

# PALAEONTOLOGICAL IMPACT ASSESSMENT

## MOOKODI INTEGRATION PHASE 2: 132KV POWER LINES NEAR VRYBURG, NORTH WEST PROVINCE 2022

COMPILED FOR: NCC-



## 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.

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**SIGNATURE:**



The Palaeontological 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 A	-
(ii) The expertise of that person to compile a specialist report including a curriculum vita	Section 2 – refer to <b>Appendix A</b>	-
(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 – Objective	-
(cA) An indication of the quality and age of base data used for the specialist report	Section 6 – 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 10	-
(d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 1;9 & 11	



<b>Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017</b>	<b>The relevant section in the report</b>	<b>Comment where not applicable.</b>
(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	-
(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;	Section 1 & 11	
(g) An identification of any areas to be avoided, including buffers	Section 1 & 11	
(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 7.1 – 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	Section 1 and 11	
(k) Any mitigation measures for inclusion in the EMP	Section 1 and 11	
(l) Any conditions for inclusion in the environmental authorisation	Section 1 and 11	
(m) Any monitoring requirements for inclusion in the EMP or environmental authorisation	Section 1 and 11	



Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 & 11	
(n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and		
(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	Section 1 and 11	-
(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



<b>Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017</b>	<b>The relevant section in the report</b>	<b>Comment where not applicable.</b>
		regarding heritage resources that require input from a specialist have been raised.
(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 appointed by NCC Environmental Services (Pty) Ltd to conduct the **Palaeontological Impact Assessment (PIA)** to assess the proposed Mookodi Integration Phase 2: 132KV Power Lines near Vryburg, North West Province. In accordance with the National Environmental Management Act 107 of 1998 (NEMA) and to comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PIA is necessary to confirm if fossil material could potentially be present in the planned development area, to evaluate the potential impact of the proposed development on the Palaeontological Heritage and to mitigate possible damage to fossil resources.

The proposed Mookodi Power Line development is underlain by Quaternary superficial sediments (Aeolian sand and Tertiary to Quaternary calcrete), Dwyka Group, Boomplaas Formation (Schmidsdrift Subgroup, Ghaap Group, Transvaal Supergroup), and Vryburg Formation (Ghaap Group, Transvaal Supergroup) as well as the Allanridge Formation of the Ventersdorp Supergroup). Updated geology (Council of Geosciences, Pretoria) indicates that the study area is underlain by the Kalahari Group, Calcrete, Surface Limestone and Hardpan sediments, the Dwyka Group, and Boomplaas Formation as well as the Allanridge Formation. The PalaeoMap of the South African Heritage Resources Information System (SAHRIS) indicates that the Palaeontological Sensitivity of the Boomplaas Formation is Very High, while that of the Quaternary to Tertiary calcrete is High. The Aeolian Sands, Dwyka Group, and Vryburg Formation has a Moderate Palaeontological Sensitivity and that of the Allanridge Formation is Low (Almond *et al*, 2013; SAHRIS website).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 19 November 2022. Weathered to fairly well-preserved stromatolitic outcrops were detected, but better-preserved outcrops have been identified nearby (Almond 2013, 2016). If significant stromatolites are uncovered during surface clearing and excavations the **Chance find Protocol** attached should be implemented immediately. Fossil discoveries ought to be protected and the ECO/site manager must report to 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](http://www.sahra.org.za)) so that mitigation (recording and collection) can be carried out.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies required by SAHRA.





These recommendations should be included in the Environmental Management Plan of the Mookodi Power Line Construction.

**Recommendations:**

- The ECO for this project must be informed that the **Boomplaas Formation (Schmidsdrift Subgroup, Ghaap Group, Transvaal Supergroup)** has a **Very High** and the **Quaternary to Tertiary** has a **High Palaeontological Sensitivity**.
- If significant stromatolite outcrops are uncovered during surface clearing and excavations the **Chance find Protocol** attached should be implemented

**Impact Summary**

<b>Environmental parameter</b>	<b>Issues</b>	<b>Rating prior to mitigation</b>	<b>Average</b>	<b>Rating post mitigation</b>	<b>Average</b>
Planning Stage	No Impact		No Impact		No Impact
Construction Stage: of the Mookodi Power Line	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	34	Negative Medium impact	17	Negative Low impact
Operational Phase: the Mookodi Power Line	No Impact		No Impact		No Impact
Decommissioning Phase the Mookodi Power Line	No Impact		No Impact		No Impact

It is therefore considered that the proposed Mookodi Power Line development will not lead to detrimental impacts on the palaeontological reserves of the area. Thus, the construction of the development may be authorised in its whole extent.



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## Appendix A: CV



## 1 INTRODUCTION

Population growth and urban expansion in South Africa has caused an urgent need for additional electrical supplies to towns and cities throughout South Africa. Eskom plans the construction of a 132kV Power Line near Vryburg in the North West Province (**Figure 1**).

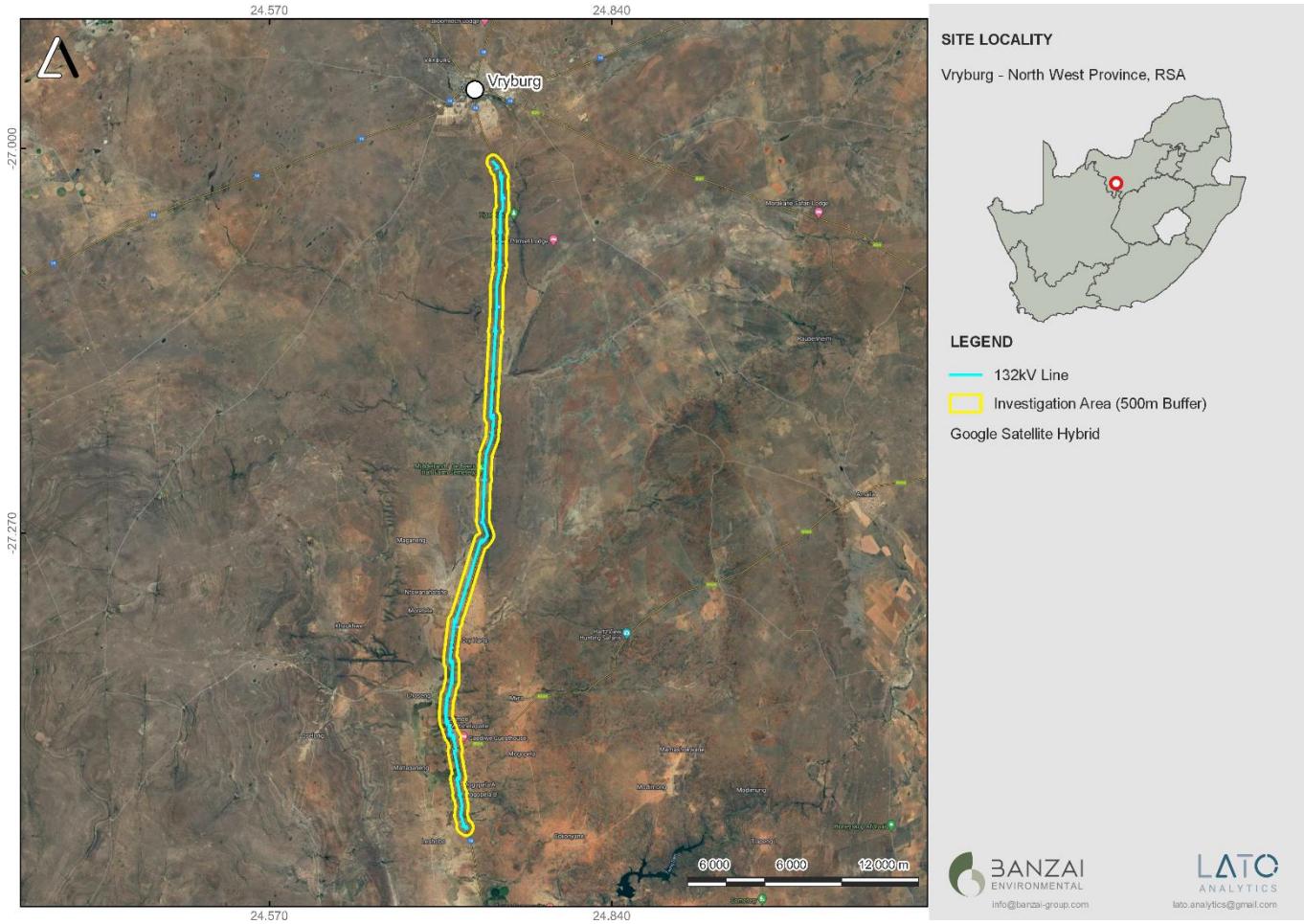
The planned Mookodi Integration Phase 2 project comprise of the following:

### **Mookodi-Magopela Power Line**

- Construction of a 132kV Power Line from the proposed Mookodi MTS to the existing Magopela Substation.
- Upgrade of Magopela Substation to accommodate the additional incoming line.
- Construction of an access track along the power line servitude.
- Establishment of associated infrastructure as required by Eskom.

### **Bophirima-Schweizer Power Line**

- Construction of a 132kV power line from the proposed Bophirima Substation to the existing Schweizer-Reneke Substation,
- Upgrade of Schweizer-Reneke Substation to accommodate the additional incoming line.
- Construction of an access track along the power line servitude.
- Establishment of associated infrastructure as required by Eskom.



**Figure 1:** Regional locality of the proposed Mookodi-Magopela Power Line near Vryburg, in North West Province.



## 2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

This study has been conducted by Mrs Elize Butler. She has conducted approximately 300 palaeontological impact assessments for developments in the Free State, KwaZulu-Natal, Eastern, Central, and Northern 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 and has been working in Palaeontology for more than twenty-nine 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.

## 3 LEGISLATION

### 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 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 107 of 1998
- National Heritage Resources Act (NHRA) Act 25 of 1999
- 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 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 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*  
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Reg No. 2015/332235/07 |



*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 the following comprehensive and legally compatible PIA report have 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 m<sup>2</sup> 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
- the re-zoning of a site exceeding 10 000 m<sup>2</sup> in extent.
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

#### **4 OBJECTIVE**

The objective of a Palaeontological Impact Assessment (PIA) is to determine the impact of the development on potential palaeontological material at the site.

According to the “SAHRA Archaeological, Palaeontological and Meteorite Unite (APM) Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports” the aims of the PIA are: 1) to **identify** the palaeontological status of the exposed as well as rock formations just below the surface in the development footprint 2) to estimate the **palaeontological importance** of the formations 3) to determine the **impact** on fossil





heritage; and 4) to recommend how the developer ought to protect or mitigate damage to fossil heritage.

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;
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study,
- Description and location of the proposed development and provide geological and topographical maps
- Provide palaeontological and geological history of the affected area.
- Identification of sensitive areas to be avoided (providing shapefiles/kmls) in the proposed development;
- Evaluation of 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
- Implications of specialist findings for the proposed development (such as permits, licenses etc).

## 5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the proposed Mookodi-Magopela Power Line near Vryburg, in North West Province is depicted on the 1: 250 000 Christiana 2724 (1994) Geological Map (Council for Geosciences, Pretoria) (**Figure 2; Table 2**). This map indicates that the proposed Power Line development is



underlain by Quaternary superficial sediments (Qw, Aeolian sand and Tertiary to Quaternary calcrete or surface limestones (T-Qc; yellow); the Dwyka Group (C-Pd), Boomplaas Formation (Vb; Schmidtsdrift Subgroup, Ghaap Group, Transvaal Supergroup), and Vryburg Formation (Ghaap Group, Transvaal Supergroup) as well as the Allanridge Formation of the Ventersdorp Supergroup). According to the South African Heritage Resources Information System, (SAHRIS) the Palaeontological Sensitivity of the Boomplaas Formation is Very High, while that of the Quaternary to Tertiary calcrete is High. The Aeolian Sands, Dwyka Group, and Vryburg Formation has a Moderate Palaeontological Sensitivity and that of the Allanridge Formation is Low (**Figure 3, Table 3**; Almond and Pether, 2009; Almond et al., 2013). The Geological Maps have been refined in 2018 (mapped by the Council of Geosciences, Pretoria) and is depicted in **Figure 4**. According to this map the proposed Power Line development is underlain by the Kalahari Group, Calcrete, Surface Limestone and Hardpan sediments, the Dwyka Group, and Boomplaas Formation as well as the Allanridge Formation.

The largest portion of the development is underlain by Quaternary sediments (**Figure 2**). The late Cretaceous to Recent Kalahari Group has been reviewed by the following authors: Thomas (1981), Dingle *et al.* (1983), Thomas & Shaw 1991, Haddon (2000) and Partridge *et al.* 2006. The Quaternary Gordonina Formation (Kalahari Group) are dated as Late Pliocene/Early Pleistocene to Recent times by the Middle to Later Stone Age stone tools recovered from them (Dingle et al (1983). The fossil assemblages of the Quaternary are generally Low in diversity and occur over a wide range and mostly has a Moderate Paleontologically Sensitivity. These fossils represent terrestrial plants and animals with a close resemblance to living forms. Fossil assemblages include bivalves, diatoms, gastropod shells, ostracods, and trace fossils. Late Cenozoic calcrete may comprise of bones, horn cores as well as mammalian teeth. Tortoise remains have also been uncovered as well as trace fossils which includes termite and insect's burrows and mammalian trackways. Amphibian and crocodile skeletons have been uncovered where the depositional settings in the past were wetter.

The Quaternary deposits are very important because palaeoclimatic changes are reflected in the different geological formations (Hunter et al., 2006). During climate fluctuations in the Cenozoic Era most geomorphologic features in southern Africa were formed (Maud, 2012). Barnosky (2005) indicated that various warming and cooling events occurred in the Cenozoic but states that climatic changes during the Quaternary Period, specifically the last 1.8 Ma, were the most drastic. Climate variations occurring in the Quaternary Period were both drier and wetter than the present and resulted in changes in river flow patterns, sedimentation processes and vegetation variation (Tooth et al., 2004).

The Late Tertiary to Quaternary calcretes/limestones (T-Qc) may stratigraphically be comparable to the Pleistocene or Late Pliocene Mokalanen Formation of the Kalahari Group (Figure 5), while others may be younger (Partridge et al. 2006, Moen 2007). These surface calcretes most probably overlie the Campbell Rand Subgroup at depth. This pedogenic limestone deposits is up to 10 meters thick



and may displace or replace near-surface bedrocks. Netterberg (1978, 1980) revived the South African calcretes and found that the calcretes comprise of glaebular calcrete (with separate nodules), hardpan calcrete that contain solid limestone and honeycomb calcrete (fusing with glaebules). These calcretes are locally conglomeratic with clasts of exotic pebbles and reworked calcretes.

Small portions in the north of the development are underlain by the Dwyka Group (**Figure 2**). The Dwyka Group is Late Carboniferous to Early Permian in age (300-290 Million years ago (Ma) and overlies glaciated Precambrian bedrock faces along the northern margin of the basin. In the south the Dwyka overlies the Cape Supergroup unconformably/paraconformably and in the east it unconformably overlies the Natal Group and Msikaba Formation. Underlying rocks, especially in the north, form in places well-developed striated glacial pavements. Visser (1986) identified several types of lithofacies which he perceived to be deposited in a marine basin. The Dwyka Group is divided into northern and southern facies (Visser, 1981) due to the distinctive lithological variations over the basin. The Mbizane Formation consists mainly of the northern inlet facies which is characterised by thickness changes, extremely varying lithology and low massive diamictite (~20 %) and high mudrock (~40%) content. The Elandsvlei Formation is the southern platform and are depicted by a high massive diamictite (~70%) and low mudrock (~8%) content, gradual southernly increase in thickness (100 m to 800 m). Debris eroded, from the highlands was deposited by a ground ice sheet but in the west fluctuations in the ice front caused bedded diamictons and subaqueous and subglacial outwash sediments (Visser *et al* 1987).

The Permo-Carboniferous Dwyka Group is known for its track-ways (trace fossils), which are also known as ichnofacies, that were formed by fish and arthropods, while fossilized faeces (coprolites) have also been recovered. Body fossils comprise of gastropods, invertebrates, and marine fish. Fossil plants include a rich diversity of conifers, cordaitaleans, glossopterids, ginkgoaleans, horsetails, lycopods, pollens and fern spores (Almond and Pether, 2008). Records indicate that the fossils recorded from the Dwyka Group in the region are ice-transported boulders of Precambrian limestone or dolomite that comprise of small stromatolites (microbial mounds/columns).

### (Figure 2)

The Transvaal Basin comprise of an assortment of stromatolites (microbial laminates), ranging from supratidal mats to intertidal columns and large subtidal domes (Eriksson *et al.* 2006). Stromatolites are layered mounds, columns and sheet-like sedimentary rocks. These structures were originally formed by the growth of layer upon layer of cyanobacteria, a single-celled photosynthesizing microbe. Cyanobacteria are prokaryotic cells (simplest form of modern carbon-bases life). Stromatolites are first found in Precambrian rocks and are known as the earliest known fossils. These algae photosynthesised in the low oxygen atmosphere and deposited layer upon layer of calcium sulphate, magnesium sulphate and calcium carbonate as well as other compounds to form these domes. Researchers have examined and classified the stromatolite structures but seldomly



find preserved algal cells. The oxygen atmosphere that we depend on today was generated by numerous cyanobacteria photosynthesizing during the Archaean and Proterozoic Era.

Stromatolites and oolites from the Transvaal Supergroup have been described by various authors (Eriksson and Altermann, 1998). Detailed descriptions of South African Archaean stromatolites are available in the literature (Altermann, 2001; Buick, 2001; and Schopf, 2006). The Malmani stromatolites literature includes articles by Truswell and Eriksson (1972, 1973, 1975), Eriksson and MacGregor (1981), Eriksson and Altermann (1998), Sumner (2000), Schopf (2006).

A small portion of the development is underlain by ancient sedimentary rocks of the Boomplaas Formation of the Schmidtsdrif Subgroup. In the Griqualand West Basin, the Schmidtsdrif Subgroup is the basal subdivision of the Late Archaean to Early Proterozoic Ghaap Group (Transvaal Supergroup), Ghaap Plateau Sub-basin (**Figure 6**). The Schmidtsdrif Subgroup can be divided into the geological older Boomplaas Formation and younger Clearwater Formation. The Ghaap Group represents 200 Ma of chemical sedimentation of which iron and manganese ores, cherts and carbonates with subordinate silicastic rocks are prominent within the Griqualand West Basin. The central and south-eastern portions of the development site are underlain by shallow marine or lagoon sediments as well as volcanic rocks of the Vryburg Formation. This formation is roughly 140m thick and overlies lavas of the Ventersdorp Supergroup. The lower portion of the Vryburg succession consists of basal conglomerates followed by the 20m thick Kobaga beds which show prominent weathering of cross-bedded feldspathic quartzites. The Kobaga beds are overlain by c. 20m andesitic or basaltic lavas of the Rosendal Member and finally by the Waterloo Member which consists of c. 20-50m of amygdaloidal and non-amygdaloidal basaltic or andesitic lavas and is overlain by 14m of interbedded pyroclastic sediments and thin lenticular limestones. These sediments form the top of the Vryburg Formation and are followed by the overlying carbonate-rich Boomplaas Formation which is present in the study area. The Boomplaas Formation is known to contain well-preserved stromatolite (microbial dome) assemblages in the Vryburg region.

Smith (1991) described microbial stromatolites in the upper Vryburg Formation. These stromatolitic carbonates are believed to be intertidal (Altermann and Wotherspoon, 1995). Vryburg Formation stromatolite have not been described in the literature although South African Archaean stromatolites have been discussed in detail (Altermann, 2001; Buick, 2001; and Schopf, 2006). Bertrand-Sarfarti and Eriksson (1977) described columnar stromatolites from the Schmidtsdrif Subgroup of the Northern Cape Province.

The Boomplaas beds comprise of grey dolomites weathering to reddish-brown with subordinate interbeds of limestone (weathering blue-grey), flaggy sandstone and shale as well as quartzite. The Farm Waterloo 992 contains well preserved stromatolites and have been described in detail by Almond 2013 (a and b); 2016, 2017).

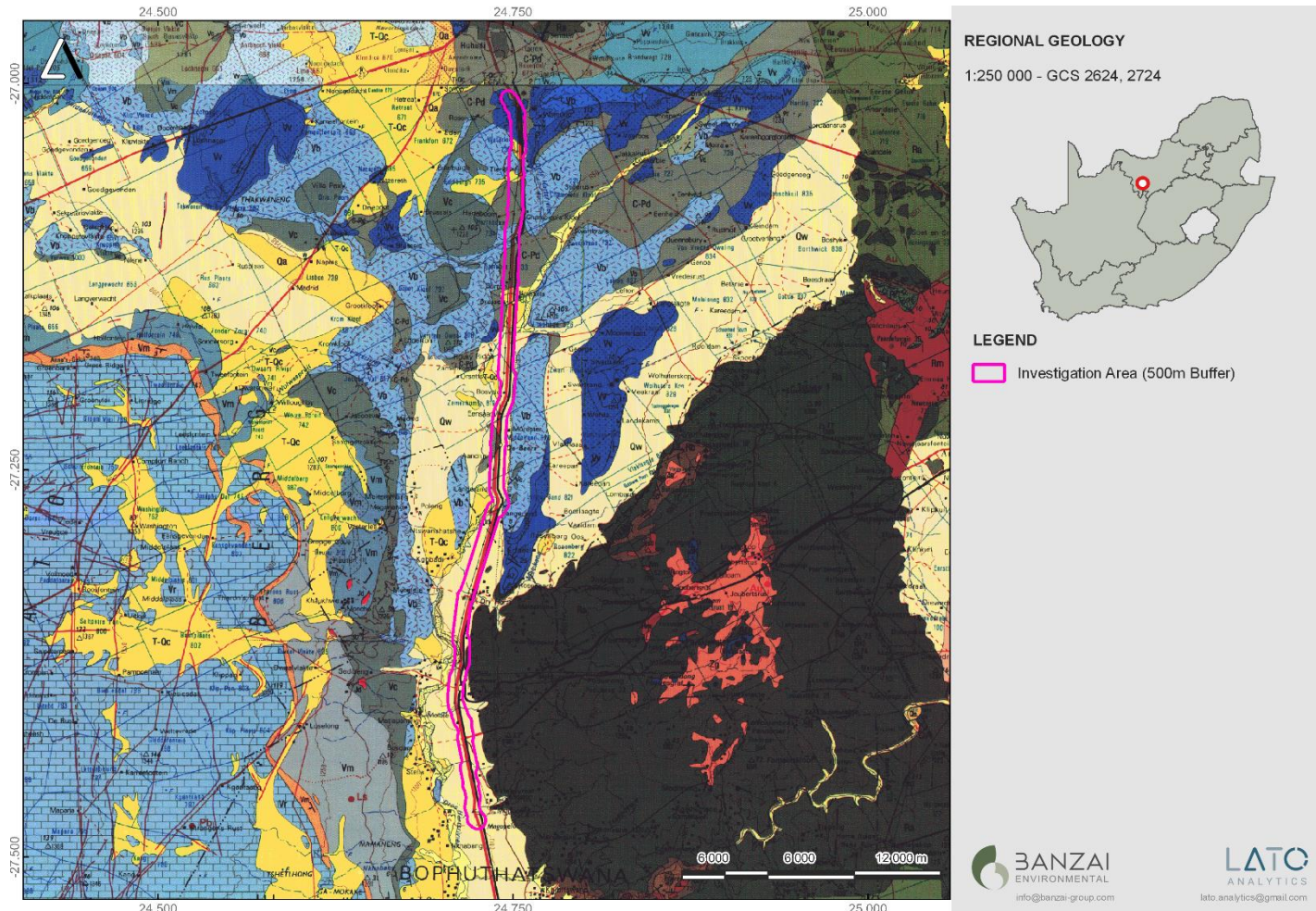
Currently very few palaeontologists study stromatolites but geologists find the stromatolites interesting because they reveal the change from a reducing environment (that is an oxygen-poor) to



an oxidizing environment (oxygen-rich). This transition is known as the Great Oxygen Event (Eroglu et al., 2017).

Four basins developed on the Kaapvaal Craton about 3000 to 2100 million years ago. The Ventersdorp Supergroup was the third Basin to develop and provides an exceptional volcano-sedimentary supracrustal record. The Ventersdorp Supergroup comprise of the biggest and most wide-spread system of volcanic rocks in the Kaapvaal Craton.

Some of the best exposures of the Ventersdorp Supergroup are in the North West Province. This Supergroup consists of the Klipriviersberg Group (oldest) which is overlain by the Platberg Group, followed by the sedimentary Bothaville Formation (Rb) and the volcanic Allanridge Formation (Ra) (uppermost Ventersdorp unit, youngest Formation and present in the development). The Allanridge Formation comprise mostly of light-greenish grey porphyritic lava, dark-green amygdaloidal lava, and pyroclastic rocks. The lavas are approximately 2700 million years old and comprise of basaltic andesites. The Allanridge Formation is not known to be fossiliferous and a Low Palaeontological Sensitivity has been allocated to this Formation.

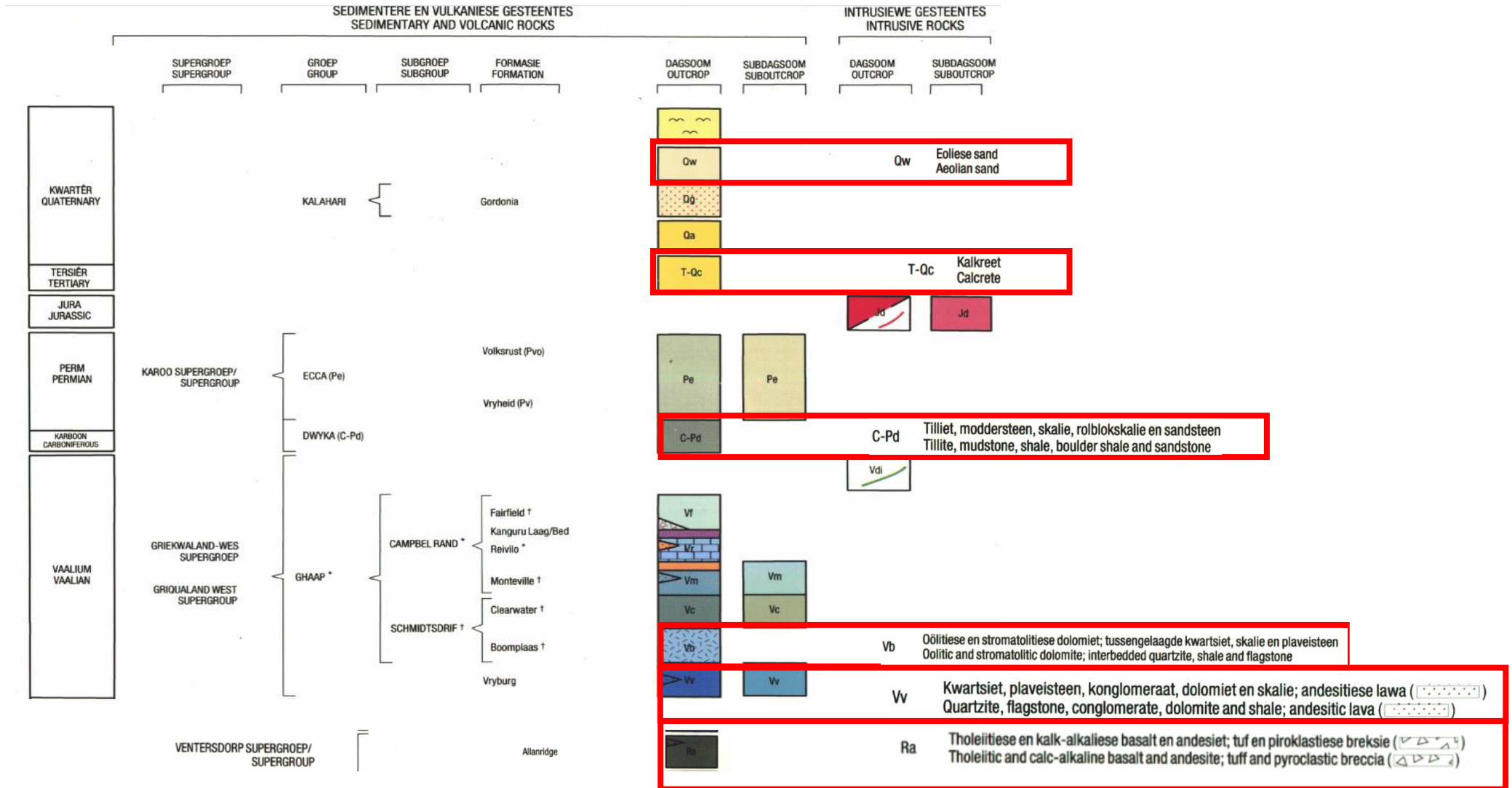


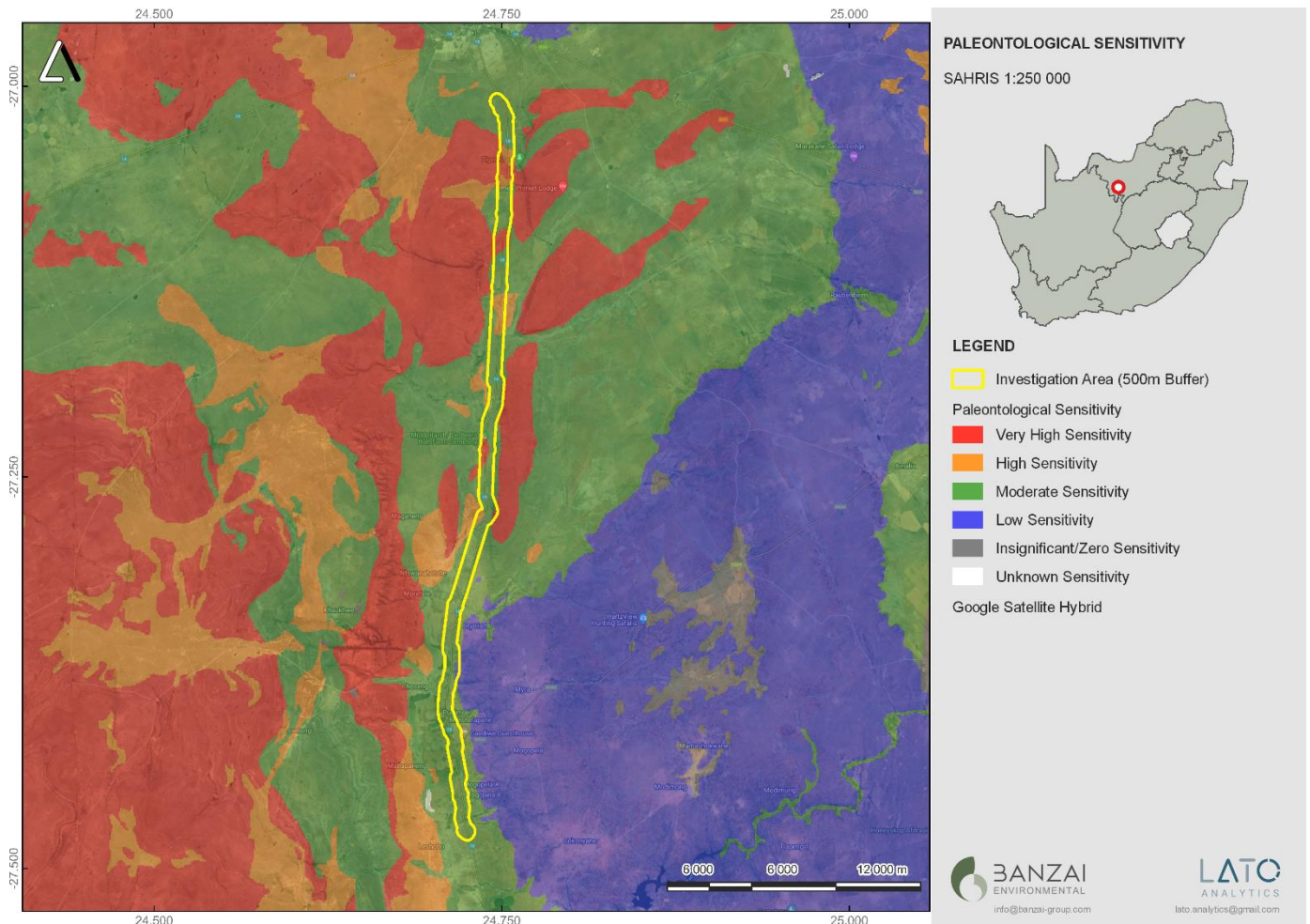
**Figure 2:** Extract of the 1:250 000 Vryburg 2624 (1993) and 2724 Christiana (1994) Geological Map (Council for Geosciences, Pretoria) indicating the geology of the proposed Mookodi-Magopela Power Line near Vryburg in North West Province.



**Table 2:** Legend of the Christiana 2724 (1994) Geological Map (Council for Geosciences, Pretoria) indicating the geology of the proposed Mookodi-Magopela Power Line near Vryburg in North West Province.

Relevant sediments are indicated in a red.



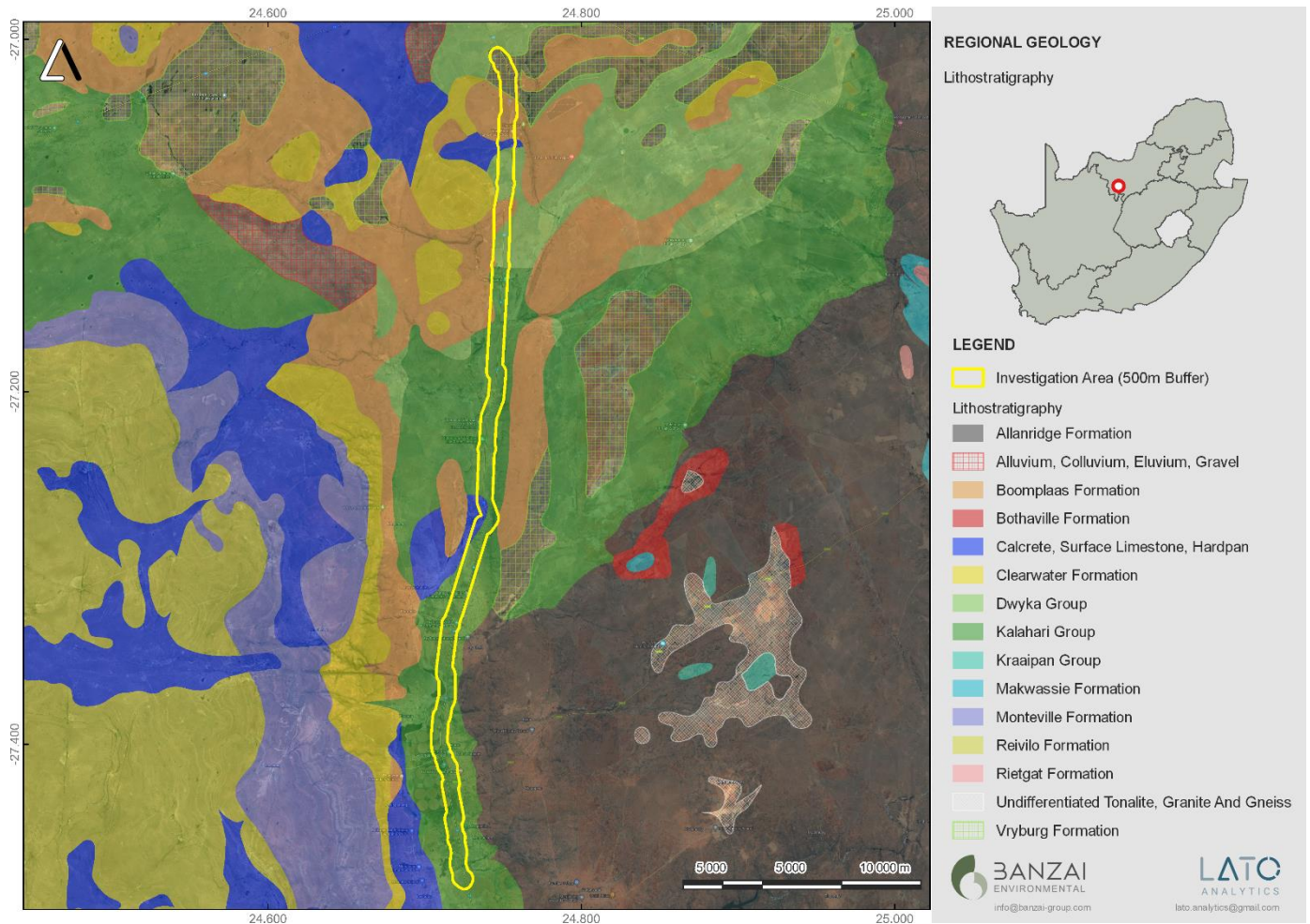


**Figure 3:** Extract of the SAHRIS Palaeosensitivity Map indicates that the proposed Power Line development is underlain by sediments with a Very High, High, Moderate and Low Palaeontological Sensitivity.

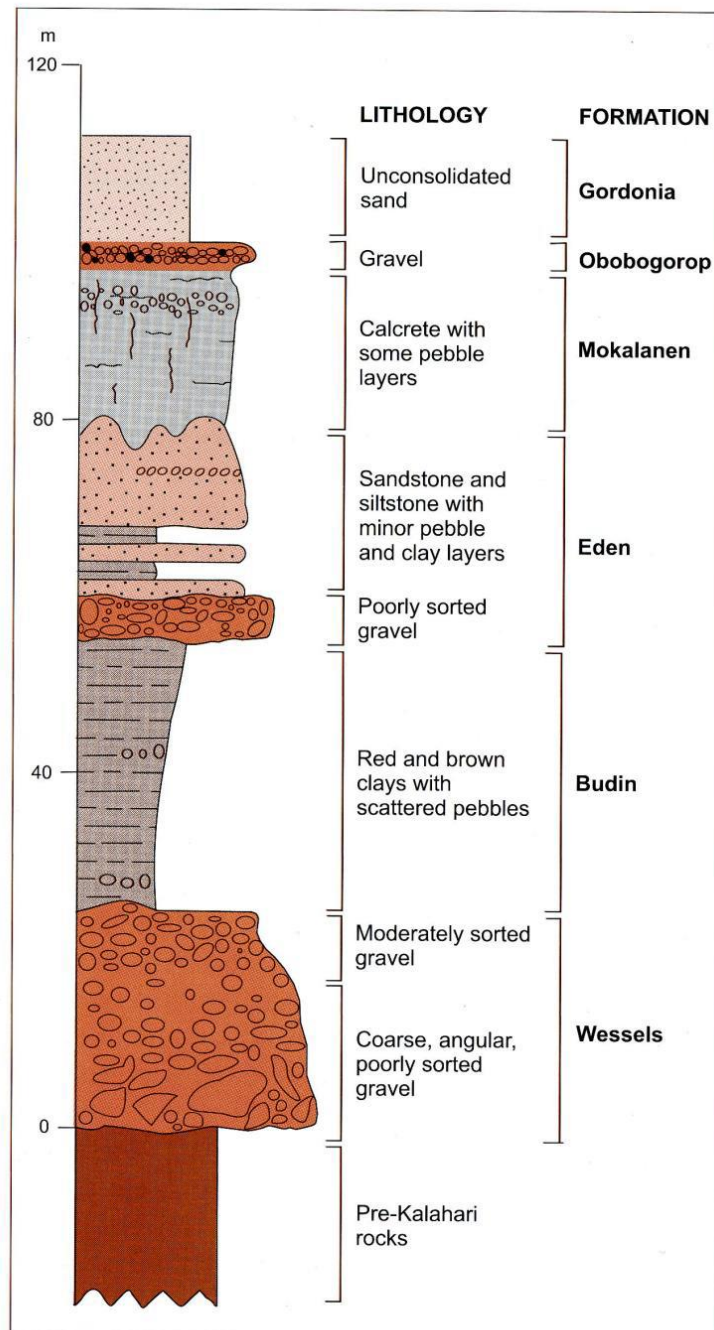
**Table 3:** Palaeontological Sensitivity according to the SAHRIS PalaeoMap (Almond et al, 2013; SAHRIS website)

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.

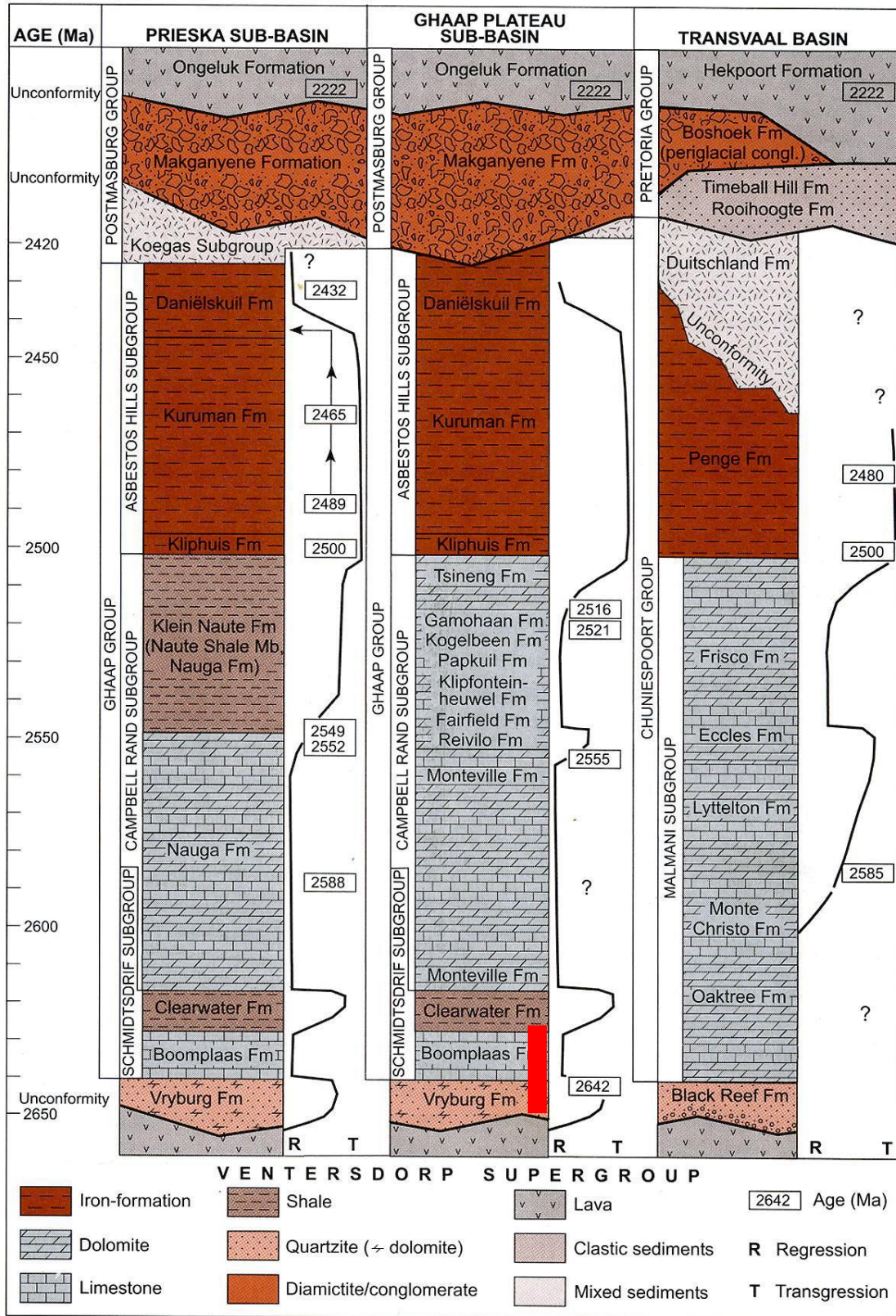




**Figure 4:** Updated geology (Council for Geosciences, Pretoria) indicates that the study area is underlain by calcretes, surface limestones and Hardpan superficial sediments



**Figure 5:** Stratigraphy of the Kalahari Group (Image taken from Partridge et al., 2006). Calcretes and aeolian sands of the Gordonia Formation possibly corresponds to the Mokalanen Formation.



**Figure 6:** Stratigraphy of the Transvaal Supergroup of the Transvaal Basin. The proposed development is indicated in blue (Eriksson, et al. 2006).



## 6 GEOGRAPHICAL LOCATION OF THE SITE

The proposed Mookodi Power Line development is located about 6 km south of Vryburg in the North West Province and will comprise of 260 pylons (**Figure 1**).

**Table 4:**Mookodi-Power Line Coordinates

	Latitude (S)	Longitude (E)
Beginning	27° 0'29.46"S	24°44'38.75"E
End	27°28'35.41"S	24°43'32.95"E

The proposed development site near Vryburg consists of characteristic flat-lying terrain of the Ghaap Plateau region. This terrain is currently used for agricultural purposes, primary cattle and game farming. The climate is semi-arid and the vegetation cover of grassy thornveld is mapped as Ghaap Plateau Vaalbosveld. Images from Google Earth show a flat relief and bedrock mantled by reddish-brown soils. These sandy soils contain abundant gravel clasts, primarily cherty material down washed from the underlying Boomplaas Formation (Eriksson, *et al.*, 2006).

## 7 METHODS

The aim of a desktop study is to evaluate the possible risk to palaeontological heritage in the proposed development. This includes all trace fossils as well as all fossils in the proposed footprint. All possible information is consulted to compile a desktop study, and this includes the following: all Palaeontological Impact Assessment reports in the same area; aerial photos and Google Earth images, topographical as well as geological maps.

### 7.1 Assumptions and Limitations

The focal point of geological maps is the geology of the area and the sheet explanations of the Geological Maps were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have never been reviewed by palaeontologists and data is generally based on aerial photographs alone. Locality and geological information of museums and universities databases have not been kept up to date or data collected in the past have not always been accurately documented.

Comparable Assemblage Zones in other areas is also used to provide information on the existence of fossils in an area which has not documented in the past. When using similar Assemblage Zones and geological formations for Desktop studies it is generally **assumed** that exposed fossil heritage is present within the footprint. A field-assessment was thus conducted for the study area that will improve the accuracy of the desktop assessment.



## 8 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 NCC.
- 1:250 000 Christiana 2724 (1994) Geological Map (Council for Geosciences, Pretoria).
- Palaeotechnical report of the North West Province (Groenewald et al, 2014)
- Topocadastral maps 2624BA, 2624BB, 2624DA, 2624DB, 2624DC, 2624DD,
  - 2624BC, 2624BD, 2724BA, 2724BB



## 9 SITE VISIT

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 19 November 2022. Weathered to fairly well-preserved stromatolitic outcrops were detected, but better-preserved outcrops have been identified nearby (Almond 2013, 2016). These outcrops have been protected/preserved for future generations.



**Figure 7:** General view over the development indicates a flat topography with vegetation cover of grassy thornveld



**Figure 8:** Example of a well-preserved stromatolites

GPS: - -27.053092; 24.752411



**Figure 9: Well preserved stromatolites**

GPS coordinates-27.043121; 24.754549; Electricity pole no 24





**Figure 10:** *Weathered stromatolite outcrop.*

GPS coordinates -27.043121; 24.754549



## 10 IMPACT ASSESSMENT METHODOLOGY

Impact assessment must take account of the nature, scale, and duration of impacts on the environment whether such impacts are positive or negative. Each impact is also assessed according to the following project phases:

- Construction.
- Operation; and
- Decommissioning.

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance should also be included. The rating system is applied to the potential impacts on the receiving environment and includes an objective evaluation of the mitigation of the impact. In assessing the significance of each impact, the following criteria is used:

**Table 5: The rating system**

<b>NATURE</b>		
The Nature of the Impact is the possible destruction of fossil heritage		
<b>GEOGRAPHICAL EXTENT</b>		
This is defined as the area over which the impact will be experienced.		
1	Site	The impact will only affect the site.
2	Local/district	Will affect the local area or district.
3	Province/region	Will affect the entire province or region.
4	International and National	Will affect the entire country.
<b>PROBABILITY</b>		
This describes the chance of occurrence of an impact.		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).



3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
<b>DURATION</b>		
This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 30 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered indefinite.
<b>INTENSITY/ MAGNITUDE</b>		
Describes the severity of an impact.		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).



3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
<b>REVERSIBILITY</b>		
This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible, and no mitigation measures exist.
<b>IRREPLACEABLE LOSS OF RESOURCES</b>		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
<b>CUMULATIVE EFFECT</b>		



This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.

1	Negligible cumulative impact	The impact would result in negligible to no cumulative effects.
2	Low cumulative impact	The impact would result in insignificant cumulative effects.
3	Medium cumulative impact	The impact would result in minor cumulative effects.
4	High cumulative impact	The impact would result in significant cumulative effects

**SIGNIFICANCE**

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula:

$$(\text{Extent} + \text{probability} + \text{reversibility} + \text{irreplaceability} + \text{duration} + \text{cumulative effect}) \times \text{magnitude/intensity} = X.$$

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact significance rating	Description
6 to 28	Negative low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative high impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.



51 to 73	Positive high impact	The anticipated impact will have significant positive effects.
74 to 96	Negative very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive very high impact	The anticipated impact will have highly significant positive



### 10.1 Summary of Impact Tables

Loss of fossil heritage will be a negative impact. Only the site will be affected by the proposed development. The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures, the damage or destruction of any palaeontological materials will be permanent. Impacts on palaeontological heritage during the construction phase could potentially occur and are regarded as having a Low probability. As fossil heritage will be destroyed the impact is irreversible. The significance of the impact occurring will be low.

**Table 6: Summary of Impact Tables**

	Site	Probability	Duration	Magnitude	Reversibility	Irreplicable Loss	Cumulative Effect	Significance
Pre-mitigation	1	2	4	2	4	4	2	34
Post-Mitigation	1	2	4	1	4	4	2	17



## 11 FINDINGS AND RECOMMENDATIONS

The proposed Mookodi Power Line development is underlain by Quaternary superficial sediments (Aeolian sand and Tertiary to Quaternary calcrete), Dwyka Group, Boomplaas Formation (Schmidsdrift Subgroup, Ghaap Group, Transvaal Supergroup), and Vryburg Formation (Ghaap Group, Transvaal Supergroup) as well as the Allanridge Formation of the Ventersdorp Supergroup). Updated geology (Council of Geosciences, Pretoria) indicates that the study area is underlain by the Kalahari Group, Calcrete, Surface Limestone and Hardpan sediments, the Dwyka Group, and Boomplaas Formation as well as the Allanridge Formation. The PalaeoMap of the South African Heritage Resources Information System (SAHRIS) indicates that the Palaeontological Sensitivity of the Boomplaas Formation is Very High, while that of the Quaternary to Tertiary calcrete is High. The Aeolian Sands, Dwyka Group, and Vryburg Formation has a Moderate Palaeontological Sensitivity and that of the Allanridge Formation is Low (Almond *et al*, 2013; SAHRIS website).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 19 November 2022. Weathered to fairly well-preserved stromatolitic outcrops were detected, but better-preserved outcrops have been identified nearby (Almond 2013, 2016). If significant stromatolites are uncovered during surface clearing and excavations the **Chance find Protocol** attached should be implemented immediately. Fossil discoveries ought to be protected and the ECO/site manager must report to 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](http://www.sahra.org.za)) so that mitigation (recording and collection) can be carried out.

Preceding any collection of fossil material, the specialist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies required by SAHRA.

These recommendations should be included in the Environmental Management Plan of the Mookodi Power Line Construction.

### Recommendations:

- The ECO for this project must be informed that the **Boomplaas Formation (Schmidsdrift Subgroup, Ghaap Group, Transvaal Supergroup)** has a **Very High** and the **Quaternary to Tertiary** has a **High Palaeontological Sensitivity**.





- If significant stromatolite outcrops are uncovered during surface clearing and excavations the **Chance find Protocol** attached should be implemented.

## **12 CHANCE FINDS PROTOCOL**

### **12.1 Introduction**

This informational document is intended for workmen and foremen on construction sites. It describes the actions to be taken when mining or construction activities accidentally uncovers fossil material.

It is the responsibility of the Environmental Site Officer (ESO) or site manager of the project to train the workmen and foremen in the procedure to follow when a fossil is accidentally uncovered. In the absence of the ESO, a member of the staff must be appointed to be responsible for the proper implementation of the chance find protocol as not to compromise the conservation of fossil material.

A fossil is the naturally preserved remains (or traces) of plants or animals embedded in rock. These plants and animals lived in the geologic past millions of years ago. Fossils are extremely rare and irreplaceable. By studying fossils, it is possible to determine the environmental conditions that existed in a specific geographical area millions of years ago.

A following procedure will only be followed if fossils are uncovered during excavation.

### **12.2 Legislation**

Cultural Heritage in South Africa (includes all heritage resources) is protected by the **National Heritage Resources Act (Act 25 of 1999) (NHRA)**. According to Section 3 of the Act, all Heritage resources include **"all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens"**.

Palaeontological heritage is unique and non-renewable and is protected by the NHRA and are the property of the State. It is thus the responsibility of the State to manage and conserve fossils on behalf of the citizens of South Africa. Palaeontological resources may not be excavated, 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.



### 12.3 Chance Find Procedure

- If a chance find is made the person responsible for the find must immediately **stop working** and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately **report** the find to his/her direct supervisor which in turn must report the find to his/her manager and the ESO or site manager. The ESO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research 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](http://www.sahra.org.za)). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS coordinates.
- A preliminary report must be submitted to the Heritage Agency within **24 hours** of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.
- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.
- Upon receipt of the preliminary report, the Heritage Agency will inform the ESO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.
- The site must be secured to protect it from any further damage. **No attempt** should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO (site manager). Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.



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## Appendix A – Elize Butler CV

### CURRICULUM VITAE

#### ELIZE BUTLER

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 30 years in Palaeontology

EDUCATION: B.Sc Botany and Zoology, 1988  
University of the Orange Free State

B. Sc (Hons) Zoology, 1991  
University of the Orange Free State

Management Course, 1991  
University of the Orange Free State

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

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

#### MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently

#### EMPLOYMENT HISTORY

Part time Laboratory assistant	Department of Zoology & Entomology University of the Free State Zoology 1989-1992
Part time laboratory assistant	Department of Virology University of the Free State Zoology 1992
Research Assistant	National Museum, Bloemfontein 1993 – 1997
Principal Research Assistant and Collection Manager	National Museum, Bloemfontein 1998–2022

#### TECHNICAL REPORTS

BANZAI ENVIRONMENTAL (PTY) LTD.  
Reg No. 2015/332235/07 |





- Butler, E. 2014. Palaeontological Impact Assessment of the proposed development of private dwellings on portion 5 of farm 304 Matjesfontein Keurboomstrand, Knysna District, Western Cape Province. Bloemfontein.
- Butler, E. 2014. Palaeontological Impact Assessment for the proposed upgrade of existing water supply infrastructure at Noupoot, Northern Cape Province. 2014. Bloemfontein.
- Butler, E. 2015. Palaeontological impact assessment of the proposed consolidation, re-division, and development of 250 serviced erven in Nieu-Bethesda, Camdeboo local municipality, Eastern Cape. Bloemfontein.
- Butler, E. 2015. Palaeontological impact assessment of the proposed mixed land developments at Rooikraal 454, Vrede, Free State. Bloemfontein.
- Butler, E. 2015. Palaeontological exemption report of the proposed truck stop development at Palmiet 585, Vrede, Free State. Bloemfontein.
- Butler, E. 2015. Palaeontological impact assessment of the proposed Orange Grove 3500 residential development, Buffalo City Metropolitan Municipality East London, Eastern Cape. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Gonubie residential development, Buffalo City Metropolitan Municipality East London, Eastern Cape Province. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Ficksburg raw water pipeline. Bloemfontein.
- Butler, E. 2015. Palaeontological Heritage Impact Assessment report on the establishment of the 65 mw Majuba Solar Photovoltaic facility and associated infrastructure on portion 1, 2 and 6 of the farm Witkoppies 81 HS, Mpumalanga Province. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed township establishment on the remainder of portion 6 and 7 of the farm Sunnyside 2620, Bloemfontein, Mangaung metropolitan municipality, Free State, Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Woodhouse 1 photovoltaic solar energy facilities and associated infrastructure on the farm Woodhouse729, near Vryburg, North West Province. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Woodhouse 2 photovoltaic solar energy facilities and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Orkney solar energy farm and associated infrastructure on the remaining extent of Portions 7 and 21 of the farm Wolvehuis 114, near Orkney, North West Province. Bloemfontein.
- Butler, E. 2015. Palaeontological Impact Assessment of the proposed Spectra foods broiler houses and abattoir on the farm Maiden Manor 170 and Ashby Manor 171, Lukhanji Municipality, Queenstown, Eastern Cape Province. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed construction of the 150 MW Noupoot concentrated solar power facility and associated infrastructure on portion 1 and 4 of the farm Carolus Poort 167 and the remainder of Farm 207, near Noupoot, Northern Cape. Prepared for Savannah Environmental. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed Woodhouse 1 Photovoltaic Solar Energy facility and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed Woodhouse 2 Photovoltaic Solar Energy facility and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.
- Butler, E. 2016. Proposed 132kV overhead power line and switchyard station for the authorised Solis Power 1 CSP project near Upington, Northern Cape. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed Senqu Pedestrian Bridges in Ward 5 of Senqu Local Municipality, Eastern Cape Province. Bloemfontein.
- Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modderfontein Filling Station on Erf 28 Portion 30, Founders Hill, City of Johannesburg, Gauteng Province. Bloemfontein.
- Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modikwa Filling Station on a Portion of Portion 2 of Mooihoek 255 Kt, Greater Tubatse Local Municipality, Limpopo Province. Bloemfontein.
- Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Heidedal filling station on Erf 16603, Heidedal Extension 24, Mangaung Local Municipality, Bloemfontein, Free State Province. Bloemfontein.



- Butler, E. 2016. Recommended Exemption from further Palaeontological studies: Proposed Construction of the Gunstfontein Switching Station, 132kv Overhead Power Line (Single or Double Circuit) and ancillary infrastructure for the Gunstfontein Wind Farm Near Sutherland, Northern Cape Province. Savannah South Africa. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed Galla Hills Quarry on the remainder of the farm Roode Krantz 203, in the Lukhanji Municipality, division of Queenstown, Eastern Cape Province. Bloemfontein.
- Butler, E. 2016. Chris Hani District Municipality Cluster 9 water backlog project phases 3a and 3b: Palaeontology inspection at Tsomo WTW. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed construction of the 150 MW Noupoot concentrated solar power facility and associated infrastructure on portion 1 and 4 of the farm Carolus Poort 167 and the remainder of Farm 207, near Noupoot, Northern Cape. Savannah South Africa. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed upgrading of the main road MR450 (R335) from Motherwell to Addo within the Nelson Mandela Bay Municipality and Sunday's River valley Local Municipality, Eastern Cape Province. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment construction of the proposed Metals Industrial Cluster and associated infrastructure near Kuruman, Northern Cape Province. Savannah South Africa. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment for the proposed construction of up to a 132kv power line and associated infrastructure for the proposed Kalkaar Solar Thermal Power Plant near Kimberley, Free State and Northern Cape Provinces. PGS Heritage. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment of the proposed development of two burrow pits (DR02625 and DR02614) in the Enoch Mgijima Municipality, Chris Hani District, Eastern Cape.
- Butler, E. 2016. Ezibeleni waste Buy-Back Centre (near Queenstown), Enoch Mgijima Local Municipality, Eastern Cape. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment for the proposed construction of two 5 Mw Solar Photovoltaic Power Plants on Farm Wildebeestkuil 59 and Farm Leeuwbosch 44, Leeudoringstad, North West Province. Bloemfontein.
- Butler, E. 2016. Palaeontological Impact Assessment for the proposed development of four Leeuwberg Wind farms and basic assessments for the associated grid connection near Loeriesfontein, Northern Cape Province. Bloemfontein.
- Butler, E. 2016. Palaeontological impact assessment for the proposed Aggeney's south prospecting right project, Northern Cape Province. Bloemfontein.
- Butler, E. 2016. Palaeontological impact assessment of the proposed Motuoane Ladysmith Exploration right application, KwaZulu Natal. Bloemfontein.
- Butler, E. 2016. Palaeontological impact assessment for the proposed construction of two 5 MW solar photovoltaic power plants on farm Wildebeestkuil 59 and farm Leeuwbosch 44, Leeudoringstad, North West Province. Bloemfontein.
- Butler, E. 2016: Palaeontological desktop assessment of the establishment of the proposed residential and mixed-use development on the remainder of portion 7 and portion 898 of the farm Knopjeslaagte 385 Ir, located near Centurion within the Tshwane Metropolitan Municipality of Gauteng Province. Bloemfontein.
- Butler, E. 2017. Palaeontological impact assessment for the proposed development of a new cemetery, near Kathu, Gamagara local municipality and John Taolo Gaetsewe district municipality, Northern Cape. Bloemfontein.
- Butler, E. 2017. Palaeontological Impact Assessment of The Proposed Development of The New Open Cast Mining Operations on The Remaining Portions Of 6, 7, 8 And 10 Of the Farm Kwaggafontein 8 In the Carolina Magisterial District, Mpumalanga Province. Bloemfontein.
- Butler, E. 2017. Palaeontological Desktop Assessment for the Proposed Development of a Wastewater Treatment Works at Lanseria, Gauteng Province. Bloemfontein.
- Butler, E. 2017. Palaeontological Scoping Report for the Proposed Construction of a Warehouse and Associated Infrastructure at Perseverance in Port Elizabeth, Eastern Cape Province.
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