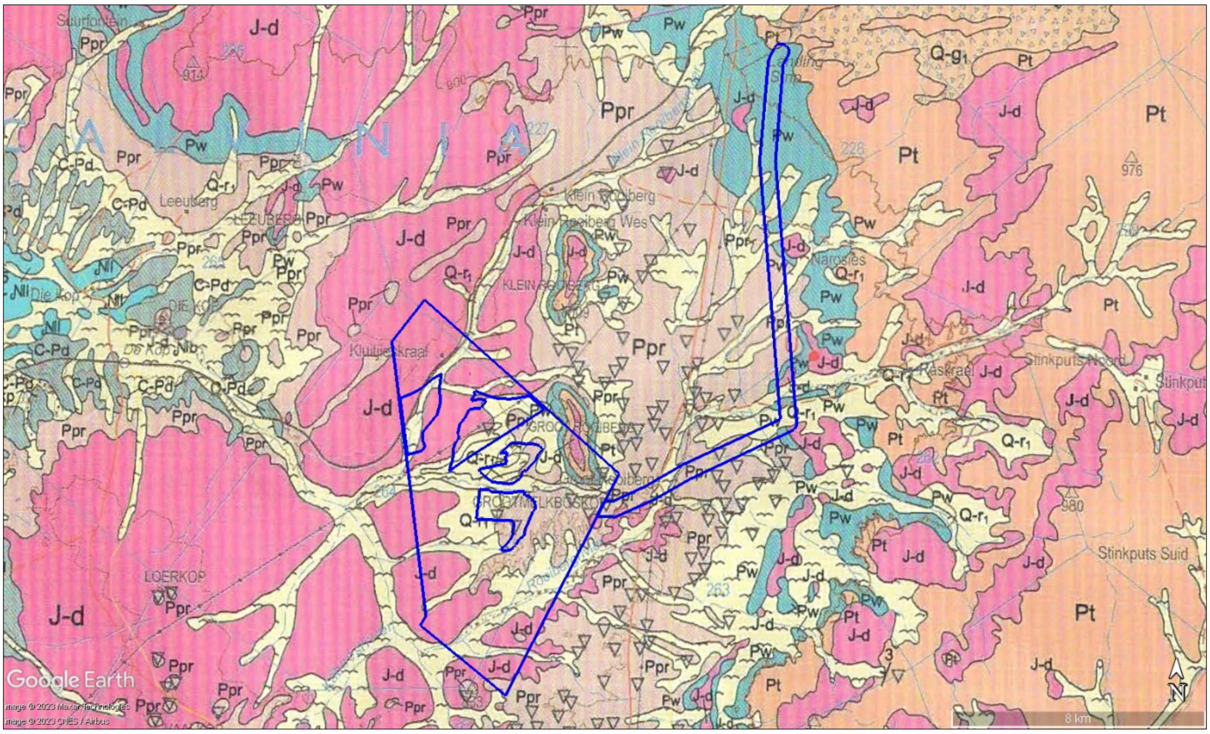
According to the 1:250 000 scale geological map 3018 Loeriesfontein (2011), the bedrock geology comprises horizontally orientated Formations of the upper Ecca Group. The eastern portion of the site is underlain by Prince Albert Formation (designated **Ppr;** shaded brown) that comprises dark grey to black carbonaceous shale and medium to fine- to medium-grained feldspathic arenite and wacke. The extreme eastern portion of the site comprises black to light grey weathering, dark grey carbonaceous, pyrite bearing, shale of the Whitehill Formation (designated **Pw**; shaded green). This exists beneath the well-laminated, dark, brown and grey shale of the Tierberg Formation (designated **Pt**; shaded orange). Intrusive dolerite in the form of a large sill intruded into the abovementioned sedimentary rock units during the Jurassic age (designated **Jd**; shaded red). The dolerite sill forms a weather resisting capping layer which results in a high-lying plateau at the eastern corner of the site. Most of the western section of the site is underlain by a large dolerite sill.

The bedrock, when not outcropping, is overlain by extensive deposits of Quaternary-aged sandy soil (designated Q-r1) and alluvium material. The area shown to be underlain by dolerite is assumed to comprises dolerite gravels formed from physical weathering of the dolerite bedrock. The isolated koppies across the site has seeming formed from the presence of breccia pipes (designated by Δ) associated with the intrusion of the dolerite.

The grid corridor options are generally underlain by the Prince Albert Formation and the Whitehill Formation in the northern portion of the site. The corridors are bestrewed with dolerite sills and breccia pipes which forms the higher lying areas.

The geological map does not indicate the any fossil occurrences in any of the geological units across the site.

The regional geology of the site is illustrated in Figure 5-3.



Symbol	Age	Sedimentary and Volcanic Rocks			Intrusive Rocks	Geological Unit Type
		Supergroup	Group	Formation		
	Quaternary	N/A				Sandy Soil
Q-r1						Alluvium
Jd	Jurassic	-	-	-	Dykes / Sills	Dolerite (Δ breccia pipes)
Pt	Permian	Karoo	Ecca	Tierberg	-	Brown to grey shale
Pw				Whitehill	-	Carbonaceous shale; cherty siltstone
Ppr				Prince Albert	-	Carbonaceous shale

Figure 5-3 The regional geology of the site

5.5. Engineering Geology

A large portion of Lesaka 1 SEF area and parts of the grid corridor option 1 area are expected to have gravelly soils lying on top of shallow occurring dolerite and associated breccia pipes. Excavatibility is expected to be intermediate to hard depending on the intensity and orientation of the discontinuities in the rock mass.

Most of the grid corridor option 1 area and parts of the south-eastern portion of Lesaka 1 SEF is expected to comprise shallow occurring shale regolith covered by transport horizons. The transported soils will be variable but generally be silty sand to gravelly sand at varying thicknesses. The shale material is expected to be thinly laminated and highly fractured, allowing a tractor loaded backhoe (TLB) to rip the material and excavate to great depths even in competent bedrock.

Most of the rills and gullies at the site surface will comprise transported soils of loose, silty gravelly sand, becoming sandier within local drainage features, and occasionally underlain by a very weakly to weakly cemented calcrete horizon. The formation of duripan (in the form of a variable calcrete horizon ranging from nodules to hardpan calcrete) is expected to occur locally in parts of the site, which is characteristic of the Namaqualand soils.

It can be expected that the alluvial material will be thick in the low-lying portions of the site, especially within large drainage features such as the Rooiberg River and Klein-Rooiberg River. The alluvial material in this area may exhibit collapsible fabric. Soils with a collapsible structure have an open-voided texture with individual grains being separated or weakly bonded by bridging material such as clay, iron oxides, calcium, or other bridges. While these soils have a high to moderate strength and can withstand fairly large loads under low soil moisture conditions, an increasing moisture content can weaken the bridging materials. Increasing the soil moisture content under load can cause a decrease in the soil volume, resulting in large settlements with no increase in the applied stress. This can lead to sudden settlements beneath foundations and structures.

It is expected that local areas with steep slope gradients will exist on both the Leska 1 SEF and grid corridor option 1 area. This entails that terracing and additional earthworks for roads and platforms may be required for construction in the steeper sections of the site. Areas adjacent to the steep slopes may comprise thick talus material made up of gravel and boulders in a loose sandy matrix.

In terms of construction material for access roads and other structures, a quarry near the site should be explored or consideration should be given to commercial suppliers. The dolerite is usually targeted for construction aggregate in this area.

5.6. Desktop Geotechnical Appraisal

Based on the desktop study, the entire assessment area may be divided into four (4 No.) ZONEs: I, II, III, and IV. Intrusive investigation may reveal additional facets once variations in the subsoil profile become apparent.

The assessment area is considered suitable for the development of the proposed Lesaka 1 SEF and grid infrastructure, from a geotechnical viewpoint, provided that standard engineering design and construction measures are implemented to mitigate the identified geotechnical constraints. The anticipated geotechnical constraints and mitigation measures are summarised in Table 5-1. The zonation for the Lesaka 1 SEF area, and the grid option 1 area are presented in Figure 5-4 and Figure 5-5, respectively.

Table 5-1 Summary of geotechnical conditions

ZONE	Shallow Geology	Geotechnical Conditions / Constraints	Impacts on Engineering Design and Construction
I	Shallow bedrock covered by thin transported and calcrete material	• Shallow bedrock • Thin soil cover • Intermediate to hard excavation conditions with depth • Overlain by alluvial soils of variable thickness in some areas (in gullies and rills)	• Generally good founding conditions for structures at shallow depths • Minor earth works required at founding level • Conventional shallow foundations suitable • Conventional subgrade preparation for roads • Variable excavation conditions • Intermediate to hard excavation conditions for pole planting / trenching / earthworks
II	Talus in steep slopes	• Mass earthworks on gradients greater than 1:10 • Potentially unstable talus slopes	• Terracing and slope stabilisation required
III	Outcropping bedrock	• Hard excavation conditions	• Heavy plant machinery / pneumatic methods / required for excavations (pole planting earthworks / trenching / foundations) • Good founding conditions for structures • Overbreak is anticipated during trenching
IV	Alluvium	• Loose sandy soils • Potentially collapsible soils • Moderate soil cover • Moderate bedrock depth • Increased erosion potential • Deep erosion gullies and rills	• Deeper spread footings (found below alluvial sands) • Soft excavation conditions becoming intermediate with depth • Unstable trench sidewalls – shoring/battering required • Erodible soils • Surface drainage measures required to minimise risk of flooding and erosion

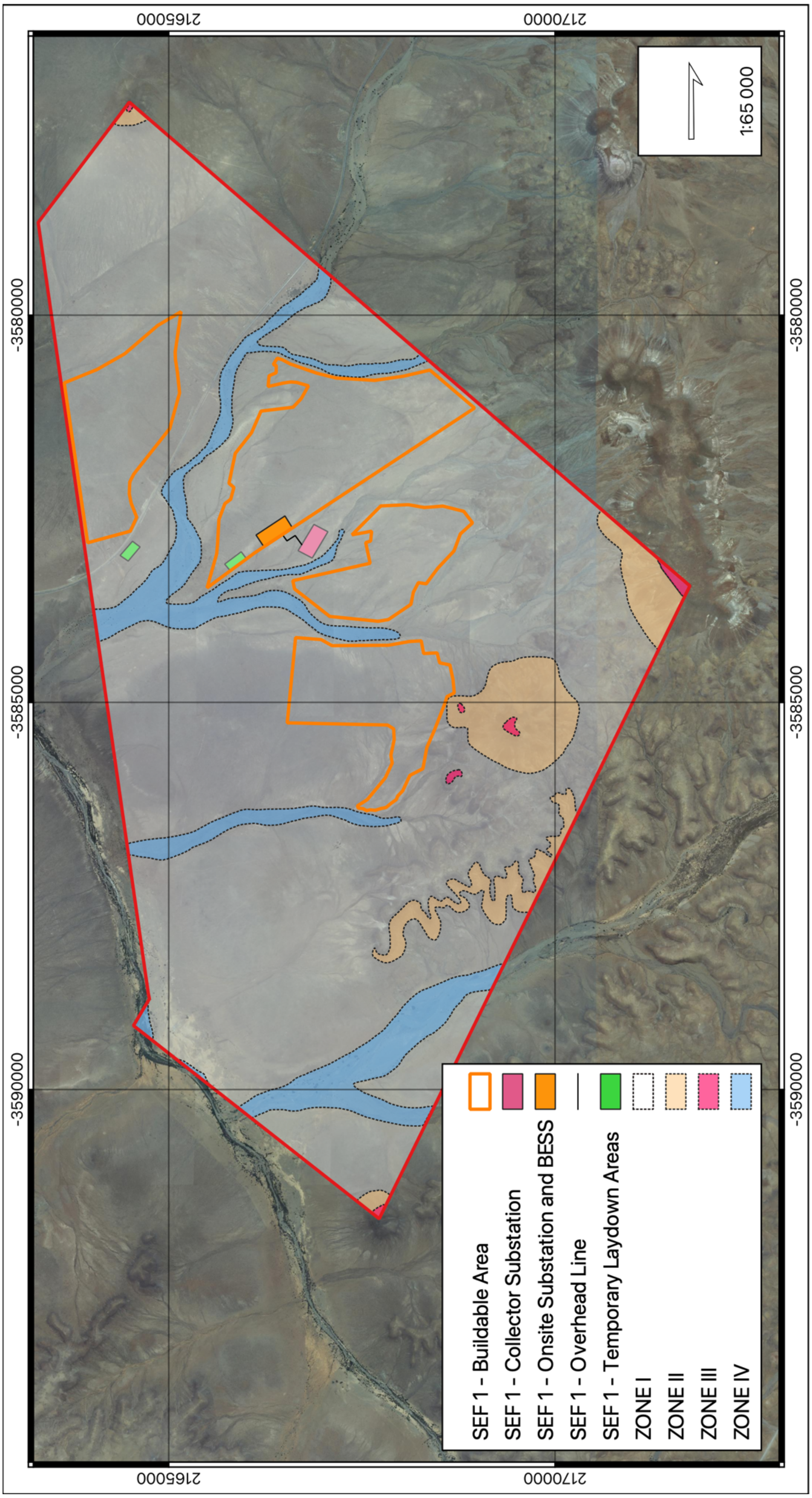


Figure 5-4 Geotechnical Desktop Zonation for Lesaka 1 SEF area

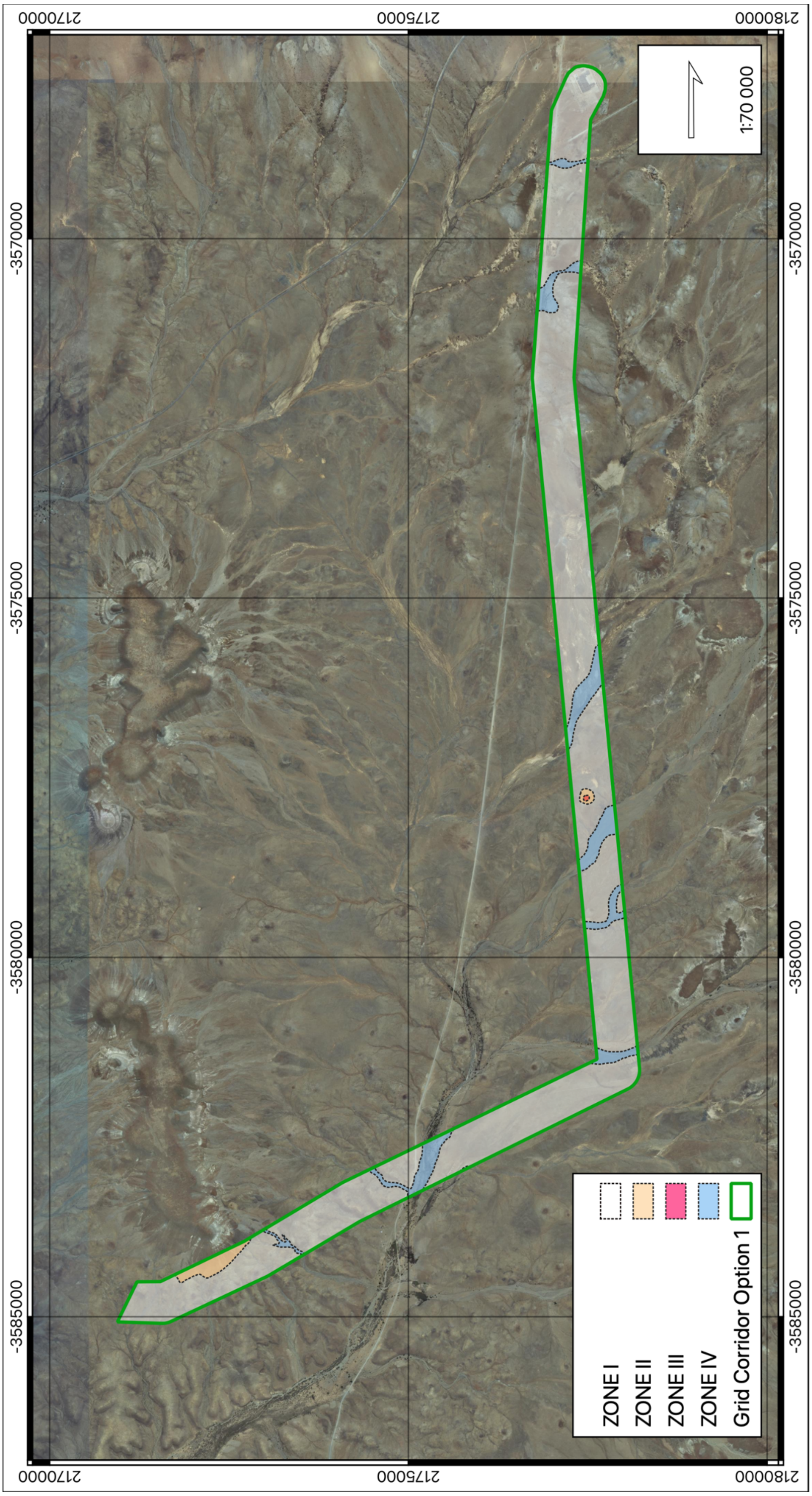


Figure 5-5 Geotechnical Desktop Zonation for Grid Option 1

6. Identification and Assessment of Impacts

No fatal flaws or 'no-go' areas have been identified that would render any assessment areas unsuitable from a geological and geotechnical perspective.

The geological impact of the Lesaka 1 SEF will be caused by the construction of access roads, earthworks required for the construction of crane pads, and excavations as well as trenching for underground cables. Bulk earthworks, where required, for the construction of access roads and working platforms on or adjacent to the steeper sections and within or adjacent streams, may cause a more significant impact. These are to be avoid in the layout design where possible.

The impact of the substation and powerlines on the geological environment is limited to topsoil stripping, excavations for plinth foundations, trenching, the construction of access roads and associated light infrastructure.

Additional impacts would be caused by the opening of borrow pits that may be undertaken to obtain construction materials.

6.1. Impact of the Project on the Geological Environment

The main impact of the proposed development from a geological perspective is the displacement and removal of soil and rock materials. These activities will predominantly take place during the construction phase. The degree of disturbance is largely dependent on the topography and location of the project site and the nature of the proposed infrastructure. Steep slopes are unfavourable as these require bulk earthworks to create working platforms and access roads. Earthworks on steep slopes increases the risk of soil movements or slope failure. Construction within drainage channels is also unfavourable due to the erosion potential of the loose, sandy soils.

The risk of soil erosion is also increased during construction activities, by the removal of vegetation and by possible disturbance to the natural surface drainage environment. These activities may prevent infiltration of rainwater, increase surface runoff and cause concentration of surface water flow. Erosion will increase the disturbance and displacement of soils and the impact may extend beyond the infrastructure footprint/s over time.

The effects of the proposed development on the geological environment were evaluated using an Environmental Impact Assessment (EIA) Methodology, provided by SiVEST, which aids in determining the significance of an environmental impact on an environmental parameter through a systematic analysis. The EIA methodology is attached as Appendix C.

Based on the impact ratings for the proposed construction of the Lesaka 1 Solar Energy Facility (SEF) and associated grid infrastructure, the site has been assigned a "Negative Low impact" rating provided that the recommended mitigation measures are implemented.

The topography of the site is generally flat with localised areas of steep slopes. The flat areas will require minor earthworks depending on the final layout design. Access routes should be carefully planned to avoid the steep areas and drainage channels. The crest of the ridges is expected to be characterised by outcropping or very shallow bedrock. This will provide good founding for the PV modules.

The majority of soils (when not in large drainage channels) do not render the site particularly susceptible to soil erosion, though mitigation measures need to be implemented, particularly within the steeper sections of the site and lower-lying sections of the site where concentrated surface flow is anticipated after heavy rainfall events.

Appropriate engineering design of access roads, particularly drainage and erosion control measures, are critical to limit the impact of the development on the geological and geotechnical environment.

Detailed geotechnical materials investigations should be undertaken to assess the suitability of the in-situ materials and the need for processing (e.g. crushing, stabilisation).

7. Comparative Assessment of Alternatives

No geologically or geotechnically sensitive areas were identified that would render the proposed Lesaka 1 SEF and grid corridor option 1 unsuitable for development, provided that standard engineering design and construction measures are implemented to mitigate the identified geotechnical constraints.

8. Conclusion and Summary

8.1. Summary of Findings

This desktop geotechnical specialist study was undertaken for the development of the 240 MW Lesaka 1 SEF and associated grid infrastructure near Loeriesfontein in the Northern Cape Province. The assessment area is underlain by rock units of Ecca Group of Karoo Supergroup and intrusive dolerite. Some geotechnical constraints have been identified, primarily shallow and outcropping bedrock which may cause excavation difficulties, localised steep slopes with thick talus and existing drainage channels with concentrated water flow. These conditions and associated constraints may be mitigated via standard engineering design and construction measures.

The assessment Lesaka 1 SEF area and grid corridor option 1 area may be divided into four (4No.) ZONEs (I, II, III and IV) where similar geotechnical conditions are anticipated. ZONE I is defined by shallow occurring bedrock covered by thin, loose transported material and varying degrees of cemented calcrete. ZONE II can be characterised by talus deposits on relatively steep slopes that is linked to ZONE III that defines the high lying outcropping bedrock of which is seemingly dolerite material. ZONE IV is confined to low lying areas that are underlain by relativity thicker alluvial deposits, identifiable by erosion paths, rills, and continuous drainage features.

Intrusive investigation may reveal additional facets once variations in the subsoil profile become apparent.

No fatal flaws or ‘no-go’ areas have been identified that would render any assessment areas unsuitable from a geological and geotechnical perspective.

The proposed developments are assessed to have a “Negative Low impact - the anticipated impact will have negligible negative effects” provided that the recommended mitigation measures are implemented. The remaining mitigation measures provided minimise the impacts related to the appropriate engineering design of earthworks and site drainage, erosion control, and topsoil and spoil material management. These do not exceed civil engineering and construction best practices.

Further intrusive geotechnical investigations should be undertaken to confirm the engineering recommendations provided in this report.

8.2. Impact Statement and Conclusion

From a geotechnical and geological perspective, no fatal flaws or sensitivities have been identified within or close to the Lesaka 1 SEF assessment area and the grid corridor option 1 area. It is therefore recommended that the proposed activity be authorised.

References

Brink, A.B.A. Engineering Geology of Southern Africa, The first 2 000 million years of geological time, Volume 1. Building Publications, 1979.

Brink, A.B.A. Engineering Geology of Southern Africa, Post-Gondwana Deposits, Volume 4. Building Publications, 1985.

Johnson, M.R. Anhaeusser, C.R. Thomas, R.J. The Geology of South Africa. Council for Geoscience, 2006.

Appendix A. Specialist Declaration of Interest and Undertaking Under Oath

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

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED LESAKA 1 SOLAR ENERGY FACILITY AND BASIC ASSESSMENTS (BA) FOR ASSOCIATED GRID CONNECTION INFRASTRUCTURE, NEAR LOERIESFONTEIN, NORTHERN CAPE PROVINCE

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:	GaGE Consulting			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	1	Percentage Procurement recognition	135%
Specialist name:	Duan Swart			
Specialist Qualifications:	BSc BSc(Hons) MSc			
Professional affiliation/registration:	Professional Natural Scientist SACNASP Reg. No. 137543			
Physical address:	17 Cowley Road, Bryanston, Johannesburg			
Postal address:	PO Box 71572, BRYANSTON			
Postal code:	2021	Cell:		
Telephone:	010 823 1621	Fax:		
E-mail:	duan@gageconsulting.co.za			

2. DECLARATION BY THE SPECIALIST

I, ________ Duan Swart___________________, 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

GaGE Consulting

Name of Company:

06/03/2023

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, ____ Duan Swart___________________, 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

GaGE Consulting

Name of Company

06/03/2023

Date

GUSTAF SWART PLS 1444 (PROFESSIONAL LAND SURVEYOR)

Signature of the Commissioner of Oaths

06/03/2023

Date

Appendix B. Specialist CV

DUAN SWART

Senior Engineering Geologist

MSc (Engineering Geology), PrSciNat, MSAIEG

DATE OF BIRTH
30 July 1993

NATIONALITY
South African

LANGUAGES
English
Afrikaans

QUALIFICATIONS

Professional registered SACNASP, PrSciNat (137543), MSAIEG, Master of Science (Engineering Geology), *Doctoral Candidate (Engineering Geology), Bachelor of Science (Hons) (Engineering Geology), Bachelor of Science (Environmental and Engineering Geology)

KEY SKILLS
Geotechnical Investigations, Dolomite Investigations, Borrow Pit and Quarry Investigations, Slope Stability Assessments, Materials Assessments, Vadose Zone Hydrology, Unsaturated Soil Mechanics, Limited Equilibrium Analysis.

INTERNATIONAL EXPEREINCE
Democratic Republic of Congo, Botswana, Swaziland.

SUMMARY OF CREDENTIALS

Duan is a registered engineering geologist, with six years' consulting experience, who has undertaken fieldwork and reporting of data for various renewable projects including solar energy facilities, wind energy facilities and associated sub-station and grid infrastructure. His responsibilities ranged from providing costing, planning site investigations, managing sub-contractors and in-situ geophysical testing, scheduling laboratory test and assisting in trial pile designs across various soil and rock conditions.

Additionally, Duan has seven years academic experience. His doctoral research aims to improve the understanding of the variably saturated saprolitic soil found within the complex vadose zone and he uses this understanding in everyday consultancy. His Master's dissertation revealed interesting mineral occurrences within residual dolomite that contributes to the material's unique behaviour.

His experience has developed through numerous intrusive and non-intrusive site investigation methods for both rock and soil orientated projects.

Key professional experience and skills includes:

- Designing and executing detailed geotechnical investigations for the relevant infrastructure types according to guidelines as set out by: SAICE Geotechnical Division Code of Practice (2010); SANS 634; GFSH-2; as well as SANS 1936 for development on dolomite land.
- Competency in: soil profiling, chip and core logging as detailed in industry standards as set out by Brink and Bruin (2001); as well as material classification; on-site supervision; on-site testing and sampling.
- Skills in project management, such as: compiling cost estimates; client communication and liaison; health and safety compliance; delegating work to junior engineering geologists and students; as well as understanding responsibilities as part of a team of scientist and engineers within a project.

In addition to the professional work experience gained in industry, a strong set of skills have been accomplished in academia as a researcher and is a technical team member of the Water Research Commission (WRC) project, K5/2326. Currently, his Ph.D. research contributes to the WRC project Complex Vadose Zone Hydraulics (K5/2826).

Key research experience includes:

- Investigating and executing fundamental scientific research questions on flow through variably saturated residual soil found in South Africa, as well as the influence of unique mineral occurrences on water storage of residual soils.

- Skills in research project management that include: working as a research team; addressing input from experts forming part of a reference group; managing a budget; managing and reviewing work of post-graduate students; and compiling deliverables as well as final research reports.

- Presenting research findings: at several conferences; as well as published papers in peer reviewed scientific journals and chapters in books, and as large research reports.

- Lecturing and mentoring to both undergraduate and postgraduate students in the Department of Geology at the University of Pretoria.

EXPERIENCE: KEY PROJECTS

Buffels Solar, Klerksdorp (2022)
Client: Kabi Solar / Solar Pack
Position: Engineering Geologist – The Buffels Solar Project comprises the installation of a 240 MW Solar Energy Facility (SEF) in the North West Province of South Africa. The project included the investigation and design of ground mounted solar photovoltaic (PV) systems covering an approximate area of 100 Ha and associated substation and access roads. Duan was responsible for the costing proposal, managing on-site works, guiding sub-contractors, and writing up of the report. The site was underlain by dolomitic land and Duan liaised with the Council for Geoscience to ensure the correct dolomite stability investigated procedures were followed. The total project costs were R 1.4 million.

Sutherland Cluster, Sutherland (2022)
Client: Mainstream Renewables
Position: Engineering Geologist – The Sutherland Cluster comprised the installation of 2040 MW Wind Energy Facility (WEF) in the Northern Cape Province of South Africa. The WEF formed part of the Round 5 of South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The project includes the investigating of 97 wind turbines and associated access roads, laydown areas and grid infrastructure. Duan was responsible for the costing proposal, managing on-site works, guiding sub-contractors, and writing up of the report. The total project cost was R 11 million.

Simandou Ore Mine, GUINEA (2022)
Client: Rio Tinto / WSP
Position: Engineering Geologist – The Simandou mountain range contains one of the largest iron ore reserves in the world. The proposed mine will be one of the largest operating iron ore mines in the world. Duan was the engineering geologist for the geotechnical bulk earthworks of the entire mine, associated infrastructure, haul roads, and new airport, including upgrade of the existing 1.80 km dirt runway. The work included slope designs, material utilisation and integration with technical teams such as geometrics, water management and structures. Duan was responsible for the geological model and ground profiles for all the road cuttings and bulk earthworks. Furthermore, Duan was task to design slopes for road cuttings ranging from 30 m high to 125 m high. Duan compiled sections of the 85% and 100% design review report, and presented weekly and work closely with technical staff in WSP Group, Rio Tinto and SRK UK.

Luphohlo – Ezulwini Hydro-Electric Scheme, Mbabane, SWAZILAND (2022)
Client: Swaziland Electricity Company
Position: Engineering Geologist – The scheme comprises a 45m high earth cored rockfill dam, which impounds a reservoir of 24 million cubic metres total capacity on the Lusushwana River. Water is drawn through an intake on the eastern side of the reservoir and transferred through the Luphohlo Mountain in a 4.3km long low-pressure tunnel to a surge chamber on the Ezulwini valley side of the mountain. The project involves the inspection of the 4.2 km long low-pressure tunnel. The tunnel inspection was carried out on foot from the intake down to the rock traps / access audit. Duan was responsible for inspection of tunnel features such as concrete lining; moisture drains and rock condition along the length of the tunnel. Duan wrote up sections within the geological and interpretive reports.

N4 Montrose Interchange, Mpumalanga, SOUTH AFRICA (2019-21)
Client: Trans African Toll Concession (TRAC) / South African National Roads Agency (SANRAL) SOC Limited Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the widening and upgrade of the National Route 4 at the intersection of the Ngodwana and Schoemanskloof bypasses. Geotechnical works comprises the investigation and design of cut and fill retaining walls, soil and rock slopes, structure abutments, foundations for the widening of the bridge over the Crocodile River, and identification of material sources. Duan was responsible for supervision of part of the site investigation, borehole core logging and write up of sections within the geological, materials and interpretive reports.

R574 Groblersdal, Limpopo, SOUTH AFRICA (2020-22)
Client: Nathoo Mbenyane Engineers/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the widening and upgrade on the National Road R574 (District Road D1547) Section 1 from R33 Groblersdal (km 0.0) to R579 Morwaneng (km 38.9). Geotechnical works comprises the investigation and design of soil and rock slopes, structure abutments, foundations for the widening of the bridges, and identification and investigation of material sources. Duan was responsible for building the bill of quantities, supervision of the site investigation, borehole core logging and write up of sections within the geological, materials and interpretive reports.

R36 Tzaneen, Limpopo, SOUTH AFRICA (2020-22)
Client: Nathoo Mbenyane Engineers/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the widening and upgrade of National Road R36 Section 6 from Manchabeni (Km 4.70) to Tzaneen (Km 33.50). Geotechnical works comprises the investigation and design of soil and rock slopes, structure abutments, foundations for the widening of the bridges, and identification and investigation of material sources. Duan was responsible for building the bill of quantities and write up of sections within the factual and interpretive reports.

R578 Giyani Materials, Limpopo, SOUTH AFRICA (2020-22)
Client: SMEC/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the widening and upgrade of National Road R578 Section 1 from Nwamatatani (Km56.0) to R81 (Km 90.70). Geotechnical works comprises the on-site identification and investigation of material sources. Duan was responsible for building the bill of quantities, on-site investigation, write up of sections within the geological and materials reports.

N3 Mariannhill, Kwa-Zulu Natal, SOUTH AFRICA (2020-22)
Client: SMEC/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the widening and upgrade of the National Route 3 between Key Ridge and Mariannhill Toll Plaza. Geotechnical works comprises the drilling and test pitting of existing cuts and laboratory testing. Duan was responsible for a portion of the on-site investigation, drawing of the geological models, write up of sections within the interpretive report.

KZN Quarries, Kwa-Zulu Natal, SOUTH AFRICA (2019-22)
Client: FDKL/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the identification of potential quarry sources to prospect and secure for future SANRAL contracts in the KZN province. Geotechnical works comprise the on-site identification of material sources. Duan was responsible for developing and implementing of a Quarry-Potential Rating system to categorize and prioritize all sites quantitatively, building the drilling BoQ, writing up of sections in the preliminary assessment report.

N1 R36 Quarries, Free State, SOUTH AFRICA (2021)
Client: HHO/ South African National Roads Agency (SANRAL) SOC Limited
Position: Engineering Geologist - The project involves the identification of potential quarry sources, between Welkom and Koppies, for use on the N1-R34 Route Upgrade project. Geotechnical works comprise the identification and investigation of potential material sources. Duan was responsible for logging and supervising logging of core (1300 m) and percussion chips (950 m) retrieved during the investigation.

EXPERIENCE: OTHER MAJOR PROJECTS

Upgrades to Damani Water Treatment Plant, SOUTH AFRICA (2019)
Client: EVN Africa Consulting Engineers (Pty) Ltd
Position: Engineering Geologist - The project involved the investigation for the addition of 12 new water reservoirs in the Vhembe District Municipality as part of the upgrading of the Damani Water Treatment Plant. Duan was tasked to undertake visual inspections of soil profiles, in excavations and on slopes, and rock outcrops to make recommendations on foundation solutions for elevated steel tanks and large water reservoirs. Duan was responsible for the site investigation, interpretation and writing of reports.

Kisanfu Geotechnical Investigation, DEMOCRATIC REPUBLIC OF THE CONGO (2019)
Client: Piteau Associates
Position: Engineering Geologist - The project encompassed the drilling of rotary core and trial pit excavations by means of a 40-ton excavator to investigate the overburden materials above an enriched ore deposit in the Democratic Republic of Congo (DRC). The nature and depth to the ore deposit necessitated the establishment of an open cast mine. The investigation was undertaken to determine the overburden properties for design input of cut slopes, haul roads and material utilization. Duan was responsible for 2 months on-site supervision while surveying and logging over 150 trial pits and 800 m of core from boreholes and was responsible for sample retrieval and laboratory testing supervision.

Umlazi and Amatikwe Housing Project, KwaZulu-Natal, SOUTH AFRICA (2019-2020)
Client: Asande Projects Consulting & Engineering
Position: Engineering Geologist - The project involves construction of low-cost housing in the areas of Umlazi and Amatikwe, near Durban in the KwaZulu-Natal Province. Geotechnical works comprises the site investigation, NHBRC classification of the site and the recommendations on foundation design. Duan was responsible for planning of site investigation, supervision of the site investigation, test pit logging and write up of the final geotechnical report. The total project costs are estimated to be R 150 million.

New Ermelo Housing Project, Mpumalanga, SOUTH AFRICA (2020-2021)
Client: Asande Projects Consulting & Engineering
Position: Engineering Geologist - The project involves construction of low-cost housing in the areas of New Ermelo, near Ermelo in the Mpumalanga Province. Geotechnical works comprises the site investigation, NHBRC classification of the site and the recommendations on foundation design. Duan was responsible for planning of site investigation, supervision of the site investigation, test pit logging and write up of the final geotechnical report. The total project costs are estimated to be R 1.3 billion.

PROFESSIONAL HISTORY

2019 (Oct) – to date:	GaGE Consulting (Pty) Ltd, Johannesburg –Engineering Geologist
2019(Jan)-2019(Sep):	RockSoil Consult – Engineering Geologist
2018 – 2019:	University of Pretoria, Geology Dept. – Lecturer for the following modules: Groundwater (GLY 265), Engineering Geology (GLY 363), Rock Mechanics (GLY 364)
2018 - 2019:	JL Van Rooy - Graduate Engineering Geologist

PROFESSIONAL STANDING, MEMBERSHIPS AND COMMITTEES

Registered Natural Scientist the South African Council for Natural Scientific Professions (SACNASP): PrSciNat 137543
Member of the South African Institute of Engineering and Environmental Geologists (SAIEG): MSAIEG 21/526
Water Research Commission – Karst Research Group K5/2326 (2018 – 2020)

Water Research Commission – Complex Vadose Zone Research Group K5/2826 (2020 – 2022*)

University of Pretoria – Geology Dept. External Examiner BSc and BSc(Hons) (2020-2022)

TECHNICAL QUALIFICATIONS

2020*	PhD Engineering Geology (**Candidate**)	University of Pretoria
2019	Master of Science (Engineering Geology)	University of Pretoria
2017	Bachelor of Science (Hons) (Engineering Geology)	University of Pretoria
2016	Bachelor of Science (Environmental and Engineering Geology)	University of Pretoria

TECHNICAL COURSES AND CONFERENCES PRESENTED

2022	**Presenter**, Kirkham Conference, Soil Science Society of America, Skukuza, Kruger National Park, South Africa.
2022	**Presenter**, Proceedings of the 20th International Conference on Soil Mechanics and Geotechnical Engineering, Sydney 2022.
2021	Attendee, Foundation Design for Housing: a short course presented by Stellenbosch University
2021	**Presenter**, Webinar on Vadose Zone Hydraulics and unsaturated soil mechanics, University of Pretoria
2020	Attendee, Construction Material Seminar, South African Institute of Engineering and Environmental Geologists (SAIEG), Salt Rock, South Africa.
2018	**Presenter**, Dolomite: (dis)solution 2018, SAICE Geotechnical Division/GSSA Groundwater Division/South African Institute of Engineering and Environmental Geologists/University of Pretoria, Pretoria, South Africa

TECHNICAL PUBLICATIONS

- **Swart, D.**, Dippenaar, MA., Van Rooy JL., (2022) Identification of silts. Bulletin of Engineering Geology and the Environment.
- Dippenaar, MA., Jones BR., Van Rooy JL., Maoyi M., **Swart, D.** (2022) The Karst Vadose Zone: Influence on Recharge, Vulnerability and Surface Stability. Water Research Commission Report No. TT 869/21.
- **Swart, D.**, Gaspar, T.A.V., & Dippenaar, M. (2022). Testing of hydromechanical properties of the variable saturated residual dolomite (wad). Proceedings of the 20th International Conference on Soil Mechanics and Geotechnical Engineering, Sydney.
- Dippenaar, MA., **Swart, D.**, Van Rooy JL., Diamond RE. (2019) The Karst Vadose Zone: Influence on Recharge, Vulnerability and Surface Stability. Water Research Commission Report No. TT 779/19.
- **Swart, D.**, Dippenaar, M., & Van Rooy, J. (2019). Mechanical and hydraulic properties of residual dolomite and wad. South African Journal of Geology, 122(3).
- **Swart, D** (2019). Hydromechanical Properties of wad and residual dolomite. Proceedings of the 7th African Young Geotechnical Engineers Conference, 7-12.

DATE OF BIRTH
30 May 1979

NATIONALITY
South African

LANGUAGES
English
Afrikaans

QUALIFICATIONS
Professionally registered SACNASP 400279/07 (Geological Science), Bachelor of Science (Geology, Geography), Bachelor of Science (Honours) (Geology)

KEY SKILLS
Geotechnical site investigations
Desktop & feasibility studies
Materials investigations
Technical report writing
Project Management

INTERNATIONAL EXPERIENCE
Botswana, Democratic Republic of the Congo, Lesotho, Madagascar, Mozambique, Sierra Leone, South Africa, Zambia,

MEMBERSHIP
GSSA 971552

STEVEN BOK
Principal Engineering Geologist
PrSciNat BSc (Hons.)

SUMMARY OF CREDENTIALS

Steven is a registered professional natural scientist with 20 years of experience in the field of engineering geology and geotechnical engineering. He has broad exposure to infrastructure developments and is adept at undertaking and managing geotechnical site investigations, materials investigations and geotechnical report writing. He also has experience in geotechnical verification and monitoring during construction projects.

Steven has worked throughout South Africa and in Africa providing services to private-sector clients in the mining, consulting and construction industries as well as to government and parastatals.

His technical strengths are the planning and undertaking of site investigations for roads, dams, railways, residential and commercial buildings, township development, large infrastructure (e.g. reservoirs, pipelines, bridges, tailings facilities) and lateral support. Materials investigations (borrow pit and quarry identification and assessment) are an area of particular interest.

Many of the projects on which he has worked represent, complex, multi-disciplinary infrastructure developments. He has been responsible for undertaking and managing the geotechnical component of a major coal mine development in Mpumalanga as well as the new Sol Plaatjie University project in Kimberly. He was the Project Leader and undertook the detailed geotechnical investigation for the Kazungula Bridge over the Zambezi River and the new ash dam facility at the Eskom Camden Power Station

He has vast experience in undertaking geotechnical investigations for housing development, for private developers and organs of state in across South Africa.

He has also been involved with several investigations for large dams including the proposed Ludeke Dam (Eastern Cape), a weir and off-channel storage dam on the Black Umfolozi River (Kwa-Zulu Natal), Thuni Dam (Botswana) and three ash dam projects at Eskom power stations.

He has undertaken geophysical investigations for quarries and borrow pits, groundwater identification and bridge and dam site investigation. Geophysical methods used are seismic refraction surveys, 2D resistivity and EM-34 electromagnetic surveys.

Steven has mentored young engineering geologists as a technical manager at a large South African consulting engineering firm.

He ensures that geotechnical investigations are undertaken in accordance with the Occupational Health and Safety Act and the Mine Health and Safety Act. He has experience in Risk Assessment and the preparation of Health & Safety files in terms of current regulations and client requirements.

STEVEN BOK: EXPERIENCE - KEY PROJECTS

Mafube Life Extension Project, Middleburg, Mpumalanga, SOUTH AFRICA, (2013-2019)
Client: Mafube Coal (Anglo Coal/Exxaro JV)
Lead Engineering Geologist – the project involved design and construction of mine infrastructure required to utilise the Nooitgedacht coal reserve, located 7km from the existing colliery. This included 7km of overland conveyor, 5km of haul roads, pollution control and water return dams, a new ROM tip, road over rail bridge, major culverts, HMV workshops and associated infrastructure. Steven was responsible for undertaking or overseeing all site investigation work, from preliminary design commencing in 2013 to detailed design and geotechnical construction supervision during 2018/2019. Services included location and monitoring of rockfill and borrow materials. Effective use of mine overburden and borrow materials during construction resulted in a significant cost saving for the Client.
Project Value: US$200million.

N4 Upgrades, Rustenburg, SOUTH AFRICA (various phases, 2010 - 2019)
Client: Bakwena
Lead Engineering Geologist – Various upgrade and duelling projects along the N4 between Brits and Swartruggens. Steven was responsible for undertaking and overseeing road prism, materials and bridge investigations required for the detailed design of upgrades between Rustenburg and Swartruggens and duelling along Sections 9, 10 and 13 (approximately 60 km of new carriageway between Brits and Rustenburg). Work included mitigation of highly expansive "black turf" subgrades and sourcing of construction materials. Drilling investigations were undertaken for approximately 12 bridges, including a new bridge over the Crocodile River. Construction supervision and verification of founding conditions.

New Sol Plaatjie University, Kimberly, South Africa (2015-2017)
Client: WITS / Sol Plaatjie University
Project Leader for Geotechnical Consultant – the project involved the construction of a new university in Kimberly. Steven was the Project Leader for the geotechnical consultant responsible detailed site investigations and geotechnical construction supervision. The university complex is constructed on variably weathered dolerite bedrock, which posed a challenge for foundation design. The use of geophysics, detailed rock mass characterisation and targeted drilling, coupled with monitoring of the founding conditions during construction, allowed the design engineers to triple the foundation loads determined during the preliminary design phase.

Camden Power Station new ash dam, water return dam, Ermelo, SOUTH AFRICA (2016)
Client: Eskom 2016

Project Engineering Geologist – the project involved the detailed design and subsequent construction of a new Ash Dam Facility, water return dam and associated slurry pipelines and access roads. Steven was responsible for undertaking the geotechnical site investigations as part of the design team. The investigation involved a detailed materials investigation, specialised laboratory and in-situ testing and included extensive interaction with the design and Eskom's technical teams. The presence of nearby undermining necessitated the use of various geophysical methods to delineate the extent of tunnels, which could have lead to instability of the ADF.

Various Eskom Substations, SOUTH AFRICA (2013-2015)
Client: Eskom SOC Limited
Project Leader for Geotechnical Consultant – detailed geotechnical investigations for 5 major new substations across South Africa, namely the Northrand Substation (Johannesburg), Nieuwehoop Substation (Northern Cape), Dwaalboom Substation (Limpopo), Upington Substation and Firgrove Substations (Somerset West). Steven undertook the site investigations which included assessment of construction materials and geophysical surveys. Engineering geological models were produced for each site, which assisted Eskom's civil design team to optimise the platform layout and earthworks design. The appointment included conceptual platform and subsoil drainage design. The completed Firgrove Substation is illustrated.

Various Bulk Water Supply pipelines, Gauteng, SOUTH AFRICA, (2009-2013)
Client: Rand Water SOC Ltd
Project Engineering Geologist / Project Leader – Steven managed or undertook detailed geotechnical investigations for a major proportion of Rand Water's pipeline construction projects between 2009 and 2013. Work included investigations for sections of the F5, H35, R5, H37, G37, B19, O5, O6 and C25 pipelines. In total, approximately 80 km of route was investigated, for pipelines ranging from 800 mm to 2500 mm diameter, including detained investigations at numerous pipe jacking positions. The investigation outputs included the compiling detailed geotechnical long sections of the pipeline routes highlighting excavation conditions and geotechnical risks. Most of the projects have been successfully constructed.

Various Rand Water Reservoirs & Pumping Stations, Gauteng, SOUTH AFRICA, (2010-2016)
Client: Rand Water SOC Ltd
Project Engineering Geologist / Project Leader – Detailed site investigations (typically drilling investigations) were undertaken for an additional reservoir a the Palmiet Pumping Station (100 Ml) the Amanzimtoti Reservoir (20 Ml), Bronberg Reservoir (100 Ml), extensions to the Palmiet Pumping Station and sections of the Zuikerbosch and Vereeniging WTW extension projects. Steven was involved with geotechnical site supervision during construction on many of the projects. Palmiet Pumping Station is illustrated.

Kazangula Bridge over the Zambezi River, BOTSWANA, (2011),
Client: EGIS BECOM International
Project Engineering Geologist for detailed geotechnical investigations – the 923-metre-long Kazangula Bridge, currently nearing completion, crosses the Zambezi River at Kasane, Botswana. The bridge provides a road and rail crossing between Botswana and Zambia and passes through Namibia, where the country's borders meet. Steven was the project Engineering Geologist for the contractor who undertook the site investigation and was responsible for ensuring that the investigations were undertaken in accordance with European standards and technical reporting. He undertook full-time supervision of the drilling and in-situ testing works, which were undertaken from a jack-up barge. The reporting included rock mass characterisation beneath the bridge piers, settlement estimates and provision of foundation recommendations.

EXPERIENCE: OTHER PROJECTS

R578 Giyani Materials, Limpopo (2020-22)
Client: SMEC/ South African National Roads Agency (SANRAL) SOC Limited
Engineering Geologist – Preliminary GI for material sources.

N1 R36 Quarries, Free State(2021)
Client: HHO/ South African National Roads Agency (SANRAL) SOC Limited
Engineering Geologist – Logging of core and percussion chips for material sources.

Khwezela Life Extension Project (2019)
Client: Anglo Coal
Project Leader (PL) & Senior Engineering Geologist - haul road materials investigation and pavement design project, including construction supervision as part of a coal mine expansion project.

Kriel Ash Dam Stability Analysis (2017-2018)
Client: Eskom
Senior Engineering Geologist - responsible for geotechnical investigations to characterise an existing wet ash dam facility.

Hendrina Step-in-and-go-higher project (2015)
Client: Eskom
Project Engineering Geologist – geotechnical investigation for the proposed raising of the ash dam facility at Hendrina Power Station.

Leeuwpan OI BFS External Roads Package (2015)
Client: Exxaro
Project Leader – a road prism and materials investigation for the realignment of the R50 provincial road around the Leeuwpan Colliery, Ogies, Mpumalanga.

Three story office building at Camden Power Station (2012/13)
Client: Eskom
Project Leader - site investigations, pilling supervision & pile integrity verification

Belfast Mine Leachate Dams (2011)
Client: Exxaro
Senior Engineering Geologist - GI for preliminary design of two lined earthfill return water dams

Foundation investigations for approx. 80 Eskom Telecommunication Towers (2010-2014)
Client: Eskom
Project Leader - term appointment for undertaking site investigations for foundation design of new Eskom telecommunication towers throughout South Africa

Sierra Leone centre line & materials investigation (2010)
client: African Minerals
Senior Engineering Geologist - road prism and materials investigation for 50km of new haul road / railway line in Sierra Leone, including foundation investigations for bridges.

Dumbe Coal Line Stability Analysis (2009-2010)
Client: Transnet
Project Leader & Senior Engineering Geologist - GI for slope stability analysis for widening of 6 km of cuttings on the Coal Line near Paulpietersburg.

Lesotho Lowlands Geotech Zone 4&5 (2007)
Client: Lesotho Ministry of Natural Resources
Engineering Geologist – Detailed GI for 350 km bulk supply pipeline, 46 Reservoirs & pump stations

Thuni Dam, in Eastern Botswana (2005)
Client: DWA Botswana
Engineering Geologist: Detailed geotechnical investigations and materials investigation for a large earthfill dam

PROFESSIONAL HISTORY

2019 – date: GaGE Consulting (Pty) Ltd, Cape Town – Principal Engineering Geologist.

2002 – 2019: JG Afrika (Pty) Ltd Engineering & Environmental Consulting. Engineering Geologist (Pietermaritzburg, 2002 to 2007), Senior Engineering Geologist (Pietermaritzburg, 2007 to 2009), Senior Engineering Geologist (Johannesburg, 2009 – 2013), Associate (Johannesburg, 2013 – 2019).

TECHNICAL QUALIFICATIONS

2000	Bachelor of Science (Geology, Geography)	Nelson Mandela University
2001	Bachelor of Science (Honours) (Geology)	Nelson Mandela University

TECHNICAL COURSES AND CONFERENCES ATTENDED

2014 Attendee, SAICE Young Geotechnical Engineers Conference, Stellenbosch.
2008 Attendee, SAICE Young Geotechnical Engineers Conference, Durban.
2005 Attendee, SAICE Young Geotechnical Engineers Conference, Swadini.

Appendix C. Environmental Impact Assessment (EIA) Methodology

1 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) METHODOLOGY

The Environmental Impact Assessment (EIA) Methodology assists in evaluating the overall effect of a proposed activity on the environment. Determining of the significance of an environmental impact on an environmental parameter is determined through a systematic analysis.

1.1 Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale (i.e. site, local, national or global), whereas intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in **Table 1**.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

1.2 Impact Rating System

The impact assessment must take account of the nature, scale and duration of effects on the environment and whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the various project stages, as follows:

- Planning;
- Construction;
- Operation; and
- Decommissioning.

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

The significance of Cumulative Impacts should also be rated (As per the Excel Spreadsheet Template).

1.2.1 Rating System Used to Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the possible mitigation of the impact. Impacts have been consolidated into one (1) rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

Table 1: Rating of impacts criteria

ENVIRONMENTAL PARAMETER		
A brief description of the environmental aspect likely to be affected by the proposed activity (e.g. Surface Water).		
ISSUE / IMPACT / ENVIRONMENTAL EFFECT / NATURE		
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity (e.g. oil spill in surface water).		
EXTENT (E)		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY (P)		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY (R)		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES (L)		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION (D)		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity.		

1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
INTENSITY / MAGNITUDE (I / M)		
Describes the severity of an impact (i.e. whether the impact has the ability to alter the functionality or quality of a system permanently or temporarily).		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
SIGNIFICANCE (S)		
Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula: **Significance = (Extent + probability + reversibility + irreplaceability + duration) x magnitude/intensity.**		

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.		
Points	**Impact Significance Rating**	**Description**
5 to 23	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
5 to 23	Positive Low impact	The anticipated impact will have minor positive effects.
24 to 42	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
24 to 42	Positive Medium impact	The anticipated impact will have moderate positive effects.
43 to 61	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
43 to 61	Positive High impact	The anticipated impact will have significant positive effects.
62 to 80	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
62 to 80	Positive Very high impact	The anticipated impact will have highly significant positive effects.

The table below is to be represented in the Impact Assessment section of the report. The excel spreadsheet template can be used to complete the Impact Assessment.

Table 2: Rating of impacts template and example

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Vegetation and protected plant species	Vegetation clearing for access roads, turbines and their service areas and other infrastructure will impact on vegetation and protected plant species.	2	4	2	2	3	3	39	-	Medium	**Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.**	2	4	2	1	3	2	24	-	Low

Operational Phase																			
Fauna	Fauna will be negatively affected by the operation of the wind farm due to the human disturbance, the presence of vehicles on the site and possibly by noise generated by the wind turbines as well.	2	3	2	1	4	3	36	-	Medium	**Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.**	2	2	2	1	4	2	22	-	Low
Decommissioning Phase																			
Fauna	Fauna will be negatively affected by the decommissioning of the wind farm due to the human disturbance, the presence and operation of vehicles and heavy machinery on the site and the noise generated.	2	3	2	1	2	3	30	-	Medium	**Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.**	2	2	2	1	2	2	18	-	Low

Cumulative																				
Broad-scale ecological processes	Transformation and presence of the facility will contribute to cumulative habitat loss and impacts on broad-scale ecological processes such as fragmentation.	2	4	2	2	3	2	26	-	Medium	**Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.**	2	3	2	1	3	2	22	-	Low

Appendix D. Impact Rating Tables

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED LESAKA SOLAR ENERGY FACILITIES AND BASIC ASSESSMENTS (BA) FOR ASSOCIATED GRID CONNECTION INFRASTRUCTURE, NEAR LOERIESFONTEIN, NORTHERN CAPE PROVINCE

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase (Corridor 1)																				
Disturbance/ displacement/ removal of soil and rock	Ground disturbance during access road construction, foundation earthworks, platform earthworks	1	4	2	2	2	1	11	-	Low	1) Design access roads and post locations to minimise earthworks and levelling based on high resoultion ground contour information 2) Correct topsoil and spoil management	1	4	2	1	2	1	10	-	Low
Soil Erosion	Increased erosion due to vegetation clearing, alteration of natural drainage	1	3	2	2	2	1	10	-	Low	1) Avoid development in preferential drainage paths 2) Appropriate engineering design of road drainage and watercourse crossings 3) Temporary berms and drainage channels to divert surface runoff where needed 4) Landscape and rehabilitate disturbed areas timeously (e.g. regressing) 5) Use designated access and laydown areas only to minimise disturbance to surrounding areas	1	2	1	1	2	1	7	-	Low
Operational Phase (Corridor 1)																				
Soil Erosion	Increased erosion due to alteration of natural drainage	1	2	1	1	2	1	7	-	Low	1) Maintain access roads including drainage features 2) Monitor for erosion and remediate and rehabilitate timeously	1	1	1	1	2	1	6	-	Low
Decommissioning Phase (Corridor 1)																				
Disturbance/ displacement/ removal of soil and rock	Ground disturbance during access road construction, foundation earthworks, platform earthworks	1	4	2	2	2	1	11	-	Low	1) Restore natural site topography 2) Landscape and rehabilitate access roads and disturbed areas timeously (e.g. regressing)	1	4	2	1	2	1	10	-	Low
Soil Erosion	Increased erosion due to vegetation clearing, alteration of natural drainage	1	2	2	2	2	1	9	-	Low	1) Temorary berms and drainage channels to divert surface runoff where needed 2) Restore natural site topography 3) Use designated access and laydown areas only to minimise disturbance to surrounding areas	1	1	1	1	2	1	6	-	Low

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED LESAKA SOLAR ENERGY FACILITIES AND BASIC ASSESSMENTS (BA) FOR ASSOCIATED GRID CONNECTION INFRASTRUCTURE, NEAR LOERIESFONTEIN, NORTHERN CAPE PROVINCE																					
ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase (SEF 1)																				
Disturbance/ displacement/ removal of soil and rock	Ground disturbance during access road construction, foundation earthworks, platform earthworks	1	4	2	2	3	1	12	-	Low	1) Design access roads and post locations to minimise earthworks and levelling based on high resoultion ground contour information 2) Correct topsoil and spoil management	1	4	2	1	2	1	10	-	Low
Soil Erosion	Increased erosion due to vegetation clearing, alteration of natural drainage	1	3	2	2	3	1	11	-	Low	1) Avoid development in preferential drainage paths 2) Appropriate engineering design of road drainage and watercourse crossings 3) Temporary berms and drainage channels to divert surface runoff where needed 4) Landscape and rehabilitate disturbed areas timeously (e.g. regressing) 5) Use designated access and laydown areas only to minimise disturbance to surrounding areas	1	2	1	1	2	1	7	-	Low
Operational Phase (SEF 1)																				
Soil Erosion	Increased erosion due to alteration of natural drainage	1	2	1	1	2	1	7	-	Low	1) Maintain access roads including drainage features 2) Monitor for erosion and remediate and rehabilitate timeously	1	1	1	1	2	1	6	-	Low
Decommissioning Phase (SEF 1)																				
Disturbance/ displacement/ removal of soil and rock	Ground disturbance during access road construction, foundation earthworks, platform earthworks	1	4	2	2	2	1	11	-	Low	1) Restore natural site topography 2) Landscape and rehabilitate access roads and disturbed areas timeously (e.g. regressing)	1	4	2	1	2	1	10	-	Low
Soil Erosion	Increased erosion due to vegetation clearing, alteration of natural drainage	1	2	2	2	2	1	9	-	Low	1) Temorary berms and drainage channels to divert surface runoff where needed 2) Restore natural site topography 3) Use designated access and laydown areas only to minimise disturbance to surrounding areas	1	1	1	1	2	1	6	-	Low