Palaeontological Impact Assessment for the proposed VLNR weather tower on Farm Faure 33, Limpopo Province

Desktop Study (Phase 1)

For

Beyond Heritage

21 January 2022

Prof Marion Bamford
Palaeobotanist
P Bag 652, WITS 2050
Johannesburg, South Africa
Marion.bamford@wits.ac.za

Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, mASSAf
Experience: 33 years research and lecturing in Palaeontology
25 years PIA studies and over 200 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 construction of a weather tower for VNLR on Farm Faure 33, adjacent to the R572, northern Limpopo 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.

The proposed site lies on the Tshipise Member of the Clarens Formation (Stormberg Group, Karoo Supergroup) that could preserve fragments of fossil vertebrates or plants of middle Triassic age although none has been recorded from this area. 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 developer/ environmental officer/ other designated responsible person once excavations/drilling activities have commenced. As far as the palaeontology is concerned, the project should be authorised.

Table of Contents

1. Background

A proposal to construct a weather tower on a small portion of the Farm Faure 33, adjacent to the provincial road R572, in the northern Limpopo Province for the Venetia-Limpopo Nature Reserve (VLNR) is the subject of this report (Figures 1 – 3).

A Palaeontological Impact Assessment was requested for the project in order 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). Since the area as indicated as highly sensitive, a desktop 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
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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
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
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

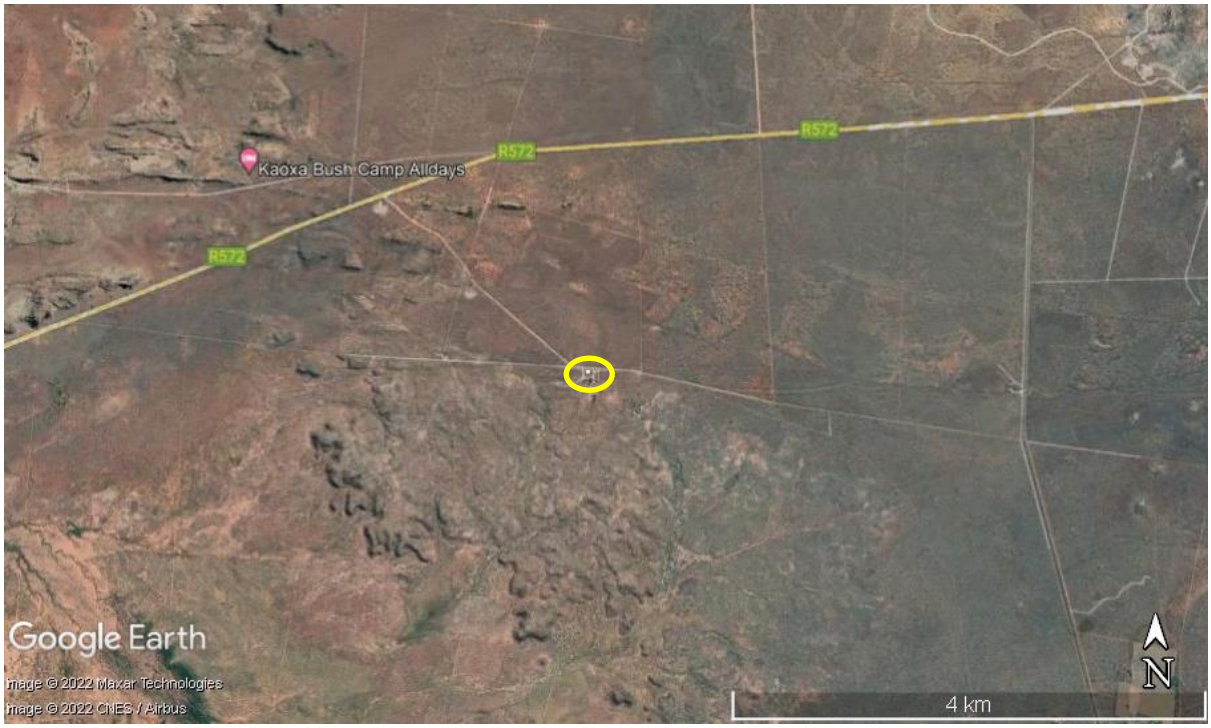

Figure 1: Google Earth map of the general area to show the relative land marks. The project is within the yellow circle.

Figure 2: Google Earth Map of the proposed construction o a weather tower for VLNR on Farm Faure 33 shown by the white block in the centre. Map supplied by Beyond Heritage.

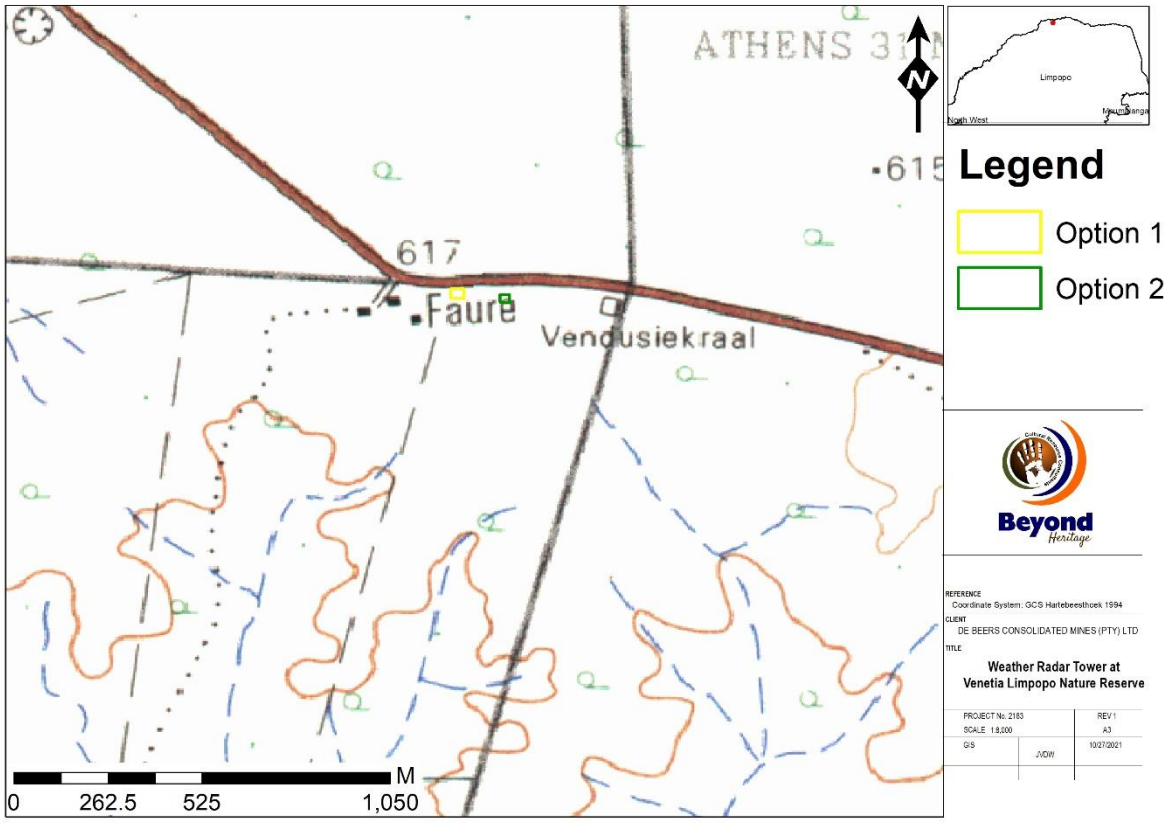

Figure 3: Annotated topographic map to show the position of the weather tower for VLNR.

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 (*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 VLNR weather tower site. The location of the proposed project is indicated within the yellow circle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2228 Alldays.

Table 2: Explanation of symbols for the geological map and approximate ages (Bordy, 2018; Bordy and Head, 2018; Johnson 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	Neogene, ca 2.5 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Tr-ct	Tshipise Mbr, Clarens Fm, Stormberg Group, Karoo SG	Fine to very fine-grained yellowish sandstones, aeolian	Jurassic
Tr-cr	Red Rocks Mbr, Clarens Fm, Stormberg Group, Karoo SG	Red rocks – fine-grained red and white mottled argillaceous sandstone	Middle - late Triassic

Symbol	Group/Formation	Lithology	Approximate Age
Tr-s	Solitude Fm, Karoo SG	Multi-coloured siltstones, sandstones, mudstones	Early Triassic, Beaufort Group
Pf	Fripp Fm, (Molteno Fm), Karoo SG	White feldspathic sandstones, grit and conglomerate	Late Permian – Triassic?
C-Pm	Mikambeni, Madzaringwe, Tshidzi Fms, Dwyka and Ecca Groups, Karoo SG	Mudstone, shale, carbonaceous shale, sandstone, conglomerate, coal seams, locally diamictites or conglomerate at the base	Late Carboniferous to Middle Permian

The site is in the Tuli Basin with a sequence of Karoo Supergroup rocks but the formations have different names. The Tuli and Tshipise Basins are controlled by faults that follow the trend of the Limpopo Belt, namely ENE – WSW faults so the sediments are preserved in fault blocks (Johnson et al., 2006).

Although not differentiated in the 1:250 000 geological map, the basal rocks comprise three formations, the Tshidzi, Madzaringwe and Mikambeni Formations that are equivalent of the Dwyka and Ecca Group sediments of the main Karoo Basin (Johnson et al., 2006; Bordy, 2018).

The overlying Fripp Formation, probably equivalent of the Molteno Formation Group is composed of sandstones and grits and was probably deposited by braided streams flowing towards the northwest and west.

Above the Fripp Formation is the Solitude Formation of fine-grained sediments and may represent the floodplain and overbank deposits of meandering rivers (Johnson et al., 2006).

Bosbokpoort Formation's predominantly red fine-grained sediments overlie the Solitude Formation and suggest deposition on the floodplains of meandering rivers, under dry oxidising conditions because of the abundance of calcareous concretions (ibid).

The youngest formation in this sequence is the Clarens Formation and it has been divided into a lower Red Rocks Member and upper Tshipise Member. Both are composed of argillaceous and aeolian sands and indicate dry conditions except for possible water-lain deposits at the base (ibid).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 5 with most of the area indicated as highly sensitive (red) because of the rocks of the Karoo Supergroup.

In particular, the Bosbokpoort and Clarens Formations potentially could have plant fossils of the *Dicriodium* flora (seed ferns, ferns, gymnosperms, lycopods and sphenophytes) or vertebrates such as therapsids (*Thrinaxodon*), dinosaurs (*Massospondylus, Euskeleosaurus*), plus many other vertebrates (Rubidge et al., 1995; Bordy, 2018; Bordy et al., 2020). Fossils are rare in the Clarens Formation relative to the older Elliot formation (Bordy et al., 2020).

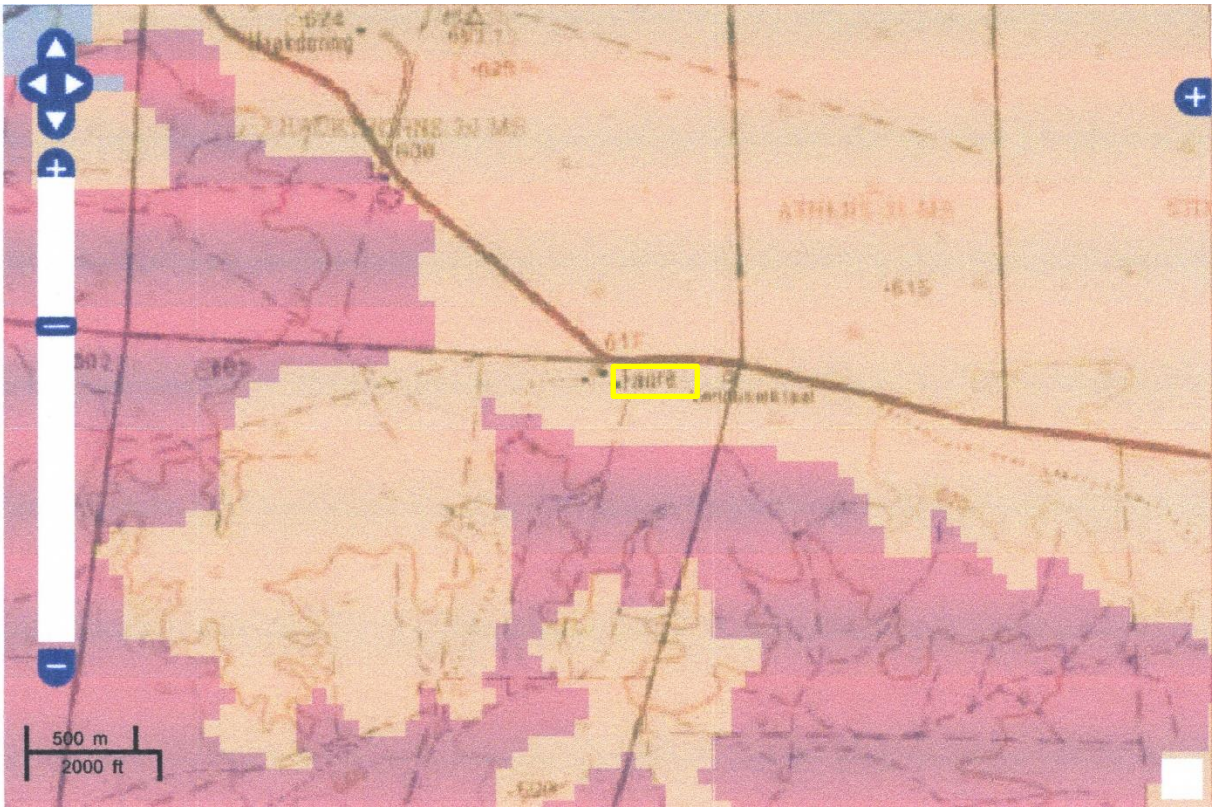

Figure 5: SAHRIS palaeosensitivity map for the site for the proposed VLNR weather tower (both options close together shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above the area is indicated as highly sensitive (orange) for the Tshipise Member of the Clarens Formation. The nearby Red Rocks Member is shown as very highly sensitive (red). Since the Tshipise Member is composed of very fine-grained aeolian sands it is unlikely to preserve fossils because the sands are windblown and represent desert conditions. Vertebrate fossils are more likely to occur in the Red Rocks Member because it represents wetter conditions in the past. The fossils, however, have been recorded from the equivalent rocks in the Kruger National Park (Bordy, 2018; Clayton, 2017; Johnson et al., 2006).

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

Table 3a: 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 3b: Impact Assessment

PART B: Assessment		
SEVERITY/NATURE	**H**	-
	M	-
	L	Surface soils and aeolian sands do not preserve fossils; so far there are no records from this area from the Tshipise Mbr of the Clarens Fm of plant or animal fossils so it is very unlikely that fossils occur on the site. The impact would be negligible
	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 trace fossils in sands or transported vertebrate bones in the sandstones, the spatial scale will be localised within the site boundary. Note – the footprint is very small.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area or in the aeolian sands of the Tshipise Mbr that will be excavated for foundations. 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 but are very fine-grained ancient aeolian sands so unlikely to contain fossils. Furthermore, the footprint for the tower foundations is very small. Since there is an extremely small chance that fossils from the Tshipise Member 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 dolomites, sandstones, shales and sands are typical for the country and might contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils. No fossils have been recorded from this area.

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 very small foot print of the tower in the aeolian sands of the Tshipise Member (Clarens Formation, Stormberg Group, Karoo Supergroup) or in the overlying soils of the of the Quaternary. There is a

very small chance that fossils may occur 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 for foundations for the tower have commenced then they should be rescued and a palaeontologist called to assess and collect a representative sample. The impact on the palaeontological heritage would be low so, as far as the palaeontology is concerned, the project should be authorised.

7. References

Bordy, E.M., 2018. Lithostratigraphy of the Tshidzi Formation (Dwyka Group, Karoo Supergroup), South Africa. South African Journal of Geology 121, 109 – 118.

Bordy, E.m., Abrahams M., Sharman, G.R., Viglietti, P.A., Benson, R.B.J., McPhee, B.W., Barrett, P.M., Sciscio, L., Condon, D., Mundil, R., Rademan, R., Jinnah, Z., Clark, J.M., Suarez, C.A., Chapelle, K.E.J., Choiniere, J.N., 2020. A chronostratigraphic framework for the upper Stormberg Group: Implications for the Triassic-Jurassic boundary in southern Africa. Earth Science Reviews 203, 103120.
https://doi.org/10.1016/j.earscirev.2020.103120

Bordy, E.M., Head, H.V., 2018. Lithostratigraphy of the Clarens Formation (Stormberg Group, Karoo Supergroup), South Africa. South African Journal of Geology 121, 119 – 130.

Clayton, K., 2016. Palaeoenvironmental succession in the Triassic/Jurassic Nyoka, Bosbokpoort, and Clarens formations of the Lebombo-Tshipise Basin: implications for fossil preservation and basin development. Unpublished MSc dissertation, University of the Witwatersrand, Johannesburg.

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.

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.

Rubidge, B.S. (Ed), 1995. Biostratigraphy of the Beaufort Group (Karoo Supergroup). Biostratigraphy Series 1, South African Commission for Stratigraphy. Council for Geoscience, 46 pp.

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, traces fossils) 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.

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

Figure 6: Photograph of a vertebrate fossil still embedded in the rock as this is what would be seen in the field (fragments of white bone).

Figure 7: Photographs of fossil leaf impressions from the Molteno Formation (Stormberg Group).

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2022

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.
NRF Rating: C-2 (1999-2004); B-3 (2005-2015); B-2 (2016-2020); B-1 (2021-2026)

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	13	0
Masters	11	3
PhD	11	6
Postdoctoral fellows	15	1

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 45 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 12-20 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 –
Associate Editor Open Science UK: 2021 -
Review of manuscripts for ISI-listed journals: 30 local and international journals
Reviewing of funding applications for NRF, PAST, NWO, SIDA, National Geographic, Leakey Foundation

x) Palaeontological Impact Assessments

Selected from the past five years only – list not complete:

- 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
- 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

xi) Research Output

Publications by M K Bamford up to January 2022 peer-reviewed journals or scholarly books: over 160 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 30; Google scholar h-index = 35; -i10-index = 92
Conferences: numerous presentations at local and international conferences.