

Appendix H.10

GEOTECHNICAL DESKTOP STUDY





Igolide Wind (Pty) Ltd

IGOLIDE WIND ENERGY FACILITY

Geotechnical Desktop Study





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Geotechnical Desktop Study

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1 INTRODUCTION

WSP Group Africa (Pty) was appointed by Igolide Wind (Pty) Ltd to undertake a geotechnical desktop study for the proposed Igolide Wind Energy Facility (WEF) in the West Rand of Gauteng.

The main objective of the desktop study is to perform a general assessment of the impacts of the proposed WEF development on the geotechnical conditions on and around the site. This geotechnical assessment will form part of the Environmental Impact Assessment (EIA).

The associated grid for the proposed Igolide WEF forms part of a separate application and has thus not been considered in the cumulative impact assessment.

This report presents the findings from the geotechnical desktop study.

1.1 PROJECT DESCRIPTION

A layout of the proposed development area is shown in Figure 1-1 and the project details are outlined in Table 1-1.

Figure 1-1 - Project layout

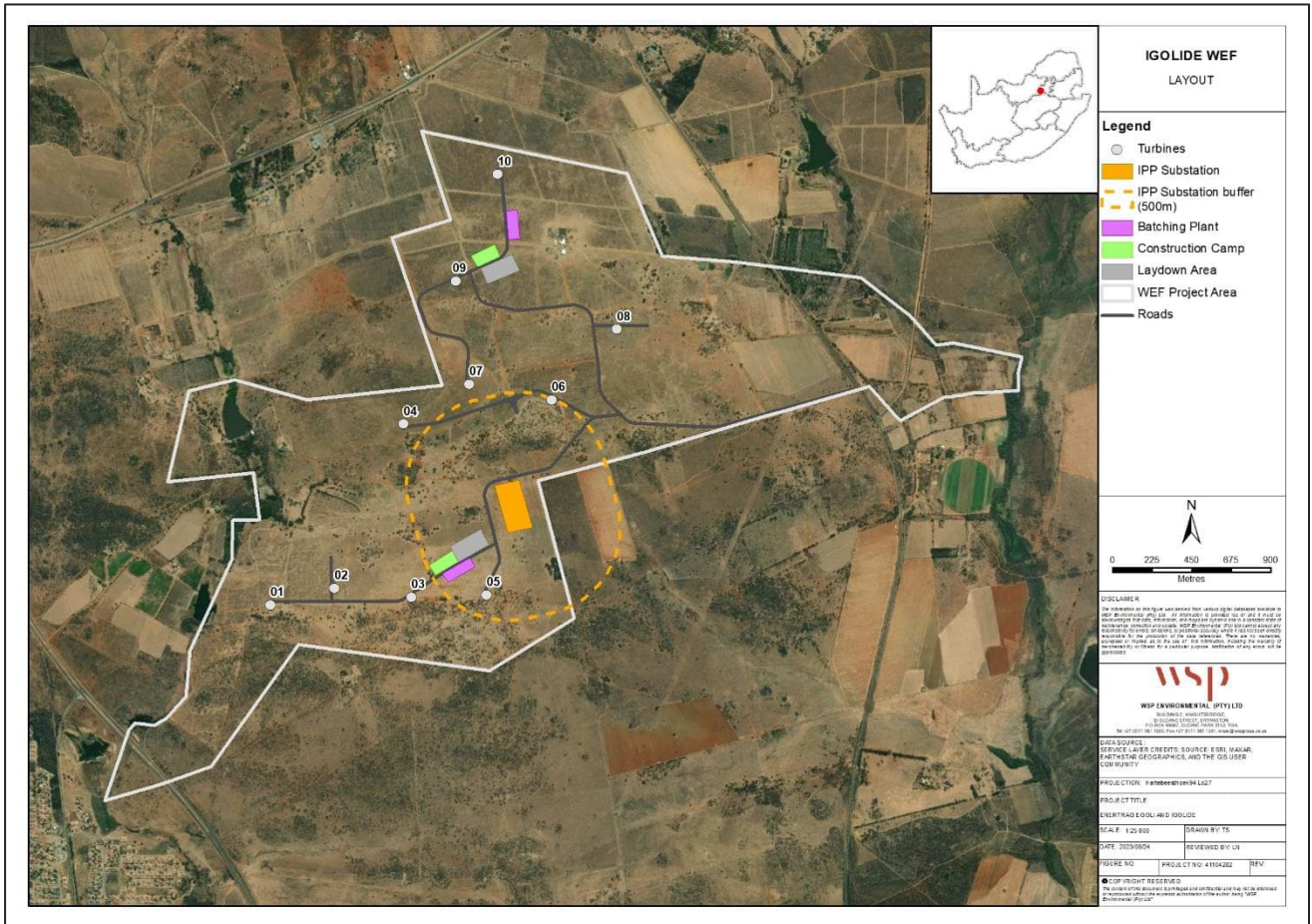


Table 1-1 – Igolide WEF project description

Component	Description
Development	Wind Energy Facility (WEF)
Municipality	Merafong City Local Municipality in the Gauteng Province of South Africa
Extent	680 hectares (ha)
Footprint	50 hectares (ha)
Capacity	Up to 100MW
Number of turbines	Ten (10)
Turbine hub height	Up to 200m
Rotor Diameter	Up to 200m
Tip Height	Up to 300m
Foundation	Approximately 25m diameter x 3m deep. Volume to be excavated will be approximately 2 200m ³ , in sandy soils due to access requirements and safe slope stability requirements.
Turbine Hardstand	Hardstand does not require concrete. Area required will be approximately 1 hectare (ha) per turbine.
Tower Type	Steel or concrete towers can be utilised at the site. Alternatively, the towers can be of a hybrid nature, comprising concrete towers and top steel sections.
On-site IPP substation and battery energy storage system (BESS)	<p>The total footprint for the on-site substation, including the BESS, will be up to 2.5 hectares (ha) in extent.</p> <p>The on-site IPP portion substation will consist of a high voltage substation yard to allow for multiple up to 132kV feeder bays and transformers, control building, telecommunication infrastructure, and other substation components, as required. A 500m buffer around the on-site IPP substation has been identified to ensure flexibility in routing the powerline.</p> <p>The BESS storage capacity will be up to 100/400 megawatt-hour (MWh) with up to four hours of storage. It is proposed that Lithium Battery Technologies, such as Lithium Iron Phosphate, Lithium Nickel Manganese Cobalt oxides or Vanadium Redox flow technologies will be considered as the preferred battery technology; however, the specific technology will only be determined following Engineering, Procurement, and Construction (“EPC”) procurement. The main components of the BESS include the batteries, power conversion system and transformer which will all be stored in various rows of containers. The BESS components will arrive on site pre-assembled.</p>

Component	Description
Grid (to form part of a separate application for EA)	<p>A single or double circuit 132kV overhead powerline and 132kV switching station (with a footprint of 1.5ha, to be located adjacent to the on-site IPP substation) to feed the electricity generated by the proposed WEF into Eskom's Midas Main Transmission Substation via a 11km overhead line.</p> <p>A corridor of up to 250m in width (125m on either side of the centre line) has been identified for the placement of the up to 132kV single or double circuit power line to allow flexibility in the design of the final powerline route, and for the avoidance of sensitive environmental features (where possible).</p>
Cables	<p>The medium voltage collector system will comprise cables up to and including 33kV that run underground, except where a technical assessment suggests that overhead lines are required, connecting the turbines to the on-site IPP substation.</p>
Operations and maintenance (O & M) building footprint	<p>Operations and Maintenance ("O&M") building footprint will be located near the on-site substation. Typical areas include:</p> <ul style="list-style-type: none"> ■ Operations building – 20m x 10m = 200m² ■ Workshop and stores area – of ~300m² ■ Refuse area for temporary waste storage and conservancy tanks to service ablution facility. <p>The total combined area of the buildings will not exceed 5 000m².</p>
Construction camps	<p>The construction camp will house the contractor offices, ablution facilities, mess area, etc., and will have a footprint of 1 hectare (ha). The construction camp will be demolished after commercial operations date and the area rehabilitated.</p>
Temporary laydown or staging areas	<p>The laydown area will be used for the storage of equipment or components that will be incorporated into the facility (such as electrical cables) as well as non-facility related equipment and components such as shipping frames, concrete shuttering, etc. The laydown area will also be used for the storage (and filling of vehicles) of diesel fuel.</p> <p>The laydown area will have a footprint of up to 2 hectares (ha), which could increase to 3 hectares (ha) for concrete towers, should they be required. The laydown area will be demolished after commercial operations date and the area rehabilitated.</p>
Cement batching plant, wind tower factory and yard (Temporary)	<p>The cement batching plant will be used to mix and blend cement, water, sand and aggregates to form quality concrete to be used for foundations. The cement batching plant will have a footprint of 1 hectare (ha).</p>
Access and internal roads	<p>Access and internal roads will have a width of 8m - 10m, increasing up to 20m for turning circle/bypass areas to allow for larger component transport. The access and internal roads will be placed within a corridor of up to 20m width to accommodate cable trenches, stormwater channels and turning circle/bypass areas of up to 20m.</p> <p>Existing access roads will be used where possible to minimise impact. Where required, the width of the existing roads will be widened to ensure the passage of vehicles.</p>

Component	Description
Supporting Infrastructure	Fencing Lightning protection Stormwater channels Offices Operations and maintenance area / warehouse / workshop Gatehouse Visitor's centre Lighting Telecommunication infrastructure Water pipelines Operational control centre Ablution facilities Security building Substation building
Site coordinates (centre point)	26°27'2.44"S, 27°30'58.82"E
Affected farm portion/s	Portions 14, 20 and RE/22 of the Farm 147 Kraalkop Portion 8, 57, 65 and 66 of the Farm 356 Leeuwpoot

1.2 SCOPE OF WORK

The scope of work is limited to a desktop study and interpretive reporting on the findings. The desktop study included the following:

- Literature reviews of available published and unpublished information including, but not limited to, geological data, geological maps, topographical maps, aerial images, and any existing geotechnical investigation reports of the study area.
- Assessment of the relevant geotechnical and geological information and to indicate any fatal flaws within the study area.
- Assessment of the excavation conditions across the sites.
- Site reconnaissance.

1.3 SPECIALIST CREDENTIALS

The geotechnical desktop study was undertaken by a geotechnical engineer and the work was overseen by a professionally registered senior geotechnical engineer. Nthabiseng Mashego is a geotechnical engineer with a Bachelor of Engineering degree in Civil Engineering and an Honours degree in Geotechnical Engineering from the University of Pretoria. Nthabiseng has two years of experience in geotechnical engineering including geotechnical site investigations.

The desktop assessment was reviewed and authorized by Heather Davis. Heather is a qualified Professional Engineer (Pr.Eng 960229) with 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. Her responsibilities include providing geotechnical inputs to various projects, quality assurance on all geotechnical work and provision of reports. She has accumulated extensive experience in Sub Saharan Africa which has included work on the Medupi and Kusile Power Plants and on renewable projects such as the Sere Wind Farm, for Eskom, in the Northern Cape.

The CV's for Nthabiseng Mashego and Heather Davis are included in APPENDIX A.

2 STUDY AREA INFORMATION

The proposed Igolide WEF is located approximately 5km northeast of Fochville in the West Rand area of Gauteng. The site can be accessed via the National Road, N12, and the Regional Road, R500. The location of the site is indicated on Figure 2-1.

The site is situated on a game farm characterised by short grass and trees. Some game animals were observed during the site reconnaissance. There are gravel roads on the farm that lead directly to the wind turbine positions.

The Fochville area receives a Mean Annual Precipitation (MAP) of 711mm with the highest precipitation occurring during the month of December and the lowest during the month of June. The area experiences a Mean Annual Evaporation of 1454mm which is approximately double the MAP (Kongiwe, 2021). The area experiences its hottest temperatures during the months of January and December, with temperatures reaching an average of 28°C.

The site terrain consists of rolling hills with an overall elevation range between 1496m and 1642m and an average slope of approximately 3.4%. However, as indicated in Figure 2-2 the wind turbine positions are situated on relatively flat terrain.



Figure 2-1 - Location of the Igolide WEF

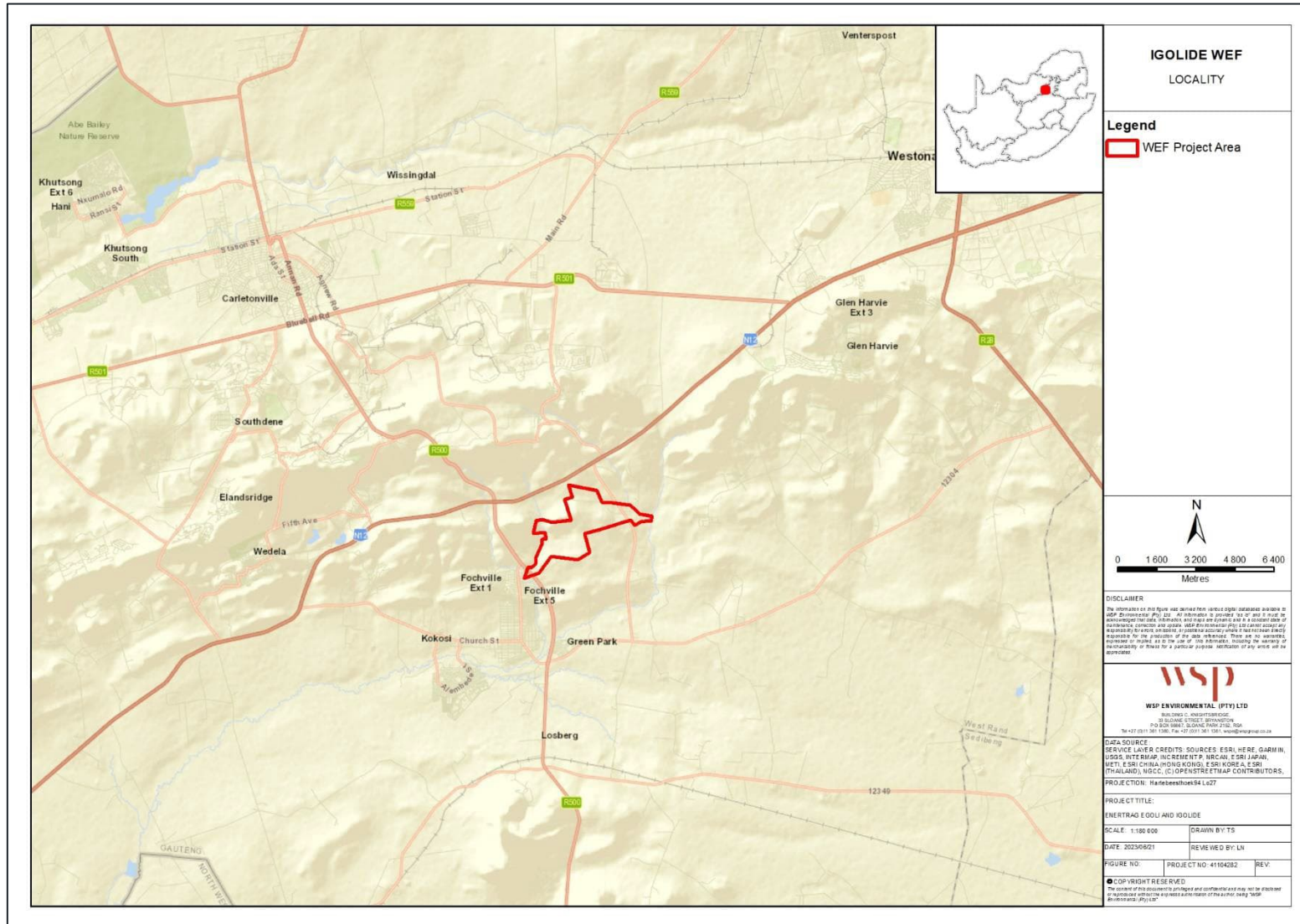


Figure 2-2 – Terrain at the turbine positions



3 GEOLOGY

According to the published 1:250 000 geological map, Sheet 2626 West Rand, the study area is underlain by rocks of the Strubenkop Shale, Hekpoort Andesite and Timeball Hill Formations of the Pretoria Group, which forms part of the Transvaal supergroup. An excerpt of the published geological map showing the project area is represented in Figure 3-1 and the lithostratigraphy is presented in Table 3-1.

The geological map indicates that most of the site is underlain by the Hekpoort Andesite Formation, a volcanic suite, which comprises andesite, agglomerate and tuff. The northeast portion of the site is underlain by the Timeball Hill Formation which comprises ferruginous shale, hornfels and ferruginous quartzite. Only a small portion on the southwestern portion of the site is underlain by the Strubenkop Shale Formation which comprises ferruginous shale and quartzite.

The regional dip of the rocks in the vicinity of the Igolide WEF is approximately 20° to the south as shown in Figure 3-2 as taken from a paper by Abbot D and Ferguson (1961) citing work done by Bisschoff AA (1962) and Borchers R (1961) .

Figure 3-1 - Regional geology of the area

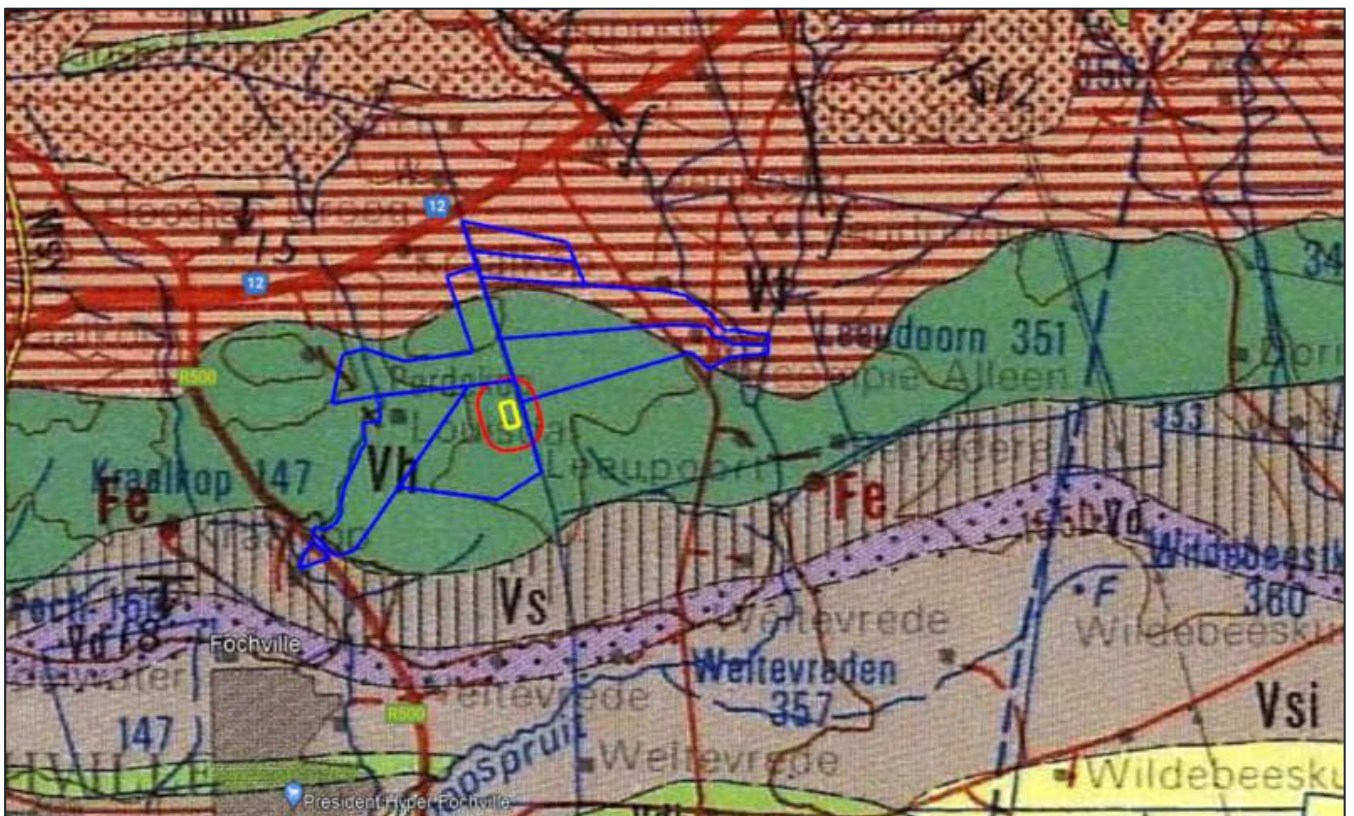
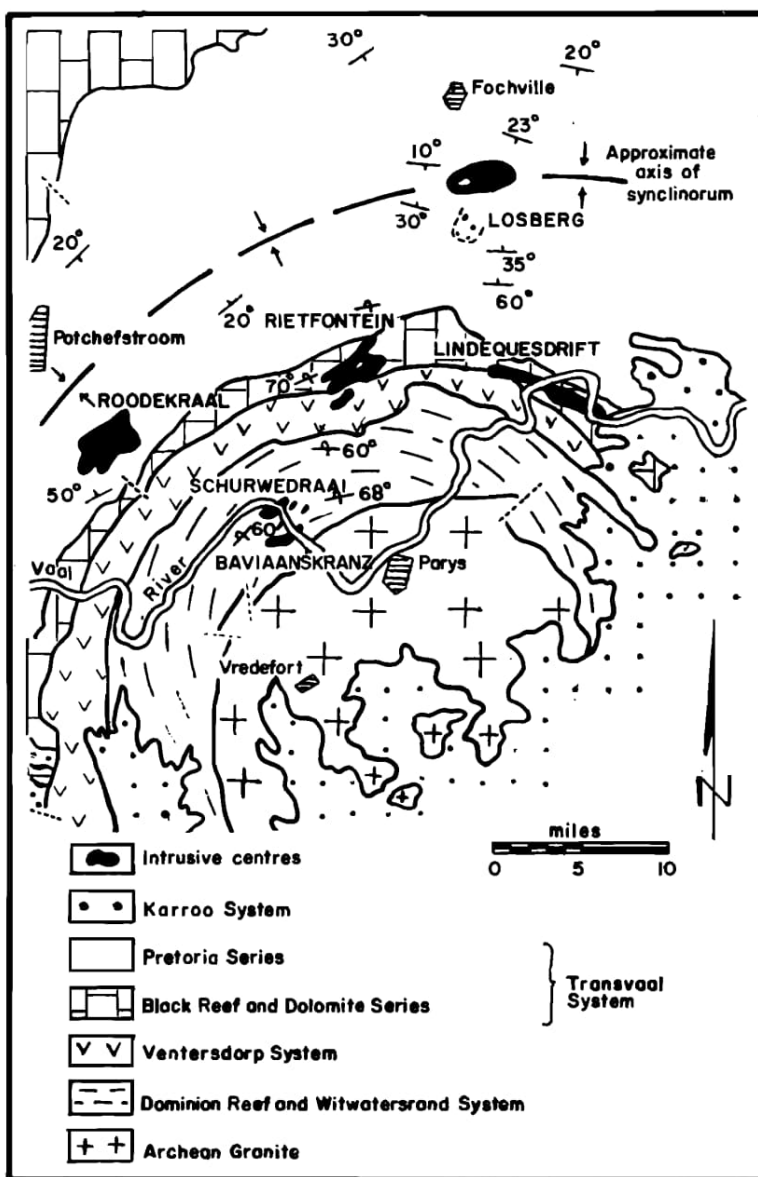


Table 3-1 – Lithostratigraphy of the area

Supergroup	Group	Formation	Lithology	Map Symbol
Transvaal	Pretoria	Strubenkop Shale	Ferruginous Shale, Quartzite	Vs
		Hekpoort Andesite	Andesite, Agglomerate, Tuff	Vh
		Timeball Hill	Ferruginous shale, Hornfels, Ferruginous Quartzite	Vt

Figure 3-2 - Geology north of the Vredefort Dome



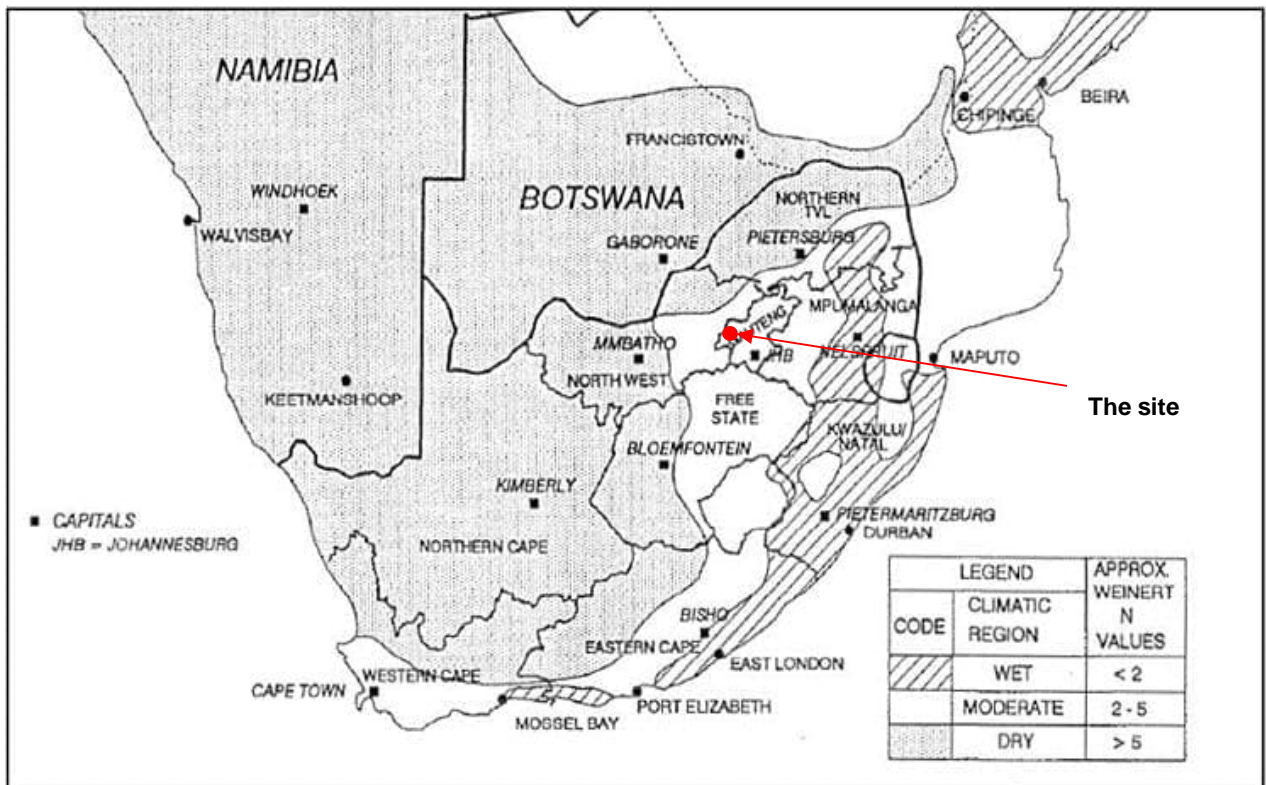
4 RESULTS OF THE DESKTOP STUDY

4.1 WEATHERING

The type and rate of rock weathering, and hence the soil profile, is determined by the climate of an area. Weinert (1980) developed an N-value system, which is used to derive the type of weathering likely to occur in an area based on macro-climatic conditions including evaporation and rainfall.

The study area falls within the temperate highland sub-tropical region of South Africa where the N value is between 2 and 5 as illustrated in . This indicates that moderate climatic conditions occur on the site and that the rock and soil are, therefore, expected to be subject to, predominantly, chemical disintegration.

Figure 4-1 - Macro climatic regions of South Africa



4.2 EXPECTED GROUND CONDITIONS

A majority of the site, and thus a majority of the turbine positions, are underlain by the Hekpoort Andesite Formation. This was evident during the site reconnaissance with several andesite and agglomerate outcrops observed across the site.

Figure 4-2 shows the positions of the outcrops observed on site. The geological formation underlying each turbine position is indicated in Table 4-1 while Table 4-2 describes the geological formation and rock type of the outcrops observed on site.

Figure 4-2 – Location of outcrops on site

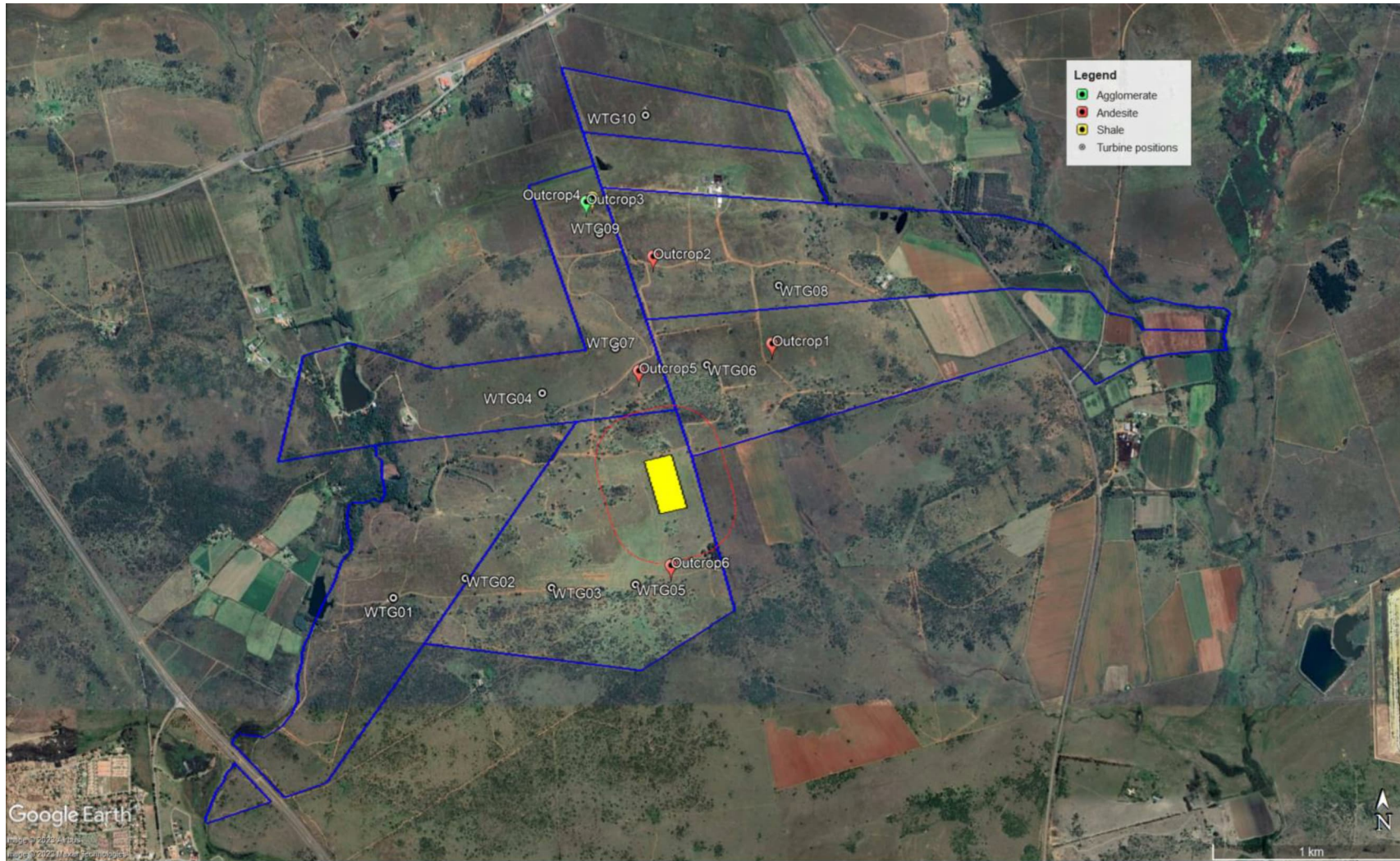


Table 4-1 – Geological formation underlying each wind turbine

Turbine ID	Formation
WTG01 to WTG08	Hekpoort Andesite
WTG09	Hekpoort Andesite and/or Timeball Hill
WTG10	Timeball Hill

Table 4-2 - Rock type of outcrops on site

Outcrop ID	Formation	Rock Type
Outcrop 1, Outcrop 2, Outcrop 5 and Outcrop 6	Hekpoort Andesite	Andesite
Outcrop 3	Hekpoort Andesite	Agglomerate
Outcrop 4	Timeball Hill	Shale

4.2.1 STRUBENKOP SHALE AND TIMEBALL HILL FORMATIONS

The Pretoria Group is generally dipping 20° to the south in the Igolide WEF area. The Pretoria Group sedimentary rocks, including the shale and quartzite, are notorious for instability in cut slopes. The rock is generally well bedded and, especially with the shale, some deterioration along the bedding planes has led to clay infill being present. Failure along the bedding planes and along the clay lubricated bedding planes is common. In general, any south facing slope should be assumed as being susceptible to failure until the rock has been assessed appropriately to determine the site specific dip of the rock.

Shale

The shale of the Pretoria Group, including that of the Strubenkop Shale and Timeball Hill Formations, commonly weathers into relatively shallow residual profiles of less than 2 to 4m in thickness. The residual soil generally comprises clayey silt to silty clay which is generally compressible and occasionally expansive. Notwithstanding this, a shale rock outcrop is present approximately 3m from the proposed position of WTG09. The shale is olive green weathered red, highly weathered, very fine grained, intensely bedded, slightly fractured, soft rock and can be seen in Figure 4-3.

Quartzite

Quartzite of the Pretoria Group is generally highly resistant to weathering and is often present as outcrop, often forming ridges, or is present at a shallow depth. The residual soil developed above the quartzite is, therefore, thinly developed and is usually sandy in nature. In some cases, the residual sand may be collapsible but are generally easily remediated due to their limited thickness.

Figure 4-3 - Shale rock encountered on site.



4.2.2 HEKPOORT ANDESITE

Andesite rock and agglomerate rock were observed as outcrops on site with some present in close proximity to WTG06, WTG07, WTG08 and WTG09. The andesite and agglomerate is shown in Figure 4-4 and Figure 4-5, respectively, and were described as follows:-:

- Dark grey weathered red and light grey, slightly weathered, fine grained, slightly fractured, hard rock **andesite** with 10mm to 12mm diameter amygdale crystals.
- Dark grey weathered red, slightly to moderately weathered, medium to fine grained, moderately to highly fractured, medium hard rock **agglomerate** with 2mm to 40mm diameter, opaque white to greyish white, subrounded, hard rock calcite fragments in rock matrix.

As stated by Brink ABA (1979) “*an interesting feature of the Hekpoort andesite is the extreme variability in depth and in degree of decomposition across relatively short distances.*”. This is as illustrated in Figure 4-6.

Therefore, although outcrops are present, a more thickly developed profile may be present within a very short distance. It is therefore of significant importance, that the depth of the residual profile directly below the turbine foundation positions be investigated and determined prior to design and construction.

Rock of the Hekpoort Andesite Formation generally weathers into a clayey soil which is generally compressible and often expansive. Care in the design of any foundations or infrastructure needs to take cognizance of this.

Drainage control in these residual profiles is also of significant importance, as localised seepage from sources such as leaky pipes can result in differential heave of structures.

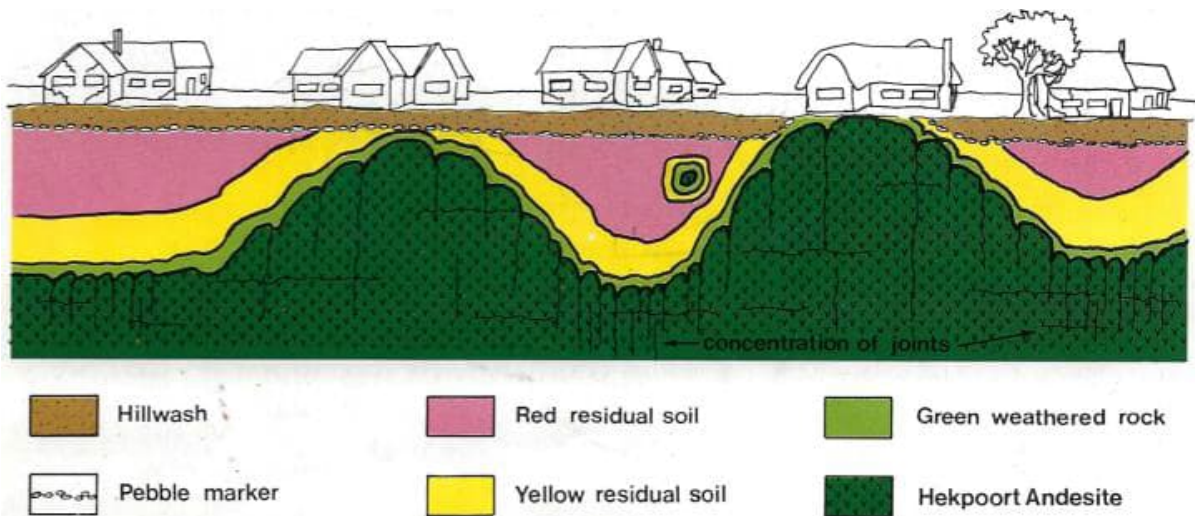
Figure 4-4 - Andesite outcrop and typical andesite



Figure 4-5 - Agglomerate rock and outcrops



Figure 4-6 - Variability of depth of decomposition in the Hekpoort andesite.



5 GEOTECHNICAL EVALUATION

5.1 SURFACE DRAINAGE

Flooding affects flat lying areas, areas confined to drained channels and flood plains. The Loopspruit river passes through the far west and far east sections of the site which can pose potential problems during wet periods especially in areas where shallow rock or clay is present. Water management is recommended on all flat areas on site to facilitate water run-off and to alleviate the possibility of standing water at the foundation positions.

5.2 EROSION

The slope on site, as well as the soil structure will influence the amount of erosion that occurs on site. The undulating gradient makes the probability of erosion likely although this is reduced by the presence of tall grass and trees, as shown in Figure 5-1, that cover large portions of the site. Construction might increase the likelihood of erosion due to the disturbance of natural vegetation. This should be mitigated by revegetation after construction.

Figure 5-1 - Vegetation on site



5.3 SUITABILITY OF INSITU MATERIAL FOR USE IN CONSTRUCTION

Shale rock can be used during construction as backfill and in layerworks. However, some shale material breaks down on exposure to air and water and this can cause severe problems. Should the shale be indicated for use as a construction material, its durability properties would need to be assessed.

Quartzite rock is generally inert and of use as a construction material ,however, it is generally hard rock or harder in situ and blasting and crushing is generally required.

Quartzitic sand is of use in construction but is likely be available only in very small quantities.

The soils developed on the Hekpoort Andesite Formation are unlikely to be suitable for use as a construction material due to their potential expansivity. The rock, however, is often used as general fill and in layerworks, once crushed.

5.4 EXCAVATIBITY

The excavation characteristics of the soil horizons has 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 Figure 5-2. The ease of excavation is a critical financial factor for any development.

Table 5-1 – SABS 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.

Class of Excavation	General Definition
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 – Excavatability on site

Material	Excavation Class
Strubenkop Shale and Timeball Hill Formations	<ul style="list-style-type: none"> ■ Soft excavations in residual shale, quartzite and hornfels and in very soft rock. ■ Intermediate to hard excavation in medium hard and hard rock.
Hekpoort Andesite Formation	<ul style="list-style-type: none"> ■ Soft excavations in residual andesite, agglomerate and tuff, and in very soft rock. Some boulder excavation may be required. ■ Intermediate to hard excavation in medium hard and hard rock.

5.5 SLOPE STABILITY

Development on the site is unlikely to cause any slope instability as no significant cut slopes will be developed. Where excavations are required, up to a depth of 3m, excavations should be excavated at a batter of 1:1 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.

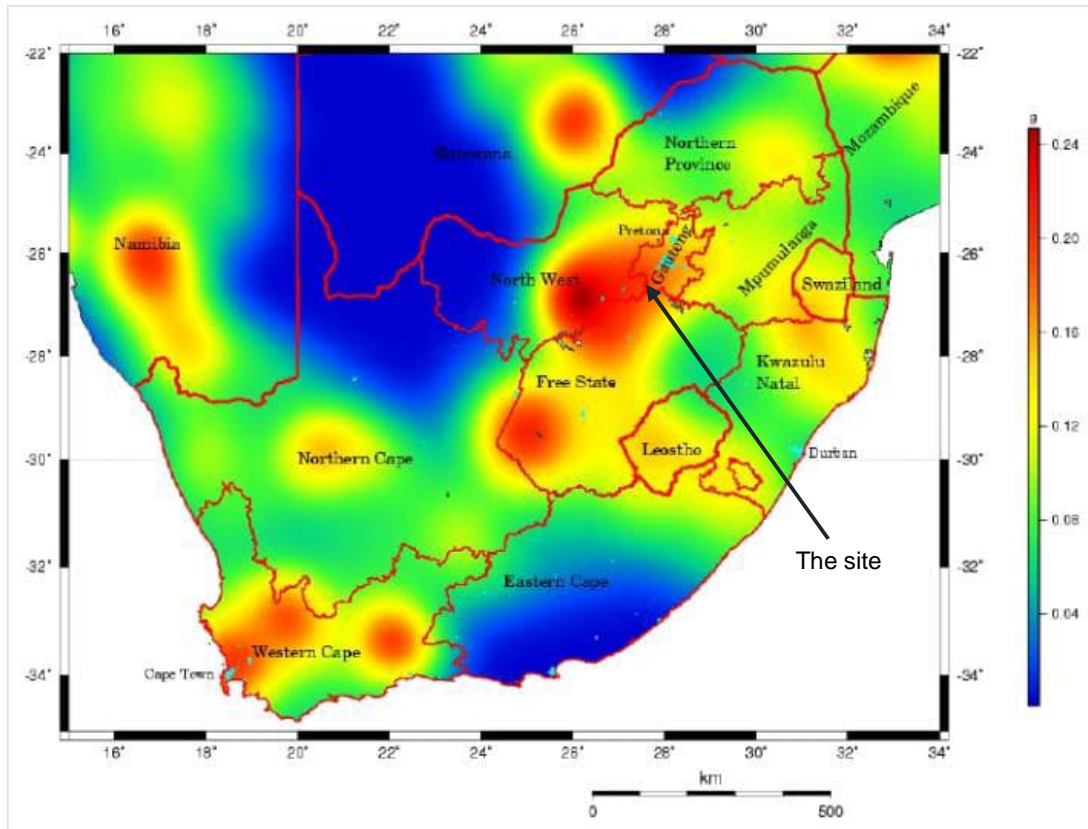
Care should be taken when rock is encountered excavating through shale rock on site as Group are prone to sliding as stated in Section 4.2.1 and repeated below:-

“The Pretoria Group is generally dipping 20° to the south in the Igolide WEF area. The Pretoria Group sedimentary rocks, including the shale and quartzite, are notorious for instability in cut slopes. The rock is generally well bedded and, especially with the shale, some deterioration along the bedding planes has led to clay infill being present. Failure along the bedding planes and along the clay lubricated bedding planes is common. In general, any south facing slope should be assumed as being susceptible to failure until the rock has been assessed appropriately to determine the site specific dip of the rock”.

5.6 SEISMIC HAZARD

According to the Seismic Hazard Map of South Africa (Council for Geoscience report No. 2003-0053.), the peak ground acceleration is between 0.16g and 0.20g for the site. The peak ground acceleration may be described as the maximum acceleration of the ground shaking during an earthquake, which has a 10% probability of being exceeded in a 50-year period as per Figure 5-2.

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



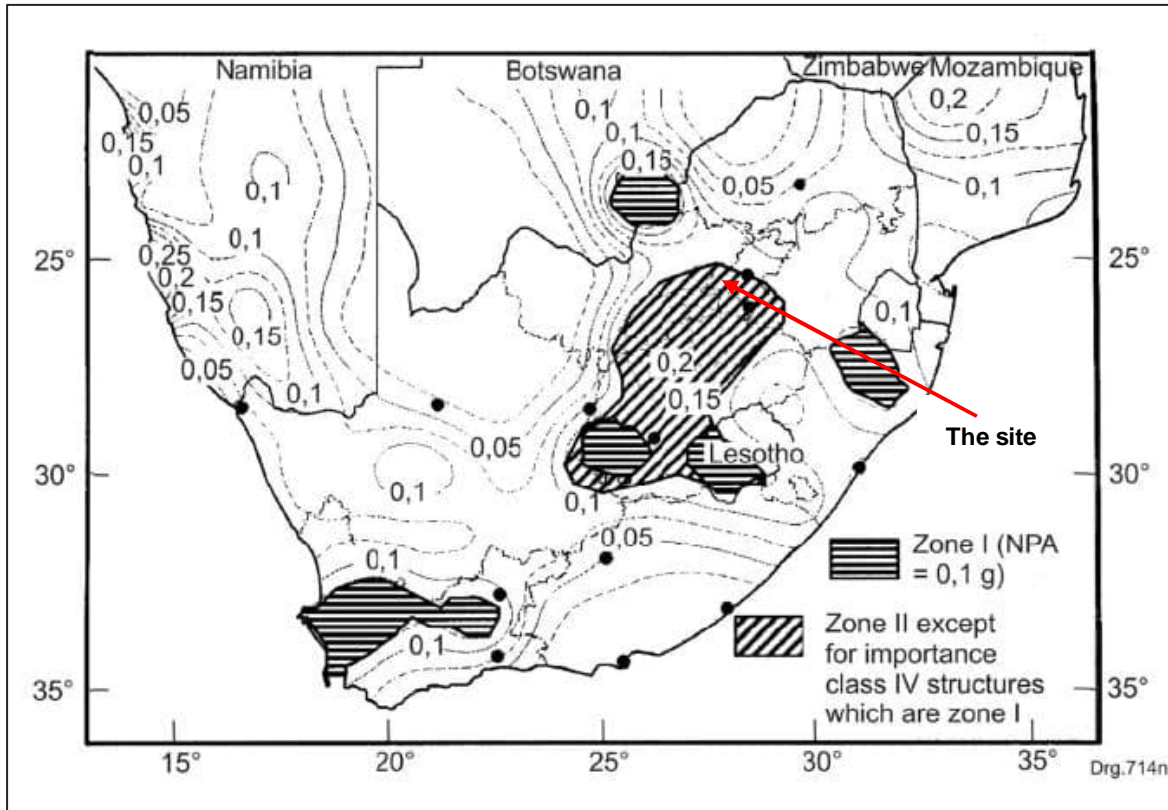
Mining induced seismicity is the failure of the earth’s crust or rock mass as a result of mining induced changes in rock stress levels. Seismic events range in size from barely discernible ground motions to very large tremors. There are three types of mining induced seismicity namely:

- Failure at pre-existing geological weaknesses such as faults, dykes and joints which result in medium to large events often far away from workings.
- Failure of the intact rock mass in the form of shear fractures that result in larger events close to workings.
- Localized bursting or failure of brittle rock types often referred to as strain bursting or face bursting (small events at the working face).

According to SANS 10160-4:2017, and as shown in

Figure 5-3, the site is situated in a zone where mining induced and natural seismic activity is possible. The last seismic event in the area was recorded on the 30th of July 2023 with a magnitude of 3.1 (Discovery, 2023). SANS 10160-4 2017 should be consulted to ensure structural design of the proposed WEF meets the minimum requirements for buildings in this seismic zone.

Figure 5-3 - Seismic zones of South Africa



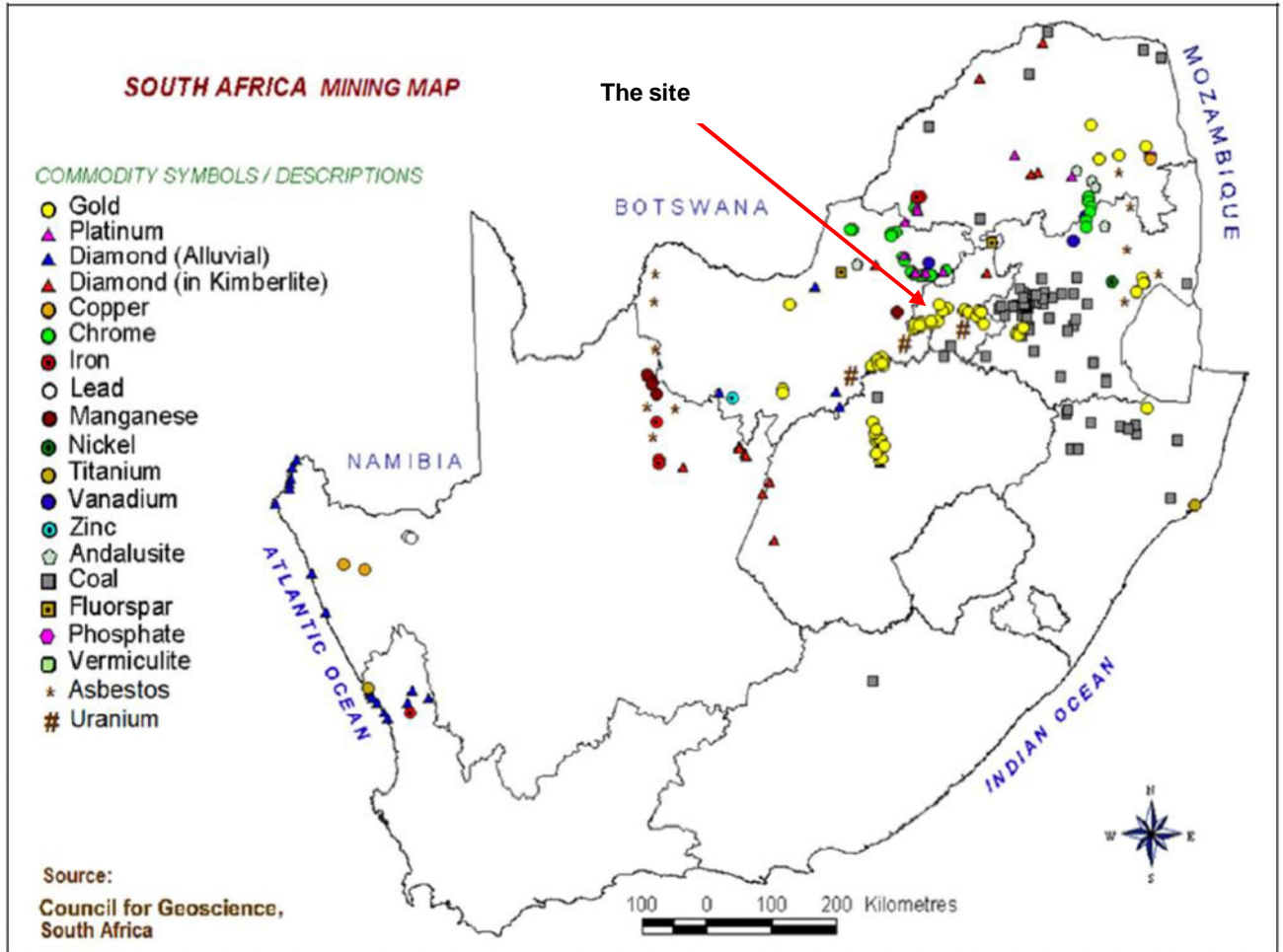
5.7 UNDERMINING

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 mining activity in South Africa is shown in Figure 5-4, It can be seen from this figure that the site is located in an area with a significant number of gold mines.

Kloof mine is an underground gold mine located approximately 6km west of the site and could potentially pose problems for the proposed WEF with the possibility of a mine induced seismic event.

The extent of any undermining below the site should be assessed, in detail, prior to development as the possibility of surface subsidence cannot be discounted should the site be undermined.

Figure 5-4 - Map indicating mining areas in South Africa



5.8 FOUNDATIONS

The turbines exert both a static load and a dynamic load on the founding material and competent material is required for founding to ensure stability and serviceability of the structures in the long term.

Outcrops and shallow rock are expected under parts of the WEF site underlain by rocks of the Strubenkop Shale and Timeball Hill Formations. The depth to rock in those areas underlain by the Hekpoort Andesite Formation is expected to be highly variable over a very small distance.

Structure specific investigation is, therefore, required at the turbine positions to determine the conditions below the entire footprint of the structures. Test pits will be required with boreholes being required where the rock is at depth.

For lightly loaded and non-sensitive structures, shallow founding is likely to be possible. However, the potential expansiveness and compressibility of the residual clays and silts, residual of the shale and andesite, will need to be taken account of. Modified foundations and remediation of the subgrade may be required.

6 GEOTECHNICAL IMPACT ASSESSMENT

The geotechnical impact assessment of the proposed Igolide WEF was performed according to the methodology included in APPENDIX B.

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.

The assessment considers the entire development but the three main parts of the development, namely Wind turbines, cable trenches and access roads, are the primary consideration. Based on the impact assessment matrix undertaken for this project, from a geotechnical perspective the impact of the Igolide WEF was found to be “Negative low to moderate impact - The anticipated impact will have negative effects and will require mitigation.” With mitigation measures the impact will be “Negative very low to low”. The assessment impact assessment matrix is presented in APPENDIX B

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

7 FURTHER GEOTECHNICAL INVESTIGATIONS

A detailed intrusive site investigation is recommended to further characterize site conditions, to better understand the key geotechnical risks characteristics and optimise the design of the WEF operations.

Based on the current lack of previous geotechnical investigation data, the primary objectives of the proposed intrusive investigation must include

- Determination of the founding conditions, especially the depth to rock, for all structures. The scope of the intrusive investigation should comprise the excavation of test pits with an excavator and possibly the drilling of a representative number of boreholes.
- Laboratory testing to determine the behavioural characteristics of the in situ materials.
- Investigation of subgrade conditions for service roads.
- Investigation of materials to be used during construction.
- Non-intrusive investigation techniques, such as geophysical surveys including thermal and electrical resistivity for ground earthing requirement.

8 CONCLUSIONS

The desktop assessment of the geotechnical conditions at the proposed development site for Igolide WEF has shown the site to be generally suitable for the proposed development.

A “negative low to moderate” impact was assessed, from a geotechnical perspective, for the pre-mitigation situation. Post-mitigation, the assessed impact decreases to “negative very low to low”.

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

The proposed development should, from a geotechnical impact perspective, be authorized. The most significant geotechnical condition that will affect the development is the possibility of hard excavation conditions as shallow rock is anticipated.

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

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Appendix A

CURRICULA VITAE





Nthabiseng Mashego

Earth and Environment, Junior Geotechnical Engineer

CAREER SUMMARY

Undergraduate qualification in Civil Engineering with an honour's degree in geotechnical engineering. 1 and ½ years of experience in geotechnical field investigations from a variety of sites including tailing's facilities and ash dams.

3 months with WSP

1 & 1/2 years of experience

Area of expertise

Geotechnical Investigations

Language

English

EDUCATION

Undergraduate Degree (BEng) in Civil Engineering, University of Pretoria. 2019
Honours Degree (BEngHons) in Geotechnical Engineering, University of Pretoria 2022

PROFESSIONAL HISTORY

WSP Group Africa (Pty) Ltd 2023 - present
Mukona Consulting Engineers 2020 - 2022

PROFESSIONAL EXPERIENCE

Geotechnical Investigations

Eskom Duvha power station, Duvha Ash Dam CPTu Testing, South Africa
2020

Overseeing on site operations

Conducting Cone Penetration tests with dissipation tests and collecting mostap samples at the Duvha power station ash dam.

Bazi Dukhan, Unizulu Campus CPT Testing, South Africa
2020

Overseeing on site operations

Conducting Cone Penetration tests at Unizulu campus in KwaZulu Natal.

Trans Africa Projects, Kadett power station, South Africa
2020

Junior Engineer

Test pitting, DPL testing and laboratory sampling for the construction of a substation platform and access road at the Kadett power station.



Nthabiseng Mashego

Earth and Environment, Junior Geotechnical Engineer

Tsholetso Projects, Sand River Bridge, South Africa

2020

Junior Engineer

Rotary Core Drilling and Test Pitting for the widening of the Sand River Bridge in the Limpopo Province.

Arup (Pty) Ltd, Neo1 Power Station Geohydrological Investigation, Lesotho

2020

Overseeing on site operations

Water borehole drilling, pump testing and laboratory sampling for the Neo1 Power station in Lesotho.

Davies Lynn and Partners, Richards Bay Minerals CPTu testing, South Africa

2021

Junior Engineer

Cone penetration testing with dissipation test at Richard's Bay Minerals to locate depth of slimes layers.

ARQ Geotech (Pty) Ltd, Booyendal TSF CPTu and SCPT Testing, South Africa

2021

Overseeing on site operations

Conduction Cone penetration tests with dissipation tests and seismic cone penetration tests at the Booyendal Tailings Storage Facility in Mpumalanga.

ARQ Geotech (Pty) Ltd, Nkomati mine CPTu and SCPT Testing, South Africa

2021

Overseeing on site operations

Conduction Cone penetration tests and seismic cone penetration tests at the Nkomati mine in Mpumalanga.

Jones and Wagener, Grootegeluk coal mine Rotary Core Drilling, South Africa

2021

Junior Engineer

Rotary core drilling at Grootegeluk coal mine in the Limpopo province.

Eskom Kriel Power Station, Kriel Ash Dam Rotary Core Drilling, South Africa

2021

Junior Engineer

Rotary core drilling at Kriel Ash Dam near Secunda.



Heather Davis

Mine Waste, Geotechnical & Material Services, Senior Geotechnical Engineer

CAREER SUMMARY

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.

4 months 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

Professionally registered Engineer with the Engineering Council of South Africa (PrEng 960229) 1996

Fellow of the South African Institution of Civil Engineering. 1998



Heather Davis

Mine Waste, Geotechnical & Material Services, Senior Geotechnical Engineer

PROFESSIONAL HISTORY

WSP Group Africa (Pty) Ltd	April 2022 – present
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

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 compiled 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.



Heather Davis

Mine Waste, Geotechnical & Material Services, Senior Geotechnical Engineer

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 (VRESAP), 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.



Heather Davis

Mine Waste, Geotechnical & Material Services, Senior Geotechnical Engineer

Eskom. Medupi, Flue Gas De-sulphurisation Project, Limpopo 2017 to 2018

Lead Geotechnical Engineer

Construction of Units 1 to 6. The investigation comprises test pitting, geophysical surveys and drilling. Foundation recommendations for all facets of the project were provided.

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.

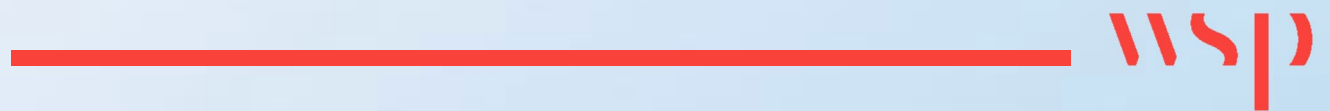
Atterbury Properties. Erasmuspark/ Castlegate, Multi Use Development, Erasmuspark, South Africa 2016 to 2020

Geotechnical Engineer and Dolomite Specialist

Existing information in line with SANS 1936 on a site underlain by dolomite and dolomitic residuum and non-dolomitic formations. Programme of drilling and near surface investigation, to feasibility level, to de-lineate those areas underlain by dolomite and provision of recommendations for a mixed-use development which will include retail and residential components. Subsequent design level investigations have been completed for various large structures across the site and further de-lineation of developable and non-developable areas.

Appendix B

IMPACT ASSESSMENT METHODOLOGY AND IMPACT ASSESSMENT





IMPACT ASSESSMENT METHODOLOGY

SCOPING PHASE

REPORTING REQUIREMENTS

- Project Description
- Legislative Context (as applicable)
- Assumptions and limitations
- Description of Baseline Environment
- Site Verification Assessment (including sensitivity mapping) (as applicable)
- 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 0-3** and **Table 0-2** respectively.

Table 0-1: 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
1	Improbable: The possibility of the impact occurring is very low

Table 0-2: 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.

Table 0-3: 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	

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

Ensure that all reports fulfil the requirements of the relevant Protocols.

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 direct¹, indirect², secondary³ as well as cumulative⁴ 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 criteria⁵ 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.

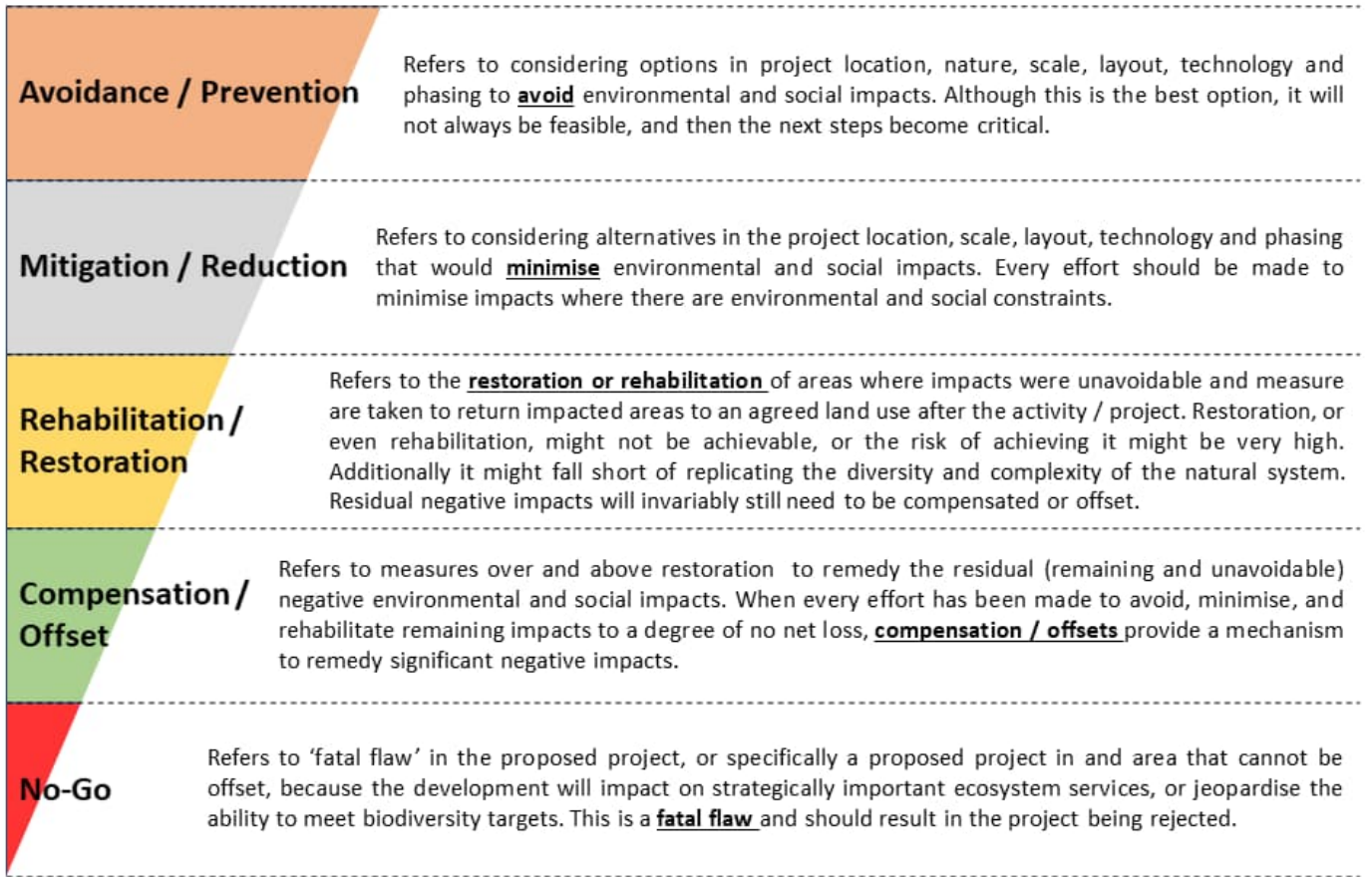


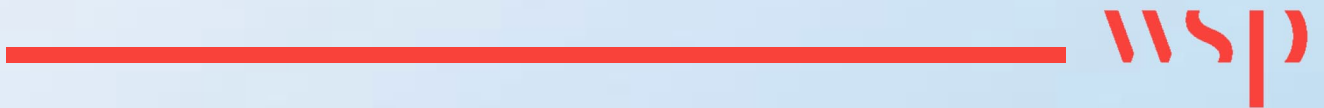
Figure 1: Mitigation Sequence/Hierarchy

Project Name		41104282 - Igolide WEF																			
Impact Assessment																					
CONSTRUCTION																					
Impact number	Aspect	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation						Rating	Post-Mitigation						Rating	Mitigation Measures	
						(M+)	E+	R+	D)x	P=	S		(M+)	E+	R+	D)x	P=	S			
Impact 1:	Soil Erosion	<ul style="list-style-type: none"> Increase 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	<ul style="list-style-type: none"> Rehabilitate affected areas (such as revegetation). Use temporary berms and drainage channels to divert surface water. Limit excavations to what is necessary. Where possible, use existing road network and access track Ensure correct engineering design and construction of gravel roads and water crossings. Ensure adequate control of 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	<ul style="list-style-type: none"> Vehicle and construction machinery repairs to be undertaken in designated areas with proper soil protection. Frequent checks of vehicles and construction machinery for oil leaks.
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	<ul style="list-style-type: none"> Limit excavations to what is necessary.
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	<ul style="list-style-type: none"> 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	3	3	2	3	36	N3	2	2	3	3	3	30	N2	<ul style="list-style-type: none"> Design all infrastructure according to SANS 10160-4 to ensure the proposed development meets the minimum requirements for infrastructure in a seismic zone.
Significance						N3 - Moderate						N2 - Low									
OPERATIONAL																					
Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation						Rating	Post-Mitigation						Rating	Mitigation Measures	
						(M+)	E+	R+	D)x	P=	S		(M+)	E+	R+	D)x	P=	S			
Impact 1:	Soil Erosion	<ul style="list-style-type: none"> Increase in soil and wind erosion due to clearance of structures. Displacement of soil and damage to vegetation by vehicles 	Operational	Negative			2	1	3	2	2	16	N2	1	1	1	1	1	4	N1	<ul style="list-style-type: none"> Where possible, use existing road network and access tracks. Use temporary berms and drainage channels to divert surface water. Minimize earthworks and demolish footprints. Rehabilitate affected areas (such as revegetation). Reinstate channelized drainage features. Strip, stockpile and re-spread topsoil.
Significance						N2 - Low						N1 - Very Low									
Impact 2:	Potential Oil Spillages	Potential oil spillages from service vehicles and heavy plant.	Operational	Negative			3	2	5	5	3	45	N3	2	1	3	1	1	7	N1	<ul style="list-style-type: none"> Vehicle repairs to be undertaken in designated areas.
Significance						N3 - Moderate						N1 - Very Low									
Impact 3:	Seismic activity	Damage of proposed development.	Operational	Negative			4	3	3	2	3	36	N3	2	2	3	3	3	30	N2	
Significance						N3 - Moderate						N2 - Low									
DECOMMISSIONING																					
Impact number	Receptor	Description	Stage	Character	Ease of Mitigation	Pre-Mitigation						Rating	Post-Mitigation						Rating	Mitigation Measures	
						(M+)	E+	R+	D)x	P=	S		(M+)	E+	R+	D)x	P=	S			
Impact 1:	Soil Erosion	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Where possible, use existing road network and access tracks. Use temporary berms and drainage channels to divert surface water. Minimize earthworks and demolish footprints. Rehabilitate affected areas (such as revegetation). Reinstate channelized drainage features. Strip, stockpile and re-spread topsoil.
Significance						N3 - Moderate						N1 - Very Low									
Impact 2:	Potential 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	<ul style="list-style-type: none"> Vehicle and construction machinery repairs to be undertaken in designated areas with proper soil protection. Frequent checks of vehicles and construction machinery for oil leaks.
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	<ul style="list-style-type: none"> Limit excavations to what is necessary.
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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> • Where possible, use existing road network and access tracks. • Use temporary berms and drainage channels to divert surface water. • Minimize earthworks and demolish footprints. • Rehabilitate affected areas (such as revegetation). • Develop a chemical spill response plan. • Reinststate 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	<ul style="list-style-type: none"> • Vehicle and construction machinery repairs to be undertaken in designated areas with proper soil protection. • Frequent checks of vehicles and construction machinery for oil leaks.
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	<ul style="list-style-type: none"> • Limit excavations to what is necessary.
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	<ul style="list-style-type: none"> • 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	3	3	4	3	42	N3	2	2	3	3	3	30	N2	<ul style="list-style-type: none"> • Design all infrastructure according to SANS 10160-4 to ensure the proposed development meets the minimum requirements for infrastructure in a seismic zone.
Significance						N3 - Moderate						N2 - Low								

Appendix C

DOCUMENT LIMITATIONS





DOCUMENT LIMITATIONS

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