Report to SiVEST

Desktop Geotechnical Specialist Study for the:

PROPOSED CONSTRUCTION OF THE KAREE WIND ENERGY FACILITY AND ASSOCIATED GRID INFRASTRUCTURE, NEAR CERES, WESTERN CAPE PROVINCE, SOUTH AFRICA
DESKTOP GEOTECHNICAL SPECIALIST STUDY

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Report by:	Approved by:
Duan Swart *MSc (Eng Geology) MSAIEG Pr.Sci.Nat*	Steven Bok *BSc Hons (Geology) Pr.Sci.Nat*

BASIC ASSESSMENT (BA) FOR THE PROPOSED CONSTRUCTION OF THE KAREE WIND ENERGY FACILITY AND ASSOCIATED GRID INFRASTRUCTURE, NEAR CERES, WESTERN CAPE PROVINCE, SOUTH AFRICA
DESKTOP GEOTECHNICAL SPECIALIST STUDY

Executive Summary

This desktop geotechnical specialist study was undertaken for the development of the 140 MW Karee WEF and associated grid infrastructure near Touws River in the Western Cape Province. The assessment area is underlain by rock units of Dwyka Group and Ecca Group of the Karoo Supergroup and locally by faulted rock units of the Cape Supergroup. Some geotechnical constraints have been identified, primarily shallow bedrock which may cause excavation difficulties, thick transported material (alluvium and scree), and steep slopes. These constraints may be mitigated via standard engineering design and construction measures.

The topography over the assessment area is undulating but generally gentle with trace areas of moderately steep to steep slopes at ridges, exceeding 1:10. The southern portion of the site and surrounding area is characterised by mountainous areas with steep sided valleys.

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. These include avoiding development on the steeper sections of the site. The remaining mitigation measures provided to minimise the impacts relate 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 practice.

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 are avoided when determining the final infrastructure layout.

It is recommended intrusive geotechnical investigations to be undertaken to confirm the ground conditions stated in this report.

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 has been appointed by SiVEST SA (PTY) Ltd (SiVEST), on behalf of South Africa Mainstream Renewable Power Developments (Pty) Ltd to undertake the geotechnical assessment of the proposed construction of the 140 MW Karee Wind Energy Facility (WEF) and associated grid infrastructure near Touws River in the Western Cape Province, South Africa.

In terms of the Environmental Impact Assessment (EIA) Regulations, which were published on 04 December 2014 and amended on 07 April 2017 [promulgated in Government Gazette 40772 and Government Notice (GN) R326, R327, R325 and R324 on 7 April 2017], various aspects of the proposed development are considered listed activities under GNR 327 and GNR 324 which may have an impact on the environment and therefore require authorisation from the National Competent Authority (CA), namely the Department of Environment, Forestry and Fisheries (DEFF), prior to the commencement of such activities. This desktop geological and geotechnical specialist study has been commissioned to assess and verify the WEF, BESS and associate infrastructure under the applicable specialist protocols.

1.1. Scope and Objectives

Assess the impacts associated with the installation of a WEF, the associated infrastructure on the 140 MW Karee WEF, including potential fatal flaws, if present.

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
- 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 and allow a comparison of environmental impacts, efficient review, and collation of the specialist studies into their Basic Assessment report. This study is undertaken in accordance with the requirements provided in Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6.

A detailed description of the infrastructure including layouts of the proposed development were 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 Boks and Mr Swarts CVs are attached in Appendix B.

1.4. Assessment Methodology

The assessment involved a review of the following information:

i) 1:250 000 Scale Geological Map 3320 Ladismith (Council for Geoscience,1991)
ii) 1:250 000 Scale Geological Map 3319 Worcester (Council for Geoscience,1997)
iii) Aerial photographs (Google Earth imagery, current and historical)
iv) Technical report titled "Factual Geotechnical Report for Peredekraal East Wind Power Project " written by SMEC for Mainstream Renewable Power dated April 2016
v) Screening Report for Environmental Authorisation (national web based environmental screening tool)
vi) 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

The proposed WEF and associated grid infrastructure is located 12 km and 20 km north, respectively, of Touws River in the Western Cape Province and is within the Witzenberg Local Municipality, in the Cape Winelands District Municipality, South Africa. The general location is show in Figure 3-1.

3.1.1. WEF

The WEF application site, as shown on the locality map in Figure 3-2, is approximately 11 841 hectares (ha) in extent and incorporates the following farm portions:

- Farm Sadawa No 239
- Farm Tierberg No 258; and
- Farm Voetpads Kloof No 253.

Note, whilst Mainstream will no longer be proceeding with turbines on Sadawa 239 (northernmost land parcel), it will remain part of the Development Area / Envelop but not the Development Footprint.

A smaller buildable area (1753.1 ha) has however been identified as a result of a preliminary suitability assessment undertaken by Mainstream and this area is likely to be further refined with the exclusion of sensitive areas determined through various specialist studies being conducted as part of the BA process.

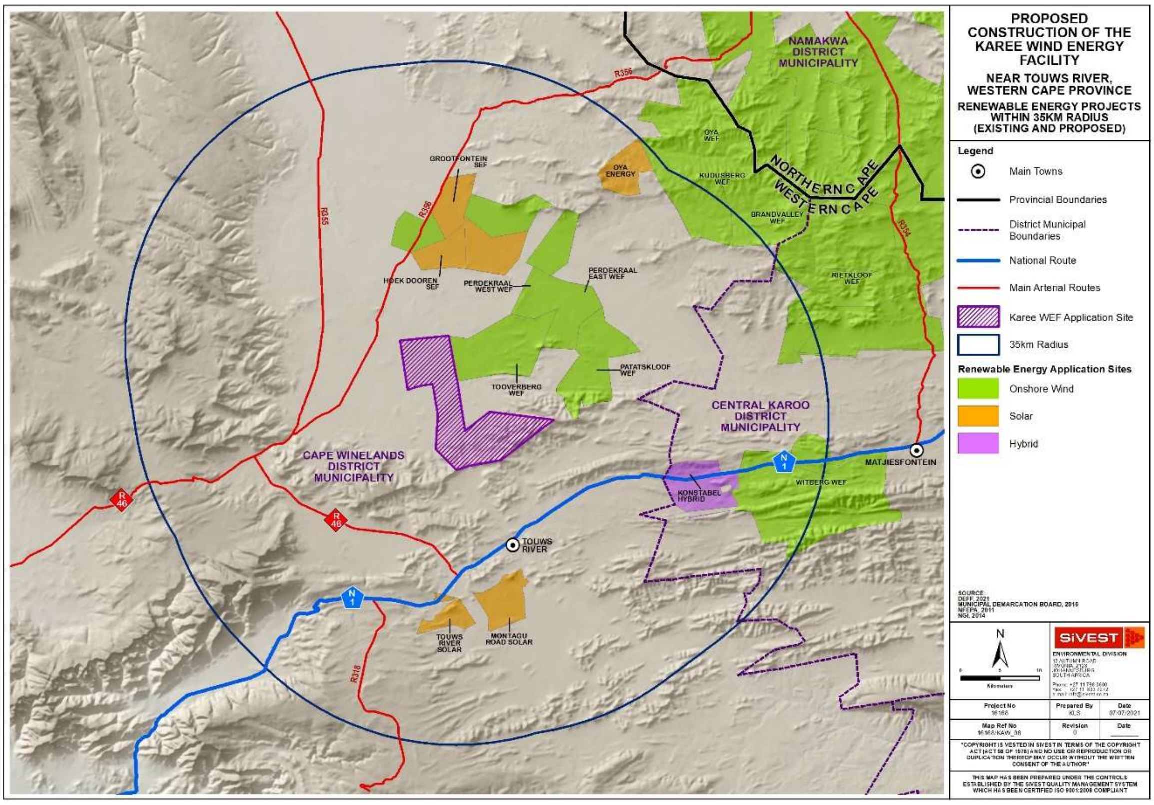

Figure 3-1 Location of the proposed WEF and associated infrastructure

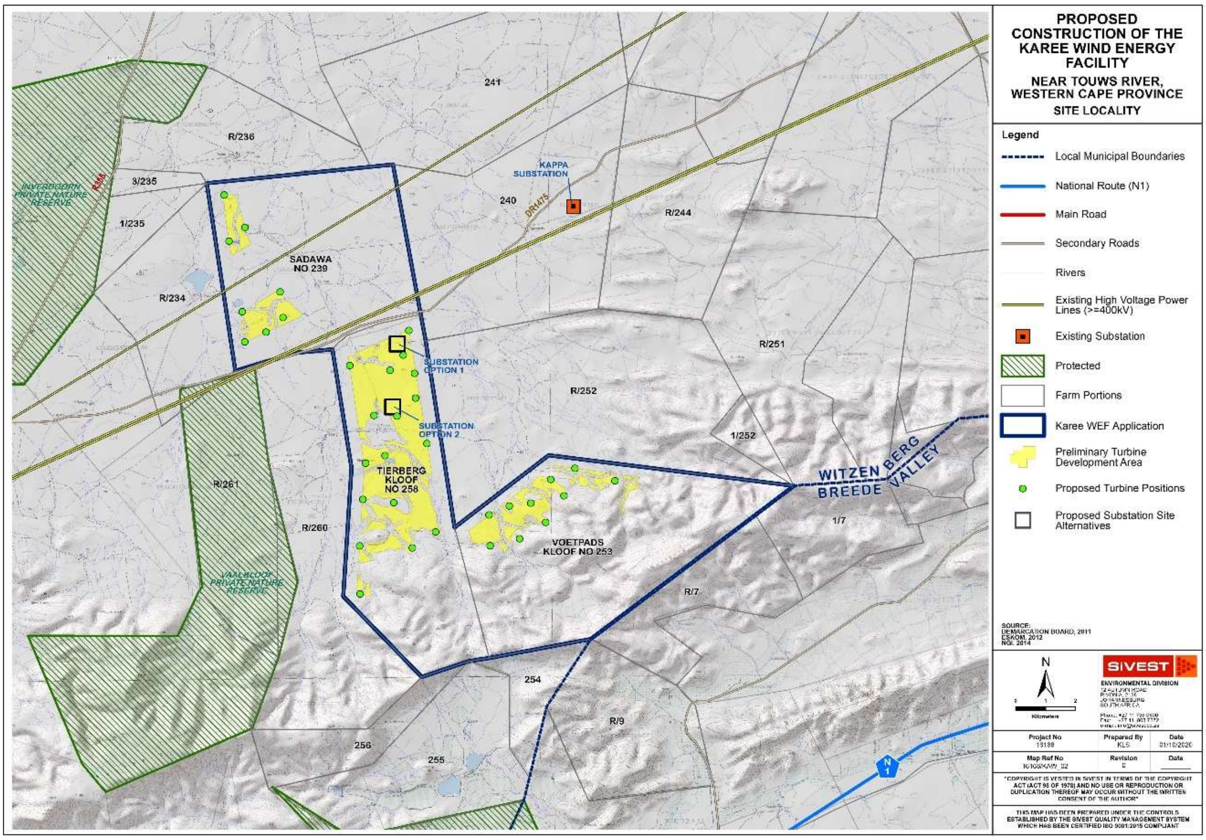

Figure 3-2 Location of the Karee WEF

Note whilst Mainstream will no longer be proceeding with turbines on Sadawa 239 (northernmost land parcel), it will remain part of the Development Area / Envelop but not the Development Footprint.

3.1.2. Grid Connection

At this stage, it is proposed that the 132 kV power lines will connect the Karee WEF on-site substation to the national grid via Kappa Substation, as shown in Figure 3-3.

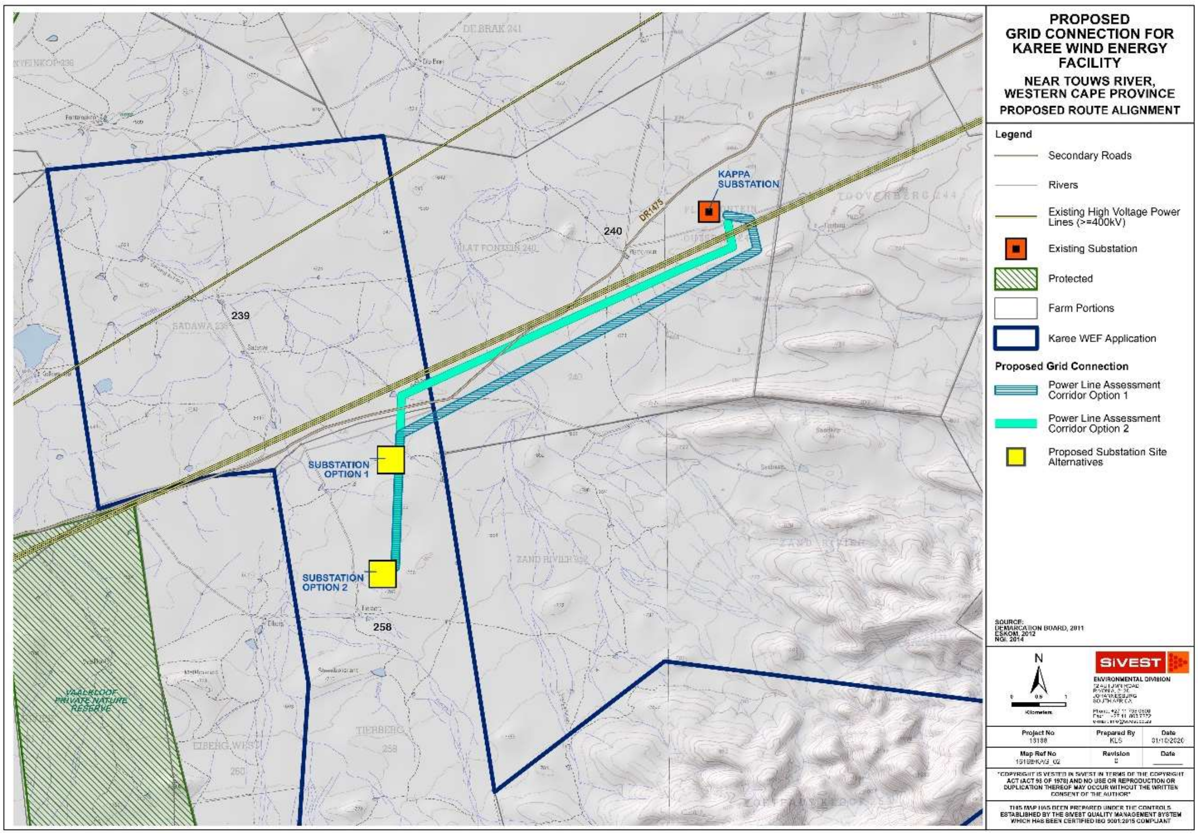

Figure 3-3 Proposed 132kV power line route alignment

3.2. Project Description

It is anticipated that the proposed Karee WEF will comprise up to twenty-seven (27) wind turbines with a maximum total energy generation capacity of up to approximately 140 MW. The electricity generated by the proposed WEF development will be fed into the national grid via a 132 kV overhead power line. The 132 kV overhead power line will however require a separate EA and is subject to a separate BA process, which is currently being undertaken in parallel to the WEF BA process.

3.2.1. Wind Farm Components

- Up to 27 wind turbines, with a maximum export capacity of approximately 140 MW. This will be subject to allowable limits in terms of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP);
- Each wind turbine will have a hub height of between 120 m and rotor diameter of up to approximately 150 m;
- Permanent compacted hardstanding areas / platforms (also known as crane pads) of approximately 100 m x 100 m (total footprint of approx. 10000 m^2) per turbine during construction and for on-going maintenance purposes for the lifetime of the proposed development;

- Each wind turbine will consist of a foundation of up to approximately 30 m in diameter. In addition, the foundations will be up to approximately 3 m in depth;
- Electrical transformers (690V/33 kV) adjacent to each wind turbine (typical footprint of up to approximately 2 m x 2 m) to step up the voltage to between 11 kV and 33 kV;
- One (1) new 11kV - 33/132kV on-site substation consisting of two (2) portions: IPP portion / yard (33kv portion of the shared 33kv/132kv portion) and an Eskom portion (132kv portion of the shared 33kv/132kv portion) including associated equipment and infrastructure, occupying a total area of approximately 25ha (i.e. 250 000m2) i.e. 15.5 ha for the IPP Portion and 15.5 ha for the Eskom Portion. The Eskom portion will be ceded over to Eskom once the IPP has constructed the onsite substation. The necessary Transfer of Rights will be lodged with DFFE when required;
- A Battery Energy Storage System (BESS) will be located next to the IPP portion / yard of the shared onsite 33/132kV substation and will be included as part of the 15.5ha. The storage capacity and type of technology would be determined at a later stage during the development phase, but most likely comprise an array of containers, outdoor cabinets and/or storage tanks;
- The wind turbines will be connected to the proposed substation via 11 to 33 kV underground cabling and overhead power lines.
- Road servitude of 8 m and a 20 m underground cable or overhead line servitude.
- Internal roads with a width of up to approximately 5 m wide will provide access to each wind turbine. Existing site roads will be used wherever possible, although new site roads will be constructed where necessary. Turns will have a radius of up to 50 m for abnormal loads (especially turbine blades) to access the various wind turbine positions. It should be noted that the proposed application site will be accessed via the DR1475 District Road and DR1475, MR316 and MR319 WCG provincial Roads;
- One (1) construction laydown / staging area of up to approximately 3 ha to be located on the site identified for the substation. It should be noted that no construction camps will be required in order to house workers overnight as all workers will be accommodated in the nearby town;
- Operation and Maintenance (O&M) buildings, including offices, a guard house, operational control centre, O&M area / warehouse / workshop and ablution facilities to be located on the site identified for the substation. This will be included in the 33kv portion/yard of the substation area i.e.15.5 ha of the IPP portion of the onsite substation;
- A wind measuring lattice (approximately 120 m in height) mast has already been strategically placed within the wind farm application site in order to collect data on wind conditions;
- No new fencing is envisaged at this stage. Current fencing is standard farm fence approximately 1-1.5 m in height. Fencing might be upgraded (if required) to be up to approximately 2 m in height; and
- Water will either be sourced from existing boreholes located within the application site or will be trucked in, should the boreholes located within the application site be limited.
- Optic fibre overhead or underground line from the Adamskraal Substation to the proposed on-site substation.

3.2.2. Grid Components

The proposed grid connection infrastructure to serve the Karee WEF will include the following components:

- One (1) new 11-33/132 kV on-site substation, situated on a site of occupying an area of up to approximately 2 ha. The proposed substation will be a step-up substation and will include an Eskom portion and an IPP portion, hence the substation has been included in both the BA for the WEF and in the BA for the grid infrastructure to allow for handover to Eskom. The applicant will remain in control of the low voltage components (i.e. 33 kV components) of the substation, while the high voltage components (i.e. 132 kV components) of this substation will likely be ceded to Eskom shortly after the completion of construction; and
- One (1) new 132 kV overhead power line connecting the on-site substation to Kappa Substation and thereby feeding the electricity into the national grid. Power line towers being considered for this development include self-supporting suspension monopole structures for relatively straight sections of the line and angle strain

towers where the route alignment bends to a significant degree. Maximum tower height is expected to be approximately 25 m.

3.3. Alternatives

3.3.1. Wind Energy Facility

No other activity or site alternatives are being considered. Renewable Energy development in South Africa is highly desirable from a social, environmental and development point of view and a wind energy facility is considered suitable for this site due to the high wind resource in this area.

The choice of technology selected for the Karee WEF is based on environmental constraints and technical and economic considerations. No other technology alternatives are being considered as wind energy facilities are more suitable for the site than other forms of renewable energy due to the high wind resource.

The size of the wind turbines will depend on the development area and the total generation capacity that can be produced as a result. The choice of turbine to be used will ultimately be determined by technological and economic factors at a later stage.

Design and layout alternatives will be considered and assessed as part of the BA. These include alternatives for the Substation locations and also for the construction / laydown area. The proposed preliminary layout is shown in Figure 3-2.

3.3.2. Grid Components

The grid connection infrastructure proposals include two (2) substation site alternatives, each of which are 25 hectares in extent, and two (2) power line route alignment alternatives Figure 3-3. These alternatives will be considered and assessed as part of the BA process and will be amended or refined to avoid identified environmental sensitivities.

All power line route alignments will be assessed within a 150 m wide assessment corridor (75 m on either side of power line). These alternatives are described below:

- Power Line Corridor Option 1 is between 8.9 km and 10.9 km in length, linking either Substation Option 1 or Substation Option 2 to Kappa Substation; and
- Power Line Corridor Option 2 is between 8.4 km and 10.3 km in length, linking either Substation Option 1 or Substation Option 2 to Kappa Substation.

3.3.3. No-go Alternative

The 'no-go' alternative is the option of not undertaking the proposed WEF and 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 surrounding local area. It provides the baseline against which other alternatives are compared and will be considered throughout the report.

The 'no-go' option is a feasible option; however, this would prevent the proposed development from contributing to the environmental, social and economic benefits associated with the development of the renewable energy sector.

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 site climate classifies as BSk by Köppen-Geiger system, which is a typical cold, semi-arid climate. The area experiences hot, drier, summers and cold, wetter, winters, with precipitation being controlled by cold fronts and orographic rainfall. Rainfall is generally lowest in January (ave. 10 mm) and greatest in June (ave. 31 mm). The hottest month is February and coldest is July with average temperatures of 21°C and 8.9°C, respectively (climate-data.org, 2021).

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. A climatic N-value of greater that 10 implies an arid climate with no significant chemical decomposition and residual soil profile development.

Weinert's climatic N-value for the site is approximately greater than 10. This implies an arid climate with a non-existent or extremely shallow residual soil profile. Very shallow bedrock can be anticipated (unless the rock is covered with transported soils). This climate is conducive to the formation of pedogenic calcrete.

5.2. Topography and Drainage

The topography in the general area surrounding the site to the north is characterised by flat plains with areas of slightly more undulating relief, including some local ridges. The topography over the northern to middle of the assessment area is slightly undulating to flat with slopes generally under 1:10 grade. The southern portion of the site and surrounding area is characterised by mountainous areas with steeped side valleys greater than 1:10 grade.

The site elevation is at its highest in the southern portion at 1360 m above mean sea level (AMSL), though this falls outside the buildable area. The highest point for the WEF is in the south-eastern portion at approximately 870 m AMSL. The grid corridor elevations are generally between 660 m and 700 m AMSL. The grid corridors transverse flat to slightly undulating terrain. The lowest elevation of the site is at approximately 600 m AMSL in the north western portion of the site.

The general site drainage is expected to occur from the southern portion towards the northern portion in the form of sheetwash, into rills and gullies and eventually into one of the non-perennial streams on the site, namely the Karee River and Kolkies River. These streams converge into the Doring River which flows into the Olifants River to the north-west.

The natural topography and drainage do not appear to have been impacted by any previous activities. However, several earth dams have been built in streams present on site.

The site's topography and slope classification are given in Figure 5-1 and Figure 5-2. The chart shows the site is generally flatter than 1:20 but, areas that exceed 1:10, and as steep as 1:5, exist within the proposed WEF area.

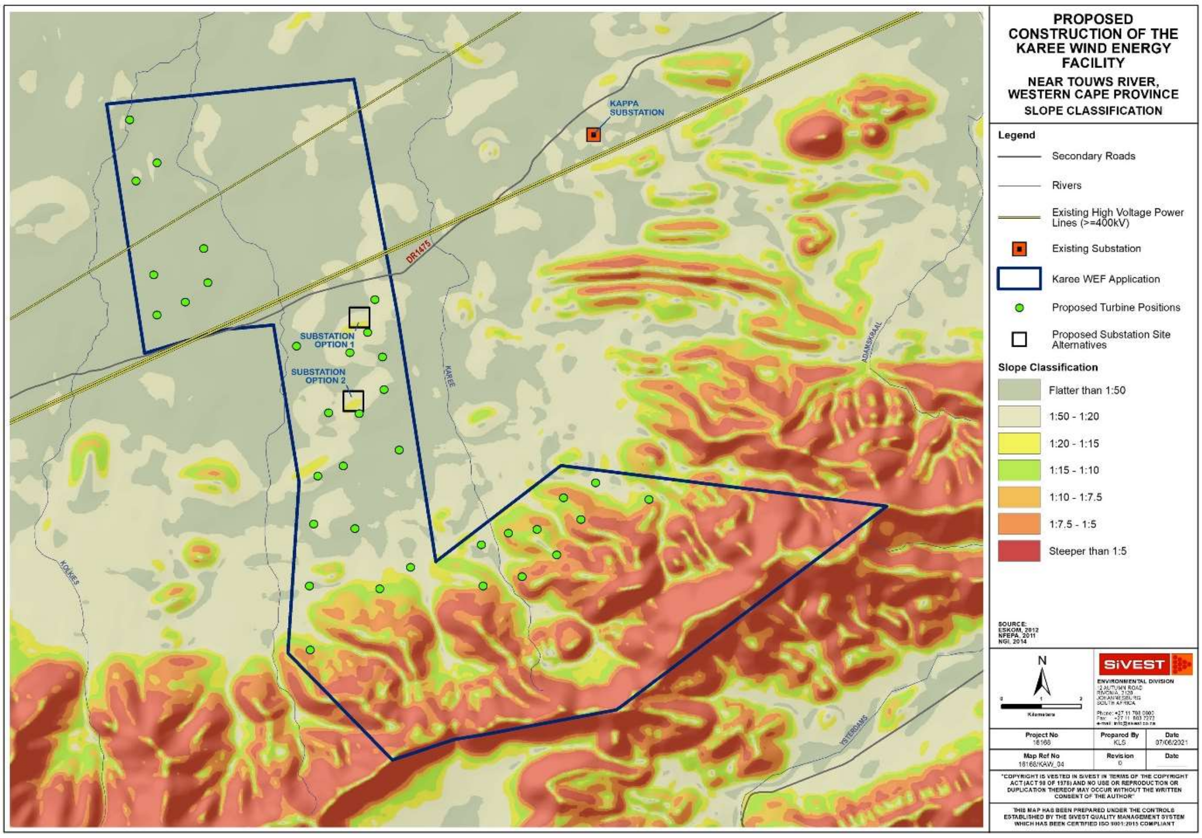

Figure 5-1 Slope classification chart of the WEF site

5.3. Seismicity

According to the Seismic Hazard Map of South Africa contained in SANS 10160, the peak ground acceleration (g) with a 10% probability of being exceeded in a 50-year period for the site is in the order of 0.12 – 0.16 g.

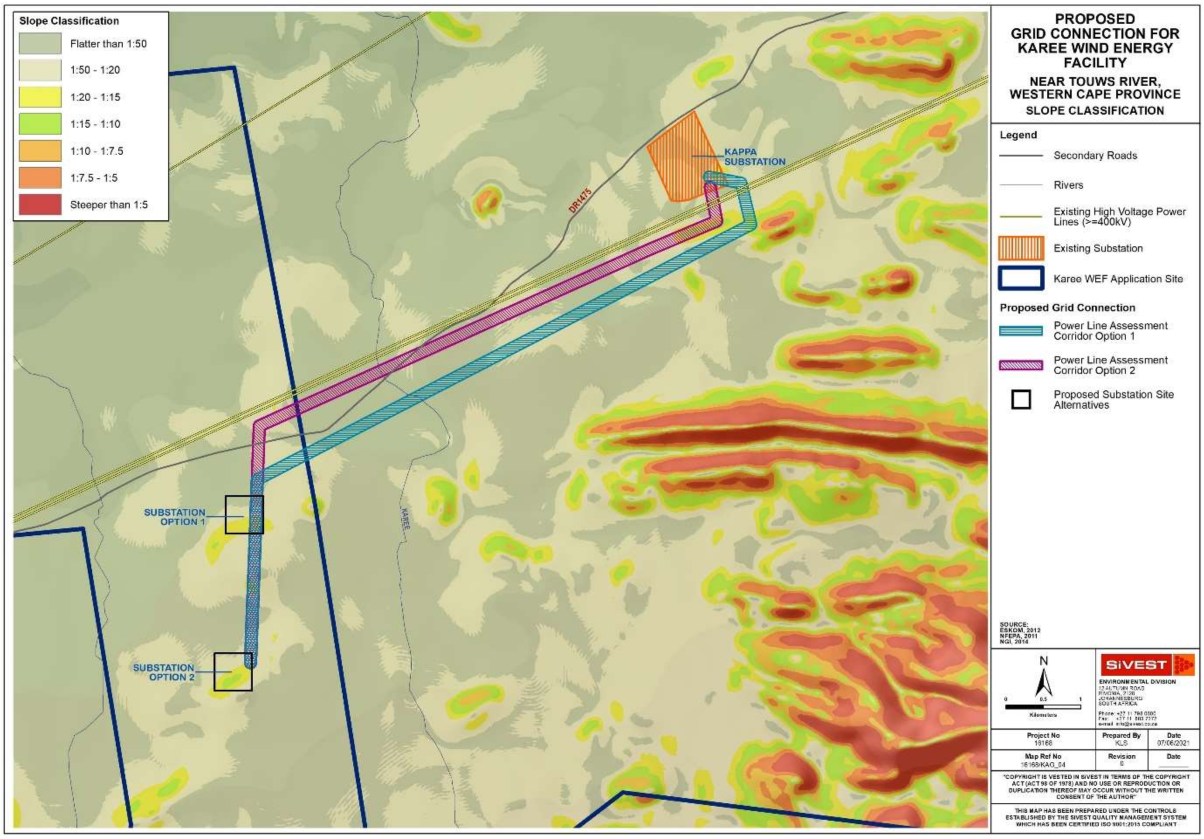

Figure 5-2 Slope classification chart of the Grid site

5.4. Bedrock Geology

According to the 1:250 000 scale geological map 3022 Ladismith, the middle to northern portion of the development area is underlain by geological units of the Karoo Supergroup. The site area is dominantly underlain by rock units of Dwyka Group (designated *C-Pd*). The Dwyka Group comprises of "tillite, boulder shale, sandstone, siltstone, shale, varved shale" of glacial, sub-glacial and subaqueous origin. The most common lithology is the massive diamictite facies, comprising of generally clast-rich diamictite (Johnson et.al., 2006) also referred to as tillite. The tillite rock comprises of a fine dark grey rock matrix with characteristic rounded to angular frequently striated drop stones of various origin. The stratified diamictite facies comprises of bedded diamictite, mudrock, sandstone and conglomerate.

Rock units of the Ecca Group of the Karoo Supergroup form a band beneath the northern section of the site, underlain predominantly by dark grey to black carbonaceous shale and medium to fine- to medium-grained feldspathic arenite and wacke of the Prince Albert Formation (designated *Ppr*), dark grey shale, with cherty siltstone beds of the Whitehill Formation (designated *Pw*), and siltstone, chert and sandstone with interbedded shale and yellow-weathering mudstone/tuff of the Collingham Formation (designated *Pc*).The latter forming the higher-lying ground in the south western portion of Farm Sadawa No 239.

The Whitehill Formation mudrocks weather to white on surface making them easily identifiable (Johnson et al, 2006). The shale is very thinly laminated and contain relatively high organic carbon (up to17%). The Collingham Formation is generally 30 m to 70 m thick and comprises a rhythmic alteration of thin, continuous beds of hard, dark grey, siliceous mudrock and very thin beds of softer yellow tuff (Johnson et al., 2006).

The southern portion of the site is underlain by geological units of the Cape Supergroup. The buildable area is underlain by shale, siltstone and thin sandstone of the Waaipoort Formation (designated *Cw*), sandstone alternating with shale and siltstone and subordinate grit beds with pebbles of the Floriskraal Formation (designated *Cf*), and quartzitic sandstone with thin siltstone beds of the Witpoort Formation (designated *Dwi*), forming the upper Wittenberg Group.

The most southern portion of the site within the application area is underlain by siltstone and mudstone with micaceous sandstone beds of the Swartruggens Formation (designated *Ds*), quartzitic sandstone with subordinate shale and siltstone of the Blinkberg Formation (designation *Dbl*), siltstone, arenaceous shale, mudstone and thin sandstone beds (designated *Dwa*), micaceous siltstone, shale and mudstone of the Karoopoort Formation (designated *Dka*), feldspathic sandstone with subordinate siltstone, shale, mudstone of the Osberg Formation (designated *Do*), and micaceous siltstone and mudstone with thin sandstone beds of the Klipbokkop Formation forming part of the lower Wittneberg Group and Upper Bokkeveld Group.

The Cape Supergroup sediments were folded during the last major orogeny event resulting in parallel ridges and valleys formed by numerous anticlines and synclines that run in an east-west direction.

The Kweekvlei Formation becomes silty and micaceous upwards grades into the overlying Floriskraal Formation. The latter comprises micaceous, grey or reddish, wavy bedded silty mudrock and two to four whitish quartz arenites forming coarsening-upward cycles (Thamm et al., 2006). The Waaipoort Formation consists of dark-grey, lenticular-bedded and massive mudrock plus subordinate dirty, fine-grained, feldspathic sandstone (Thamm et al., 2006).

Significant portions of site to the north of the mountainous southern section are underlain by Quaternary and Tertiary aged sediments which overlays the regional geology bedrock. These are described as scree and gritty sand. The large non-perennial streams are characterised by alluvium in the stream beds. Localised areas in the southern portion are underlain by terrace gravels that have collected in an area after being transported down from higher elevations.

5.4.1. Fossiliferous units

Certain sedimentary rock units of the Dwyka Group are fossiliferous, and the environmental sensitivity classified as "High Sensitivity" for the palaeontology theme. While the sensitivity for the site was not assessed further, the potential for preserved fossils to be present at shallow depth is considered to be low due to mechanical disintegration and calcification of the upper bedrock profile (described further in Section 5.5).

The Permian-aged Whitehill Formation is known to contain plant, palaeoniscoid fish and anthropod fossils and remains of two species of the swimming reptile Mesosaurus (Johnson et al., 2006). This rock unit may be classified as "High Sensitivity" for the palaeontology theme. The Prince Albert possesses marine fossils, as well as plant and palaeoniscoid fish remains and coprolites have been identified in this formation. The Colligham Formation contains a variety of trace fossils, including grazing trails which probably belongs to Nereites community (Johnson et al., 2006). The Waaipoort Formation contains fossils of plant remains, giant eurypterids and palaeoniscoid and acanthodian fishes (Thamm et al., 2006).

The intrusive rocks, namely dolerite, are not fossiliferous.

No mining activities have taken place on or close to the assessment area.

An extract from the 1:250 000 scale geological map 3320 Ladismith and 3319 Worcester is provided Figure 5-3 showing the assessment area and associated infrastructure. Table 5-2 summaries the geological units according to the local regional geological map.

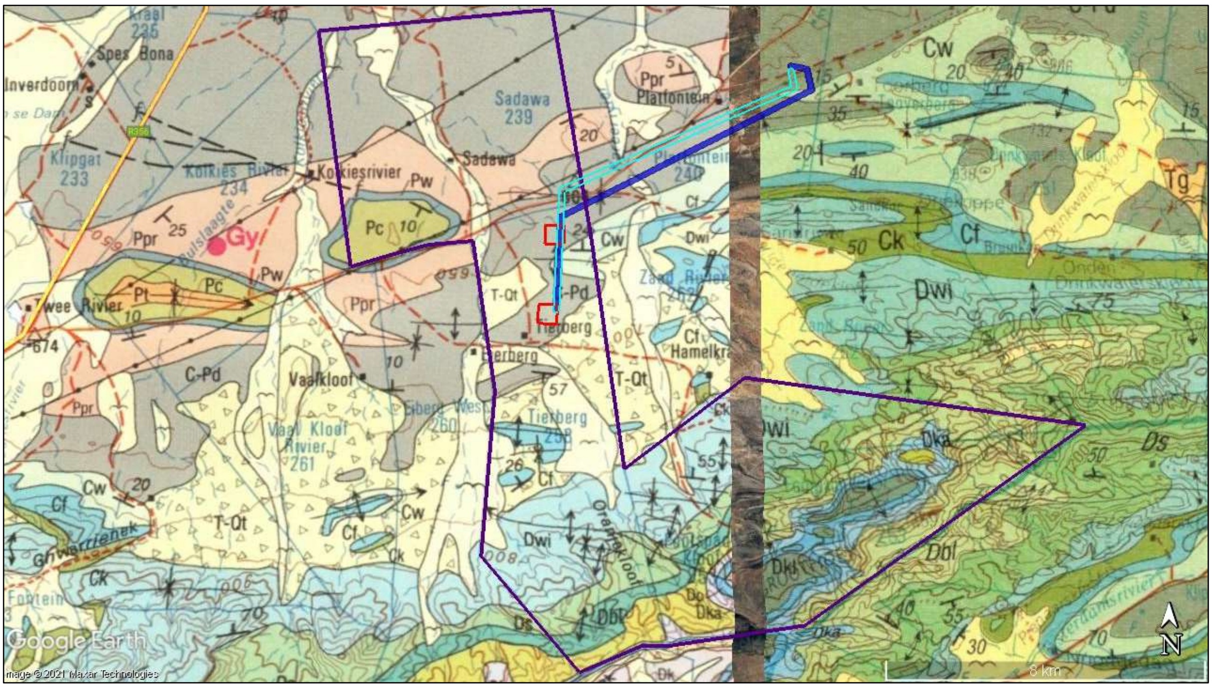

Figure 5-3 Extract of 1:250 000 scale Geological Map 3320 Ladismith and 3319 Worcester

Table 5-1 Summary of geological units

Age	Supergroup	Group	Formation	Symbol
Tertiary to Quaternary	-	-	-	Alluvium
	-	-	-	T-Qt Scree and gritty sand; scree
Permain	Karoo	Ecca	Collingham	Pc
			Whitehill	Pw
			Prince Albert	Ppr
Carboniferous		Dwyka	-	C-Pd
	Cape	Witteberg	Waaiport	Cw
			Floriskraal	Cf
			Kweekvlei	Ck
Devonian			Witpoort	Dwi
			Swartruggens	Ds
			Blinkberg	Dbl
			Wagen Drift	Dwa
		Bokkeveld	Karoopoort	Dka
			Osberg	Do
			Klipbokkop	Dk

5.5. Engineering Geology

The site's geology and climate will result in thin gravelly to sandy residual soils overlying shallow bedrock when not covered by thick transported soils in low-lying areas and adjacent to high elevation areas.

Brink (1983) highlights that variable soils and weathering profiles, and subsequently variable geotechnical conditions can develop on tillite bedrock, with the nature of the profile development largely controlled by the climate and geomorphological history. Expansive soils are known to develop in the Vryburg/Kimberley/Hopetown area. However, given the more arid climate these soils are not expected to be prominently developed at the site.

Tillite bedrock is often intensely jointed and develops a blocky structure. Hard rock may also disintegrate on exposure to the atmosphere.

The geotechnical investigation report referenced in Technical report titled "Factual Geotechnical Report for Peredekraal East Wind Power Project " written by SMEC for Mainstream Renewable Power dated April 2016, provides information that enables a satisfactory preliminary assessment of the geotechnical conditions near to the assessment area. As part of this investigation test pits were excavated by means of a tracked excavator. The exact location of the investigation points and area are not given in the report. The general soil profile comprised a thin, loose to medium dense colluvium becoming a weakly cemented calcrete with depth. The bedrock generally occurs at a shallow depth of less than 1.00 m below ground level (BGL), when not covered by thicker alluvium and transported material.

The bedrock encountered during the previous investigation was described as being medium hard to hard rock and was excavated as angular boulder to cobble sized fragments on which the excavator refused. This will hinder deep excavations for wind turbines, installation services and construction of roads but, provides good founding for large structures.

Similar shallow ground conditions are anticipated over much of the site, with a shallower depth to hard rock in areas of steeper topography and a thicker upper transported soil horizon in the lower-lying areas. The alluvial material in this area exhibits collapsible fabric when comprising mainly sand. 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 (Brink, 1985). 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. The previous investigation also revealed the alluvium can occur as sandy gravel to depths greater than 3.00 m BGL.

The middle to southern areas, north of the mountainous southern portion, of the site is expected to be underlain by scree and talus comprising angular, cobble to boulder size fragments in a gritty sandy matrix. This material is expected to occur locally across the site.

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. An economical gypsum deposit is located to the west of the site according to the local geological sheet. This indicates large calcrete formations may be present at the site.

The charts provided by SiVEST indicate that slopes exceed gradients of 1:10, and as steep as 1:5, within the proposed corridors and WEF assessment area. This entails that terracing and additional earthworks for roads and stormwater may be required for construction in the steeper sections of the site.

5.6. Geohydrology

The site is located in the Olifants/Doorn Water Management Area (WMA). The southern portion of the WMA is characterised by fractured bedrock aquifer within which the permanent groundwater table is found at depth. The local farmers are reliant on groundwater extraction for farming activities.

There are no boreholes that are registered with the Department of Water and Sanitation (DWS) near the site. No information on the groundwater conditions could be obtained during this study.

5.7. Desktop Geotechnical Appraisal

Based on the desktop study, the assessment areas may be divided into five (5No.) Ground Units (GU), I, II, III, IV and V are presented in Figure 5-4, Figure 5-5 and Figure 5-6, where similar geotechnical conditions are anticipated. GU I is defined by shallow occurring bedrock covered by thin, loose transported material and varying degrees of cemented calcrete. GU II can be characterised by talus deposits on relatively steep slopes greater than 1:10. GU III can be defined by talus deposits on steep slopes greater than 1:5 that is linked to GU V that defines the high lying outcropping bedrock. GU III and GU V have been mapped where practically valuable for information near turbines and within the buildable area. Though, the majority of the southern mountainous portion of the site is characterised by GU III and GU V.

GU IV is confined to low lying areas that are underlain by relativity thicker alluvial deposits, identifiable by erosion paths, rills and continuous drainage features.

The boundaries between the zones are approximate only and will need to be confirmed on site through intrusive investigations. The boundaries of GU were drawn with the assistance of the satellite imagery and other available data.

The assessment area is considered suitable for the development of the proposed 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 5-2.

Table 5-2 Summary of geotechnical conditions

Ground Unit	Shallow Geology	Geotechnical Conditions / Constraints	Impacts on Engineering Design and Construction
I	Fairly shallow bedrock covered by transported and calcrete material and zones of scree	• Shallow bedrock • Thin soil cover • Intermediate to hard excavation conditions • Possible strongly cemented calcrete • Overlain by transported material with varying thickness (including moderately thick scree deposits)	• Good founding conditions for structures at shallow to moderate depths • Conventional shallow foundations suitable for light structures • Deeper founding level for turbine foundations (in bedrock below transported materials and calcrete) • Conventional subgrade preparation for roads • Intermediate to hard excavation conditions for trenching / earthworks / pole planting
II	Talus on steep slopes greater than 1:10	• Boulder excavation conditions • Potentially unstable talus slopes • Additional earthworks for roads and stormwater control	• Terracing and slope stabilisation required • Surface drainage measures required to mitigate erosion
III	Talus on steep slopes greater than 1:5	• Boulder excavation conditions • Potentially unstable talus slopes • Additional earthworks for roads and stormwater control	• Terracing and slope stabilisation required • Surface drainage measures required to mitigate erosion
IV	Alluvium	• Loose sandy soils • Boulder excavation conditions • Potentially collapsible soils • Moderate soil cover • Moderate bedrock depth • Increased erosion potential	• Deeper spread footings (found below alluvial sands) • Soft excavation conditions becoming intermediate with depth • Unstable trench sidewalls – shoring/battering required • Surface drainage measures required
V	Outcropping bedrock	• Hard excavation conditions	• Heavy plant machinery / pneumatic methods / required for excavations (pole planting earthworks / trenching/foundations) • Good founding conditions for structures

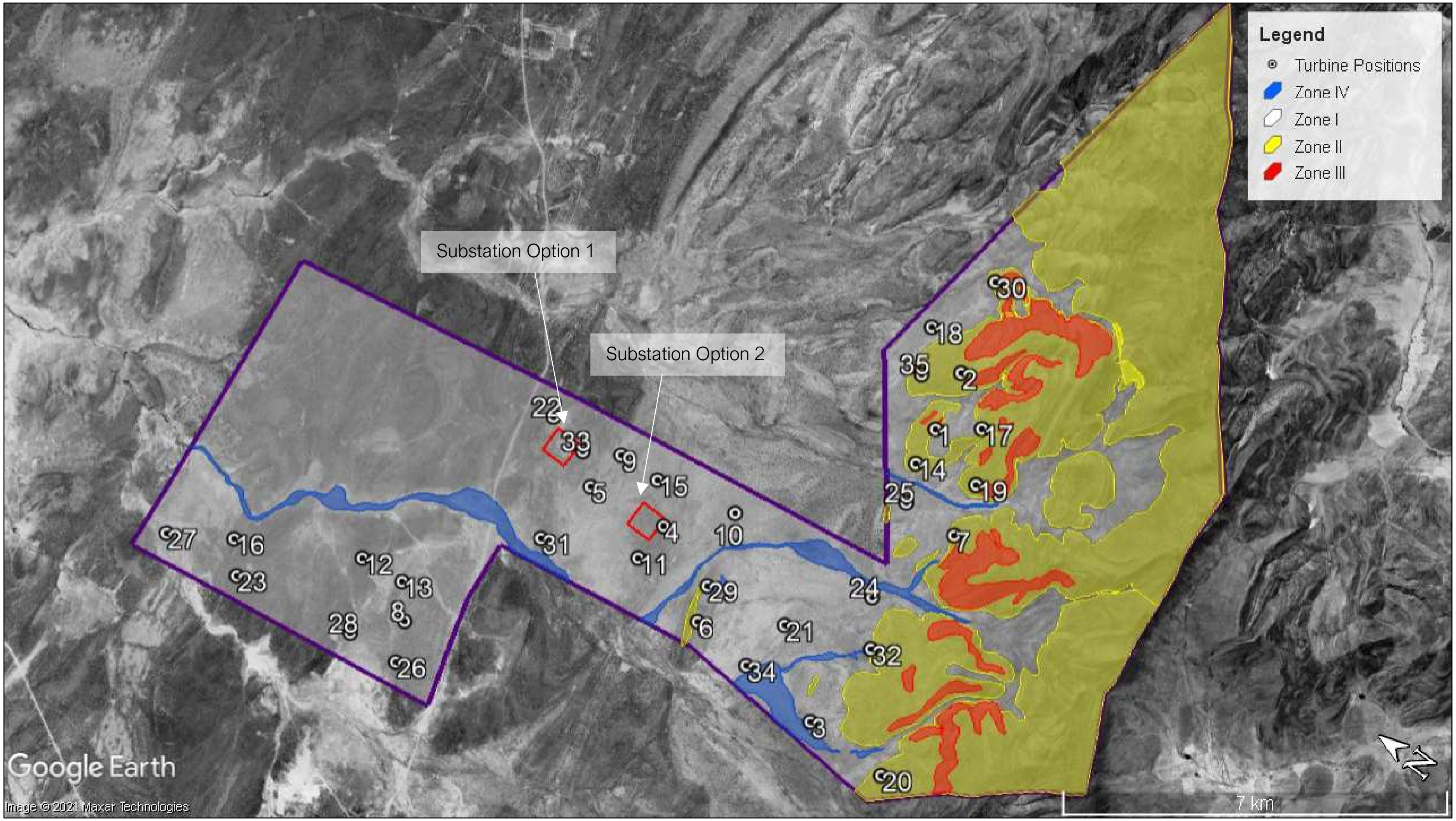

Figure 5-4 Inferred Ground Units for WEF application area (Google Earth, 2021)

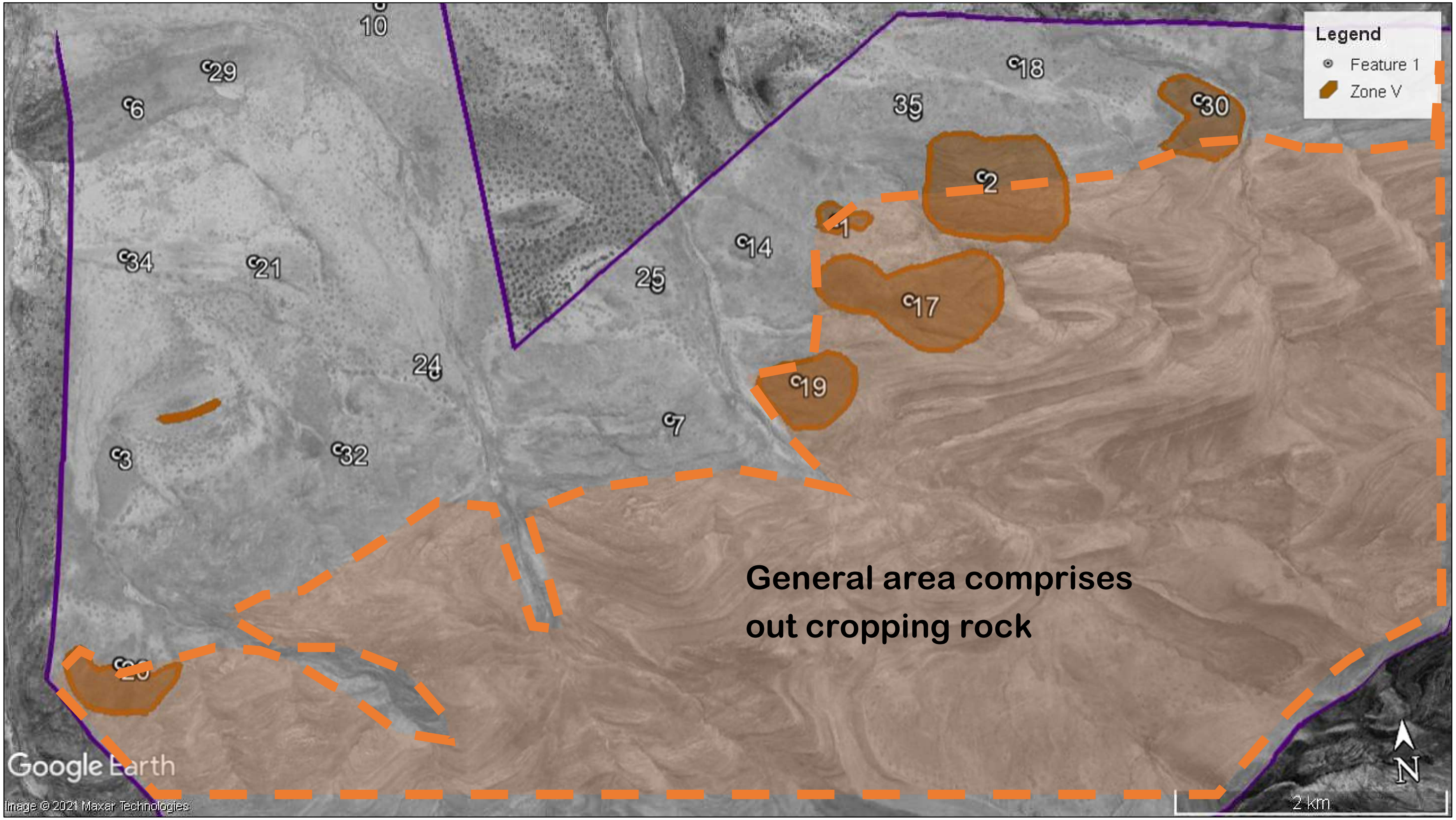

Figure 5-5 Inferred Ground Unit V for WEF application area (Google Earth, 2021)

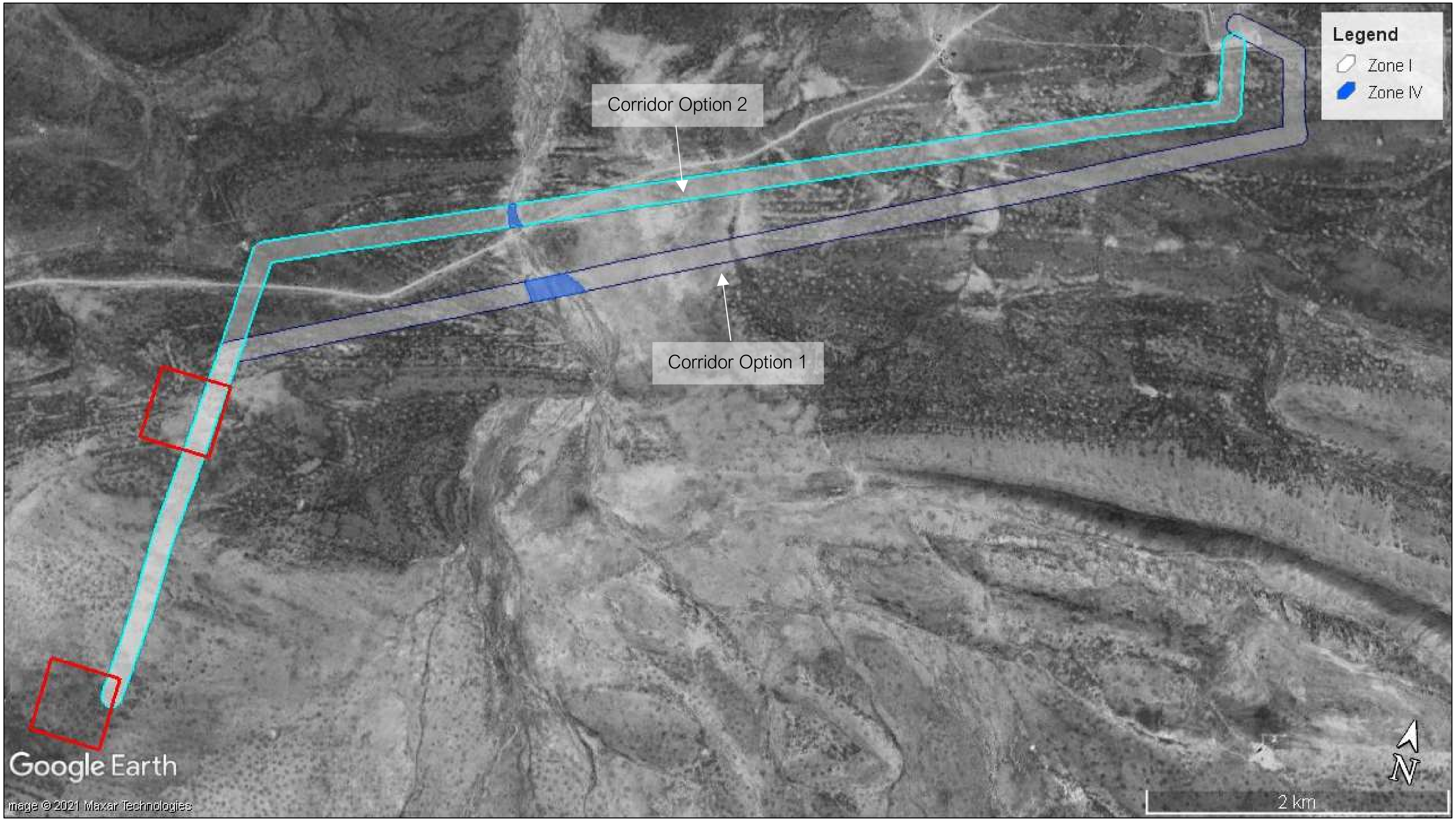

Figure 5-6 Inferred Ground Units for grid corridor areas (Google Earth, 2021)

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 impact of the WEF will be caused by the construction of access roads to the turbine positions (designed to carry large abnormal loads), earthworks required for the construction of crane pads, excavations of the turbine foundations (up to 30 m in diameter, typically excavated up to 5 m into the ground) as well as trenching for underground cables. Given the required grades and radius requirements for transporting the large turbine components as well as the large size of the crane pads, significant earthworks would be required, particularly in steep topography. Additional impacts would be caused by the opening of borrow pits that may be undertaken to obtain construction materials.

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.

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 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.

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 significance ratings, presented in Appendix D, the development of the proposed construction of the Karee Wind Energy Facility (WEF) and associated grid infrastructure, from a geological and geotechnical perspective, will be "Negative Low impact", provided that the recommended mitigation measures are implemented. These include avoiding development on the steeper sections of the site.

The topography of the major portion of the site is gentle and significant earthworks are not anticipated in these areas (although some bulk earthwork will be required). However, moderately steep to very steep slopes occur with talus on the slopes, and it is recommended the steepest slopes (greater than 1:5) are avoided when determining the final infrastructure layout. Access routes should be carefully planned to avoid these areas, where possible.

It is recommended that construction materials are obtained from cuttings and excavations rather than through the establishment of borrow pits. 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).

The soils do not render the site particularly susceptible to soil erosion, although mitigation measures need to be implemented, particularly within the lower-lying sections of the site where concentrated surface flow is anticipated after heavy rainfall events.

The crest of the ridges is characterised by outcropping bedrock. This will provide good founding for large structures but will hinder excavations for turbine foundations, services and road construction.

7. Comparative Assessment of Alternatives

Alternative layouts of the grid corridors, provided by SiVEST, will be considered. Both corridor options have the same impact rating. However, it is recommended that corridor options that transverse areas with slopes steeper than 1:5 be avoided when determining the final infrastructure layout. The steeper slopes will require additional earthworks for access roads as discussed in Section 6. The final location for the substation is recommended to avoid slopes steeper than 1:10 as this will require terracing for platform construction.

8. Conclusion and Summary

8.1. Summary of Findings

This desktop geotechnical specialist study was undertaken for the development of the 140MW Karee WEF and associated grid infrastructure near Touws River in the Western Cape Province. The assessment area is underlain by rock units of Dwyka Group ad Ecca Group of the Karoo Supergroup and locally by faulted rock units of the Cape Supergroup. Some geotechnical constraints have been identified, primarily shallow bedrock which may cause excavation difficulties, thick transported (alluvium and scree) and steep slopes. These constraints may be mitigated via standard engineering design and construction measures. Spread footings are considered suitable to support the structures on majority of the site.

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. These include avoiding development on the steeper sections of the site. The remaining mitigation measures provided to minimise the impacts relate 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 practice.

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 WEF assessment areas and grid corridors. It is therefore recommended that the proposed activity be authorised.

References

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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

140 MW KAREE WIND ENERGY FACILITY AND ASSOCIATED GRID INFRASTRUCTURE

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

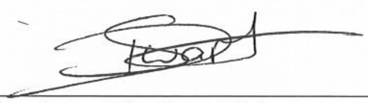
1. SPECIALIST INFORMATION

Specialist Company Name:	GaGE Consulting (Pty)Ltd			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	1	Percentage Procurement recognition	
Specialist name:	Duan Swart			
Specialist Qualifications:	MSc Engineering Geology			
Professional affiliation/registration:	South Africa Institute of Engineering Geologist (SAIEG)			
Physical address:	57 Witney Street, Country Life Park, Sandton, 2060			
Postal address:				
Postal code:		Cell:	0824516394	
Telephone:		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 (Pty) Ltd

Name of Company:

15/10/2021

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 (Pty) Ltd
____
Name of Company

15/10/2021
____
Date

____
Signature of the Commissioner of Oaths

15-10-2021
____
Date

GERHARD P. SWART
PROFESSIONAL LAND SURVEYORS PLS 1216
COMMISSIONER OF OATHS
No. 5 VILLA LA MANCHA
326 GIOVANETTI STREET
NIEUW MUCKLENEUK 0181
TEL: 083 541 2276

Appendix B. Specialist CV

GaGE CONSULTING

STEVEN BOK
Principal Engineering Geologist
PrSciNat BSc (Hons.)

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,

SUMMARY OF CREDENTIALS

Steven is a registered professional natural scientist with 19 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, railways, residential and commercial buildings, township development, large infrastructure (e.g. dams, 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.

He has also been involved with renewable energy projects from feasibility to preliminary and detailed design investigations.

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, 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.

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EXPERIENCE: OTHER PROJECTS

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.

Matjhabeng Solar Park (Sunelex Energy) 2015
Client: Sunelex Energy
Project Leader – detailed ground investigation for a proposed 500 MW Solar Park on 2000 ha site for the Matjhabeng Local Municipality, Odendaalsrus.

75 MW Nokukhanya Solar PV Plant (2015)
Client: Nokukhanya Energy
Project Leader – foundation investigations for a proposed solar project in near Groblersdal

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 Metropolitan University
2001	Bachelor of Science (Honours) (Geology)	Nelson Mandela Metropolitan 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.

GaGE CONSULTING

DUAN SWART

Engineering Geologist

MSc (Engineering Geology), PrNatSci, MSAIEG

DATE OF BIRTH
30 July 1993

NATIONALITY
South African

LANGUAGES
English
Afrikaans

QUALIFICATIONS

Professional registered SACNASP, PrNatSci (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

Field Mapping; Geotechnical Investigations; Dolomite investigations and risk assessment; Borrow Pit and Quarry investigations; Slope stability assessments; Materials assessments; Vadose zone hydrology; Unsaturated soil mechanics.

INTERNATIONAL EXPEREINCE

Democratic Republic of Congo, Botswana

SUMMARY OF CREDENTIALS

Duan is a registered engineering geologist, with four years' experience, who has undertaken fieldwork and reporting of data for various projects including housing and township development, light structures, petrol stations, piling investigations, retaining walls, bridge foundations, roads, pipelines and open cast mines, and has shown keen interest in development on dolomitic land and sinkhole occurrence and flow mechanics through a soil medium, as well as logged many hours in the laboratory and the research environment.

Duan's doctoral research aims to improve the understanding of the variably saturated residual 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. Furthermore, he has successfully consulted on multiple D4 dolomite sites.

His experience has developed through numerous intrusive and non-intrusive site investigation methods for both rock and soil orientated projects and continues to display interest in learning and improving in the field of environmental and engineering geology and geotechnics.

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, obtained during M.Sc. studies which form part of the Water Research Commission (WRC) project, K5/2326. Currently, the 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

N4 Montrose Interchange, Mpumalanga, SOUTH AFRICA (2019-21)
Client: Trans African Toll Concession (TRAC) / South African National Roads 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 (2020-21)
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 (2020-21)
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, supervision of the site investigation, borehole core logging and write up of sections within the geological, materials and interpretive reports.

EXPERIENCE: OTHER MAJOR PROJECTS

Upgrades to Damani Water Treatment Plant
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
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 boreholes and was responsible for sample retrieval and testing supervision.

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): Pr.Nat.Sci 137543

Member of the South African Institute of Engineering and Environmental Geologists (SAIEG): MSAIEG 21/526

Water Research Commission – Karst Research Group K5/2326

Water Research Commission – Complex Vadose Zone Research Group K5/2826

University of Pretoria – Geology Dept. External Examiner (2020-2021)

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 ATTENDED

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.
2019	Attendee, Short Course on Geotechnical Investigation of Dams, Tunnels and Mine Tailings Storage Facilities, South African Institute of Engineering and Environmental Geologists (SAIEG), Johannesburg, 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
2017	Attendee, 9th South African Young Geotechnical Engineers (SAYGE) Conference, SAICE Geotechnical Division, Salt Rock Hotel, KwaZulu-Natal, South Africa.

TECHNICAL PUBLICATIONS

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.

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

PROPOSED CONSTRUCTION OF THE KAREE WIND ENERGY FACILITY

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																				
Disturbance/ displacement/ removal of soil and rock	Ground disturbance during access road construction, foundation earthworks, platform earthworks	1	4	3	2	3	1	13	-	Low	1) Design access roads and pylon locations to minimise earthworks and levelling based on high resolution ground contour information 2) Correct topsoil and spoil management	1	4	2	1	3	1	11	-	Low
Soil Erosion	Increased erosion due to vegetation clearing, alteration of natural drainage	1	4	3	2	2	1	12	-	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																				
Soil Erosion	Increased erosion due to alteration of natural drainage	1	2	1	1	2	1	7	-	Low	1) Maintain drainage channels 2) Monitor for erosion and remediate and rehabilitate timeously	1	1	1	1	2	1	6	-	Low
Decommissioning Phase																				
Disturbance/ displacement/ removal of soil and rock	Ground disturbance during platform earthworks, road rehabilitation, removal of subsurface infrastructure	1	4	2	2	2	1	11	-	Low	1) Restore natural site topography 2) Landscape and rehabilitate disturbed areas timeously (e.g. regrassing)	1	4	2	1	2	1	10	-	Low

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
Soil Erosion	Increased erosion due to ground disturbance during rehabilitation activities	1	2	2	2	2	1	9	-	Low	1) Temporary 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
Cumulative																				
Disturbance/ displacement/ removal of soil and rock	No cumulative effect							0										0		
Soil Erosion								0										0		

KAREE SOLAR WEF - GRID CONNECTION																				
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																				
Disturbance/ displacement/ removal of soil and rock	Ground disturbance during access road construction, foundation earthworks, platform earthworks	1	4	3	2	3	1	13	-	Low	1) Design access roads and pylon locations to minimise earthworks and levelling based on high resolution ground contour information 2) Correct topsoil and spoil management	1	4	2	1	3	1	11	-	Low
Soil Erosion	Increased erosion due to vegetation clearing, alteration of natural drainage	1	4	3	2	2	1	12	-	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																				
Soil Erosion	Increased erosion due to alteration of natural drainage	1	2	1	1	2	1	7	-	Low	1) Maintain drainage channels 2) Monitor for erosion and remediate and rehabilitate timeously	1	1	1	1	2	1	6	-	Low
Decommissioning Phase																				
Disturbance/ displacement/ removal of soil and rock	Ground disturbance during platform earthworks, road rehabilitation, removal of subsurface infrastructure	1	4	2	2	2	1	11	-	Low	1) Restore natural site topography 2) Landscape and rehabilitate disturbed areas timeously (e.g. regrassing)	1	4	2	1	2	1	10	-	Low

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
Soil Erosion	Increased erosion due to ground disturbance during rehabilitation activities	1	2	2	2	2	1	9	-	Low	1) Temporary 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
Cumulative																				
Disturbance/ displacement/ removal of soil and rock	No cumulative effect							0										0		
Soil Erosion								0										0		