(AHSA) Archaeological and Heritage Services Africa (Pty) Ltd

Palaeontological Impact Assessment for the proposed construction of the Witpan - Everest 2.8 km 132kV powerline, Welkom, Matjhabeng Local Municipality, Free State Province

Site Visit Report (Phase 2)

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Date: 07 October 2022

1. TITLE AND APPROVAL PAGE

Project Name:	Paleontological Impact Assessment (PIA) for the Construction of the Witpan-Everest 2.8km 132kv Powerline,	
Report Title:	Site Visit Report (Phase 2)	
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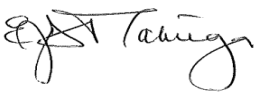
Reviewed by:	Dr Edward Matenga P O Box 2702, The Reeds, 0158, Centurion, Pretoria Email: e.matenga598@gmail.com. Cell: +27 73 981 0637 Website: www.archaeologicalheritage.co.za	 Signature
Managing Member	Gembe Moses Mahlangu	

Expertise of Specialist

The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 33 years research; 25 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Archaeological & Heritage Services Africa (Pty) Ltd, Pretoria, 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 the Witpan-Everest 2.8 km overhead 132 kV powerline Welkom, Matjhabeng Local Municipality, Free State Province. This deviation is required in order to improve accessibility to the poles because the pan water levels have risen in the last few years.

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 site lies on the potentially very highly fossiliferous shales of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) that could contain vertebrate fossils of therapsids. The site visit and walk through by the palaeontologist confirmed that there were NO FOSSILS in the powerline footprint or in the wider area. It is not known if there are fossils below the ground surface but from the existing exposures, this seems unlikely. 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, environmental officer or other designated responsible person once excavations for pole foundations have commenced. Since the impact will be low, as far as the palaeontology is concerned, the project should be authorised.

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2. Background

Since the water table has risen in the past few years and the water surface of the pan has increased, the Witpan-Everest 132kV power line has several pylons that are submerged in water. This has in created a challenge within the Eskom Maintenance division as the pylons are not accessible for maintenance and there is a high risk of loss of electrical supply to numerous customers should any of the pylons collapse. The Eskom staff need to be able to access these pylons at all times for repair or maintenance. Eskom, therefore, has initiated a project to deviate the power line in order to have all the new pylons running outside of the pan and any areas that are challenging to access..

A Palaeontological Impact Assessment was requested for the Witpan-Everest deviation 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
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 2
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 3
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

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
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 6
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 5
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 proposed development showing the relevant land marks.

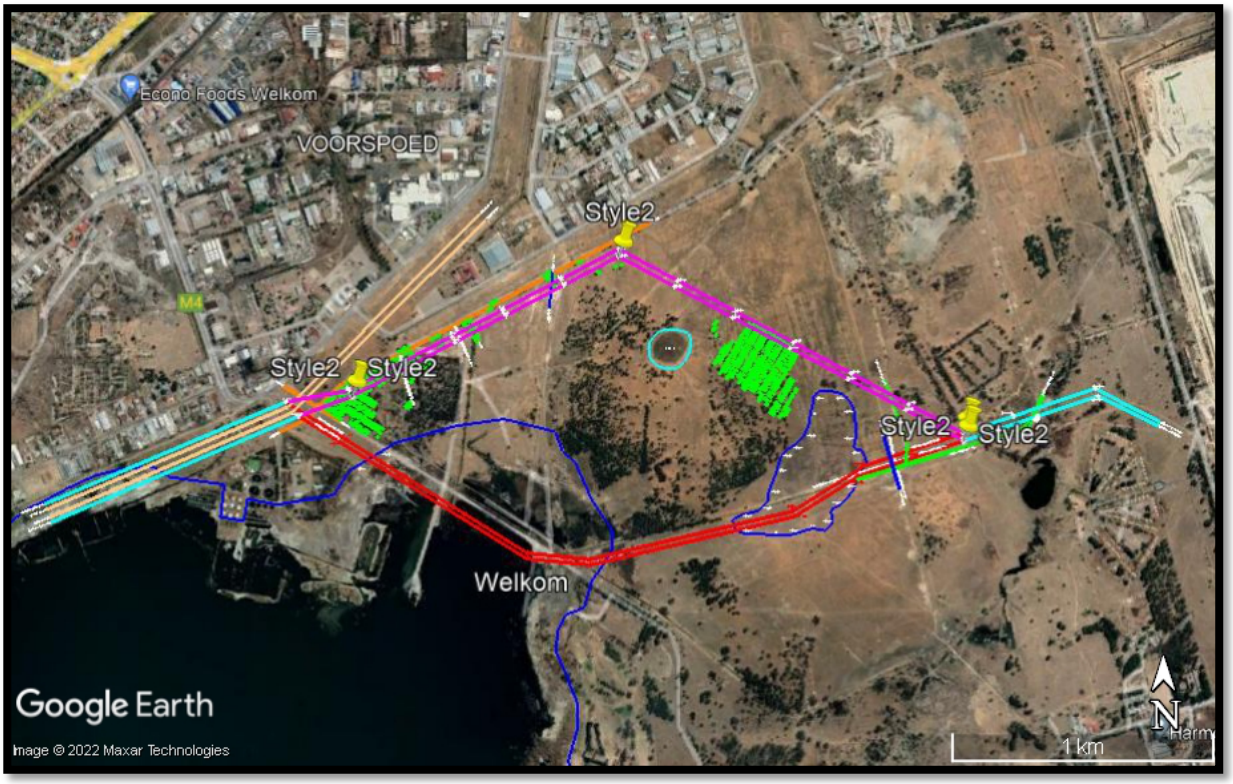

Figure 2: Google Earth map for the proposed powerline diversion (lilac line) to avoid the water (red line = existing line) for Witpan-Everest.

3. 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*).

4. Geology and Palaeontology

i. Project location and geological context

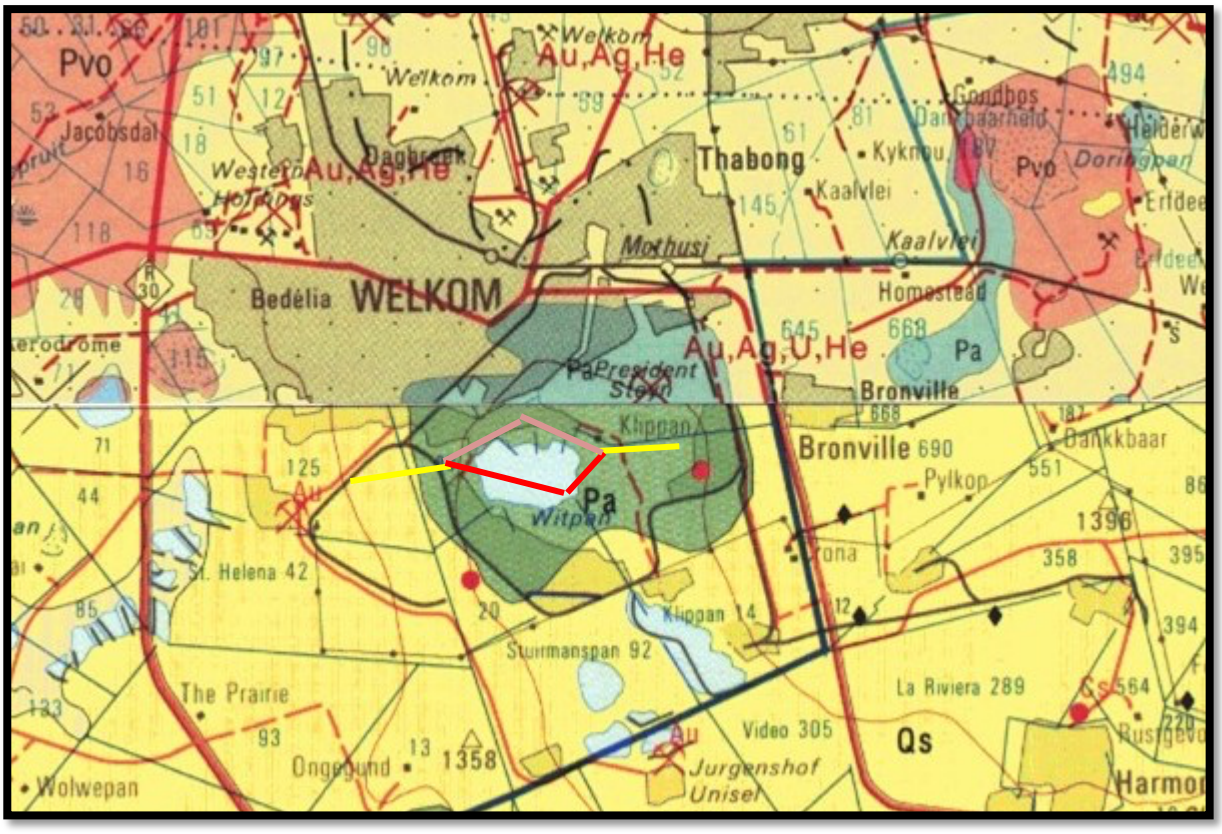

Figure 3: Geological map of the area around Welkom with the existing Witpan-Everest line (red) and the proposed deviation (lilac). Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2726 (top) and 2826 Winburg (bottom).

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
Qs	Quaternary	Alluvium, sand, calcrete	Neogene, ca 2.5 Ma to present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pa	Adelaide Subgroup, Beaufort Group, Karoo SG	Blue-grey silty mudstone, subordinate brownish-red mudstone; sandstone	Late Permian
Pvo	Volksrust Fm, Ecca Group, Karoo SG	Shales, carbonate-rich concretions; subordinate siltstone and sandstone	Middle Permian

The site lies in the central part of the Karoo basin where the middle Karoo Supergroup strata are exposed (Figure 3). Along the rivers and streams much young reworked sands and alluvium overly the older strata, and calcrete has formed in some areas.

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). Gradual melting of the ice as the continental mass moved northwards and the earth warmed, formed fine-grained sediments in the large inland sea. These are the oldest rocks in the system and are exposed around the outer part of the ancient Karoo Basin, and 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 Free State and KwaZulu Natal, from the 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 that has been divided into the lower Adelaide Subgroup for the Upper Permian strata, and the Tarkastad Subgroup

for the Early to Middle Triassic strata. As with the older Karoo sediments, the formations vary across the Karoo Basin.

In the eastern part of the Karoo Basin the Adelaide Subgroup comprises part of the Volksrust Formation that unconformably underlies the Normandien Formation. Previously known as the Estcourt Formation, the Normandien Formation has been divided into the Frankfort, Rooinekke, Schoondraai and Harrismith Members. Probaably because of the lack of fossils, the Adelaide Subgroup formations have not been distinguishable in this part of the basin.

Large exposures of Jurassic dolerite dykes occur throughout the area. These intruded through the Karoo sediments around 183 million years ago at about the same time as the Drakensberg basaltic eruption.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is in the Adelaide Subgroup which is not subdivided but might be the Daptocephalus Assemblage Zone.

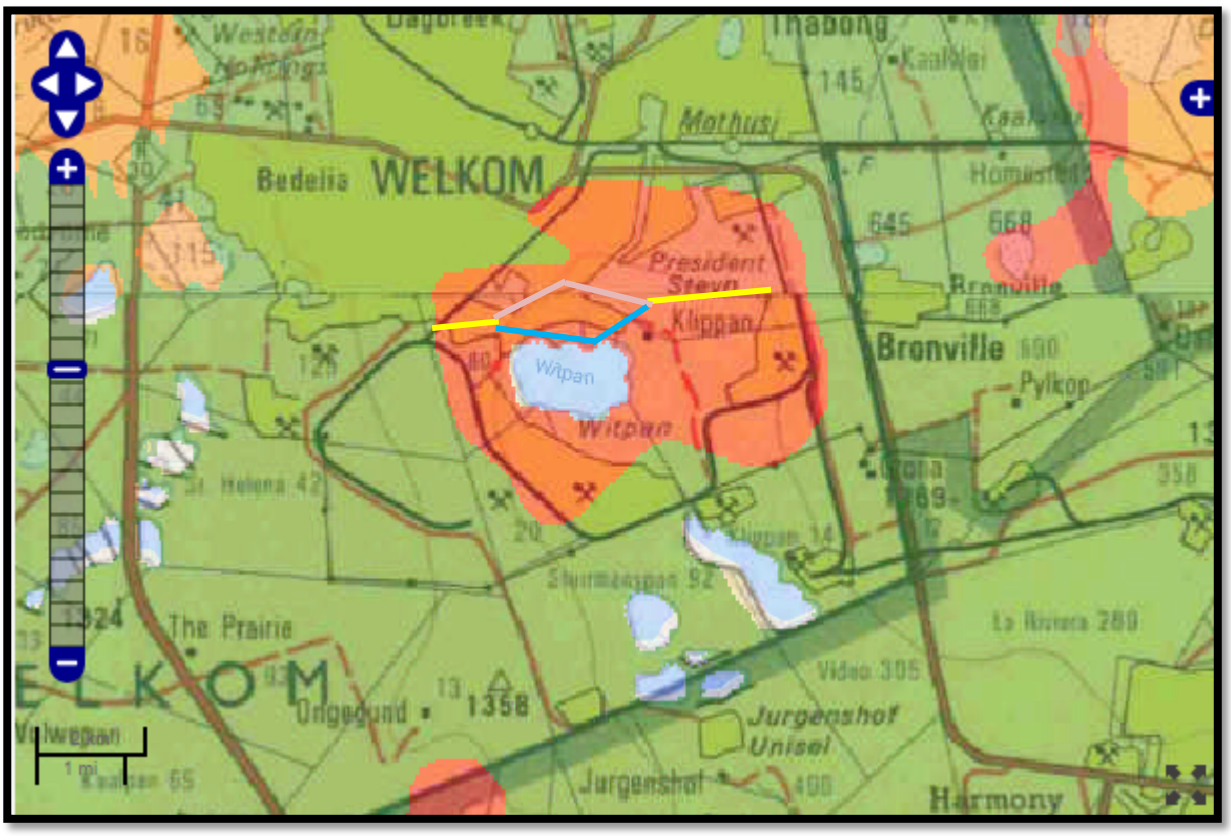

Figure 4: SAHRIS palaeosensitivity map for the site for the proposed Eskom Witpan-Everest 132kV line deviation. Lilac = new route; turquoise = existing route. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

The **Daptocephalus Assemblage Zone** is recognised by the co-occurrence of the dicynodontoid *Daptocephalus leoniceps*, the therocephalian *Theriognathus microps*, and the cynodont *Procynosuchus delaharpeae* (Viglietti, 2020). This has been further divided into two subzones, the lower *Dicynodon -Theriognathus* Subzone (in co-occurrence with *Daptocephalus*), and the upper *Lystrosaurus maccaigi – Moschorhinus kitchingi* Subzone (ibid). Other taxa include fish, amphibians, parareptiles, eureptiles, biarmosuchians, anomodontians, gorgonopsians, therocephaleans, cynodonts and molluscs. The flora is more diverse than the older Assemblage Zones and comprises glossopterids, mosses, ferns, sphenophytes, lycopods, cordaitaleans and gymnosperm woods (Plumstead, 1969; Anderson and Anderson, 1985; Bamford, 2004).

From the SAHRIS map above the area is indicated as very highly sensitive (red) so site visit is required. The precise identify of fossil bones in the field is difficult but it is possible to identify bones in general, and plant impressions.

iii. Site visit observations

The area of study is peri-urban and located on the fringe of a mining town. The area has been affected by physical works associated with the town's service infrastructure, mining operations and possibly previous cultivation. The deviation line traverses portions of a plantation, while the open veld to the east over which the lines will run was probably under cultivation in the past. In the cultivated areas the upper soil horizon would have been disturbed and rocks removed. The photographs in Figures 5-8 below illustrate the areas that were examined closely. No rocky outcrops of shales and no fossils were found in the footprint and along the wider route.

Table 3: Site observations, GPS points and relevant figures

GPS	Observations	Figure
Stop 1 27°59'54.02"S 26°45'50.82"E end: 27°59'55.79"S 26°45'52.64"E	The deviation from the existing line will start at the pair of pylons in the background. Note generally flat topography and no exposures of rocky outcrops.	5A
Stop 2 28° 9'56.59"S 26°46'12.30"E	The existing powerline that passes through a pan contaminated with sewerage will be decommissioned when the deviation has been completed. The powerlines will be removed, but a decision has been made not to excavate out the pylons since their footings are submerged in the contaminated pan. Photo taken facing east at this GPS point. No fossils would survive being submerged in water.	5B

Stop 3 27°59'56.64"S 26°46'5.60"	An area once occupied by a tailing dam. It is therefore considered as disturbed, and nothing in it would be in a primary context.	5C-D
Stop 4 27°59'51.6"S 26°46'01.6"E	Two pairs of pylons will be installed. The area was excavated to a depth of at least 60 cm to prepare the ground for the pine plantation. Such disturbance may make it unlikely that fossils will be found undisturbed.	6A
Stop 5 27°59'51.0"S 26°46'01.7"E	Between the plantation and the road, evidence of trench excavations along the road possibly for installations such as bulk water or sewer reticulation, or Transnet installations.	6B
Stop 6 27°59'45.4"S 26°46'16.8"E	A pair of pylons, 1EWD10 and 2EWD10 will be installed near a streambank profile that was examined. Modern alluvium and no fossil bones present.	6C-D
Stop 7 27°59'35.12"S 26°46'45.36"E	The open space on the eastern side of the plantation where the pairs 1EWD07 and 2EWD07; 1EWD06 and 2EWD06; 1EWD05 and 2EWD05; 1EWD03and 2EWD03; 1EWD02 and 2EWD02; 1EWD01 and 2EWD01. This photo is taken facing southeast at this GPS point.	7A
Stop 8 27°59'49.97"S 26°47'12.19"E	The pair 1EWD04 and 2EWD04 are located in the footprint if the plantation (the trees in the background), an area that is considered to be disturbed. This photo is taken facing northwest at this GPS point. No rocky outcrops and no fossils seen.	7B
Stop 9 28° 0'1.67"S 26°47'15.85"E	The existing powerline near the eastern point that the deviation will connect with; the old line will be decommissioned. This photo is taken facing east at the GPS point.	7C
Stop 10 27°59'53.6"S 26°47'.15.7"E	A test pit opened by a TLB - 150 cm deep shows a grey topsoil horizon, and brown subsoil. Sterile.	7D, 8A
Stop 11 27°59'59.16"S 26°47'14.94"E	Trenching done in the recent past probably to facilitate stormwater drainage from a mining site. No fossils.	8B

Figure 5. Bamford – PIA site – Witpan-Everest deviation

Figure 6

Bamford – PIA site – Witpan-Everest deviation

Figure 7.

Bamford – PIA site – Witpan-Everest deviation

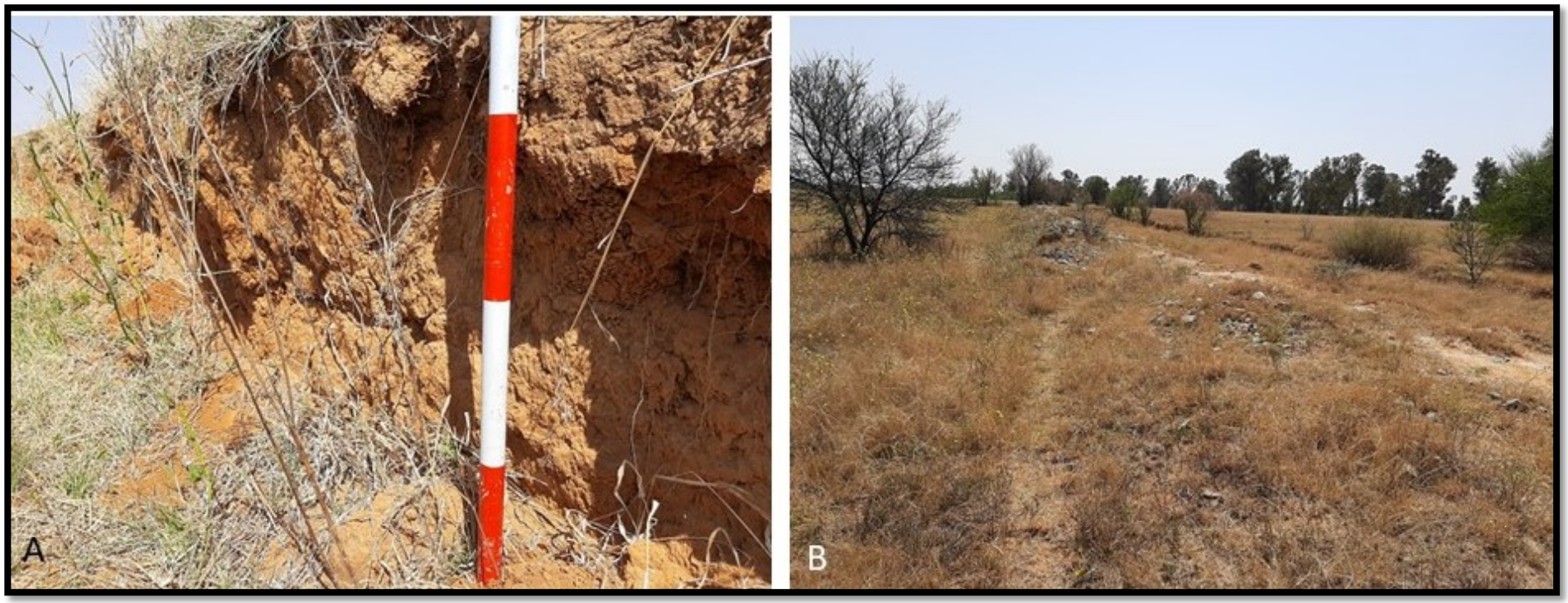

Figure 8. (see descriptions in Table 3) for the site observations.

5. 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 and sands do not preserve plant fossils; so far there are no records from the Adelaide Subgroup 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 bones of the Daptocepahlus Assemblage Zone 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 project footprint. Furthermore, the material to be excavated for foundations is soil and this does not preserve fossils. Since there is a small chance that fossils may occur in the undisturbed rocks below the surface 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 extremely low.

6. 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 only some might do contain fossil plant, insect, invertebrate and vertebrate material. The site visit and walk through by the palaeontologist confirmed that there are NO FOSSILS on the surface in the foundation footprints. The sands and soils of the Quaternary period would not preserve fossils.

7. Recommendation

Based on the fossil record but confirmed by the site visit and walk through there are NO FOSSILS of the Adelaide Subgroup (Daptocephalus Assemblge Zone) 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 and mudstones 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 (see Section 8).

8. 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.

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.

Viglietti, P.A., 2020. Biostratigraphy of the Daptocephalus Assemblage Zone (Beaufort Group, Karoo Supergroup). South African Journal of Geology 123, 191-206

9. 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 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 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 Figures 9-11). 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.

10. Appendix A – Examples of fossils from the Adelaide Subgroup

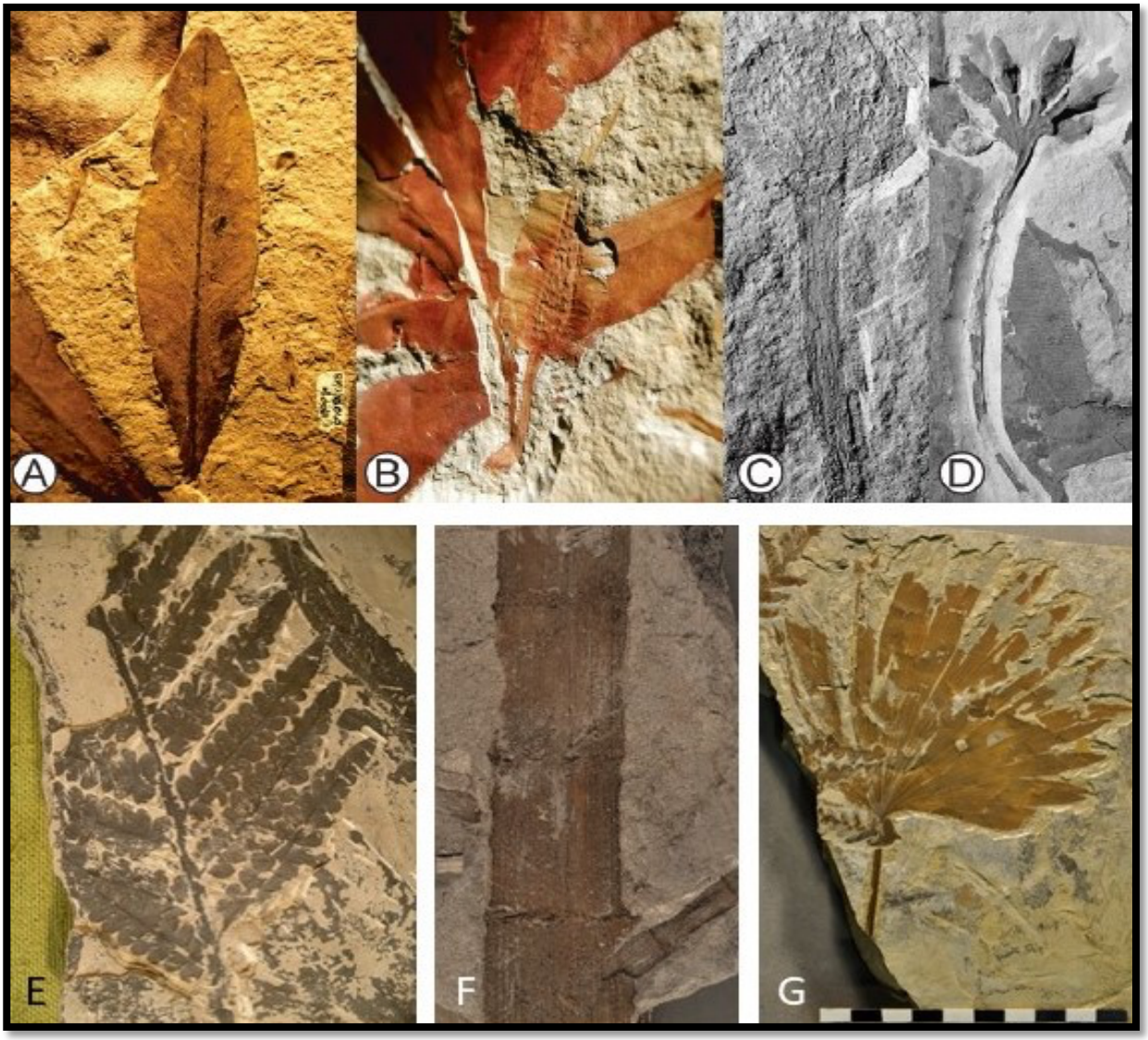

Figure 9: Photographs of fossil plant impressions from the Adelaide Subgroup.

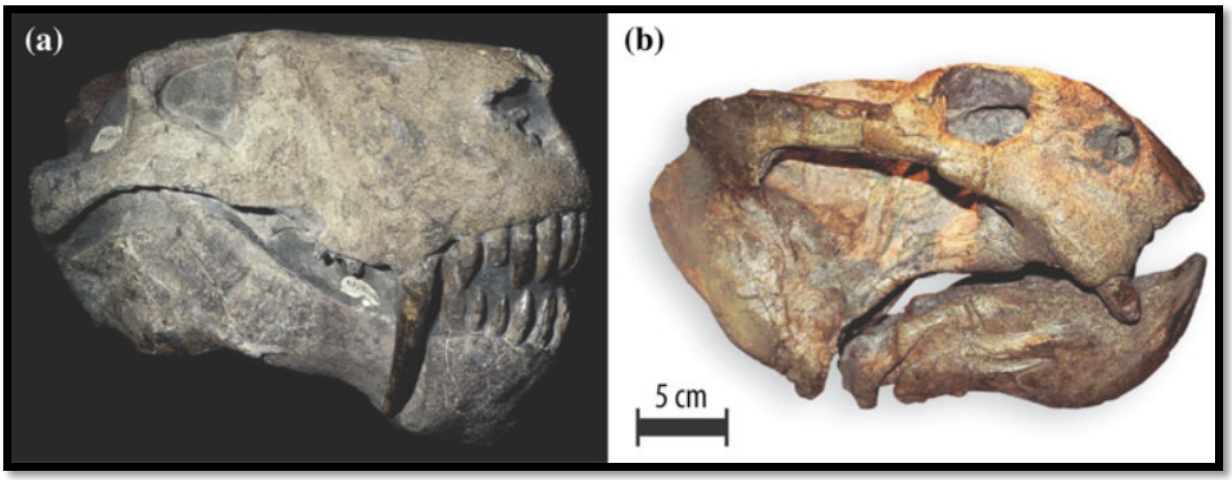

Figure 10: Therapsid skulls representative of two families that went extinct in the Permian: a flesh eating gorgonopsian, and b the herbivore dicynodont *Daptocephalus* (Photos supplied by Bruce Rubidge). In Linol and de Wit (2016) book Preface.

Figure 11: Photograph of what unidentified bones look like in the field – they appear white in the darker matrix.

11. Appendix B – Details of specialists

Marion Bamford (PhD)

Short CV for PIAs – July 2022

I) **Personal details**

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

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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	14	1
PhD	11	6
Postdoctoral fellows	12	2

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 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: Cretaceous Research: 2018-2020
Associate Editor: Royal Society Open: 2021 -
Review of manuscripts for ISI-listed journals: 25 local and international journals

x) **Palaeontological Impact Assessments**

Selected from recent project 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
- Glosam Mine 2021 for AHSA

Xi) **Research Output**

Publications by M K Bamford up to July 2022 peer-reviewed journals or scholarly books: over 165 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 30; Google Scholar h-index = 36; -i10-index = 95
Conferences: numerous presentations at local and international conferences.