PHASE 1 PALAEONTOLOGICAL IMPACT ASSESSMENT FOR THE CONSTRUCTION OF THE 400KV SUBSTATION AND POWERLINE SOUTH OF EMALAHLENI, EMALAHLENI LOCAL MUNICIPALITY, NKANGALA DISTRICT MUNICIPALITY, MPUMALANGA PROVINCE

For:

HIA CONSULTANTS

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By

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EXECUTIVE SUMMARY

Gideon Groenewald was appointed by PGS Heritage to undertake a Phase 1 Palaeontological Impact Assessment (PIA) to assess the potential palaeontological impact of the construction of a proposed power line and substation near the proposed Khanyisa power station near eMalahleni in the Mpumalanga Province. The study refers to proposed development areas where the palaeontology might be affected by the construction activities.

This report forms part of the Environmental Impact Assessment and complies with the requirements of the South African National Heritage Resource Act No 25 of 1999. In accordance with Section 38 (Heritage Resources Management), a Heritage Impact Assessment (HIA) is required to assess any potential impacts to palaeontological heritage within the development footprint of the development.

Dr Gideon Groenewald, Patricia Groenewald and David Groenewald visited the site of the proposed power line on Thursday 24 September 2015. Good outcrops of representative geological formations were recorded in the vicinity of the development and this report refers to these outcrops as well. The topography of the study area is undulating, with the coal deposits associated with near horizontal bedding of coarse-grained sandstone and interbedded, dark-grey shales of the Vryheid Formation. No outcrops of the Loskop Formation were observed and good outcrops of Vryheid Formation sandstone and siltstone are present north of the study area. In the study area, the geological formations are covered in relatively deep soils and only a few outcrops were observed in excavation trenches on site.

The area where the 400kV power line is proposed is underlain by Vaalian aged sandstone, shale conglomerate and volcanic rocks of the Loskop Formation and Permian aged sandstone and interbedded shale, with very well-developed coal beds of the Vryheid Formation, Ecca Group, Karoo Supergroup. Trace fossils are present in the siltstone layers. Iron enriched plant remains were observed in the sandstones. These plant remains are small and relatively sparse. Thus, they are not deemed to have a high palaeontological significance. The potential for finding well-defined plant fossils still remains high, and the sections of the study area where sandstone and shale of the Vryheid Formation might be uncovered have, thus, been allocated a moderate sensitivity for palaeontology. The areas underlain by rocks of the Loskop Formation are allocated a low palaeontological sensitivity.

It is recommended that:

1. The ECO of the project be informed of the possibility of finding well-defined plant and trace fossils in exposures of rocks of the Vryheid Formation. If fossils are observed they must be recorded and the palaeontologist must be informed of the finds.
2. No further mitigation for palaeontological heritage is required.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1. Background

Gideon Groenewald was appointed by PGS Heritage to undertake a Phase 1 PIA, assessing the potential palaeontological impact of the construction of the 400kV substation and power line near eMalahleni in the Mpumalanga Province. The study refers to proposed development areas where the palaeontology might be impacted on by the construction activities.

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Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include:

- geological sites of scientific or cultural importance;
- objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens; and
- objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

1.1. Aims and Methodology

Following the *"SAHRA APM Guidelines: Minimum Standards for the Archaeological & Palaeontological Components of Impact Assessment Reports"* the aims of the palaeontological impact assessment are:

- to identify exposed and subsurface rock formations that are considered to be palaeontologically significant;
- to assess the level of palaeontological significance of these formations;
- to comment on the impact of the development on these exposed and/or potential fossil resources; and
- to make recommendations as to how the developer should conserve or mitigate damage to these resources.

Prior to the field investigation a preliminary assessment (desktop study) of the topography and geology of the study area was made using appropriate 1:250 000 geological maps (2528 Pretoria) in conjunction with Google Earth. Potential fossiliferous rock units (groups, formations etc.) were identified within the study area and the known fossil heritage within each rock unit was inventoried from the published scientific literature, previous palaeontological impact studies in the same region and the author's field experience.

Priority palaeontological areas were identified within the development footprint to focus the field investigator's time and resources. The aim of the fieldwork was to document any exposed fossil material and to assess the palaeontological potential of the region in terms of the type and extent of rock outcrop in the area.

The likely impact of the proposed development on local fossil heritage was determined on the basis of the palaeontological sensitivity of the geological units concerned and the nature and scale of the development itself. The different sensitivity classes used are explained in Table 1.1 below.

Table 1.1 Palaeontological Sensitivity Analysis Outcome Classification

PALAEONTOLOGICAL SIGNIFICANCE/VULNERABILITY OF GEOLOGICAL UNITS	
The following colour scheme is proposed for the indication of palaeontological sensitivity classes. This classification of sensitivity is adapted from that of Almond et al (2008, 2009) (Groenewald etal.,2014).	
RED	Very high palaeontological sensitivity/vulnerability. Development will most likely have a very significant impact on the palaeontological heritage of the region. Very high possibility that significant fossil assemblages will be present in all outcrops of the unit. Appointment of professional palaeontologist, desktop survey, phase I Palaeontological Impact Assessment (PIA) (field survey and recording of fossils) and phase II PIA (rescue of fossils during construction) as well as application for collection and destruction permit compulsory.
ORANGE	High palaeontological sensitivity/vulnerability. High possibility that significant fossil assemblages will be present in most of the outcrop areas of the unit. Fossils most likely to occur in associated sediments or underlying units, for example in the areas underlain by Transvaal Supergroup dolomite where Cenozoic cave deposits are likely to occur. Appointment of professional palaeontologist, desktop survey and phase I Palaeontological Impact Assessment (field survey and collection of fossils) compulsory. Early application for collection permit recommended. Highly likely that a Phase II PIA will be applicable during the construction phase of projects.
GREEN	Moderate palaeontological sensitivity/vulnerability. High possibility that fossils will be present in the outcrop areas of the unit or in associated sediments that underlie the unit. For example areas underlain by the Gordonia Formation or undifferentiated soils and alluvium. Fossils described in the literature are visible with the naked eye and development can have a significant impact on the Palaeontological Heritage of the area. Recording of fossils will contribute significantly to the present knowledge of the development of life in the geological record of the region. Appointment of a professional palaeontologist, desktop survey and phase I PIA (ground proofing of desktop survey) recommended.
BLUE	Low palaeontological sensitivity/vulnerability. Low possibility that fossils that are described in the literature will be visible to the naked eye or be recognized as fossils by untrained persons. Fossils of for example small domal stromatolites as well as micro-bacteria are associated with these rock units. Fossils of micro-bacteria are extremely important for our understanding of the development of Life, but are only visible under large magnification. Recording of the fossils will contribute significantly to the present knowledge and understanding of the development of Life in the region. Where geological units are allocated a blue colour of significance, and the geological unit is surrounded by highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a blue colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in larger alluvium deposits. Collection of a representative sample of potential fossiliferous material is recommended.

GREY	Very low palaeontological sensitivity/vulnerability. Very low possibility that significant fossils will be present in the bedrock of these geological units. The rock units are associated with intrusive igneous activities and no life would have been possible during implacement of the rocks. However, it is essential to note that the geological units mapped out on the geological maps are invariably overlain by Cenozoic aged sediments that might contain significant fossil assemblages and archaeological material. Examples of significant finds occur in areas underlain by granite, just to the west of Hoedspruit in the Limpopo Province, where significant assemblages of fossils and clay-pot fragments are associated with large termite mounds. Where geological units are allocated a grey colour of significance, and the geological unit is surrounded by very high and highly significant geological units (red or orange coloured units), a palaeontologist must be appointed to do a desktop survey and to make professional recommendations on the impact of development on significant palaeontological finds that might occur in the unit that is allocated a grey colour. An example of this scenario will be where the scale of mapping on the 1:250 000 scale maps excludes small outcrops of highly significant sedimentary rock units occurring in dolerite sill outcrops. It is important that the report should also refer to archaeological reports and possible descriptions of palaeontological finds in Cenozoic aged surface deposits.

When geological units of moderate to high palaeontological sensitivity are present within the development footprint, palaeontological mitigation measures should be incorporated into the Environmental Management Plan.

1.2. Scope and Limitations of the Phase 1 Investigation

The scope of a phase 1 Investigation includes:

- an analysis of the area's stratigraphy, age and depositional setting of fossil-bearing units;
- a review of all relevant palaeontological and geological literature, including geological maps, and previous palaeontological impact reports;
- data on the proposed development provided by the developer (e.g. location of footprint, depth and volume of bedrock excavation envisaged);
- where feasible, examination of fossil collections from the study area (e.g. museums); and
- on-site investigation to assess the identified palaeontological sensitive areas within the development footprint/study area rather than formal palaeontological collection. The investigation should focus on the sites where bedrock excavations would definitely require palaeontological monitoring.

The results of the field investigation are then used to predict the potential of buried fossil heritage within the development footprint. In some investigations this involves the examination of similar accessible bedrock exposures, such as road cuttings and quarries, along roads that run parallel to or across the development footprint.

2. DESCRIPTION OF THE PROPOSED DEVELOPMENT

The project involves the construction of the 400kV substation and power line for the Khanyisa IPP project, close to eMalahleni, Mpumalanga Province (Figure 2.1) .

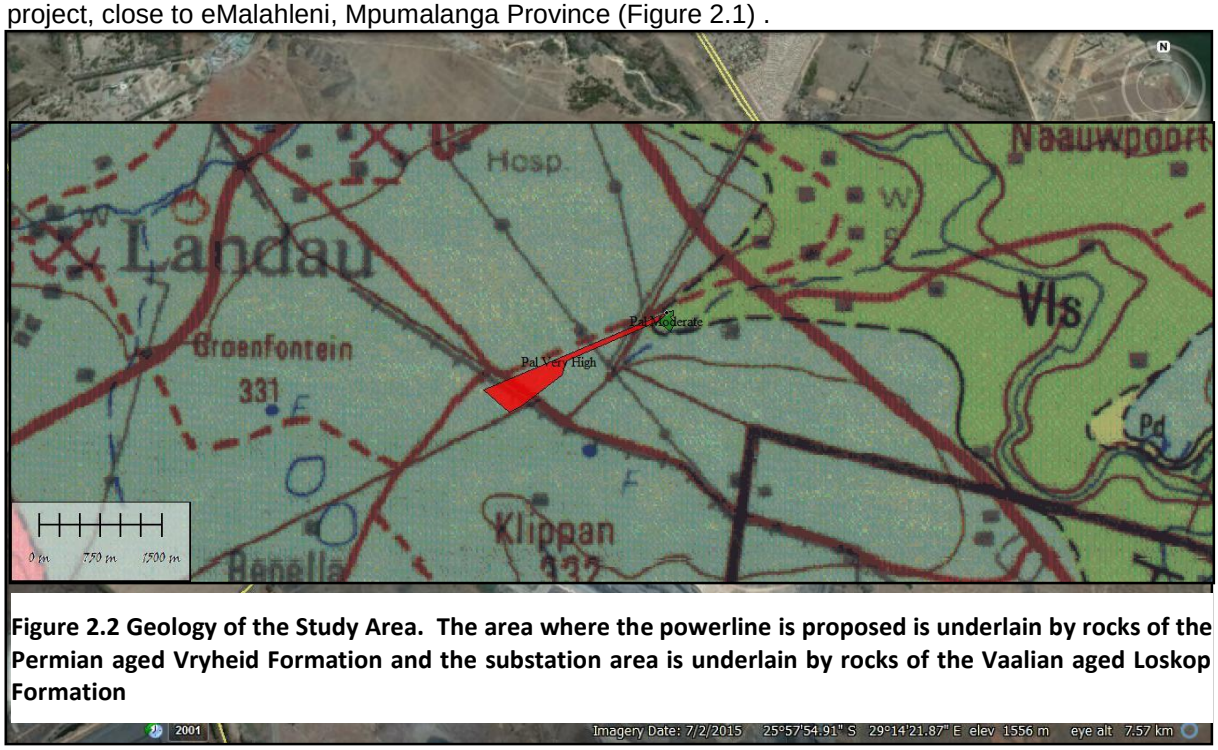


Figure 2.2 Geology of the Study Area. The area where the powerline is proposed is underlain by rocks of the Permian aged Vryheid Formation and the substation area is underlain by rocks of the Vaalian aged Loskop Formation

Figure 2.1 Study Area of the Khanyisa IPP Project

2.1. GEOLOGY

The study area is underlain by mudstone, sandstone, conglomerate and volcanic rocks of the Vaalian aged Loskop Formation, Group and sedimentary rocks of the Permian aged Vryheid Formation (PV), Ecca Group, Karoo Supergroup (Figure 3.1). The Vryheid Formation consists predominantly of grey sandstone with interbedded prominent coal beds and lenses of shale and grit. The sediments are interpreted as having been deposited on a sandy shoreline, beyond which lay vast swamplands. The plant material that accumulated within these swamps formed the coal deposits that are mined today (Johnson et al, 2009).

3. PALAEONTOLOGY OF THE STUDY AREA

3.1. Loskop Formation

Although no fossils have been described from the Loskop Formation to date, earliest known terrestrial cyanobacterial mats have been recorded from similar aged playa lake deposits in the Makgabeng Formation of the Waterberg Group. Recording of these fossil structures will contribute significantly to our understanding of the palaeoenvironments in this part of the study area.

3.2. Vryheid Formation

The Vryheid Formation is well-known for the occurrence of coal beds that resulted from the accumulation of plant material over long periods of time. Plant fossils described by Bamford (2011) from the Vryheid Formation are; *Azaniodendron fertile, Cyclodendron leslii, Sphenophyllum*

hammanskraalensis, Annularia sp., Raniganjia sp., Asterotheca spp., Liknopetalon enigmata, Glossopteris > 20 species, Hirsutum 4 spp., Scutum 4 spp., Ottokaria 3 spp., Estcourtia sp., Arberia 4 spp., Lidgetonnia sp., Noeggerathiopsis sp. and *Podocarpidites sp.*

According to Bamford (2011), little data has been published on these potentially fossiliferous deposits. Good fossil material is likely around the coal mines and yet in other areas the exposures may be too poor to be of interest. When they do occur, fossil plants are usually abundant and it would not be feasible to preserve and maintain all the sites. In the interests of heritage and science, however, such sites should be well recorded, sampled and the fossils kept in a suitable institution.

Although no vertebrate fossils have been recorded from the Vryheid Formation, invertebrate trace fossils have been described in some detail by Mason and Christie (1986). It should be noted, however, that the aquatic reptile, *Mesosaurus*, which is the earliest known reptile from the Karoo Basin, as well as fish (*Palaeoniscus capensis*), have been recorded in equivalent-aged strata in the Whitehill Formation in the southern part of the basin (MacRae, 1999). Indications are that the Whitehill Formation in the main basin might be correlated with the mid-Vryheid Formation. If this assumption proves correct, there is a possibility that Mesosaurus could be found in the Vryheid Formation.

The late Carboniferous to early Jurassic Karoo Supergroup of South Africa includes economically important coal deposits within the Vryheid Formation of Natal. The Karoo sediments are almost entirely lacking in body fossils but ichnofossils (trace fossils) are locally abundant. Modern sedimentological and ichnofaunal studies suggest that the north-eastern part of the Karoo basin was marine. In KwaZulu-Natal a shallow basin margin accommodated a prograding fluviodeltaic complex forming a broad sandy platform on which coal-bearing sediments were deposited. Ichnofossils include U-burrows (formerly *Corophioides*) which are assigned to ichnogenus *Diplocraterion* (Mason and Christie, 1986).

4. PRELIMINARY ASSESSMENT RESULTS

The palaeontological sensitivity was predicted after identifying potentially fossiliferous geological units, ascertaining the fossil heritage from the literature and evaluating the nature and scale of the development itself. The palaeontological sensitivity of the area underlying the power line and substation development can be described as significant due to the potential abundance of Permian aged plant fossils known to occur within the Vryheid Formation.

5. FIELD INVESTIGATION

Dr Gideon Groenewald, Patricia Groenewald and David Groenewald visited the site of the Khanyisa IPP development on Thursday 24 September 2015. Good outcrops of representative geological formations were recorded in the vicinity of the development and this report refers to these outcrops as well. The topography of the study area is undulating, with the coal deposits associated with near horizontal bedding of coarse-grained sandstone and interbedded, dark-grey shales of the Vryheid Formation. No outcrops of the Loskop Formation were observed and good outcrops of Vryheid Formation sandstone and siltstone are present north of the study area. In the study area the geological formations are covered in relatively deep soils and only a few outcrops were observed in excavation trenches on site. Field observations, made during the investigation include:

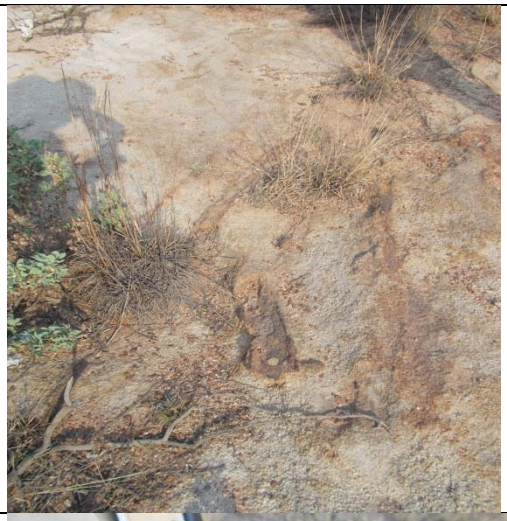
- Poorly defined trace fossils associated with interbedded siltstone of the Vryheid Formation (Table 6.1). No attempt was made to identify these structures, other than recording them as possible trace fossils resembling *Scolithos* traces.
- Several poorly-defined albeit iron enriched plant fossil, were observed in outcrops of the Vryheid Formation sandstone.

Table 5.1 Photographic information on site

Photo no	GPS Coordinates	Description	Photograph
1	S25° 58' 34.1" E29° 13' 16.2"	Deep soils – no outcrop	
2	S25° 58' 06.6" E29° 13' 38.2"	Deep soils, No outcrop	
3	S25° 58' 06.6" E29° 13' 38.2"	Deep soils, no outcrop, no fossils observed	
4	S25° 58' 05.5" E29° 13' 40.0"	Deep soils with no outcrop	

5	S25° 58' 04.4" E29° 13' 42.3"	Deep soils with no outcrop	
6	S25° 57' 59.9" E29° 13' 53.1"	Deep soils with no outcrop	
7	S25° 57' 59.9" E29° 13' 53.1"	Deep soils with no outcrop	
8	S25° 57' 48.2" E29° 14' 21.6"	Deep soils with no outcrop	

9	S25° 57' 47.5" E29° 14' 19.5"	Deep soils with no outcrop	
10	S25° 57' 46.7" E29° 14' 21.1"	Outcrop of Vryheid Sandstone – no fossils observed	
11	S25° 57' 46.7" E29° 14' 21.1"	Iron oxide cast of fossil wood in Vryheid Sandstone	
12	S25° 57' 46.7" E29° 14' 21.1"	Casts of plants in sandstone	

13	S25° 57' 46.7" E29° 14' 21.1"	Casts of plants in sandstone	
14	S25° 57' 46.7" E29° 14' 21.1"	Small scale trace fossils (*Scolithos*-like) in siltstone of the Vryheid Formation	
15	S25° 57' 46.8" E29° 14' 17.8"	Typical sandbar deposit in Vryheid Formation. No fossils observed	
16	S25° 57' 45.7" E29° 14' 27.5"	Trench excavation. Deep soils, little outcrop and no fossils observed	

17	S25° 57' 45.7" E29° 14' 27.5"	Trench excavation. Deep soils, little outcrop and no fossils observed	
18	S25° 57' 42.0" E29° 14' 36.4"	Trench excavation. Deep soils, little outcrop and no fossils observed	
19	S25° 57' 42.0" E29° 14' 36.4"	Trench excavation. Deep soils, little outcrop and no fossils observed	
20	S25° 57' 42.8" E29° 14' 34.3"	Excavation into deep sandy soils and some sandstone outcrops. No fossils observed	

21	S25° 57' 35.9" E29° 14' 50.2"	Deep soils on Loskop Formation. No outcrops and no fossils expected or observed	
22	S25° 57' 35.9" E29° 14' 50.2"	Deep soils on Loskop Formation. No outcrops and no fossils expected or observed	

6. PALAEONTOLOGICAL SENSITIVITY AND SIGNIFICANCE

The desktop study suggests that the study area is underlain by Vaalian aged sandstone, shale, conglomerate and volcanic rocks of the Loskop Formation and sedimentary deposits of the Permian aged Vryheid Formation of the Ecca Group, Karoo Supergroup. The Loskop Formation has a moderate sensitivity for palaeontological heritage and with a lack of outcrops and the fact that the fossils expected are casts of micro-bacteria, the palaeontological sensitivity for the area underlain by this rock group is lowered to low. Rocks of the Vryheid Formation are known to be rich in fossils and it was expected that areas underlain by these rocks would thus be highly sensitive from a palaeontological heritage perspective. The field investigation results indeed indicate that trace fossils occur in the siltstone layers and iron enriched plant fossils are mainly associated with the sandstone outcrops. The extent of exposure of bedrock during construction of pylon foundations are expected to be small. Therefore, it is recommended that the study area is allocated a moderate palaeontological sensitivity, as illustrated in Figure 7.1, for the areas that still need to be uncovered during the construction process and that any well-defined plant fossils that might be observed during construction be reported to the Environmental Control Officer (ECO).

Figure 6.1 Palaeosensitivity of the study area reduced to moderate and low due to nature of development. For explanation of colour coding see Table 1.1

6.1. CONCLUSION AND RECOMMENDATIONS

The substation and power line are underlain by Vaalian aged sandstone, shale conglomerate and volcanic rocks of the Loskop Formation and Permian aged sandstone and interbedded shale, with very well developed coal beds of the Vryheid Formation, Ecca Group, Karoo Supergroup. Trace fossils are present in the siltstone layers. Iron enriched plant remains were observed in the sandstones. These plant remains are small and relatively sparse. Thus, they are not deemed to have a high palaeontological significance. The potential for finding well-defined plant fossils still remains high, and the sections of the study area where sandstone and shale of the Vryheid Formation might be uncovered have thus been allocated a moderate saensitivity for palaeontology. The areas underlain by rocks of the Loskop Formation are allocated a low palaeontological sensitivity.

It is recommended that:

1. The ECO of the project be informed of the possibility of finding well-defined plant and trace fossils in exposures of rocks of the Vryheid Formation. If fossils are observed they must be recorded and the palaeontologist must be informed of the finds.
2. No further mitigation for palaeontological heritage is required.

7. REFERENCES

Almond J.E. and Pether J. 2008. Palaeontological Heritage of the Western Cape. Internal Report Heritage Western Cape.

Almond J.E., De Klerk B. and Gess R., 2009. Palaeontological Heritage of the Eastern Cape. Internal Report, SAHRA.

Bamford M. 2011. Desktop study Palaeontology Ermelo to Empangeni – Eskom powerline. Internal report Bernard Price Institute for Palaeontological Research, University of the Witwatersrand.

Groenewald G.H., Groenewald D.P. and Groenewald S.M., 2014. Palaeontological Heritage of the Free State, Gauteng, Limpopo, Mpumalanga and North West Provinces. Internal Palaeotechnical Reports, SAHRA.

Johnson MR, Anhausser CR and Thomas RJ. 2006. The Geology of South Africa. Geological Society of South Africa.

MacRae C. 1999. Life Etched in Stone. Geological Society of South Africa.

Mason TR and Christie ADM 1986. Palaeoevironmental significance of ichnogenus Diplocraterion torell from the Permian Vryheid Formation of the Karoo Supergroup, South Africa. Palaeogeography, Palaeoclimatology, Palaeoecology 53(3-4):249-265.

8. QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

Dr Gideon Groenewald has a PhD in Geology from the University of Port Elizabeth (Nelson Mandela Metropolitan University) (1996) and a National Diploma in Nature Conservation from Technicon RSA (the University of South Africa) (1989). He specialises in research on South African Permian and Triassic sedimentology and macrofossils with an interest in biostratigraphy and palaeoecological aspects. He has extensive experience in the locating of fossil material in the Karoo Supergroup and has more than 20 years of experience in locating, collecting and curating fossils, including exploration field trips in search of new localities in the southern, western, eastern and north-eastern parts of the country. His publication record includes multiple articles in internationally recognised journals. Dr Groenewald is accredited by the Palaeontological Society of Southern Africa (society member for 25 years).

9. DECLARATION OF INDEPENDENCE

I, Gideon Groenewald, declare that I am an independent specialist consultant and have no financial, personal or other interest in the proposed development, nor the developers or any of their subsidiaries, apart from fair remuneration for work performed in the delivery of palaeontological heritage assessment services. There are no circumstances that compromise the objectivity of my performing such work.

Dr Gideon Groenewald
Geologist