



PALAEONTOLOGICAL DESKTOP ASSESSMENT

ARIES – KOKERBOOM 400 KV LOOP
IN LOOP OUT AND SUBSTATION
UPGRADE PROJECT IN THE
NORTHERN CAPE PROVINCE

January 2026

Compiled for: Environmental Impact
Management Services (Pty) Ltd (EIMS)



Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not
- All the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.



Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

PALAEONTOLOGICAL CONSULTANT:

Banzai Environmental (Pty) Ltd

CONTACT PERSON:

Elize Butler

Tel: +27 844478759

Email: info@banzai-group.com

SIGNATURE:



This Palaeontological Impact Assessment report (as part of the Heritage Impact Assessment report) has been compiled considering the National Environmental Management Act 1998 (NEMA) and Environmental Impact Regulations 2014 as amended, requirements for specialist reports, Appendix 6, as indicated in the table below.

Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended).		
Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
1.(1) (a) (i) Details of the specialist who prepared the report	Page ii and Section 2 of Report – Contact details and company and Appendix 2	-
(ii) The expertise of that person to compile a specialist report including a curriculum vita	Section 2 – refer to Appendix 2	-
(b) A declaration that the person is independent in a form as may be specified by the competent authority	Page ii of the report	-
(c) An indication of the scope of, and the purpose for which, the report was prepared	Section 4 – Methods and TOR	-
(cA) An indication of the quality and age of base data used for the specialist report	Section 5 – Geological and Palaeontological history	-
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 7	-
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Executive Summary, Section 8	Desktop Assessment
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 7 Approach and Methodology	-



Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended).

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
(f) details of an assessment of the specifically identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Executive Summary, Section 8	
(g) An identification of any areas to be avoided, including buffers	Executive Summary, Section 8	
(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;	Section 5 – Geological and Palaeontological history	
(i) A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4.1 – Assumptions and Limitation	-
(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	Executive Summary, Section 8	
(k) Any mitigation measures for inclusion in the EMP	Executive Summary, Section 8	
(l) Any conditions for inclusion in the environmental authorisation	Executive Summary, Section 8	
(m) Any monitoring requirements for inclusion in the EMP or environmental authorisation	Executive Summary, Section 8	
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and		

**Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended).**

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and	Executive Summary, Section 8	
(n)(ii) If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMP, and where applicable, the closure plan	Executive Summary, Section 8	-
(o) A description of any consultation process that was undertaken during the course of carrying out the study	N/A	Not applicable. A public consultation process was handled as part of the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) process.
(p) A summary and copies of any comments that were received during any consultation process	N/A	Not applicable. To date, no comments regarding heritage resources that require input from a specialist have been raised.



Table 1: Checklist for Specialist studies conformance with Appendix 6 of the EIA Regulations of 2014 (as amended).

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
(q) Any other information requested by the competent authority.	N/A	Not applicable.
(2) Where a government notice 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.	Section 3 compliance with SAHRA guidelines	



EXECUTIVE SUMMARY

Banzai Environmental was commissioned by Environmental Impact Management Services (Pty) Ltd (EIMS) to perform the Palaeontological Desktop Assessment (PDA) for the proposed **Establishment of a 400/132 kV transformation at Paulputs Substation** (Phase 1). The study area is located in close proximity of the existing Paulputs substation, approximately 35 km northeast of the small town of Pofadder. This Palaeontological Desktop Assessment (PDA) is required to determine the potential presence of fossil material in the proposed development area, evaluate the prospective impact of the development on Palaeontological Heritage, and mitigate potential harm to fossil resources, in accordance with the National Environmental Management Act 107 of 1998 (NEMA) and the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA).

The Aries-Paulputs-Kokerboom 400 kV LILO and Substation Upgrade project in the Northern Cape Province is mantled by superficial deposits of the Kalahari Group, with isolated inselbergs comprising Skuitklip, Nouzees Suite (unfoliated gabbro and olivine pyroxenite) as well as Konkresies Granite all of the Namaqua-Natal Igneous Province. According to the SAHRIS PalaeoMap, the Site Sensitivity of the study area is Moderate, Low, Zero and Unknown (Almond & Pether 2009; Almond et al. 2013; Groenewald et al. 2014). This is in agreement with the Medium Palaeontology Theme Sensitivity of the DFFE (Department of Forestry, Fisheries and the Environment) Environmental Screening Tool.

A Low Palaeontological Significance has been allocated for impacts associated with the construction phase of the development pre-mitigation and post-mitigation. The construction phase will be the only development phase with the potential of impacting Palaeontological Heritage, and **no significant impacts are expected to impact the Operational and Decommissioning phase.** As the No-Go Alternative considers the option of 'do nothing' and maintaining the status quo, it will have a Neutral impact on the Palaeontological Heritage of the development. **The Cumulative impacts of the development are considered to be Low (as the area is not highly fossiliferous), and falls within the acceptable limits for the project.** It is therefore considered that the study Project will not lead to damaging impacts on the palaeontological resources of the area. The development **may thus be permitted in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources.** It is consequently recommended that **no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required, pending the discovery of newly discovered fossils.**

Recommendations:

- In the **unlikely event** that, Palaeontological Heritage is uncovered during surface clearing and mining excavations, the ECO/site manager must report the find to the South African Heritage Resources Agency (SAHRA) (Contact details: **SAHRA, 111 Harrington Street, Cape Town. PO**



Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation (recording and collection) can be carried out.

- Before any fossil material can be collected from the development site, the specialist involved would need to apply for a **collection permit from SAHRA**. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012).

These recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Aries-Paulputs-Kokerboom 400 kV LIL0 and Substation Upgrade project study area in the Northern Cape Province.

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GLOSSARY OF TERMS

Fossil

A fossil is the preserved remains or traces of an organism that lived in the distant past, typically millions of years ago. These remains may include shells, mineralised bones, and other hard parts of ancient animals and plants, as well as impressions, moulds, and casts left in sedimentary rocks where organic material has decayed. Fossils offer important insights into the history of life on Earth, enabling scientists to study the evolution, diversity, and distribution of past organisms and ecosystems.

Heritage

That which is inherited and forms part of the National Estate (historical places, objects, fossils as defined by the National Heritage Resources Act (Act 25 of 1999) as amended.

Heritage resources

This means any place or object of cultural significance and can include (but not limited to) as stated under section 3 of the National Heritage Resources Act (Act 25 of 1999) as amended,

- places, buildings, structures and equipment of cultural significance,
- places to which oral traditions are attached, or which are associated with living heritage,
- historical settlements and townscapes,
- landscapes and natural features of cultural significance,
- geological sites of scientific or cultural importance,
- archaeological and palaeontological sites,
- graves and burial grounds and
- sites of significance relating to the history of slavery in South Africa.

Palaeontology

Palaeontology is the scientific study of ancient life through time and entails the examination of fossils—remains, traces, or impressions of organisms preserved in rocks. It seeks to understand the evolution, diversity, and interactions of past life forms, as well as the environmental conditions in which they lived. By integrating geology and biology, palaeontology provides crucial insights into the history of life on Earth over geological time.

The term palaeontology derives from the Latin palaeontologia, which in turn originates from the Greek words palaios (παλαιός), meaning “ancient,” and ontos (ὄντος), meaning “being” or “creature,” combined with the suffix -logia, meaning “study of.” The literal translation is therefore “the study of ancient beings.” In English usage, the classical Latin, British and South African spelling is palaeontology, while the American spelling omits the a after the p, rendering paleontology. In this report the Latin, English and South African spelling of Palaeontology will be used.



LIST OF ABBREVIATIONS

DFFE	Department of Forestry, Fisheries and the Environment
CA	National Competent Authority
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EIMS	Environmental Impact Management Services (Pty) Ltd
EMPr	Environmental Management Programme
ESO	Environmental Site Officer
GN	Government Notice
HIA	Heritage Impact Assessment
IRP	Renewable Generation Integration Plan
Ma	Millions of years ago
NEMA	National Environmental Management Act
NHRA	National Heritage Resources Act
PDA	Palaeontological Desktop Assessment
PSSA	Palaeontological Society of South Africa
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
S&EIA	Scoping & Environmental Impact Assessment
ToR	Terms of Reference



1 INTRODUCTION

Environmental Impact Management Services (Pty) Ltd (EIMS) was appointed to conduct the Scoping and EIA Application for the proposed construction of the **Aries-Paulputs-Kokerboom 400 kV LILO and Substation Upgrade project in the Northern Cape Province**. The project is in the Strategic Transmission Corridors that were set up by Government Notice (GN) R.113 on February 16, 2018. The planned development would trigger the following operations under the Environmental Impact Assessment (EIA) Regulations established under the National Environmental Management Act (NEMA), Act 107 of 1998, especially Regulations R982 to R985 of 2014, as revised in 2017.

This project's rationale is derived from the **Northern Cape Strengthening for Renewable Generation Integration** (IRP 2019) report (GP_20/206). The initiative constitutes an integral element of a collection of strategic programs delineated to fulfil the Northern Cape network enhancement requisites essential for achieving the renewable energy integration targets outlined in IRP 2019. **The Northern Cape already has more installed generation capacity than the province's peak load, and this is likely to grow even more when large-scale renewable energy generation capacity is added**, thanks to good solar and wind conditions. As a result, the **network infrastructure** has to be **significantly improved** so that the expected renewable energy facilities in the province can be connected to the grid and send power back to the grid (**Figure 1-3**).

The proposed **Aries-Paulputs-Kokerboom 400 kV LILO and Substation Upgrade project in the Northern Cape Province** will include:

- Loop in loop out the Aries – Kokerboom 400 kV line into Paulputs (~2 x 40 km);
- Establish/Equip 2 x 400 kV feeder bays at Paulputs Substation;
- Install a 100 MVA busbar reactor at Paulputs Substation
- Paulputs-Konkoonsies 33 kV OHL Deviation
- Build new MV OHL with new switchgear and equipment
- -± 1 km of new MV OHL (±800m of 33 kV OHL & ±200m of 19 kV SWER OHL)
- -New 33 kV Recloser
- -New 33 kV CT/VT metering unit
- -New 33/19 kV SWER Transformer
- New SWER 19 kV Single Phase Recloser
- -Disconnect, Decommission & Dismantle old equipment (the existing 33kV and associated infrastructure)



Aries-Paulputs-Kokerboom 400 kV LIL0 and Substation Upgrade Project in the Northern Cape

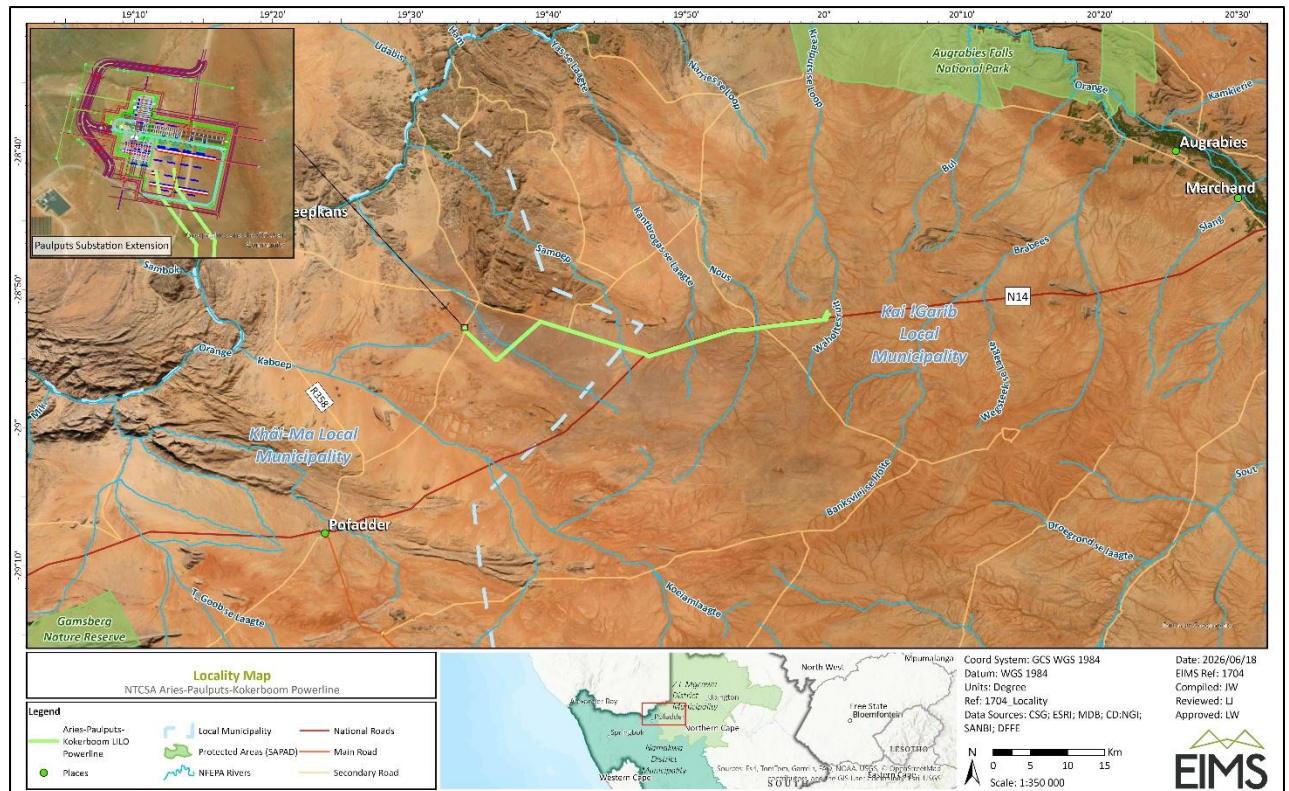


Figure 1: Proposed layout (supplied by EIMS).

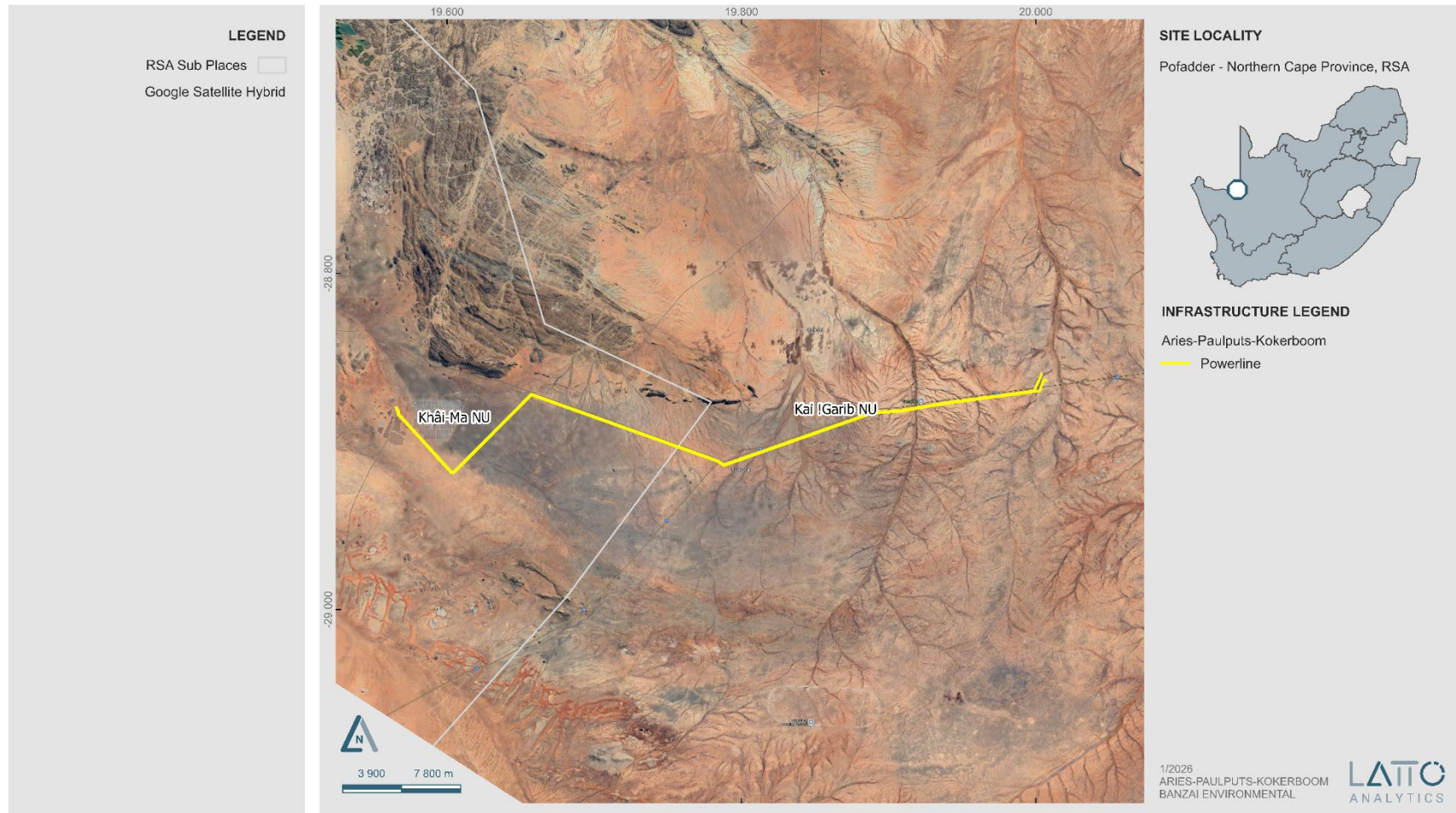


Figure 2: Extract of Google Earth (2025) indicating the proposed Aries-Paulputs-Kokerboom 400 kV LILO and Substation Upgrade project in the Northern Cape Province.

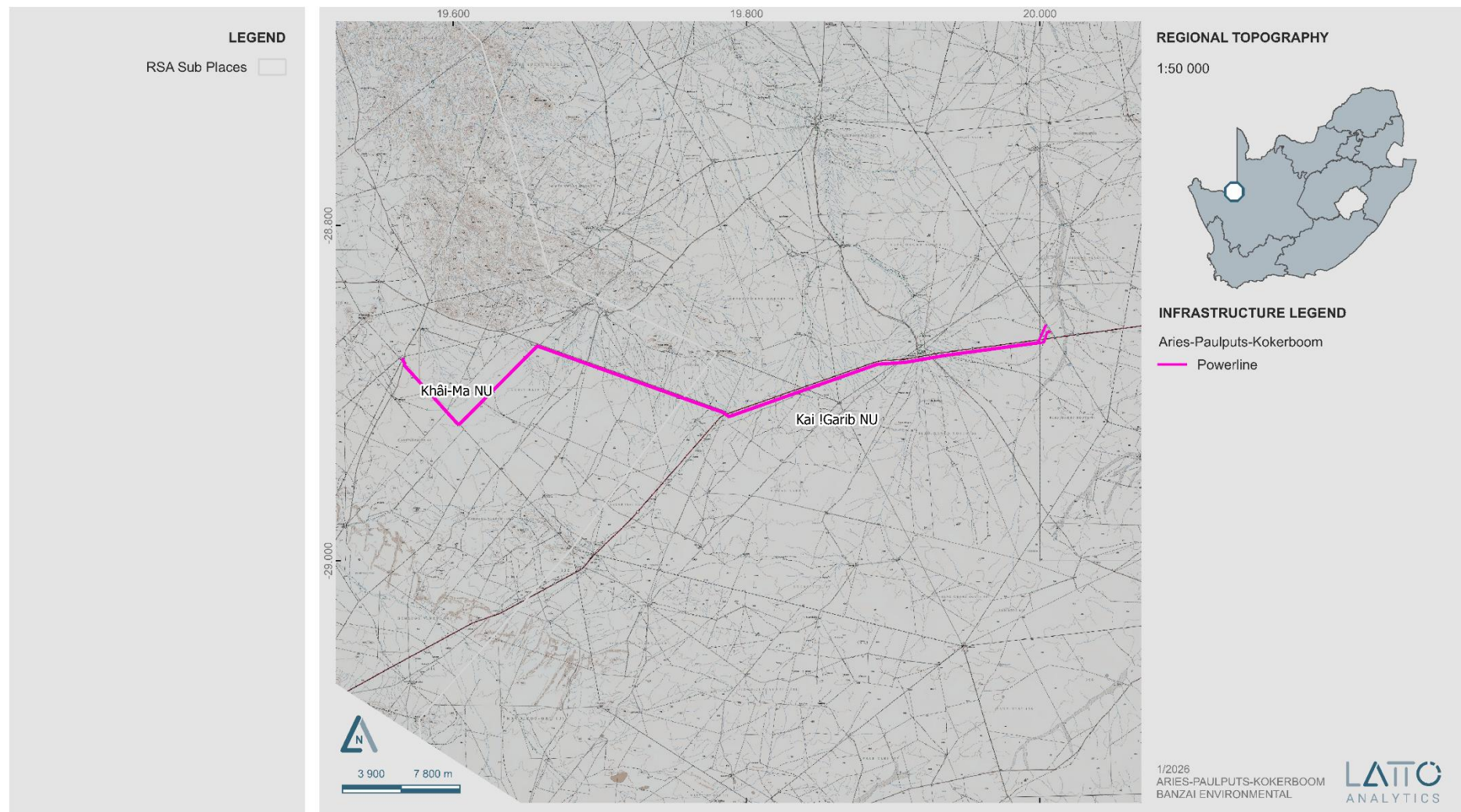


Figure 3: Locality Map.



2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

This study has been conducted by Mrs Elize Butler, palaeontologist of Banzai Environmental (Pty) Ltd. She has conducted approximately 900 palaeontological impact assessments for developments in the Free State, KwaZulu-Natal, Eastern, Western, and Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. She has an MSc (cum laude) in Zoology (specialising in Palaeontology) from the University of the Free State, South Africa and has been working in Palaeontology for more than thirty years. She has experience in locating, collecting, and curating fossils, including exploration field trips in search of new localities in the Karoo Basin. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

A short CV is attached in **Appendix 2**, while a detailed CV could be provided on request.

3 LEGISLATION

3.1 National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act No. 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include **“all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens”**.

The identification, evaluation and assessment of any cultural heritage site, artefact or finds in the South African context is required and governed by the following legislation:

- National Environmental Management Act (NEMA) Act No. 107 of 1998
- National Heritage Resources Act (NHRA) Act No. 25 of 1999
- Minerals and Petroleum Resources Development Act (MPRDA) Act No. 28 of 2002
- Notice 648 of the Government Gazette 45421- general requirements for undertaking an initial site sensitivity verification where no specific assessment protocol has been identified.

The next section in each Act is directly applicable to the identification, assessment, and evaluation of cultural heritage resources.

GNR 982 (Government Gazette 38282, 14 December 2014) promulgated under the National Environmental Management Act (NEMA) Act No. 107 of 1998

- Basic Assessment Report (BAR) – Regulations 19 and 23
- Environmental Impacts Assessment (EIA) – Regulation 23
- Environmental Scoping Report (ESR) – Regulation 21
- Environmental Management Programme (EMPr) – Regulations 19 and 23

National Heritage Resources Act (NHRA) Act No. 25 of 1999



- Protection of Heritage Resources – Sections 34 to 36
- Heritage Resources Management – Section 38

The NEMA (No. 107 of 1998) states that an integrated EMP should (23:2 (b)) “...identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage”.

In agreement with legislative requirements, EIA rating standards as well as SAHRA policies a comprehensive and legally compatible PIA report has been compiled.

Palaeontological heritage is exceptional and non-renewable and is protected by the NHRA. Palaeontological resources and may not be unearthed, broken moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This Palaeontological Impact assessment forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to Section 38 (1), an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length.
- the construction of a bridge or similar structure exceeding 50 m in length.
- any development or other activity which will change the character of a site—
 - exceeding 5 000 m² in extent; or
 - involving three or more existing erven or subdivisions thereof; or
 - involving three or more erven or divisions thereof which have been consolidated within the past five years; or
 - the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority or
 - the re-zoning of a site exceeding 10 000 m² in extent or
 - any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

4 METHODS AND TERMS OF REFERENCE

This PDA assesses the development's potential impact on the fossil heritage. This Palaeontological Assessment is part of the HIA Report. The PIA's goals are to: 1) identify the palaeontological significance of the rock formations in the footprint; 2) evaluate the palaeontological magnitude of the formations; 3) clarify the impact on fossil heritage; and 4) make recommendations for how the developer might protect and minimize potential harm to fossil heritage, according to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports".



Calculations of the palaeontological state of each rock segment and the potential impact of development on fossil history take into account the palaeontological status of the rocks, the type of development, and the amount of bedrock removed.

The Provisional DFFE Screening Tool, the SAHRIS Palaeosensitivity map, all Palaeontological Impact Assessment reports for the same area, Google Earth images, topographical and geological maps, as well as academic articles about specimens from the development area and Assemblage Zones, are all used to create scoping reports.

When the development footprint has a moderate to high palaeontological sensitivity, a field-based assessment is necessary. A desktop or field assessment of the exposed rock is used to evaluate the significance of the proposed development's impact, and recommendations for more research or mitigation are made. Excavations for the project often only take place during the building phase, changing the terrain and destroying or permanently encasing fossils at or below the ground surface. Then, access to Fossil Heritage will no longer be available for academic study.

When doing a site investigation, a palaeontologist examines the local development as well as the quantity and variety of fossils found there. This can be demonstrated by looking at representative fossiliferous rock exposures (most igneous and metamorphic rocks are not fossiliferous, whereas sedimentary rocks contain fossil heritage). Examined rock exposures frequently contain a sizeable portion of the stratigraphic unit, which is primarily made up of recently exposed (unweathered) rock. These exposures may be man-made (such as quarries, open building excavations, even railway and road cuttings) or natural (such as cliffs, and dongas as well as rocky outcrops along stream or river banks). It is usual practice for palaeontologists to record well-preserved fossils (GPS, and stratigraphic data) during field assessment examinations.

Although mitigation is often done prior to construction, it may take place if potentially fossiliferous bedrock is revealed. Fossil collection and documentation are examples of mitigation. A permit from SAHRA must be obtained before beginning any fossil excavation, and the material must be stored at an authorized facility. When mitigation is properly used, it is possible to have a positive impact by raising awareness of the palaeontological past of the area.

By physically evaluating bedrock outcrops to determine their lithology and fossil richness and crisscrossing the development footprint, one can assess an area's fossil potential. Because the presence of fossils at the surface is so unexpected, an average sample size of the region is investigated. To be clear, however, the lack of fossils in a development footprint does not automatically suggest that there is no palaeontologically important material present on the site (on or below the ground surface).



The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended;
- Adherence to all applicable best practice recommendations, appropriate legislation and authority requirements;
- Submit a comprehensive overview of all appropriate legislation, guidelines;
- Describe of the proposed project and provide information regarding the developer and consultant who commissioned the study;
- Describe location of the proposed development and provide geological and topographical maps
- Provide palaeontological and geological history of the affected area;
- Identify sensitive areas to be avoided (providing shapefiles/kmls) in the proposed development;
- Evaluate the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:
 - a. **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
 - b. **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity.
 - c. **Cumulative impacts** are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities.
- Fair assessment of alternatives (infrastructure alternatives have been provided);
- Recommend mitigation measures to minimise the impact of the proposed development; and
- Detail the implications of specialist findings for the proposed development (such as permits, licenses etc).

4.1 Assumptions and Limitations

The geology of the area is the focal point of geological maps, and the sheet explanations of the Geological Maps were not intended to focus on palaeontological heritage. Many inaccessible areas of South Africa have never been examined by palaeontologists, and data is typically dependent solely on aerial pictures. Locality and geological information in museums and university databases is out of date, and data acquired in the past is not always adequately documented.

Comparable Assemblage Zones in other places are also used to provide information on the existence of fossils in areas that have not before been recorded. When similar Assemblage Zones and geological



formations are used for Desktop studies, it is commonly assumed that exposed fossil exists within the footprint.

5 GEOLOGICAL AND PALAEOONTOLOGICAL HISTORY

The Aries-Paulputs-Kokerboom 400 kV LIL0 and Substation Upgrade project in the Northern Cape Province is shown on the 1:250 000 Onseepkans 2818 and Kenhardt 2920 Geological Map (**Figure 4; Table 2**; Council for Geoscience, Pretoria), with accompanying sheet explanations by Moen and Toogood (2007) and Slabbert et.al. (1999). The study area is mantled by superficial deposits of the Kalahari Group (Q-s1 and Q-s2), with isolated inselbergs comprising Skuitklip Granite (Nskw) Nouzees Suite (Nnz, unfoliated gabbro and olivine pyroxenite) as well as Konkresies Granite (Nkon) (Namaqua Natal Igneous Province).

The underlying geology is dominated by these high-grade crystalline basement rocks of Palaeoproterozoic to Mesoproterozoic age, consisting predominantly of metamorphosed igneous and sedimentary precursors. Owing to their metamorphic character and age, these units are regarded as having Very Low to negligible palaeontological potential. According to the SAHRIS PalaeoMap, the Site Sensitivity of the study area is Moderate (green), Low (blue), Zero (grey) and Unknown (white) Palaeontological Sensitivity, (Almond & Pether 2009; Almond et al. 2013; Groenewald et al. 2014) (**Figure 5; Table 3**). In contrast, the DFFE Environmental Screening Tool classifies the project area as having a Medium (orange) Palaeontology Theme Sensitivity (**Figure 6**).

Scattered basement inliers of the general area consist of resistant-weathering igneous and high-grade metamorphic lithologies, including amphibolites, gneisses, quartzites and schists of Mid-Proterozoic (Mokolian) age, approximately one to two billion years old. These rocks are assigned to the **Namaqua Sector of the Namaqua–Natal** None of these basement units are fossiliferous and they are therefore not discussed further in this report.

The study area is also underlain by unconsolidated Late Cenozoic superficial sediments, including Quaternary to Recent sands and gravels of probable braided fluvial or sheetwash origin (Q-s2), as well as colluvial scree and residual surface gravels. The geology of the Late Cretaceous to Recent Kalahari Group has been comprehensively reviewed by Thomas (1981), Dingle et al. (1983), Thomas and Shaw (1991), Haddon (2000) and Partridge et al. (2006). These deposits are locally overlain, and may also be underlain, by aeolian sands of the Gordon Formation (Kalahari Group) of Pleistocene to Holocene age (Q-s1). The sands form sparsely vegetated linear dune systems, particularly within the Koa River Palaeovalley near Aggeneys (south-west of the study area), and may attain thicknesses of up to approximately 40 m.

An **important regional geological feature** is the Koa River Palaeovalley, a defunct south-bank tributary of the palaeo–Orange River of Miocene to Pliocene age. Consolidated Miocene alluvial deposits are preserved locally within the Palaeovalley. However, fossiliferous fluvial sediments have not been recorded from the northern sector of the Palaeovalley near Aggeneys itself and, if present, are likely to be



deeply buried beneath younger superficial deposits. This potentially sensitive feature is not reflected on the SAHRIS Palaeosensitivity map due to the overlying mantle of lower-sensitivity Kalahari sediments.

The fossil record of the Kalahari Group is generally sparse and poorly documented in the study region, with no fossils recorded in the Onseepkans sheet explanations. While Kalahari sediments may very occasionally preserve Late Cenozoic fossil material—such as mammal bones and teeth, reptile remains, non-marine molluscs, ostrich eggshell, trace fossils (e.g. rhizoliths, termite nests, coprolites), and plant microfossils—such occurrences are rare and unpredictable. Fossiliferous “high-level gravels” are not mapped in the study area and are unlikely to occur at this distance from the Orange River.

It is important to note that Late Cenozoic fossil assemblages are known elsewhere in the region, including the Early to Middle Miocene vertebrate fauna recorded at Bosluis Pan, approximately 50 km south-southwest of Aggeneys.

In summary, the Mid-Proterozoic basement rocks underlying the study area are unfossiliferous, while the overlying Kalahari Group sediments have a generally low and poorly documented palaeontological potential. On this basis, the likelihood of encountering significant palaeontological resources within the proposed development footprint is considered LOW.

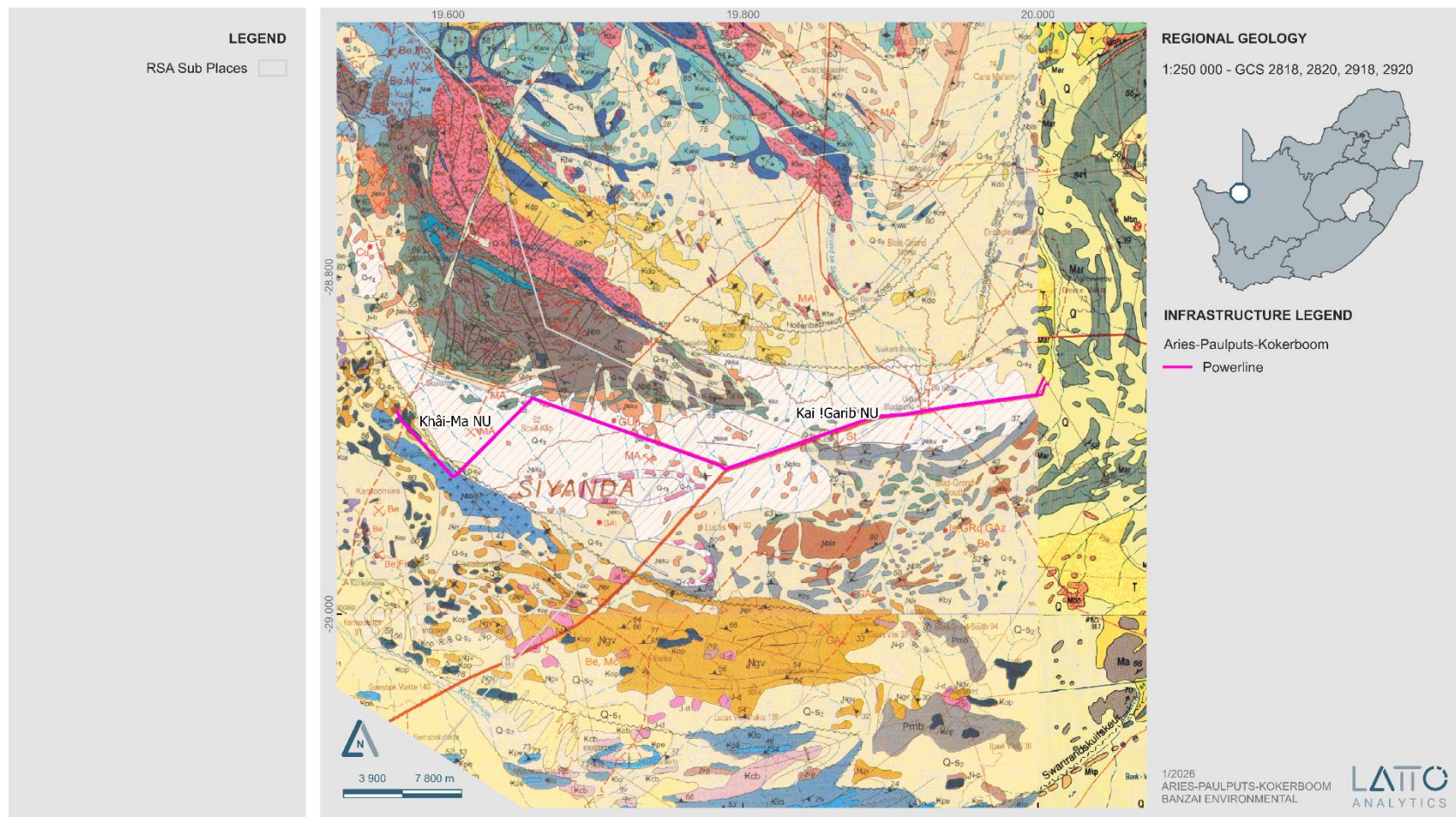


Figure 4: Extract of the 1:250 000 Onseepkans 2818 and Kenhardt 2920 Geological Map (Council for Geosciences, Pretoria) indicating that the proposed study area near Pofadder is mantled by the superficial Kalahari Group (Q-s1 ad Q-s2) with inselbergs comprising of Skuitklip Granite (Nskw) , Nouzees Suite (Nnz) as well as Konkresies Granite (Nkon) (Namaqua Natal Igneous Province).

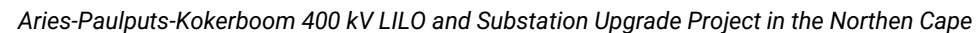


Table 2: Legend of the 2824 Kimberly (1993) Geological Map (Council for Geosciences, Pretoria).

SEDIMENTARY AND METAMORPHIC ROCKS

INTF

GROUP

SUBGROUP

QUATERNARY

CRETACEOUS

MESO-ZOIC

JURASSIC

QUATERNARY

CRETACEOUS

MESO-ZOIC

JURASSIC

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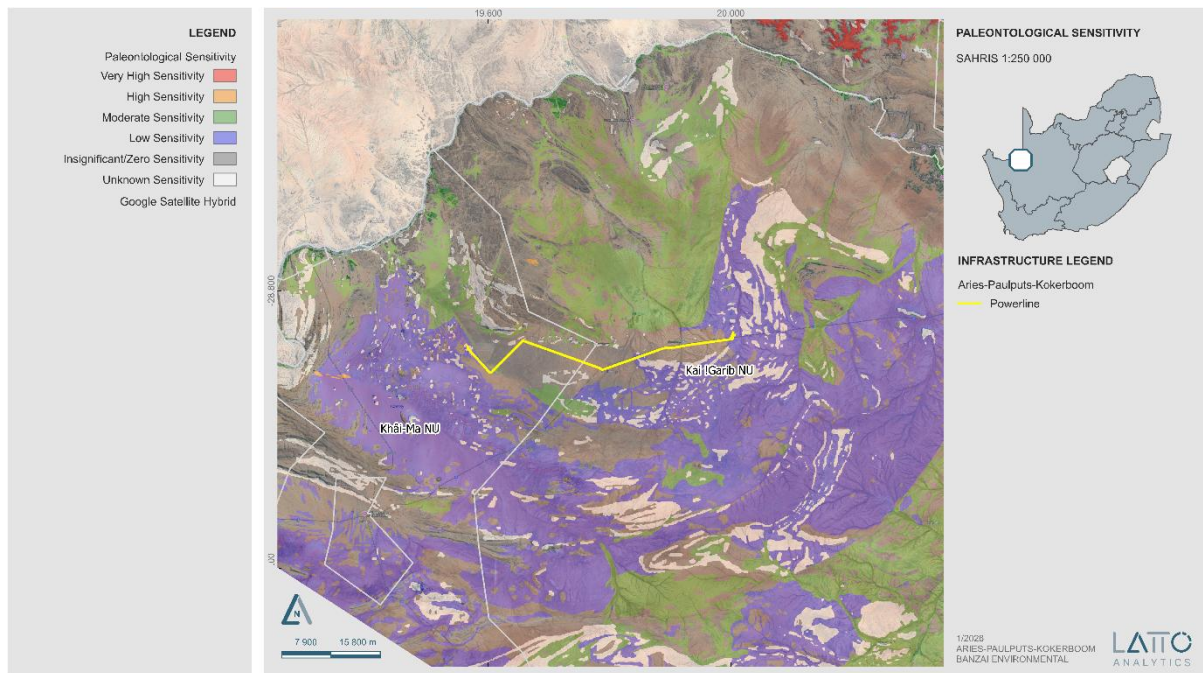


Figure 5: Extract of the SAHRIS PalaeoMap (Council of Geosciences) indicating the Moderate (green), Low (blue), Zero (grey) and Unknown (white) Palaeontological Sensitivity.

Table 3: Palaeontological Sensitivity according to the SAHRIS PalaeoMap (Almond et al, 2013; SAHRIS website)		
Colour	Sensitivity	Required Action
RED	VERY HIGH	Field assessment and protocol for finds is required
ORANGE/YELLOW	HIGH	Desktop study is required and based on the outcome of the desktop study; a field assessment is likely
GREEN	MODERATE	Desktop study is required
BLUE	LOW	No palaeontological studies are required however a protocol for finds is required
GREY	INSIGNIFICANT/ZERO	No palaeontological studies are required



WHITE/CLEAR	UNKNOWN	These areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map.
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The SAHRIS Palaeosensitivity map (Figure 5, Table 3) indicates that the proposed development is underlain by sediments with a Moderate (green), Low (blue) and Unknown (white) Palaeontological Sensitivity, while the DFFE Screening tool indicates a Medium (orange) Palaeontological Sensitivity (Figure 6). The above-mentioned Palaeontological Sensitivities required a desktop and a Chance Finds Protocol being conducted and thus the Palaeontological Sensitivity was not verified by a site investigation. However, desktop research has indicated that the Palaeontological Sensitivity of the area is LOW.

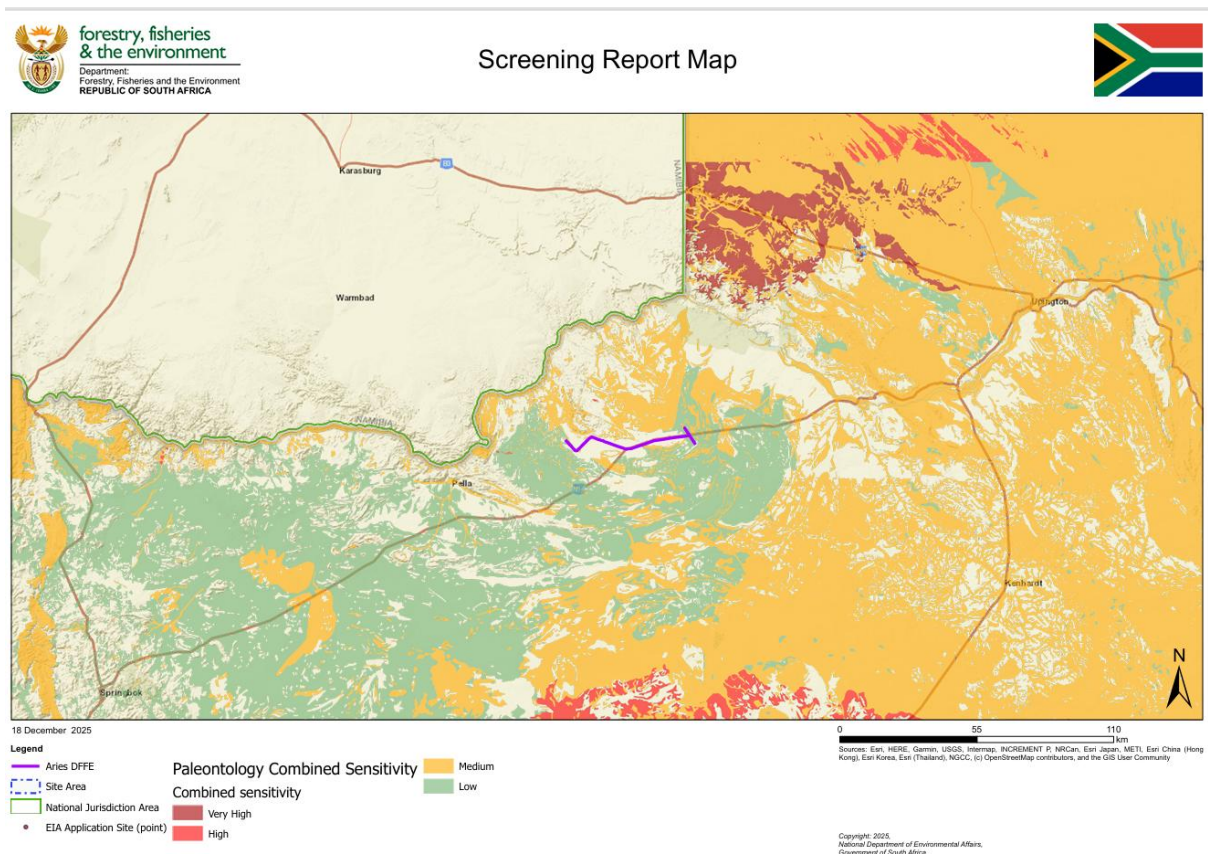


Figure 6: Palaeontological Sensitivity generated by the DFFE National Environmental Web-Based Screening Tool indicating a Medium (orange) Palaeontological Sensitivity while areas with a Low (green) and unknown (white) is also crossed.

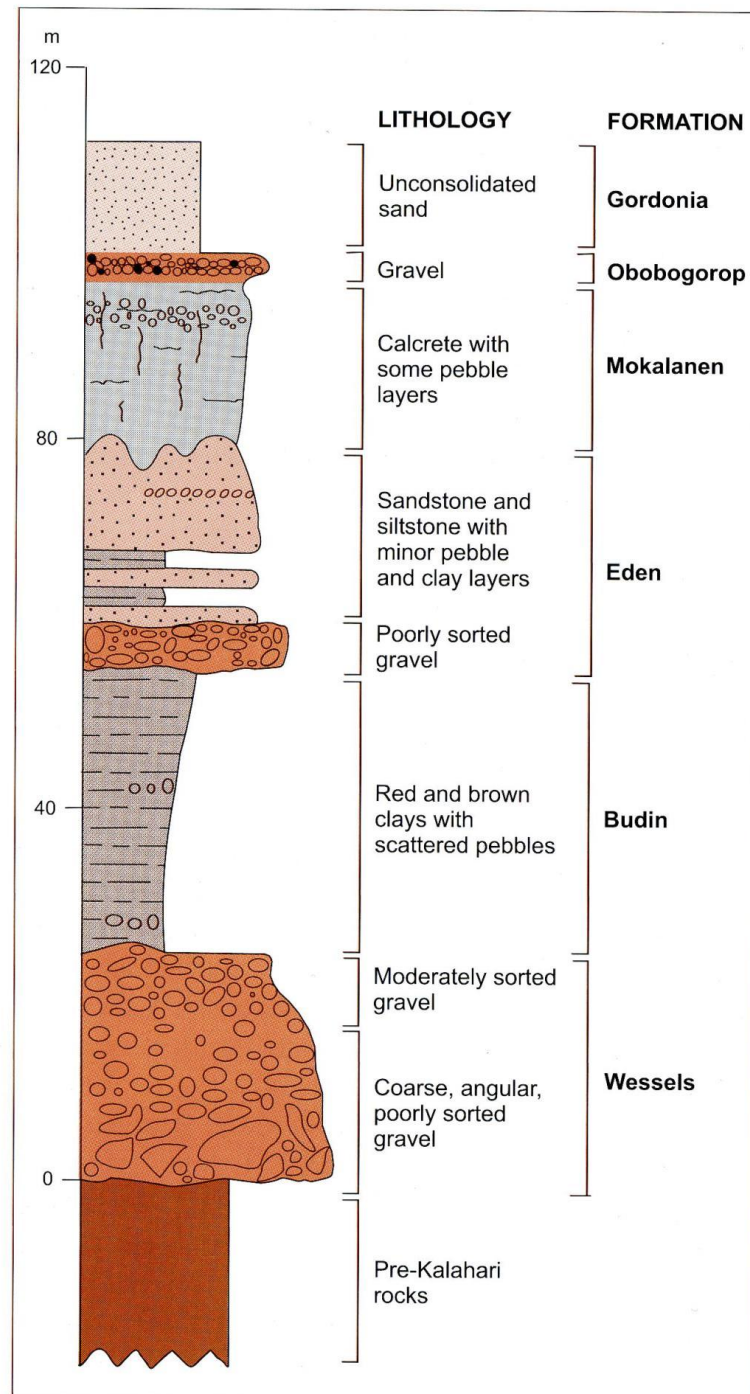


Figure 7: Generalised stratigraphy of the Kalahari Group (after Partridge et al. 2006). Only aeolian sands of the Gordonia Formation are mapped within the present study area; however, older gravels and calcretes, as well as Late Tertiary alluvial sediments at depth along the Koa River palaeovalley, may also be present.



6 ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984)
- A Google Earth map with polygons of the proposed development was obtained from Blue Crane Environmental
- Google Earth® satellite imagery.
- 1:250 000 Onseepkans 2818 Geological Map (Council for Geosciences, Pretoria)
- Palaeosensitivity map on SAHRIS (South African Heritage Resources Information System) website
- Department of Forestry, Fisheries and the Environment Screening tool report
- The combined National Palaeontological Databases of the Museums and Universities of Southern Africa.
- Published geological and palaeontological literature

7 IMPACT ASSESSMENT

The EIMS Impact Assessment Methodology was utilized for this project (Appendix 1)

7.1 PLANNING PHASE IMPACTS

No Impact

7.2 CONSTRUCTION/OPERATIONAL PHASE IMPACTS

The excavations and clearing of vegetation during the construction phase will consist of digging into the superficial sediment cover as well as underlying deeper bedrock. These excavations will change the existing topography and may possibly destroy or even permanently close-in fossils at or below the ground surface. These fossils will then be lost for research.

7.3 MITIGATION MEASURES

- When a **chance find** is made the person must instantly stop all work near the find.
- The site must be secured to protect it from any additional damage
- The finder of the fossil heritage must immediately report the find to his/her direct supervisor, according to the reporting protocols instituted by the development management. The supervisor must in turn report the find to his/her manager and the EO. The EO must report the find to the relevant Authorities and a relevant palaeontologist.



- The developer/contractor must appoint a relevant palaeontologist to investigate and access the chance find and site.
- The palaeontologist must ensure that accurate records and documentation are kept. The documentation must start with the initial chance find report, including records of all actions taken, persons involved and contacted, comments received and findings.
- These documents will be necessary to request authorizations and permits from the relevant Authorities to continue with the work on site
- The reports and all other documents will be submitted to SAHRA by the palaeontologist.
- The report will include recommendations for additional specialist work if necessary, or request approval to continue with the development.
- When the necessary approvals have been issued, the development may carry on with the development.

The EO will close off the **Chance Find Procedure** and would be required to implement any requirements issued by the Authority and to add it to the operational management plan

7.4 CUMULATIVE IMPACTS

The SAHRIS PalaeoMap indicates that the general Palaeontological Sensitivity, in a radius of 30 km of the development is Zero to Moderate. However, it is important to note that the quality of preservation of fossils at different sites will most probably vary, and it is thus difficult to allocate a Cumulative Sensitivity to the project.

7.5 IRREPLACEABLE LOSS OF RESOURCES

Fossil Heritage is irreplaceable.

7.6 Alternatives considered

- No Alternatives

7.7 REHABILITATION AND CLOSURE PHASE IMPACTS

- No Impact



Table 4: Summary of Impact on Construction and Operational Phases

	Identifier
Palaeontology	Discipline
Loss of fossil Heritage	Impact
No	Alternative
Construction	Phase
Normal Operation	Event
- 1	Pre-Nature
1	Pre-Extent
5	Pre-Duration
1	Pre-Magnitude
5	Pre-Reversibility
-3.0	Consequence
1	Pre-Probability
-3	Pre-Mitigation Significance Score
-Low	Pre-Mitigation Significance
-1	Post-Nature
1	Post-Extent
5	Post-Duration
1	Post-Magnitude
5	Post-Reversibility
-3.0	Consequence2
1	Post-Probability
-3	Post-mitigation Significance Score
- Low	Post-Mitigation Significance
High	Confidence
1	Cumulative Impact
3	Irreplaceable loss
-1.25	Priority Factor
-3.75	Final score
- Low	Post-Mitigation Significance

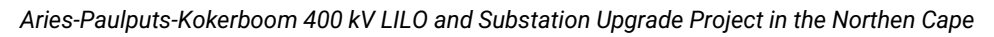


Table 5: Summary of Impact on Planning and Decommissioning Phases

	Identifier
Palaeontology	Discipline
Loss of fossil Heritage	Impact
No	Alternative
Construction	Phase
Normal Operation	Event
No Impact	Pre-Nature
No Impact	Pre-Extent
No Impact	Pre-Duration
No Impact	Pre-Magnitude
No Impact	Pre-Reversibility
No Impact	Consequence
No Impact	Pre-Probability
No Impact	Pre-Mitigation Significance Score
No Impact	Pre-Mitigation Significance
No Impact	Post-Nature
No Impact	Post-Extent
No Impact	Post-Duration
No Impact	Post-Magnitude
No Impact	Post-Reversibility
No Impact	Consequence2
No Impact	Post-Probability
No Impact	Post-mitigation Significance Score
No Impact	Post-Mitigation Significance
No Impact	Confidence
No Impact	Cumulative Impact
No Impact	Irreplaceable loss
No Impact	Priority Factor
No Impact	Final score
No Impact	Post-Mitigation Significance



Table 6: Mitigation measures

No.	Mitigation Measures	Phase	Timeframe	Responsible Party for Implementation	Monitoring Party (Frequency)	Target	Performance Indicators (Monitoring Tool)
1. Palaeontological Heritage							
A	Mitigation involves the collection and documentation of fossils, together with recording data on the surrounding sedimentary matrix within the proposed development footprint by a qualified palaeontologist. In the unlikely event that, Palaeontological Heritage is uncovered during surface clearing and mining excavations, the ECO/site manager must report the find to the South African Heritage Resources Agency (SAHRA) (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za)	Construction	Construction	Environmental Manager or EO and specialist	None	Fossils	Finding of fossils



	<p>so that mitigation (recording and collection) can be carried out.</p> <p>Before any fossil material can be collected from the development site, the specialist involved would need to apply for a collection permit from SAHRA. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012).</p>						
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8 FINDINGS AND RECOMMENDATIONS

The Aries-Paulputs-Kokerboom 400 kV LIL0 and Substation Upgrade project in the Northern Cape Province is mantled by superficial deposits of the Kalahari Group, with isolated inselbergs comprising Skuitklip, Nouzees Suite (unfoliated gabbro and olivine pyroxenite) as well as Konkresies Granite all of the Namaqua Natal Igneous Province. According to the SAHRIS PalaeoMap, the Site Sensitivity of the study area is Moderate, Low, Zero and Unknown (Almond & Pether 2009; Almond et al. 2013; Groenewald et al. 2014). This is in agreement with the Medium Palaeontology Theme Sensitivity of the DFFE (Department of Forestry, Fisheries and the Environment) Environmental Screening Tool

A **Low Palaeontological Significance** has been allocated for impacts associated with the construction phase of the development pre-mitigation and post-mitigation. The construction phase will be the only development phase with the potential of impacting Palaeontological Heritage, and **no significant impacts are expected to impact the Operational and Decommissioning phase**. As the No-Go Alternative considers the option of 'do nothing' and maintaining the status quo, it will have a Neutral impact on the Palaeontological Heritage of the development. The **Cumulative impacts of the development are considered to be Low (as the area is not highly fossiliferous), and falls within the acceptable limits for the project**. It is therefore considered that the study Project will not lead to damaging impacts on the palaeontological resources of the area. The development **may thus be permitted in its whole extent, as the development footprint is not considered sensitive in terms of palaeontological resources**. It is consequently recommended that **no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required, pending the discovery of newly discovered fossils**.

Recommendations:

- In the **unlikely event** that, Palaeontological Heritage is uncovered during surface clearing and mining excavations, the ECO/site manager must report the find to the South African Heritage Resources Agency (SAHRA) (Contact details: **SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za**) so that mitigation (recording and collection) can be carried out.
- Before any fossil material can be collected from the development site, the specialist involved would need to apply for a **collection permit from SAHRA**. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012).

These recommendations should be incorporated into the Environmental Management Programme (EMPr) for the Aries – Kokerboom 400 kV loop in loop out – Paulputs Substation (Phase 2) Project study area in the Northern Cape Province.



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APPENDIX 1

EIMS Impact Assessment Methodology

The impact significance rating methodology, as presented herein and utilised for all EIMS Impact Assessment Projects, is guided by the requirements of the NEMA EIA Regulations 2014 (as amended). The approach may be altered or substituted on a case-by-case basis if the specific aspect being assessed requires such- such instances require prior EIMS Project Manager approval. The broad approach to the significance rating methodology is to determine the significance (S) of an environmental risk or impact by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relating this to the probability/ likelihood (P) of the impact occurring. The S is determined for the pre- and post-mitigation scenario. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the S to determine the overall final significance rating (FS). The impact assessment will be applied to all identified alternatives.

Determination of Significance

The final significance (FS) of an impact or risk is determined by applying a prioritisation factor (PF) to the post-mitigation environmental significance. The significance is dependent on the consequence (C) of the particular impact and the probability

(P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and Reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{(E + D + M + R) * N}{4}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table below.



Criteria for Determining Impact Consequence

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. Highly localised, limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property or site boundary, or the area within a few hundred meters of the site)
	3	Local (i.e. beyond the site boundary within the Local administrative boundary (e.g. Local Municipality) or within consistent local geographical features, or the area within 5 km of the site)
	4	Regional (i.e. Far beyond the site boundary, beyond the Local administrative boundaries within the Regional administrative boundaries (e.g. District Municipality), or extends into different distinct geographical features, or extends between 5 and 50 km from the site).
	5	Provincial / National / International (i.e. extends into numerous distinct geographical features, or extends beyond 50 km from the site).
Duration	1	Immediate (<1 year, quickly reversible)
	2	Short term (1-5 years, less than project lifespan)
	3	Medium term (6-15 years)
	4	Long term (15-65 years, the impact will cease after the operational life span of the project)
	5	Permanent (>65 years, no mitigation measure of natural process will reduce the impact after construction/ operation/ decommissioning).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected)
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected, or affected environmental components are already degraded)
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; moderate improvement for +ve impacts; or where change affects area of potential conservation or other value, or use of resources).
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease; high improvement for +ve impacts; or where change affects high conservation value areas or species of conservation concern)
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease, substantial improvement for +ve impacts; or disturbance to pristine areas of critical conservation value or critically endangered species)



Reversibility	1	Impact is reversible without any time and cost.
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	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring very high time and cost.
	5	Irreversible Impact.

Once the C has been determined, the significance is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/ scored as per Table below.

It is noted that both environmental risks as well as environmental impacts should be identified and assessed. Environmental Risk can be regarded as the potential for something harmful to happen to the environment, and in many instances is not regarded as something that is expected to occur during normal operations or events (e.g. unplanned fuel or oil spills at a construction site). Probability and likelihood are key determinants or variables of environmental risk. Environmental Impact can be regarded as the actual effect or change that happens to the environment because of an activity and is typically an effect that is expected from normal operations or events (e.g. vegetation clearance from site development results in loss of species of concern). Typically, the probability of an unmitigated environmental impact is regarded as highly likely or certain (management and mitigation measures would ideally aim to reduce this likelihood where possible). In summary, environmental risk is about what could happen, while environmental impact is about what does happen.

Probability/ Likelihood Scoring

Probability	1	Improbable (Rare, the event may occur only in exceptional circumstances, the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <5% chance).
	2	Low probability (Unlikely, impact could occur but not realistically expected; >5% and <20% chance).
	3	Medium probability (Possible, the impact may occur; >20% and <50% chance).
	4	High probability (Likely, it is most probable that the impact will occur- > 50 and <90% chance).
	5	Definite (Almost certain, the impact is expected to, or will, occur, >90% chance).

The result is a qualitative representation of relative significance associated with the impact. Significance is therefore calculated as follows:

$$S = C \times P$$

Determination of Significance

	5- Very High ¹	5	10	15	20	25
	4- High	4	8	12	16	20
	3- Medium	3	6	9	12	15
	2- Low	2	4	6	8	10
	1- Very low	1	2	3	4	5



¹ In the event that an impact or risk has very high or catastrophic consequences, but the likelihood/probability is low, then the resultant significance would be Low-medium. This does in certain instances detract from the relative importance of this impact or risk and must consequently be flagged for further specific consideration, management, mitigation, or contingency planning

		1- Improbable	2- Low	3- Medium/ Possible	4- High/ Probable	5- Highly likely/ Definite
		Probability				

The outcome of the significance assessment will result in a range of scores, ranging from 1 through to 25. These significance scores are then grouped into respective classes as described in Table below.

Significance Scores

S Score	Description
≤4.25	Low (i.e. where this impact is unlikely to be a significant environmental risk/ reward).
>4.25, ≤8.5	Low-Medium (i.e. where the impact could have a significant environmental risk/ reward).
>8.5, ≤13.75	High-Medium (i.e. where the impact could have a significant environmental risk/ reward).
>13.75	High (i.e. where the impact will have a significant environmental risk/ reward).

The impact significance will be determined for each impact without relevant management and mitigation measures (pre-mitigation significance), as well as post implementation of relevant management and mitigation measures (post-mitigation significance). This allows for a prediction in the degree to which the impact can be managed/mitigated.

Impact Prioritization

Further to the assessment criteria presented in the section above, it is necessary to consider each potentially significant impact in terms of:

Cumulative impacts; and

The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impacts' post-mitigation significance (post-mitigation). This prioritisation factor does not aim to detract from the significance ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the post-mitigation significance based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 5: Criteria for Determining Prioritisation

	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
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Cumulative Impact (CI)	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/ definite that the impact will result in spatial and temporal cumulative change.
	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.

Irreplaceable Loss of Resources (LR)	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 5. The impact priority is therefore determined as follows:

$$\text{Priority} = CI + LR$$

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (Refer to Table below).

Determination of Prioritisation Factor

Priority	Prioritisation Factor
2	1
3	1.125
4	1.25
5	1.375
6	1.5

In order to determine the final impact significance (FS), the PF is multiplied by the post-mitigation significance scoring. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a factor of 0.5, if all the priority attributes are high (i.e. if an impact comes out with a high medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a higher significance).

Final Environmental Significance Rating

Significance Rating	Description
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<-25	Very High (Impacts in this class are extremely significant and pose a very high environmental risk. In certain instances these may represent a fatal flaw. They are likely to have a major influence on the decision and may be difficult or impossible to mitigate. Offset's may be necessary).
<-13.75 to -25	High negative (These impacts are significant and must be carefully considered in the decision-making process. They have a high environmental risk or impact and require extensive mitigation measures).
-8.5 to -13.75	Medium-High negative (i.e. Impacts in this class are more substantial and could have a significant environmental risk. They may influence the decision to develop in the area and require more robust mitigation measures).
<-4.25 to <-8.5	Medium- Low negative (i.e. These impacts are slightly more significant than low impacts but still do not pose a major environmental risk. They might require some mitigation measures but are generally manageable).

Significance Rating	Description
-1 to -4.25	Low negative (i.e. Impacts in this class are minor and unlikely to have a significant environmental risk. They do not influence the decision to develop in the area and are typically easily mitigated).
0	No impact
1 to 4.25	Low positive
>4.25 to <8.5	Medium-Low positive
8.5 to 13.75	Medium-High positive
>13.75	High positive

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

Nature	-1	Likely to result in a negative/ detrimental impact	CONSEQUENCE	ENVIRONMENTAL SIGNIFICANCE
	1	Likely to result in a positive/ beneficial impact		
Extent	1	Activity (i.e. Highly localised, limited to the area applicable to the specific activity)		
	2	Site (i.e. within the development property or site boundary, or the area within a few hundred meters of the site)		
	3	Local (i.e. beyond the site boundary within the Local administrative boundary (e.g. Local Municipality) or within consistent local geographical features, or the area within 5 km of the site)		
	4	Regional (i.e. Far beyond the site boundary, beyond the Local administrative boundaries within the Regional administrative boundaries (e.g. District Municipality), or extends into different distinct geographical features, or extends between 5 and 50 km from the site).		
	5	Provincial / National / International (i.e. extends into numerous distinct geographical features, or extends beyond 50 km from the site).		



Duration	1	Immediate (<1 year, quickly reversible)	PROBABILITY	PRIORITISATION FACTOR
	2	Short term (1-5 years, less than project lifespan)		
	3	Medium term (6-15 years)		
	4	Long term (15-65 years, the impact will cease after the operational life span of the project)		
	5	Permanent (>65 years, no mitigation measure of natural process will reduce the impact after construction/ operation/ decommissioning).		
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected)		
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected, or affected environmental components are already degraded)		
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; moderate improvement for +ve impacts; or where change affects area of potential conservation or other value, or use of resources).		
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease; high improvement for +ve impacts; or where change affects high conservation value areas or species of conservation concern)		
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease, substantial improvement for +ve impacts; or disturbance to pristine areas of critical conservation value or critically endangered species)		
Reversibility	1	Impact is reversible without any time and cost.		
	2	Impact is reversible without incurring significant time and cost.		
	3	Impact is reversible only by incurring significant time and cost.		
	4	Impact is reversible only by incurring prohibitively high time and cost.		
	5	Irreversible Impact		
Probability	1	Improbable (Rare, the event may occur only in exceptional circumstances, the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <5% chance).		
	2	Low probability (Unlikely, impact could occur but not realistically expected; >5% and <20% chance).		
	3	Medium probability (Possible, the impact may occur; >20% and <50% chance).		
	4	High probability (Likely, it is most probable that the impact will occur- > 50 and <90% chance).		
	5	Definite (Almost certain, the impact is expected to, or will, occur, >90% chance).		
Cumulative Impact	1	Low: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.		
	2	Medium: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.		
	3	High: Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.		
Irreplaceable loss of resources	1	Low: Where the impact is unlikely to result in irreplaceable loss of resources.		
	2	Medium: Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.		



Degree of Confidence	3	High: Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).
	Low	<30% certain of impact prediction
	Medium	>30 and < 60% certain of impact prediction
	High	>60% certain of impact prediction



APPENDIX 2

CURRICULUM VITAE

PROFESSION: Palaeontologist
YEARS' EXPERIENCE: 30 years in Palaeontology
EDUCATION: University of the Orange Free State
B.Sc Botany and Zoology, 1988

University of the Orange Free State
B. Sc (Hons) Zoology, 1991
University of the Free State
M. Sc. *Cum laude* (Zoology), 2009

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

EMPLOYMENT HISTORY

Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant and Collection Manager	National Museum, Bloemfontein 1998–2022
Banzai Environmental	2016 to present

Elize Butler has conducted approximately 850 Palaeontological Impact Assessments for developments in the Free State, KwaZulu-Natal, Eastern, Northern and Western Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. She has an MSc (*cum laude*) in Zoology (specializing in Palaeontology) from the University of the Free State, South Africa. She has experience in locating, collecting, and curating fossils. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently.