Report to SiVEST

Desktop Geotechnical Specialist Study for the:

Proposed construction and operation of the Battery Energy Storage System (BESS) and associated infrastructure for the authorised Dwarsrug Wind Energy Facility, located near Loeriesfontein in the Hantam Local Municipality, Namakwa District in the Northern Cape Province of South Africa

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GaGE CONSULTING

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Project name:	Dwarsrug Wind Energy Facility (WEF) Battery Energy Storage System (BESS)
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Report by:	Approved by:
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Loeriesfontein in the Hantam Local Municipality, Namakwa District in the Northern Cape Province of South Africa

Executive Summary

This desktop geological and geotechnical specialist study assed the proposed development of a Battery Energy Storage System (BESS) and associated infrastructure for the authorised Dwarsrug WEF (14/12/16/3/3/2/690/AM4), located near, approximately 50km northeast of, Loeriesfontein in the Hantam Local Municipality, Namakwa District in the Northern Cape Province of South Africa. The assessment area comprises of a 500 m radius around the authorised substation position.

The assessment area is located between two low ridges and while the majority of the topography is gentle, some areas towards the ridges are moderately steep with slope gradients greater than 1:20. The site seems to be located close to the watershed between two drainage basins. The topographical map indicates a non-perennial drainage feature originates near the south eastern boundary and concentrated overland flow is expected to occur in the valley, running in a north easterly to south westerly direction through the central section of the assessment area. The nature of the drainage features could not be confirmed in the desk study. The site falls within a hot desert climate (BWk) according to the Köppen-Geiger climate classification.

The assessment area has been divided into two Ground Units, namely Zone I, which underlays majority of the area of interest and comprises thin surficial sandy gravel, to possibly gravelly sand, transported horizon transitioning into a variably cemented calcrete horizon that overlays soft to hard rock shale at a shallow depth below ground level. Zone II can be characterised as outcropping bedrock, most likely to be shale of the Tierberg Formation and talus on steeper slopes. Founding conditions will be adequate for the proposed infrastructure, although engineering mitigation will be required to address the potentially collapsible sands and shallow bedrock.

No faults, lineaments or other geological features were identified. The Permian-aged Tierberg Formation is known to contain fossils, mainly being sparse to locally concentrated assemblages of trace fossils.

No fatal flaws have been identified that would render the proposed BESS site unsuitable from a geological and geotechnical perspective. Some geotechnical and geological constraints and sensitivities have been identified, notably related to the presence of shallow bedrock and steeper talus slopes. It is therefore recommended that that the ridges and areas of steeper slope gradients (>1:20) are avoided when determining the final infrastructure layout. A survey of the slope gradients should be utilised in this regard. The remaining constraints may be mitigated via standard engineering design and construction measures.

The proposed BESS is assessed to have a “Negative Low impact - the anticipated impact will have negligible negative effects and will require little to no mitigation” from a geological and geotechnical viewpoint, provided that the recommended mitigation measures are implemented. These include avoiding development on the ridges and steep slopes. Should the activities take place with these areas of the footprint the impact will increase to “Negative Medium impact”. The remaining mitigation measures 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. It is recommended that the proposed activity be authorised.

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

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Section of Report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	 1.3 Appendix B
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix A
c) an indication of the scope of, and the purpose for which, the report was prepared;	1.1, 1.2
(cA) an indication of the quality and age of base data used for the specialist report;	1.4, References
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	5, 6
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Not applicable
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	1.4, Appendix C
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	3, 6, 7
g) an identification of any areas to be avoided, including buffers;	None identified
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	No sensitivities identified
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	2
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, (including identified alternatives on the environment) or activities;	5,6,7
k) any mitigation measures for inclusion in the EMPr;	6.1 Table 6-1
l) any conditions for inclusion in the environmental authorisation;	6.1 Table 6-1
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	6.1 Table 6-1
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 Table 6-1
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 (Pty) Ltd, on behalf of South Africa Mainstream (Pty) Ltd, to undertake the assessment of the proposed development of a Battery Energy Storage System (BESS) and associated infrastructure for the authorised Dwarsrug Wind Energy Facility (hereafter referred to as "Dwarsrug WEF") (14/12/16/3/3/2/690/AM4), located near Loeriesfontein in the Hantam Local Municipality, Namakwa District in the Northern Cape Province of 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 BESS under the applicable specialist protocols.

1.1. Scope and Objectives

Assess the geological and geotechnical conditions and the impacts associated with the installation of a BESS on the Dwarsrug WEF (14/12/16/3/3/2/690/AM4), as well as including potential fatal flaws, if any.

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 enable 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 detained description of the infrastructure required for the BESS including layouts of the proposed development were provided by SiVEST.

1.3. Specialist Credentials

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

1.4. Assessment Methodology

The assessment involved a review of the following information:

i) 1:250 000 Scale Geological Map 3018 Loeriesfontein (Council for Geoscience, 2011)
ii) Aerial photographs (Google Earth imagery, current and historical)

iii) Technical report titled "Factual Report on Preliminary Geotechnical Investigation Loeriesfontein Wind & Solar PV Project" published by Vela VKE Consulting Engineers and produced by Mainstream Renewable Power dated July 2012 (Version Number 0)
iv) Technical report titled "Proposed Development of the Dwarsrug Wind Farm near Loeriesfontein, in the Northern Cape Province. Surface Water Impact Assessment Report" produced by Mainstream Renewable Power dated March 2015
v) Technical report titled "Dwarsrug Wind Energy Facility. Heritage Impact Report" published by PGS Heritage and dated May 2015
vi) Screening Report for Environmental Authorisation (national web based environmental screening tool)
vii) General site photographs provided by SiVEST
viii) Literature as referenced within this report

The geotechnical investigation report referenced in bullet iii provides covers an area northwest of the site with the closest test pits located approximately 7.2 km from the proposed BESS. This area is underlain by the similar stratigraphic units.

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 BESS is located on the authorised Dwarsrug WEF (14/12/16/3/3/2/690/AM4), located near, approximately 50 km northeast of, Loeriesfontein in the Hantam Local Municipality, Namakwa District in the Northern Cape Province of South Africa.

The Dwarsrug WEF BESS will be located adjacent to the approved Dwarsrug WEF substation associated with the approved Dwarsrug WEF. To reduce electrical losses the BESS must be in close proximity to the on-site 33/132kV substation. A ~5 ha study site has been established around the approved substation (500 m zone) to allow for the micrositing / specialist guidance regarding placement can be made. The location of the study area is presented in Figure 3-1.

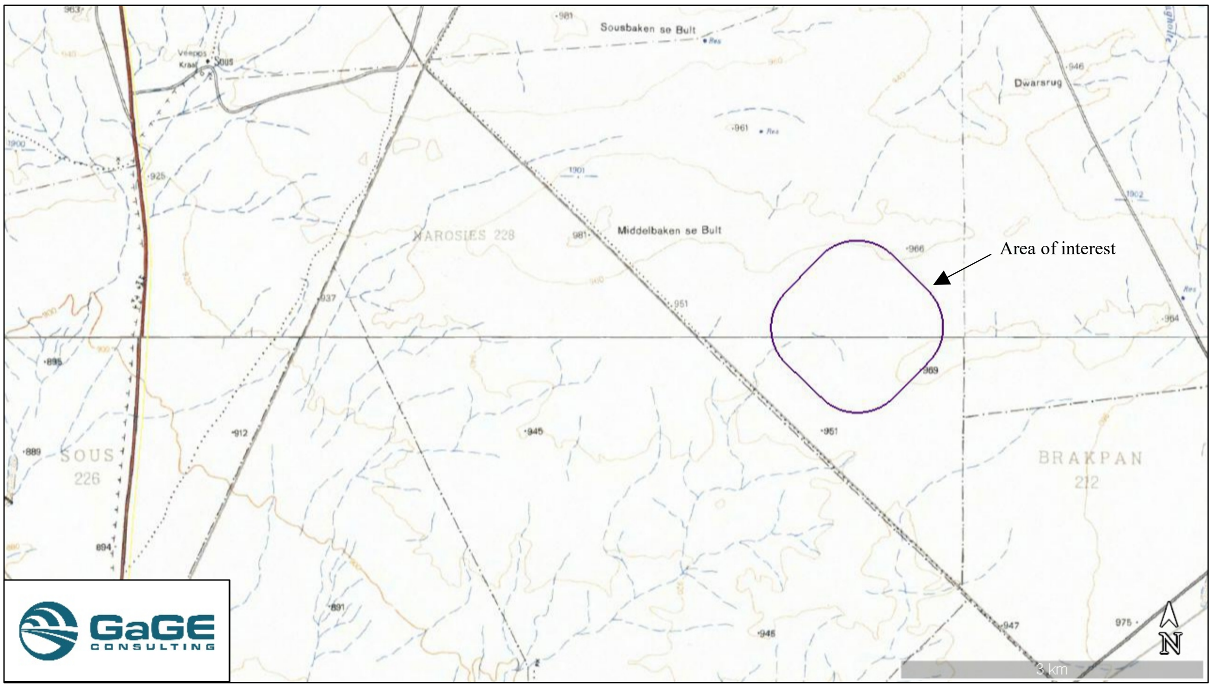

Figure 3-1 BESS is located on the authorised Dwarsrug WEF (Google Earth, 2020)

3.2. Project Description

South Africa Mainstream (Pty) Ltd is proposing the construction and operation of Battery Energy Storage System (BESS) and associated infrastructure for the authorised Dwarsrug WEF (14/12/16/3/3/2/690/AM4), located near Loeriesfontein in the Hantam Local Municipality, Namakwa District in the Northern Cape Province of South Africa. The need for a BESS stems from the fact that electricity is only produced by the Renewable Energy Facility while the sun is shining, while the peak demand may not necessarily occur during the day-time. Therefore, the storage of electricity and supply thereof during peak-demand will mean that the facility is more efficient, reliable and electricity supply more constant.

The BESS will:

- Store and Integrate a greater amount of renewable energy from the Renewable Energy Facility into the electricity grid;
- This will assist with the objective to generate electricity by means of renewable energy to feed into the National Grid which will be procured under either the Renewable Energy Independent Power Producer Procurement Program (REIPPPP), other government run procurement programmes or for sale to private entities if required

The need for a BESS stems from the fact that electricity is only produced by the Renewable Energy Facility (REF) while the sun is shining, while the peak demand may not be necessarily occur during day-time. Therefore, the storage of electricity and supply thereof during peak-demand will mean that the facility is more efficient, reliable and stable electricity supply.

3.2.1. Alternatives

No site alternatives for this proposed development were considered as the placement of the proposed BESS is dependent on the location of the Dwarsrug WEF (14/12/16/3/3/2/690/AM4).

Technology alternatives are limited to battery types, namely Redox flow batteries and Solid State Batteries. No other activity alternatives are being considered.

The BESS alternatives are:

BESS Specifications	
BESS Footprint	Up to 2Ha
BESS Capacity	200MWh
BESS Technology	Lithium Ion
BESS Type Alternative-Solid State Batteries	Containerised systems assembled within shipping containers and delivered to the project site. Dimensions are approximately 17 m long x 3.5 m wide x 4 m high. Containers will be placed on a raised concrete plinth (30 cm) and may be stacked on top of each other to a maximum height of approximately 15 m. Additional instrumentation, including inverters and temperature control equipment, may be positioned between the battery containers.

The 'no-go' alternative is the option of not constructing and operating a BESS in support of the authorised Renewable Energy (RE) facility. This alternative would result in no additional environmental impact other than that assessed during the EIA for the RE facility

The 'no-go' option is an option; however, this would prevent the Dwarsrug WEF from contributing to the environmental, social and economic benefits associated with the development of the renewables sector.

The above-mentioned alternatives (including 'no-go' alternative) will all be assessed by the appointed specialists as part of the BA process. All the above-mentioned location alternatives will be informed by the identified environmental sensitive and/or 'no-go' areas (i.e. status quo). The respective alternatives being considered as part of the BA process for the proposed development will also be comparatively assessed.

4. Legal Requirement and Guidelines

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

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

5. Description of the Receiving Environment

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

5.1. Climate

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

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

Weinert's climatic N-value for the site is greater than 10, approximately 18, which indicates a scarcity of water. Physical disintegration will dominate resulting in a thin gravelly residual soil and a shallow bedrock (unless covered with transported soils). This climate is conducive to the formation of pedogenic calcrete.

5.2. Topography and Drainage

The topography of the general area is flat to gentle with scattered low ridges. The assessment area is located between two such ridges, one to the north running in an east-west direction and another to the south east. Based on Google Earth elevation information, these ridges are between approximately 10 and 20 m higher than the surrounding landscape. The slope gradients with the assessment area are predominantly gently (less that 1:20) although some areas towards the ridges exceed 1:20. This implies that terracing would be required for construction in the steeper sections of the site.

The greater area is scattered with non-perennial drainage lines and features that eventually lead to either an endoreic basin, named Brakpan, in the northeast or towards the Rooiberg River in the southwest. Portions of the site seems to be located very closely to the watershed between these two drainage basins. The topographical map indicates a non-perennial drainage feature originating near the western site boundary. Concentrated overland flow is expected to occur in the valley, running in a north easterly to south westerly direction through the central section of the assessment area. The extent and detailed nature of the drainage features within the area of interest could not be confirmed in the desk study.

5.3. Seismicity

The Northern Cape can generally be considered a region with a low hazard (peak ground acceleration of 0 – 0.2m/s2). According to the Seismic Hazard Map of South Africa contained in the new South African Loading Code - 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 – 0.16g.

5.4. Bedrock Geology

According to the 1:250 000 scale geological map 3018 Loeriesfontein (2011), the bedrock geology beneath the site comprises well laminated, dark, brown and grey shale of the Tierberg Formation (designated ***Pt***), which is the upper-most formation of the Ecca Group. The planar lamination of these shales suggests settling suspension in a low-energy environment. The Tierberg Formation also supports a number of upward coarsening sequences of 2 m to 10 m thick comprising mudstone, siltstone and very fine-grained sandstone. Calcareous formations are common in the towards the top of the formation. Aerial photography indicates that the bedrock outcrops in the vicinity of the site.

The bedrock, when not outcropping, is overlain by extensive deposits of Quaternary-aged dolerite rubble (designated $\boldsymbol{Q\text{-}g_1}$), assumed to originate from dolerite sills that intruded into the shale during the Jurassic age. The local geological map indicates the BESS assessment area is underlain by the transported dolerite rubble. The area to the southwest of the site is seemingly underlain by dolerite (designated ***Jd***), which may extent to beneath the area of interest.

No faults, lineaments or other geological features are illustrated on the geological map or are visible from aerial photography.

The Permian-aged Tierberg Formation is known to contain fossils, mainly being sparse to locally concentrated assemblages of trace fossils (Johnson et al 2006). Body fossils are very rarely recorded. The volcanic rocks, namely dolerite, are not fossiliferous.

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

An extract from the 1:250 000 scale geological map 3018 Loeriesfontein is provided in Figure 5-1.

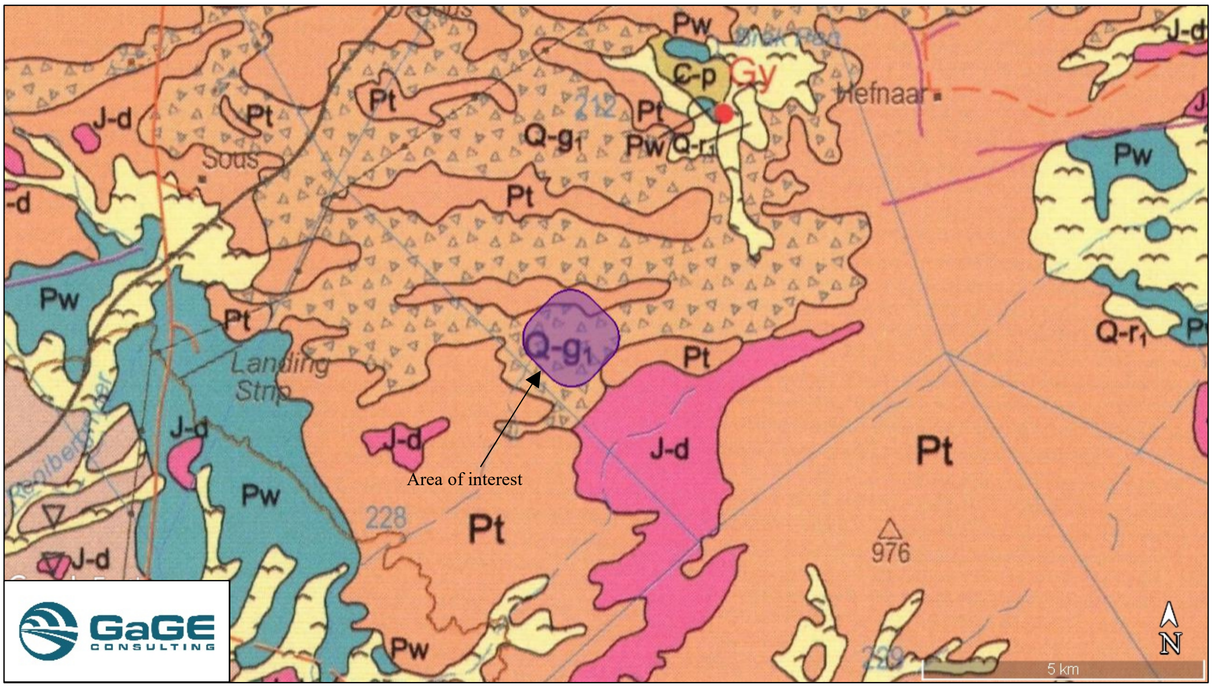

Figure 5-1 Extract of 1:150 000 scale Geological Map 3018 Loeriesfontein (Google Earth, 2020)

5.5. Engineering Geology

The shale is expected to occur from a very shallow depth below ground level (BGL). Review of the pervious geotechnical investigation in the vicinity of the site indicates that shallow refusal of the TLB occurred at approximately 0.75 m BGL on similar ground conditions indicated by the geological map. Outcropping bedrock exists in close proximity to the site, with outcropping bedrock in the southwestern portion of the site as indicated on Google Earth imagery.

The pervious investigation revealed that the bedrock, being hard rock shale and occasional soft rock sandstone, is covered by a relatively thin surface veneer, from surface to an average depth of 0.20 m BGL, that comprises sandy gravel, being sandier within the floodplains of the local streams and within the vicinity of pans. The formation of duripan (in the form of a variable calcrete horizon ranging from nodules to hardpan calcrete) developed across the site, which is characteristic of the Namaqualand soils. The calcrete existed between 0.20 m to 0.70 m BGL and possesses a medium dense to dense in-situ consistency.

Though alluvium deposits are not indicated on the geological map, the site may contain alluvial material as the site is located in a slight drainage line between low-lying outcropping shale ridges. The alluvial material in this area exhibits collapsible fabric according to pervious geotechnical investigations. 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.

5.6. Desktop Geotechnical Appraisal

Based on the desktop study, the area of interest may be divided into two Ground Units, **I** and **II,** as presented in Figure 5-2. Zone I underlays majority of the area of interest and seemingly comprises a thin surficial sandy gravel, to possibly gravelly sand, transported horizon transgressing into a variably cemented calcrete horizon that overlays soft to hard rock shale at a shallow depth. A thin surficial horizon of alluvial soils may be encountered in the base of the value, but this is unlikely to extent to depths that would significantly influence the geotechnical conditions. Zone 2 can be characterised as very shallow or outcropping bedrock (most likely to be shale) and talus deposits on the steeper slopes below the ridge.

The boundaries of the zones are approximate only and should be confirmed by intrusive investigations and survey of the slope gradients.

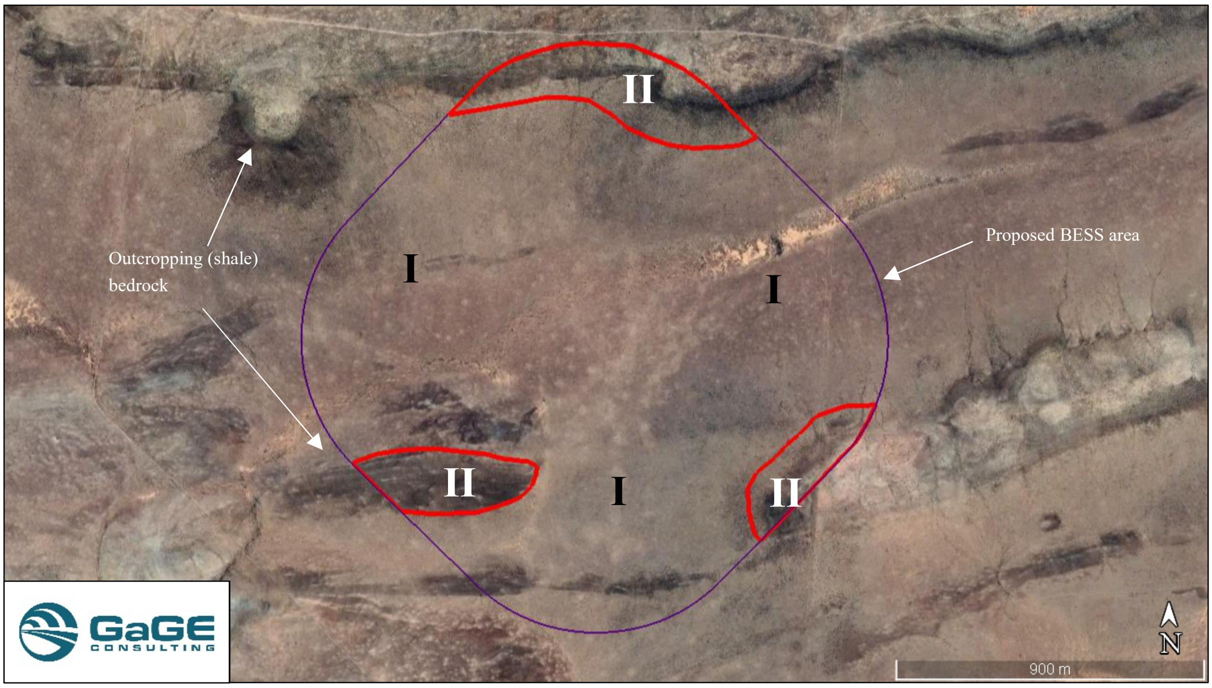

Figure 5-2 Inferred Ground Units (Google Earth, 2020)

Ground Unit I is considered suitable for the development of the BESS infrastructure, from a geotechnical viewpoint, provided that standard engineering design and construction measures are implemented to mitigate the identified geotechnical constraints.

Ground Unit II is potentially developable, but with increased geotechnical constraints. Additional earthworks would also be required to create terraces for the infrastructure and access roads. These Ground Unit II is therefore considered less suitable for development that Ground Unit I.

The anticipated geotechnical constraints and mitigation measures are summarised in Table 2-1.

Table 5-1 Summary of Geotechnical Conditions

Ground Unit	Geology	Geotechnical Conditions / Constraints	Impacts on Engineering Design and Construction
I	Fairly shallow shale bedrock covered by transported and calcrete material	• Shallow bedrock • Thin soil cover • Hard excavation conditions with depth	• Good founding conditions for structures at shallow depths • Conventional shallow foundations suitable • Conventional subgrade preparation for roads • Intermediate to hard excavation conditions for trenching / earthworks
II	Outcropping shale Talus on steep slopes	• Hard excavation conditions • Potentially unstable talus slopes	• Heavy plant machinery and blasting required for excavations (earthworks / trenching/foundations) • Terracing and slope stabilisation required

6. Identification and Assessment of Impacts

No fatal flaws have been identified that would render the proposed BESS site unsuitable from a geological and geotechnical perspective.

The BESS is containerised and the impact of the activity on the geological environment is limited to topsoil stripping, excavations for plinth foundations, trenching, the construction of access roads and associated light infrastructure. Bulk earthworks, where required for the construction of platforms and access roads on the steeper sections of the site, may be a significant impact.

6.1. Impact of the Project on the Geological Environment

The main impact of the BESS development from a geological perspective is the displacement and possible 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 BESS development on the geological environment was 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 Table 6-1, the development of the proposed BESS on the Dwarsrug WEF, 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 ridges and steep slopes. Should the activities take place with these areas of the footprint the impact will increase to “Negative Medium impact”.

The topography of the major portion of the site (excluding steeper slopes adjacent to the ridges) is gentle and significant earthworks are not anticipated in these areas. However, moderately steep slopes occur adjacent to the ridges and it is recommended that these areas are avoided (where slope gradients exceed 1:20).

The soils do not render the site particularly susceptible to soil erosion, though 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.

While shallow shale outcrop occurs on the ridges, these are not considered to be of significant geological importance.

Table 6-1 Impact Assessment Methodology Matrix

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 platform earthworks, road subgrade preparation, trenching	1	4	3	3	3	2	28	-	Med	1) Avoid ridges and steep slopes (gradients >1:20) 2) Design facility layout to minimise earthworks and levelling 3) 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	3	2	2	2	1	10	-	Low	1) Avoid ridged and steep slopes (gradients >1:20) 2) Temporary berms and drainage channels to divert surface runoff where needed 3) Landscape and rehabilitate disturbed areas timeously (e.g. regrassing) 4) Correct engineering design of road and site drainage	1	2	1	1	2	1	7	-	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
											5) Use designated access and laydown areas only to minimise disturbance to surrounding areas									
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 Soil Erosion	No cumulative effect																			

7. Comparative Assessment of Alternatives

Layout alternatives which subsequently informed the area for the potential construction of the proposed substation and subsequent BESS assessment area were identified and comparatively assessed as part of the BA process undertaken in 2016.

Alternative layouts of the BESS infrastructure within the identified assessment area will be considered. It is recommended that the ridges and areas of steeper slope gradients (>1:20) are avoided when determining the final infrastructure layout.

8. Conclusion and Summary

8.1. Summary of Findings

This desktop geotechnical specialist study was undertaken for the installation of a BESS on the Dwarsrug WEF. The assessment area is underlain by a thin surficial sandy gravel, to possibly gravelly sand, transported horizon transgressing into a variably cemented calcrete horizon that overlays soft to hard rock shale at a shallow depth. Some geotechnical constraints and sensitivities have been identified, including the presence of shallow bedrock, talus slopes and variably cemented calcrete horizon that may cause excavation difficulties. It is recommended that that the ridges and areas of steeper slope gradients (>1:20) are avoided when determining the final infrastructure layout. A survey of the slope gradients should be utilised in this regard. The remaining constraints may be mitigated via standard engineering design and construction measures.

No fatal flaws have been identified that would render the proposed BESS site unsuitable from a geological and geotechnical perspective.

The proposed BESS is assessed to have a “Negative Low impact - the anticipated impact will have negligible negative effects and will require little to no mitigation” provided that the layout of the BESS excludes development on the ridges and steep slopes. Should the activities take place with these sections of the assessment area the impact will increase to “Negative Medium impact”.

The remaining recommended 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 have been identified within or close to the BESS assessment area. However, geotechnical and geological sensitivities have been identified and these should be avoided when determining the final infrastructure layout. It is recommended that the proposed activity be authorised.

References

Brink, A.B.A. Engineering Geology of Southern Africa, Karoo Sequence, Volume 3 . Building Publications, 1983

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Appendix A. Specialist Declaration of Interest and Undertaking Under Oath

Appendix B. Specialist CV

Appendix C. Environmental Impact Assessment (EIA) Methodology