Palaeontological Impact Assessment for the proposed Maintenance Management Plan (MMP) for the Laingsburg to Droëriver 132 kV Line, Western Cape Distribution Division, Western Cape Province

Project No: IDW00007E05053

Desktop Study (Phase 1)

For

Zutari (Pty) Ltd

30 August 2024; 16 September 2024

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27 years PIA studies and 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 Zutari (Pty) Ltd, 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: *MKBamford*

Executive Summary

A Palaeontological Impact Assessment (PIA) was requested for the proposed Maintenance Management Plan (MPP) for the entire route of approximately 192.54 km of the 132 kV overhead transmission line between Laingsburg Substation and Droëriver Substation, Western Cape Province. The line is in the Central Karoo District Municipality, Laingsburg Municipality, the Prince Albert Local Municipality and the Beaufort West Municipality. The proposed new pylon locations are within the strategic transmission corridor.

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 PIA was completed for the proposed development.

The existing route lies on the potentially very highly sensitive Ecca Subgroup Subgroup in the south, and the Abrahamskraal Formation in the central part and the Teekloof Formation (both Adelaide Subgroup) in the north. Along watercourses it traverses the moderately sensitive Quaternary fluvial sands. Although no fossils have been reported from this route any new excavations might expose fossil bones, therefore, a Fossil Chance Find Protocol should be added to the Environmental Management Programme (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 or drilling activities for new foundations have commenced. Since the impact will be moderate to low, as far as the palaeontology is concerned, the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	Very High	Moderate to Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

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1. Background

The Western Cape Distribution Division of ESKOM Holdings SOC Ltd is developing a Maintenance Management Plan (MMP) for the entire 132 kV overhead transmission line, which extends from the Laingsburg Substation to the Droërivier Substation, located just southwest of Beaufort West, covering a distance of 182.54 km (Figures 1-2).

The project is located in the Western Cape Province, in the following municipalities:

- Central Karoo District Municipality,
- Laingsburg Municipality,
- Prince Albert Local Municipality and the
- Beaufort West Municipality,

Duration of Assessment:
A pre application meeting was conducted with the Department of Forestry, Fisheries and the Environment (DFFE) on the 7th of August 2024, to confirm the triggered Environmental Impact Assessment (EIA) process.

A PIA was requested for the MMP for the Laingsburg to Droërivier powerline 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 desktop 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 EIA Regulations, 2014 (as amended) - Requirements for Specialist Reports (Appendix 6). Includes the requirements from GNR Appendix 6 of GN 326 EIA Regulation 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

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

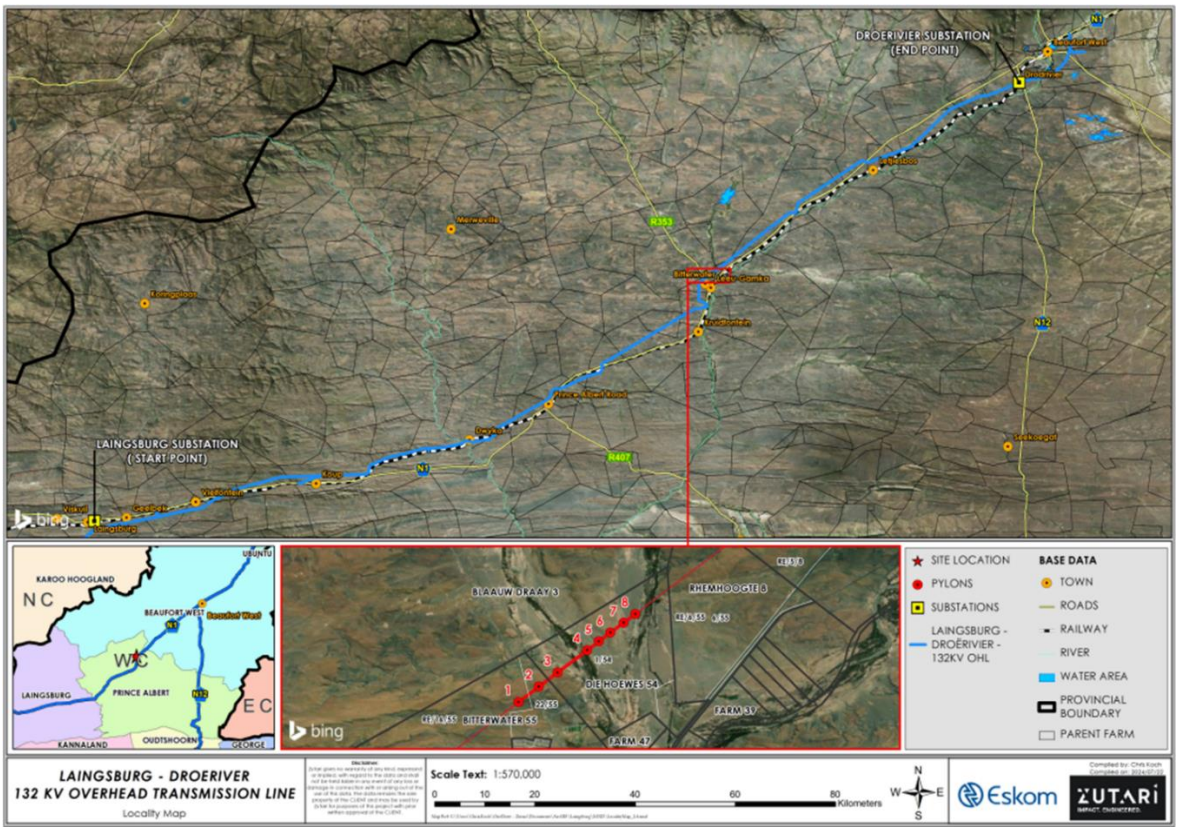

Figure 1: Google Earth map of the general area to show the entire transmission line route from Laingsburg in the southwest to Droërivier in the north east.

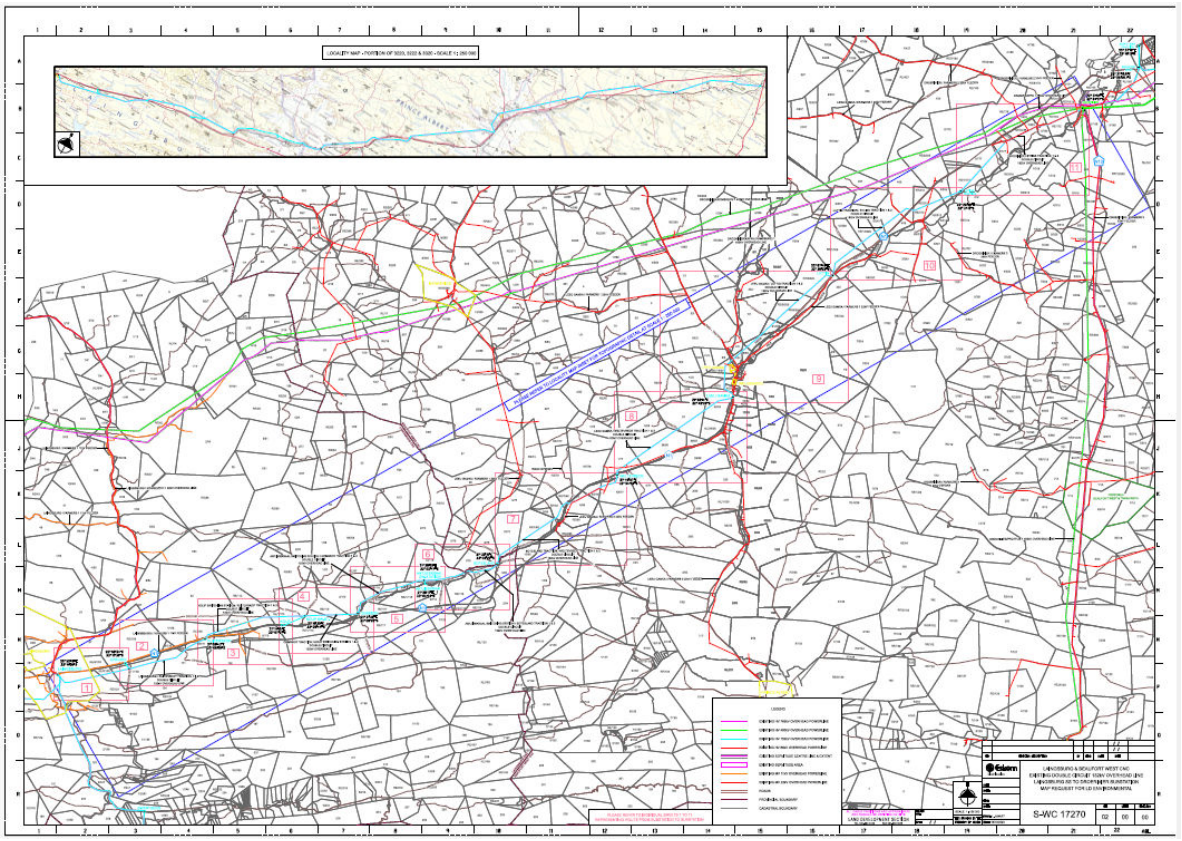

Figure 2: Map of the powerline route between Laingsburg and Droërivier near Beaufort West and the farms intersected.

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; eg https://sahris.sahra.org.za/map/palaeo
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' representativity 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

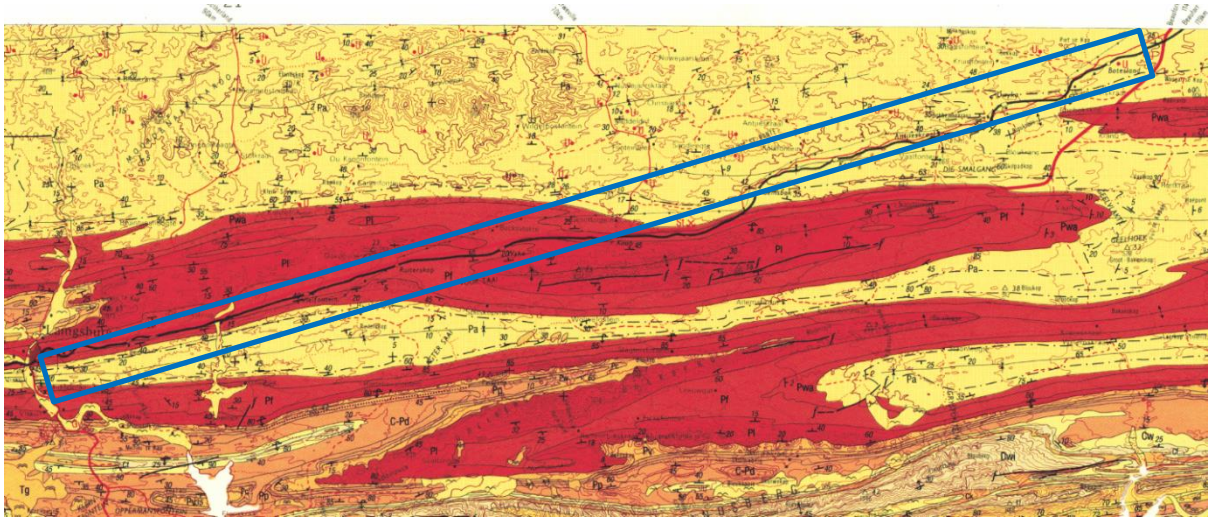

Figure 2a: Geological map of the <u>southern</u> section of the transmission line between Laingsburg to Leeu Gamka within the blue rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 3320 Ladismith.

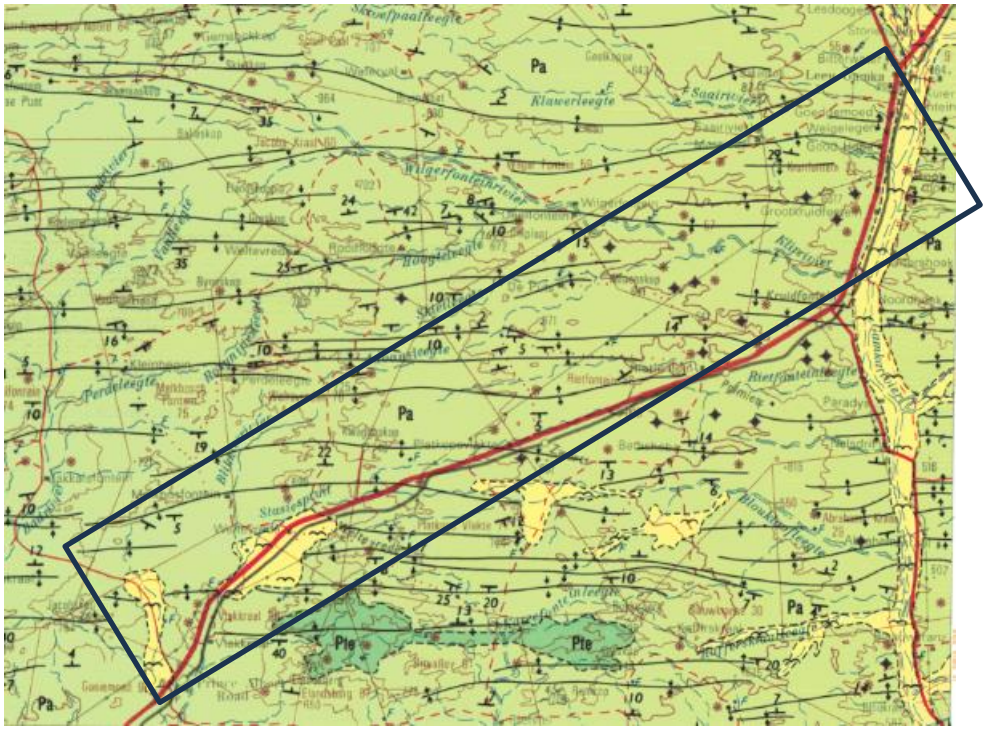

Figure 3b: Geological map of the <u>central</u> section of the transmission line from Laingsburg to Leeu Gamka within the blue rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 3220 Sutherland.

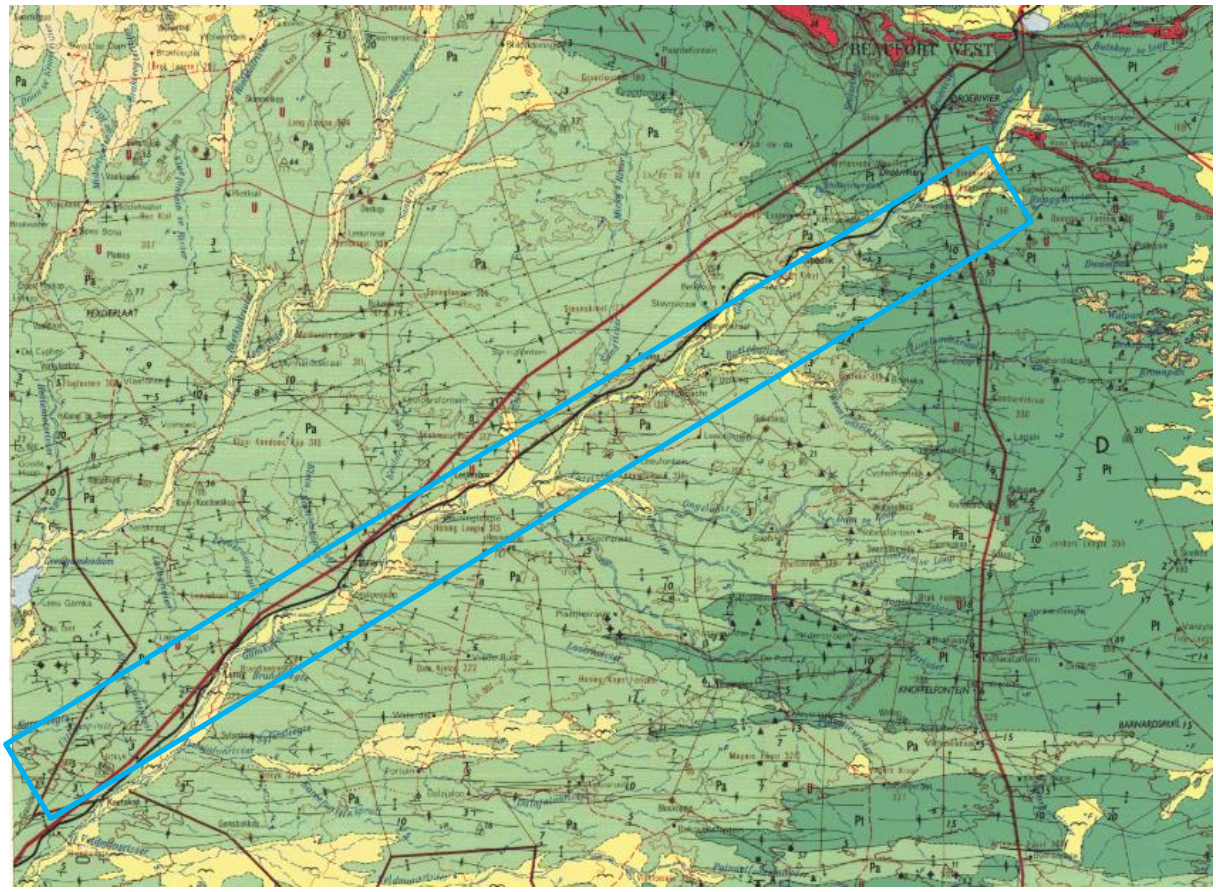

Figure 3c: Geological map of the <u>northern</u> section of the transmission line between Leeu Gamka and Droërivier within the blue rectangle. Abbreviations of the rock types are

explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 3222 Beaufort West.

Table 2: Explanation of symbols for the geological map and approximate ages (Eriksson et al., 2006. 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
Q	Quaternary	Alluvium, sand, calcrete	Quaternary Ca 1.0 Ma to Present
Jd	Jurassic dykes	Dolerite dykes, intrusive	Jurassic, approx. 180 Ma
Pa	Teekloof Fm, Adelaide Subgroup, Beaufort Group, Karoo SG	Mudstone, sandstone	Late Permian, ca 260 - 255 Ma
Pa	Abrahamskraal Fm, Adelaide Subgroup, Beaufort Group, Karoo SG	Mudstone, sandstone	Late Permian, ca 266 - 260 Ma
Pwa	Waterford Fm, Ecca Group, Karoo SG (Carnarvon Fm) old	Sandstone, shale	Middle Permian ca 269 – 266 Ma
Pf	Fort Brown Fm, Ecca Group, Karoo SG	Brown to grey shale	Middle Permian ca 269 – 266 Ma
C-Pd	Elandsvlei Fm, Dwyka Group, Karoo SG	Tillites, diamictites, sandstone , mudstone, shale	Early Permian, ca 298 – 290 Ma

The project lies in the southwestern part of the Main Karoo Basin where the older rocks of the sequence are present. Much of the area is unconformably overlain by the much younger Quaternary sands and alluvium.

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.

Overlying the basal Dwyka Group glacigene 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 west and central part are the following formations, from base upwards: Prince Albert Formation, Whitehill Formation, Collingham Formation, Laingsburg / Ripon Formations, Tierberg / Fort Brown Formations, and Waterford 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.

There are only two formations of the Adelaide Subgroup west of 24°E in the Karoo Basin, the basal Abrahamskraal Formation and the Teekloof Formation. The latter has been divided into four members, from the base upwards they are the Poortje, Hoedemaker, Oukloof and Steenkampsvlakte Members. There are no younger strata in this part of the basin (Smith et al., 2020).

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.

From uplift of the continent at various times in the past, weathering and erosion, sands alluvium and colluvium have washed down and been deposited on lower pediments, hillslopes and depressions. Some of these have become consolidated and in the eastern part only of the basin are known as the Masotcheni Formation (Partridge et al., 2006). These Late Pleistocene deposits are well represented in some parts of KwaZulu Natal but tend to erode easily and leave dongas (Botha, 2021). Along the rivers and valleys such sands are reworked and deposited and also are difficult to date. In the western part of the basin they are referred to as the Quaternary sands.

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 4. The site for development is in the very highly sensitive Adelaide Subgroup (red) and the moderately sensitive Quaternary fluvial sands (green). Depending on which assemblage zone is present, there are different vertebrate species that might be present:

The overlying **Fort Brown Formation** extends west and east of the 24°E line but outcrops are confined to the southern margin of the basin. It is composed of rhythmites and mudrock with minor sandstone intercalations, and displays an overall upward coarsening pattern (Johnson et al., 2006). The depositional environment was that of prodelta and distal-delta fronts. Trace fossils in this formation are those of worm burrows, *Cruziana* and *Skolithos* and indicate a progressive decrease in water depth in addition to the evidence from an increase in grain size and ripple marks (Johnson et al., 2006).

In the southern part of the basin the **Waterford Formation** comprises alternating very fine-grained lithofeldspathic sandstones and mudrock or clastic rhythmite units. These sediments represent fairly shallow water accumulations with deformation and dewatering features. A delta front setting is implied and trace fossils of trails, tubes and burrows have been reported (Johnson et al., 2006) Structures.

In the westernmost part of the basin the **Tierberg Formation** is predominantly argillaceous. In the northwest of its occurrence where it is in contact with the Collingham or Whitehill Formations, it grades up into the arenaceous overlying Waterford Formation (Johnson et al., 2006). Trace fossils of *Nereites, Planolites* and *Zoophycus* can be found in the fine mudstones (Johnson et al., 2006).

The **Abrahamskraal Formation** (lower Adelaide Subgroup) has been divided into the *Eodicynodon* and *Tapinocephalus* Assemblage Zones based on the dominant basal therapsid genera.

Typical fossils of the *Eodicynodon* Assemblage Zone are fish, amphibians, dinocephalians, anomodonts (including *Eodicynodon*), gorgonopsians, therocephalians, invertebrate trace fossils and molluscs (Rubidge and Day, 2020). Plants are not common but there are leaves of *Glossopteris* and *Schizoneura* (sphenophyte) (Plumstead, 1969; Anderson and Anderson, 1985; Bamford, 2004).

Typical fossils of the *Tapinocephalus* Assemblage Zone are fish, amphibians, parareptiles, eureptiles, biarmosuchians, dinocephalians (including *Tapinocephalus*), anomodontians, therocephalians, vertebrate and invertebrate trace fossils and molluscs (Day and Rubidge. 2020). There is a low diversity of fossil plants from this assemblage zone but they include glossopterids, sphenophytes and gymnosperm woods (Plumstead, 1969; Anderson and Anderson, 1985; Bamford, 2004).

The **Teekloof Formation** (Adelaide Subgroup) has been divided into the *Endothiodon, Cistecephalus* and lower *Daptocephalus* Assemblage Zones based on the dominance of various vertebrate taxa. Fauna of the ***Endothiodon* Assemblage Zone** include the co-occurrence of the dicynodonts *Endothiodon, Emydops, Pristerodon* as well as the gorgonopsian *Gorgonops* (Day and Smith, 2020). Other vertebrates are fish, amphibians, biarmosuchains, anomodontians, other gorgonopsians, therocephalians and vertebrate and invertebrate traces. Plants include glossopterids, lycopods and sphenophytes (Plumstead, 1969; Anderson and Anderson, 1985; Bamford, 2004).

The ***Cistecephalus* Assemblage Zone** is characterised by the co-occurrence of the *Aulacephalodon, Oudenodon* and *Odontocyclops,* which are medium- to large-sized dicynodonts, as well as *Diictodon, Pristerodon* and *Cistecephalus* which are smaller dicynodonts (Smith, 2020). Important components are the diverse, gorgonopsians *Aelurognathus, Cyonosaurus* and *Lycaenops.* The therocephalians *Theriognathus, Ictidosuchoides* and *Ictidosuchops* are rare components, as is the early cynodont *Cynosaurus.* Of the parareptiles, *Pareiasaurus* is most common taxon. The much rarer small-bodied pareiasaurs *Anthodon, Nanoparia*, and *Pumiliopareia* make their first and last appearances in the upper *Cistecephalus* Assemblage Zone (ibid). Fossil plants are rare and include glossopterids, lycopods and sphenophytes (Plumstead, 1969; Anderson and Anderson, 1985; Bamford, 2004).

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).

QUATERNARY

Fossils can be trapped in the Tertiary and Quaternary sands and alluvium but are seldom preserved there. Such fossils could be associated with palaeo-channels from rivers that have changed their course, such as the palaeo Koa and Orange Rivers.

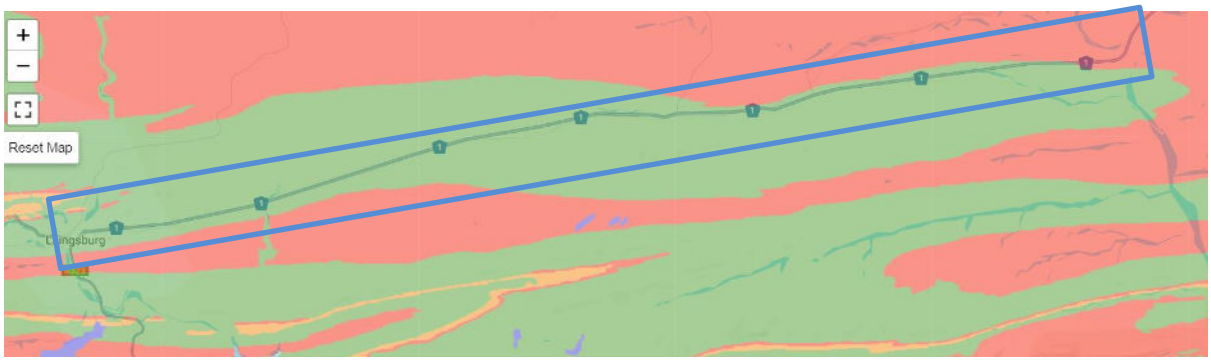

Figure 4a: SAHRIS palaeosensitivity map for the <u>southern</u> section of the Laingsburg to Droërivier transmission line shown within the blue rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

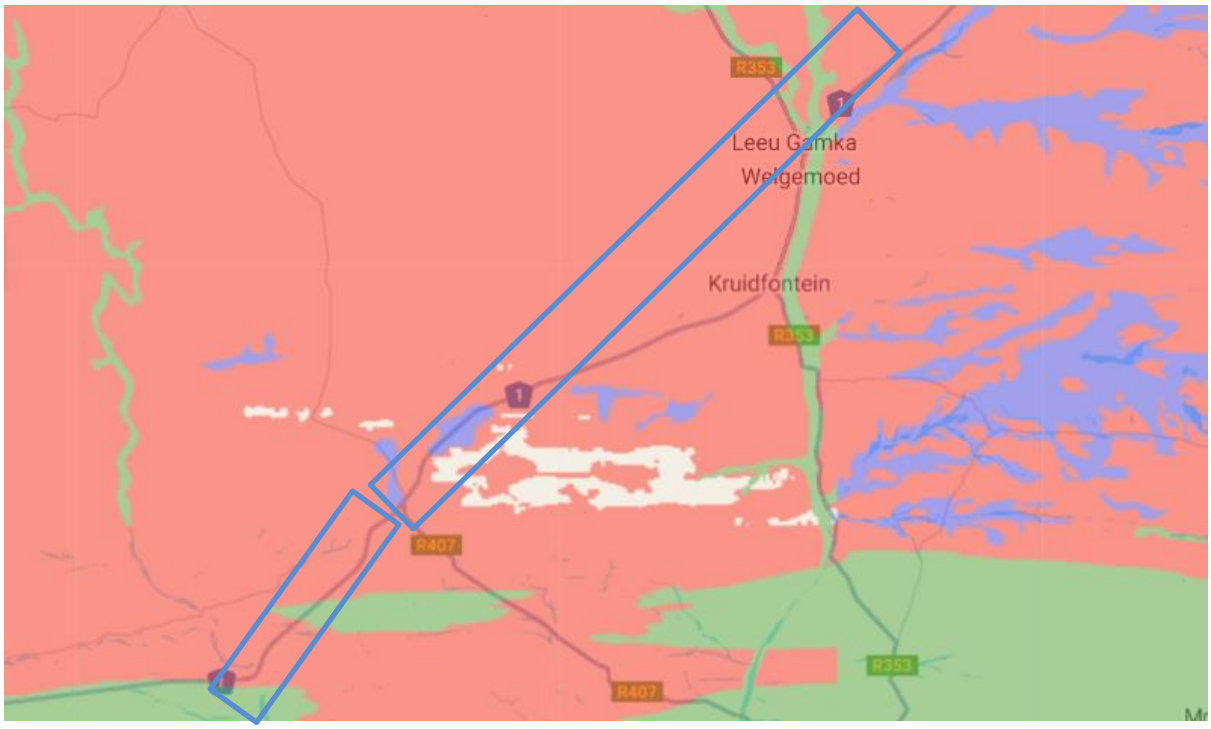

Figure 5b: SAHRIS palaeosensitivity map for the <u>central</u> section of the Laingsburg to Droërivier transmission line shown within the blue rectangle. Background colours as for Figure 4a.

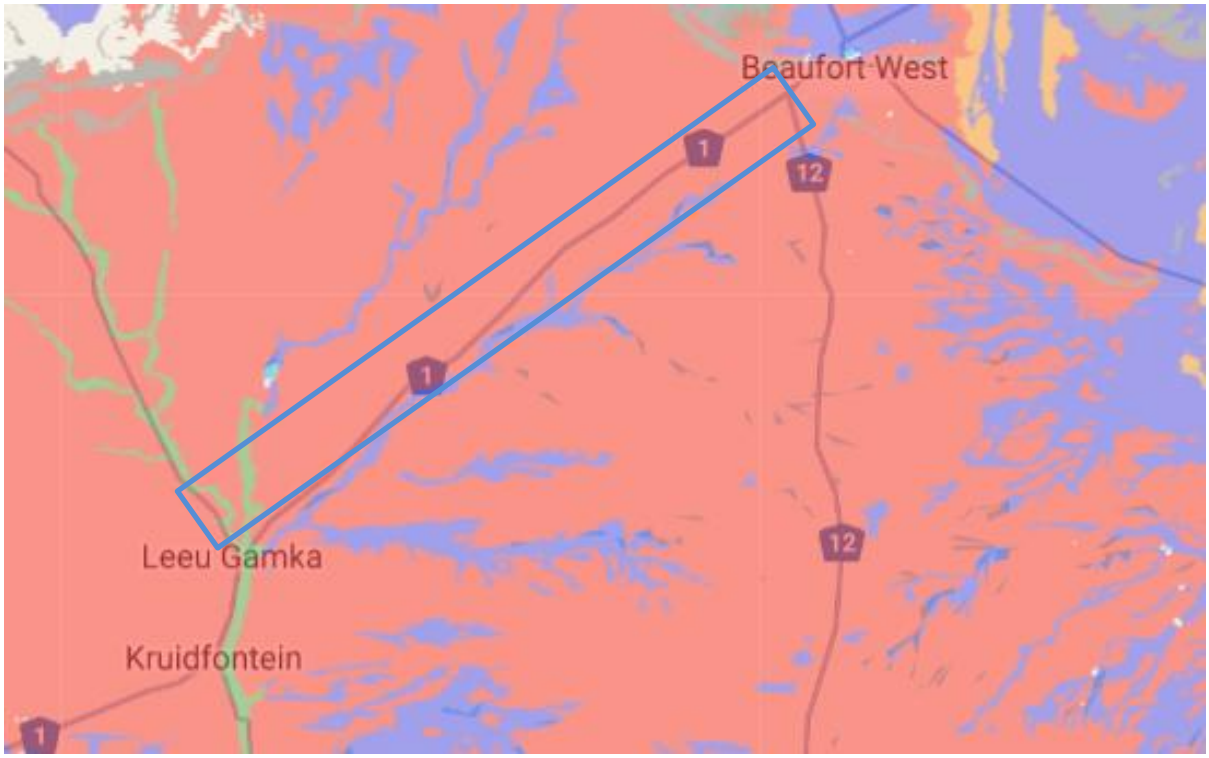

Figure 6c: SAHRIS palaeosensitivity map for the <u>northern</u> section of the Laingsburg to Droërivier transmission line shown within the blue rectangle. Background colours as for Figure 4a.

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	Sands do not preserve fossils; so far there are no records from the Adelaide Subgroup of plant or animal fossils in this route so it is very unlikely that fossils occur on the site. The impact would be negligible
	L+	-
	M+	-
	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 vertebrates in the mudstones, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	It is possible that vertebrates occur in the mudstones of the Adelaide Subgroup. Therefore, a Fossil Chance Find Protocol should be added to the eventual EMPr.
	L	It is extremely unlikely that any fossils would be found in the loose soils and sands that cover the area.

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 type and age to contain fossils but the route is disturbed by the current lines and recent flooding. Furthermore, the material to be excavated for foundations is soil and this does not preserve fossils. Since there is a small chance that fossils from the Adelaide Subgroup 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.

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 only some might contain fossil plant, insect, invertebrate and vertebrate material. Based on the geology map alone, the formations are not always discernible in this part of the Karoo Basin. More recent maps shown in Smith et al., 2020 are low resolution and the general area is simply indicated as being in the *Eodicynodon, Tapinocephalus* and *Cistecephalus* Assemblage Zones. The sands of the Quaternary period would not preserve fossils.

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 overlying soils of the Quaternary. There is a small chance that fossils may occur in the mudstones of the Adelaide Subgroup, probably the *Eodicynodon, Tapinocephalus* and *Cistecephalus* Assemblage Zones 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 new lattice structures and infrastructure 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, therefore as far as the palaeontology is concerned the project should be authorised.

ASPECT	SCREENING TOOL SENSITIVITY	VERIFIED SENSITIVITY	OUTCOME STATEMENT/ PLAN OF STUDY	RELEVANT SECTION MOTIVATING VERIFICATION
Palaeontology	Very High	Moderate to Low	Palaeontological Impact Assessment	Section 7.2. SAHRA Requirements

7. References

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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 discard must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, insects, bone or coal) 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 5-6). This information will be built into the EMPr'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 Heritage Western Cape (HWC) permit must be obtained. Annual reports must be submitted to HWC 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 HWC 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 Adelaide Subgroup

Figure 5: Photographs of fossil plants from the Beaufort Group (*Vertebraria* roots, *Glossopteris* leaves and silicified wood.

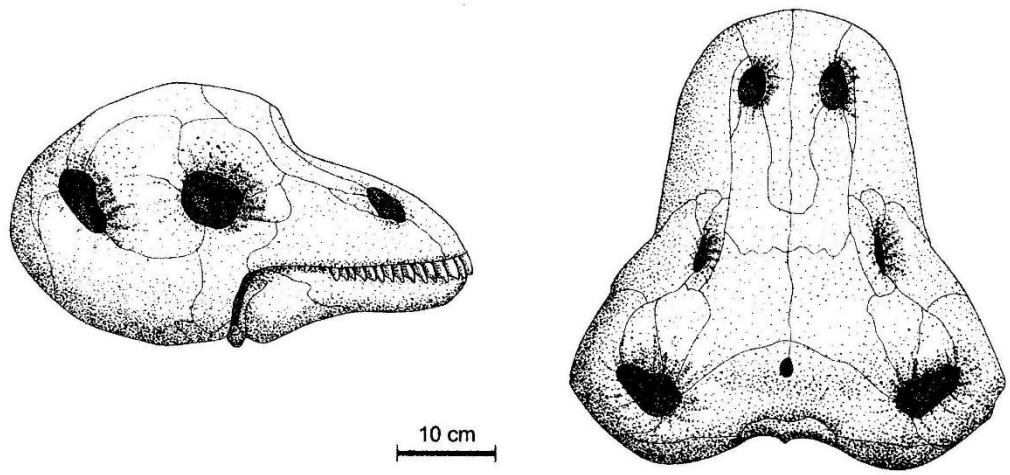

Figure 6: Diagrams of the skull of *Tapinocephalus* sp (From Rubidge, 2005; Day and Rubidge, 2020). In the field fragments or partly exposed white to beige bones is all that would be recognised.

10. Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2024

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
Telephone : +27 11 717 6690
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: 1983 onwards
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**
27 years' experience in PIA site and desktop projects
Selected from recent projects only – list not complete:

- 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
- Adara 2 SEF 2023 for CTS Heritage
- Buffalo & Lyra SEFs 2023 for Nextec
- Camel Thorn Group Prospecting Rights 2023 for AHSA
- Dalmanutha SEFs 2023 for Beyond Heritage
- Elandsfontein Residential 2023 for Beyond Heritage
- Waterkloof Samancor 2023 for Elemental Sustainability
- Zonnebloem WTP 2023 for WSP
- Elders Irrigation 2023 for SRK
- Leghoya WEFS 2023 for Red Cap & SLR

ix) **Research Output**
Publications by M K Bamford up to January 2024 peer-reviewed journals or scholarly books: over 175 articles published; 5 submitted/in press; 14 book chapters.
Scopus h-index = 32; Google Scholar h-index = 40; -i10-index = 121 based on 7261 citations.
Conferences: numerous presentations at local and international conferences.