Appendix G

SPECIALIST REPORTS

Confidential

Appendix G.1

GEOTECHNICAL REPORT

Phefumula Emoyeni One (Pty) Ltd

PHEFUMULA EMOYENI ONE WIND ENERGY FACILITY

Geotechnical Assessment Report

AUGUST 2024

CONFIDENTIAL

Phefumula Emoyeni One (Pty) Ltd

PHEFUMULA EMOYENI ONE WIND ENERGY FACILITY

Geotechnical Assessment Report

REPORT (REV1) CONFIDENTIAL

PROJECT NO. 41105236

DATE: AUGUST 2024

Phefumula Emoyeni One (Pty) Ltd

PHEFUMULA EMOYENI ONE WIND ENERGY FACILITY

Geotechnical Assessment Report

WSP

Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa

Phone: +27 11 254 4800

WSP.com

CONFIDENTIAL

QUALITY CONTROL

Issue/revision	First issue	Revision 1
Remarks	Phefumula Emoyeni One Wind Energy Facility Geotechnical Assessment Final Report	Phefumula Emoyeni One Wind Energy Facility Geotechnical Assessment Final Report
Date	12 August 2024	30 August 2024
Prepared by	Khuthadzo Bulala	Khuthadzo Bulala
Signature		pp heather.davis@wsp.com 10/September/2024
Checked by	Heather Davis	Heather Davis
Signature		heather.davis@wsp.com 10/September/2024
Authorised by	Heather Davis	Heather Davis
Signature		heather.davis@wsp.com 10/September/2024
Project number	41105236	41105236
Report number	Rev 0	Rev 1
File reference	..\Rev0\41105236_RPT_WSP_Phefumula Emoyeni One WEF 550MW_Final_Rev0_20240812.docx	41105236_RPT_WSP_Phefumula Emoyeni One WEF 550MW_Final_Rev1_20240830.docx

CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

WSP Group Africa (Pty) Ltd was appointed by Phefumula Emoyeni One (Pty) Ltd to undertake a geotechnical desktop study for the proposed Phefumula Emoyeni One Wind Energy Facility (WEF) located on a site between the towns of Bethal, Ermelo and Hendrina in the Mpumalanga Province of South Africa.

The main components of the proposed development comprise a WEF, with a generating capacity of up to 550MW, an on-site Main Transmission Substation (MTS) and an overhead powerline (OHL), up to 400kV, required to connect the project to the national grid.

The objective of the desktop study is to perform a high-level assessment of the environmental impacts of the proposed WEF on the geotechnical conditions on and around the site. The geotechnical assessment is required as part of the Environmental Authorisation (EA) process.

This final report details the findings of the geotechnical desktop study undertaken for the Phefumula Emoyeni One WEF.

1.1 PROJECT DESCRIPTION

The proposed activity is defined as establishing the development of a WEF and associated infrastructure as detailed in Table 1-1.

Table 1-1 – Phefumula Emoyeni One WEF Technical Details

Component	Description
Applicant Name	Phefumula Emoyeni One (Pty) Ltd
Development	Wind energy facility
Municipality	Msukaligwa Local Municipality, Gert Sibande District Municipality
Extent	33 660ha
Buildable area	Subject to finalization based on the technical and environmental requirements
Export Capacity	Up to 550MW
Power system technology	Wind
Number of Turbines	Up to 120
Turbine Capacity	Between 6MW and 15MW each
Rotor Diameter	88m
Hub Height	Up to 200m
Hard Standing Dimensions	Approximately 75m x 120m

Component	Description
Turbine Foundations	Diameter of up to 40m per turbine – excavation up to 6 m deep, constructed of reinforced concrete to support the mounting ring. Once tower established, footprint of foundation is covered with soil.
Substations and Internal Powerlines (to form separate application for EA)	▪ 33kV cabling to connect the wind turbines to the onsite collector substations, to be laid underground where practical. ▪ 3 x 33kV/132kV onsite collector substation (IPP Portion), each being up to 5ha. ▪ Cabling between turbines, to be laid underground where practical
Internal Roads	12-13m wide roads with 12m radius turning circles, gravel surface
Operations and Maintenance (O&M) building footprint	3 x (O&M) office of approximately 1.5ha each adjacent to each collector sub station
Batching Plant	Up to 3 x batching plants of up to 7ha
BESS	▪ Battery Energy Storage System (BESS) (200MW/800MWh). Type has not been confirmed at this stage. It is proposed that all impacts related to both types be assessed in the EIA. ▪ Export Capacity of up to 200MW ▪ Total storage capacity 800MWh ▪ Storage capacity of up to 6-8 hours ▪ The BESS will be housed in containers covering a total approximate footprint of up to 5ha. ▪ Battery types to be considered: Solid State Batteries as the preferred (Lithium Ion) and Redox Flow Batteries as the alternative (Vanadium Redox).

1.2 SPECIALIST'S CREDENTIALS

The geotechnical desktop study was undertaken by an experienced professionally registered engineering geologist and the work was overseen by a professionally registered senior geotechnical engineer. The CV's for Khuthadzo Bulala and Heather Davis are included in Appendix A.

Khuthadzo Bulala is an engineering geologist with a Bachelor of Science Honors Degree from the University of Limpopo. She is registered as a Professional Scientist (Pr.Sci.Nat 116482). Khuthadzo has eight years of experience in engineering geology, geotechnical engineering, environmental geology, and soil surveys. She has extensive experience in conducting renewable energy geotechnical assessments and their detailed geotechnical investigations.

The desktop studies were reviewed and authorized by **Heather Davis**. Heather is a qualified Professional Engineer (Pr.Eng 960229) with over 40 years of experience. She obtained a BSc Honours degree in Engineering Geology and Geotechnics from the University of Portsmouth (UK) in 1982. A post graduate diploma was obtained from the University of the Witwatersrand in 1993 which focused on geotechnical engineering and rock mechanics. She is currently the geotechnical team lead at WSP. She has accumulated extensive experience in Sub Saharan Africa which has included work on Power Plants and on renewable energy projects in South Africa.

2 STUDY AREA INFORMATION

The proposed WEF site is located approximately 16km north-west of Ermelo in the Msukaligwa Local Municipality of the Gert Sibande District Municipality in the Mpumalanga Province. The site can be accessed via the N11 and existing access roads as shown in Figure 2-1. The proposed WEF will be developed within a project area of approximately 33 660 hectares. The vast majority of the WEF site is currently utilized for crop farming. The proposed WEF site will affect a total of 95 property portions across its extent including state owned land. The farms are listed in Table 2-1.

Table 2-1 – Phefumula Emoyeni One WEF Affected Farm Portions

Farm	Portion
ISRAEL 207 IS	0
BOSMANSKRANS 217 IS	0,3,4,6,7,8,9
VAALBANK 233 IS	6
KUILFONTEIN 234 IS	1,2,7,8,9,11,12,14,15,16,17,21,22,23
BOSMANSHOEK 235 IS	3
WITBANK 236 IS	2,4,5,7,10,11,13
NOOITGEDACHT 237 IS	0,2,4,5,7,8,9,10,11,12,13
ORPENSKRAAL 238 IS	0,2
GELIKSDRAAI 240 IS	1,2
ELIM 247 IS	0
KRANSPOORT 248 IS	0,2,3,4,6,8,9,10,11,12,13,18,19,21,22
TWEEFONTEIN 249 IS	1,2,3,8,9
VOORZORG 250 IS	0
NOOITGEDACHT 251 IS	0,2,5,6,7,9,10,11
SPION KOP 252 IS	1,2
UITZICHT 266 IS	4,15
DAVELFONTEIN 267 IS	7
MIDDELPLAAT 271 IS	2,3,4,5,8
DRIEHOEK 273 IS	0,1,2,3,7
SPITSKOP 276 IS	59,68
KRANSPOORT 827 IS	0

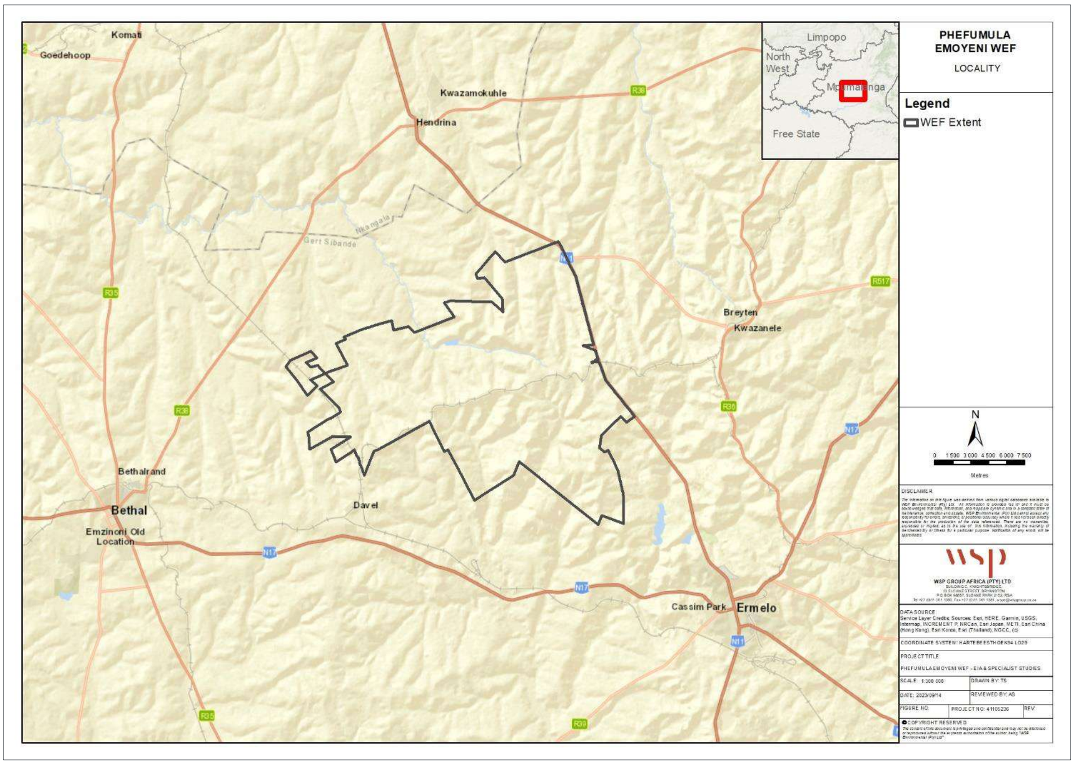

Figure 2-1 – Locality map.

3 GEOLOGY

According to the published 1: 250 000 geological map (Sheet 2628 East Rand), the study area is underlain by rocks of the Vryheid Formation (Pv), Ecca Group of the Karoo Supergroup. The Vryheid Formation comprises sandstone, shale and coal beds. The Vryheid Formation has been extensively intruded by Jurassic age dolerite (Jd). The dolerites occur both as sills and linear dyke structures that may extend over tens of kilometres. Minor areas of recent surficial deposits, alluvium, blanket areas along Klein Olifants River and Viskuile River at the north-eastern and western portions of the site, respectively.

An excerpt of the published geological map showing the project area is presented as Figure 3-1 and the lithostratigraphy is presented as Table 3-1.

Figure 3-1 – Geological Map of the Project Area

Table 3-1 – Lithostratigraphy of the Study Area

Supergroup	Group	Formation	Lithology	Map Symbol
			Alluvium	
			Dolerite	Jd
Karoo	Ecca	Vryheid	Sandstone, shale, coal beds	Pv

4 EXPECTED GROUND CONDITIONS

The turbines are underlain by different geological formations as listed in Table 4-1 below.

Table 4-1 – Geological Formations Underlying Site

Geology	Turbines
Dolerite	WTG2 – WTG6 WTG9 – WTG12 WTG14 – WTG15 WTG20, WTG23, WTG25, WTG26, WTG29, WTG31, WTG32, WTG38, WTG42, WTG45 and WTG46, WTG49 – WTG55, WTG57 – WTG58, WTG60 – WTG61 WTG66, WTG78, WTG85 and WTG88
Vryheid Formation	WTG1 WTG7 – WTG8 WTG13 WTG16 – WTG19, WTG21 – WTG22 WTG24 WTG27 – WTG28, WTG30 WTG33 – WTG37, WTG39 – WTG41, WTG43, WTG44, WTG47, WTG48, WTG56, WTG59, WTG62 – WTG64 WTG67 – WTG77 WTG79 – WTG84 WTG86 and WTG87

The plan indicating the layout of the proposed positions of the turbines, access roads and internal roads at the proposed site is presented as Figure 4-1.

4.1 VRYHEID FORMATION

Sandstone

Vryheid Formation sandstone generally weathers into sandy residual soils. Residual sandstone does not weather uniformly which often leads to dense layers being underlain by less dense layers of the same soil. In some cases, the residual sandstone may develop a potentially collapsible grain structure.

Collapsible soils exhibit additional settlement upon wetting without any change in the load. This can occur many years after construction as a result of any inundation and can even occur as a results of a broken water pipe. If recognised at investigation stage, these collapsible materials can be easily dealt with during construction with some remediation being required.

Slope stability issues can arise in areas where closely intercalated sandstones and mudrock (shale and siltstone) exist. When shales and siltstones slake or disintegrate the exposed sandstone layers are undercut, this can result in rockfalls. Intercalated siltstone layers are relatively impermeable, and impede the flow of water, which leads to pore pressure build up and sliding along the interface. This can only happen if the rock is dipping at an angle, towards the slope face, greater than the friction angle of the material.

Where material is required for the construction of roads and laydown areas, natural sandstone gravel or crushed sandstone bedrock can potentially be a suitable source. Consideration must be given to the presence of excessive pyrite and muscovite which can cause distress where sandstone is used as basecourse. In addition, where chemical stabilization is required the potential clay matrix of some sandstones make them suitable for stabilization with lime. The material quality will have to be assessed during the detailed geotechnical investigation.

Shale

Vryheid Formation shale generally weathers to a clayey residual soil which is often compressible and potentially expansive. Expansive soils are those materials that exhibit volume change with a change in moisture content. These materials “shrink” when the moisture content decreases and “heave” or “expand” when the moisture content increases. Where the residual clay profile is thinly developed, it is recommended that the material should be stripped. Where thickly developed, the structural design needs to take cognizance of the potential expansiveness and compressibility of this material.

Shale rock and excavated shale, which presents as a gravel, often deteriorates on exposure. Although shale material can be considered for use in construction, the potential for deterioration needs to be pre-determined in the laboratory. If suitable, the gravel can be used in selected layers in road construction, but seldom as base course. Gravelly shales are occasionally used in the wearing course of gravel roads but not all types are suitable.

Slope instability may occur when sliding occurs on bedding planes which are inclined sufficiently. Ingress of water into layers and the resulting high pore-water pressure plays a key role in sliding failures. This is considered highly unlikely as the strata are mostly horizontally disposed.

Coal Beds

Coal seams are present within the Vryheid Formation with a thickness ranging from centimetres to 10m but are not generally encountered at surface. A number of mines are present in the area and are discussed in Section 5.5.

4.2 DOLERITE

Generally, residual dolerite soil is relatively thickly developed above dolerite rock with the profile becoming coarser with depth. Cobbles and boulders are often present above the rock grading into gravel, sand and finally residual clay at the top of the profile. Cobbles and boulders of dolerite, however, can be present throughout the residual profile.

Residual dolerite comprising clay is generally compressible and potentially expansive in the “medium to high” range. Where a structure straddles residual dolerite and a different soil type, the structure should be moved to avoid differential settlement or designed accordingly.

Dolerite rock, cobbles, boulders and gravel are generally durable and are suitable for a variety of purposes. Dolerite rock is commonly quarried and used as a construction material such as for concrete aggregate and road construction materials.

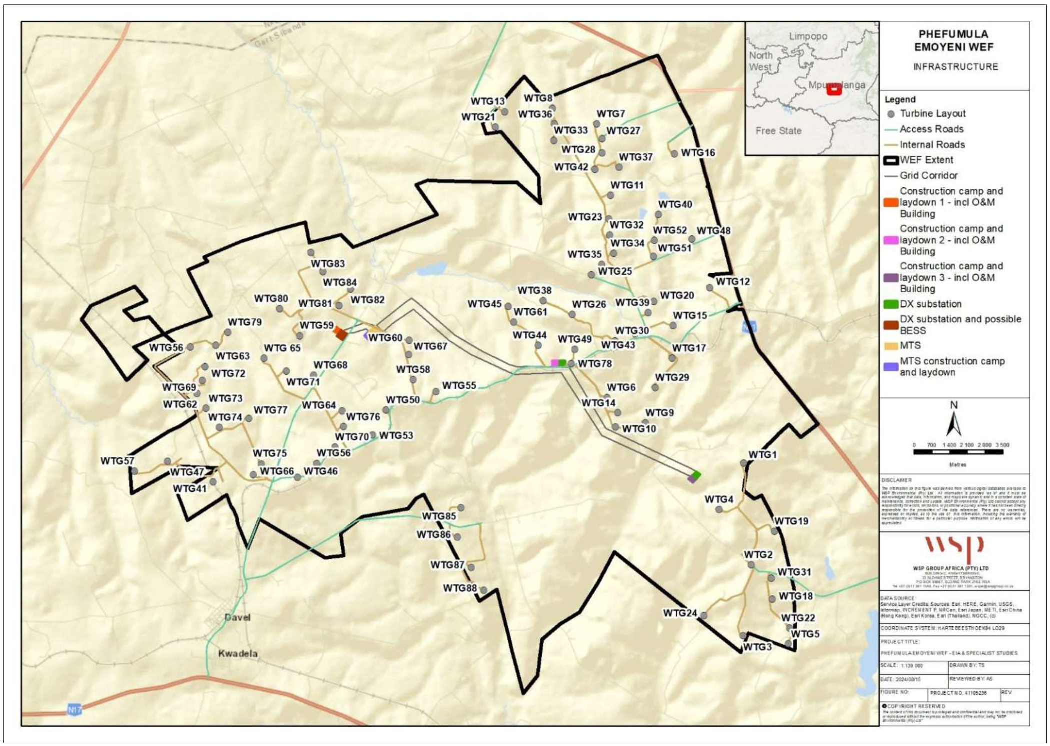

Figure 4-1 - Position of the Phefumula Emoyeni WEF Turbines

5 GEOTECHNICAL EVALUATION

5.1 PRELIMINARY FOUNDATION CONDITIONS

The proposed foundation bases have a diameter of up to 40m per turbine and are generally founded at a depth of up to 6 m deep. The turbines are relatively heavily loaded structures and have a very low tolerance for differential movement. The structures exert a static load. However, it is loading as a result of the high wind shear that drives the selection of founding medium. A high strength material is required for founding to provide sufficient bearing capacity and strength. Foundations on or in rock are recommended. This will require the depth to rock to be established and testing of the rock to provide parameters for design.

Where structures are underlain by Vryheid sandstone, rock is expected at a depth of, generally, less than 3m. Therefore, founding in rock should be possible. Where structures are underlain by shale or dolerite the residual profile may be more thickly developed with rock expected at a depth of, generally, more than 3m but less than 6m. Dolerite boulders in the profile must not be mistaken for solid dolerite rock.

It is recommended that test pits be excavated at each turbine position during the geotechnical site investigation to determine the depth to rock and the strength characteristics thereof. Some rotary cored boreholes would be required to determine the depth to rock and the rock strength with depth in, particularly, the areas underlain by shale and dolerites.

5.2 WATER PRECAUTIONS

Flooding affects flat lying areas, areas confined to drainage channels and flood plains. All the turbines are located on flat hill tops where water ponding is a possibility. Stormwater management is recommended at all flat areas to facilitate water run-off and to alleviate the possibility of standing water at the positions of foundations.

5.3 SLOPE STABILITY

Up to a depth of 3m, all excavations should be excavated at a batter of 1:1.5 in soil where no water or seepage is evident and to 1:2, or flatter, where water is encountered. Rock can be excavated at a batter of 1:0.5 or vertically in the temporary case up to a depth of 3m. Should permanent excavations or deep excavations be proposed for the site, a slope assessment will be required.

For the most part the strata of the Karoo Supergroup, in this area, are horizontally disposed. Instability is, therefore, not expected in rock slopes.

5.4 EXCAVATABILITY

The expected excavation characteristics of the soil horizons have been evaluated according to the South African Bureau of Standards standardized excavation classification for earthworks (SABS – 1200D).

The definition of the excavation classes is indicated in Table 5-1 and the assessment of the in-situ profile in Table 5-2. The ease of excavation is a critical financial factor for any development.

Table 5-1 – SABS 1200D Excavation Classes

Class of Excavation	General Definition
Soft	Excavation in material which can be efficiently removed or loaded by any of the following plant without prior ripping: A bulldozer with a mass of at least 22 tons (which includes the mass of the ripper, if fitted) and an engine developing approximately 145kW at the flywheel. Or A tractor-scraper unit with a mass of at least 28 tons and an engine developing approximately 245kW at the flywheel, pushed during loading by a bulldozer as specified for intermediate excavation. Or A track type front end loader with a mass of at least 22 tons and an engine developing approximately 140kW at the flywheel
Intermediate	Excavation (excluding soft excavation) in material which can be efficiently ripped by a bulldozer with a mass of at least 35 tons when fitted with a single tine ripper and an engine developing approximately 220kW at the flywheel.
Hard	Excavation (excluding boulder excavation) in material which cannot be efficiently ripped by a bulldozer with properties equivalent to those described for intermediate excavation. This type of excavation generally includes excavation in material such as formations of unweathered rock, which can be removed only after blasting.
Boulder Class A	Excavation in material containing in excess of 40% by volume of boulders between $0.03m^3$ and $20m^3$ in size, in a matrix of softer material or smaller boulders. Excavation of fissured or fractured rock shall not be classed as boulder excavation but as hard or intermediate excavation according to the nature of the material.
Boulder Class B	Where material contains 40% or less by volume of boulders in a matrix or soft material or smaller boulders.

Table 5-2 – Expected Excavatability on Site

Material	Excavation Class
Dolerite	Soft excavation in residual clay, sand and gravel. Boulder Class A and Boulder Class B where boulders are encountered. Hard excavation in dolerite rock
Vryheid shale and residual shale	Soft excavation in residual shale and very soft to soft rock shale. Intermediate to hard excavation in medium hard and harder rock shale.
Vryheid Sandstone and residual sandstone	Soft excavation in residual sandstone and very soft to soft rock sandstone. Intermediate to hard excavation in medium hard and harder rock sandstone.

5.5 UNDERMINING

Subsidence at surface in undermined areas is caused by the collapse and failure of the underground mining voids relatively close to the surface (Heath and Engelbrecht, 2011). The extent of coal seams in South Africa as well as the location both historical and active opencast and underground mining activities are displayed in Figure 5-1, after Heath and Engelbrecht, 2011. The following underground mines are located around the proposed site:

- Msobo Coal – 8km
- Bankfontein Colliery – 10km
- Mbuyelo Coal – 10km
- Exxaro Forzando – 13km

All of these mines have underground workings and could potentially pose undermining problems for the proposed site. Areas with roof strata composed of shale are more susceptible to gradual movements. Roof strata composed of competent sandstone are less susceptible to deformation. Gradual subsidence and sudden collapse are accompanied by surface deformation including fractures, crevices, faults, step folds and slides. The extent of any undermining below the site should be assessed, in detail, prior to development.

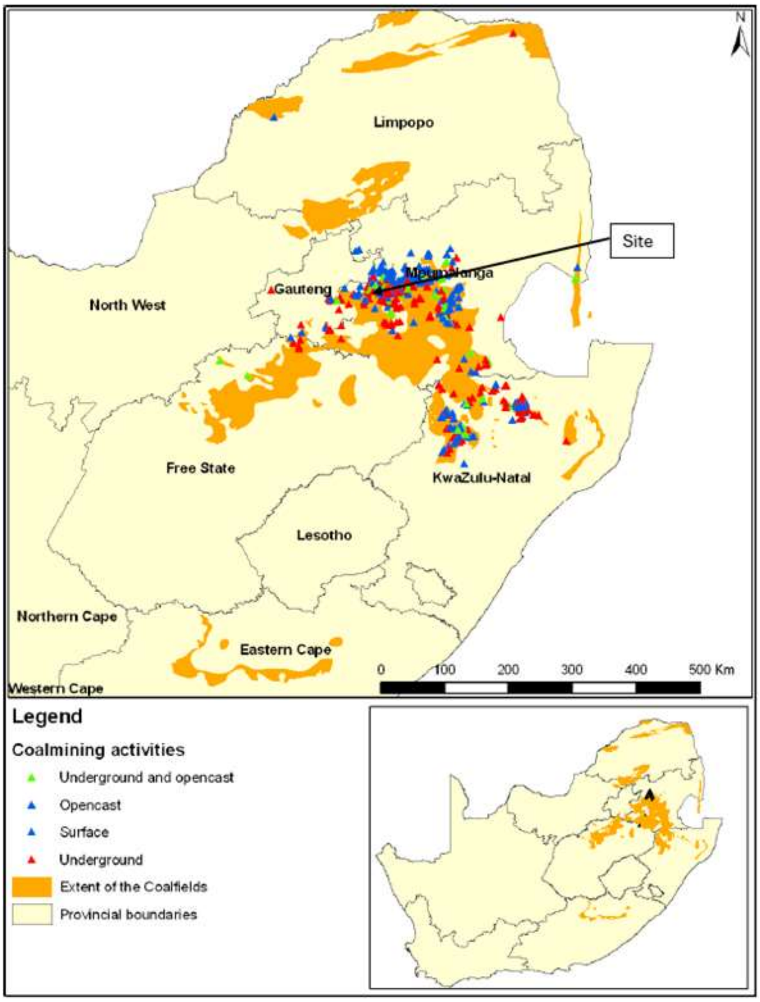

Figure 5-1 - Coal Seams in South Africa (Heath and Engelbrecht, 2011)

5.6 SEISMIC HAZARD

The southern African region is characterised by natural and mining-induced seismic activity. Data that was produced by Council for Geoscience placed the site within the zone where the minimum seismic event, with a 10% probability of being exceeded in a 50-year period, is 0.10g as illustrated in Figure 5-2. This basically suggests that the area is expected to have medium levels of seismic hazard. Most of these earthquakes will be mining induced.

There are two seismic activity zones according to SANS 10160-4 (2011):

- Zone I – Regions of natural seismic activity
- Zone II – Regions of mining-induced and natural seismic activity

In accordance with the seismic zones contained in SANS 10160-4, the site does not fall within either zone (Figure 5-3). However, the site is not located on either zone.

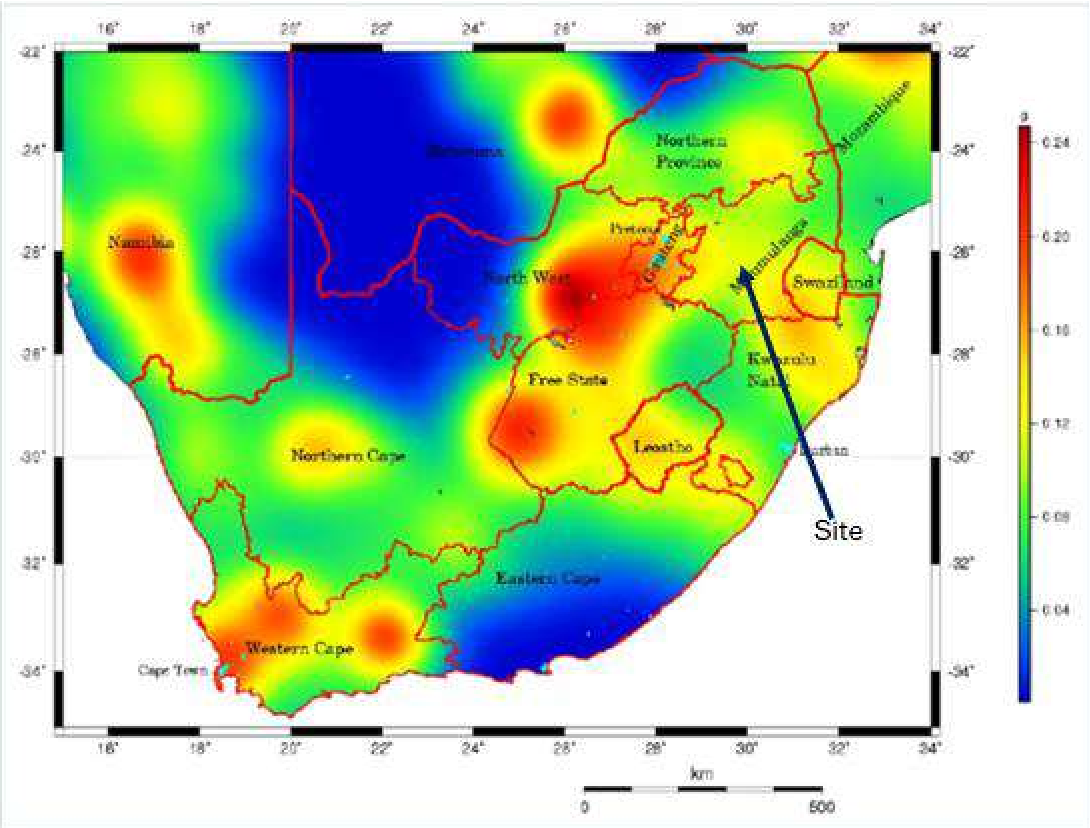

Figure 5-2 - Probabilistic seismic hazard map of South Africa

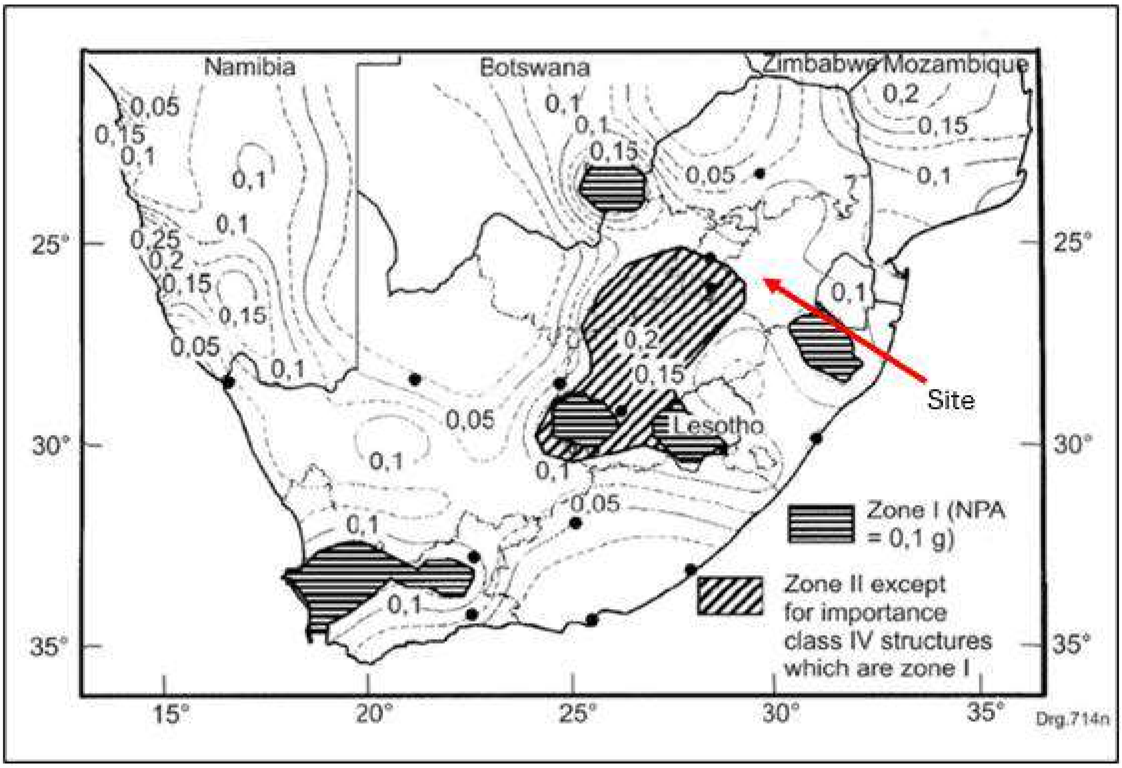

Figure 5-3 - Seismic zones of South Africa

6 FURTHER GEOTECHNICAL INVESTIGATIONS

A detailed site-specific intrusive site investigation is recommended, prior to construction, to further characterize site conditions, to better understand the key geotechnical risks characteristics and to provide input into the design.

The detailed geotechnical investigation should include:

- Determination of the founding conditions for all structures. This will require the excavation of test pits, the possible drilling of rotary cored boreholes and subsequent laboratory testing.
- Investigation of subgrade conditions for service roads.
- Investigation for materials to be used during construction.
- Non-intrusive investigation techniques, such as geophysical (seismic refraction) surveys, thermal and electrical resistivity for ground earthing requirement.

7 GEOTECHNICAL IMPACT ASSESSMENT

Geotechnical impacts need to be taken into account as part of the WEF development. The identified risks can typically be mitigated by the implementation of an appropriate and effective plan. Mitigation measures must be implemented to avoid or reduce negative impacts during the construction, operation and decommissioning phases.

Based on the impact assessment matrix undertaken for this project, from a geotechnical perspective the impact of the Phefumula Emoyeni WEF was found to be *"Negative very low to moderate impact - The anticipated impact will have negative effects and will require mitigation."* After mitigation the impact will be "*negative very low*". The assessment impact assessment matrix is presented as Appendix B.

The WEF application site is considered suitable for the proposed development provided that the recommendations presented in this report are adhered too and which need to be verified by more detailed geotechnical investigations during detailed design.

8 CONCLUSIONS

Based on WSP's geotechnical desktop study, the proposed Phefumula Emoyeni One WEF site is suitable for the operation of a wind energy facility.

A "very low to medium" negative impact was assessed, from a geotechnical perspective. Post-mitigation, the assessed impact decreases significantly to "very low."

A geotechnical site investigation must be undertaken to provide detailed geotechnical information for the design of the proposed structures and roads.

8.1 ASSUMPTIONS AND LIMITATIONS

As no site walkover of the site has been completed, there is a degree of uncertainty associated with the data reviewed as conditions may have changed since data sources were created. The uncertainty, however, is considered acceptable for the purpose of the desktop assessment stage.

Your attention is drawn to Appendix C: Document Limitations.

The statements presented in this document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimize the risks associated with the groundworks for this project. The document is not intended to reduce the level of responsibility accepted by WSP, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

9 REFERENCES

- 1:250 000 Geological Map Series (2628 East Rand). Published by the Council of Geoscience.
- Brink. A.B.A (1983). Engineering Geology of Southern Africa: The Karoo Sequence. Volume 3. Building Publications: Pretoria.
- Heath G. and Engelbrecht J. (2011). Deformation due to Mining Activities. Council for Geoscience. Report Number 2011-065.
- Kijko A., Graham G., Bejaichund M., Roblin D, Brand M.B.C., (2003). Probabilistic Peak Ground Acceleration and Spectral Seismic Hazard Maps for South Africa. Council for Geoscience. Report No. 2003-0053.
- South African National Standards 1200D: Earthworks, (1998).
- South African National Standard SANS 10160-4: 2017. Seismic action and general requirement for buildings.

Appendix A

SPECIALIST CV'S

Heather Davis

Earth & Environment, Mine Waste, Geotechnical & Material Services – Geotechnical Team Lead

CAREER SUMMARY

Over forty years of experience within the fields of geotechnical engineering and engineering geology. Most of the work has been gained in Sub Saharan Africa including South Africa, Swaziland, Botswana, Malawi, and Angola. A wide range of projects have been handled ranging from investigations for large projects such as coal fired power stations, hydroelectric power schemes, mine processing plants, major freeways and major pipelines to smaller scale projects for commercial developments and residential buildings. Forensic investigations have, also, been completed for failed tailings facilities, structures and slopes.

Responsibility has been taken for all facets of the geotechnical investigation including the site investigation planning, procurement, drilling supervision, fieldwork, in situ testing, analysis, reporting and supervision during construction. Contract documentation and administration for geotechnical investigations has, also, been handled.

Extensive experience in dolomitic terrain and was involved in the re-drafting of SANS 1936 Parts 1 and 2 and subsequent revisions to the standard. Also, involved in the ECSA feasibility study to have a specified category of registration for D4 level dolomite geo-professionals. Dolomite assessments for large facilities such as the Telkom site in Centurion, the Mispah tailings facility as well as for residential complexes and individual units have been carried out. Linear dolomitic assessments for roads and pipelines have been completed.

Heather is a registered professional engineer, a fellow of the South African Institution of Civil Engineers and served as Treasurer of the Geotechnical Division from 2006 to 2020.

2 years with WSP

40 years of experience

Area of expertise

Site Investigations

Forensic Assessments

Dolomitic Terrain Assessments

Problem Soil Assessments

Language

English – Fluent

EDUCATION

Graduate Diploma in Civil Engineering in the field of Geotechnical Engineering, University of the Witwatersrand SA	1993
BSc (Honours) Engineering Geology and Geotechnics, Portsmouth University, England	1982

PROFESSIONAL MEMBERSHIPS

ECSA – Professional Engineer, Engineering Council of South Africa – Member No. 960229	1996
SAICE - Fellow of the South African Institution of Civil Engineering	1998

PROFESSIONAL HISTORY

WSP Group Africa (Pty) Ltd	April 2022 – present

Heather Davis

Earth & Environment, Mine Waste, Geotechnical & Material Services – Geotechnical Team Lead

Jones & Wagener (Pty) Ltd (following the merger with Verdi Consulting)	January 2018 – March 2022
Verdi Consulting Engineers (Pty) Ltd	March 2014 – December 2017
AECOM SA (Pty) Ltd (formerly BKS (Pty) Ltd.	February 2007 – February 2014
ARQ (Pty) Ltd	January 2003 – January 2007
Knight Hall Hendry (Pty) Ltd	January 2001 – December 2003
VKE Engineers (Pty) Ltd	November 1987 – December 2000
National Building Research Institute of the CSIR	November 1985 – October 1987
Geological Survey of South Africa	November 1982 – October 1985

PROFESSIONAL EXPERIENCE

Western Range Iron Ore Mine Development, Liberia
2022 - 2023
Lead Geotechnical Engineer: South Africa Team
Design level geotechnical investigations for the Processing Plant, Quarries and several Tailings Residual Facilities were undertaken. The investigations included rotary core drilling, Cone Penetration testing and test pitting. All the data was analysed and assessed with recommendations provided for founding and required remedial measures. A challenging project due to the shallow water table which reaches the surface during the wet season.

Wessels and Mamotwan Mine Geotechnical Investigations, Hotazel, South Africa
2022 – 2024
Lead Geotechnical Engineer.
Geotechnical investigations carried out to allow the Mine to comply with International Standards with regard to information pertaining to the Tailings Residue Facilities (TSF). In addition, rail lines are to be constructed across the TSFs in places. Investigations including rotary core drilling, Cone Penetration Testing, test pitting and sampling of the tailings streams were undertaken. Comprehensive reports issued.

SANRAL, N1 Sections 20 and 21 Geotechnical Investigation, Brakfontein, South Africa
2008 to 2012
Lead Geotechnical Engineer
Upgrade, extensions and additions to the N1 Ben Schoeman Freeway, Sections 20 and 21, between the Brakfontein and Allandale Interchanges as part of the Gauteng Freeway Improvement Project (GFIP) carried out for South African National Roads Agency SOC Ltd (SANRAL). Contract documentation for the subsurface investigation was drafted and all components of the project management of the SANRAL contract were handled. The site investigation included extensive rotary core drilling, percussion drilling and test pitting. Work included the analysis, assessment and provision of founding recommendations for the 22km of dual carriageway. Design components included culverts, retaining walls, cut slopes, embankments and bridges founded on ancient granite, sedimentary rocks of the Pretoria Group along with dolomite and dolomitic residuum. Both conventional and piled foundations were used for the various bridge structures and elements.

SANRAL, N11 Section 9, Hendrina, South Africa
2015 to 2016
Lead Geotechnical Engineer
Upgrade of National route N11 Section 9 between Hendrina and Hendrina Power Station. Planning and supervision of the linear investigation, by means of rotary drilling and test pitting, of 18.56km of roadway including two river bridges, cuts, fills and culverts. Full report complied including recommendations for all

facets of the project. All work carried out as per the current SANRAL requirements and all contract administration for the drilling investigation handled.

SANRAL, National Route N5, between Harrismith and Kestell, Harrismith and Kestell, Orange Free State, South Africa
2011 to 2013
Lead Geotechnical Engineer
Carried out for SANRAL, which included drafting the contract documentation for the subsurface investigation which included extensive rotary core drilling and test pitting. The project includes the rehabilitation of the National Route 5 involving extending existing bridges, design and construction of new bridges and design of significant culvert structures. The bridge structures included river bridges, road over rail and road over road structures. Work carried out included supervision of the site investigation, analysis and provision of founding recommendations for all structures, contract administration and arbitration of claims.

Anglo Platinum. Mogalakwena Platinum Mine, New Northern Concentrator, Limpopo, South Africa.
2020 to 2021
Lead Geotechnical Engineer
Pre-feasibility and feasibility level investigations for the New Northern Concentrator. Supervision of all field work and provision of recommendations for all the structural elements. Additional design level investigation carried out for the M3C BOS Low Grade Stockpile.

NMPP/ Transnet, Multi Products Pipeline, Geotechnical Investigation, Johannesburg. South Africa
2008 to 2009
Section Lead Geotechnical Engineer
Geotechnical input for pipeline section running from Kendal to Waltloo and Jameson Park to Langlaagte in Johannesburg. Investigations have included test pitting; in situ testing and borehole have included test pitting, in situ testing and borehole drilling. The assessment of the route underlain by dolomite and dolomitic residuum was, also undertaken.

TCTA, Vaal River Eastern Sub-System Augmentation, Vaal, South Africa
2006 to 2008
Lead Geotechnical Investigation
Geotechnical investigation for TCTA for a pipeline to carry water from the Vaal Dam to Secunda for use by SASOL and ESKOM. Planning and preparation of contract documentation for drilling, trenching programmes, laboratory and in situ testing. Extensive field work was completed, and recommendations provided for trench sidewall stability, excavatability, construction through problem areas and recommendations for design and construction of the surge tanks, pipe bridges, abstraction works, de-silting works and access roads.

Aquarius Mining. Marikana, Mine Processing Plant, Rustenburg, South Africa
2001 to 2002
Geotechnical Engineer – Plant side
Several candidate sites and the detailed Geotechnical investigation of the final site for the processing plant for new platinum mine. Foundation recommendations for all plant elements were provided including those for silos, mills, crushers and conveyor trestles. Foundation design for large vibratory plant elements. Ongoing foundation inspections and providing geotechnical advice and recommendations to the client throughout construction.

Eskom, Medupi and Kusile Power Stations, Investigations and Foundation Assessments, Limpopo, South Africa
2008 to 2014
Lead Geotechnical engineer for AECOM
Assessment carried out for Hitachi/Eskom of existing information regarding the founding conditions. Provision of structure specific foundation recommendations which included settlement analysis, assessment of bearing capacity and determination of parameters for dynamic design. Site inspections and assessment of ground

conditions during construction for both Kusile and Medupi. Also, project manager for an additional geotechnical investigation carried out at Medupi Power Station due to unforeseen ground conditions. Investigation included percussion drilling with the Jean Lutz computerised system along with triple tube rotary drilling. Analysis of data allowing optimisation of the power station design.

Harmony Goldfields, Mispah, Tailings Storage Facility, Far West Rand
2017 to 2018
Geotechnical Team Lead
Failure of a section of the Mispah Tailings Storage Facility (TSF) which is underlain by dolomite, dolomitic residuum and rocks of the Karoo Supergroup. The initial assessment lead to the entire facility being re-assessed and candidate sites for new facilities being investigated. Of specific note was the liaison with several other geotechnical/engineering geological consulting firms regarding the failure.

Irene Village, Mall Extensions, Centurion, South Africa
2015 to 2018
Dolomite Specialist
In depth assessment of existing information applicable to the Irene Village Mall retail development in Irene. Dolomite stability assessments for extensions to the existing shopping mall including the addition of a multi-level parkade and additional retail space. Provision of founding recommendations for all facets of the development including earthworks, roadways and foundations.

Gautrans. Gautrain Project, Centurion, South Africa
2007 to 2014
Geotechnical Engineer
Input and comment on aspects of the route underlain by dolomite including the Centurion Gautrain Station were provided. Assessment of the efficacy of the remedial measures utilised at the station including an extensive programme of grouting. Also, investigation of dolomite related subsidence and a sinkhole adjacent to the Gautrain route and below a raised section of the train line in the Centurion area. Subsequent design of the remedial measures for the sinkhole, drainage measures and long-term monitoring of the area.

Africa Kingdom Holdings. Serengeti Golf and Wildlife Estate, Estate Developments, Kempton Park, South Africa
2016 to 2022
Dolomite Specialist
Dolomite stability assessments, coupled with near surface investigations, of parcels of land throughout the Serengeti Golf and Wildlife Estate. Developments have included single, double and triple storey residential units, Hotel, Club House and artificial lake. All reports have been submitted to the Council for Geoscience (CGS) and have included IHC to IHC7 conditions with Dolomite Area Designations of D2 to D4 being represented. NHBRC applications have been made for all the residential developments.

Aerosud, Manufacturing Facility, Pierre van Ryneveld Park, Centurion . South Africa
2016 to 2018
Dolomite Specialist
Various dolomite stability investigations and reviews have been undertaken for warehouses, ablution blocks, workshops, parking areas and other infrastructure elements across the Aerosud manufacturing facility. All work has, and is, being carried out according to SANS 1936 Parts 1 to 4 of 2012. A Dolomite Risk Management Plan was drafted for the Aerosud Facility and is updated on a regular basis. The site manly classifies as IHC4 to IHC7 with Dolomite Area Designation D2 and D3 being applicable to most of the site.

Khuthadzo Bulala

Earth & Environment, Mine Waste, Geotechnical & Engineering Services – Senior Consultant

CAREER SUMMARY

Khuthadzo Bulala is an Engineering Geologist with 8 years' experience in geotechnical investigations. Her experience and technical skills include:

- Compilation of geotechnical investigation reports
- Geotechnical core logging
- Core orientation for inclines boreholes
- Planning, managing, and executing in-situ testing (test-pitting, geotechnical drilling operations, DCP testing and piezometer installations) for geotechnical investigations
- Laboratory testing selection and liaison with laboratories
- Analysis and interpretation of laboratory and in-situ test data
- Geological mapping and sourcing of construction materials and aggregates
- Sourcing, testing and specification of construction materials and aggregates
- Health and safety documentation for fieldwork projects
- Project management including resource management and client liaison

3 years with WSP

Area of expertise

Geotechnical Investigations

Geotechnical Core Logging

Geotechnical Report Writing

Laboratory Sampling Selection

Geological Mapping

H&S Documentation

Project Management

8 years of experience

Language

English – Fluent

Tshivenda – Fluent

EDUCATION

BSc. (Honours) in Geological Sciences, University of Limpopo South Africa	2013
BSc. Degree in Geological Sciences, University of Johannesburg (Auckland Park Campus)	2011

ADDITIONAL TRAINING

Civil Engineering and Renewable Energy, Geopile Africa	2020
Geotubes and Dewatering, Kaytech	2019
Site Monitoring Workshop, JG Afrika	2019

Khuthadzo Bulala

Earth & Environment, Mine Waste, Geotechnical & Engineering Services – Senior Consultant

ArcGIS1, Introduction to Geographic Information System, JG Africa 2018

PROFESSIONAL MEMBERSHIPS

South African Council for Natural Professions – Pr. Sci Nat Member No. 116482 2021

PROFESSIONAL HISTORY

WSP Group Africa (Pty) Ltd	September 2021 – present
JG Afrika (Pty) Ltd	September 2016 – September 2021
Lesotho Highlands Development Agency (LHDA)	March 2016 – August 2016

PROFESSIONAL EXPERIENCE

Geotechnical Investigations

Ib vogt (Pty) Ltd, Ngonyama Solar Energy Facility Detailed Geotechnical Investigation, Bloemfontein, Free State, South Africa
March 2023 – ongoing
Engineering Geologist
Field investigation including test pitting, DCP and sampling and report writing.

South32 Mamatwan Mine, Tailings Storage Facility Geotechnical Investigation, Hotazel, Northern Cape, South Africa
January 2023 – ongoing
Engineering Geologist
Field investigation including test pitting, sampling and report writing.

Sasol Secunda Operations, Inside Ash Geotechnical Inside Ash Seepage Analysis, Secunda, Mpumalanga, South Africa
October 2022 – Ongoing
Geotechnical Desktop Study
Gap analysis and additional investigation executions plans for Inside Ash Seepage Analysis.

Enertrag South Africa (Pty) Ltd, Impumelelo Wind Energy Facility Geotechnical Desktop Study, Secunda, Mpumalanga, South Africa
October 2022 – January 2023
Field Engineering Geologist
Field investigation including test pitting, DCP and sampling. Report writing and foundation recommendation.

Enertrag South Africa (Pty) Ltd, Mukondeleli Wind Energy Facility Geotechnical Desktop Study, Secunda, Mpumalanga, South Africa
October 2022 – December 2022
Field Engineering Geologist
Field investigation including test pitting, DCP and sampling. Report writing and foundation recommendation.

Enertrag South Africa (Pty) Ltd, Vhuvhili Solar Energy Facility Geotechnical Desktop Study, Secunda, Mpumalanga, South Africa
June – August 2022
Project Management and Client Liaison

Geotechnical desktop study for the Vhuvhili Solar Energy Facility and the associated structures to supplement a project Environmental Impact Assessment.

Enertrag South Africa (Pty) Ltd, Vhuvhili Solar Energy Facility Detailed Geotechnical Investigation, Secunda, Mpumalanga, South Africa
October 2020 – July 2021
Field Engineering Geologist
Field investigation including test pitting, DCP and sampling. Report writing and foundation recommendation.

Scaw South Africa (Pty) Ltd, Union Junction Hill Borrow Pit Geotechnical Investigation, Johannesburg, South Africa
February 2022 – May 2022
Project Management and Client Liaison
Geotechnical investigation for clay lining material that is needed for the development of the landfill site for their operations and

ArcelorMittal Mine Extensions, Geotechnical Investigation, Tokadeh, Liberia
January 2022
Geotechnical Report Writing
For the ArcelorMittal facilities; Tokadeh pit, Tokadeh infrastructure, Gangra Pit, Water Storage Dam, Tailings Management Facility, and Bucanan Port.

Debswana Diamond Company, Debswana Mine Facilities, Central District, Botswana
November 2021
Geotechnical Desktop Study
Gap analysis and additional investigation executions plans for Damtshaa, Orapa and Letlhakane mine facilities.

Lesotho Highlands Development Agency (LHDA), Polihali Dam, the Diversion Tunnel and the Transfer Tunnel, Tlokeng, Lesotho
March 2016 – December 2017
Site Supervision
Drilling, water pressure tests, installation of piezometers, rotary core logging for the dam site, the saddle dam, the coffer dam, the diversion tunnel, the Katse Dam transfer tunnel and the proposed borrow pits.

Calvus Properties (Pty) Ltd, Rietfontein Dam, Eastern Cape, South Africa
May 2019 – September 2021
Project Manager
Trial pitting for the dam foundation, spillway construction and the construction material at the site. Evaluation of engineering properties of subsurface material. Geotechnical reporting for dam design purposes. Geotechnical investigation and reporting for construction material borrow pits.

Umgeni Water, Darvil Dam, Pietermaritzburg, Kwa-Zulu Natal, South Africa
August 2018 – December 2018
In-Situ Investigation
Including test pitting for geotechnical soil profiles of the proposed dam site to determine the dam foundation depth. Project management and selection of laboratory tests for study objectives subsequent to the fieldwork. Compilation of a geotechnical report for the dam design and fr the construction material.

Sivest SA (Pty) Ltd, Gluckstadt Water Supply Scheme, Tugela Ferry, Kwa-Zulu Natal, South Africa
November 2019 – March 2020
Field Geologist

Evaluation along the proposed water supply pipeline, at the proposed borehole structures and at the proposed reservoir. Assessment of geotechnical properties of potential bedding material for construction. Ntabamhlophe Tank –Responsible for the field investigation and the report writing for the proposed tank.

JG Afrika Water Division, Ntabamhlophe Tank, Wembezi, Kwa-Zulu Natal, South Africa
January – April 2021
Project Manager and Client Liaison
Field investigation including test pitting and sampling. Report writing and foundation recommendation. Foundation assessment during construction.

Scatec Solar South Africa, Kenhardt Solar Farm, Kenhardt, Northern Cape, South Africa
October 2020 - July 2021
Project and Subcontract Management
Drilling supervision, in-situ investigation for site characterization. Management and selection of laboratory tests for study objectives. Client liaison and geotechnical report for pylon foundations, substation foundation and access road construction.

Enertrag SA (Pty) Ltd, Dalmanutha Wind Energy Facility, Belfast, Mpumalanga, South Africa
December 2021 – May 2022
Project Manager and Client Liaison
Geotechnical desktop study for three wind energy facilities and their associated structures to supplement a project Environmental Impact Assessment.

G7 Renwable Energies (Pty) Ltd, Oya and Yemaya Solar and Wind Energy Facility, Maitjiesfontein, Western Cape, South Africa
August 2019 – July 2020
Geotechnical Desktop Study Reports
For the two sites for the two solar sites. Test pitting and sample selection for required tests for the Oya site. Analysing and interpreting fieldwork data and laboratory results.

Sivest SA (Pty) Ltd, Client, Koup 1 and Koup 2 Wind Energy Facility, Leeu Gamka, Western Cape, South Africa
February 201 – July 2021
Project Manager and Client Liaison
Geotechnical desktop study for two wind energy facilities and their associated structures to supplement a project Environmental Impact Assessment.

WSP Africa, Client, Three Wind Energy Facilities, Northern and Western Cape, South Africa
May – September 2021
Project Manager and Client Liaison
Project management and client liaison. Geotechnical desktop studies for the proposed Brandvalley, Karreebosch and Rietkloof wind farm energy facilities and three 33kV powerlines and their associated structures.

WSP Africa Group, Uvuvuselela Railway Line Extensions, South Africa
October 201 – December 2021
Project Manager and Client Liaison
Geotechnical desktop studies for the proposed Transnet Railway Loop extensions, Port Elizabeth Port extensions and loading yards in Gauteng.

South African National Road Agency Limited, N2 Pongola to Kangela, Kwa-Zulu Natal, South Africa
2017 – 2021
Field Geologist

Responsible for trial pitting, logging, and sample collection for laboratory analysis for the N2 construction borrow pits. Collation of field data and laboratory data.

HHO Consulting Engineers, N3 Borrow Pits, Kwa-Zulu Natal, South Africa
November 2018 – April 2019
Field Engineering Geologist
Rotary core logging and percussion chips logging for the proposed borrow pits located between Durban and Pietermaritzburg for the N3 construction.

ZVK Holdings (Pty) LtdMfulamuni Access Road and Aggregates, Pomeroy, Kwa-Zulu Natal, South Africa
January – June 20221
Project Manager andClient Liaison
Fieldwork for the realignment and the re-gravelling of the Mfulamuni access road. Ensuring adequate laboratory testing for the road and the potential borrow pits. Report compilation for the road and the material investigation.

Naidu Consulting, P77 Culverts, Dududu, Kwa-Zulu Natal, South Africa
January – July 2020
Project Manager and Client Liaison

Responsible for trial pitting, logging and DPL testing to determine the subsurface characteristics for the proposed seven culverts. Compilation of an interpretive geotechnical report highlighting the foundation depths for each culvert and the geotechnical constraints thereof.

Royal HaskoningDHV, Kikwood to Addo Borrow Pit and Retaining Walls, Kirkwood, Eastern Cape, South Africa
April – December 2019
Project Manager and Client Liaison
Soil profiling and interpretation of the field profiles and laboratory results for the borrow pit and retaining walls. Material volume calculations for the borrow pits. Dynamic cone penetration and interpretation for the competent foundations for the retaining walls. Data assimilation and assessment for report writing.

High End Construction, Eastwood Pedestrian Bridge, Pietermaritzburg, Kwa-Zulu Natal, South Africa
February – May 2019
Project Manager and Client Liaison
Construction of a pedestrian bridge. Fieldwork including test pitting and DPL testing. Analysing and interpreting the field data to recommend foundation levels.

Eskom, Refurbishment of 9 Eskom Towers, Eastern Cape, South Africa
August 2019 – September 2019
Engineering Geologist
Test pitting for geotechnical ground profiles of each site. Management and selection of laboratory tests for study objectives. Foundation recommendations for each site. Geotechnical report for design purposes.

KZN Department of Public Works, Nkweletsheni Primary School, Richmond, Kwa-Zulu Natal, South Africa
January – March 2020
Project Manager and Client Liaison
School refurbishment. Test pitting, percolation testing and DPL testing for geotechnical ground profiles of the site. Management and selection of laboratory tests for study objectives. Geotechnical report for foundations, recommendations for the soak-away and for the multipurpose sports ground.

JG Afrika (Pty) Ltd Water Department, Zwelisha Moyeni Water Treatment Works, Bergville, Kwa-Zulu Natal, South Africa

Khuthadzo Bulala

Earth & Environment, Mine Waste, Geotechnical & Engineering Services – Senior Consultant

January – March 2021
Project Manager and Client Liaison
Test pitting and DPL testing for geotechnical ground profiles of the site. Management and selection of laboratory tests for study objectives. Geotechnical report for foundations of treatment works structure founded at depth of 4-5m below NGL.

JG Afrika (Pty) Ltd Water Department, Hammersdale Waste-Water Treatment Works, Hammersdale, Kwa-Zulu Natal, South Africa
May 2020 – March 2021
Engineering Geologist
Subsurface profiling and DPL testing for the extensions to the existing Hammersdale WWTW. Analysis of the profiles and selection of laboratory tests for study objectives. Data analysis and report compilation for structure foundations.

Sultex Holdings (Pty) Ltd, Proposed Giba Industrial Development, Pinetown, Kwa-Zulu Natal, South Africa
May 2019 – July 2019
Engineering Geologist
Test pitting for soil profiling, disturbed and undisturbed sampling, delineation of groundwater seepage areas. Management and selection of laboratory tests. Analysing and interpretation of laboratory test results. Compilation of geotechnical report for foundations and groundwater management recommendations.

Smec, Cornubia Fills, Cornubia, Kwa-Zulu Natal, South Africa
March 2020 – January 2021
Project Manager and Client Liaison
In-situ testing for geotechnical soil profiles of the site and general site characterization for fills for the proposed housing development. Engineering geological report for the study for the fills. Reviewing the rotary drilling report for the client.

Mariswe (Pty) Ltd, Ward 7 Community Hall, Taylors Halt, Kwa-Zulu Natal, South Africa
January 2020 – March 2020
Project Manager and Client Liaison
Conducting the geotechnical investigation that included trial pitting, laboratory testing and percolation testing. Fieldwork and laboratory data processing for geotechnical report compilation.

Dartingo Consulting Engineers (Pty) Ltd, Mandalathi Community Hall, Kwa-Zulu Natal, South Africa
2020
Project Manager and Client Liaison
Conducting the geotechnical investigation that included trial pitting, laboratory testing and percolation testing. Fieldwork and laboratory data processing for geotechnical report compilation.

Ethekwini Municipality: Human Settlements and Infrastructure, Austerville Sites, Durban, Kwa-Zulu Natal, South Africa
February 2021 – June 2021
Project Manager and Client Liaison
In situ soil profiling and interpretation of the profiles. Consistency tests (DPL) and interpretation of the results evaluate the EASPB. Data compilation and report writing to determine the site's suitability for temporary housing development and recommending relevant foundation measures.

JG Afrika (Pty) Ltd Agricultural Engineering Division, Five ADA Rabbitry Sites, Kwa-Zulu Natal, South Africa
August 2019 – October 2019
Project Manager and Client Liaison

In situ soil profiling and interpretation of the profiles. Consistency tests (DPL) and interpretation of the results evaluate the EASPB and sample collection for laboratory analysis. Report compilation with foundation recommendations.

Private Developers, Several Intaba Ridge Estate Houses Pietermaritzburg, Kwa-Zulu Natal, South Africa
2017 – 2020
Project Manager and Client Liaison with Property Developers
In situ soil profiling, conducting in-situ consistency tests (DPL) and sampling for laboratory analysis. Report writing to determine the site's suitability for the house developments and recommending foundation depths and types as per NHBRC guidelines.

Private Developer, Student Accommodation, Pietermaritzburg, Kwa-Zulu Natal, South Africa
April 2019 – July 2019
Project Manager and Client Liaison
For the proposed three storey student accommodation development. In situ soil profiling, conducting in-situ consistency tests (DPL) and sampling for laboratory analysis. Report writing to determine the site's suitability for the housing development and recommending foundation depths and type as per NHBRC guidelines.

Green Door Environmental, 220 Murray Road Development, Pietermaritzburg, Kwa-Zulu Natal, South Africa
June 2019 – August 2019
Project Manager and Client Liaison
Report writing and field data analysis for the infill geotechnical investigation report for a multi-story development in Hayfields. The development includes a school, a shopping complex, a drive through, a petrol filling station and a residential area.

Marang Environmental and Associates (Pty) Ltd, Heidelberg Cemetery Extension, Heidelberg, Gauteng, South Africa
June 2020 – December 2020
Project Manager and Client Liaison
For the extension of the existing Heidelberg cemetery. Subsurface profiling and interpretation of the profiles. Field sampling for laboratory analysis. Geotechnical report writing and evaluating the site as per the South African Council for Geoscience Guidelines for Cemeteries.

Ziphelele Planning and Environmental Consultancy, Three Proposed Umhlathuze Cemeteries, Empangeni, Kwa-Zulu Natal, South Africa
May 2018 – February 2019
Project Manager and Client Liaison
For the development of three cemetery sites. Subsurface profiling, percolation testing and field sampling for laboratory analysis. Geotechnical report writing, evaluating and rating the sites as per the South African Council for Geoscience Guidelines for Cemetery Development.

Ziphele Planning and Environmental Consultancy, Alfred Duma Cemeteries, Ladysmith, Kwa-Zulu Natal, South Africa
June 2019 – October 2019
Project Manager and Client Liaison
For the development of cemetery sites in the municipality. Geotechnical desktop studies to evaluate and rate the proposed sites in Colenso, Ladysmith and Ezakheni. The desktop study reports were written as per the South African Council for Geoscience Guidelines for Cemeteries.

Alfred Duma Municipality, Closure of Acaciavale Landfill Site, Ladysmith, Kwa-Zulu Natal, South Africa
2018 – 2020
Engineering Geologist

Khuthadzo Bulala

Earth & Environment, Mine Waste, Geotechnical & Engineering Services – Senior Consultant

Fieldwork including test pit profiling and interpretation from test pitting and sampling for study objectives. Data analysis and report compilation for the closure of the landfill site and recommendations on closure material.

Alfred Duma Municipality, Danskraal Landfill Site, Ladysmith, Kwa-Zulu Natal, South Africa
2020
Project Manager and Client Liaison

Including GIS work to identify and shortlist potential landfill sites. Fieldwork including test pit profiling and interpretation from test pitting for landfill site development investigation. Data analysis and report compilation.

Department of Rural Development and Land Reform, UMgungundlovu Landfill Site, Pietermaritzburg, Kwa-Zulu Natal, South Africa
March 2020
Site Supervision
For the percussion drilling contract for the proposed new landfill site. Subcontractor management and client liaison. Percussion chip logging. Borehole water level and yield measurements. Hydrocensus and sampling existing boreholes in a 1km radius.

Department of Rural Development and Land Reform, Agricultural Potential Assessment for the Ground Truthing: New Irrigation Schemes Survey in Harry Gwala District, Umzimkhulu, Kwa-Zulu Natal, South Africa
July 2017 – August 2019
Project Manager and Client Liaison
Agricultural soil survey and sampling. Data analysis and report compilation for the agricultural potential and the irrigation potential of 7500ha land in the district municipality. Presentation of the final findings to the client.

Appendix B

IMPACT ASSESSMENT METHODOLOGY

IMPACT ASSESSMENT METHODOLOGY

SCOPING PHASE

REPORTING REQUIREMENTS

- Project Description
- Legislative Context (as applicable)
- Assumptions and limitations
- Description of Baseline Environment – including sensitivity mapping
- Identification and high-level screening of impacts
- Plan of Study for EIA

HIGH-LEVEL SCREENING OF IMPACTS AND MITIGATION

Appendix 2 of GNR 982, as amended, requires the identification of the significance of potential impacts during scoping. To this end, an impact screening tool has been used in the scoping phase. The screening tool is based on two criteria, namely probability; and, consequence (**Table 0-3**), where the latter is based on general consideration to the intensity, extent, and duration.

The scales and descriptors used for scoring probability and consequence are detailed in **Table 0-1** and **Table 0-2** respectively.

Table 0-1: Significance Screening Tool

		CONSEQUENCE SCALE			
PROBABILITY SCALE		**1**	**2**	**3**	**4**
	1	**Very Low**	**Very Low**	**Low**	**Medium**
	2	**Very Low**	**Low**	**Medium**	**Medium**
	3	**Low**	**Medium**	**Medium**	**High**
	4	**Medium**	**Medium**	**High**	**High**

Table 0-2: Probability Scores and Descriptors

SCORE	DESCRIPTOR
4	**Definite**: The impact will occur regardless of any prevention measures
3	**Highly Probable**: It is most likely that the impact will occur
2	**Probable**: There is a good possibility that the impact will occur

The Pavilion, 1st Floor
Cnr Portswood and Beach Road, Waterfront
Cape Town, 8001
South Africa

T: +27 21 481 8700
F: +086 606 7121
www.wsp.com

1	**Improbable:** The possibility of the impact occurring is very low

Table 0-3: Consequence Score Descriptions

SCORE	NEGATIVE	POSITIVE
4	Very severe: An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated.	Very beneficial: A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit.
3	Severe: A long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming or some combination of these.	Beneficial: A long term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these.
2	Moderately severe: A medium to long term impacts on the affected system(s) or party (ies) that could be mitigated.	Moderately beneficial: A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way.
1	Negligible: A short to medium term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary.	Negligible: A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.

The nature of the impact must be characterised as to whether the impact is deemed to be positive (+ve) (i.e. beneficial) or negative (-ve) (i.e. harmful) to the receiving environment/receptor. For ease of reference, a colour reference system (**Table 0-4**) has been applied according to the nature and significance of the identified impacts.

Table 0-4: Impact Significance Colour Reference System to Indicate the Nature of the Impact

Negative Impacts (-ve)	Positive Impacts (+ve)
Negligible	**Negligible**
Very Low	**Very Low**
Low	**Low**
Medium	**Medium**
High	**High**

EIA PHASE

REPORTING REQUIREMENTS

- Project Description
- Legislative Context (as applicable)
- Assumptions and limitations
- Description of methodology (as required)
- Update and/or confirmation of Baseline Environment – including update and / or confirmation of sensitivity mapping
- Identification and description of Impacts
- Full impact assessment (including Cumulative)
- Mitigation measures
- Impact Statement

ASSESSMENT OF IMPACTS AND MITIGATION

The assessment of impacts and mitigation evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the risk assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct[1], indirect[2], secondary[3] as well as cumulative[4] impacts.

A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria[5] presented in **Table 0-5**.

Table 0-5: Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes

[1] Impacts that arise directly from activities that form an integral part of the Project.
[2] Impacts that arise indirectly from activities not explicitly forming part of the Project.
[3] Secondary or induced impacts caused by a change in the Project environment.
[4] Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.
[5] The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very low**	**Low**	**Moderate**	**High**	**Very High**

IMPACT MITIGATION

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development's actual extent of impact and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this report.

The mitigation measures chosen are based on the mitigation sequence/hierarchy which allows for consideration of five (5) different levels, which include avoid/prevent, minimise, rehabilitate/restore, offset and no-go in that order. The idea is that when project impacts are considered, the first option should be to avoid or prevent the impacts from occurring in the first place if possible, however, this is not always feasible. If this is not attainable, the impacts can be allowed, however they must be minimised as far as possible by considering reducing the footprint of the development for example so that little damage is encountered. If impacts are unavoidable, the next goal is to rehabilitate or restore the areas impacted back to their original form after project completion. Offsets are then considered if all the other measures described above fail to remedy high/significant residual negative impacts. If no offsets can be achieved on a potential impact, which results in full destruction of any ecosystem for example, the no-go option is considered so that another activity or location is considered in place of the original plan.

The mitigation sequence/hierarchy is shown in **Figure 1** below.

Avoidance / Prevention	Refers to considering options in project location, nature, scale, layout, technology and phasing to **avoid** environmental and social impacts. Although this is the best option, it will not always be feasible, and then the next steps become critical.
Mitigation / Reduction	Refers to considering alternatives in the project location, scale, layout, technology and phasing that would **minimise** environmental and social impacts. Every effort should be made to minimise impacts where there are environmental and social constraints.
Rehabilitation / Restoration	Refers to the **restoration or rehabilitation** of areas where impacts were unavoidable and measure are taken to return impacted areas to an agreed land use after the activity / project. Restoration, or even rehabilitation, might not be achievable, or the risk of achieving it might be very high. Additionally it might fall short of replicating the diversity and complexity of the natural system. Residual negative impacts will invariably still need to be compensated or offset.
Compensation / Offset	Refers to measures over and above restoration to remedy the residual (remaining and unavoidable) negative environmental and social impacts. When every effort has been made to avoid, minimise, and rehabilitate remaining impacts to a degree of no net loss, **compensation / offsets** provide a mechanism to remedy significant negative impacts.
No-Go	Refers to 'fatal flaw' in the proposed project, or specifically a proposed project in and area that cannot be offset, because the development will impact on strategically important ecosystem services, or jeopardise the ability to meet biodiversity targets. This is a **fatal flaw** and should result in the project being rejected.

Figure 1: Mitigation Sequence/Hierarchy

Project Name	41105236 - Phefumula Emoyeni Wind Energy Facility Geotechnical Impact Assessment

Impact Assessment

CONSTRUCTION

Impact number	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation (M+	E+	R+	D)x	P=	S	Rating	Post-Mitigation (M+	E+	R+	D)x	P=	S	Rating	Mitigation Measures
Impact 1:	Soil Erosion	• Increased stormwater velocity. • Increase in soil and wind erosion due to clearing of vegetation. • Creation of drainage paths along access tracks. • Sedimentation of non-perennial features and excessive dust.	Construction	Negative		3	3	3	3	4	**48**	**N3**	2	1	1	2	2	**12**	**N1**	• Rehabilitation of affected areas (such as revegetation). • Construction of temporary berms and drainage channels to divert surface water. • Minimize earthworks and fills. • Use existing road network and access tracks. • Correct engineering design and construction of gravel roads and water crossings. • Control stormwater flow.
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 2:	Oil Spillages	Contamination of ground and surface water resources from heavy plant leading to quality deterioration of the water resources.	Construction	Negative		3	3	3	3	4	**48**	**N3**	2	2	1	1	2	**12**	**N1**	• Vehicle and construction machinery repairs to be undertaken in designated areas with proper soil protection. • Frequent checks and conditional monitoring
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 3:	Disturbance of fauna and flora	The displacement of natural earth material and overlying vegetation leading to erosion.	Construction	Negative		3	1	3	3	3	**30**	**N2**	2	1	1	2	2	**12**	**N1**	Limit and control excavations
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 4:	Slope stability	Slope instability around structures.	Construction	Negative		2	1	3	3	2	**18**	**N2**	1	1	3	2	2	**14**	**N1**	• Avoid steep slope areas. • Design cut slopes according to detailed geotechnical analysis.
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 8:	Seismic activity	Damage of proposed development.	Construction	Negative		4	1	3	4	1	**12**	**N1**	2	1	3	3	1	**9**	**N1**	Design according to expected peak ground acceleration.
					Significance	**N1 - Very Low**							**N1 - Very Low**							

OPERATIONAL

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation (M+	E+	R+	D)x	P=	S		Post-Mitigation (M+	E+	R+	D)x	P=	S		
Impact 1:	Seismic activity	Damage of proposed development.	Operational	Negative		4	1	3	4	1	**12**	**N1**	2	1	3	3	1	**9**	**N1**	Monitor seismic activity in the area
					Significance	**N1 - Very Low**							**N1 - Very Low**							

DECOMISSIONING

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation (M+	E+	R+	D)x	P=	S		Post-Mitigation (M+	E+	R+	D)x	P=	S		
Impact 1:	Soil Erosion	• Increase in soil and wind erosion due to clearance of structures. • Displacement of soil and damage to vegetation by vehicles	Decommissioning	Negative		4	2	3	3	4	**48**	**N3**	2	1	1	2	2	**12**	**N1**	• Use existing road network and access tracks. • Use of temporary berms and drainage channels to divert surface water. • Minimize earthworks and demolish footprints. • Rehabilitation of affected areas (such as revegetation). • Reinstate channelized drainage features. • Strip, stockpile and re-spread topsoil
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 2:	Oil spillages	• Potential oil spillages due to clearance of structures.	Decommissioning	Negative		3	3	3	3	4	**48**	**N3**	2	1	3	1	2	**14**	**N1**	• Vehicle and construction machinery repairs to be undertaken in designated areas with proper soil protection. • Frequent checks and conditional monitoring
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 3:	Disturbance of fauna and flora	The displacement of natural earth material and overlying vegetation leading to erosion.	Decommissioning	Negative		3	1	3	3	3	**30**	**N2**	2	1	1	2	2	**12**	**N1**	Limit excavation
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 4:	Slope stability	Slope instability around structures.	Decommissioning	Negative		2	1	3	3	2	**18**	**N2**	1	1	3	2	2	**14**	**N1**	• Avoid steep slopes areas. • Design cut slopes according to detailed geotechnical analysis.
					Significance	**N2 - Low**							**N1 - Very Low**							

CUMULATIVE

Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation							Post-Mitigation							
						(M+	E+	R+	D)x	P=	S		(M+	E+	R+	D)x	P=	S		
Impact 1:	Erosion	The displacement of natural earth material and overlying vegetation leading to: • Exposure of upper soil layer. • Increase in stormwater velocity. • Soil washed downslope into drainage channels leading to sedimentation. •The erosion of these slopes will be exacerbated during periods of heavy rainfall.	Cumulative	Negative		3	2	3	3	4	**44**	**N3**	2	1	1	2	2	**12**	**N1**	• Use existing road network and access tracks. • Use of temporary berms and drainage channels to divert surface water. • Minimize earthworks and demolish footprints. • Rehabilitation of affected areas (such as revegetation). • Develop a chemical spill response plan. • Reinstate channelized drainage features.
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 2:	Potential Oil Spillages	Contamination of ground and surface water resources from heavy plant leading to quality deterioration of the water resources.	Cumulative	Negative		3	3	3	3	4	**48**	**N3**	2	1	3	1	2	**14**	**N1**	• Vehicle and construction machinery repairs to be undertaken in designated areas with proper soil protection. • Frequent checks and conditional monitoring
					Significance	**N3 - Moderate**							**N1 - Very Low**							
Impact 3:	Disturbance of fauna and flora	The displacement of natural earth material and overlying vegetation leading to erosion.	Cumulative	Negative		3	1	3	3	3	**30**	**N2**	2	1	1	2	2	**12**	**N1**	Limited excavations
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 4:	Slope stability	Slope instability around structures.	Cumulative	Negative		2	1	3	3	2	**18**	**N2**	1	1	3	2	2	**14**	**N1**	• Avoid steep slopes areas. • Design cut slopes according to detailed geotechnical analysis.
					Significance	**N2 - Low**							**N1 - Very Low**							
Impact 5:	Seismic activity	Damage of proposed development.	Cumulative	Negative		4	1	3	4	1	**12**	**N1**	2	1	3	3	1	**9**	**N1**	Design according to expected peak ground acceleration.
					Significance	**N1 - Very Low**							**N1 - Very Low**							

Appendix C

DOCUMENT LIMITATIONS

DOCUMENT LIMITATIONS

This document has been provided by WSP Group Africa Pty Ltd ("WSP") subject to the following limitations:

i) This Document has been prepared for the particular purpose outlined in WSP's proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.

ii) The scope and the period of WSP's Services are as described in WSP's proposal, and are subject to restrictions and limitations. WSP did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by WSP in regard to it.

iii) Conditions may exist which were undetectable given the limited nature of the enquiry WSP was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

iv) In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. WSP's opinions are based upon information that existed at the time of the production of the Document. It is understood that the Services provided allowed WSP to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

v) Any assessments made in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

vi) Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by WSP for incomplete or inaccurate data supplied by others.

vii) The Client acknowledges that WSP may have retained sub-consultants affiliated with WSP to provide Services for the benefit of WSP. WSP will be fully responsible to the Client for the Services and work done by all its sub-consultants and subcontractors. The Client agrees that it will only assert claims against and seek to recover losses, damages or other liabilities from WSP and not WSP's affiliated companies. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any legal recourse, and waives any expense, loss, claim, demand, or cause of action, against WSP's affiliated companies, and their employees, officers and directors.

viii) This Document is provided for sole use by the Client and is confidential to it and its professional advisers. No responsibility whatsoever for the contents of this Document will be accepted to any person other than the Client. Any use which a third party makes of this Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party because of decisions made or actions based on this Document.

Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa

wsp.com

CONFIDENTIAL