Palaeontological Impact Assessment for the proposed Hendrina South Grid connection, Mpumalanga Province

Site Visit Report (Phase 2)

For

Beyond Heritage

08 January 2023

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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 34 years research; 26 years PIA studies
Over 350 projects completed.

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Beyond Heritage, Modimolle, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A Palaeontological Impact Assessment was requested for the proposed grid connection for the Hendrina South Wind Energy Facilities (WEFs).

To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a site visit (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed routes lie on the potentially very highly sensitive Vryheid Formation (Ecca Group, Karoo Supergroup) that could preserve impressions of fossil plants of the *Glossopteris* flora. The site visit and walk through by the palaeontologist at the end of 2022 (summer) confirmed that there were NO FOSSILS of any kind present on the land surface. Most of the route is adjacent to existing roads and servitudes or across secondary grasslands or agricultural fields so there were no rocky outcrops and no fossils. Nonetheless, a Fossil Chance Find Protocol should be added to the EMPr. Based on this information it is recommended that no further palaeontological impact assessment is required unless fossils are found by the contractor, developer, environmental officer or other designated responsible person once excavations for pole foundations, access roads or the new substation have commenced. Both routes are on the Vryheid Formation so there is no preferred option as far as the palaeontology is concerned. Since the impact will be low to moderate, as far as the palaeontology is concerned, the project should be authorised.

Table of Contents

1. Background

In order to connect the proposed Hendrina North and Hendrina South Wind Energy Facilities (WEFs) to the national grid, two grid connection alternatives are under consideration:

- Grid Connection Alternative 1 (Preferred) (Option A, white line in Figures 1-2):
  The proposed powerline will be approximately 23.7km and will connect the Hendrina South WEF to the Hendrina Power Station. The 132kV powerline from the grid operator substation on the Hendrina South WEF (subject to a separate application for EA) will lead to the Hendrina North collector substation (subject to a separate application for EA). Should the Hendrina North WEF not be built, the connection will continue from the grid operator substation on Hendrina South all the way to the Hendrina Power Station. This alternative is spans over existing road and farm boundaries. This is the landowners preferred routing. The preferred pylon and powerline will be 132 kV Intermediate Self-Supporting single circuit or double circuit Monopole.
- Grid Connection Alternative 2: (Option B, blue line in Figures 1-2):
  The proposed powerline will be approximately 22.8km and will connect the Hendrina South WEF to the Hendrina Power Station. The 132kV powerline from the grid operator substation on the Hendrina South WEF (subject to a separate application for EA) will lead to the Hendrina North collector substation (subject to a separate application for EA). Should the Hendrina North WEF not be built, the connection will continue from the grid operator substation on Hendrina South all the way to the Hendrina Power Station. This alternative spans over farm portions.

A Palaeontological Impact Assessment was requested for the Hendrina South Grid connection project. To comply with the regulations of the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a site visit and walkthrough (Phase 2) Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6).

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report,	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
k	Any mitigation measures for inclusion in the EMPr	Section 8, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 8, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	Section 6
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Sections 6, 8
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies of any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	Relevant section in report
2	Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

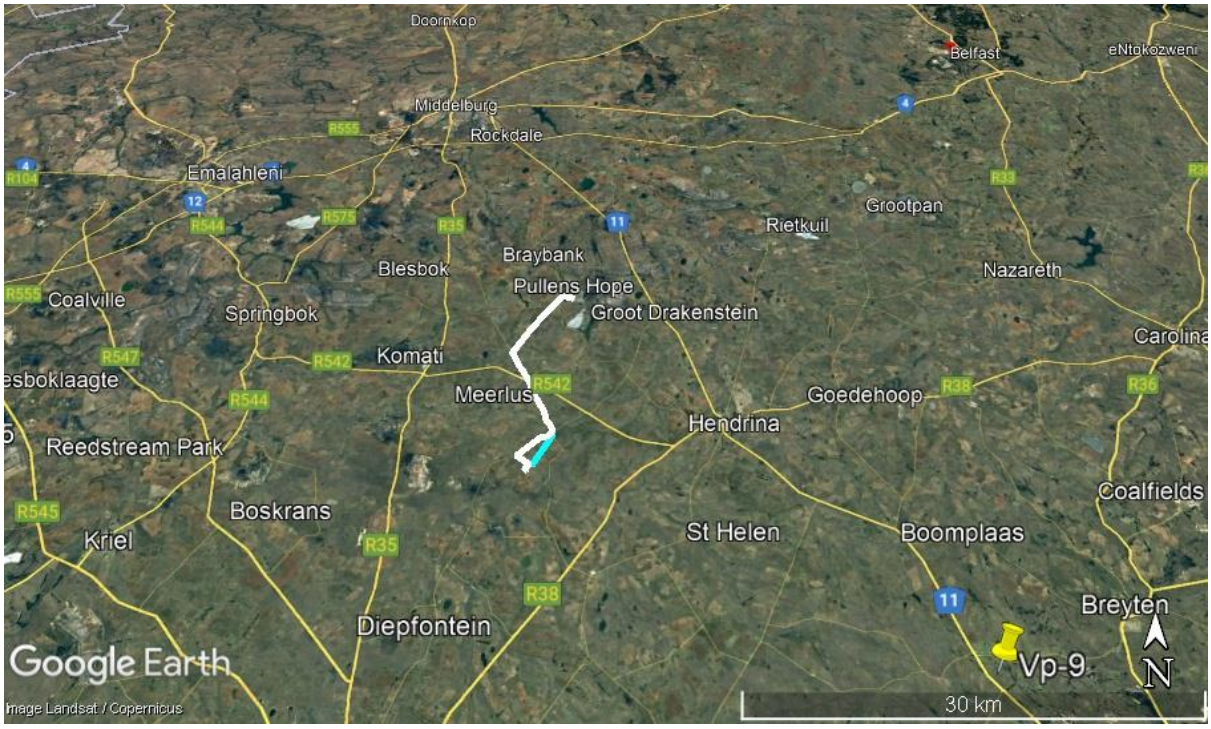

Figure 1: Google Earth map of the proposed development showing the relevant landmarks.

Figure 2: Google Earth map for the two alternatives for the proposed Hendrina South grid connection, with Option A (white line) being the preferred one.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance, as is the case here;
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

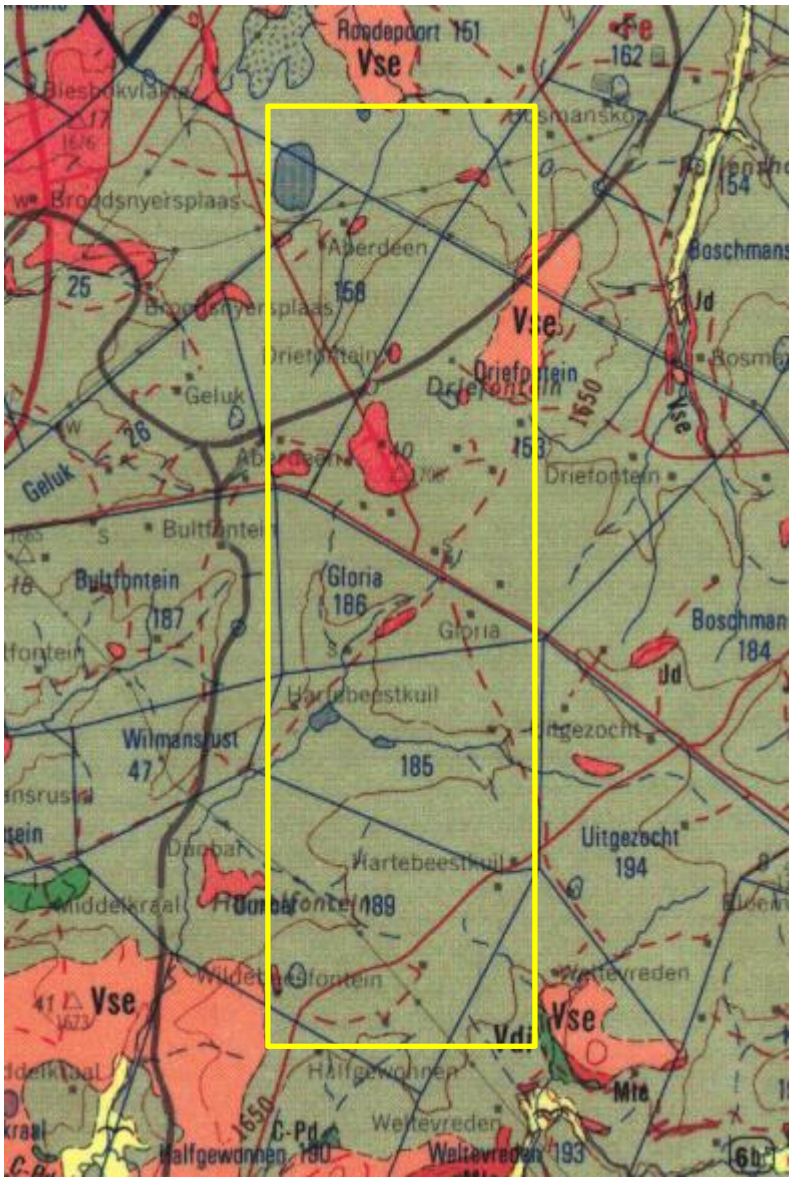

Figure 4: Geological map of the area of the proposed route for the Hendrina South Grid Connection. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2628 East Rand.

Table 2: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006; Partridge et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Qc	Quaternary	Alluvium, sand, calcrete	Quaternary Ca 1.0 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic,

Symbol	Group/Formation	Lithology	Approximate Age
			Ca 183 Ma
Pv	Vryheid Fm, Ecca Group, Karoo SG	Shales, mudstone, sandstone, coal seams	Early Permian Ca 290-270 Ma
Vse	Selons River Fm (now Schrikkloof Fm) Rooiberg Group	Flow-banded rhyolite, quartzitic lenses; felsic lava	Palaeoproterozoic 2056 Ma

The site lies in the northeastern part of the Karoo basin where the lower Karoo Supergroup strata are exposed (Figure 3). It is unconformably underlain by the volcanic rocks of the Rooiberg Group. Along the rivers and streams much young reworked sands and alluvium overly the older strata.

According to more recent publications the Rooiberg Group is divided into four formations based on the proportions of various volcanic rocks that are present (Buchanan, 2006) with the upper Selons River Formation now called the Kwaggasnek and Sckhrikkloof Formations. Dated at 2056 Ma (Zeh et al., 2020) these volcanic rocks do not preserve any fossils.

The Karoo Supergroup rocks cover a very large proportion of South Africa and extend from the northeast (east of Pretoria) to the southwest and across to almost the KwaZulu Natal south coast. It is bounded along the southern margin by the Cape Fold Belt and along the northern margin by the much older Transvaal Supergroup rocks. Representing some 120 million years (300 – 183Ma), the Karoo Supergroup rocks have preserved a diversity of fossil plants, insects, vertebrates and invertebrates.

During the Carboniferous Period South Africa was part of the huge continental landmass known as Gondwanaland and it was positioned over the South Pole. As a result, there were several ice sheets that formed and melted, and covered most of South Africa (Visser, 1986, 1989; Isbell et al., 2012). These are the oldest rocks in the system and are are known as the Dwyka Group. (Johnson et al., 2006).

Overlying the Dwyka Group rocks are rocks of the Ecca Group that are Early Permian in age. There are eleven formations recognised in this group but they do not all extend throughout the Karoo Basin. In the central and east part are the following formations, from base upwards are the Pietermaritzburg Formation, Vryheid Formation and the Volksrust Formation. All of these sediments have varying proportions of sandstones, mudstones, shales and siltstones and represent shallow to deep water settings, deltas, rivers, streams and overbank depositional environments.

Overlying the Ecca Group are the rocks of the Beaufort Group and the Stormberg Group that complete the Karoo sequence. They are not present in this part of the basin. Large exposures of Jurassic dolerite dykes occur throughout the area but more to the south. These intruded through the Karoo sediments around 183 million years ago at about the same time as the Drakensberg basaltic eruption (Johnson et al., 2006).

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ii. Palaeontological context

Figure 4: SAHRIS palaeosensitivity map for the site for the proposed Hendrina South Grid connection shown within the yellow rectangles. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is in the Vryheid Formation and non-fossiliferous volcanic rocks of the Rooiberg Group.

From the SAHRIS map above the area is indicated as very highly sensitive (red) for the Vryheid Formation so a site visit is required and has been completed. Volcanic rocks do not preserve fossils, only sedimentary rocks might preserve fossils if there were organisms present at the time of their deposition. At the time of deposition of the Vryheid Formation there were extensive deltas and floodplains with vegetation growing on the banks and in the flooded areas, or swamps. Overtime these became peats and were buried in the sediments that gradually filled the Karoo inland sea. With increased pressure from the overburden and increased geothermal temperatures, the peats were altered over time to form coal seams. These coal seams of varying thickness, depth and extent are exploited today for coal.

The coal itself does not preserve any recognisable plant material because the organic matter has been compressed, devolatilised and altered, however, in the carbonaceous shales or siltstones between coal seams it is possible to find impressions or compressions of the plants that originally formed the peats (Plumstead, 1969). The extinct seed fern

glossopteris was the dominant plant in all Gondwana floras. It was a deciduous shrub to large tree with long tongue-shaped leaves. Other woody plants growing in the swamps were the cordaitaleans, a group of extinct early gymnosperms (Plumstead, 1969; Gastaldo et al., 2020). Many other plants made up this rich flora including lycopods, sphenophytes, ferns, mosses and early gymnosperms, as well as a variety of plants known only from their spores.

No vertebrates are known to occur with the *Glossopteris* flora because different conditions are required for the preservation of plants and animals. In general, plants require a reducing environment such as burial in an anoxic mud, while bones can survive exposure and an oxidising environment (Cowan, 1995). Moreover, in the Early Permian there were very few vertebrates but fish and invertebrates were present. In some depositional environments it is possible to find fish bones and traces of the invertebrates in the form of burrows and trackways (Cowan, 1995).

Although when present, the plants of the *Glossopteris* flora are abundant, but their distribution is difficult to predict (Kovacs-Endrody, 1976, 1991). This has resulted in known sites being well studied while the greater distribution remains unknown.

iii. Site visit observations

The proposed powerline routes (the same route for both options for the majority of the distance but differing slightly in the southern one fifth) run mostly along existing powerlines, along farm boundaries or across cultivated lands. The topography is flat to slightly undulating and the land surface has been disturbed by decades of agriculture (ploughed fields for crops, fallow fields and cattle grazing) as well as evidence of coal mining in the form of a conveyor system, haul roads and access roads.

The powerline routes were walked down from north to south, to cover a broad swathe of land wherever possible without disturbing planted crops in mid December. Recent heavy rains made some sections impassable and thick secondary grasses covered the fallow fields. The land cover comprises deep sandy, reddish soil and only one outcrop of rock was encountered in the southern section. This was dolerite forming a low ridge and so does not have any fossils.

There were no outcrops of shales or mudstones that might preserve fossil plant impressions and so NO FOSSILS of plants or vertebrates were seen on the surface. According to the borehole core logs for the area west of Hendrina soils and sandstones overlie the uppermost coal seam, Seam A, to a depth of about 20m, and the shales and mudstones are below that (Snyman, 1998; fig 17). Soils and coarse sandstones do not preserve fossils so it would be unlikely to find them except where erosion has occurred.

No fossils were found anywhere along both proposed route corridors on the land surface (Figures 5-7).

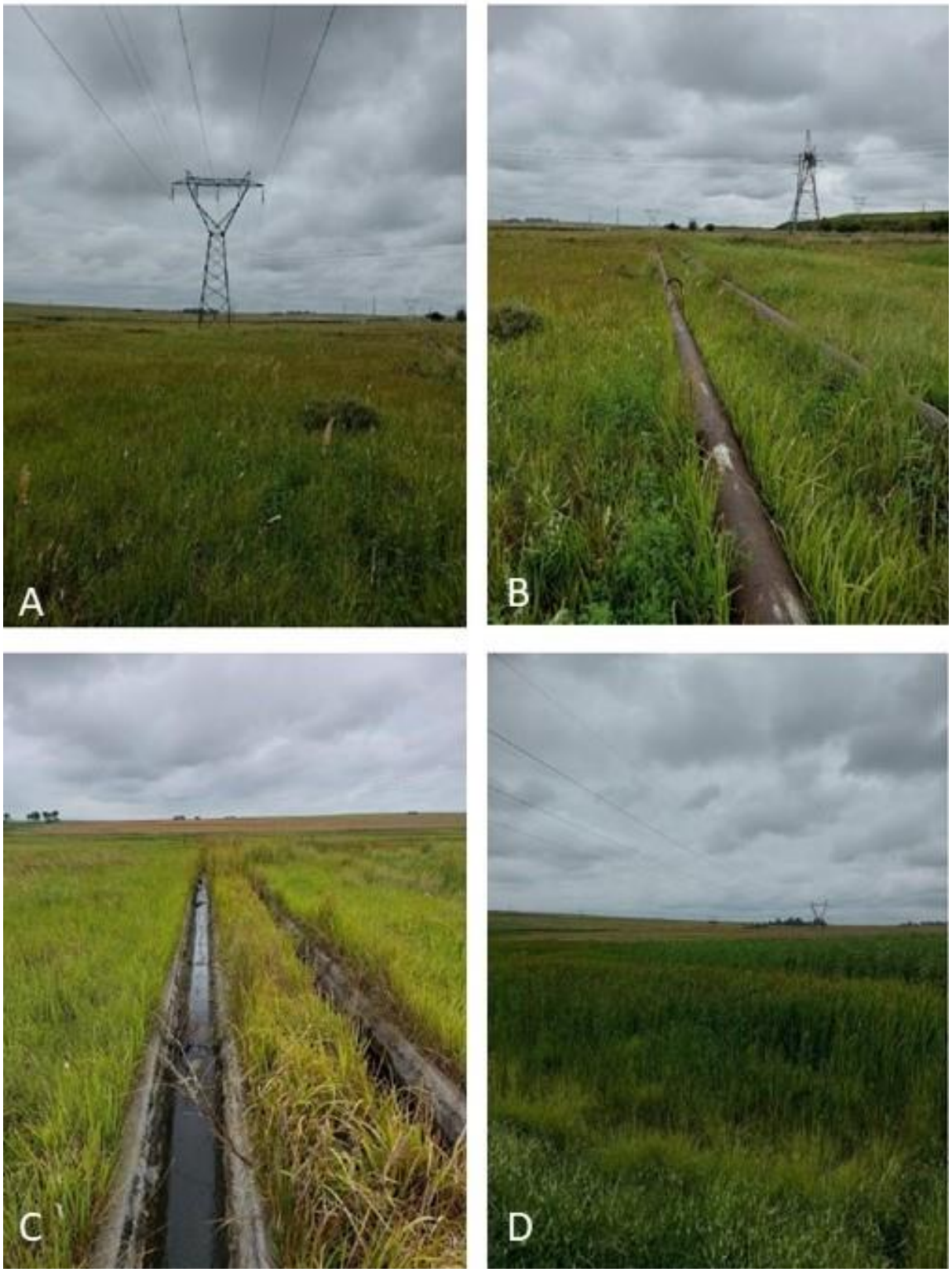

Figure 5: Hendrina South grid connection route (northern part) site visit photographs. A-B - route parallel to and perpendicular to existing powerlines. B-C – pipes and canals for agriculture. Note deep soils and thick grasslands. D – another section along the route with thick grassland and no rocky outcrops.

Figure 6: Hendrina South grid connection route (central section) site visit photographs. A – C – flat land already ploughed and planted with maize. C-D – access roads expose the underlying sandy soil. Note no rocky outcrops.

Figure 7: Hendrina South grid connection (southern section) site visit photographs. A – C flat land lying fallow with short secondary grassland that is water-logged . D – rocky outcrop on a low ridge that is composed of dolerite only. No fossils.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table :

Table 4a: Criteria for assessing impacts

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

Table 4b: Impact Assessment

PART B: Assessment		
SEVERITY/NATURE	**H**	-
	M	-
	L	Soils do not preserve plant fossils; so far there are no records from the Vryheid Formation of plant or animal fossils in this region so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	L+	-
	M+	-

PART B: Assessment		
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since the only possible fossils within the area would be fossil plants from the *Glossopteris* flora in the shales, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossils would be found in the loose soil and sand that will be excavated. Nonetheless, a Fossil Chance Find Protocol should be added to the eventual EMPr.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are the correct age and type to preserve fossils. The site visit and walk through confirmed that there were NO FOSSILS in the proposed grid connection routes. Furthermore, the material to be excavated for foundations is soil and this does not preserve fossils. Since there is an extremely small chance that fossils from the Vryheid Formation may occur below ground and may be disturbed, a Fossil Chance Find Protocol has been added to this report. Taking account of the defined criteria, the potential impact to fossil heritage resources is low to moderate.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and some do contain fossil plant, insect, invertebrate and vertebrate material. The site visit and walk through in December (summer) by the palaeontologist confirmed that there are no fossils on the surface along the proposed grid connection routes. The sands of the Quaternary period would not preserve fossils. It is not known if there are shales bearing fossil plants below the ground surface.

6. Recommendation

Based on the fossil record but confirmed by the site visit and walk through there are NO FOSSILS of the *Glossopteris* flora even though fossils have been recorded from rocks of a similar age and type in South Africa. It is extremely unlikely that any fossils would be preserved in the overlying soils and sands of the Quaternary. There is a very small chance that fossils may occur in below the ground surface in the shales of the Vryheid Formation but more than 20m down, so a Fossil Chance Find Protocol should be added to the EMPr.

If fossils are found by the environmental officer or other responsible person once excavations and drilling have commenced, then they should be rescued and a palaeontologist called to assess and collect a representative sample.

7. References

Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodromus of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Buchanan, B.C., 2006. The Rooiberg Group. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 283 – 289.

Cowan, R., 1995. History of Life. 2nd Edition. Blackwell Scientific Publications, Boston. 462pp.

Gastaldo, R.A., Bamford, M., Calder, J., DiMichele, W.A., Ianuzzi, R., Jasper, A., Kerp, H., McLoughlin, S., Opluštil, S., Pfefferkorn, H.W., Roessler, R., and Wang, J., 2020, The non-analog vegetation of the Late Paleozoic icehouse–hothouse and their coal-forming forested environments: in Martinetto, E. Tschopp, E., and Gastaldo, R.A., (eds), Nature Through Time: Springer Nature Switzerland, Cham, Switzerland, p. 291-316. ISBN 978-3-030-35057-4.
https://doi.org/10.1007/978-3-030-35058-1

Isbell, J.L., Henry, L.C., Gulbranson, E.L., Limarino, C.O., Fraiser, F.L., Koch, Z.J., Ciccioli, P.l., Dineen, A.A., 2012. Glacial paradoxes during the late Paleozoic ice age: Evaluating the equilibrium line altitude as a control on glaciation. Gondwana Research 22, 1-19.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.

Kovacs-Endrody, E., 1976. Notes on some *Glossopteris* species from Hammanskraal (Transvaal). Palaeontologia africana 19, 67-95.

Kovacs-Endrody, E. 1991. On the Late Permian age of Ecca Glossopteris floras in the Transvaal Province with a key to and descriptions of twenty five Glossopteris species. Memoir of the Geological Survey of South Africa, 77, 111pp.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

Visser, J.N.J., 1986. Lateral lithofacies relationships in the glacigene Dwyka Formation in the western and central parts of the Karoo Basin. Transactions of the Geological Society of South Africa 89, 373-383.

Visser, J.N.J., 1989. The Permo-Carboniferous Dwyka Formation of southern Africa: deposition by a predominantly subpolar marine icesheet. Palaeogeography, Palaeoclimatology, Palaeoecology 70, 377-391.

8. Chance Find Protocol

Monitoring Programme for Palaeontology – to commence once the excavations / drilling activities begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (trace fossils, fossils of plants, insects, bone or coalified plant material) should be put aside in a suitably protected place. This way the project activities will not be interrupted.
3. Photographs of similar fossils must be provided to the developer to assist in recognizing the fossil plants, vertebrates, invertebrates or trace fossils in the shales and mudstones (for example see Figure 8). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. If there is any possible fossil material found by the contractor or environmental officer then the qualified palaeontologist sub-contracted for this project, should visit the site to inspect the selected material and check the dumps where feasible.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then no site inspections by the palaeontologist will be necessary. A final report by the palaeontologist must be sent to SAHRA once the project has been completed and only if there are fossils.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

9. Appendix A – Examples of fossils from the Vryheid Formation

Figure 8:Photographs of fossil plants from the *Glossopteris* flora that could occur in the shales of the Vryheid Formation.

10. Appendix B – Details of specialists

Curriculum vitae (short) - Marion Bamford PhD
January 2023

Present employment: Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DSI Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa
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ii) **Academic qualifications**
Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) **Professional qualifications**
Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) **Membership of professional bodies/associations**
Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

v) **Supervision of Higher Degrees**

All at Wits University

Degree	Graduated/completed	Current

Honours	13	0
Masters	13	3
PhD	13	7
Postdoctoral fellows	14	4

vi) **Undergraduate teaching**
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 12 - 20 students per year.

vii) **Editing and reviewing**
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Associate Editor: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals

viii) **Palaeontological Impact Assessments**
25 years' experience in PIA site and desktop projects

- Selected from recent projects only – list not complete:
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for Enviropro
- Frankfort-Windfield Eskom Powerline 2020 for 1World
- Beaufort West PV Facility 2021 for ACO Associates
- Copper Sunset MR 2021 for Digby Wells
- Sannaspos PV facility 2021 for CTS Heritage
- Smithfield-Rouxville-Zastron PL 2021 for TheroServe
- Glosam Mine 2022 for AHSA
- Wolf-Skilpad-Grassridge OHPL 2022 for Zutari
- Iziduli and Msenge WEFs 2022 for CTS Heritage
- Hendrina North and South WEFs & SEFs 2022 for Cabanga
- Dealesville-Springhaas SEFs 2022 for GIBB Environmental
- Vhuvhili and Mukondeleli SEFs 2022 for CSIR
- Chemwes & Stilfontein SEFs 2022 for CTS Heritage
- Equestria Exts housing 2022 for Beyond Heritage
- Zeerust Salene boreholes 2022 for Prescali
- Tsakane Sewer upgrade 2022 for Tsimba
- Transnet MPP inland and coastal 2022 for ENVASS
- Ruighoek PRA 2022 for SLR Consulting (Africa)
- Namli MRA Steinkopf 2022 for Beyond Heritage

ix) **Research Output**

Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 170 articles published; 5 submitted/in press; 14 book chapters.
Scopus h-index = 30; Google Scholar h-index = 39; -i10-index = 116 based on 6568 citations.
Conferences: numerous presentations at local and international conferences.