PALAEONTOLOGICAL IMPACT ASSESSMENT FOR THE PROPOSED THAKADU SOLAR POWER PLANT (PART OF THE AUTHORISED PALESO SOLAR POWER PLANT) NEAR VILJOENSKROON, IN THE FREE STATE

Prepared for:

ENVIRONAMICS

Environamics CC

14 Kingfisher Street, Potchefstroom, 2531

Prepared by

Banzai Environmental (Pty) Ltd

November 2021

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: elizebutler002@gmail.com

SIGNATURE: 

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: NEMA Table

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 **Appendix A**	-
(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 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 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	
(e) a description of the methodology adopted in preparing the report or carrying out the specialised	Section 7 Approach and Methodology	-

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
process inclusive of equipment and modelling used		
(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 & 12	
(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 EMPr	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 EMPr or environmental authorisation	Section 1 and 11	
(n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and	Section 1 & 11	

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		
(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 EMPr, 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 regarding heritage resources that require input from a specialist

Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017	The relevant section in the report	Comment where not applicable.
		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 Environamics to conduct the **Palaeontological Impact Assessment** (PIA) to assess the Thakadu Solar Plant which forms part of the authorised Paleso Solar Powerplant near Viljoenskroon in the Free State. This PIA is compiled to comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), to confirm if fossil material could potentially be present in the planned development area and to evaluate the impact of the proposed development on the Palaeontological Heritage.

The proposed development is underlain by Precambrian dolomites and associated marine sedimentary rocks that are allocated to the Malmani (Chuniespoort Group, Transvaal Supergroup). Two power line options is proposed for the Thakadu Solar Power Plant but as they have the same geology there is no preference between the options from a Palaeontological point of view. According to the PalaeoMap of SAHRIS the Palaeontological Sensitivity of the Malmani Subgroup is Very High (Almond *et al*, 2013; SAHRIS website).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 6-7 November 2021. Outcrops of weathered to well-preserved stromatolites were discovered on the whole development, but less prominent in the south. Examples of exceptionally well preserved oolites were recovered from the northern portion of the development footprint. Mitigation of a sample of well-preserved stromatolites is thus recommended. By implementing mitigation measures the significance of the impact will be reduced to low. Mitigation should take place after initial vegetation is cleared away but *before* the ground is levelled for construction. These recommendations should be included in the Environmental Management Plan of the ThakaduSolar Plant.

Recommendations:

- The ECO must be made aware that fossils (stromatolites) of the Malmani (Chuniespoort Group, Transvaal Supergroup) has a Very High Palaeontological Significance.
- When the Thakadu Power Plant layout has been established a walkdown of the area must be completed by a qualified Palaeontologist to catalogue and photograph well-preserved stromatolites. This action should take place after initial vegetation clearance but *before* the ground is levelled for construction.
- If a well preserved stromatolite outcrop falls in the development footprint the stromatolites ought to be cordoned off and a buffer of 30m should be placed around the outcrop.
- An representative example of well-preserved stromatolites should be removed and placed near the offices of the PV as a informative example of fossils in the area.

Impact Summary

Environmental parameter	Issues	Rating prior to mitigation	Average	Rating post mitigation	Average
Construction Stage PV Loss of fossil heritage	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	64	Negative High impact	30	Negative medium impact
Operation Phase PV	No Impact		No Impact		No Impact
Decommissioning Phase PV	No Impact		No Impact		No Impact
Construction Stage Grid connection Option 1-2	Destroy or permanently seal-in fossils at or below the surface that are then no longer available for scientific study	64	Negative High impact	30	30
Operation Phase Grid connection Option 1-2	No Impact		No Impact		No Impact
Decommissioning Phase Grid Connection Option 1-2	No Impact		No Impact		No Impact

It is therefore considered that the proposed development is deemed appropriate and 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

The Thakadu Solar Power Plant near Viljoenskroon in the Free State is proposed. This Solar Power Plant forms part of the authorised Paleso Solar Power Plant that includes the following projects:

- Thakadu Solar Power Plant near Viljoenskroon, Free State Province
- Ngwedi Solar Power Plant near Viljoenskroon, Free State Province
- Noko Solar Power Plant near Orkney, North West Province
- Power line as part of the Paleso solar Power Plant near Viljoenskroon, Free State Province

The Thakadu Solar Power Plant is located on Groot Vaders Bosch No 592, while power line option 1 is located on the Farm Anglo No 593 and Portion 2 of the farm Zuiping No 394 and the Remaining Extent of the farm Zuiping No 394. Power line Option 2 is located on Farm Anglo No 593 and the Remaing Extension of Portion 1 of the Farm Die Hoek No 114 and Farm Hoekplaas No 598 in the Fezile Dabi District Municipality, Moqhaka Local Municipality.

The following information was provided by Environamics and Subsolar (RF) (Pty) Ltd.

Table 2: General site information

Description of affected farm portion	Solar Power Plant Farm Groot Vaders Bosch No. 592 Power Line: Option 1 Farm Anglo No. 593 Portion 2 of the Farm Zuiping No. 394 Remaining Extent of the Farm Zuiping No. 394 Power Line: Option 2 Farm Anglo No. 593 Remaining Extent of Portion 1 of the Farm Die Hoek No. 114 Farm Hoekplaats No. 598
Province	Free State
District Municipality	Fezile Dabi District Municipality
Local Municipality	Moqhaka Local Municipality
Ward numbers	22
Closest towns	Viljoenskroon located ~32km south-east and Orkney ~6.5km north-west
21 Digit Surveyor General codes	Solar Power Plant Farm Groot Vaders Bosch No. 592 - F03600000000059200000

	Power Line: Option 1 Farm Anglo No. 593 - F03600000000059300000 Portion 2 of the Farm Zuiping No. 394 - F03600000000039400002 Remaining Extent of the Farm Zuiping No. 394 - F03600000000039400000 Power Line: Option 2 Farm Anglo No. 593 - F03600000000059300000 Portion 1 of the Farm Die Hoek No. 114 - F03600000000011400001 Farm Hoekplaats No. 598 – F03600000000059800000
Type of technology	Photovoltaic solar facility
Structure Height	Panels ~6m, buildings ~ 6m, power line ~32m and battery storage facility ~8m height
Battery storage	Within a 4-hectare area
Surface area to be covered (Development footprint)	Approximately 326
Laydown area dimensions (EIA footprint)	Assessed 360 hectares
Structure orientation	The panels will either be fixed to a single-axis horizontal tracking structure where the orientation of the panel varies according to the time of the day, as the sun moves from east to west or tilted at a fixed angle equivalent to the latitude at which the site is located in order to capture the most sun.
Generation capacity	Up to 150MW
Expected production	320-360 GWh per annum (Expected production by 150MWdc modules Considering Bifacial and one-axis tracker)

1.1.1 TECHNICAL DETAILS

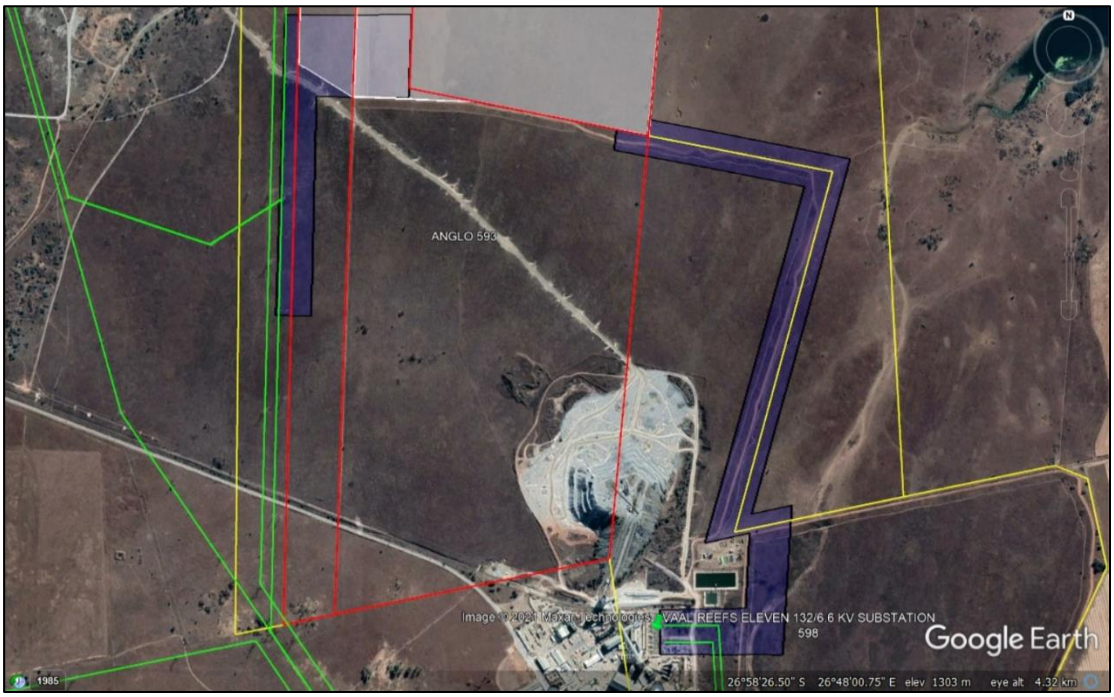
The term photovoltaic describes a solid-state electronic cell that produces direct current electrical energy from the radiant energy of the sun through a process known as the Photovoltaic Effect. This refers to light energy placing electrons into a higher state of energy to create electricity. Each PV cell is made of silicon (i.e. semiconductors), which is positively and negatively charged on either side, with electrical conductors attached to both sides to form a circuit. This circuit captures the released electrons in the form of an electric current (direct current). The key components of the proposed project are described below:

- PV Panel Array - To produce up to 150MW, the proposed facility will require numerous linked cells placed behind a protective glass sheet to form a panel. Multiple panels will be required to form the solar PV arrays which will comprise the PV facility. The PV panels will be tilted at a northern angle in order to capture the most sun, or using one-axis tracker structures to follow the sun to increase the Yield.

- Wiring to Inverters - Sections of the PV array will be wired to inverters. The inverter is a pulse width mode inverter that converts direct current (DC) electricity to alternating current (AC) electricity at grid frequency.

- Connection to the grid - Connecting the array to the electrical grid requires transformation of the voltage from 480V to 33kV to 132kV. The normal components and dimensions of a distribution rated electrical substation will be required. Output voltage from the inverter is 480V and this is fed into step up transformers to 132kV. An onsite substation will be required on the site to step the voltage up to 132kV, after which the power will be evacuated into the national grid via the proposed power line. Whilst Thakadu Solar Power Plant (RF) (Pty) Ltd. has not yet received a cost estimate letter from Eskom, it is expected that generation from the facility will tie in with either the existing Vaal Reefs Eleven Substation or two options within the same assessment corridor, the existing Mercury-South Vaal 2 132kV Power Line or the South Vaal-Carrdell 132kV. The Project will inject up to 100MW into the National Grid. The installed capacity will be approximately 150MW.

  Two grid connection corridors, each with a width of between 100-150m and up to 250m, have been identified for the assessment and placement of the power line (i.e., the power line will be developed within one of the two proposed corridors). The option is located to the south-west of the SPP site and will connect into either the existing Mercury-South Vaal 2 132kV (maximum length 1,22km) or the South Vaal-Carrdell 132kV (maximum length 0,86km).
  The other option is located to the south-east of the SPP site and will connect into the existing Vaal Reefs Eleven Substation. The length of this option is ~2.7km. This is the preferred alternative from a development point of view due to the fact that the Vaal Reefs 11 Substation has capacity to accommodate the project. Refer to the Figure below:



- Electrical reticulation network – An internal electrical reticulation network will be required and will be lain ~2-4m underground as far as practically possible.

- Supporting Infrastructure – The following auxiliary buildings with basic services including water and electricity will be required on site:

    - Office (~200m²);
    - Switch gear and relay room (~400m²);
    - Staff lockers and changing room (~200m²); and
    - Security control (~60m²)

- Battery storage – A Battery Storage Facility with a maximum height of 8m and a maximum volume of 1,740 m^3 of batteries and associated operational, safety and control infrastructure.

- Roads – Access will be obtained via the Stokkiesdraai road to the north of the site. An internal site road network will also be required to provide access to the solar field and associated infrastructure. The access and internal roads will be constructed within a 25-meter corridor.

- Fencing - For health, safety and security reasons, the facility will be required to be fenced off from the surrounding farm. Fencing with a height of 2.5 meters will be used.

*Table 3:*Technical details for the proposed facility

Component	Description / dimensions
Height of PV panels	6 meters
Area of PV Array	326 Hectares (Development footprint) 360 Hectares (EIA Footprint)
Number of inverters required	Minimum 50

Area occupied by inverter / transformer stations / substations / BESS	Central inverters+ LV/MV trafo: 20 m^2 HV/MV substation with switching station: 15 000 m^2 BESS: 4 000 m^2
Capacity of on-site substation	132kV
Capacity of the power line	132kV
Area occupied by both permanent and construction laydown areas	Permanent Laydown Area: 360 Hectares Construction Laydown Area: ~2000 m^2
Area occupied by buildings	Security Room: ~60 m^2 Office: ~200 m^2 Staff Locker and Changing Room: ~200 m^2
Battery storage facility	Maximum height: 8m Maximum volume: 1740 m^3
Length of internal roads	Approximately 15 km
Width of internal roads	Between 6 & 12 meters
Proximity to grid connection	Approximately 1.6 kilometers
Grid connection corridor width	100 - 150m, and up to 250m
Grid connection corridor length	Approximately 1.6 kilometers
Power servitude width	32m
Height of fencing	Approximately 2.5 meters

1.1.2 CONSIDERATION OF ALTERNATIVES

The DEAT 2006 guidelines on 'assessment of alternatives and impacts' proposes the consideration of four types of alternatives namely, the no-go, location, activity, and design alternatives. It is however, important to note that the regulation and guidelines specifically state that only 'feasible' and 'reasonable' alternatives should be explored. It also recognizes that the consideration of alternatives is an iterative process of feedback between the developer and EAP, which in some instances culminates in a single preferred project proposal. An initial site assessment was conducted by the developer the affected properties and the farm portions were found favorable due to its proximity to grid connections, solar radiation, ecology and relative flat terrain. These factors were then taken into consideration and avoided as far as possible.

The following alternatives were considered in relation to the proposed activity and all specialists should also make mention of these:

<u>No-go alternative</u>

This alternative considers the option of 'do nothing' and maintaining the status quo. The site is currently zoned for agricultural land uses. Should the proposed activity not proceed, the site will remain unchanged and will continue to be used for agricultural purposes. The potential opportunity costs in terms of alternative land use income through rental for energy facility and the supporting social and economic development in the area would be lost if the status quo persist.

<u>Location alternatives</u>

No other possible sites were identified on the Farm Groot Vaders Bosch No. 592. This site is referred to as the preferred site. Some limited sensitive features occur on the site. The size of the site makes provision for the exclusion of any sensitive environmental features that may arise through the Basic Assessment (BA) proses.

Technical alternatives: Powerlines

It is expected that generation from the facility will tie in with either the existing the existing Mercury-South Vaal 2 132kV or the South Vaal-Carrdell 132kV Power Lines to the south-west or the existing Vaal Reefs Eleven Substation located to the south-east. Two grid connection corridor alternatives have been proposed for the placement of the power line infrastructure (with three possible conn3ection). However, Option 2 (Vaal Reefs Eleven Substation) has been identified by the developer as the preferred option from a technical perspective.

Battery storage facility

It is proposed that a nominal up to 500 MWh Battery Storage Facility for grid storage would be housed in stacked containers, or multi-storey building, with a maximum height of 8m and a maximum volume of 1,740m^3 of batteries and associated operational, safety and control infrastructure. Three types of battery technologies are being considered for the proposed project: Lithium-ion, Sodium-sulphur or Vanadium Redox flow battery. The preferred battery technology is Lithium-ion.

Battery storage offers a wide range of advantages to South Africa including renewable energy time shift, renewable capacity firming, electricity supply reliability and quality improvement, voltage regulation, electricity reserve capacity improvement, transmission congestion relief, load following and time of use energy cost management. In essence, this technology allows renewable energy to enter the base load and peak power generation market and therefore can compete directly with fossil fuel sources of power generation and offer a truly sustainable electricity supply option.

Design and layout alternatives

Design alternatives will be considered throughout the planning and design phase and specialist studies are expected to inform the final layout of the proposed development.

Technology alternatives

There are several types of semiconductor technologies currently available and in use for PV solar panels. Two, however, have become the most widely adopted, namely crystalline silicon (Mono-facial and Bi-facial) and thin film. The technology that (at this stage) proves more feasible and reasonable with respect to the proposed solar facility is crystalline silicon panels, due to it being non-reflective, more efficient, and with a higher durability. However, due to the rapid technological advances being made in the field of solar technology the exact type of technology to be used, such as bifacial panels, will only be confirmed at the onset of the project.

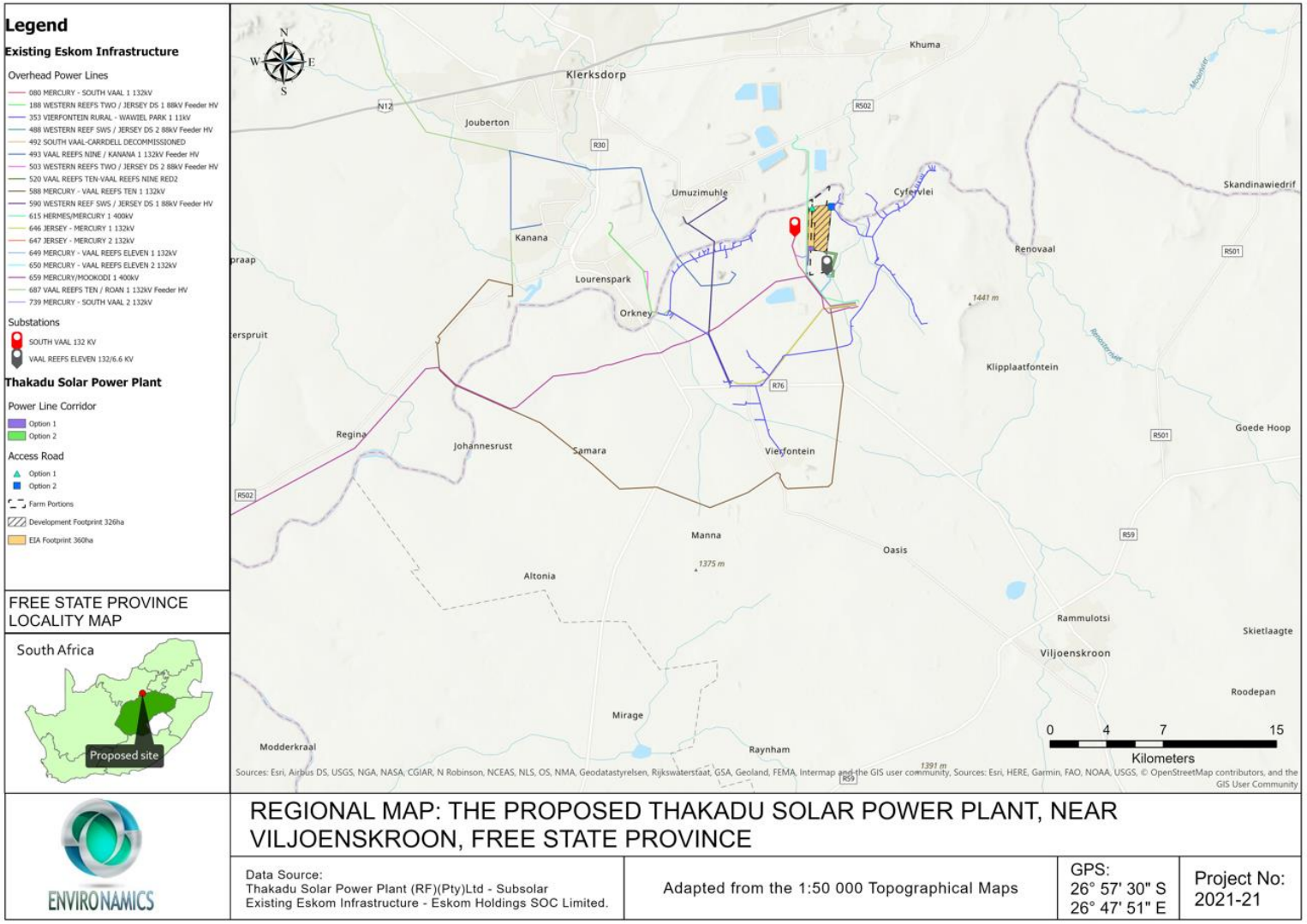


Figure 1: Regional Locality of the proposed Thakadu Solar Power Plant near Viljoenkroon in the Free State.

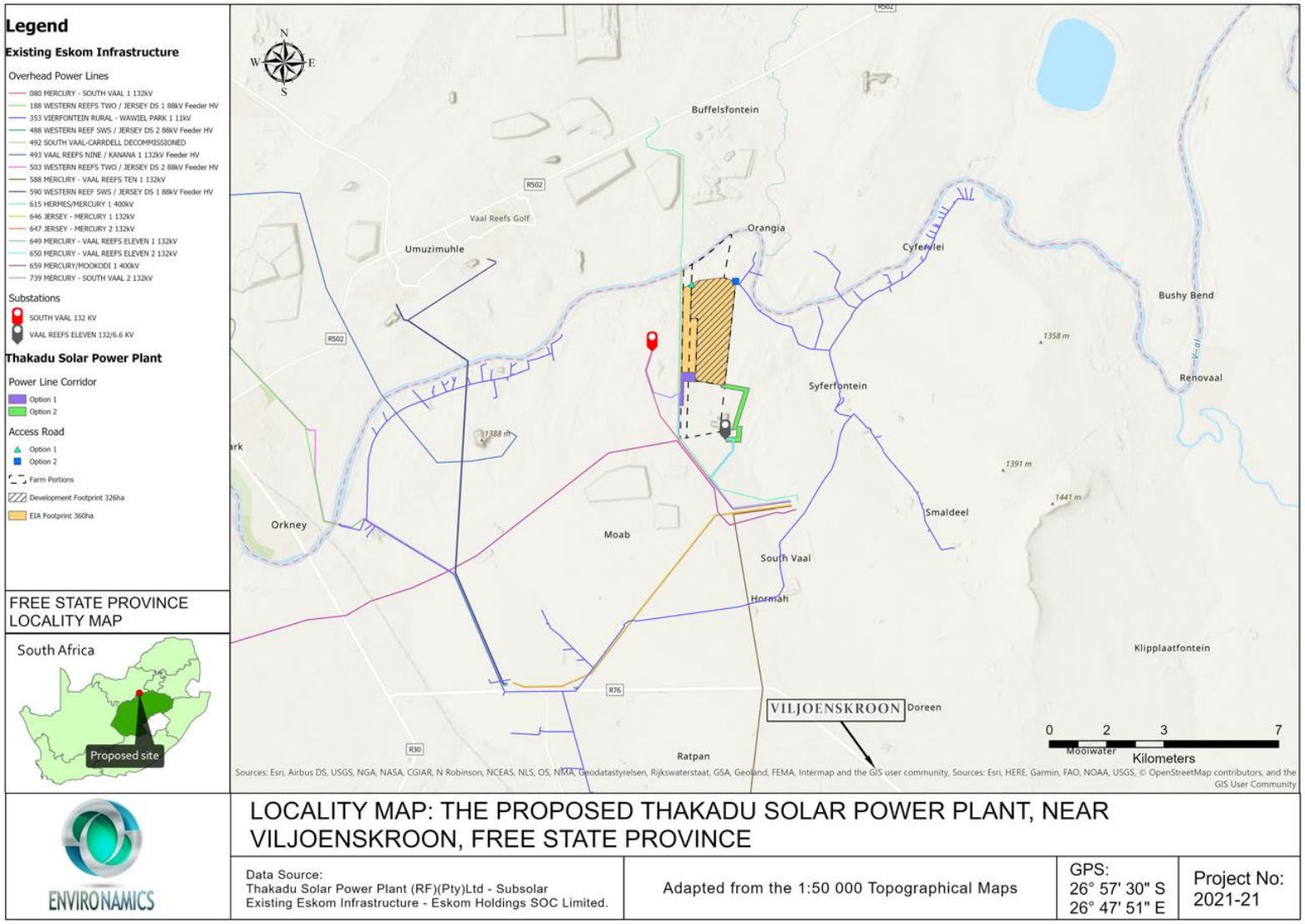


Figure 2: Locality of the proposed Thakadu Solar Power Plant and grid connection near Viljoenkroon in the Free State

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-eight 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
- Minerals and Petroleum Resources Development Act (MPRDA) Act 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 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

MPRDA Regulations of 2014

Environmental reports to be compiled for application of mining right – Regulation 48

- Contents of scoping report – Regulation 49
- Contents of environmental impact assessment report – Regulation 50
- Environmental management programme – Regulation 51
- Environmental management plan – Regulation 52

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 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^2 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 m² 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 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 Thakadu Solar Power Plant and grid connection is indicated on the 1: 250 000 2626 Wes-Rand (1986) Geological Map (Council for Geosciences, Pretoria) (**Figure 4-5**). The proposed development is underlain by Precambrian dolomites and associated marine sedimentary rocks that are allocated to the Malmani Subgroup (blue-green - Vmd) (Chuniespoort Group, **Figure 4**) within the Transvaal Supergroup. According to the PalaeoMap of SAHRIS the Palaeontological Sensitivity of the Malmani Subgroup is Very High (**Figure 6**) (Almond *et al*, 2013; SAHRIS website).

The Malmani Subgroup carbonates of 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).

The Malmani Subgroup succession is about 2 km-thick and consists of a series of formations of oolitic and stromatolitic carbonates (limestones and dolomites), black carbonaceous shales and minor secondary cherts. The Malmani Dolomites also consist of historic lime mines, and palaeocave fossil deposits. Dolomite (limestone rock) forms in warm, shallow seas from slow gathering remainders of marine microorganisms and fine-grained sediment. Dolomites of the Malmani Subgroup has a higher magnesium content than other limestones. These materials contain high levels of calcium carbonate and are often referred to as *carbonates*.

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).

The Vaalriver lies just north of the proposed Thakadu Solar Power Plant. Quaternary alluvium is deposited in this area. The Quaternary superficial deposits are the youngest geological deposits formed during the most recent period of geological time (approximately 2.6 million years ago to present). The rocks and sediments can be found at or near the surface of the Earth. Most of the superficial deposits are unconsolidated sediments and consist of gravel, sand, silt, and clay, and they form relatively thin, often discontinuous patches of sediments or larger spreads onshore.

The Quaternary deposits are of most importance due to the palaeoclimatic changes that are reflected in the different geological formations (Hunter et al., 2006). During the climate fluctuations in the Cenozoic Era most geomorphologic features in southern Africa where 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 changes relative to all climate variations in the past. Climate variations that occurred 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).

Quaternary fossil assemblages are generally rare and low in diversity and occur over a wide-ranging geographic area. These fossil assemblages may in some cases occur in extensive alluvial and colluvial deposits cut by dongas. In the past palaeontologists did not focus on Caenozoic superficial deposits although they sometimes comprise of significant fossil deposits. These fossil assemblages resemble modern animals and may comprise of mammalian teeth, bones and horn corns, reptile skeletons and fragments of ostrich eggs. Microfossils, non-marine mollusc shells are also known from Quaternary deposits. Plant material such as foliage, wood, pollens and peats are recovered as well as trace fossils like vertebrate tracks, burrows, termitaria (termite heaps/ mounds) and rhizoliths (root casts).

The Vryheid Formation (Ecca Group, Karoo Supergroup) is present to the south and east of the proposed Thakadu Solar Power Plant. The Vryheid Formation is characterized by light grey, fine to course sandstone and siltstone sediments. The dark coloured siltstones can be accredited to the existence of carbon enrichment and coal beds. Infrequent coal seams, deltaic mudrocks and sandstones as well as coastal and fluvial deposits are present in this formation. These sediments were probably deposited on a sandy shoreline that stretched out beyond massive swamplands. In these swamps, plants accumulated and formed the coal deposits that are mined today (Johnson et al, 2006).

The Vryheid Formation is world renowned for the occurrence of coal beds formed by the accumulation of plant material over long periods of time. Numerous plant fossils have been described from this formation by Bamford (2011). The Vryheid Formation is also characterised by its trace fossil assemblages of the non-marine *Mermia* Ichnofacies, insect fossils track ways, fish and small crustaceans. The *Mesosaurus* reptile may also be present.

The Hekpoort Formation of the Pretoria Group is present to the east of the development. The Hekpoort formation consists of Basaltic andesite and pyroclastic rocks and is volcanic in origin.

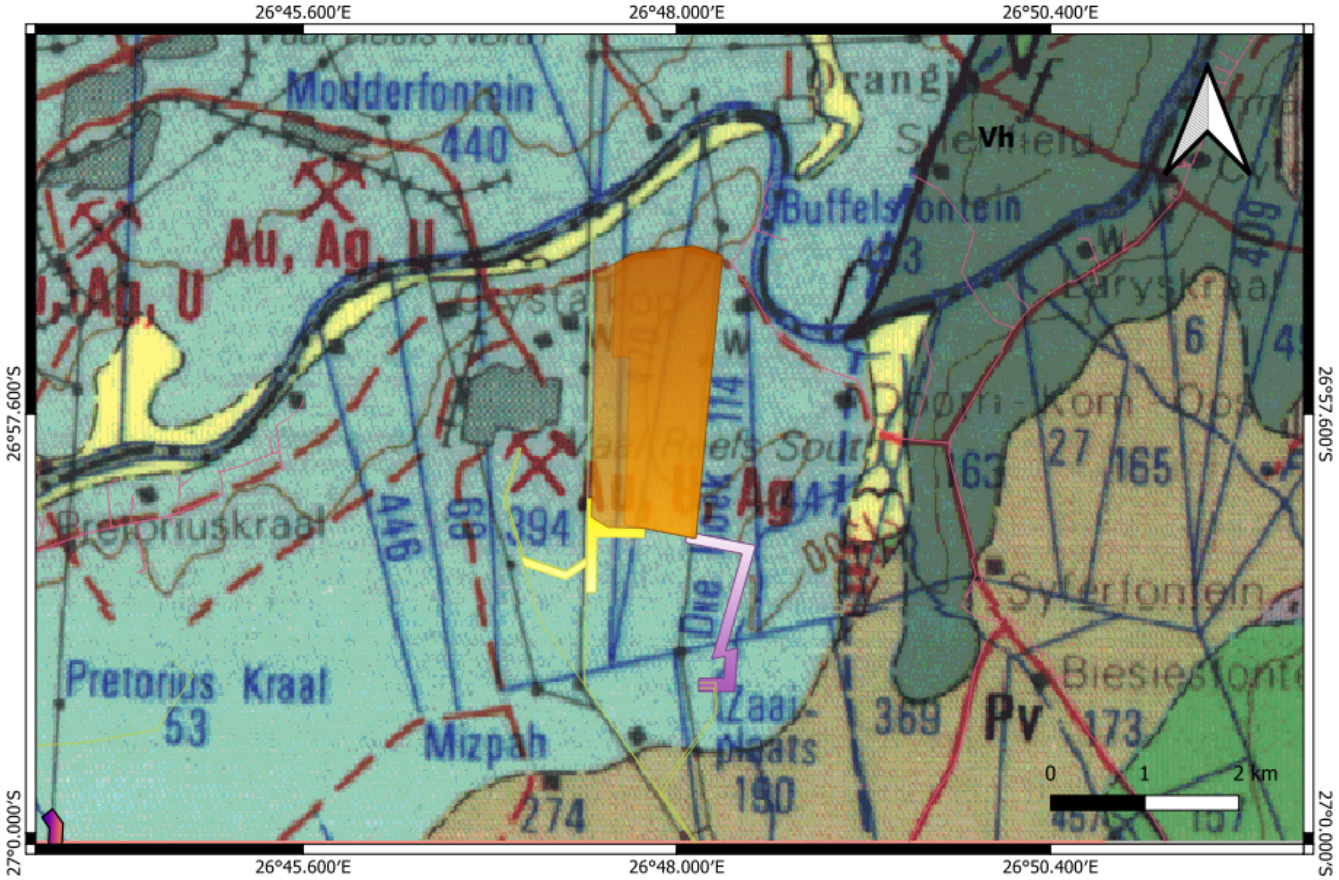
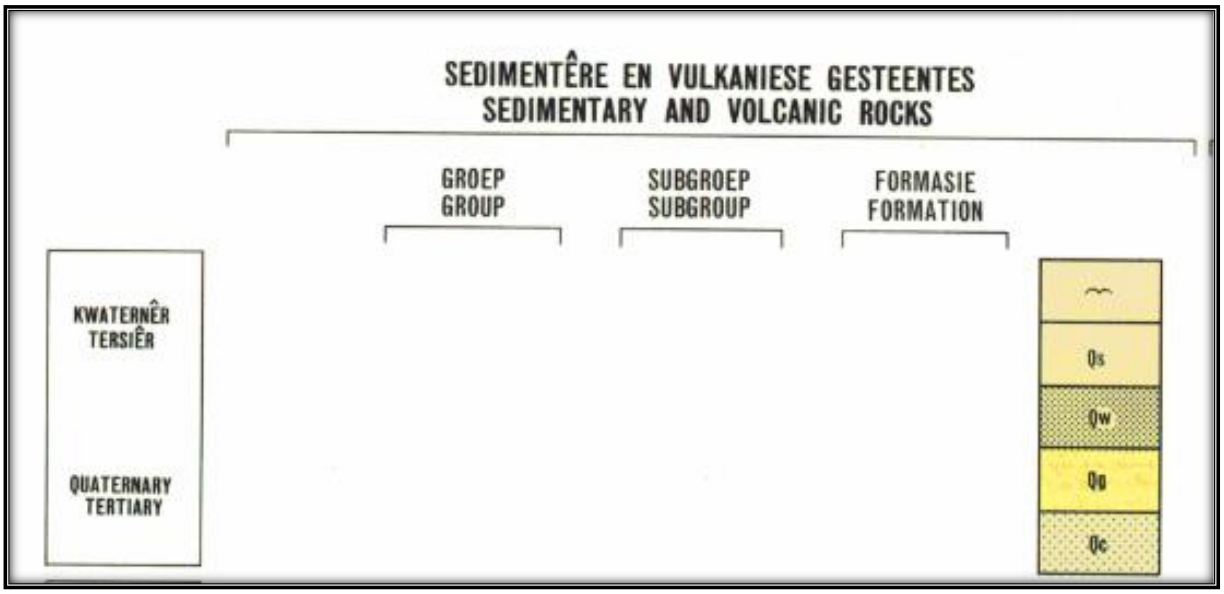


Figure 3. Extract of the 1:250 000 2626 Wes-Rand (1986) Geological Map (Council for Geosciences, Pretoria) indicating the proposed Thakadu Solar Power Plant and power line in orange, yellow and purple The proposed development is underlain by Precambrian dolomites and associated marine sedimentary rocks allocated to the Malmani Subgroup (blue-green - Vmd) (Chuniespoort Group, Transvaal Supergroup.


SEDIMENTÊRE EN VULKANIESE GESTEENTES
SEDIMENTARY AND VOLCANIC ROCKS
GROEP
GROUP
SUBGROEP
SUBGROUP
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FORMATION
KWATERNÊR
TERSIÊR
QUATERNARY
TERTIARY
Qs
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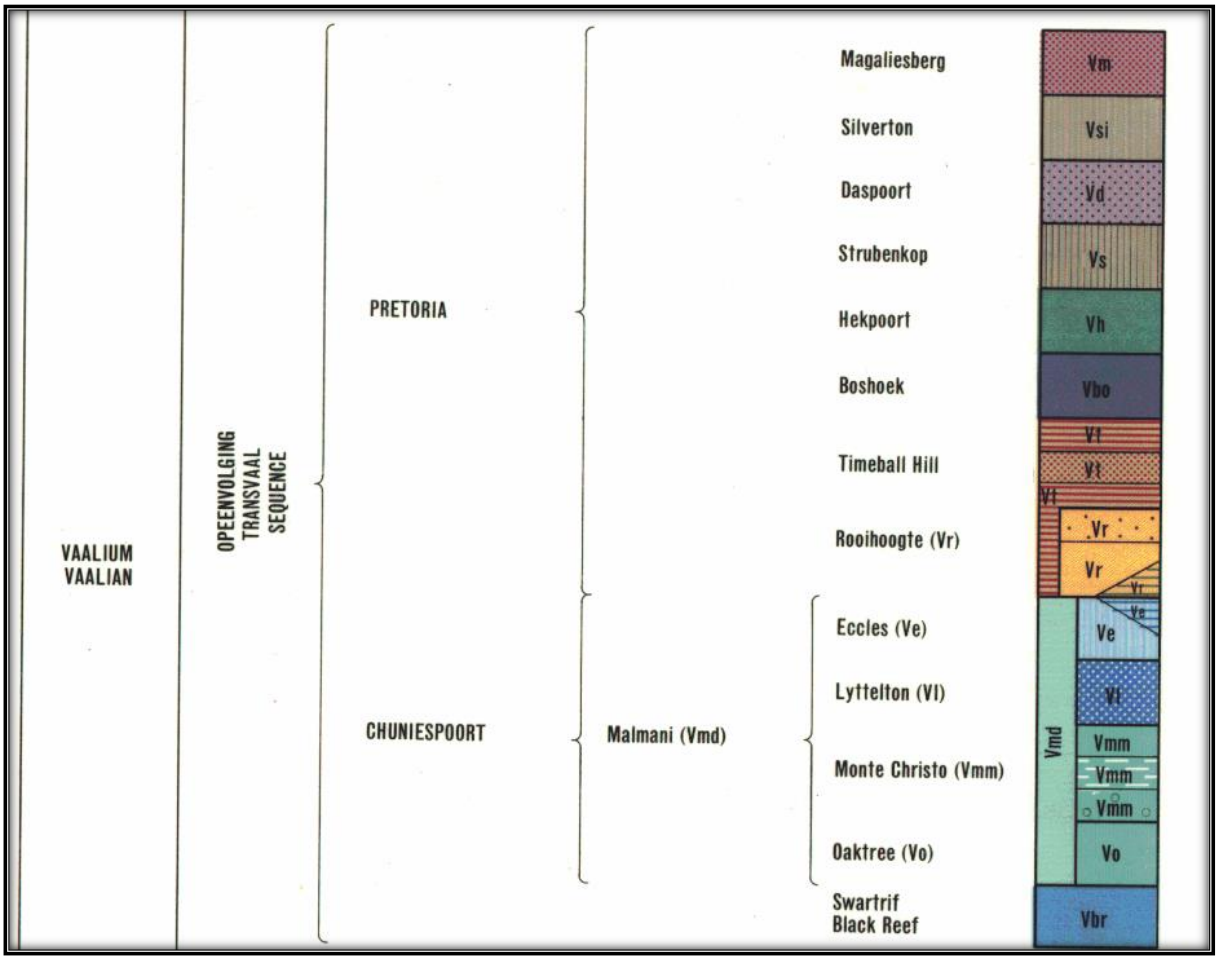
VAALIUM
VAALIAN
OPEENVOLGING
TRANSVAAL
SEQUENCE
PRETORIA
CHUNIESPOORT
Malmani (Vmd)
Magaliesberg
Silverton
Daspoort
Strubenkop
Hekpoort
Boshoek
Timeball Hill
Rooihoogte (Vr)
Eccles (Ve)
Lyttelton (Vl)
Monte Christo (Vmm)
Oaktree (Vo)
Swartrif
Black Reef
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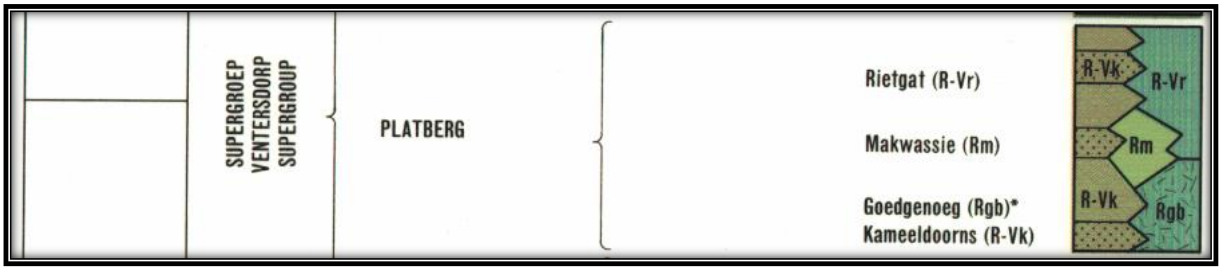

LEGEND TO THE 2626 WES-RAND GEOLOGICAL MAP (1986) (COUNCIL OF GEOSCIENCE).

Sediments in the proposed development is indicated in bold

Synbol	Group/Formation	Lithology
Q		Alluvium surface deposits
Pv	Vryheid Formation, Ecca Group, Karoo Supergroup	Sandstone, Shale, coal
Vh	Hekpoort Formation, Pretoria Group, Transvaal Supergroup	Andesite, agglomerate, tuff
Vmd	**Chuniespoort Group, Malmani Subgroup**	**Dolomite, chert**
R-Vr	Rietgat Formation, Platberg Group, Ventersdorp Supergroup	Amagdaloidal lava, agglomerate, tuff

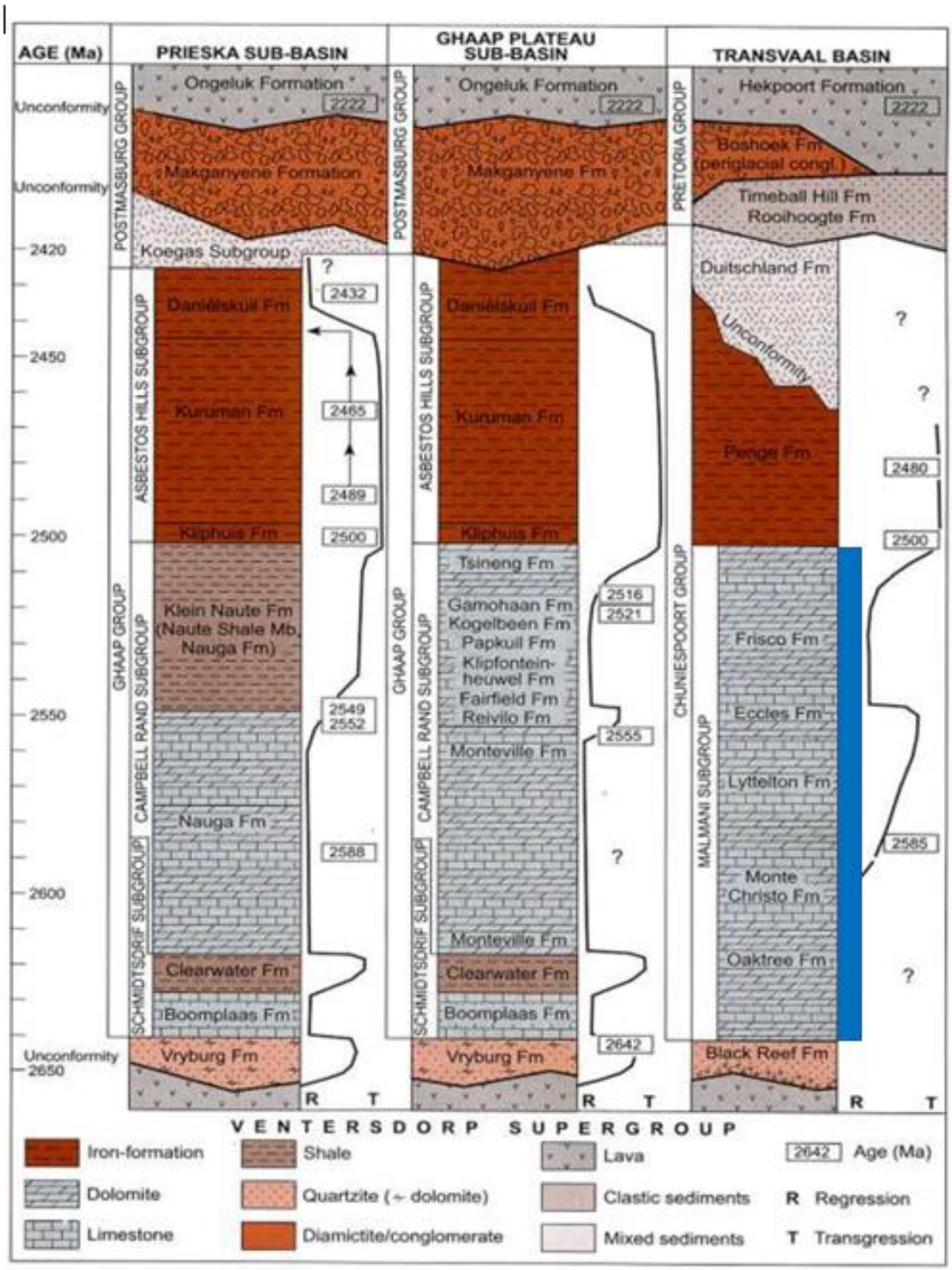

Figure 4: Stratigraphy of the Transvaal Supergroup of the Transvaal Basin. The proposed development is indicated in blue (Eriksson, et al. *2006).*

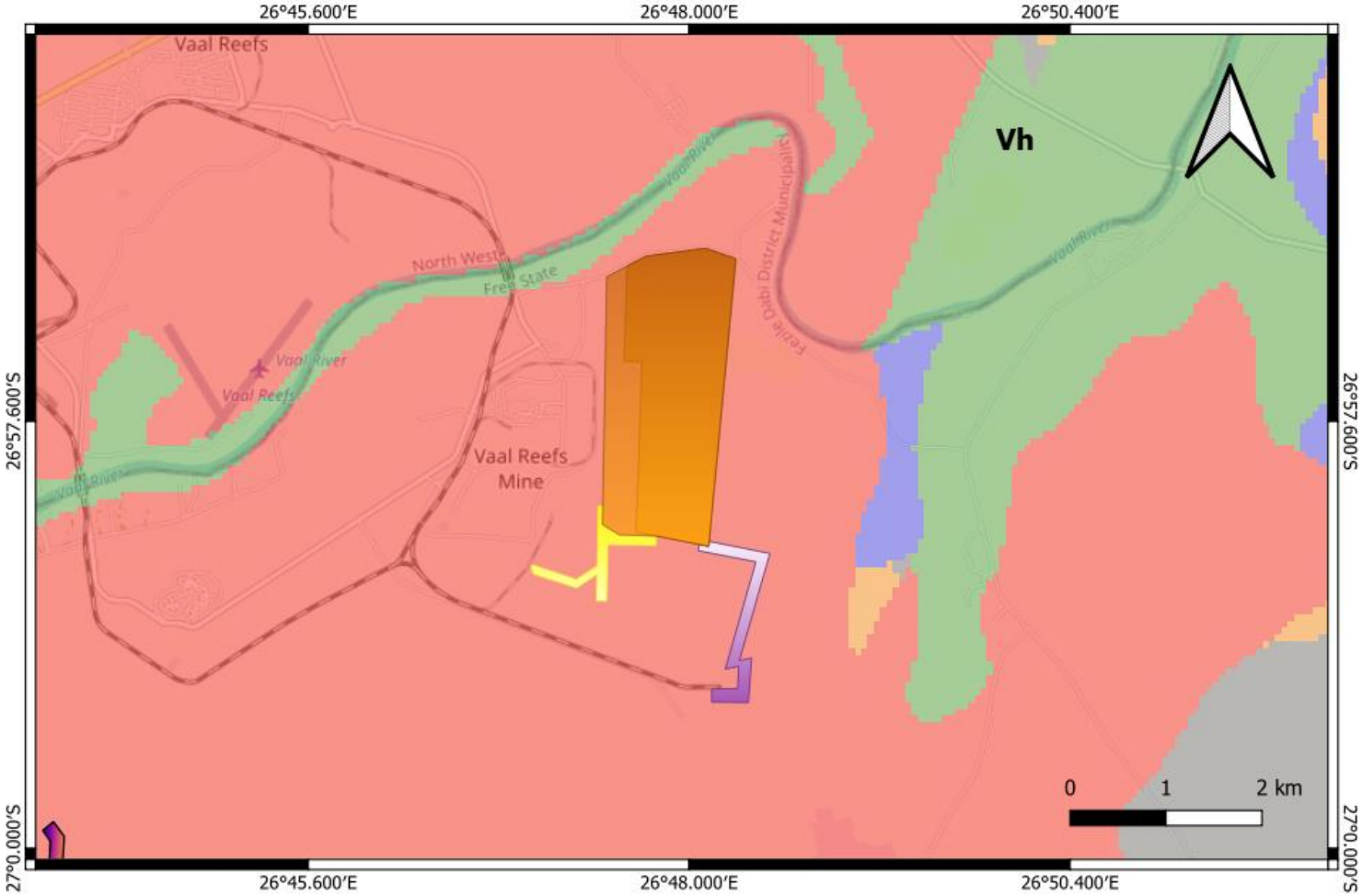

Figure 5: Extract of the 1 in 250 000 SAHRIS PalaeoMap map (Council of Geosciences) indicating the proposed PV and grid development.

Table 4:Palaeontological Sensitivitie according tho 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.

The proposed Thakadu Solar Power Plant is indicated in orange, yellow and purple. According to the SAHRIS Palaeosensitivity map (**Figure 5**) the proposed development is underlain by sediments with a Very High (red) Palaeontological Significance.

The colors on the PalaeoMap indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

6 GEOGRAPHICAL LOCATION OF THE SITE

The Thakadu Solar Power Plant is located on Groot Vaders Bosch No 592, while power line option 1 is located on the Farm Anglo No 593 and Portion 2 of the farm Zuiping No 394 and the Remaining Extent of the farm Zuiping No 394. Power line Option 2 is located on Farm Anglo No 593 and the Remaing Extension of Portion 1 of the Farm Die Hoek No 114 and Farm Hoekplaas No 598 in the Fezile Dabi District Municipality, Moqhaka Local Municipality **(Figure 1-2**).

7 METHODS

The aim of a desktop study is to evaluate the possible risk to palaeontological heritage in the proposed development. This include 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 accuratetely 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 will thus 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 Environmaics.
- 1:250 000 2626 Wes-Rand (1986) Geological Map (Council for Geosciences, Pretoria)

9 SITE VISIT

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 6-7 November 2021. Outcrops of weathered to well-preserved stromatolites were discovered on the whole development. Examples. Stromatolite abundancy in the development footprint is indicated in **Figure 10**. A small portion of a stromatolite is usually exposed at the surface while the largest part of the specimen is below surface.

Figure 6: Well preserved oolite
GPS coordinates 26.946944S; 26.803889E

Figure 7:Stromatolite outcrop

GPS coordinates 26.933611S 26.753889E

Figure 8:Stromatolites outcrops on the surface of the proposed development.

GPS coordinates -26.951389S 26.794444E

Figure 9:Southern portion of the proposed devevelopment with no stromatolites visible on the surface

GPS coordinates -26.970556S 26.788611E

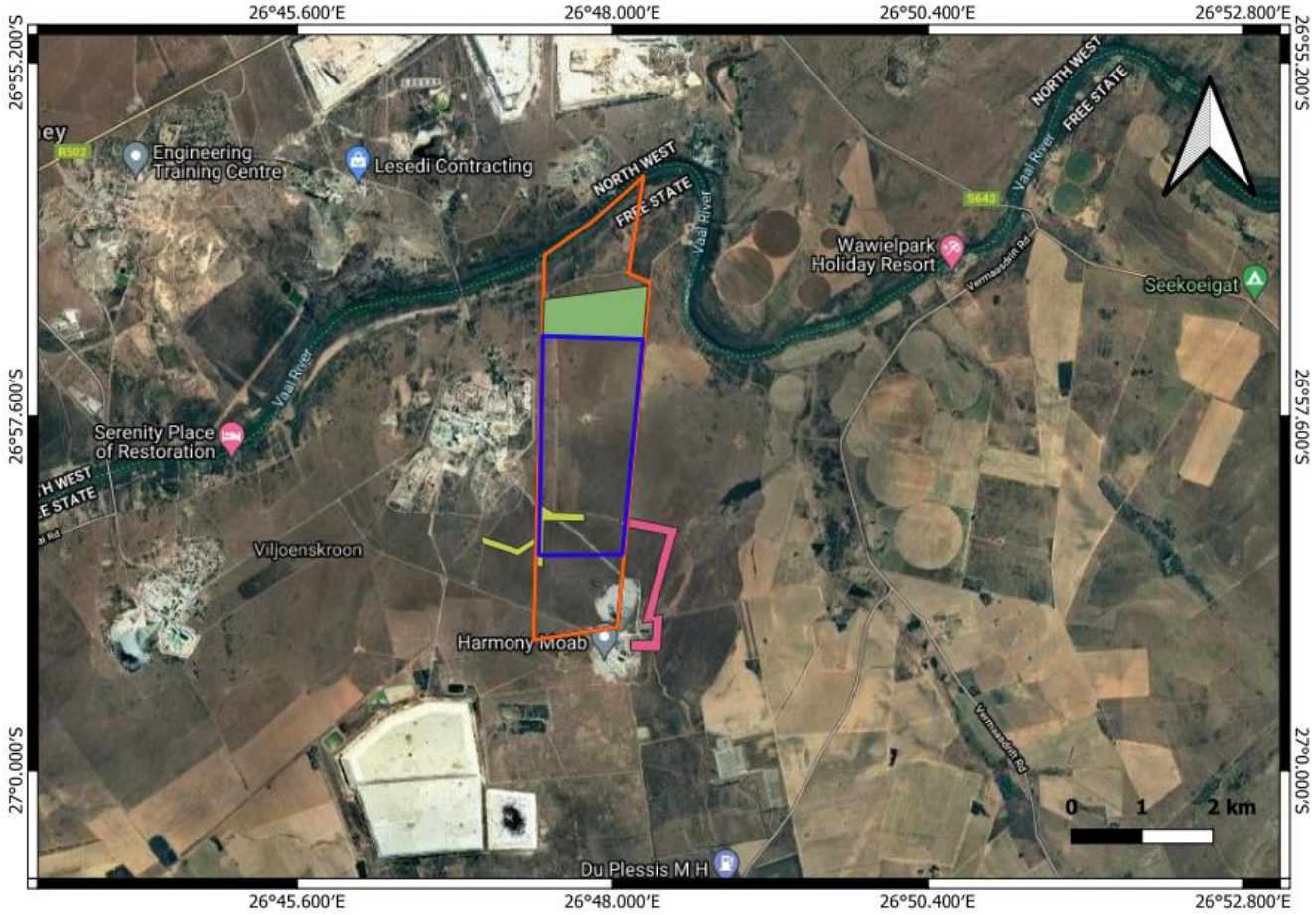

Figure 10:Exceptional well preserved oolites and stromatolites are preserved in the green area while stromatolites are found throughout the footprint but is more prominent from the blue and green areas.

10 IMPACT ASSESSMENT METHODOLOGY

The environmental assessment aims to identify the various possible environmental impacts that could results from the proposed activity. Different impacts need to be evaluated in terms of its significance and in doing so highlight the most critical issues to be addressed.

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e., site, local, national or global whereas intensity is defined by the severity of the impact e.g., the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 4.1.

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 total number of points scored for each impact indicates the level of significance of the impact.

10.1 Impact Rating System

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 project phases:

- planning
- construction
- operation
- 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

NATURE		
Loss of fossil heritage.		
GEOGRAPHICAL EXTENT		
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.
PROBABILITY		
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).
DURATION		
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.
INTENSITY/ MAGNITUDE		
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.
REVERSIBILITY		
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.
IRREPLACEABLE LOSS OF RESOURCES		
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.
CUMULATIVE EFFECT		
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: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity. 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 effects.

Table 6:Summary of Impacts (Pre-mitigation)

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity

Extent	Duration	Mafnitude	Reversibility	Irriplacable loss	Cumulative effect	Impact
Site	Permanent	Very High	Irreversible	Complete	Medium	Negative Medium
1	4	2	4	4	2	30

Table 7:Summary of Impacts (Post-mitigation)

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensit

Extent	Duration	Mafnitude	Reversibility	Irriplacable loss	Cumulative effect	Impact
Site	Permanent	Very High	Irreversible	Complete	Medium	Negative High
1	4	3	4	4	3	64

11 FINDINGS AND RECOMMENDATIONS

The proposed development is underlain by Precambrian dolomites and associated marine sedimentary rocks that are allocated to the Malmani (Chuniespoort Group, Transvaal Supergroup). Two power line options is proposed for the Thakadu Solar Power Plant but as they have the same geology there is no preference between the options from a Palaeontological point of view. According to the PalaeoMap of SAHRIS the Palaeontological Sensitivity of the Malmani Subgroup is Very High (Almond *et al*, 2013; SAHRIS website).

A site-specific field survey of the development footprint was conducted on foot and by motor vehicle on 6-7 November 2021. Outcrops of weathered to well-preserved stromatolites were discovered on the whole development. Examples of exceptionally well preserved oolites were recovered from the northern portion of the development footprint. Mitigation of a sample of well-preserved stromatolites is thus recommended. By implementing mitigation measures the significance of the impact will be reduced to low. Mitigation should take place after initial vegetation is cleared away but *before* the ground is levelled for construction. These recommendations should be included in the Environmental Management Plan of the ThakaduSolar Plant.

Recommendations:

- The ECO must be made aware that fossils (stromatolites) of the Malmani (Chuniespoort Group, Transvaal Supergroup) has a Very High Palaeontological Significance.
- When the Thakadu Power Plant layout has been established a walkdown of the area must be completed by a qualified Palaeontologist to catalogue and photograph well-preserved stromatolites. This action should take place after initial vegetation clearance but *before* the ground is levelled for construction.
- If a well preserved stromatolite outcrop falls in the development footprint the stromatolites ought to be cordoned off and a buffer of 30m should be placed around the outcrop.
- An representative example of well-preserved stromatolites should be removed and placed near the offices of the PV as a informative example of fossils in the area.

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CURRICULUM VITAE

ELIZE BUTLER

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 28 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	National Museum, Bloemfontein
and Collection Manager	1998–currently

TECHNICAL REPORTS

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 Noupoort, Northern Cape Province. 2014. Bloemfontein.

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Butler, E. 2016. Proposed 132kV overhead power line and switchyard station for the authorised Solis Power 1 CSP project near Upington, Northern Cape. Bloemfontein.

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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.

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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.

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Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvior aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape. Bloemfontein.

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Butler, E. 2017. Palaeontological Impact Assessment of the proposed consolidation of the proposed Ilima Colliery in the Albert Luthuli local municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.

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Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the Sandriver Canal and Klippan Pump station in Welkom, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the 132kv and 11kv power line into a dual circuit above ground power line feeding into the Urania substation in Welkom, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed diamonds alluvial & diamonds general prospecting right application near Christiana on the remaining extent of portion 1 of the farm Kaffraria 314, registration division HO, North West Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Hartebeesfontein, near Panbult, Mpumalanga. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Rustplaas near Piet Retief, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment for the Proposed Landfill Site in Luckhoff, Letsemeng Local Municipality, Xhariep District, Free State. Bloemfontein.

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Butler, E. 2018. Palaeontological Impact Assessment of the authorisation and amendment processes for Manangu mine near Delmas, Victor Khanye local municipality, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Mashishing township establishment in Mashishing (Lydenburg), Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the Proposed Mlonzi Estate Development near Lusikisiki, Ngquza Hill Local Municipality, Eastern Cape. Bloemfontein.

Butler, E. 2018. Palaeontological Phase 1 Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed electricity expansion project and Sekgame Switching Station at the Sishen Mine, Northern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological field assessment of the proposed construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Field Assessment for the proposed re-alignment and de-commissioning of the Firham-Platrand 88kv Powerline, near Standerton, Lekwa Local Municipality, Mpumalanga province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London. Bloemfontein.

Butler, E. 2018. Palaeontological field Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed Mookodi – Mahikeng 400kV line, North West Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Thornhill Housing Project, Ndlambe Municipality, Port Alfred, Eastern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed housing development on portion 237 of farm Hartebeestpoort 328. Bloemfontein.

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Butler, E. 2018. Palaeontological field assessment of the proposed development of the Wildealskloof mixed use development near Bloemfontein, Free State Province. Bloemfontein.

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Butler, E. 2018. Palaeontological Impact Assessment of the proposed construction of a new 11kV (1.3km) Power Line to supply electricity to a cell tower on farm 215 near Delportshoop in the Northern Cape. Bloemfontein.

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Butler, E. 2018. Palaeontological Exemption Letter for the proposed reclamation and reprocessing of the City Deep Dumps in Johannesburg, Gauteng Province. Bloemfontein.

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Butler, E. 2018. Proposed Kalabasfontein Mine Extension project, near Bethal, Govan Mbeki District Municipality, Mpumalanga. Bloemfontein.

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