Palaeontological Impact Assessment for the proposed Eskom Ararat-Bafokeng 88 kV powerline, Distribution Gemma Cluster, Northwest Province

Desktop Study (Phase 1)

For

Humba Environmental Consultancy

14 October 2021

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Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 32 years research; 24 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Humba Environmental Consultancy, 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 strengthening of the 88 kV powerline between the Ararat Substation and the Bafokeng 7 Substation, Northwest Province.

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 desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

Since there is no chance of fossils occurring at the **Ararat** site (Rustenburg Layered Suite) there will be no impact on the fossil heritage. The Significance is **Negligible**

There is a very small chance that fossils may be in the **Bafokeng 7** site (Quaternary gravels) but these will not be visible until excavations commence (construction phase). Mitigation requires that the developer / environmental officer look for fossils while the excavations are in progress (Section 8, Appendix A). If fossils are found and removed then there is no further impact on the other phases of the project. The Significance is **Negligible**

Based on this information it is recommended that, as far as the paleontological heritage is concerned, the project may be approved.

Table of Contents

1. Background

Impala Platinum has applied for an increase in NMD from 59 to 85MVA at the Bafokeng 7 substation point of supply. The application to ESKOM for an increase in the notified maximum demand (NMD) was necessitated by the Impala Platinum's increased mining activities, i.e., additional shafts, pumps, crushers and other rotational machinery that will require additional energy.

Project Description

Eskom's Bafokeng 7 substation currently has two (2) transformers that supply electricity to Impala platinum mine. Eskom proposes to add a 3rd transformer at Eskom Bafokeng 7 substation for Impala Platinum mine by reducing electricity load at Millennium Substation which feeds Millennium mine and increasing/taking it to Bafokeng 7 substation which will supply more electricity load for Impala Platinum mine.

The scope of work for this project entails then,

1. the installation of a new 40MVA 88/33kV transformer at Eskom Bafokeng 7 substation; and
2. the splitting of the 2xSycamore 88kV lines that are entering the Bafokeng 7 88/33kV substation and the 2xSycamore 88kV lines that are also leaving the Eskom Ararat Main Transmission Substation (MTS), so as to increase a load for Impala Platinum mine while maintaining a firm supply at Eskom's Millennium 88/33/6.6kV substation by shifting load from the Millennium point of supply to Eskom's Bafokeng 7 substation.

In addition, Eskom Bafokeng 7 substation supplies the local townships of Mogono and Ga-Luka. The Ararat MTS supplies local substations like Minpro, SA Chrome, Millennium, Impala Platinum, Phokeng, Wildeplats and Bafokeng 7.

The proposed project will be in the Rustenburg Local Municipality (RLM) under the magisterial municipal district of Bojanala Platinum (BPDM) (Figures 1 - 3). Ararat MTS is approximately 4km due north-east of Phokeng town, capital of the Royal Bafokeng Nation. Bafokeng 7 substation is located between the Ga-Luka and Magono townships, Rustenburg. Ararat MTS is approximately 7.5km due south of Bafokeng 7 substation.

A Palaeontological Impact Assessment was requested for the Eskom Distribution Gemma Cluster – Rustenburg Sector 88 kV powerline. To comply with 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 desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (amended 2017)

	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
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	None
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;	None
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	N/A
o	A description of any consultation process that was undertaken during the course of carrying out the study	None

p	A summary and copies if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A

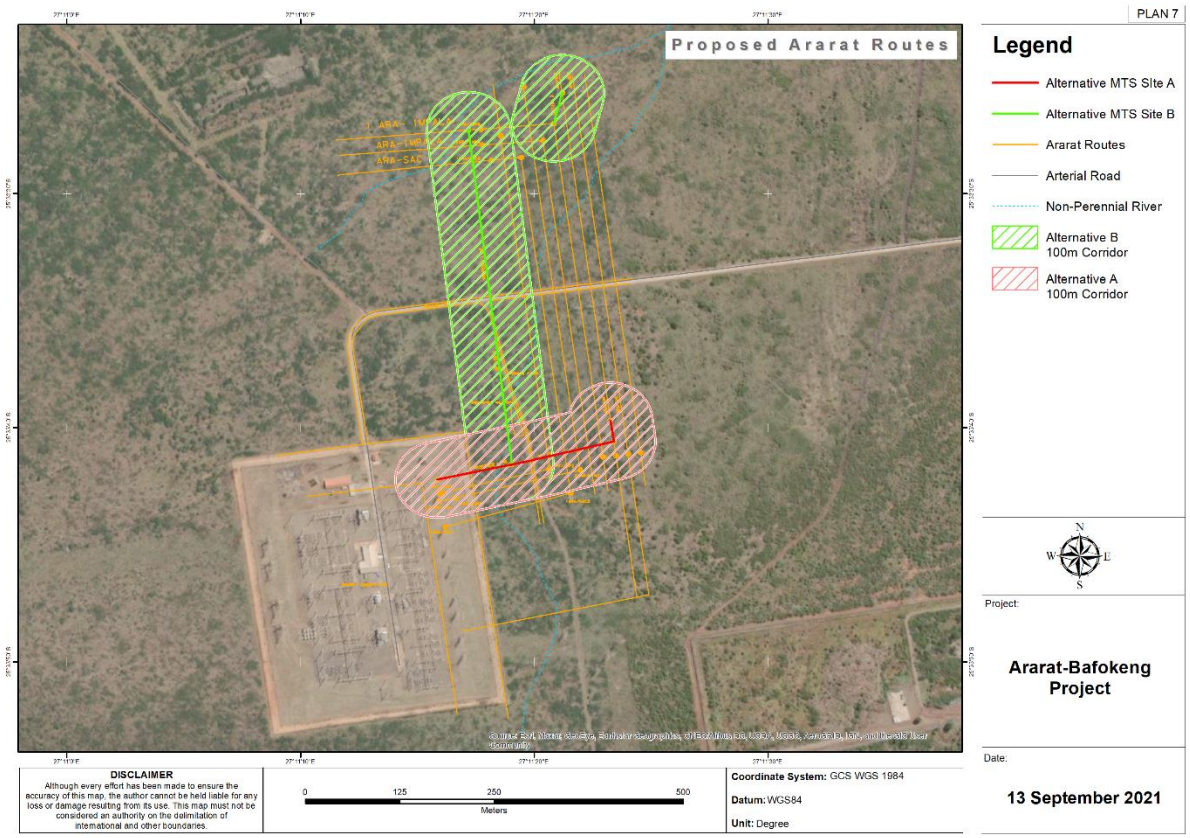

Figure 1: Aerial map of the proposed powerline route for Ararat Substation as part of the required increase in power supply for Impala Platinum (Pty) Ltd, Gemma Cluster, Rustenburg Sector. Map supplied by Humba.

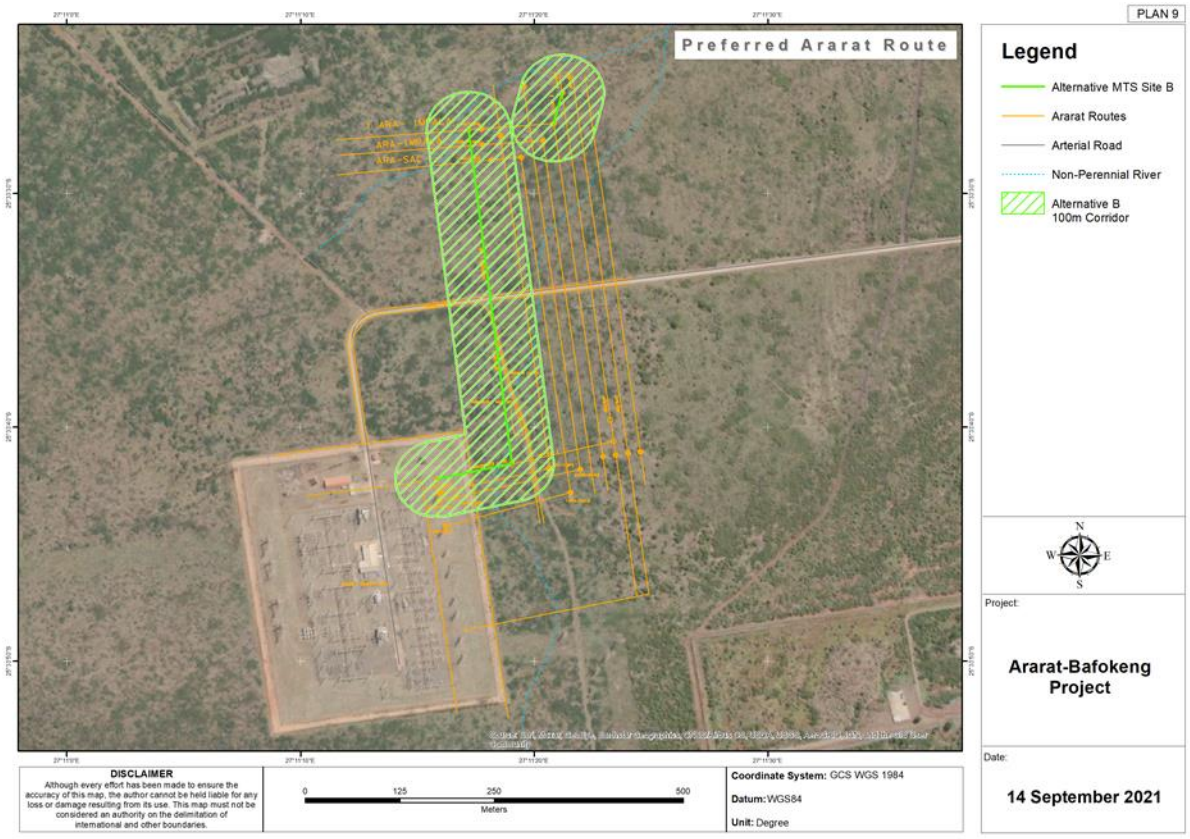

Figure 2: Aerial map of the preferred powerline route for Ararat Substation as part of the required increase in power supply for Impala Platinum (Pty) Ltd, Gemma Cluster, Rustenburg Sector. Map supplied by Humba.

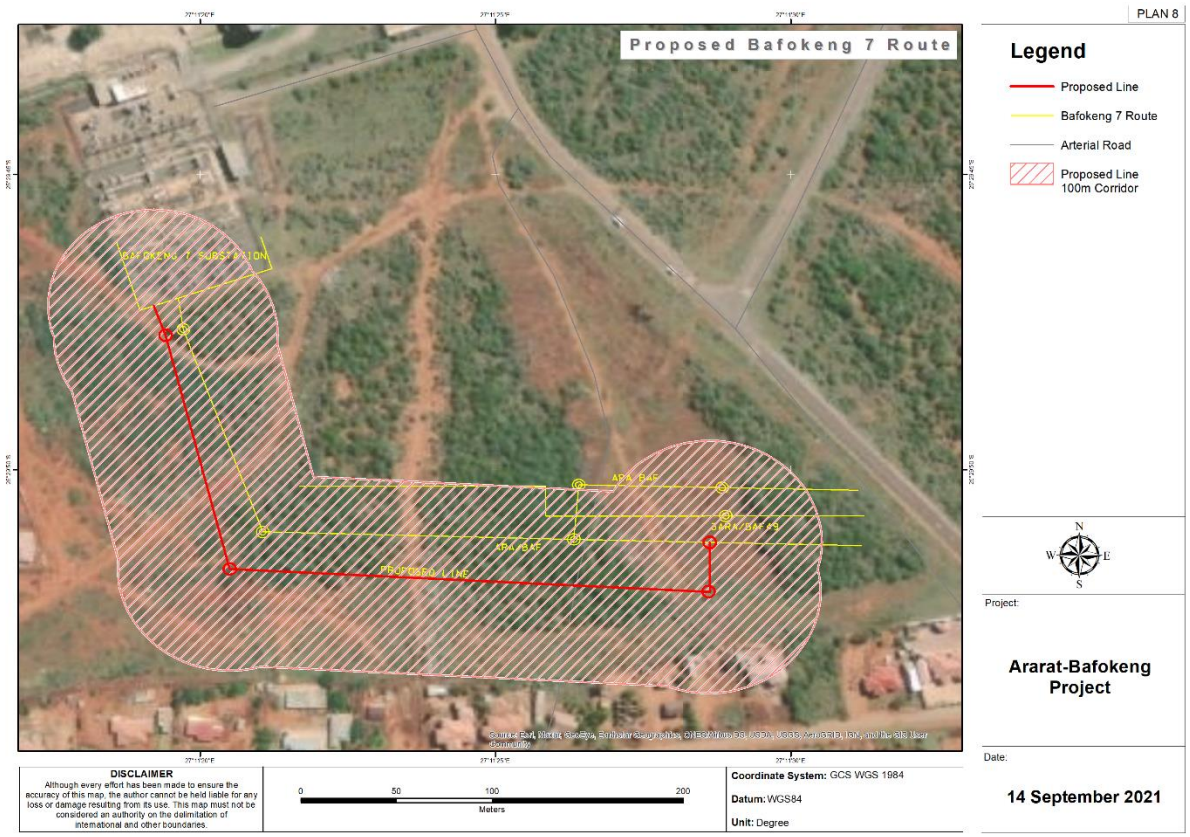

Figure 3: Aerial map of the proposed powerlines for Bafokeng 7 Substation as part of the required increase in power supply for Impala Platinum (Pty) Ltd, Gemma Cluster, Rustenburg Sector. Map supplied by Humba.

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 up to date 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 (*not applicable to this assessment*);
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

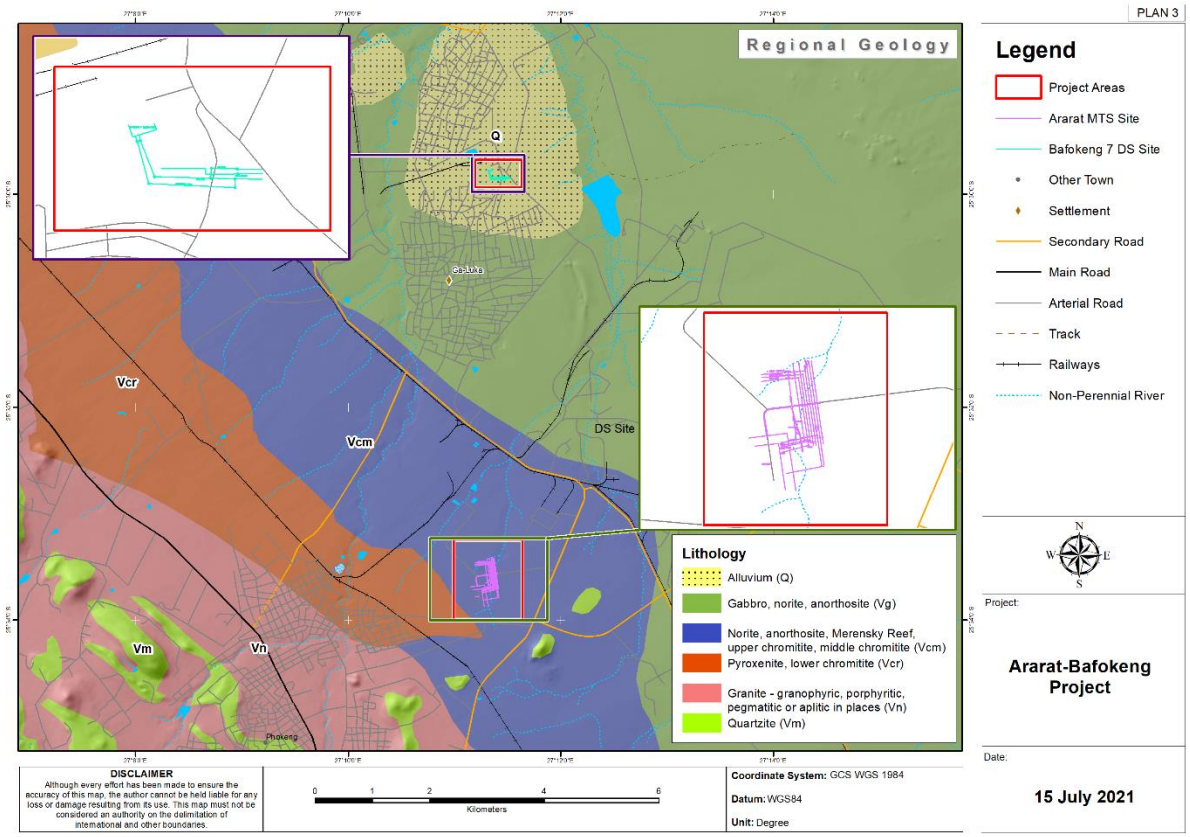

Figure 4: Geological map of the area around the Ararat (south) and Bafokeng 7 (north) substations are indicated within the red rectangles. Abbreviations of the rock types are explained in Table 2. Map based on the Geological Survey 1: 250 000 map 2526 Rustenburg with new colour coding.

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

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary gravel	Gravel, alluvium, scree	Quaternary, last 2.5 Ma
Vg	Pyramid Gabbro, Main Zone, western limb, Rustenburg Layered Suite, Bushveld Complex	Gabbro, norite, anothosite	Ca 2060 Ma
Vcm	Mathlagame Norite-Anorthosite, Critical Zone, western limb, Rustenburg Layered Suite, Bushveld Complex	Norite, anorthosite	Ca 2060 Ma
Vcr	Ruighoek Pyroxenite, Critical Zone, western	Pyroxenite, lower chromitite	Ca 2060 Ma

Symbol	Group/Formation	Lithology	Approximate Age
	limb, Rustenburg Layered Suite, Bushveld Complex		
Vn	Koloberg Norite, Marginal Zone, western limb, Rustenburg Layered Suite, Bushveld Complex	Norite	Ca 2060 Ma
Vm	Magaliesberg Fm, Pretoria Group, Transvaal SG	Quartzite, minor hornfels	Ca 2080 Ma

Rustenburg lies in the western limb of the Rustenburg Layered Suite of the Bushveld Complex (Figure 4). These volcanic rocks intruded through and between the sediments of the Transvaal Supergroup about 2060 million years ago (Cawthorn et al., 2006). The Rustenburg Layered Suite contains the platinum group elements that are being mined by a number of companies in the area.

Much younger sediments of Quaternary age overlie large areas of north western South Africa and are part of the widespread loose sands and sand dunes of the Gordonia Formation, Kalahari Group of Neogene Age. The Gordonia Formation is the youngest of six formations and is the most extensive, stretching from the northern Karoo, Botswana, Namibia to the Congo River (Partridge et al., 2006). It is considered to be the biggest palaeo-erg in the world (ibid). The sands have been derived from local sources with some additional material transported into the basin (Partridge et al., 2006). Much of the Gordonia Formation comprises linear dunes that were reworked a number of times before being stabilised by vegetation (ibid). In the Transvaal area there are only the outliers of this system, and locally derived soils and gravels are included in the transported sands.

ii. Palaeontological context

The intrusive volcanic rocks of the Rustenburg Layered Suite do not preserve fossils of any kind because they are igneous in origin. The Magaliesberg Formation quartzites are older than the evolution of body fossils. They were deposited in a high energy tidal flat, regressive shoreline and braid-delta setting (Eriksson et al., 2006) that is not suitable for the preservation of microbial traces, the only organisms that were present at that time (Plumstead, 1969).

Quaternary sands and gravel do not preserve fossils because they are transported and very young, but they might have included fragmentary or very small fossils within the sands from the source area (Partridge et al., 2006). However, because they are transported, the primary context of the fossils, if any, is lost, and so they are of very limited scientific value.

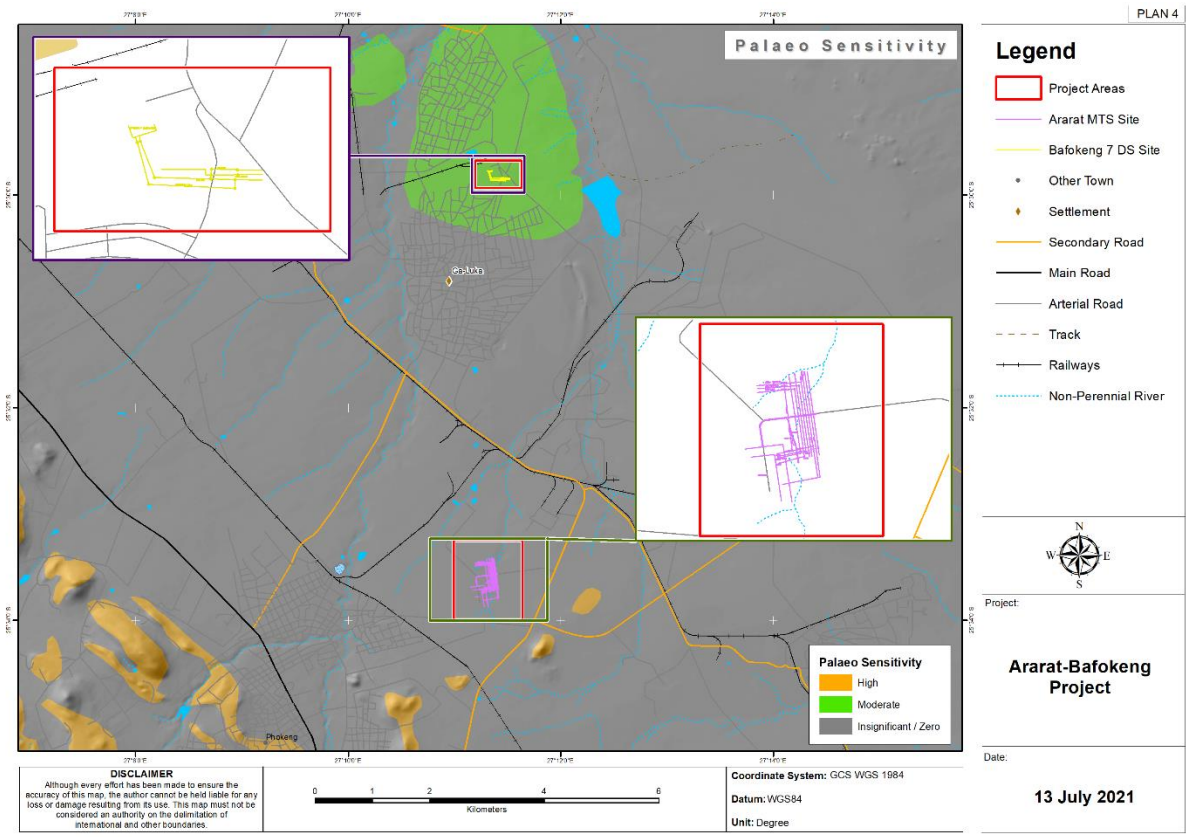

Figure 5: SAHRIS palaeosensitivity map for the site for the proposed Ararat and Bafokeng 7 Substation and powerline upgrades with the sites shown within the red rectangles. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above (Figure 5) the Ararat area is indicated as having insignificant palaeosensitivity (grey) and this applies to the rocks of the Rustenburg Layered Suite. The Bafokeng 7 site is on moderately sensitive rocks (green) applicable to the Quaternary Gravels.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in **Error! Reference source not found.**:

Table 3A: Criteria for Assessments

Category	Level	Explanation	Weight
Probability: This describes the likelihood of the impact	**Improbable**	The possibility of the impact occurring is very low, due to the circumstances, design, mitigation measures or experience	1
	Probable	There is a probability that the impact will occur to the extent that provision must be made, therefore	2

actually occurring	**Highly Probable**	It is most likely that the impact will occur at some stage of the development	4
	Definite	The impact will take place regardless of any prevention plans and there can only be relied on mitigatory measures or contingency plans to contain the effect	5
Duration: The lifetime of the impact	**Short Term**	The impact will either disappear with mitigation or will be mitigated through natural processes in a time span that is as long as the activity	1
	Medium Term:	The impact will last up to the end of the phases, where after it will be negated	3
	Long Term	The impact will last for the entire operational phase of the project but will be mitigated by direct human action or by natural processes thereafter	4
	Permanent:	The impact is non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.	5
Scale: The physical and spatial size of the impact	**Local:**	The impacted area extends only as far as the activity, e.g., the footprint	1
	Site:	The impact could affect the whole, or a measurable portion of the above-mentioned properties.	2
	Regional:	The impact could affect the area including the neighbouring district areas.	3
Magnitude / Severity: Does the impact destroy the environment, or alter its function?	**Low:**	The impact alters the affected environment in such a way that natural processes are not affected.	2
	Medium:	The affected environment is altered, but functions and processes continue in a modified way.	6
	High:	Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases	8
Significance = SUM (Duration + Scale + Magnitude) x Probability			
Significance: This is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required	**Negligible**	The impact is non-existent or unsubstantial and is of no or little importance to any stakeholder and can be ignored.	**≤ 20**
	Low:	The impact is limited in extent, has low to medium intensity; whatever its probability of occurrence is, the impact will not have a material effect on the decision and is likely to require management intervention with increased costs.	**> 20 ≤ 40**
	Moderate:	The impact is of importance to one or more stakeholders, and its intensity will be medium or high; therefore, the impact may materially affect the decision, and management intervention will be required.	**> 40 ≤ 60**
	High	The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the	**> 60**

		cost of management intervention will be a significant factor in mitigation.	

TABLE 3B: IMPACT ASSESSMENT

Impact	Project phase	Mitigation measures	Magni-tude	Scale	Duration	Probab	Signifi-cance
Project	**Ararat SS and powerlines**						
Destruction of fossils	Pre Con	WOM				0	none
Removal of fossils	Pre Con	WM				0	none
Absence of fossils	Constr					0	none
	Operation					0	none
	Decom					0	none
Project	**Bafokeng 7 SS and powerlines**						
Destruction of fossils	Pre Con	WOM	6	1	1	2	16
Removal of fossils	Pre Con	WM	2	1	1	1	4
Destruction of fossils	Constr	WOM	6	1	1	2	16
Removal of fossils	Contru	WM	2	1	1	1	4
Absence of fossils	Operation						n/a
	Decom						n/a

Abbreviations: Pre Con = Pre-Construction phase; Constr = Construction phase; WOM = Without mitigation; WM = With mitigation; Decon = Deconstruction Phase.

Since there is no chance of fossils occurring at the **Ararat** site (Rustenburg Layered Suite) there will be no impact on the fossil heritage. The Significance is **Negligible**

There is a very small chance that fossils may be in the **Bafokeng 7** site (Quaternary gravels) but these will not be visible until excavations commence (construction phase). Mitigation requires that the developer / environmental officer look for fossils while the excavations are in progress (Section 8, Appendix A). If fossils are found and removed then there is no further impact on the other phases of the project. The Significance is **Negligible**

Rationale: 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 either much too old to contain fossils and of the incorrect type (Rustenburg Layered Suite for the Ararat site), or transported so only fragments might be present (Quaternary gravels for the Bafokeng 7 site. Since there is an extremely small chance that fossils from the

source area of the gravels 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 extremely low.

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 igneous rocks (Rustenburg Layered Suite – Ararat site) are typical for the country and do not contain any fossils at all. Assuming that the Quaternary sands and gravels (Bafokeng 7 site) are typical for the country and have been transported, they would only be likely to entrap fragmentary fossils or very small fossils, if any were present in the source area. The Bafokeng 7 site most likely overlies rocks of the Rustenburg Layered Suite so there would be no fossils below ground. No fossils have been recorded from this region.

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the transported gravels and sands of the Quaternary. There is a very small chance that fossils may occur have been entrapped and transported so a Fossil Chance Find Protocol should be added to the EMPr. If fossils are found once excavations for poles and infrastructure has commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample (Section 8 and Appendix A for photographs).

7. References

Cawthorn, R.G., Eales, H.V., Walraven, F., Uken, R., Watkeys, M.K., 2006. The Bushveld Complex. 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 261-281.

Eriksson, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its pre-cursors. 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 237-260.

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.

Partridge, T.C., Botha, G.A., Haddon, I.G., 2006. Cenozoic deposits of the interior. 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 585-604.
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.

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 drilling/excavations commence.
2. When excavations begin the rocks and must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone or fragments) 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 6, 7). 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 developer/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.

Appendix A – Examples of transported fossils from the Quaternary deposits

Figure 6: Fragmentary fossil bones from a Quaternary deposit in the Free State.

Figure 7: Transported fragments of silicified wood (hard so can survive being transported) from a Quaternary fluvial deposit.

Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2021

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

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

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	11	0
Masters	10	4
PhD	11	4
Postdoctoral fellows	10	5

viii) 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 2-8 students per year.

ix) 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 –

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells

- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC
- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for EnviroPro
- 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

xi) Research Output

Publications by M K Bamford up to January 2021 in peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 29; Google scholar h-index = 35; -i10-index = 92
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)